WORLD METEOROLOGICAL ORGANIZATION

MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM

VOLUME I

(Annex IV to the WMO Technical Regulations)

GLOBAL ASPECTS

1992 edition

WMO – No. 485

Secretariat of the World Meteorological Organization – Geneva – Switzerland
1992

ISBN 92-63-12485-X

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

TABLE FOR NOTING SUPPLEMENTS RECEIVED

Supplement No.	*Dated*	*Inserted in the publication*	
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NOTE ON UNITS FOR ATMOSPHERIC PRESSURE

In order to bring Volume I of the *Manual on the Global Data-processing System* into line with the decision of EC-XXXII to begin the dual use of both the terms *millibar* and *hectopascal* in WMO technical publications as of 1 January 1982, and to allow a gradual transition in the use of these terms for atmospheric pressure, *hectopascal* is used as the unit for atmospheric pressure instead of *millibar.*

The pressure unit *hectopascal* (hPa) is equivalent to the pressure unit *millibar* (mb). Therefore, 1 hPa = 1 mb; 700 hPa = 700 mb; 1021.3 hPa = 1021.3 mb.

EDITORIAL NOTE

The typographical practice indicated below has been followed in the text.
Standard meteorological practices and procedures have been printed in semi-bold.
Recommended meteorological practices and procedures have been printed in roman.
Notes have been printed in smaller type, roman, preceded by the indication: NOTE.

CONTENTS

INTRODUCTION

PURPOSE

1. The *Manual on the Global Data-processing System** is issued in accordance with a decision of Seventh Congress.

2. This *Manual* is designed:

   (*a*) To facilitate cooperation in data-processing between Members;

   (*b*) To specify obligations of Members in the implementation of the World Weather Watch (WWW) Global Data-processing System (GDPS);

   (*c*) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (*a*) and (*b*) above.

3. The *Manual* consists of Volumes I and II, which deal with global and regional aspects, respectively. Volume I of the *Manual* consists of Part I (Organization and functions of the GDPS), Part II (Data-processing aspects) and Part III (Data management aspects), which contain regulatory material for the global aspects of the WWW Global Data-processing System. The regulatory material stems from recommendations of the Commission for Basic Systems (CBS) as well as from decisions taken by Congress and the Executive Council.

4. Volume I of the *Manual* – Global aspects – forms part of the *Technical Regulations* and is referred to as Annex IV to the *Technical Regulations*.

TYPES OF REGULATIONS

5. Volume I of the *Manual* contains both *standard* practices and procedures and *recommended* practices and procedures. The definitions of these two types in the *Manual* are as follows:

The *standard* practices and procedures:

   (*a*) Shall be the practices and procedures which it is necessary that Members follow or implement; and therefore

   (*b*) Shall have the status of requirements in a technical resolution in respect of which Article 9 (*b*) of the Convention is applicable; and

   (*c*) Shall invariably be distinguished by the use of the term "shall" in the English text, and by suitable equivalent terms in the French, Russian and Spanish texts.

The *recommended* practices and procedures:

   (*a*) Shall be the practices and procedures which it is desirable that Members follow or implement; and therefore

   (*b*) Shall have the status of recommendations to Members to which Article 9 (*b*) of the Convention shall not be applied; and

   (*c*) Shall be distinguished by the use of the term "should" in the English text (except where specifically otherwise provided by decision of Congress) and by suitable equivalent terms in the French, Russian and Spanish texts.

6. In accordance with the above definitions, Members shall do their utmost to implement the standard practices and procedures. In accordance with Article 9 (*b*) of the Convention and in conformity with the provisions of Regulation 127 of the General Regulations, Members shall formally notify the Secretary-General, in writing, of their intention to apply the standard practices and procedures of the *Manual,* except those for which they have lodged a specific deviation. Members shall also inform the Secretary-General, at least three months in advance, of any change in the degree of their implementation of a standard practice or procedure as previously notified and of the effective date of the change.

7. With regard to the recommended practices and procedures, Members are urged to comply with these, but it is not necessary to notify the Secretary-General of non-observance.

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* Following the recommendation of CBS-Ext.(02) and the decision of Fourteenth Congress, the Global Data-processing System (GDPS) is renamed Global Data-processing and Forecasting System (GDPFS).

8. In order to clarify the status of the various regulatory material, the standard practices and procedures are distinguished from the recommended practices and procedures by a difference in typographical practice as indicated in the editorial note.

NOTES AND ATTACHMENTS

9. Certain notes are included in the *Manual* for explanatory purposes. They do not have the status of the annexes to the *Technical Regulations*.

10. A number of detailed guidelines, specifications and formats of data-processing practices and procedures are included in the *Manual*. Taking into account the rapid development of data-processing techniques and the increasing requirements of WWW and other WMO programmes, these guidelines etc. are given in "attachments" to the *Manual* and do not have the status of the annexes to the *Technical Regulations*. This will enable the Commission for Basic Systems to update them as necessary.

11. Volume II of the *Manual* – Regional aspects – does not form part of the *Technical Regulations*.

12. The words "shall" and "should" in the attachments and in Volume II have their dictionary meanings and do not have the regulatory character mentioned in paragraph 5 above.

13. In this *Manual,* the term "forecast" is used throughout to indicate a meteorological prediction in word or chart form. This is in accordance with the wording used in the amendments to the *Technical Regulations* adopted by the extraordinary session (1976) of CBS and approved by the Executive Committee* (paragraph 3.1.1.6 of the Abridged Final Report, EC-XXIX). However, it is recognized that the term "prognosis" is used interchangeably with "forecast" in some parts of the *Technical Regulations*.

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* By its Resolution 42 (Cg-IX), Ninth Congress (1983) changed the name of the Executive Committee to Executive Council.

PART I

ORGANIZATION AND FUNCTIONS OF THE GLOBAL DATA-PROCESSING SYSTEM*

1. PURPOSE OF THE GDPS

The main purpose of the GDPS shall be to prepare and make available to Members in the most cost-effective way meteorological analyses and forecast products. The design, functions, organizational structure and operations of the GDPS shall be in accordance with Members' needs and their ability to contribute to, and benefit from, the system.

2. FUNCTIONS OF THE GDPS

2.1 The real-time functions of the GDPS shall include:

(*a*) Pre-processing of data, e.g. retrieval, quality control, decoding, sorting of data stored in a database for use in preparing output products;

(*b*) Preparation of analyses of the three-dimensional structure of the atmosphere with up-to-global coverage;

(*c*) Preparation of forecast products (fields of basic and derived atmospheric parameters) with up-to-global coverage;

(*d*) Preparation of ensemble prediction products;

(*e*) Preparation of specialized products such as limited area very-fine mesh short-, medium-, extended- and long-range forecasts, tailored products for marine, aviation, environmental quality monitoring and other purposes;

(*f*) Monitoring of observational data quality;

(*g*) Post-processing of NWP data using workstation and PC-based systems with a view to producing tailored value-added products and generation of weather and climate forecasts directly from model output.

2.2 The non-real-time functions of the GDPS shall include:

(*a*) Preparation of special products for climate-related diagnosis (i.e. 10-day or 30-day means, summaries, frequencies and anomalies) on a global or regional scale;

(*b*) Intercomparison of analysis and forecast products, monitoring of observational data quality, verification of the accuracy of prepared forecast fields, diagnostic studies and NWP model development;

(*c*) Long-term storage of GOS data and GDPS products, as well as verification results for operational and research use;

(*d*) Maintenance of a continuously-updated catalogue of data and products stored in the system;

(*e*) Exchange between GDPS centres of *ad hoc* information via distributed databases;

(*f*) Conduct of workshops and seminars on the preparation and use of GDPS output products.

3. ORGANIZATION OF THE GDPS

The GDPS shall be organized as a three-level system of World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NMCs), which carry out GDPS functions at the global, regional and national levels, respectively. The GDPS shall also support other WMO Programmes and relevant programmes of other international organizations in accordance with policy decisions of the Organization.

4. FUNCTIONS OF GDPS CENTRES

4.1 The general functions of GDPS centres shall be as follows:

4.1.1 *World Meteorological Centres (WMCs)*

These shall consist of centres applying sophisticated high-resolution global NWP models (including ensemble prediction system) and preparing for distribution to Members and other GDPS centres the following products:

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* Following the recommendation of CBS-Ext.(02) and the decision of Fourteenth Congress, the Global Data-processing System (GDPS) is renamed Global Data-processing and Forecasting System (GDPFS).

(*a*) Global (hemispheric) analysis products;

(*b*) Short-, medium-, extended- and long-range forecasts and products with a global coverage, but presented separately, if required, for:

(i) The tropical belt;

(ii) The middle and high latitudes or any other geographical area according to Members' requirements;

(*c*) Climate-related diagnostic products, particularly for tropical regions.

WMCs shall also carry out verification and intercomparison of products, support the inclusion of research results into operational models and their supporting systems, and provide training courses on the use of WMC products.

4.1.2 ***Regional Specialized Meteorological Centres (RSMCs)***

4.1.2.1 *Centres with geographical specialization*

These shall be either existing national or regional centres which have accepted responsibilities by multilateral or regional agreement, or centres implemented by a joint cooperative effort by several countries in a Region. The functions of RSMCs with geographical specialization shall include:

(*a*) Providing the interface between WMCs and NMCs by formatting and distributing global products to meet the needs in a particular Region;

(*b*) Providing regional analysis and forecast products for 12–48 hours, for designated areas;

(*c*) Providing meteorological assistance to United Nations humanitarian missions, in the event the relevant associated NMC is facing an emergency or is in catastrophic distress and out of service, as specified in Appendix I-5;

(*d*) Coordinating with other RSMCs as appropriate.

4.1.2.2 *Centres with activity specialization*

The functions of RSMCs with activity specialization shall include, *inter alia*:

(*a*) Providing long-, extended- and/or medium-range forecasting products;

(*b*) Providing advisories for tropical cyclones, severe storms and other dangerous weather phenomena;

(*c*) Providing tailored specialized products to service users in a particular area;

(*d*) Providing trajectories or dispersion of pollutants in case of environmental emergencies;

(*e*) Providing information on prolonged adverse weather conditions, including drought monitoring;

(*f*) Undertaking activities related to the WCP and other WMO international programmes. This includes providing climate diagnostic, climate analysis and prediction products to assist in climate monitoring.

4.1.2.3 **RSMCs shall also carry out verification and intercomparison of products and arrange regional workshops and seminars on centres' products and their use in national weather forecasting. RSMCs with geographical and activity specialization shall be co-located where possible.**

4.1.2.4 **RSMCs designated by WMO for the provision of atmospheric transport model products for environmental emergency response shall implement the regional and global arrangements and related procedures in Appendix I-3.**

4.1.2.5 The designated WMCs and RSMCs are given in Appendix I-1 and the procedures for broadening the functions of existing RSMCs and for designating new RSMCs are given in Appendix I-2. Regional and global arrangements for the provision of transport model products for environmental emergency response are given in Appendix I-3.

NOTE: Guidelines to review the status of RSMCs with geographical specialization are given in Attachment I.1.

4.1.3 ***National Meteorological Centres (NMCs)***

The NMCs carry out functions to meet their national and international requirements. Typically, the functions of NMCs include the preparation of:

(*a*) Nowcasts and very short-range forecasts;

(*b*) Short-, medium-, extended- and long-range forecasts by applying objective or subjective interpretation methods to products received from World and Regional Specialized Meteorological Centres or by integrating regional models using boundary conditions based on these products;

(*c*) Special application-user products, including warnings of severe weather, climate and environmental quality monitoring and prediction products;

(*d*) Specific products and their delivery in support of United Nations humanitarian missions as specified in Appendix I-5;

(*e*) Non-real-time climate-related analyses and diagnosis.

NMCs should be linked via suitable terminals to computer systems at other GDPS centres in order to carry out inter-processing activities between centres, according to bilateral or multilateral agreements among Members. The definition of forecast ranges is given in Appendix I-4.

4.1.3.1 The basic organization of the GDPS is also given in Chapter A.2.1 of the *Technical Regulations*.

NOTES:

(1) The national data-processing activities may also be concerned with large-scale analyses and forecasts.

(2) Detailed specifications of the real-time and non-real-time functions of WWW centres are given in Parts II and III, respectively.

(3) Procedures for the elaboration of observational data requirements are given in Attachment I.2.

(4) In some instances, WMCs, RSMCs and NMCs are co-located and the functions of one centre are included in those of the other.

4.2 **The above functions of the various centres shall not affect the status of any international commitments of Members for support to shipping and aviation, nor determine the manner in which Members execute these responsibilities.**

APPENDIX I-1

LOCATION OF WMCs AND RSMCs WITH GEOGRAPHICAL SPECIALIZATION AND RSMCs WITH ACTIVITY SPECIALIZATION

1. The WMCs are located at:

   Melbourne (southern hemisphere only)
   Moscow
   Washington

2. The RSMCs with geographical specialization are located at:

Algiers	Jeddah	Novosibirsk
Beijing	Khabarovsk	Offenbach
Bracknell	Melbourne	Pretoria
Brasilia	Miami	Rome
Buenos Aires	Montreal	Tashkent
Cairo	Moscow	Tokyo
Dakar	Nairobi	Tunis/Casablanca
Darwin	New Delhi	Washington
		Wellington

   Broadened RSMC functions:

   Offenbach — Provision of ultraviolet-index forecasts for Region VI (Europe)

3. The RSMCs with activity specialization are the following:

RSMC Nadi – Tropical Cyclone Centre	Tropical cyclone forecasting
RSMC New Delhi – Tropical Cyclone Centre	
RSMC Miami – Hurricane Centre	
RSMC Tokyo – Typhoon Centre	
RSMC La Réunion – Tropical Cyclone Centre	
RSMC Honolulu – Hurricane Centre	
RSMC European Centre for Medium Range Weather Forecasts (RSMC ECMWF)	Global medium-range weather forecasting
RSMC Beijing	Provision of transport model products for environmental emergency response
RSMC Bracknell	
RSMC Melbourne	
RSMC Montreal	
RSMC Obninsk	
RSMC Tokyo	
RSMC Toulouse	
RSMC Washington	

APPENDIX I-2

PROCEDURES FOR BROADENING THE FUNCTIONS OF EXISTING RSMCs AND FOR DESIGNATION OF NEW RSMCs

The procedures are as follows:

1. Establishment of a statement of requirements for WWW products and services initiated and endorsed by the WMO constituent body or bodies concerned.
2. Identification of capabilities of relevant existing RSMCs and/or candidate RSMCs, to meet the requirements.
3. Determination in principle whether there is a requirement to:
   (*a*) Broaden the functions of an existing RSMC; and/or
   (*b*) Establish a new RSMC.
4. Formal commitment by a Member or a group of cooperating Members to fulfil the required function(s) of a centre;
   - The prospective RSMC should:
     (*a*) Establish a closely defined relationship between the RSMC and the WWW Meteorological Centres as users of RSMC products;
     (*b*) Commit itself to make available a set of products and services designed to meet the given requirements, where appropriate, in terms of specific forecast parameters and formats, the frequency of their issue and targets for timeliness, overall reliability and quality;
     (*c*) Propose method(s) and procedures by which such products and services will be delivered;
     (*d*) Propose method(s) and procedures by which ongoing performance will be assessed (e.g. by verification);
     (*e*) Propose method(s) by which particular WWW Meteorological Centres' changing requirements could be made known and improvements in operational performance introduced by the RSMC;
     (*f*) Address the question of contingency and back-up arrangements to cover situations where the RSMC may not be able to provide the required services.
5. Demonstration of the capabilities to CBS and the constituent body or bodies referred to under (1);
   - The prospective RSMC should expect to demonstrate its general capabilities of relevance to the service to be offered (such as access to relevant data and processing capability), its ability to meet the above commitment and the suitability of its other proposals.
6. Recommendation by CBS to include in the *Manual on the GDPS*:
   (*a*) The new function(s) of the existing centre; or
   (*b*) The identification and function(s) of the new centre.
7. Acceptance of the CBS recommendation by Congress or the Executive Council.

APPENDIX I-3

REGIONAL AND GLOBAL ARRANGEMENTS FOR THE PROVISION OF TRANSPORT MODEL PRODUCTS FOR ENVIRONMENTAL EMERGENCY RESPONSE

SUPPORT FOR NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

IAEA NOTIFICATION OF WMO

In the framework of the Convention on Early Notification of Nuclear Accidents, the IAEA informs the WMO Secretariat and the RTH Offenbach (Germany) of the status of the emergency. If needed, the IAEA will request support from the WMO RSMCs. Beginning with a site area emergency, RTH Offenbach will disseminate the EMERCON messages on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs (see also WMO *Manual on the Global Telecommunication System*, WMO-No. 386).

When the IAEA no longer requires WMO RSMC support, the IAEA will send an EMERCON termination message to the RSMCs, WMO Secretariat and RTH Offenbach. RTH Offenbach will disseminate the EMERCON termination message on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs.

REGIONAL ARRANGEMENTS

The RSMCs designated by WMO for the provision of atmospheric transport model products for nuclear environmental emergency response shall:

1. **Provide products only when either the delegated authority[1] of any country in the RSMC region of responsibility or the International Atomic Energy Agency (IAEA) requests RSMC support. Upon receipt of a request from the delegated authority[2] or from the IAEA, the RSMC shall provide basic information to the National Meteorological Service of that country or to the IAEA, respectively. If multiple requests are received, highest priority will be given to IAEA requests.**
2. **Upon receipt of a first request for products related to a nuclear incident and in the absence of a prior notification by the IAEA, inform the WMO Secretariat, all designated RSMCs and IAEA of the request.**
3. **For an IAEA request sent to the RSMCs to produce and distribute products, the requested RSMCs will distribute the basic products to the IAEA, and all RSMCs will distribute to National Meteorological Services in the region[3] and WMO. For a request for support from a Delegated Authority and without notification by IAEA, basic information provided to the National Meteorological Service of the requesting country will not be disclosed to the public in that country nor distributed by RSMCs to other National Meteorological Services.**
4. **Provide, on request, support and advice to the IAEA and WMO Secretariats in the preparation of public and media statements.**
5. **Determine the standard set of basic products and the method of delivery in consultation with users and the IAEA.**
6. **Provide product interpretation guidelines to users.**
7. **Provide support and technology transfer to national and regional meteorological centres that want to become designated RSMCs.**
8. **Make arrangements to provide backup services. These would normally be between the two designated centres in a region. Interim arrangements should be made by centres in regions with a single designated RSMC.**

GLOBAL ARRANGEMENTS

Until such time as new RSMCs have been designated, it is proposed that Regional Association VI-designated RSMCs be responsible to provide services for radiological emergencies to Regional Association I; Regional Association IV-designated RSMCs be responsible to provide services to Regional Association III; while the Regional Association V-designated RSMC, in collaboration with Regional Association IV-designated RSMCs, will be responsible to provide services to Regional Association V.

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1 **The person authorized by the Permanent Representative of the country to request RSMC support.**

2 **The RSMC products will be provided to the NMS Operational Contact Point designated by the Permanent Representative.**

3 **The basic information will normally be provided by the NMS to the IAEA national contact point.**

In cases of radiological emergencies where coordination is required between RSMCs of different regions, the RSMCs of the region where the emergency has occurred will provide this coordination.

SUPPORT FOR NON-NUCLER ENVIRONMENTAL EMERGENCY RESPONSE

If support is required for response to a non-nuclear environmental emergency, related to atmospheric transport of pollutants, the Permanent Representative with WMO of the affected country may direct its request for support to the operational contact point of the designated RSMC(s) for its Regional Association.

1. **Due to the potentially broad range of environmental emergencies, the RSMC shall consider each request with regard to its capabilities and the suitability of its products to address the emergency requirements and will then respond accordingly.**

2. **The RSMC shall inform all other designated RSMCs and the WMO Secretariat of the request and the agreed actions.**

APPENDIX I-4

DEFINITIONS OF METEOROLOGICAL FORECASTING RANGES

1.	Nowcasting	A description of current weather parameters and 0 to 2 hours' description of forecasted weather parameters
2.	Very short-range weather forecasting	Up to 12 hours' description of weather parameters
3.	Short-range weather forecasting	Beyond 12 hours' and up to 72 hours' description of weather parameters
4.	Medium-range weather forecasting	Beyond 72 hours' and up to 240 hours' description of weather parameters
5.	Extended-range weather forecasting	Beyond 10 days' and up to 30 days' description of weather parameters, usually averaged and expressed as a departure from climate values for that period
6.	Long-range forecasting	From 30 days up to two years
	6.1 Monthly outlook	Description of averaged weather parameters expressed as a departure (deviation, variation, anomaly) from climate values for that month (not necessarily the coming month)
	6.2 Three-month or 90-day outlook	Description of averaged weather parameters expressed as a departure from climate values for that 90-day period (not necessarily the coming 90-day period)
	6.3 Seasonal outlook	Description of averaged weather parameters expressed as a departure from climate values for that season

NOTES:

(1) In some countries, long-range forecasts are considered to be climate products.

(2) Season has been loosely defined as December/January/February = Winter; March/April/May = Spring; etc. ... in the northern hemisphere. In the tropical areas seasons may have different durations. Outlooks spanning several months such as multi-seasonal outlooks or tropical rainy season outlooks may be provided.

7.	Climate forecasting	Beyond two years
	7.1 Climate variability prediction	Description of the expected climate parameters associated with the variation of interannual, decadal and multi-decadal climate anomalies
	7.2 Climate prediction	Description of expected future climate including the effects of both natural and human influences

APPENDIX I-5

ARRANGEMENTS FOR THE PROVISION OF METEOROLOGICAL ASSISTANCE TO UNITED NATIONS HUMANITARIAN MISSIONS

The United Nations Office for the Coordination of Humanitarian Affairs (UN/OCHA)* shall normally request a service from a National Meteorological Centre (NMC) of the national Meteorological Service of the country concerned. If the NMC is not operational, this fact shall be confirmed to the associated RSMC with geographical specialization when requesting a service. UN/OCHA shall also specify details of the area or location for which the service is required. The NMCs or RSMCs usually provide the products to the UN/OCHA Headquarters operation centre. The RSMCs zones of responsibility are as specified in the annex to this appendix.

The NMC shall:

Upon receipt of a request from UN/OCHA, provide to it or its designated recipient location, basic meteorological and climate information and forecasts. The products to be provided will be negotiated with UN/OCHA, but could consist of 72-hour public weather forecasts, severe weather advisories and warnings, longer-range outlooks, and may include climate information for specified areas or locations in support of humanitarian missions.

The WMO Secretariat shall:

(*a*) **Upon request, from UN/OCHA, arrange guidance in the interpretation of specialized meteorological information and products made available by NMCs or RSMCs;**

(*b*) **Establish and maintain up-to-date NMCs operational contact points for assistance to United Nations humanitarian missions and make these available to UN/OCHA and RSMCs;**

(*c*) **Establish and maintain up-to-date RSMCs contact points and their back-ups.**

The RSMC with geographical specialization and its back-up for the relevant zone of responsibility shall:

(*a*) **Upon receipt of a request from UN/OCHA with confirmation that the relevant NMC of the national Meteorological Service of a Member facing an emergency or in catastrophic distress and out of service, provide to UN/OCHA, basic meteorological and climate information and forecasts. The products to be provided will be negotiated with UN/OCHA, but could consist of 72-hour public weather forecasts, severe weather advisories and warnings, and longer-range outlook and may include climate information for specified areas or locations in support of humanitarian missions;**

(*b*) **For ongoing requirement determine in consultation with UN/OCHA, the relevant set of climate information, basic forecasts, their format and methods of delivery, location of delivery, depending on the nature of the situation.**

Provision of forecasts from a remote RSMC is not an ideal arrangement and the quality of the forecasts can be expected to be reduced accordingly. The service provided should be accepted on the terms of a best effort basis and recognized as such by the UN/OCHA.

ANNEX

ZONES OF RESPONSIBILITY OF RSMCs FOR PROVIDING BACKUP SERVICES TO UNITED NATIONS HUMANITARIAN MISSIONS

RSMC	ZONE OF RESPONSIBILITY
REGION I	
Algiers	Algeria, Libyan Arab Jamahiriya, Tunisia
Cairo	Egypt, Sudan
Dakar	Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Morocco, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo, Ascension Islands, Spain (Canary Islands), St Helena, Portugal (Madeira), Western Sahara

* UN/OCHA is the former United Nations Department of Humanitarian Affairs (UN/DHA).

Nairobi	Burundi, Djibouti, Ethiopia, Kenya, Rwanda, Somalia, Uganda, United Republic of Tanzania
Pretoria	Angola, Comoros, Botswana, Kerguelen and New Amsterdam, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, France (Department of La Réunion), Seychelles, South Africa, Swaziland, Zimbabwe, Zambia

REGION II

Beijing	China, Democratic People's Republic of Korea, Hong Kong (China)*, Macao, Viet Nam
Jeddah	Bahrain, Kuwait, Oman, Qatar, Republic of Yemen, Saudi Arabia, United Arab Emirates
Khabarovsk	Russian Federation (in RA II)
New Delhi	Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Novosibirsk	Mongolia, Russian Federation
Tashkent	Afghanistan (Islamic State of), Iran (Islamic Republic of), Iraq, Kazakstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan
Tokyo	Cambodia, Japan, Lao People's Democratic Republic, Myanmar, Philippines, Thailand, Republic of Korea

REGION III

Brasilia	Brazil, Colombia, Ecuador, France (Department of French Guyana), Suriname, Venezuela
Buenos Aires	Argentina, Bolivia, Chile, Paraguay, Peru, Uruguay

REGION IV

Washington	Bahamas, Barbados, Belize, British Caribbean Territories, Canada, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, France (Martinique, Guadeloupe, Saint-Pierre-and-Miquelon), Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Saint Lucia, Trinidad and Tobago, United States, Venezuela
Miami	El Salvador

REGION V

Melbourne	Australia
Darwin	Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, Singapore, Solomon Islands
Wellington	Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, New Zealand, Niue, Pitcaim, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, Western Samoa

REGION VI

Bracknell	Gibraltar, Denmark (Greenland), Iceland, Ireland, Netherlands, United Kingdom
Moscow	Albania, Armenia, Azerbaijan, Belarus, Cyprus, Georgia, Jordan, Poland, Romania, Republic of Moldova, Russian Federation (in RA VI), Ukraine, Yugoslavia
Offenbach	Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, Former Yugoslav Republic of Macedonia, Germany, Hungary, Israel, Finland, France, Latvia, Lithuania, Luxembourg, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland
Rome	Greece, Italy, Lebanon, Malta, Syrian Arab Republic, Turkey

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* With effect from 1 July 1997, Hong Kong became a Special Administrative Region of the People's Republic of China.

ATTACHMENT I.1

GUIDELINES TO REVIEW THE STATUS OF RSMCS WITH GEOGRAPHICAL SPECIALIZATION

1. RSMC CAPABILITIES TO BE REVIEWED

Taking into account the functions to be performed by designated RSMCs with geographical specialization, their capabilities will be examined under three aspects: their ability to communicate with other centres, their access to computing facilities to achieve specific tasks, and their ability to issue the products which are requested by the users.

Telecommunication aspects

In order to play fully their role, existing RSMCs have to be linked with neighbouring centres. The following type of links are necessary for the effective implementation of their assignments:

(*a*) Medium- or high-speed lines connecting the RSMC and the appropriate WMC, as well as the RSMC which is chosen to provide backup assistance;

(*b*) Lines with sufficient bandwidth to transmit the products issued by the RSMC to the users in the corresponding NMCs.

Computing facilities aspects

The computing facilities available in existing RSMCs with geographical specialization must have enough power to enable:

(*a*) Preprocessing of observational data including data in binary data representation forms;

(*b*) Objective analysis and NWP models over the geographical responsibility area;

(*c*) Postprocessing of data including display in the form of charts, time-series, tables, as well as the generation of products in binary data representation forms.

Product aspects

In order to fulfil their responsibilities, the RSMCs have to provide several products to the users, some of which are:

(*a*) Gridded fields or local forecasts in the form of maps, time-series, GRID/GRIB and BUFR messages;

(*b*) Elaborated technical guidance (maps and directives);

(*c*) Verification of the quality of the products by means of CBS approved procedures.

2. DOCUMENTS TO BE PRODUCED BY RSMCS

In order to demonstrate their capabilities to perform the activity related to geographical specialization, the documentation to be provided by the RSMCs should include the following:

(*a*) A description of telecommunication and data-processing facilities including contingency and backup arrangements;

(*b*) The product guide indicating the list of the products which are available and their transmission schedule;

(*c*) Monthly statistics on the availability and timeliness of the products;

(*d*) Monthly verifications of the products by means of CBS-approved procedures.

RSMCs with geographical specialization have to summarize this information in order to produce, every year, their contribution to the WWW Technical Report on the activity of the GDPS.

3. PROCEDURE

A regular review of the capabilities of the RSMCs with geographical specialization should be undertaken by their regional association. In order to do so, it is suggested that regional associations request their RSMCs to produce the above-mentioned documentation. It is also suggested that regional associations obtain feedback from the users. Regional associations should inform CBS, for further action, of the results of the review of the capabilities of the RSMCs with geographical specialization in their region.

ATTACHMENT I.2

PROCEDURES FOR THE ELABORATION OF OBSERVATIONAL DATA REQUIREMENTS

The formulation of observational data requirements is a complicated process which consists of several stages. At various levels this process involves groups of end-users, regional associations, WMO technical commissions and other bodies. In order to rationalize the formulation of the observational data requirements, the following procedures (schematically shown in Figure 1) are proposed:

1. Users present to WMO Members their needs for observational data for various applications (e.g. meteorological services for aviation, marine navigation, industry, agriculture, climate research, etc.). Meteorological data might be used in two ways: directly in the provision of meteorological services, and in the preparation of meteorological products (weather analysis and prognoses) by GDPS centres. In the latter case, GDPS centres are considered as users.

2. WMO technical commissions are responsible for the consolidation of data needs presented by Members and for the formulation, on their basis, of a statement on observational data requirements/goals (usually in the form of tables) in various WMO Programmes. This should include explanatory notes and a rationale for the requirements/goals and, if possible, a statement on the incremental value of partially meeting these goals (in terms of accuracy, density, frequency, etc.). Often this will include a feedback process with users to ensure that enough information and understanding about users' needs are available. If a statement on requirements/goals is addressed to the World Weather Watch, and in particular to the WWW Global Observing System, it should be presented to the Commission for Basic Systems for consideration.

3. The Commission for Basic Systems:

   (*a*) Evaluates the feasibility of stated requirements/goals through expertise by appropriate working groups, particularly the Working Groups on Observations and on Satellites. The evaluation of technical and instrumental feasibility should be conducted in collaboration with the Commission for Instruments and Methods of Observation, the WMO body responsible for the Instruments and Methods of Observation Programme (IMOP). This would probably involve a feedback process between working groups and technical commissions. The evaluation process will result in the formulation (in the form of tables) of what portion of the statement of requirements/goals is feasible and can be achieved;

   (*b*) Formulates system requirements to provide observational data to meet the requirements/goals defined by the technical commissions;

   (*c*) Develop any amendments to the WMO mandatory and guidance publications on the basis of system requirements and submit them (in case of mandatory publications) to the Executive Council.

4. The Executive Council approves the amendments and requests the Secretary-General to incorporate them in appropriate WMO *Manuals*.

5. The Members will be advised on the performance of observing systems and programmes through updated WMO *Manuals* and *Guides* to meet users' needs for observational data.

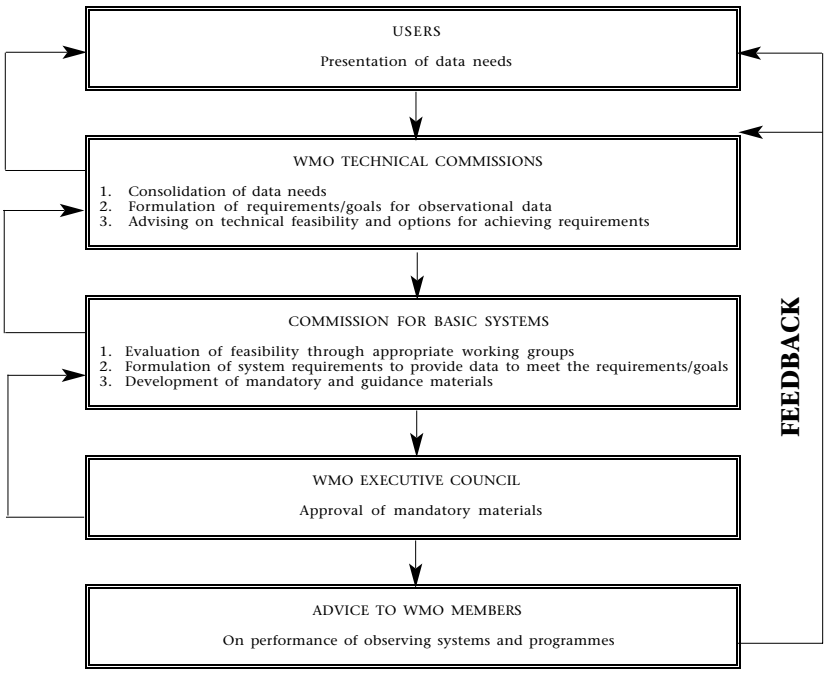

Figure 1 — Procedure for the elaboration of observational data requirements.

PART II

DATA-PROCESSING ASPECTS

1. FUNCTIONS OF WMCs, RSMCs AND NMCs

1.1 GDPS products and services

Each Member or group of Members(s) responsible for a GDPS Centre should ensure that its centre performs the relevant category of the following functions:

1.1.1 *Real-time products and services for middle latitudes and subtropical areas*

For *middle latitudes and subtropical areas*, the GDPS should provide the following products derived from deterministic and ensemble NWP systems and services in *real time*:

(*a*) Surface and upper-air analyses;

(*b*) Prognoses one to three days in advance, including:

(i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind in map or other form;

(ii) Diagnostic interpretation of numerical weather prediction (NWP) products to give:

a. Areal distribution of cloudiness;

b. Precipitation location, occurrence, amount and type;

c. Sequences at specific locations (time diagrams), at the surface and aloft, of temperature, pressure, wind, humidity, etc., subject to agreement between Members where appropriate;

d. Vorticity advection, temperature/thickness advection, vertical motion, stability indices, moisture distribution, and other derived parameters as agreed by Members;

e. Jet-stream location and tropopause/layer of maximum wind;

f. Numerical products providing sea-state or storm-surge forecasts;

(*c*) Prognoses four to 10 days in advance, including:

(i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind;

(ii) Outlooks of temperature, precipitation, humidity and wind in map or other form;

(*d*) Extended- and long-range forecasts of averaged weather parameters as appropriate, including sea-surface temperature, temperature extremes and precipitation;

(*e*) Interpretation of numerical products using relations derived by statistical or statistical/dynamical methods to produce maps or spot forecasts of probability of precipitation or precipitation type, maximum and minimum temperature, probability of thunderstorm occurrence, etc.;

(*f*) Sea-state and storm-surge forecasts using models driven by winds from global NWP models;

(*g*) Environmental quality monitoring and prediction products;

(*h*) Independent real-time quality control of the Level II and Level III data defined in Note (3) to paragraph 1.5.2.

1.1.2 *Real-time products and services for tropical areas*

For tropical areas, the GDPS should provide the following products derived from deterministic and ensemble NWP systems and services in real time:

(*a*) Surface and upper-air analyses;

(*b*) Prognoses one to three days in advance, including:

(i) Surface and upper-air prognoses, particularly of wind and humidity in map or other form;

(ii) Diagnostic interpretation of NWP products to give:

a. Areal distribution of cloudiness;

b. Precipitation location/occurrence/amounts;

c. Time sequence of weather parameters at specific locations, subject to agreement between Members, where appropriate;

d. Vorticity, divergence, velocity potential, vertical motion, stability indices, moisture distribution and other derived parameters as agreed by Members;

e. Jet stream and layer of maximum wind locations;

f. Numerical products providing sea-state or storm-surge forecasts;

(iii) The use of special NWP-nested models or diagnostic interpretation of fine-mesh global models to give:

a. Tropical storm positions and tracks;

b. Tropical depression and easterly wave positions and movement;

(*c*) Prognoses four to 10 days in advance, including:

(i) Surface and upper-air prognoses, particularly of wind and humidity;

(ii) Outlooks of precipitation, wind, cloudiness and wet and dry periods;

(iii) Life cycle of tropical storms;

(*d*) Extended- and long-range forecasts of averaged weather parameters, as appropriate, including sea-surface temperature, temperature range and precipitation;

(*e*) Interpretation of numerical products, using relations derived by statistical/dynamical methods to produce maps or at specific location of forecast probability of cloudiness, temperature range, precipitation, thunderstorm occurrence, tropical cyclone tracks and intensitities, etc.;

(*f*) Environmental quality monitoring and prediction products;

(*g*) Sea-state and storm-surge forecasts using models driven by winds from global NWP models;

(*h*) Independent real-time quality control of the Level II and Level III data defined in Note (3) to paragraph 1.5.2.

1.1.3 ***Non-real-time products and services***

The GDPS should also provide the following products and services in non-real time:

(*a*) Long-range weather and climate monitoring products when operationally useful;

(*b*) Climate-related diagnoses (10- or 30-day mean charts, summaries, anomalies, etc.) particularly for the tropical/subtropical belt;

(*c*) Intercomparison of products, verification and diagnostic studies, as well as NWP model development;

(*d*) Access to data, products and intercomparison results using internationally-accepted formats and media;

(*e*) Provision of continuously updated catalogues of data and products;

(*f*) Regional and global analyses (circulated by Members or research institutions) of the atmosphere and oceans, including means and anomalies of surface and upper-air pressure, temperature, wind and humidity, ocean currents, sea-surface temperature, and ocean surface layer temperature; derived indices, including blocking and teleconnection indices;

(*g*) Satellite remote sensing products distributed by Members; including outgoing long-wave radiation, sea-surface elevation, and normalized vegetation indices;

(*h*) Monthly and annual means or totals for each year of a decade (e.g. 1971–1980, etc.) and the corresponding decadal (10-year) averages of pressure (station level and mean sea level), temperature and precipitation, principally from CLIMAT reporting stations;

(*i*) Climatological standard normals (for the periods 1931–1960, 1961–1990, etc.) of selected elements, principally from CLIMAT reporting stations;

(*j*) Guidelines on the operational use of GDPS centre products; and

(*k*) Carrying out periodic monitoring of the operation of the WWW.

1.2 Functions of Members responsible for GDPS centres

1.2.1 *Interpretation at NMCs*

National Meteorological Centres (NMCs) should be able to use, interpret and interact fully with GDPS products in order to reap the benefits of the WWW system. Appropriate guidance on the methods for the interpretation of the GDPS output to end-user products should be made available to Members, as well as methods for the verification and intercomparison of forecasts.

1.2.2 *Accessibility of products*

GDPS products should be accessible through a system of World Meteorological Centres (WMCs) and Regional Specialized Meteorological Centres (RSMCs)* with functions and responsibilities as defined in the *Manual* and according to agreements among Members when appropriate.

1.2.3 *Data management*

The WWW data management function shall be used to coordinate the real-time storage, quality control, monitoring and handling of GDPS data and products.

1.3 WMC responsibilities

1.3.1 *Output products*

1.3.1.1 Each WMC applying sophisticated high-resolution global NWP models including ensemble prediction systems should prepare for distribution to Members and other GDPS centres the following products, based on the list in paragraphs 1.1 to 1.1.3 above:

(*a*) Global (hemispheric) analysis products;

(*b*) Short-, medium-, extended- and long-range weather forecasts based on deterministic and ensemble NWP system with global coverage presented separately, if required, for:

(i) The tropical belt;

(ii) The middle and high latitudes or any other geographical area according to Members' requirements;

(*c*) Climate-related diagnostic products, particularly for tropical regions;

(*d*) Environmental quality monitoring, analyses, forecasts and prediction products.

1.3.1.2 Global model products required to meet the needs of all WMO Programmes should be made available to national and regional centres at the highest possible resolution given technological and other constraints.

1.3.2 *Use of products*

WMCs should also carry out verification and intercomparison of products and make results available to all Members concerned, support the inclusion of research results into operational models and their supporting systems and provide training courses on the use of WMC products.

1.3.3 The functions of a WMC should also include the following non-real-time activities:

(*a*) Carrying out the development of research in support of large- and planetary-scale analyses and forecasting;

(*b*) Exchanging technical information with other centres;

(*c*) Providing opportunities for training personnel in data processing;

(*d*) Managing non-real-time data involving:

(i) Collection and quality control of data not available from the GOS in real-time, via mail or other means;

(ii) Storage and retrieval of all basic observational data and processed information needed for large- and planetary-scale research and applications;

(iii) Making non-real-time data available to Members or research institutes upon request;

(*e*) Continuously updating and providing, on request, catalogues of available products.

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* The present structure of the GDPS is given in Appendix I-1.

1.4 RSMC responsibilities

1.4.1 *Output products*

1.4.1.1 *Regional Specialized Meteorological Centres (RSMCs) with geographical specialization*

Regional Specialized Meteorological Centres (RSMCs) with geographical specialization shall be designated in each Region, capable of preparing with the support of WMCs, and where applicable RSMCs outside the Region, analyses and short-, medium-, extended- and long-range weather forecasts with the highest possible quality and with meteorological content, geographical coverage and frequency required by Members and agreed for the system. Output products from RSMCs should comprise:

(*a*) Analyses and prognoses at the surface and/or in the free atmosphere for short-, medium-, extended- and long-ranges, for the tropical, subtropical and extra-tropical areas, according to the obligations of each RSMC and as agreed by the Regional Association;

(*b*) Interpreted forecasts of specific weather parameters in map form or at specific locations (e.g. precipitation amounts, temperature, wind, humidity, etc.), subject to agreement between Members, where appropriate;

(*c*) Guidance on storm-position and track forecasts for the areas affected by tropical storms;

(*d*) Climate analyses, long-range forecasts, onset, intensity and cessation of the rainy season(s);

(*e*) Environmental quality monitoring and predictions, such as UV-B;

(*f*) Results of forecast verifications and intercomparison studies.

1.4.1.2 *Regional Specialized Meteorological Centres (RSMCs) with activity specialization*

Regional Specialized Meteorological Centre (RSMC) with activity specialization shall be designated, subject to the formal commitment by a Member or group of cooperating Members, to fulfil the required functions of the centre and meet the requirements for the provision of WWW products and services initiated and endorsed by the relevant WMO constituent body or bodies concerned. The centre should be capable of preparing independently or with the support of WMCs, and where appropriate, other GDPS centres and disseminating to Members concerned:

(*a*) Global medium-range forecasts and related analyses;

(*b*) Extended- and long-range weather forecasts and related mean analysed values and anomalies;

(*c*) Tropical cyclone warnings and advisories, storm position, intensity and track forecasts for their areas;

(*d*) Three-dimensional environmental emergency response transport model trajectories, integrated pollutant concentration, and total deposition;

(*e*) Drought monitoring products such as drought indices.

1.4.1.3 Regional model output products required to meet the needs of all WMO Programmes should be made available to national centres at the highest possible resolution given technological and other constraints.

1.4.1.4 The overall list of output products required for international exchange from GDPS centres is given in Appendix II-6.

1.4.2 *Binary/character conversion capabilities for transmission*

In order to meet the requirements of NMCs for output products in character representation and/or graphical form, all RSMCs should have facilities for conversion of products from binary to character and/or graphical form for regional transmission.

1.4.3 *Constraints for adjacent centres*

To the maximum extent feasible, adjacent RSMCs with geographical specialization should be prepared to assume each other's functions. This does not necessarily mean that each RSMC should be prepared to use the analytical models employed by RSMCs adjacent to it. Each RSMC should, however, be able to issue products covering equivalent geographical areas and to give information generally similar to that contained in the products of adjacent RSMCs.

1.4.4 The functions of an RSMC should also include the following non-real-time activities:

(*a*) Assistance in the management of non-real-time data involving:

(i) Assistance to the WMC in management and maintenance of non-real-time data, in particular by obtaining late and delayed observational data for its area of responsiblity;

(ii) Storage and retrieval of basic observational data and processed information needed to discharge the non-real-time responsiblities of the RSMC;

(iii) Making non-real-time data available to Members or research institutes upon request;

(*b*) Development and refinement of new techniques and applications;

(*c*) Carrying out comparative verifications of RSMC products and making results available to all Members concerned;

(*d*) Regular exchange with other centres of information on techniques and procedures used and results achieved;

(*e*) Providing opportunities for training of personnel in manual and automated techniques;

(*f*) Continuously updating and providing, on request, a catalogue of available products.

1.5 Members' responsibilities

Each Member shall ensure that it has a National Meteorological Centre adequately staffed and equipped to enable it to play its part in the World Weather Watch.

1.5.1 *NMC functions*

Each Member should ensure that its National Meteorological Centre performs the functions defined in Part I, paragraph 4.1.3 and as elaborated in Part II, paragraphs 1.1 to 1.2.3.

1.5.2 *Checking of collected information*

Each Member shall designate a National Meteorological Centre, or other appropriate centre, to be responsible for meteorological checking of information collected before transmission on the Global Telecommunication System.

NOTES:

(1) It is for each Member to decide, in the light of its own capabilities and needs, the extent to which it wishes to receive and use products of WMCs and RSMCs.

(2) The telecommunication functions of World Meteorological Centres and National Meteorological Centres are specified in the *Manual on the GTS*.

(3) Definition of data levels. In discussing the operation of the GDPS it is convenient to use the following classification of data levels, which was introduced in connection with the data-processing system for the Global Atmospheric Research Programme (GARP):

Level I: Primary data. In general these are instrument readings expressed in appropriate physical units and referred to Earth coordinates. Examples are: radiances or positions of constant-level balloons, etc. but not raw telemetry signals. Level I data still require conversion to the meteorological parameters specified in the data requirements.

Level II: Meteorological parameters. These are obtained directly from many kinds of simple instruments, or derived from the Level I data (e.g. average winds from subsequent positions of constant-level balloons).

Level III: Initial state parameters. These are internally consistent data sets, in grid-point form obtained from Level II data by applying established initialization procedures. At those centres where manual techniques are employed, Level III data sets will consist of a set of manually-produced initial analyses.

1.5.3 The functions of an NMC should also include the following non-real-time activities:

(*a*) Support, as required, of the appropriate RSMC in managing non-real-time data, including management of its national database;

(*b*) Storage and retrieval (including quality control) of observational data and processed information to meet national and certain international requirements;

(*c*) Research concerning operations to meet national requirements.

2. QUALITY CONTROL OF OBSERVATIONAL DATA AND THEIR RECEPTION AT GDPS CENTRES IN REAL- AND NON-REAL TIME

2.1 Quality control of observational data

2.1.1 *Definitions*

2.1.1.1 Quality assurance should be taken to mean the procedures that ensure the best possible quality of the data which are used for purposes of the GDPS.

2.1.1.2 Quality control (QC) requires that an operational entity, be it a WMC, RSMC, NMC or observing site, has the ability to select, edit, or otherwise manipulate observations according to its own set of physical or dynamical principles. Furthermore,

real-time QC should carry the connotation that such a centre has the ability to feedback, or query, an observation-originating point of a responsible staff, where appropriate, on erroneous or questionable data, or on the lack of an expected report within a time sufficient to retain the synoptic usefulness of the report.

2.1.1.3 Quality monitoring, on the other hand, is the act of aggregating information on the quality of a sample of observations from the point of view of a particular application, e.g. numerical weather prediction. It is important to make a distinction between quality monitoring and delayed-time quality control. The latter needs to be clarified in terms of the actual practices of the centres producing delayed-time products.

2.1.1.4 Quantity monitoring is the act of aggregating information on the numbers of observations available, transmitted and used by a centre.

2.1.2 *Responsibility for real-time quality control*

2.1.2.1 The primary responsibility for quality control of all observational (Level II) data should rest with the national Meteorological Service from which the observation originated ensuring that when these observations enter the GTS they are as free from error as possible.

2.1.2.2 **Quality control of observational data needed for real-time uses shall not introduce any significant delay in the onward transmission of the data over the GTS.**

2.1.2.3 To detect errors which may escape the national quality-control system and errors introduced subsequently, RSMCs, WMCs and other GDPS centres should also carry out appropriate quality monitoring of the observational data they receive.

2.1.3 *Minimum standards*

2.1.3.1 Members should implement minimum standards of real-time quality control at all NMCs, RSMCs and WMCs. These standards of quality control for real-time data are given in Appendix II-1.

2.1.3.2 For the NMCs not capable of implementing these standards, Members concerned should establish agreements with an appropriate RSMC or NMC to perform the necessary quality control on an interim basis.

2.2 Requirements for observational data

2.2.1 **In determining observational data requirements for their data-processing functions, Members shall keep in mind the needs of all WMO Programmes and WMO supported programmes.**

2.2.2 **To determine the minimum overall area of data coverage required, Members shall consider the area for which they are preparing analyses and forecasts, the scale of phenomena being dealt with, and the needs of the actual analysis/forecast process in use.**

NOTES:

(1) Requirements of GDPS centres for national, regional and global exchange of observational data needed, including in particular those of large-scale advanced NWP, are given in Appendix II-2.

(2) Intra- and inter-regional exchange programmes of observational data for large-scale and mesoscale analysis are set up by the regional associations concerned.

2.3 Times of receipt of observational data

2.3.1 **The observational data required for real-time purposes shall reach the national Meteorological Services sufficiently quickly to be used effectively.**

2.3.2 **The observational data shall therefore be handled rapidly during pre-processing by the GDPS and during transmission by the GTS.**

NOTE: Target times for the receipt of observational data are given in Appendix II-3.

3. ANALYSIS AND FORECASTING PRACTICES

NOTE: In addition to the regulations contained in this chapter, detailed guidance is given in the *Guide on the Global Data-processing System* (WMO-No. 305) and in the *International Meteorological Tables* (WMO-No. 188).

3.1 Reference surfaces for upper-air analysis

3.1.1 **The principal type of reference surface for representing and analysing the conditions in the free atmosphere over large areas shall be isobaric.**

3.1.2 **The standard isobaric surfaces for representing and analysing the conditions in the lower atmosphere shall be the 1 000 hPa, 850 hPa, 700 hPa, 500 hPa, 400 hPa, 300 hPa, 250 hPa, 200 hPa, 150 hPa and 100 hPa surfaces.**

3.1.3 The standard isobaric surfaces for representing and analysing the conditions in the atmosphere above 100 hPa should be the 70 hPa, 50 hPa, 30 hPa, 20 hPa and 10 hPa surfaces.

3.2 Preparation of upper-air charts

3.2.1 Members should either prepare or have available upper-air charts for at least four of the six following standard isobaric surfaces: 850 hPa, 700 hPa, 500 hPa, 300 hPa, 250 hPa and 200 hPa.

4. PRACTICES FOR PICTORIAL REPRESENTATION OF INFORMATION ON METEOROLOGICAL CHARTS AND DIAGRAMS

4.1 Scales and projections of meteorological charts

4.1.1 The following projections, as appropriate, should be used for weather charts:

(*a*) The stereographic projection on a plane cutting the sphere at the standard parallel of latitude 60°;

(*b*) Lambert's conformal conic projection, the cone cutting the sphere at the standard parallels of latitude 10° and 40° or 30° and 60°;

(*c*) Mercator's projection with true-scale standard parallel of latitude $22^1/_2$°.

4.1.2 The scales along the standard parallels should be as follows for weather charts:

(*a*)	Covering the world:		1 : 40 000 000
		Alternative:	1 : 60 000 000
(*b*)	Covering a hemisphere:		1 : 40 000 000
		Alternatives:	1 : 30 000 000
			1 : 60 000 000
(*c*)	Covering a large part of a hemisphere or hemispheres:		1 : 20 000 000
		Alternatives:	1 : 25 000 000
			1 : 30 000 000
			1 : 40 000 000
(*d*)	Covering a portion of a continent or an ocean or both		1 : 10 000 000
		Alternatives:	1 : 25 000 000
			1 : 20 000 000
			1 : 15 000 000
			1 : 7 500 000

4.1.3 The name of the projection, the scale at the standard parallels and the scales for other latitudes should be indicated on every weather chart.

4.2 Symbols used on meteorological charts

4.2.1 A standard set of symbols and models should be used for plotting data on meteorological charts.

4.2.2 A standard set of symbols should be used for representing analyses and forecasts on meteorological charts.

NOTE: The symbols used for the pictorial representation of observational data, analyses and forecasts on meteorological charts are those given in Appendix II-4.

4.3 Construction of aerological diagrams

4.3.1 Diagrams used for representation and analysis of upper-air observations of pressure, temperature and humidity should:

(*a*) Be constructed on the basis of:

(i) The values of the physical constants and parameters given in Appendix C to the *Technical Regulations*;

(ii) The assumption of ideal gas properties, except for the values of both saturation vapour pressure and heats of transformation of phases of water, at specific temperatures;

(*b*) Bear a legend stating the principles used in their construction.

4.3.2 Diagrams used for the accurate computation of geopotential from upper-air observations of pressure, temperature and humidity should possess the following features:

(*a*) Equal-area transformation of pressure-volume diagram;

(*b*) Straight and parallel isobars;

(*c*) A scale such that the errors involved in computation are significantly smaller than those arising from instrumental errors.

4.4 Preparation of charts and diagrams for facsimile transmission

4.4.1 *Preparation of charts*

4.4.1.1 When preparing charts for facsimile transmission, the following basic considerations in the preparation of the original copy should be followed:

(*a*) The minimum line thickness should be sufficiently large to ensure clear reproduction;

(*b*) Lines which are required to be reproduced uniformly should be of uniform width and intensity;

(*c*) The minimum separations of detail in letters, figures, symbols, etc. should be sufficient to avoid filling-in of the spaces in the reproduction;

(*d*) Letters, figures, symbols, etc. should be drawn as simply as possible;

(*e*) Models employed in plotting should be as simple as possible.

4.4.2 *Standardization of maps for facsimile transmission*

4.4.2.1 The standard projections and scales in paragraphs 4.1.1 and 4.1.2 should also apply to documents prepared for facsimile transmission.

4.4.3 *Colours and features*

4.4.3.1 Since the reproduced chart or diagram may show little, if any, colour differentiation between the different elements plotted on the original copy, the original should be prepared either using a monochromatic system or, if a polychromatic system is employed, in such a way that the reproduction conforms to a monochromatic system. For example, on the original copy, fronts should be entered in their appropriate colours, providing the symbols used to draw the fronts conform to the frontal symbols of the monochromatic system given in Appendix II-4.

4.4.3.2 Synoptic weather maps and charts prepared for transmission by facsimile should include the following features:

(*a*) Geographical outlines of minimum detail necessary for orientation purposes with coastlines interrupted where station data are to be plotted;

(*b*) Selected meridians and parallels printed in double thickness (bold-face) for orientation purposes;

(*c*) Map references required only for convenience in the entering of data, e.g. index numbers, 1° intersections of latitude and longitude, station circles, etc., to be printed in non-photo blue;

(*d*) Letter and figures of a size compatible with resolution characteristics of the transmission system(s) over which the charts are to be transmitted.

4.4.4 *Legend*

4.4.4.1 All charts and diagrams transmitted by facsimile should bear a bold legend including:

(*a*) The type of chart or diagram;

(*b*) The date and time to which the data refer or, in the case of forecast charts, the time to which the forecast applies;

(*c*) An explanation of the plotted symbols or isopleths if these are not obvious from the style of the chart.

NOTE: Minimum requirements for identification of charts transmitted in pictorial form are also given in the *Manual on the GTS* (WMO-No. 386) (see Volume I, Part II, paragraph 3.1).

4.4.5 *Plotted data*

4.4.5.1 Entries on the original copy should conform to the basic principles outlined in Appendix II-4.

4.4.6 ***Analysed data***

4.4.6.1 Isopleths, frontal symbols, areas of precipitation, etc. should be entered, as appropriate, in the manner laid down in Appendix II.4. Care should be taken not to obliterate one set of plotted data by another.

5. EXCHANGE OF PRODUCTS BETWEEN CENTRES

5.1 Times of availability of products

5.1.1 **Processed data (products) required for real-time and non-real time purposes shall reach the national Meteorological Service sufficiently quickly to be of effective use in its associated time-scale.**

5.1.2 **Both observational and processed data shall therefore be handled rapidly by both the GDPS and the GTS (see also paragraph 2.3.2).**

NOTE: Target times for the availability of processed information are given in Appendix II.5.

5.2 Programmes of output products

5.2.1 **Members shall establish programmes of output products for general distribution by their WMCs and/or RSMCs, taking into account requirements of other Members and the capability of the GTS to handle these products.**

NOTE: Overall lists of products, to be used as general guidance by Members in establishing output programmes for their WMCs and RSMCs, are found in Appendix II-6.

5.2.2 Each Member should state which products its NMC, RSMC or WMC wishes to receive from other centres.

5.2.3 In order to avoid overloading the GTS, Members should limit requests by their NMCs for products, taking into account the following considerations:

(*a*) Members should require output products from RSMCs with geographic specialization normally from one RSMC located in the same WMO Region (exceptions should be restricted to cases where the area, for which a Member needs to receive RSMC output products, is not covered by the products from one RSMC in the same Region);

(*b*) If there is an urgent need for a Member to receive the same product from more than one geographically specialized RSMC or WMC for special operational purposes, these requirements should be limited to a selection of two levels of analyses and prognoses;

(*c*) Members should request processed information from the centres most readily accessible on the GTS.

NOTE: The lists of global and regional model products, to which the highest priority should be given by WMCs and RSMCs for preparation, are given in Attachments II.1 and II.2.

5.2.4 Globally specialized RSMCs should tailor their products to regions to meet regional requirements and, if possible, to limit their size to avoid overloading the GTS.

5.3 Transmission priorities for GDPS products

NOTE: The priorities listed in this section are intended as guidance to GDPS centres on providing observational data and output products to the GTS in the proper sequence. As regards the relay of information by automated telecommunication centres, the provisions of the *Manual on the GTS* apply.

5.3.1 *Transmission priorities for global model products from WMCs and RSMCs*

5.3.1.1 Priorities for the transmission of global model output products should be used when several such WMC and RSMC products are available at the same time.

NOTE: Transmission priorities for global model output products are given in Attachment II.3.

5.3.2 *Transmission priorities for regional model products from RSMCs*

5.3.2.1 Priorities for transmission of regional model products should be based on the requirements for interregional exchange of RSMC products on the MTN and its branches.

NOTE: Transmission priorities for regional model products, from RSMCs which have the highest priority for transmission on the MTN and its branches (without indication of order of preference), is given in Attachment II.4.

5.3.3 *Transmission priorities after transmission outages on the MTN and its branches*

(*a*) Normal transmission schedules of observational data should be resumed no later than the first main standard time of observation following the cessation of the outage;

(*b*) Procedures for the transmission of accumulated meteorological data should not interfere with the resumption of normal transmission schedules. If these data are redundant, they should not be transmitted.

NOTES:

(1) Although new automatic re-routeing procedures provide a capability for routeing traffic when a segment of the MTN is disrupted, there is still a need for a system of priorities which can be used for the transmission of meteorological data when the re-routeing procedures cannot be used.

(2) Priorities for transmission of observational data on the MTN and its branches are given in Attachment II.5 (Part 1).

5.3.4 *Transmission priorities for global model products from WMCs and RSMCs after outages*

5.3.4.1 Global model products accumulated due to circuit disruption should be transmitted with the least possible delay.

NOTE: A list of transmission priorities for global model products, from WMCs and RSMCs after outages on the MTN and its branches, is given in Attachment II.5 (Part 2).

5.3.5 *Transmission priorities for regional model products from RSMCs after outages*

5.3.5.1 Regional model products from RSMCs accumulated due to circuit disruptions on the MTN and its branches should be transmitted with the least possible delay.

5.3.5.2 The regional model products should have a higher priority than global model products for transmission after outages on the MTN and its branches.

NOTE: A list of transmission priorities for regional model products, from RSMCs after outages on the MTN and its branches, is given in Attachment II.5 (Part 3).

5.3.6 *Priority of observational data over processed data*

5.3.6.1 **On the MTN and its branches, transmission of observational data shall have priority over the transmission of processed data (in both analogue and digital form).**

5.3.7 *Transmission of products in binary, alphanumeric and pictorial form*

5.3.7.1 Until such time as all centres are in a position to convert output products in GRIB and/or GRID code form into pictorial form, Members should transmit certain of their WMC and RSMC products also in pictorial form in addition to alphanumeric and/or binary form.

5.3.7.2 A list of such products for transmission on the MTN and its branches should provide guidance to members for triple transmissions.

NOTES:

(1) Members are encouraged to transmit processed information in the GRID and/or GRIB code forms.

(2) A minimum list for transmission of products in binary, alphanumeric and pictorial form is given in Attachment II.6.

(3) As Members develop the capability at their RSMCs for transforming these products from GRID and/or GRIB to pictorial form, the pictorial transmission will be discontinued, where appropriate.

5.3.8 *Plan for monitoring the operation of the World Weather Watch*

5.3.8.1 Members should implement the plan for monitoring the operation of the World Weather Watch, in particular the real-time monitoring.

NOTE: The plan for monitoring the operation of the World Weather Watch is given in Attachment II.7.

5.3.9 *Procedures and formats for the exchange of monitoring results*

5.3.9.1 GDPS centres participating in the exchange of monitoring results should implement standard procedures and use the agreed formats.

NOTE: Procedures and formats for the exchange of monitoring results are given in Attachment II.8.

5.3.10 *Standards in the provision of international services by Regional Specialized Meteorological Centres (RSMCs) for radiological environmental emergency response*

5.3.10.1 **The designated RSMCs with activity specialization in this field shall implement agreed standard procedures and products.**

NOTE: Standards in the provision of international services by RSMCs for radiological evnvironmental emergency response are given in Appendix II-7.

5.4 Responsibilities of Members for providing information on their real-time data-processing activities

5.4.1 **Members shall provide the Secretariat, at stated intervals, with current lists of output products, grid systems, available and used at their centre(s) for inclusion in WMO Publication No. 9, Volume B, *Data Processing*.**

5.4.2 **Members shall provide the Secretariat annually, at the end of January, with information on equipment in use at their centre, usage of data and products from the GTS, analysis and prediction techniques, real-time quality control and verification procedures, and results obtained at their centre(s) for inclusion in an Annual WWW Technical Progress Report on the Global Data-processing System.**

5.4.3 Members should provide the Secretariat, at stated intervals, with current information on appropriate routine computer programs used in their centres, which they are willing to make available, or their requirements and requests for software support for inclusion in the WMO Secretariat Software Registry.

APPENDIX II-1

MINIMUM STANDARDS FOR QUALITY CONTROL OF DATA FOR USE IN THE GDPS (BOTH REAL-TIME AND NON-REAL-TIME)

INTRODUCTION

1. According to the WWW plan the Commission for Basic Systems was required to develop minimum standards for quality control of data in the GDPS. The Plan for Monitoring the Operation of the WWW, developed by CBS (as presently published in the *Manual on the GTS*, WMO–No. 386, Attachment I-5), also includes reference to the fact that minimum standards should be defined in the *Manual on the GDPS*.

OBJECTIVES

2. The objectives of the GDPS quality control are:

(*a*) To ensure the best possible quality of the data which are used in the real-time operations of the GDPS;

(*b*) In non-real time, to protect and improve the quality and integrity of data destined for storage and retrieval within the GDPS;

(*c*) To provide the basis for feedback of information on errors and questionable data to the source of the data.

BASIC COMPONENTS

3. The minimum standards for quality control of data apply to all WWW centres: NMCs, RSMCs, WMCs. They include quality control at various stages of processing. They apply to both real-time and non-real-time processing and should lead to various records of quality-control actions.

ASPECTS OF IMPLEMENTATION

4. Quality-control standards may be introduced progressively at a GDPS centre using a modular approach. The general priorities for implementation of the minimum standards under the modular concept concern quality control of data, according to:

(*a*) Sources (e.g. stations);

(*b*) Type (e.g. SYNOP, TEMP);

(*c*) Time (e.g. 00 UTC, 12 UTC);

(*d*) Parameters and characteristics (e.g. pressure, wind, temperature, amount of precipitation).

5. WMCs having multiple responsibilities as an RSMC and/or an NMC, and RSMCs also having a responsibility as an NMC, should assume the minimum standards pertinent to all levels at which the centre operates.

6. Table I of this Appendix lists the minimum standards for real-time and non-real-time quality control at NMCs, RSMCs and WMCs. Where applicable, regional associations and national Meteorological Services will set up similar quality-control standards for data exchanges only at regional or national levels.

RESPONSIBILITIES

7. General principles for the application and administration of GDPS minimum standards for quality control of data are given in the following paragraphs.

8. The basic responsibilities for implementing minimum standards for quality control of the GDPS rest with Members.

9. An essential part of the quality-control plan includes an exchange of information about data deficiencies between GDPS centres and observation points in order to resolve those deficiencies and minimize their recurrence.

10. The frequency with which information is exchanged in order to improve the quality of data and products should correspond to the frequency with which monitoring reports are exchanged. These are given in the Plan for Monitoring the Operation of the WWW, as given in Attachment II.7, in particular, paragraph 22.

11. The minimum standards specify which data are to be quality-controlled and how often. The detailed methods for performing the quality control are left to the Members to develop, but should conform to the minimum standards.*

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* Methods for real-time and non-real-time quality control are given in the *Guide on the GDPS*, WMO–No. 305.

Table I

GDPS MINIMUM STANDARDS FOR QUALITY CONTROL OF INCOMING DATA (RECEIVED VIA THE GTS OR OTHER MEANS)

(1)	*Station list* (2)	*Types of report* (3)	*Times of observations** (4)	*Parameters to be quality-controlled* (5)	*Procedures for quality control* (6)	*Records to be maintained* (7)	*Minimum frequency for performing quality control* (8)
REAL TIME	WMCs, RSMCs and NMCs: Global exchange list of RBSNs in Volume A, WMO-No. 9, *Observing Stations*	SYNOP	00, 06, 12, 18	FM 12: All mandatory groups	*Checking* • Detection of mission data at centres • Adherence to prescribed coding formats • Internal consistency • Time consistency • Space consistency • Physical and climatological limits *Remedial Action* Before further processing, correct or flag erroneous or suspect data *Notification:* Discrepancies and missing data should be made known to the appropriate centre or station NOTE: It is recognized that notification of not all errors or doubtful data can be done in real time by a processing centre. Thus when it becomes feasible binary data representation should be used to exchange together with observations: • Instruments • Information on data correction applied • Information on quality control	• Information to identify source of data such as station, aircraft, ship • Type of deficiency (non-receipt, incomplete or incorrect reports, etc.) • Identification of deficient element (whole report, specific group, specific parameter, etc.) • Frequency of occurrence of data deficiencies (according to station type and element)	Preferably with each operational cycle; otherwise, with sufficient frequency to establish representative records
		SHIP	00, 06, 12, 18	FM 13: All mandatory groups			
		PILOT Parts A and B C and D	00, 06, 12, 18	FM 32: Sections 1, 2, 3, 4			
		PILOT SHIP Parts A and B C and D	00, 06, 12, 18	FM 33: Sections 1, 2, 3, 4			
		TEMP Parts A and B C and D	00, 06, 12, 18	FM 35: Sections 1, 2, 3, 4, 5, 6			
		TEMP SHIP Parts A and B C and D	00, 06, 12, 18	FM 36: Sections 1, 2, 3, 4, 5, 6			
		PILOT MOBIL Parts A and B C and D		FM 34: Sections 1, 2, 3, 4			
		TEMP MOBIL Parts A and B C and D		FM 38: Sections 1, 2, 3, 4, 5, 6			
		SATEM SATOB	Asynoptic	FM 86: Mean temperatures FM 88: Cloud-motion winds			
		Aircraft meteorological observations	Asynoptic	• Time and position • Wind • Temperature • Flight level			
		BUOY	Asynoptic	FM 18: Sections 1, 2			

(continued)

GDPS MINIMUM STANDARDS FOR QUALITY CONTROL OF INCOMING DATA (RECEIVED VIA THE GTS OR OTHER MEANS) *(contd.)*

(1)	*Station list* (2)	*Types of report* (3)	*Times of observations** (4)	*Parameters to be quality-controlled* (5)	*Procedures for quality control* (6)	*Records to be maintained* (7)	*Minimum frequency for performing quality control* (8)
		CLIMAT**	Monthly	FM 71: Section 1			
		CLIMAT SHIP**	Monthly	FM 72: Section 1			
		CLIMAT TEMP**	Monthly	FM 75			
		CLIMAT TEMP SHIP**	Monthly	FM 76			
		BUFR	As defined within the message	FM 94: Section 4			
NON REAL TIME	WMCs, RSMCs and NMCs: Global exchange list of RBSNs in Volume A, WMO-No. 9, *Observing Stations*	Same as for real time plus:	Same as for real time plus:	Same as for real time plus:	*Checking* Same as for real time and in addition: • Review of recorded data in comparison with observations taken before and after • Inter-comparison of parameters and calculations • Check of supplementary data • Check of extreme values *Remedial Action* Correct errors and flag data as appropriate *Notification* Refer discrepancies to observing stations or WWW centre as follows: • Once per month from NMCs • Once every three months from RSMCs • Once every six months from WMCs and lead centres	*Summarize records developed in real time to include:* Same as for real-time with all data deficiencies found in real time combined with additional ones found in non-real time	With sufficient frequency to establish representative records
		ROCOB	Asynoptic	FM 39: Sections 1, 2			

* Use observation time nearest to maintain synoptic hours when observation not taken at main synoptic hours.

** Monthly on receipt and prior to initial distribution or use.

NOTES: (1) Any of the observational data types, described in column (3) in terms of their alphanumeric code forms, may also be transmitted in BUFR code. If so, they should be subject to the same minimum standards of quality control as their alphanumeric counterpart. New data (in BUFR) should have quality-control standards developed as appropriate.

(2) Lead centres for data-quality monitoring are given in WMO-No. 488, *Guide on the Global Observing System*, Part VII, paragraph 7.2.2.1.

The geographic area (zone) of responsibility for application of the minimum standards will correspond to that undertaken by each WWW centre for data processing, as laid down in Attachment III.2.

ADVANCED STANDARDS

12. The primary purpose of quality control is to detect data deficiencies and to attempt to correct them in real time. Thus, the WWW centres should perform quality-control operations as these are developed and as their technical capabilities allow. Centres which have high-speed computers can apply standards for quality control which are far beyond the minimum standards. These advanced standards should involve more real-time quality control, including correcting or flagging of more reports, parameters and levels than listed in Table I. The *WWW Guides* give information on methods for more advanced quality control.*

13. It is also the responsibility of automated centres to perform nearly continuous inspection and quality control of processing programmes that enable computers to identify, decode, process and array data properly.

MINIMUM STANDARDS FOR PROCESSED DATA

14. Minimum standards for quality control of processed data should include:

(*a*) Standards for presentation of processed data as they are given in Appendix II-4;

(*b*) Spatial and temporal coherence in the meteorological structure of the product (that is, no impossible or contradictory atmospheric states).

* Methods for real-time and non-real-time quality control are given in the *Guide on the GDPS*, WMO-No. 305.

APPENDIX II-2

OBSERVATIONAL DATA REQUIREMENTS FOR GDPS CENTRES FOR GLOBAL AND REGIONAL EXCHANGE

The following paragraphs 1, 2 and 3 state the observations required to operate all GDPS centres at national, regional and global levels. Paragraph 4 addresses the data requirements for NWP operations only.

1. The types of observation networks and platforms providing data required at data-processing centres are as follows:

   (*a*) All stations included in the Regional Basic Synoptic Networks;

   (*b*) The network of supplementary synoptic stations, including automatic stations;

   (*c*) Automatic marine stations (drifting buoy and moored buoys);

   (*d*) Mobile sea stations;

   (*e*) All other stations making radiowind, radiosonde/radiowind and pilot balloon observations;

   (*f*) Meteorological rocket stations;

   (*g*) Aircraft meteorological observations;

   (*h*) Wind profilers;

   (*i*) Doppler and weather watch radar systems and networks;

   (*j*) Space-based systems producing:

      (i) Imagery (including both analogue and digital imagery);

      (ii) Radiance data;

      (iii) Vertical temperature and humidity profiles;

      (iv) Cloud and water vapor motion winds;

      (v) Cloud height, temperature, type and amount;

      (vi) Digital information about clouds (liquid water or ice (total));

      (vii) Surface wind, precipitation rate and precipitable water;

      (viii) Land temperature;

      (ix) Sea-surface temperature;

      (x) Ocean surface wind vector;

      (xi) Albedo;

      (xii) Ocean wave spectra;

      (xiii) Sea ice cover;

      (xiv) Snow cover, depth and water equivalent;

      (xv) Earth radiation fluxes;

      (xvi) Aerosols and trace gases;

      (xvii) Volcanic ash;

      (xviii) Other meteorological and environmental products;

   (*k*) Radiological data reporting stations in case of nuclear accidents (required for GDPS centres running transport models for environmental emergency response);

   (*l*) Selected climatological/agrometeorological/hydrological stations;

   (*m*) Lightning detection and location systems network;

   (*n*) Global Atmosphere Watch (GAW) network.

The observational data which will be needed to obtain optimum results from NWP systems by the year 2000 and meet the needs of all WMO Programmes and WMO supported Programmes are elaborated in paragraph 4 below and its related three tables.

2. The report code types which carry the data provided by the platforms listed in paragraph 1 above are given below:

(*a*) BUFR and GRIB;

(*b*) TEMP — Parts A, B, C and D;

(*c*) PILOT — Parts A, B, C and D;

(*d*) TEMP SHIP — Parts A, B, C and D;

(*e*) PILOT SHIP — Parts A, B, C and D;

(*f*) TEMP MOBIL — Parts A, B, C and D;

(*g*) PILOT MOBIL — Parts A, B, C and D;

(*h*) COLBA;

(*i*) TEMP DROP;

(*j*) ROCOB;

(*k*) SYNOP;

(*l*) SHIP;

(*m*) Reports from automatic stations on land and at sea;

(*n*) CODAR/AIREP/AMDAR;

(*o*) Selected satellite data, such as cloud images, SATEM, SAREP, SARAD, SATOB;

(*p*) BUOY;

(*q*) CLIMAT, CLIMAT SHIP;

(*r*) CLIMAT TEMP, CLIMAT TEMP SHIP;

(*s*) BATHY, TESAC, TRACKOB;

(*t*) WAVEOB;

(*u*) RADOB;

(*v*) RADREP.

NOTES:

(1) Items (*a*) to (*v*) do not indicate priorities.

(2) BUFR and CREX can encode any of the other above data forms and many more. If BUFR or CREX is used to represent any of these data forms, in lieu of the specific alphanumeric code form, the same data requirements apply.

3. The frequency of observational reports required is as follows:

(*a*) BUFR and GRIB, as available;

(*b*) TEMP, PILOT, TEMP SHIP, PILOT SHIP, TEMP MOBIL, PILOT MOBIL, ROCOB, COLBA and TEMP DROP, as available;

(*c*) SYNOP, SHIP and reports from automatic stations on land and at sea — 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100 UTC and hourly whenever possible;

(*d*) CODAR/AIREP/AMDAR reports, as available;

(*e*) Selected satellite data, such as cloud images, SATEM, SAREP, SARAD and SATOB and digital cloud data, as available;

(*f*) BUOY, as available;

(*g*) CLIMAT, CLIMAT SHIP, CLIMAT TEMP and CLIMAT TEMP SHIP — once per month;

(*h*) BATHY, TESAC, TRACKOB and WAVEOB, as available;

(*i*) RADOB and RADREP, as available.

4. Data needed for advanced NWP by the year 2000 is as follows:

GENERAL CONSIDERATIONS

The following tables list the observational data which will be needed for advanced NWP systems by the year 2000. They include the needs for data assimilation and for analysis and model validation for global short- and medium-range forecasting (excluding long-range forecasting).

Requirements for regional modelling have also been considered. They have been mentioned in the explanatory text, where appropriate, but they have not been listed in the tables. Mesoscale modelling has not been considered.

It is most likely that data of the given specifications would benefit global NWP, if available; however, it does not mean that NWP could not be carried out without such data, as NWP models produce useful products even with the observational data set currently available. It does not mean either that data of higher specification would not be useful; on the contrary, when and where such data are produced they should be made available.

The problem of the feasibility of observing all the variables listed in these tables is not addressed. Most of the requirements stated here could only be met by satellite-borne observing systems. However, in many cases a combination of satellite and *in situ* data is needed to obtain adequate resolution and to ensure stability of calibration of remote sensing systems.

CONTENTS OF THE TABLES

The following notes provide some explanation of how the lists were prepared and some provisos on their use:

Variables

Following past convention, the observational requirements for data assimilation are stated in terms of geophysical variables. This is thought to be useful since, from a user's perspective, these are the variables on which information is required. However, it is important to note that these variables are not always observed directly (satellite systems observe none of them directly, with the exception of top-of-the-atmosphere radiation and a Doppler wind lidar). Also, it is no longer true that the users need their data exclusively in the form of geophysical parameters; recent developments in data assimilation have demonstrated the potential and the benefits of using data at the engineering level (e.g. radiances, brightness temperatures).

Horizontal resolution

(*a*) In general (and with some oversimplification), data are useful for assimilation and validation on spatial scales which the models are attempting to represent. One hundred kilometres are given as the requirement for the variables listed in the tables. However, it is possible to benefit from higher resolution data, considering the current developments towards global models with a grid length of less than 50 km;

(*b*) Regional models attempt to represent spatial scales above the mesoscale. Observational data are required at a resolution of 10 km.

Vertical resolution

(*a*) The same rationale is applied here: global NWP models are expected to have a resolution of less than one kilometre throughout the troposphere and lower stratosphere, with considerably higher resolution in the planetary boundary layer. In the mid- and upper stratosphere, a resolution of two kilometres is likely to be sufficient. The requirements for observations should be comparable;

(*b*) For regional models, observations are required at a resolution of 100 m (50 m in the planetary boundary layer).

Temporal resolution

(*a*) Just as with spatial resolution, data will be useful for assimilation and validation on temporal scales, which the models are attempting to represent. In the past, this has not been the case; so-called "four-dimensional" assimilation systems would more appropriately be described as "intermittent three-dimensional" systems, and they have not been able to make proper use of observations more frequently than the period of the data assimilation cycle (typically six hours). However, continued progress towards truly four-dimensional data assimilation is making it possible to extract useful information from observations at higher temporal frequency. With such systems, higher temporal resolution can compensate, to some extent, for poor horizontal resolution when the atmosphere is moving. A requirement of three hours for upper-air data and one hour for surface data has been specified. However, like in the case of spatial resolution, upper-air data of higher specification (up to one hour) should also be made available (e.g. cloud motion wind data from geostationary satellites, wind profiles from wind profilers);

(*b*) For regional models, both upper-air and surface data are required at a resolution of one hour.

Accuracy

The values given are intended to represent the RMS of the observation errors. The assessment of accuracy should include not only the true instrumental error but also the representativeness error (i.e. the characteristics of some observing systems, particularly *in situ* systems, which sample spatial and temporal scales that are not represented by the models). For NWP applications, such effects appear as though they were observation errors.

Timeliness

In NWP, the value of data degrades with time, and it does so particularly rapidly for variables which change quickly. Operational assimilation systems are usually run with a cut-off time of about three hours for global models and one and a half hours for regional models (although data received with longer delays remain useful). Therefore, the timeliness of data delivery must take into account the advertized initiation time of any operational model that uses that data. For observations which are expected to be used for validation, and not for analysis/assimilation in near-real-time, the timeliness is less critical.

TABLE 1

Three-dimensional fields

	Horizontal resolution (km)	*Vertical resolution (km)*	*Temporal resolution (hours)*	*Accuracy (RMS error)*	*Notes*
Wind (horizontal)	100	.1 up to 2 km .5 up to 16 2 up to 30	3	2 m s^{-1} in the troposphere 3 m s^{-1} in the stratosphere	(1) (2)
Temperature	100	.1 up to 2 km .5 up to 16 2 up to 30	3	.5 K in the troposphere 1K in the stratosphere	(3)
Relative humidity (RH)	100	.1 up to 2 km .5 up to tropopause	3	5% (RH)	
Turbulence	100	.3	1	–	
Ozone	Variable	Variable	Variable	5%	
Greenhouse gases	Variable	Variable	Variable	2–10% (1pptv–1ppmv)	
Reactive gases	Variable	Variable	Variable	2–10% (1pptv–1ppbv)	
Aerosols-chemical and physical properties	Variable	Variable	Variable	–	
Salinity	250	Variable	6h	1%	
Sub-sea surface temperature	250	Variable	6h	0.5 K	
Sub-sea surface current	250	Variable	6h	2 cm s^{-1}	
Soil moisture 0–10 cm	100	–	1 day	0.02 m^3 m^{-3}	
Soil moisture 10–100 cm	100	–	1 week	0.02 m^3 m^{-3}	

NOTES:

(1) Accuracy specified as RMS vector error.

(2) Hourly wind data from geostationary satellites and from wind profilers are also required. Tropospheric horizontal and vertical resolution and accuracy can be met by a space-based Doppler wind lidar in a Sun-synchronous orbit.

(3) Geopotential height can be retrieved from specified T and RH with sufficient accuracy.

TABLE 2

Surface fields

	Horizontal resolution (km)	*Temporal resolution*	*Accuracy (RMS error)*	*Notes*
Pressure	100	1h	0.5 hPa	
Wind	100	1h	2 m s^{-1}	(1)
Temperature	100	1h	1 K	
Relative humidity	100	1h	5%	
Visibility	100			
Accumulated precipitation	100	1h	0.1 mm	(2)
Precipitation rate	100	1h	0.1 mm h^{-1}	
Sea and lake surface temperature	100	1 day	0.5 K	
Soil temperature	100	3h	0.5 K	
Sea-ice and lake ice cover	100	1 day	10%	
Snow cover	100	1 day	10%	
Snow equivalent-water depth	100	1 day	5 mm	
River runoff	250	1 week		
Lake water level	Variable	1 week		
Water quality	250	1 week		
Sediments	250	1 week		
Percentage of vegetation	100	1 week	10% (relative)	
Phenomological data	Variable	10 days		
Soil temperature, 20 cm	100	6h	0.5 K	
Deep soil temperature, 100 cm	100	1 day	0.5 K	
Surface roughness	50	1 month		
Albedo, visible	100	1 day	1%	
Albedo, near infrared	100	1 day	1%	
Long-wave emissivity	100	1 day	1%	
Multipurpose imagery	1 or 4	6h	–	
Surface net radiation	50	6h	1%	
UV incoming	50	1h	1–5%	
Waves spectra	100	1h	0.01 m	
Salinity	100	6h	1%	
Sea level	50	12h	0.01m	
Ocean current	100	6h	2 cm s^{-1}	
Greenhouse gas concentrations	Variable	Variable	2–10% (1pptv–1ppmv)	(3)
Ozone	Variable	Variable	1–5%	
Precipitation chemistry	Variable	Variable	–	
Aerosols-chemical and physical properties	Variable	Variable	–	
Reactive gases	Variable	Variable	2–10% (1pptv–1ppmv)	
Radionuclides	Variable	Variable		
Volcanic activity	Variable	Variable		(3)

NOTES:

(1) Wind at 10 metres over land;
Over sea, height in the range 1 to 40 metres (to be transmitted with the observation).

(2) Required principally for model validation, not time critical.

(3) For some programmes, e.g. environmental monitoring, environmental emergency response and public weather services, much higher resolution data is needed operationally.

TABLE 3

Other two-dimensional fields

	Horizontal resolution (km)	*Temporal resolution*	*Accuracy (RMS error)*	*Notes*
Cloud fractional cover	100	3h	10%	
Cloud top height	100	3h	0.5 km	(1)
Cloud base height	100	3h	0.5 km	(1)
Total liquid water content	100	3h	20%	
Cloud phase/particle size	50	6h	–	
TOA net short-wave radiation	100	3h	5 W m^{-2}	(2)
TOA net long-wave radiation	100	3h	5 W m^{-2}	(2)
Multipurpose IR/VIS imagery	5	30 min	–	(3)
Radiance				
Column ozone	Variable	Variable	1%	
Optical depth/turbidity	Variable	Variable	–	
Column greenhouse and reactive gases	Variable	Variable	–	

NOTES:

(1) Accuracy is higher in planetary boundary layer.

(2) Required principally for model validation; not time critical.

(3) Required to assist real-time observation monitoring and analysis/forecast validation.

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APPENDIX II-3

TIMES OF RECEIPT OF OBSERVATIONAL DATA

Received data \ *Receiving centre*			*WMC*	*RSMC (RTH)*	*NMC*
Time of receipt of observational data	Global network	Surface + Upper	H + 3 (6)	H + 3 (6)	H + 3 (6)
	Regional network	Surface		H + 2 (3)	H + 2 (3)
		Upper		H + 3 (4)	H + 3 (4)
Minimum storage time of observational data for transmission purposes		Surface	H + 24	H + 24	
		Upper	H + 24	H + 24	

NOTES:

(1) This table states times, e.g. H + 3 (6) hours, within which different categories of data should normally be transmitted to the different centres. H is the time of observation. The first figure is the time necessary for collection of data in regions where telecommunication systems and receiving centres make full use of modern technical equipment. The figure in brackets is applicable where the Global Telecommunication System operates under most difficult conditions.

(2) Time of receipt of observational data is the time at which an adequate amount of data needed for analyses has been received.

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APPENDIX II-4

GRAPHICAL REPRESENTATION OF DATA, ANALYSES AND FORECASTS

1. THE SURFACE PLOTTING MODEL

If it is required to plot the elements shown in the model, they should be placed in the relative positions shown. Any of the elements may be omitted.

T_gT_g	$T_xT_xT_x$ or $T_nT_nT_n$	C_H	E or E'sss	
	TTT	C_M	PPPP/$P_oP_oP_o$ or $a_3$hhh/ $P_oP_oP_oP_o$	
V V	ww/w_1w_1 or w_aw_a/w_1w_1	N	PPP	a
	$T_dT_dT_d$	C_LN_h h or hh	W_1W_2/w_1w_1 or $W_{a1}W_{a2}$/w_1w_1	GG or GGgg
	$T_wT_wT_w$	$P_{wa}P_{wa}H_{wa}H_{wa}$ or $P_wP_wH_wH_w$	RRR/t_R D_sv_s	

$d_{w1}d_{w1}P_{w1}P_{w1}H_{w1}H_{w1}$

$d_{w2}d_{w2}P_{w2}P_{w2}H_{w2}H_{w2}$

The "boxes" are included in the diagram simply to fix the relative positions of the elements and are not included in the actual plot. The wind plot is not shown in the model. Ship identification letters or buoy identifiers should be plotted above the model. In the case of automatic weather stations, an equilateral triangle should be plotted round the station circle so that the apex of the triangle (△) points towards the position of the medium-cloud symbol.

2. GRAPHIC REPRESENTATION OF DATA ON WEATHER CHARTS

2.1 The following rules concern the symbols to be used for the plotting of various elements figuring in a surface observation:

N Total cloud cover

Code	*Symbol*
0 = 0	
1 = 1 okta or 1/10 or less, but not zero	
2 = 2 oktas or 2/10–3/10	
3 = 3 oktas or 4/10	
4 = 4 oktas or 5/10	
5 = 5 oktas or 6/10	
6 = 6 oktas or 7/10-8/10	
7 = 7 oktas or 9/10 or more, but not 8 oktas or 10/10	
8 = 8 oktas or 10/10	
9 = 9 Sky obscured, or cloud amount cannot be estimated	
/ = No measurements made	

ddff True direction, in tens of degrees, from which wind is blowing (dd) and wind speed in units indicated by i_w (ff)

Wind is represented by barbs and solid pennants in black, the full barbs representing 5 m s^{-1} or 10 knots, the half barbs representing 2.5 m s^{-1} or 5 knots and the solid pennant representing 25 m s^{-1} or 50 knots.

The wind shaft in black is directed along the axis of the wind towards the centre of the station circle and stops at its circumference.

All pennants and barbs lie to the left of the wind shaft in the northern hemisphere and to the right of the wind shaft in the southern hemisphere.

Barbs are at an angle of approximately 120° from the wind shaft. Pennants are triangles with their bases on the wind shaft.

A calm should be indicated by a circle drawn around the station circle:

Missing wind speed should be indicated by placing an "x" at the end of the wind shaft in lieu of the wind barbs. Wind direction is indicated in the usual manner, e.g. x——o. When the wind direction is missing, no wind should be plotted.

V V Horizontal visibility at surface

The code figures are plotted.

ww Present weather reported from a manned weather station (see Note 1)

The symbols for the appropriate code figures are given in the following table:

ww	0	1	2	3	4	5	6	7	8	9
00										
10										
20										
30										
40										
50										
60										
70										
80										
90										

In the polychromatic method, black is used.

In the symbols  and , Δ or * are alternatives, according to the observation.

In the symbols  and , the rain symbol and the snow symbol are alternatives, either • or * being used, except in cases of doubt.

NOTES: (1) The meanings of the code figures for present weather are given in Code table 4677 in the *Manual on Codes* (Publication No. 306) (Annex II to the *Technical Regulations*).

(2) When present and past weather are not included because:

(*a*) They are not significant (i_x = 2 or 5), the spaces for ww and W_1W_2 are left blank;

(*b*) No observation was made (i_x = 3 or 6) or the data are missing (i_x = 1 or 4, but no 7-group in the message), ww and W_1W_2 are both plotted as //.

w_aw_a Present weather reported from an automatic weather station (see Note 2)

The symbols for the appropriate code figures are given in the following table:

w_aw_a	0	1	2	3	4	5	6	7	8	9
00										
10										
20										
30										
40										
50										
60										
70										
80										
90										

The symbols 30, 50, 60 and 70 represent the generic form of weather phenomena and may be plotted in an enlarged form.

The symbol ⌒ can specify any form of precipitation. ‚ specifies rain or drizzle. × specifies solid precipitation.

The symbols in row 80 represent intermittent precipitation, including showers.

NOTES: (1) The meaning of the code figures for present weather reported from an automatic station are given in Code table 4680 in the *Manual on Codes* (WMO-No. 306) (Annex II to the *Technical Regulations*).

(2) When present weather and past weather are not included because:

(*a*) They are not significant ($i_x = 5$),
the squares for w_aw_a and $W_{a1}W_{a2}$ are left blank;

(*b*) No observation was made ($i_x = 6$) or the data are missing ($i_x = 7$ but no 7-group in the message),
w_aw_a and $W_{a1}W_{a2}$ are both plotted as //.

w_1w_1 Present weather (in addition to ww or $w_a w_a$)

The symbols for the appropriate code figures are given in the following table:

w_1w_1	0	1	2	3	4	5	6	7	8	9
00										
10										
20										
30										
40										
50	/0	/1	/2	/3	/4	/5	/6	/7		
60	/0	/1	/2	/3	/4	/5	/6	/7		
70	/0	/1	/2	/3	/4	/5	/6	/7		
80										
90										

The pairs of symbols , or are alternatives according to the observation.

The symbol /2 means drizzle, rain or snow whose rates of fall are indicated by code figures 52, 62, and 72 respectively. The symbols are plotted in conjunction with ww, present weather, or w_aw_a or W_1W_2 or $W_{a1}W_{a2}$. (e.g. /2).

Symbol means over sea, lake or river (over water).

Symbol means on or over mountains.

Symbol means in or over valleys.

NOTE: The meanings of code figures for present weather are given in Code table 4687 in the *Manual on Codes* (Publication No. 306) (Annex II to the *Technical Regulations*).

W_1W_2 Past weather reported from a manned station

The symbols to be plotted for both W_1 and W_2 are taken from the following list:

Code figure		*Symbol*
3	Sandstorm or dust storm	
3	Blowing snow	
4	Fog or ice fog or thick haze	
5	Drizzle	
6	Rain	
7	Snow or rain and snow mixed	
8	Shower(s)	
9	Thunderstorms	

The two symbols are plotted as W_1W_2.

In the polychromatic method, red is used.

NOTE: See Note (2) under ww.

$W_{a1}W_{a2}$ Past weather reported from an automatic station

Code figure		*Symbol*
1	VISIBILITY REDUCED	
2	Blowing phenomena, visibility reduced	
3	FOG	
4	PRECIPITATION	
5	Drizzle	
6	Rain	
7	Snow or ice pellets	
8	Snow shower(s) or intermittent precipitation	
9	Thunderstorm	

NOTE: The meanings of code figures for past weather reported from an automatic station are given in Code table 4531 in the *Manual on Codes* (Publication No. 306) (Annex II to the *Technical Regulations*).

PPPP or $a_3$hhh

Pressure at mean sea-level in tenths of a hectopascal omitting thousands digit of hectopascal of the pressure value or geopotential of the standard "constant pressure level" given by a_3 in standard geopotential metres omitting the thousands digit

Normally the pressure is that which has been reduced to mean sea-level. It may be plotted as reported in four figures or alternatively in three figures by plotting the last three figures only of the group. If $a_3$hhh has been reported instead of pressure reduced to mean sea-level and it is to be plotted on the same chart as mean sea-level pressure observations then it is plotted in four figures and the first figure (a_3) can be used to indicate the datum plane, other than mean sea-level, to which the plotted value refers.

TTT

Air temperature in tenths of a degree Celsius, its sign given by s_n

The actual value of this temperature may be plotted in degrees and tenths of a degree Celsius, the tenths figure being separated by a decimal point , or it may be plotted in whole degrees Celsius, having first been rounded to the nearest degree. Negative values are preceded by a minus sign.

$C_LC_MC_H$

Cloud of the genera Stratocumulus, Stratus, Cumulus and Cumulonimbus (C_L); Altocumulus, Altostratus and Nimbostratus (C_M); and Cirrus, Cirrocumulus and Cirrostratus (C_H)

The symbols for the appropriate code figure are given in the following table:

	1	2	3	4	5	6	7	8	9
C_L									
C_M									
C_H									

In the polychromatic method, black is used. However, the use of red for plotting C_H symbols is optional.

NOTES: (1) The meanings of the code figures for type of cloud are given in Codes tables 0509, 0513 and 0515 in the *Manual on Codes* (Publication No. 306) (Annex II to the *Technical Regulations*).

(2) If, with C_L = 8, it is known that the base of the Sc is below the base of the Cu, the symbol  is used.

N_h

Amount of all C_L cloud(s) present or, if no C_L cloud is present, the amount of all the C_M cloud(s) present

The code figure for N_h is entered to the right of the position allotted to C_L.

h or hh

Height, above ground, of the base of the lowest cloud seen. The cloud figure for h is entered below the position allotted to C_L. If hh is reported, the two code figures for hh may be entered in lieu of h.

$8N_sCh_sh_s$

Genus of cloud (C)

Code figure		*Monochromatic*
0	Cirrus Ci	
1	Cirrocumulus Cc	
2	Cirrostratus Cs	

Code figure		*Monochromatic*
3	Altocumulus Ac	
4	Altostratus As	
5	Nimbostratus Ns	
6	Stratocumulus Sc	
7	Stratus St	
8	Cumulus Cu	
9	Comulonimbus Cb	

The symbols corresponding to code figures 6 to 9 will be plotted in the position allotted to C_L, those corresponding to code figures 3 to 5 in the position allotted to C_M and those corresponding to code figures 0 to 2 in the position allotted to C_H. The symbols should be arranged in ascending order of height of cloud base, i.e. the lowest cloud will be at the bottom.

The code figures for N_s and h_sh_s relating to the lowest cloud layer should normally be plotted in the positions reserved for N_h and h. If the purpose of the chart requires it, the code figures for N_s and h_sh_s for each cloud layer may be plotted against the corresponding cloud symbol in the same manner as are N_h and h for C_L.

$T_dT_dT_d$ Dew-point temperature in tenths of a degree Celsius, its sign being given by s_n

The actual value of this temperature may be plotted in degrees and tenths of a degree Celsius, the tenths figure being separated by by a decimal point, or it may be plotted in whole degrees Celsius, having first been rounded to the nearest degree. Negative values are preceded by a minus sign.

a Characteristic of pressure tendency during the three hours preceding the time of observation

Code figure		*Monochromatic*
0	Increasing, then decreasing; atmospheric pressure the same as or higher than three hours ago	
1	Increasing, then steady; or increasing, then increasing more slowly; atmospheric pressure now higher than three hours ago	
2	Increasing (steadily or unsteadily); atmospheric pressure now higher than three hours ago	
3	Decreasing or steady, then increasing; or increasing, then increasing more rapidly; atmospheric pressure now higher than three hours ago	
4	Steady; atmospheric pressure the same as three hours ago	
5	Decreasing, then increasing; atmospheric pressure the same as or lower than three hours ago	
6	Decreasing, then steady; or decreasing, then decreasing more slowly; atmospheric pressure now lower than three hours ago	
7	Decreasing (steadily or unsteadily); atmospheric pressure now lower than three hours ago	
8	Steady or increasing, then decreasing; or decreasing, the decreasing more rapidly; atmospheric pressure now lower than three hours ago	

ppp — Amount of pressure tendency at station level during the three hours preceding the time of observation, expressed in tenths of a hectopascal

The pressure change is plotted in two figures by plotting only the last figures of ppp unless the first figure of ppp is other than zero, in which case the pressure change is plotted as reported in three figures. The plotting figures may be preceded by a plus sign when a = 0, 1, 2 or 3 and by a minus sign when a = 5, 6, 7 or 8. In this case the symbol for a = 2, 4 (if used) or 7 may be omitted.

D_sv_s — Direction (true) of resultant displacement of the ship (D_s) and ship's average speed made good (v_s) during the three hours preceding the time of observation

The direction D_s is plotted by means of an arrow pointing in the direction towards which the ship is moving and the code figure for the speed v_s is entered to the right of the arrow.

$T_wT_wT_w$ — Sea-surface temperature in tenths of a degree Celsius, its sign given by s_n

The actual value of this temperature is plotted in degrees and tenths of a degree Celsius, the tenths figure being separated by a decimal point, or it may be plotted in whole degrees Celsius, having first been rounded to the nearest degree. Negative values are preceded by a minus sign.

$d_{w1}d_{w1}$ $d_{w2}d_{w2}$ — True direction, in tens of degrees, from which swell waves are coming

This is represented by an arrow with a wavy shaft; the arrow-heads point in the direction towards which the waves are moving. If $d_{w1}d_{w1}$ is reported as 00, a wavy line without an arrow-head is drawn in a north-south direction.

If $d_{w1}d_{w1}$ is reported as 99, crossed arrows with wavy shafts are drawn one from south-west to north-east and the other from south-east to north-west, thus .

If $d_{w1}d_{w1}$ is missing, it is plotted as for $d_{w1}d_{w1}$ 99 but the arrowheads are omitted.

When there is a second swell system reported by $d_{w2}d_{w2}$, this is plotted below the first.

$P_{w1}P_{w1}$ $P_{w2}P_{w2}$ — Period of swell waves in seconds

The code figures for $P_{w1}P_{w1}$ and $P_{w2}P_{w2}$ are plotted immediately to the right of the symbol for $d_{w1}d_{w1}$ and $d_{w2}d_{w2}$.

When there are no swell waves $P_{w1}P_{w1}$ and $P_{w2}P_{w2}$ are not plotted.

$H_{wa}H_{wa}$ H_wH_w $H_{w1}H_{w1}$ $H_{w2}H_{w2}$ — Height of waves, obtained by instrumental methods ($H_{wa}H_{wa}$), wind waves (H_wH_w) or swell waves ($H_{w1}H_{w1}$ and $H_{w2}H_{w2}$), respectively in units of 0.5 metre

These code figures are plotted immediately to the right of the symbols for $P_{wa}P_{wa}$, P_wP_w, $P_{w1}P_{w1}$ or $P_{w2}P_{w2}$ respectively.

When there are no swell waves H_{w1} and H_{w2} are not plotted.

NOTE: If instrumental wave data, as reported in group $1P_{wa}P_{wa}H_{wa}H_{wa}$, are plotted, they should be underlined.

$P_{wa}P_{wa}$ P_wP_w — Period of waves, obtained by instrumental methods ($P_{wa}P_{wa}$) or period of wind waves (P_wP_w), in seconds

The code figure either for $P_{wa}P_{wa}$ or for P_wP_w is plotted under the symbol for low clouds.

NOTE: If instrumental wave data, as reported in group $1P_{wa}P_{wa}H_{wa}H_{wa}$, are plotted, they should be underlined.

RRR — Amount of precipitation which has fallen during the period preceding the time of observation, as indicated by t_R

If following a national decision this element is to be plotted, the following cases may occur:

(*a*) Precipitation amount is reported (i_R = 1 or 2), the figures of RRR are entered at the appropriate place

in the plotting model (see paragraph 1 of this Appendix);

(*b*) Precipitation amount is zero (i_R = 3), RRR is not entered on the map;

(*c*) No observation was made (i_R = 4), RRR is entered as ///.

t_R Duration of period of reference for amount of precipitation, expressed in units of six hours, and ending at the time of the report

The code figure for t_R is entered, except in cases where precipitation is not reported (i_R = 3 or 4).

$T_xT_xT_x$ or $T_nT_nT_n$ Maximum ($T_xT_xT_x$) or minimum ($T_nT_nT_n$) temperature in degrees Celsius and tenths, its sign given by s_n

The actual maximum or minimum temperature is entered in degrees and tenths of a degree Celsius, the tenths figure being separated by a decimal point and negative values being preceded by a minus sign.

T_gT_g Ground (grass) minimum temperature of the preceding night in whole degrees Celsius, its sign given by s_n

The actual value is entered in degrees Celsius, negative values being preceded by a minus sign.

E or E' State of the ground without (E) or with (E') snow or measurable ice cover

One of these is plotted using the appropriate symbol from the following tables:

Code figure for E

0 Surface of ground dry (without cracks and no appreciable amount of dust or loose sand)

1 Surface of ground moist

2 Surface of ground wet (standing water in small or large pools on surface)

3 Flooded

4 Surface of ground frozen

5 Glaze on ground

6 Loose dry dust or sand not covering ground completely

7 Thin cover of loose dry dust or sand covering ground completely

8 Moderate or thick cover of loose dry dust or sand covering ground completely

9 Extremely dry with cracks

Code figure for E'

0 Ground predominantly covered by ice

1 Compact or wet snow (with or without ice) covering less than one-half of the ground

2 Compact or wet snow (with or without ice) covering at least

one-half of the ground but ground not completely covered

Code figure for E' (continued)

3 Even layer of compact or wet snow covering ground completely 

4 Uneven layer of compact or wet snow covering ground completely 

5 Loose dry snow covering less than one-half of the ground 

6 Loose dry snow covering at least one-half of the ground (but not completely) 

7 Even layer of loose dry snow covering ground completely 

8 Uneven layer of loose dry snow covering ground completely 

9 Snow covering ground completely; deep drifts

sss Total depth of snow in centimetres

This is plotted in code figures or actual depths in accordance with national or regional decisions.

GG Actual time of observation to the nearest hour UTC

GG is plotted only if it is different from the reference hour of the chart.

2.2 The following rules determine the symbols to be used for the plotting of the various upper-air observation elements which appear on the constant pressure charts.

(*a*) The wind at the level of the chart should be plotted with a solid shaft touching the station circle, the barbs and solid pennants flying to the left of the wind shaft in the northern hemisphere and to the right of the wind shaft in the southern hemisphere. The full barbs represent 5 m s^{-1} or 10 knots, the half-barbs represent 2.5 m s^{-1} or 5 knots, and the solid pennant represents 25 m s^{-1} or 50 knots.

Derived winds should be plotted with the shaft touching the station circle and the barbs and solid pennants flying towards the side of higher pressure. If one derived wind is plotted, the shaft should be a solid line. If two derived winds are plotted, one of them should be plotted with a broken shaft.

Colour separation between the observed and derived winds is recommended. In wind field analyses code figures may replace the barbs and pennants.

(*b*) Clouds should be plotted with the same symbols as used on surface charts.

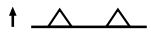
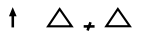
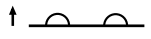
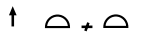
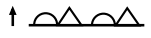
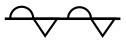
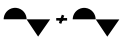
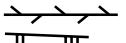
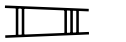
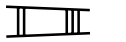
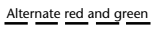
3. ANALYSES AND FORECASTS ON WEATHER CHARTS

3.1 General rules

(*a*) The basic symbol shown in the table below is placed on the chart along the line of the phenomenon and it is repeated as necessary to indicate the extent of the phenomenon;

(*b*) The arrows on items 1 to 10 of the table are not part of the symbol but are entered to indicate the orientation of the symbol with respect to the direction of motion of the phenomenon.

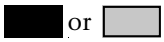
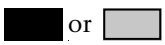
3.2 **Symbols**

Term	*Symbol*	
	Monochromatic	*Polychromatic*
1. Cold front at the surface		
2. Cold front above the surface		
3. Cold front frontogenesis		
4. Cold front frontolysis		
		blue
5. Warm front at the surface		
6. Warm front above the surface		
7. Warm front frontogenesis		
8. Warm front frontolysis		
		red
9. Occluded front at the surface		
10. Occluded front above the surface		
		purple
11. Quasi-stationary front at the surface		
12. Quasi-stationary front above the surface		
13. Quasi-stationary front frontogenesis		
14. Quasi-stationary front frontolysis		
		alternate red and blue
15. Instability line		
16. Shear line		
		black
17. Convergence line		
18. Intertropical convergence zone		
		orange
19. Intertropical discontinuity		

NOTE: The separation of the two lines gives a qualitative representation of the width of the zone; the hatched lines may be added to indicate areas of activity.

3.3 **Representation of weather features**

Weather features on charts may be shown in the manner indicated below:

Feature	*Monochromatic*	*Polychromatic*
(*a*) Zones of continuous precipitation		
	Solid shading or cross-hatching	Solid shading or cross-hatching in green
(*b*) Zones of intermittent precipitation		
	Single hatching	Single hatching in green

The appropriate weather symbol may be distributed over the zone.

Feature	*Monochromatic*	*Polychromatic*
(*c*) Areas of showers	Large shower symbols distributed over the area with the symbol for rain, snow or hail added as appropriate, e.g. 	As monochromatic system but in green
(*d*) Areas of thunderstorms	Large thunderstorm symbols distributed over the area with the symbol for rain, snow or hail added as appropriate, e.g. 	As monochromatic system but in red
(*e*) Areas of fog	Large fog symbols distributed over the area	Solid shading in yellow
(*f*) Areas of duststorm, sandstorm or dust haze	Large symbols for the appropriate phenomenon distributed over the area	Solid brown shading with the appropriate weather symbol distributed over the area

NOTE: In all cases, the extent of the area affected by the phenomena may be delineated by a thin boundary line of the same colour. The shading, hatching or superimposed symbols should not obliterate the plotted data.

4. REPRESENTATION OF THE ANALYSIS AND FORECAST ON SPECIFIC CHARTS

4.1 Surface charts

4.1.1 *Fronts*

Fronts will be shown using the symbols given in paragraph 3.2.

4.1.2 *Isobars*

It is recommended that isobars be drawn at intervals of 4 or 5 hPa. Multiples or sub-multiples of these basic intervals may be used depending on the scale and purposes of the chart but, whatever the intervals, the 1 000 hPa isobar should always be included in the series.

4.1.3 *Pressure centres*

(*a*) The location of a pressure centre may be indicated by a cross. To indicate the nature of the centre, a capital letter appropriate to the language of the country is entered above the symbol marking the centre.

(*b*) In the case of tropical cyclonic circulations the centre is marked by a special symbol as shown below:

 For a tropical cyclonic circulation with observed or estimated maximum winds of 17 to 63 kt (29 to 117 km/h);

 For a tropical cyclonic circulation with observed or estimated maximum winds of 64 kt (118 km/h) or more.

(*c*) The letter or the symbol for a tropical cyclonic circulation should be aligned parallel to the adjacent meridian.

(*d*) Pressure centres may be given an identifying letter to assist in their tracking from chart to chart. This should be written as a suffix to the letter or symbol defining the pressure centre. A tropical cyclonic circulation may have a name assigned to it. This may be entered in block letters near to the centre.

(*e*) The value of the pressure at the centre should be entered in whole hectopascals immediately below the symbol marking the centre, the number being parallel to the adjacent line of latitude.

4.1.4 *Tracks of pressure centres*

The previous positions of a pressure centre may be entered by means of symbols in the same way as the present position. Above each symbol may be entered the corresponding time in hours (two figures) and below it the pressure of the centre at that time in hectopascals. The symbols should be joined by a thick broken line. The forecast position of a pressure centre may also be indicated by a symbol in the same way as the present position, the time and the estimated pressure being entered above and below the symbol respectively. The present position and the forecast position should be joined by a solid arrow drawn along the track the centre is forecast to take.

4.1.5 *Isallobars*

Isallobars of three-hour change should normally be drawn for intervals of single hectopascals. Large intervals may be used if the scale of the chart is small or if the period is longer than three hours. The "no change" line will be numbered with a zero and the numbers on the other lines will be preceded by a plus sign if the pressure has risen and a minus sign if it has fallen.

4.2 Charts of isobaric surfaces

4.2.1 *Fronts*

If fronts are entered, the symbols given in paragraph 3.2 should be used.

4.2.2 *Isohypses of absolute topography or contour lines*

It is recommended that contour lines be drawn at intervals of either 40 gpm (80, 20 and 10 when appropriate) or 60 gpm (120, 30, 15 when appropriate). The lines should be numbered in geopotential decametres, e.g. 5280 gpm should be labelled 528.

4.2.3 *Height centres*

The positions present, past and forecast of high and low centres in the contours may be indicated in the same way as for pressure centres on surface charts (see paragraphs 4.1.3 and 4.1.4). Above the symbol marking a centre may be entered a capital letter appropriate to the language of the country. The value of the height at the centre should be entered immediately below the symbol marking the centre to the nearest ten metres, e.g. 5280. The number should be entered parallel to the adjacent line of latitude.

4.2.4 *Isotachs*

Isotachs should normally be drawn at intervals of 20 kt (40, 10 and 5 when appropriate). Centres of regions of minimum and maximum speed may be marked according to national practices. On the maximum wind charts, however, the maximum should be marked by a "J" followed by the estimated maximum speed, e.g. J 120.

4.2.5 *Jet streams*

A jet stream should be marked by a heavy, solid line with arrow-heads placed at intervals along it pointing in the direction of the flow in the stream.

4.2.6 *Isohypses of relative topography or thickness lines*

If thickness lines are drawn, the following intervals are recommended: either 40 gpm (80, 20 and 10 when appropriate) or 60 gpm (120, 30, 15 when appropriate).

4.2.7 *Isotherms*

Isotherms will not normally be drawn on charts on which thickness lines are entered. Isotherms should be drawn at intervals of either 5°C (10°C and 2.5°C when appropriate) or 2°C (1°C when appropriate).

4.2.8 *Moisture lines*

If lines of equal dew point are drawn, the same intervals as for isotherms may be used.

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APPENDIX II-5

TIMES OF AVAILABILITY OF PRODUCTS WITH HIGH OPERATIONAL PRIORITY

	*Short-range 00–72 hours	Medium-range 72–120 hours	Medium-range 120–240 hours
Global model products (digital)	H + 5 (9)	H + 6 (10)	H + 11 (13)
Global model products (graphic)	H + 6 (10)	H + 7 (11)	H + 12 (14)
Regional model products (digital)	H + 4 (5)		
Regional model products (graphic)	H + 5 (6)		

* 00 denotes analyses.

Notes:

(1) This table states, e.g. H + 5 (9) hours, within which different categories of products should normally be transmitted to the different centres. H is the time of basic observations. The first figure is the time necessary for collection of data, for processing and transmission of products in regions where telecommunication systems, processing and receiving centres make full use of modern technical equipment. The figure in brackets is applicable where the GDPS operates under most difficult conditions.

(2) Charts of high operational priority normally mean surface and 500 hPa analyses and forecasts. High priority may also be given to other products, if based on regional requirements and agreements.

(3) Concerning forecasts, high priority is given to regional forecasts up to one or three days, and to global forecasts up to five days or even more, if these forecasts will have reached an acceptable degree of reliability.

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APPENDIX II-6

OVERALL LIST OF OUTPUT PRODUCTS REQUIRED FOR INTERNATIONAL EXCHANGE FROM GDPS CENTRES

Within the constraints of technology and programme requirements, model output should be supplied at the highest possible resolution.

1. **ANALYSES**

Surface (including synoptic features)
925 hPa
850 hPa
700 hPa
500 hPa
400 hPa
300 hPa
250 hPa
200 hPa
150 hPa
100 hPa
70 hPa
50 hPa
30 hPa
20 hPa
10 hPa

} Parameters: Pressure (P)/geopotential height (H), temperature (T), wind (W) and humidity (R), as appropriate and applicable

Tropopause and maximum wind or tropopause and vertical wind shear
Relative topography, in particular the thickness 500/1 000 hPa
Jet streams
Digitized cloud mosaics
Mapped radiometric data
Stability
Precipitable water
Snow depth
Changes to 500 hPa, 24 hours
Changes to relative topography, thickness 500/1 000 hPa, 24 hours
Freezing level
Pressure changes, three hours
Pressure changes, 12 and/or 24 hours
Precipitation areas, six hours
Precipitation areas, 24 hours
Sferics
Radar echoes
Nephanalyses
Sea-surface temperature
Land-surface temperature
Snow and ice cover
Storm alerts
Sea ice
State of sea
Storm surge
Thermoclines
Superstructure icing
Top of Ekman layer
Surface air trajectories

850 hPa air trajectories
700 hPa air trajectories
500 hPa air trajectories
Health risk index for travellers
Stratospheric ozone bulletins
Assessments of satellite ground-truthing radiation experiments
Climate-related analyses (e.g. climate system monitoring and climate normals)

2. **FIVE-DAY, 15-DAY AND 30-DAY MEAN ANALYSED VALUES AND ANOMALIES**

Surface, 850 hPa, 500 hPa } Parameters: P/H, T, W and R, as appropriate and applicable
Sea-surface temperature anomaly

3. **PLOTTED DATA**

Plotted surface data (three-hourly)
Plotted upper-air data (850, 700, ..., 100 hPa)
Tabulated winds
Aerological diagrams

4. **FORECASTS**

Surface (including synoptic features), 925 hPa, 850 hPa, 700 hPa, 500 hPa, 400 hPa, 300 hPa, 250 hPa, 200 hPa, 150 hPa, 100 hPa, 70, 50, 30, 20, 10 hPa } Parameters: P/H, T, W and R, as appropriate and applicable
Jet-stream location and tropopause/layer of maximum wind
Significant weather
Relative topography, thickness 500/1 000 hPa

NOTE: The above list includes products which are required as part of the ICAO World Area Forecast System in accordance with requirements determined by ICAO.

Freezing level
Vorticity
Vertical motion
Areal distribution of cloudiness
Precipitation location, occurrence, amount and type
Sequences at specific locations (time diagrams) at the surface and aloft of T, P, W and R
Vorticity advection, temperature/thickness advection, vertical motion, stability indices, moisture distribution and other derived parameters
Tropical storm positions and intensities
River stage, discharge and ice phenomena
Tropical depression and easterly wave positions and movement
Four-to-10-day outlook for T, W, R and precipitation
Forecasts of probability of precipitation and temperature extremes for mid-latitudes and subtropical areas or forecasts of cloudiness, temperature range and precipitation probability for tropical areas
State of sea
Storm surge

Sea-surface temperature
Thermoclines
Sea ice
Superstructure icing
Three-dimensional trajectories with particle locations at synoptic hours for EER
Time integrated pollutant concentration within the 500 m layer above ground in three time periods up to 72 hours for EER
Total deposition up to 72 hours

4.1 **Ensemble prediction system products**

4.1.1 Products for short range and medium range

(*a*) GOBAL PRODUCTS FOR ROUTINE DISSEMINATION
(Period for all fields: forecast D+0 to D+10 (12-hour intervals) at highest resolution possible)
Probabilities of:
(i) Precipitation exceeding thresholds 1, 5, 10, 25 and 50 mm/24 hours
(ii) 10 m sustained wind and gusts exceeding thresholds 10, 15 and 25 m s^{-1}
(iii) T850 anomalies with thresholds -4, -8, +4 and +8 K with respect to a reanalysis climatology specified by the producing Centre
Ensemble mean (EM) + spread (standard deviation) of Z500, PMSL, Z1000, vector wind at 850 and 250 hPa
Tropical storm tracks (lat/long locations from EPS members)

(*b*) MODEL FIELDS
Full set or subset of EPS members variables and levels for requesting WMO Members for specific applications.
Extended range forecasts (levels and parameters as appropriate five, 10, 15 or 30 day) and applicable mean values
Long-range forecasts (monthly, three-month or 90-day, seasonal to multi-seasonal outlook)

4.1.2 Products for extended range

ENSEMBLE MEANS ANOMALIES/SPREAD
One week averages and the monthly mean (all anomalies with respect to model climate):
Tropical SST
Standard ENSO/indices
Z500 and Z1000, precipitation, T850 and surface temperature

Probabilities:
Terciles: above, below, normal (with respect to model climate)
Precipitation
Z500
Z1000
T850 and surface temperature

Model fields:
(*a*) Full set or subset of EPS members variables and levels for requesting WMO Members for specific applications.
(*b*) Relevant post-processed fields from sequence of daily output (e.g. indices of monsoon onset, droughts, tropical storm activity, extratropical storm track activity)

NOTE: The list of long-range products for distribution as developed by the CBS Expert Team on the Infrastructure for Long-range Forecasting is being validated prior to being adopted as part of the appendix to this *Manual*.

APPENDIX II-7

USERS INTERPRETATION GUIDE FOR ATMOSPHERIC TRANSPORT MODEL PRODUCTS PROVIDED BY RSMCs

Standards in the provision of international services by RSMCs for nuclear environmental emergency response

The Delegated Authority requests support from WMO Regional Specialized Meteorological Centres (RSMC) for atmospheric transport modelling products by using the form entitled "Environmental Emergency Response — Request for WMO RSMC Support by Delegated Authority". The Delegated Authority then sends the completed form immediately to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. This will initiate a joint response from the RSMCs in their region of responsibility.

The International Atomic Energy Agency (IAEA) requests support from WMO RSMCs for atmospheric transport modelling products by using the form agreed between WMO and IAEA. The IAEA then sends the completed form immediately to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. This will initiate a joint response from the RSMCs in their region of responsibility.

The designated RSMCs shall implement agreed standard procedures and products by:

(*a*) The provision of the following standard set of basic products within two to three hours of reception of a request and according to the general rules for displaying results;

(*b*) The adoption of the following forecast periods for the numerical calculations;

(*c*) The adoption of a joint response approach;

(*d*) The adoption of the general rules for displaying results.

1. Default values to be used in response to a request for products for the unspecified source parameters[1]

(*a*) Uniform vertical distribution up to 500 m above the ground;

(*b*) Uniform emission rate during six hours;

(*c*) Starting date/time: date/time specified at "START OF RELEASE" on request form or, if not available, then the "date/time of request" specified at the top of the request form;

(*d*) Total pollutant release 1 Bq (Becquerel) over six hours;

(*e*) Type of radionuclide ^{137}Cs.

2. Basic set of products

Five maps consisting of:

(*a*) Three-dimensional trajectories starting at 500, 1 500 and 3 000 m above the ground, with particle locations at six-hour intervals (main synoptic hours up to the end of the dispersion model forecast);

(*b*) Time-integrated airborne concentrations within the layer 500 m above the ground, in Bq s m^{-3} for each of the three forecast periods;

(*c*) Total deposition (wet + dry) in Bq m^{-2} from the release time to the end of the dispersion model forecast.

A joint statement that will be issued as soon available.

3. Forecast periods for numerical calculations

The initial set of products will cover the period from T, the start time of the release, through a forecast of 72 hours from t, the start time of the current output from the operational NWP model.

1 The adoption of default values is based on the understanding that some runs of the transport/dispersion models need to be carried out with default parameters because little or no information (except location) will be available to the RSMC at an early stage. RSMCs are, however, requested to conduct and propose subsequent model runs with more realistic parameters as they become available (products based upon updated parameters will be provided on request only or confirmed from IAEA or a Delegated Authority). This may, for example, refer to a more precise assumption of the vertical distribution or the need to conduct a model run for the release of noble gases.

The first 24-hour period for integrated exposures in the dispersion model will start at the nearest synoptic time (0000 or 1200 UTC) prior to or equal to T. Subsequent 24-hour integrations of the dispersion model will be made up to, but not exceeding, the synoptic time nearest to t+72.

If T is earlier than t, the first response will use hindcasts to cover the period up to t.

4. Joint response and joint statements

A joint response means that the collaborating RSMCs shall immediately inform each other of any request received; initially both should produce and send the basic set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a "joint statement" to describe a synopsis of the current and forecast meteorological conditions over the area of concern, and the results from the transport models, their differences and similarities and how they apply to the event.

5. General rules for displaying results

In order to make the interpretation of the maps easier, the producing centres should adopt the following guidelines:

General guidelines for all maps:

(*a*) Provide labelled latitude and longitude lines at 10° intervals and sufficient geographic map background (shore lines, country borders, etc.) to be able to locate precisely the trajectories and contours;

(*b*) Indicate the source location with a highly visible symbol (●, ▲, ✕, ✻, ■, etc.);

(*c*) Indicate the source location in decimal degrees (latitude — N or S specified, longitude — E or W specified, plotting symbol used), date/time of release (UTC), and the meteorological model initialization date/time (UTC);

(*d*) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

(*e*) Previously transmitted products from the dispersion model need not be re-transmitted;

(*f*) Indicate with a legend if this is an exercise, requested services, or an IAEA notified emergency.

Specific guidelines for trajectory maps:

(*a*) Distinguish each trajectory (500, 1 500, 3 000 m) with a symbol (▲, ●, ■, etc.) at synoptic hours (UTC);

(*b*) Use solid lines (darker than map background lines) for each trajectory;

(*c*) Provide a time-height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

Specific guidelines for concentration and deposition maps:

(*a*) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10;

(*b*) A legend should indicate that contours are identified as powers of 10 (i.e. $-12 = 10^{-12}$). If grey-shading is used between contours, then the individual contours must be clearly distinguishable after facsimile transmission and a legend provided on the chart;

(*c*) Use solid dark lines (darker than map background lines) for each contour;

(*d*) Indicate the following input characteristics: (i) source assumption (height, duration, isotope, amount released); (ii) the units of time integrated concentration (Bq s m^{-3}) or deposition (Bq m^{-2}). In addition, charts should specify: (i) "Time integrated surface to 500 m layer concentrations"; (ii) "Contour values may change from chart to chart", and if the default source is used; (iii) "results based on default initial values";

(*e*) Indicate, if possible, the location of the maximum concentration/deposition with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(*f*) Indicate the time integration starting and ending date/time (UTC).

The RSMCs will normally provide the products in the ITU-T T4 format suitable for both group 3 facsimile machines and transmission on parts of the GTS. The RSMC may also make use of other appropriate technologies.

ENVIRONMENTAL EMERGENCY RESPONSE ALERT

REQUEST FOR WMO RSMC SUPPORT BY DELEGATED AUTHORITY

This form should be sent by fax to the RSMC. At the same time, the Delegated Authority must immediately call the RSMC to confirm the transmission of this request for RSMC support.

(This section must be completed in full)

STATUS: . . . . . .(EVENT OR EXERCISE) Date/time of request: .....(UTC)

NAME OF DELEGATED AUTHORITY: . . . . . .

COUNTRY: . . . . . .

DELEGATED AUTHORITY TELEPHONE/FAX NUMBERS: (.....) . . . . . .(Tel)

(.....) . . . . . .(Fax)

REPLY TELEPHONE/FAX NUMBERS FOR NMS OF

REQUESTING COUNTRY: (.....) . . . . . .(Tel)

(.....) . . . . . .(Fax)

NAME OF RELEASE SITE: . . . . . .(facility and place)

GEOGRAPHICAL LOCATION OF RELEASE: . . . . . .(lat./long. decimal degrees N or S; E or W)

(essential accident information for model simulation — if not available, model will execute with standard default values)

RELEASE CHARACTERISTICS:

START OF RELEASE: . . . . . .(date/time, UTC)

DURATION: . . . . . .(hours), or end of release . . . . . .(date/time, UTC)

RADIONUCLIDE SPECIES: . . . . . .

TOTAL RELEASE QUANTITY: . . . . . .(Becquerel)

OR POLLUTANT RELEASE RATE: . . . . . .(Becquerel/hour)

EFFECTIVE HEIGHT OF RELEASE: Surface: . . . . . .or

Stack height: . . . . . .(m), or

Aloft: top . . . . . .(m), base . . . . . .(m)

(helpful information for improved simulation)

SITE ELEVATION: . . . . . .(m)

LOCAL METEOROLOGICAL CONDITIONS NEAR ACCIDENT: . . . . . .

. . . . . .

. . . . . .

. . . . . .(wind speed and direction/weather/cloudiness, etc.)

OTHER INFORMATION: . . . . . .

. . . . . .

. . . . . .

. . . . . .(nature of accident, cause, fire explosion, controlled release, foreseeable development, normal activity, projected conditions, etc.)

(to be completed by RSMC)

DATE/TIME OF RECEIPT OF REQUEST: . . . . . .(UTC)

DATE/TIME OF RETURN CONFIRMATION OF RECEIPT: . . . . . .(UTC)

NOTE: All times in UTC.

ENVIRONMENTAL EMERGENCY RESPONSE REQUEST
FOR WMO RSMC SUPPORT BY IAEA

STATUS: ❒ **EMERGENCY** ❒ **EXERCISE** Date/Time of Request: - - / : (UTC)

REQUESTED RSMCs: (indicate the lead RSMCs by a checkmark below)

❒ BRACKNELL ❒ TOULOUSE ❒ MELBOURNE ❒ MONTREAL ❒ WASHINGTON
❒ BEIJING ❒ TOKYO ❒ OBNINSK

SENDERS NAME: INTERNATIONAL ATOMIC ENERGY AGENCY

COMMUNICATION DETAILS:
Tel.: +43 1 2600 22023 use to confirm receipt of request
Fax: +43 1 26007 29309 use to confirm receipt of request
Email: eru3@iaea.org use to confirm receipt of request

NAME OF RELEASE SITE AND COUNTRY (facility and place)

GEOGRAPHICAL LOCATION OF RELEASE:
(MUST BE COMPLETED) . decimal degrees ❒ N ❒ S
. decimal degrees ❒ E ❒ W

DECLARED EMERGENCY CLASS:
❒ NONE ❒ other, specify:

ACTION REQUIRED:
- ❒ NONE
- ❒ GO ON STANDBY (request for products or for assistance on weather conditions is to be expected)
- ❒ GENERATE STANDARD PRODUCTS AND SEND TO IAEA ONLY
- ❒ GENERATE STANDARD PRODUCTS FOR IAEA AND REGIONAL DISTRIBUTION
- ❒ OTHER ACTION:

(essential accident information for model simulation — if not available, model will execute with standard default values)

RELEASE CHARACTERISTICS:
START OF RELEASE: . . . . . .(date/time, UTC)
DURATION: . . . . . .(hours), or end of release . . . . . .(date/time, UTC)
RADIONUCLIDE SPECIES: . . . . . .
TOTAL RELEASE QUANTITY: . . . . . .(Becquerel)
OR POLLUTANT RELEASE RATE: . . . . . .(Becquerel/hour)
EFFECTIVE HEIGHT OF RELEASE: Surface: . . . . . .or
Stack height: . . . . . .(m), or
Aloft: top . . . . . .(m), base . . . . . .(m)

(helpful information for improved simulation)

SITE ELEVATION: . . . . . .(m)
LOCAL METEOROLOGICAL CONDITIONS NEAR ACCIDENT: . . . . . .
. . . . . .
. . . . . .
(wind speed and direction/weather/cloudiness, etc.)
OTHER INFORMATION: . . . . . .
. . . . . .
. . . . . .
(nature of accident, cause, fire explosion, controlled release, foreseeable development, normal activity, projected conditions, etc.)

(to be completed by RSMC)

DATE/TIME OF RECEIPT OF REQUEST: . . . . . .(UTC)
DATE/TIME OF RETURN CONFIRMATION OF RECEIPT: . . . . . .(UTC)

NOTE: All times in UTC.

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ATTACHMENT II.1

LIST OF GLOBAL MODEL OUTPUT PRODUCTS WHOSE PREPARATION SHOULD BE GIVEN HIGHEST PRIORITY BY WMCs AND RSMCs

1. **ANALYSES**

Surface 00, 12 UTC
850 hPa "
700 hPa "
500 hPa "
300 hPa "
200 hPa "
100 hPa "
50 hPa* "
or
70 hPa* "

} Parameters: Pressure (P)/geopotential height (H), temperature (T), wind (W) and humidity (R), as appropriate and applicable

Nephanalyses or digitized cloud mosaics
Storm alerts

} As applicable

Area coverage: northern hemisphere, southern hemisphere and the tropical areas

Five-day, 15-day and 30-day mean analysed values and anomalies
Surface
850 hPa
500 hPa
Sea-surface temperature anomaly

} Parameters P/H, T, W and R as appropriate and applicable

2. **FORECASTS**

Surface	H+24 (00, 12 UTC),	H+48 (00, 12 UTC),	H+72,	beyond H+72,	beyond 240		
850 hPa	"	"	"	"	"	"	"
700 hPa	"	"	"	"	"	"	
500 hPa	"	"	"	"	"	"	, beyond 240
300 hPa	H+24 (00, 12 UTC),	H+48 (00, 12 UTC)					
250/200 hPa	H+24 (00, 12 UTC),	H+48 (00, 12 UTC),	H+72,	beyond H+72,	beyond 240		
100 hPa	H+24 (00, 12 UTC),	H+48 (00, 12 UTC),	H+72				

Precipitation and vertical motion (twice per day)
Tropical storm position and intensity
Sea-surface temperature anomaly
Transport model products for EER (as required)
Extended-range forecasts
Five-, 10-, 15- or 30-day mean surface
Five-, 10-, 15- or 30-day mean 850 hPa
Five-, 10-, 15- or 30-day mean 500 hPa

} Parameters as appropriate and applicable

Long-range forecasts (monthly, three-month or 90-day, seasonal to multi-seasonal outlook)
Area coverage: northern hemisphere and southern hemisphere, middle latitude and subtropical areas, and products for the tropical areas
Parameters: P/H, T, W and R, as appropriate and applicable

* In accordance with any requirements expressed by regional associations

ATTACHMENT II.2

LIST OF REGIONAL MODEL OUTPUT PRODUCTS WHOSE PREPARATION SHOULD BE GIVEN HIGHEST PRIORITY BY RSMCs

1. **ANALYSES**

Surface	00, 06, 12, 18 UTC	Parameters: Pressure (P)/ geopotential height (H), temperature (T), wind (W) and humidity (R), as appropriate and applicable
925 hPa	00, 12 UTC	
850 hPa	00, 12 UTC	
700 hPa	00, 12 UTC	
500 hPa	00, 12 UTC	
400 hPa	00, 12 UTC	
300 hPa ***or*** 250 hPa	00, 12 UTC	
200 hPa	00, 12 UTC	
150 hPa	00, 12 UTC	
100 hPa	00, 12 UTC	
50 hPa* ***or*** 70 hPa*	00, 12 UTC*	

Tropopause and maximum wind or tropopause and vertical wind shear 00, 12 UTC

Sea-surface temperature as appropriate, but not more than once daily

Nephanalyses

Sea-ice distribution as appropriate, but not more than once daily

2. **FORECASTS**

Surface	00, 06, 12, 18 UTC, H+24 (once daily), H+48 or H+36 (once daily)
850 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)
700 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC)
500 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)
400 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC), H+36 (00, 12 UTC)
300 hPa ***or*** 250 hPa ***or*** 200 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)
150 hPa	H+18 (00, 12 UTC)*, H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)
100 hPa**	H+24 (00, 12 UTC)**, H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)

Parameters: P/H, T, W and R as appropriate and applicable

Precipitation location, occurrence, amount and type

* In accordance with any requirements expressed by regional associations

** To meet aviation demands in accordance with requirements expressed by regional associations

Tropopause and maximum wind or tropopause and vertical wind shear: H+18 (00, 12 UTC), H+24 (00, 12 UTC)

Significant weather: four times per day*

State of sea: at least once daily

Vertical motion or vorticity: H+24 (00, 12 UTC), H+48 or H+36 (00, 12 UTC)

Tropical storm position and intensity

Tropical depression and coastal wave position and movement

Transport model products for EER (as required)

Four- to-10-day outlook for surface T, W, R and precipitation

Forecasts of probability of precipitation and temperature extremes for middle latitude and subtropical areas or forecasts of cloudiness, temperature range and precipitation probability for tropical areas

* In accordance with any requirements expressed by regional associations

ATTACHMENT II.3

TRANSMISSION PRIORITIES FOR GLOBAL MODEL PRODUCTS FROM WMCs AND RSMCs

1. **FORECASTS BASED ON 00 AND 12 UTC DATA**

24 h	500 hPa
24 h	surface
48 h	500 hPa
48 h	surface
72 h	500 hPa
72 h	surface
300 hPa *or* 250 hPa *or* 200 hPa	24 h, 48 h and 72 h

Medium-range products (beyond H+72):

surface
850 hPa
500 hPa
250/200 hPa

Larger-range products (beyond H + 240):

surface
850 hPa
500 hPa
200/250 hPa

} Parameters, as appropriate

2. **ANALYSES**

Surface	00 and 12 UTC
500 hPa	00 and 12 UTC
300 hPa *or* 250 hPa *or* 200 hPa	00 and 12 UTC
100 hPa	00 and 12 UTC*
50 hPa	00 UTC*

Nephanalyses, as available

3. **FORECASTS**

24 h 100 hPa, based on 00 and 12 UTC data*
Parameters: P/H, T, W and R, as appropriate and applicable
Precipitation and vertical motion
Tropical storm position and intensity
Sea-surface temperature anomaly
Transport model products for EER (as required)
Extended-range forecasts five-, 10-, 15- or 30-day mean values (level surface, 500 hPa and parameters as applicable)
Long-range forecasts (monthly, three-month or 90-day, seasonal to multi-seasonal outlook)

* In accordance with any requirements expressed by regional associations

ATTACHMENT II.4

TRANSMISSION PRIORITIES FOR REGIONAL MODEL PRODUCTS FROM RSMCs

Surface	Analyses: 00 and 12 UTC Forecasts: 24 h, based on 00 and 12 UTC data
850 hPa, 700 hPa, 500 hPa	Analyses: 00 and 12 UTC Forecasts: 24 h, based on 00 and 12 UTC data
Either 300, 250 or 200 hPa*	Analyses: 00 and 12 UTC Forecasts: 24 h, based on 00 and 12 UTC data
100 hPa** and 50 hPa**	Analyses: 00 and 12 UTC Forecasts: 24 h, based on 00 and 12 UTC data
Products beyond H+36 up to and including H+72	Surface 850 hPa 700 hPa 500 hPa 250/200 hPa 100 hPa
Medium-range products (beyond H+72)	Surface 850 hPa 500 hPa 250/200 hPa
Significant weather	Forecasts: 00/06/12/18 UTC Requirements established regionally
Nephanalyses	One per day as available
State of sea	Forecasts: 24 h, based on 00 and 12 UTC data
Tropopause/maximum wind ***or*** Tropopause/vertical wind-shear analysis	00 and 12 UTC
Precipitation location, occurence, amount and type	As available
Parameters: PH, T, W and R as appropriate and applicable	
Tropical storm position and intensity	
Tropical depression and easterly wave position and movement	
Transport model products for EER (as required)	
Four-to-five-day or four-to-10-day outlook for surface T, W, R and precipitation	
Forecasts of probability of precipitation and temperature extremes for middle latitude and subtropical areas or forecasts of cloudiness, temperature range and precipitation probability for tropical areas	

* The use of 300 hPa, 250 hPa or 200 hPa to be decided by regional associations

** In accordance with any requirements expressed by regional associations

ATTACHMENT II.5

TRANSMISSION PRIORITIES AFTER OUTAGES

1. **OBSERVATIONAL DATA**

Storm alerts
TEMP, TEMP SHIP (Part A)
Soundings derived from satellite data
} Not more than 12 hours after the time of observation

SYNOP and SHIP – Not more than six hours for the 06 and 18 UTC observations or 12 hours for the 00 and 12 UTC observations

2. **GLOBAL MODEL PRODUCTS FROM WMCS AND RSMCS**

48 h surface, 850, 700 and 500 hPa forecasts, 00 or 12 UTC
72 h surface, 850, 700 and 500 hPa forecasts, 00 or 12 UTC
} Until new products are available

3. **REGIONAL MODEL PRODUCTS FROM RSMCS**

24 h surface forecasts, 00 or 12 UTC
24 h 850, 700 and 500 hPa forecasts, 00 or 12 UTC
24 h forecasts of the 300 ***or*** 250 ***or*** 200 hPa level
24 h 100 hPa forecasts, 00 or 12 UTC*
24 h 50 hPa forecasts, 00 or 12 UTC*
} Until new products are available

Parameters: P/H, T, W and R as appropriate and applicable

* In accordance with any requirements expressed by regional associations

ATTACHMENT II.6

MINIMUM PRODUCT LIST FOR TRANSMISSION IN BINARY, ALPHANUMERIC AND PICTORIAL FORM

1. **FORECASTS**

24 h 500 hPa 24 h 700 hPa 24 h 850 hPa 24 h surface 48 h 500 hPa 48 h 700 hPa 48 h 850 hPa 48 h surface	Based on 00 and 12 UTC data
72 h 500 hPa 72 h 700 hPa 72 h 850 hPa 72 h surface	Based on 00 *or* 12 UTC data
300 hPa ***or*** 250 hPa ***or*** 200 hPa	24 h, based on 00 and 12 UTC data

2. **ANALYSES**

Surface 850 hPa 700 hPa 500 hPa 300 hPa ***or*** 250 hPa ***or*** 200 hPa	Based on 00 or 12 UTC data

Nephanalyses, as available

Parameters: P/H, T, W and R as, appropriate and applicable

ATTACHMENT II.7

PLAN FOR MONITORING THE OPERATION OF THE WORLD WEATHER WATCH

OBJECTIVES

1. The objectives of the monitoring effort are to improve the performance of the World Weather Watch (WWW), in particular the efficiency and effectiveness of the operation of the WWW Global Observing System (GOS), the Global Data-processing System (GDPS) and the Global Telecommunication System (GTS) on a national, regional and global level. As the operation of these three elements of the WWW (GOS, GDPS, and GTS) is so interrelated, each element cannot be monitored independently; therefore, for efficient monitoring of the operation of the WWW as an integrated system, close coordination between all centres concerned, as well as with the WMO Secretariat, is essential in order to identify the deficiencies and initiate corrective action as quickly as possible.

2. The implementation of the monitoring plan involves all three subsystems of the WWW. Thus, in the context of monitoring, the GOS is responsible for ensuring that the observations are made according to the prescribed standards, are encoded correctly and are presented for transmission at the times laid down; in addition, the GOS responds in timely fashion to requests for checks, corrections, etc. The GTS is responsible for ensuring the regular flow of meteorological information, both raw and processed. This involves keeping a close watch on the receipt and transmission of information, generating requests for missing bulletins and other products when necessary, checking telecommunication formats, arranging for the re-routeing of traffic in cases of outages and other difficulties, and so on. The GDPS provides processed information for timely distribution and also has an important role in the quality control of data.

3. An important objective of any monitoring activity must include provision for the identification of deficiencies and also for corrective action to improve the efficiency and effectiveness of the WWW. Success is measured in terms of how many deficiencies are corrected.

4. In accordance with the decision of Seventh Congress, the following items should be included in the monitoring programme:

(*a*) Regularity of observations;

(*b*) Quality of observational data and correct coding;

(*c*) Completeness and timeliness of collection of observational data at the NMC concerned;

(*d*) Adherence to WMO standard codes and telecommunication procedures;

(*e*) Collection of observational data at RTHs and WMCs;

(*f*) Exchange of data and processed information on the regional meteorological telecommunication networks and the Main Telecommunication Network;

(*g*) Evaluation of the observations and processed information received at NMCs, RSMCs and WMCs in respect of their data needs.

BASIC COMPONENTS

5. REAL-TIME MONITORING

Real-time monitoring is the term used to describe monitoring which is carried out quickly enough to allow remedial action to be taken in time to be of value in day-to-day meteorological work. Ideally, it should be carried out within the times specified in the appropriate *Manuals* and *Guides* as the maximum acceptable time delays for the receipt of meteorological information, but in practice it is still valuable if it can be carried out before similar subsequent information is received.

In view of the short time available, corrective action on real-time monitoring should be restricted to departures from the normal, e.g. bulletins or observations which are not received in time, obvious or suspected errors, and so on. Thus real-time monitoring requires the provision of information concerning:

- Bulletins not received by the specified time;
- Observations not received by the specified time, or which are incorrect or suspect, or cannot be interpreted with confidence;
- Inadequacies in receipt of processed information.

6. NON-REAL-TIME MONITORING

Non-real-time monitoring is the term used to describe monitoring which is carried out over a specific time period. The purpose of non-real-time monitoring is to keep under review the general performance of the WWW and to identify shortcomings which may persist after real-time monitoring has been carried out. Non-real-time monitoring requires the preparation of summaries and various statistics which become available after a certain time, which may vary from a few hours to several months.

7. FOLLOW-UP ACTION FOR COORDINATION AND ASSISTANCE

In the real-time mode, the initial corrective action will be immediate and will be taken at the centres concerned or at the point of observation. In the non-real-time mode, follow-up action will be taken by the Members concerned to remedy any deficiencies with respect to the WWW plan. In some cases, this might involve obtaining advice on the procedures for obtaining external assistance and information on the maintenance and operation of their WWW facilities. In addition, the Secretary-General will take action as indicated in paragraph 16 below.

DEFINITIONS AND STANDARDS

8. IN THE MONITORING CONTEXT, THE TERMS USED AND THE MINIMUM STANDARDS TO BE ATTAINED SHOULD BE AS DEFINED IN THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM*, THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM*, THE *MANUAL ON CODES*, THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* AND RELEVANT PARTS OF THE *TECHNICAL REGULATIONS*.

PRIORITIES

9. THE MONITORING SCHEME SHOULD CONCENTRATE, IN THE ORDER OF PRIORITY GIVEN BELOW, ON THE ESTABLISHMENT OF CHECKS ON THE FOLLOWING INFORMATION:

(*a*) TEMP and TEMP SHIP and TEMP MOBIL, Parts A and B;

(*b*) PILOT, PILOT SHIP and PILOT MOBIL, Parts A and B;

(*c*) SYNOP (global exchange);

(*d*) SHIP and AIREP/AMDAR (global exchange);

(*e*) CLIMAT and CLIMAT TEMP;

(*f*) All other observational data and processed information, regularly exchanged.

Monitoring of satellite data presents a special case. There are only a few operators and their standards for monitoring, including quality control of satellite data, are already high. Monitoring of satellite data bulletins and GRID-code bulletins shall be a special event for a limited time as designated by the WMO Secretariat.

10. In implementing this monitoring plan, it is important to establish the capability for quick responses at the observing points and at all centres to requests for checks and repetitions in real time. It will also be found useful to give particular attention to ensuring the following elements of the monitoring plan:

(*a*) The correct telecommunication formats of messages in the GTS;

(*b*) The correct coding of messages and reports;

(*c*) The timely availability of data;

(*d*) The quality of the meteorological content of messages.

RESPONSIBILITIES

11. The basic responsibilities for monitoring the operation of the WWW rest with the Members.

12. The responsibilities for carrying out the real-time and non-real-time monitoring activities are given in Tables A and B. An essential part of the monitoring plan is that information should be exchanged between adjacent centres on the GTS in order that telecommunication problems in particular may be readily identified. A special aspect of the exchange of information is that procedures should be developed to ensure that no doubts exist that a bulletin contains all the observations available for inclusion in it. In the case of standard bulletins containing routine observations, the contents of the bulletins should always conform to the list included in the appropriate WMO publication, as amended. When the observations from some stations included in the publication are not available for any reason, NIL should appear in place of the coded report. As

a further check on completeness, NMCs should send messages to the associated RTH, preferably in advance, when it is known that observations from listed stations are not (or will not be) available. It is important that all WWW centres (NMCs, RSMCs, RTHs and WMCs) make a contribution to the overall monitoring effort. Obviously, centres having a multiple role will make more than one contribution. In the contributions, the following points should be taken into account:

(*a*) For the monitoring at *bulletin* level, retard (RTD) and corrected (COR) bulletins should be included;

(*b*) For the monitoring at *report* level, corrected reports should not be counted as additional reports, but retard reports should be counted;

(*c*) Duplicated reports and duplicated bulletins should be counted only once;

(*d*) The contributions should clearly indicate the database used for monitoring (telecommunications or data processing);

(*e*) The contributions should also report any outages of centres and/or circuits occurring during the monitoring period;

(*f*) In the contributions every possible effort should be made to adhere to the times included in the headings of the tables.

13. The frequency with which monitoring reports should be prepared and/or exchanged is illustrated in the following table:

Every day:	Every centre carries out continuous real-time monitoring;
At intervals of not more than one month:	NMCs prepare a summary of relevant information on monitoring for use on a national and international level as appropriate;
At least once every three months:	RTHs/RSMCs send a summary of monitoring information to their associated NMCs;
At least once every three months:	RTHs/RSMCs send a summary of monitoring information to adjacent RTHs which supply them with data;
Once every six months:	WMCs send a summary of monitoring information to adjacent RTHs/RSMCs.

Reports called for at intervals of three months or more should always be forwarded to the Secretary-General in an agreed format for further action. As regards contents, reports should include as many items for Table B as are practical and useful.

14. Members should implement the plan for monitoring the operation of the WWW at the earliest possible date, in particular the real-time monitoring.

15. In order to keep under review the efficient operation of the WWW, internationally coordinated monitoring on a non-real-time basis should be carried out periodically, once a year in October, on the full range of global observational data and with the participation of a limited number of major WWW centres. During other periods, particular problem areas should be monitored, in respect of either selected information only or limited parts of the world. The Secretary-General will arrange, in consultation with the appropriate centres, details of the special monitoring exercises and the periods during which they should be carried out, and will provide adequate notice well in advance.

16. The Secretariat will carry out the necessary analyses of the non-real-time monitoring reports from WWW centres and will make the results of the analyses available to the centres concerned. The Secretary-General will coordinate and advise on assistance necessary to rectify the deficiencies revealed from the results of the monitoring. The Secretary-General will also arrange (as required) for the specific monitoring exercises mentioned in paragraph 15 above to be carried out.

PROCEDURES

17. As far as real-time monitoring is concerned, each centre should develop the necessary detailed procedures for this purpose. These procedures will vary from centre to centre, but should be designed to facilitate the real-time checking of the receipt of bulletins and observations as appropriate. At fully automated centres, these procedures may include the use of telecommunication system records, visual display units, special programs in telecommunication and data-processing computers, and so on. At manual centres, check lists or sheets may be developed for the same purposes using ticks, crosses or the entry of times to indicate when selected bulletins and/or reports have been received. To avoid excessive use of paper forms, it may be convenient to place transparent sheets of plastic over the check sheets and make entries using soft wax pencils. The entries can be removed very easily when a suitable period has elapsed and the sheets made ready for the checks to be repeated for a later period. Some further guidance on the operation of real-time monitoring, together with examples of the kind of forms which might be developed, is given in Table C.

18. As far as non-real-time monitoring is concerned, when special exercises are requested by the Secretariat, an indication of the

form in which contributions should be made will be provided at the time the request is made. It is important that, as far as possible, centres should follow closely the procedures indicated in order that results from various centres be directly comparable with each other. It is particularly important that this should be the case when the annual global monitoring exercise is carried out. The procedures, together with the standard forms to be used for the provision of results, are given in Table D.

19. It is emphasized that nothing in the formal monitoring procedures prescribed in the attachment is intended to replace the normal day-to-day exchange of information and advice between adjacent centres. As far as possible, all problems should be resolved in this way and, after a time, only serious difficulties will be reflected in the formal monitoring reports.

QUALITY OF OBSERVATIONAL DATA

20. Centres with global, hemispheric or near-hemispheric models should monitor the quality of one or more of the main types of observations using techniques such as those listed in Table E. Statistics should be compiled separately for each land station by station index number, for each ship or aircraft by call sign, for each buoy by identifier, and for each satellite by identifier, and for various geographic areas and levels in the atmosphere.

21. The centres should analyse the results and produce in an agreed format lists of observations believed to be consistently of low quality, together with information on which element of the observation (pressure, temperature, etc.) is thought to be of low quality and the evidence for considering it as such. These lists should be based on data received over one month and should be exchanged monthly between participating centres.

22. For each type of observation a lead centre shall be nominated from time to time by the president of CBS. The lead centre should liaise with the participating centres to coordinate all the monitoring results of that observation type and to define common methods and criteria to be used for compiling the monthly statistics. The lead centre should draw the attention of appropriate focal points where they have been identified and of the WMO Secretariat to obvious problems as they are detected. It should also produce every six months a consolidated list of observations of the relevant observation type believed to be of consistently low quality. Information on problems with observing systems, as well as individual observations, should also be included. When compiling the consolidated lists of suspect stations the lead centres should be rigorous so as to identify only those stations where they are confident that the observations are of consistently low quality. They should state which elements of the observation are considered of low quality and provide as much information as possible identifying the problem. The list should be passed on to the participating centres and to the WMO Secretariat. Where focal points have not been identified the Secretariat should notify Members of agencies responsible for the observations which appear to be of low quality, and request them to make an investigation with a view to identifying and correcting any possible cause of error. Members should be asked to reply within a fixed period of time, reporting on any remedial action and stating if any assistance is required. Monitoring results including follow-up action should be made available to CBS, the Executive Council and Congress. In the case of enquiries made by WMO, feedback to the lead centres is requested.

STATISTICAL VERIFICATION OF NUMERICAL WEATHER PREDICTION

23. The accuracy of forecasts of numerical weather prediction models should be monitored by objective verification procedures.

(*a*) Centres operating global, hemispheric or near-hemispheric models and regional models covering appropriate areas should compile verification statistics using the standard procedures described in Table F. The results, together with any relevant information such as improvements that have been made to their NWP systems, should be exchanged monthly between participating centres. Such information may enable centres to identify deficiencies or problems and make improvements in their NWP systems;

(*b*) Centres receiving GDPS products over the GTS may wish to verify appropriate areas using the standardized measures listed in Table F and send the results to the producing centres.

TABLE A

REAL-TIME MONITORING

Items	*National units*	*NMC*	*RTH/RSMC*	*RTH/WMC*
1. Bulletins not received in time	←	←	↔	↔
2. Observations not received in time	←			
3. Processed information not received in time			→	→
4. Errors in observations	←	(←)		
5. Special bilateral checks	↔	↔	↔	↔

(Items are indicative rather than mandatory)

NOTES:

1. *Bulletins not received in time* are bulletins which appear on the transmission schedule and have not been received by a time agreed bilaterally between two adjacent centres.
2. *Observations not received in time* are observations which appear in the published contents of the bulletins listed for transmission but which have not been received by the time agreed.
3. *Processed information not received in time* refers to data not received by the time agreed but known to be in the transmission schedule.
4. Errors in observations are errors detected or suspected in the coding and/or meteorological content of messages.
5. *Special bilateral checks* are checks on any of the previous elements 1–4 or other elements which may have been arranged temporarily or on a more continuous basis by the centres concerned.

The phrase *national units* is understood in this context to mean national observing, collecting and dissemination systems.

The arrows indicate the direction in which messages concerning monitoring will normally be sent. Thus, for example, messages concerning suspected errors in observations will normally be sent to the observing network only by NMCs — unless a special bilateral agreement has been made between an NMC and an appropriate RSMC to carry out real-time quality control on its behalf. To cover this possibility, an entry in parentheses has been made under RSMC.

TABLE B

NON-REAL-TIME MONITORING

Items	*NMC*	*RTH/RSMC*	*RTH/WMC*
1. Bulletins not received	x	x	x
2. Bulletins received late	x	x	x
3. Observations not received	x	x	x
4. Observations received late	x	x	x
5. Processed information not received	x	x	
6. Processed information received late	x	x	
7. Non-adherence to telecommunication format	x	x	x
8. Completeness of observational data	x	x	x
9. Quality of observational data	x	x	x
10. Deficiencies in processed information	x	x	x
11. Statistical verification of numerical weather prediction	x	x	x
12. Special bilateral or multilateral checks	x	x	x
13. Notes on recurrent problems	x	x	x
14. Monitoring reports	x	x	x

(Items are indicative rather than mandatory)

NOTES:

1. *Bulletins not received* are bulletins scheduled for transmission but not received.
2. *Bulletins received late* are bulletins received later than the time periods specified by WMO or agreed bilaterally.
3. *Observations not received* are observations scheduled for transmission but not received.
4. *Observations received late* are defined in a similar way as "bulletins received late" in Note 2 above.
5. *Processed information not received* is products in alphanumeric or pictorial form scheduled for transmission but not received.
6. *Processed information received late* is defined in a similar way as "bulletins received late" in Note 2 above.
7. *Non-adherence to telecommunication format* refers to errors made consistently or frequently by transmitting stations which interfere with the regular transmission of messages.
10. *Deficiencies in processed information* are shortcomings (e.g. data missing, messages garbled, facsimile products unreadable) which seriously interfere with the operational value of the products.
11. *Statistical verification of numerical weather prediction* would be supplied only by centres having a special interest in, and capability for, this type of information.
12. *Special bilateral or multilateral checks* means supplementary checks arranged between two or more centres by mutual agreement, on either a temporary or a continuous basis, to deal with special problems.
13. *Notes on recurrent problems* indicate areas of difficulty not covered by Notes 1–12 inclusive.
14. *Monitoring reports are reports in the format* to be developed by the Secretary-General, in consultation with the president of CBS and the chairmen of the appropriate working groups.

The crosses in the various columns indicate the centres at which these functions would normally be carried out.

TABLE C

GUIDANCE FOR REAL-TIME MONITORING

1. CHECK ON THE RECEPTION OF OBSERVATIONAL REPORTS FROM LAND STATIONS

In order to implement real-time monitoring, suitable forms should be used for checking the reception of observational reports from land stations. Separate tables may be prepared for SYNOPs for global exchange, for TEMP/PILOTs for global exchange, for SYNOPs for regional exchange, and so on in order to check the availability of various types of observational data. If an observation from a particular station has not been received within the appropriate time, a request should be made to the station. Detailed procedures must be developed to meet the needs of centres of various kinds.

2. CHECK ON THE RECEPTION OF AIRCRAFT AND SHIPS' WEATHER REPORTS FROM COASTAL RADIO STATIONS OR AERONAUTICAL RADIO STATIONS

Each centre should ensure that all bulletins have been received, and procedures to ensure that this is the case (for example by introducing the use of channel sequence numbers and similar ideas) should be developed to meet local needs.

3. CHECK ON CODING OF OBSERVATIONAL REPORTS

Observational reports should be checked before transmission of bulletins, in order to eliminate coding errors. This check should be made by the observer when the observation is first made and by suitably qualified staff when the bulletins are prepared. Such checking procedures, however, must not result in appreciable delays in the transmission of bulletins.

4. CHECK ON THE STANDARD FORMAT OF METEOROLOGICAL MESSAGES

Meteorological messages shall be checked *to ensure that the standard format has been used and corrections shall be made as required*. In particular, the following points shall be checked:

(*a*) The starting line, the abbreviated heading and the end-of-message signal of messages shall be completely free of error;

(*b*) Reports included in a bulletin shall be separated by the report separation signal.

It is emphasized that messages which can be handled without difficulty at manual centres may still give very serious problems at automated centres, unless the procedures are scrupulously observed. Even a single incorrect character can lead to difficulties in some cases.

5. CHECK ON THE RECEPTION OF SCHEDULED BULLETINS WITHIN SPECIFIED TIMES

Each RTH should check the reception of bulletins from the NMCs in the zone of responsibility. For this purpose, forms such as Examples 1 and 2 may be useful. If channel sequence numbers (nnn) have not been received in sequential order, queries should be made to the centre concerned immediately. Where no channel sequence number procedures are in operation, other measures must be taken to ensure that no transmissions have been missed and no individual observations missed because of garbling, radio fading, or other causes.

EXAMPLE 1

REAL-TIME MONITORING

(Check for individual meteorological bulletins, not received, incorrect format or mutilated)

CENTRE:	*DATE:*	*CIRCUIT:*			*PAGE:*
Abbreviated heading	*Description of fault*	*Time of receipt*	*Time of request*	*Time of receipt of repeat*	*Remarks (e.g. circuit outage times)*

EXAMPLE 2

MONITORING OF THE RECEPTION OF SHIP/AIREP BULLETINS AND NUMBER OF REPORTS

SHIP			AIREP		
Abbreviated heading	*Time of receipt*	*Number of reports*	*Abbreviated heading*	*Time of receipt*	*Number of reports*

TABLE D

PROCEDURES FOR INTERNATIONALLY COORDINATED NON-REAL-TIME MONITORING

1. MONITORING PERIODS

The internationally coordinated monitoring of data for global exchange will be carried out once a year in October with a view to periodically checking the efficiency of the operation of the WWW. Statistics should be compiled by manually operated and automated centres for the periods 1–5 October and 1–15 October respectively. In order to facilitate the comparison of results between manually operated and automated centres, automated centres should also provide results for the two periods of 1–5 October and 1–15 October.

NOTE: As regards CLIMAT/CLIMAT TEMP, the monitoring period should be extended to 15 days, even if (for other observations) a return for a period of only five days is made.

2. TYPES OF DATA TO BE MONITORED

The types of data listed in the following table should be monitored:

Types of data	*Abbreviated headings of bulletins* $T_1T_2A_1A_2$	*Reference format for presentation of results*
SYNOP reports	SMA_1A_2	A
Parts A and B of TEMP reports	USA_1A_2/UKA_1A_2	B_1/B_2
Parts A and B of PILOT reports	UPA_1A_2/UGA_1A_2	B_1/B_2
SHIP reports	SMA_1A_2	C_1/C_2
Parts A and B of TEMP SHIP reports	USA_1A_2/UKA_1A_2	$D_1/D_2/D_3/D_4$
Parts A and B of PILOT SHIP reports	UPA_1A_2/UGA_1A_2	$D_5/D_6/D_7/D_8$
DRIFTER reports	SSA_1A_2	E
AIREP reports	UAA_1A_2	F
AMDAR reports	UDA_1A_2	G
BATHY/TESAC reports	SOA_1A_2	H
CLIMAT reports	CSA_1A_2	I_1
CLIMAT TEMP reports	CUA_1A_2	I_2

(*a*) *Monitoring of* SYNOP *reports*

For each monitored station identified by the station index number (IIiii), the number of SYNOP reports made at the main standard synoptic hours (00, 06, 12 and 18 UTC) and available during the monitoring period within one hour, two hours and six hours of the standard bulletin times, should be inserted in the appropriate columns of Format A;

(*b*) *Monitoring of Parts A and B of* TEMP *and* PILOT *reports*

For each monitored station identified by the station index number (IIiii), the number of Parts A and B of TEMP and PILOT reports (made by tracking a free balloon by electronic or optical means at the main standard synoptic hours (00, 06, 12 and 18 UTC) and available during the monitoring period within two hours and 12 hours of the standard bulletin times) should be inserted in the appropriate columns of Formats B_1 and B_2;

(*c*) *Monitoring of* SHIP *reports*

The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including SHIP reports made at the main synoptic hours (00, 06, 12 and 18 UTC) and available during the monitoring period within two hours and 12 hours of the standard bulletin times with the number of reports included in these bulletins should be inserted in the appropriate columns of Formats C_1 and C_2;

(*d*) *Monitoring of Parts A and B of* TEMP SHIP *and* PILOT SHIP *reports*

The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including Parts A and B of TEMP SHIP and PILOT SHIP reports made at the main synoptic hours (00, 06, 12 and 18 UTC) and avail-

able during the monitoring period within 12 hours and 24 hours of the standard bulletin times with the number of reports included in these bulletins should be inserted in the appropriate columns of Formats D_1 to D_8;

(*e*) *Monitoring of* DRIFTER, AIREP *and* AMDAR *reports*

The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including DRIFTER, AIREP and AMDAR reports compiled between 21 and 03 UTC, 03 and 09 UTC, 09 and 15 UTC and 21 UTC and available during the monitoring period before 05, 11, 17 and 23 UTC respectively, as well as the number of reports included in these bulletins, should be inserted in the appropriate columns of Formats E, F and G;

(*f*) *Monitoring of* BATHY/TESAC

The time of receipt of bulletins identified by their complete abbreviated headings ($T_1T_2A_1A_2$ii CCCC YYGGgg (BBB)) containing BATHY/TESAC reports as well as the number of reports included in these bulletins should be inserted in the appropriate columns of Format H;

(*g*) *Monitoring of* CLIMAT *and* CLIMAT TEMP *reports*

For each station monitored and identified by the station index number (IIiii), "1" should be inserted in the appropriate column of Format I_1, if the September CLIMAT report is received between 1 and 5 October or 6 and 15 October, otherwise "0" should be inserted in these columns. The same procedure should be applied to the September CLIMAT TEMP report in the Format I_2.

3. GLOBAL DATA SET TO BE MONITORED

3.1 The global data set to be monitored is determined by:

(*a*) The lists of stations, the observations (SYNOP, TEMP, PILOT, CLIMAT and CLIMAT TEMP reports) of which have to be globally exchanged as included in the *Manual on the GTS,* Volume I, Attachment I–4;

(*b*) The lists of abbreviated headings of bulletins containing SHIP, TEMP SHIP, PILOT SHIP, DRIFTER, AIREP and BATHY/TESAC reports which have to be globally exchanged according to the *Catalogue of Meteorological Bulletins*. For ease of reference, the Secretariat will compile these lists of abbreviated headings which will be attached to the relevant format for each monitoring.

3.2 The references of the lists mentioned (including the references to the relevant amendment to the *Manual on the GTS* and of the edition of the *Catalogue of Meteorological Bulletins*) are given in the formats prepared by the Secretariat for each monitoring.

4. GEOGRAPHICAL AREA IN WHICH DATA SHOULD BE MONITORED

GTS centres should monitor the global data set or part of it as follows:

(*a*) NMCs or centres with similar functions should monitor at least the availability of the data from the zone for which they are responsible for the data collection and their insertion into the GTS;

(*b*) RTHs not located on the MTN should monitor at least the availability of the observational data from their zone of responsibility for the collection of observational data as prescribed in Volume II of the *Manual on the GTS*. RTHs should also monitor the availability of observational data from the Region in which they are located and from any other Region to which they are linked by an interregional circuit;

(*c*) WMCs and RTHs located on the MTN should monitor the availability of the complete set of data for global exchange.

5. IMPLEMENTATION OF MONITORING PROCEDURES AND QUESTIONNAIRES

5.1 Questionnaires related to the procedures implemented at the centres, suspension of observing programmes at observing stations and suspension of transmission on circuits are given in Formats J, K and L respectively.

5.2 Monitoring procedures should be implemented at centres in such a way that all replies to the questions included in Format J should be positive (reply: Yes).

6. STANDARD FORMAT FOR STATISTICS

6.1 With a view to enabling the easy comparison of results of internationally coordinated monitoring carried out by the different centres, the standard formats attached should be used. All centres carrying out monitoring should state clearly the period covered. In each format, centres should present the results Region by Region as well as for the Antarctic and give totals

of the number of bulletins or reports received within the specified time Region by Region and for the Antarctic.

6.2 If the report or bulletin indicated in the first column is not scheduled to be received, N should be inserted in the second column of the format concerned, otherwise S should be inserted.

6.3 The statistics should be sent to the adjacent centres concerned and to the WMO Secretariat at the earliest possible date after the end of the monitoring period but not later than 15 November.

7. ROLE OF THE WMO SECRETARIAT

The Secretariat will ensure that the Members are aware of their respective responsibilities and will collect the statistical results of internationally coordinated monitoring from the Members concerned. The Secretariat will make a summary of the statistics and will evaluate the deficiencies and effectiveness of the operation of the WWW as a whole and in part. In this connection, the Secretariat will check the observing programme of individual observing stations. The results of the monitoring will be made available to the Executive Council and CBS by correspondence or at sessions as appropriate. The Secretariat will take up the possibility of remedial action with Members concerned in order to eliminate shortcomings in the operation of the GOS and the GTS as quickly as possible.

8. SPECIAL TYPES OF NON-REAL-TIME MONITORING OF THE WWW

If necessary, monitoring of the WWW may be undertaken in different regions and for various types of observational data. The purpose of such monitoring is to identify, in greater detail, deficiencies in the collection and exchange of data in different parts of the GTS and the reason for such deficiencies. Special types of monitoring should be initiated by the Secretary-General or by some of the Members concerned. The dates and duration of such monitoring would have to be agreed upon by those Members.

NOTE TO FORMATS A – L

See the *Catalogue of Meteorological Bulletins* (WMO-No. 9) for lists of abbreviated headings for global exchange of the following bulletins: SHIP, TEMP SHIP, Parts A and B; PILOT SHIP, Parts A and B; DRIFTER; AIREP; AMDAR; and BATHY TESAC. These lists will also be included by the WMO Secretariat in the letter of invitation to participate in the monitor-

FORMAT A

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: SYNOP

Monitoring centre: ..... *Monitoring period*: .....

*Station index number** IIiii	*S/N* **	*Number of* SYNOP *reports received between HH (standard bulletin time) and*														
		HH (UTC) + 1 hour					*HH (UTC) + 2 hours*					*HH (UTC) + 6 hours*				
		00	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*

* Reference for the global exchange list: *Manual on the GTS* — Amendment .....

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT B_1

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP and PILOT (PART A)

Monitoring centre: ..... *Monitoring period*: .....

*Station index number** IIiii	*S/N* **	*Number of* TEMP *reports (Part A) received between HH (standard bulletin time) and*										*Number of* PILOT *reports (Part A) received between HH (standard bulletin time) and*									
		HH (UTC) + 2 hours					*HH (UTC) + 12 hours*					*HH (UTC) + 2 hours*					*HH (UTC) + 12 hours*				
		00	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*

* Reference for the global exchange list: *Manual on the GTS* — Amendment .....

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT B_2

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP and PILOT (PART B)

Monitoring centre: ..... *Monitoring period*: .....

*Station index number** IIiii	*S/N* **	*Number of* TEMP *reports (Part B) received between HH (standard bulletin time) and*										*Number of* PILOT *reports (Part B) received between HH (standard bulletin time) and*									
		HH (UTC) + 2 hours					*HH (UTC) + 12 hours*					*HH (UTC) + 2 hours*					*HH (UTC) + 12 hours*				
		00	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*	*00*	*06*	*12*	*18*	*Total*

* Reference for the global exchange list: *Manual on the GTS* — Amendment .....

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT C_1

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: SHIP

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* SHIP *bulletins and reports received within 2 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of SHIP bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT C_2

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: SHIP

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* SHIP *bulletins and reports received within 12 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of SHIP bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_1

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP SHIP (PART A)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* TEMP SHIP *bulletins and reports (Part A) received within 12 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of TEMP SHIP (Part A) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_2

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP SHIP (PART A)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* TEMP SHIP *bulletins and reports (Part A) received within 24 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of TEMP SHIP (Part A) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_3

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP SHIP (PART B)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* TEMP SHIP *bulletins and reports (Part B) received within 12 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of TEMP SHIP (Part B) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_4

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: TEMP SHIP (PART B)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* TEMP SHIP *bulletins and reports (Part B) received within 24 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of TEMP SHIP (Part B) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_5

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: PILOT SHIP (PART A)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* PILOT SHIP *bulletins and reports (Part A) received within 12 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of PILOT SHIP (Part A) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_6

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: PILOT SHIP (PART A)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* PILOT SHIP *bulletins and reports (Part A) received within 24 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of PILOT SHIP (Part A) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_7

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: PILOT SHIP (PART B)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* PILOT SHIP *bulletins and reports (Part B) received within 12 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of PILOT SHIP (Part B) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT D_8

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: PILOT SHIP (PART B)

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC	*S/N* **	*Number of* PILOT SHIP *bulletins and reports (Part B) received within 24 hours of the standard bulletin time*									
		00 UTC		*06 UTC*		*12 UTC*		*18 UTC*		*Total*	
		Bulletins	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*	*Bulletins*	*Reports*

* See attached list of abbreviated headings of PILOT SHIP (Part B) bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT E

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: DRIFTER

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading*** $T_1T_2A_1A_2$ii CCCC	*S/N* ***	*Bulletins compiled between 21* and 03* UTC and received before 05 UTC*		*Bulletins compiled between 03* and 09* UTC and received before 11 UTC*		*Bulletins compiled between 09* and 15* UTC and received before 17 UTC*		*Bulletins compiled between 15* and 21* UTC and received before 23 UTC*		*Total*	
		Number of bulletins	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*

* Hour of compilation = GGgg included in the abbreviation heading.

** See attached list of abbreviated headings of DRIFTER bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

*** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT F

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: AIREP

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading*** $T_1T_2A_1A_2$ii CCCC	*S/N* ***	*Bulletins compiled between 21* and 03* UTC and received before 05 UTC*		*Bulletins compiled between 03* and 09* UTC and received before 11 UTC*		*Bulletins compiled between 09* and 15* UTC and received before 17 UTC*		*Bulletins compiled between 15* and 21* UTC and received before 23 UTC*		*Total*	
		Number of bulletins	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*

* Hour of compilation = GGgg included in the abbreviation heading.

** See attached list of abbreviated headings of AIREP bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

*** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT G

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: AMDAR

Monitoring centre: ..... *Monitoring period*: .....

*Abbreviated heading*** $T_1T_2A_1A_2$ii CCCC	*S/N* ***	*Bulletins compiled between 21* and 03* UTC and received before 05 UTC*		*Bulletins compiled between 03* and 09* UTC and received before 11 UTC*		*Bulletins compiled between 09* and 15* UTC and received before 17 UTC*		*Bulletins compiled between 15* and 21* UTC and received before 23 UTC*		*Total*	
		Number of bulletins	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*	*Number of bulletins*	*Number of reports*

* Hour of compilation = GGgg included in the abbreviation heading.

** See attached list of abbreviated headings of AMDAR bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

*** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT H

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: BATHY/TESAC

Monitoring centre: ..... *Monitoring period*: .....

BATHY/TESAC				BATHY/TESAC			
*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC YYGGgg (BBB)	*S/N***	*Date/Time of receipt*	*Number of reports*	*Abbreviated heading** $T_1T_2A_1A_2$ii CCCC YYGGgg (BBB)	*S/N***	*Date/Time of receipt*	*Number of reports*

* See attached list of abbreviated headings of BATHY/TESAC bulletins for global exchange as prepared by the WMO Secretariat for each monitoring (Reference: *Catalogue of Meteorological Bulletins*—edition .....)

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT I_1

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: CLIMAT

Monitoring centre: ..... *Monitoring period*: .....

CLIMAT				CLIMAT			
Station index number IIiii*	*S/N***	*Reports received 1 – 5 October*	*Reports received 6 – 15 October*	*Station index number* IIiii*	*S/N***	*Reports received 1 – 5 October*	*Reports received 6 – 15 October*

* Reference for the global exchange list: *Manual on the GTS* — Amendment .....

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT I_2

STATISTICS ON GLOBAL EXCHANGE DATA RECEIVED: CLIMAT TEMP

Monitoring centre: ..... *Monitoring period*: .....

CLIMAT TEMP				CLIMAT TEMP			
Station index number Iliii*	*S/N***	*Reports received 1 – 5 October*	*Reports received 6 – 15 October*	*Station index number* Iliii*	*S/N***	*Reports received 1 – 5 October*	*Reports received 6 – 15 October*

* Reference for the global exchange list: *Manual on the GTS* — Amendment .....

** S = if data are scheduled to be received; N = if data are not scheduled to be received

FORMAT J

QUESTIONNAIRE RELATED TO THE IMPLEMENTATION OF PROCEDURES AT THE MONITORING CENTRES

Monitoring centre: ..... *Monitoring period*: .....

Question:	1	2	3	4	5	6	7	8	9	10	11
	Is the monitoring automated?	Is the counting of bulletins and reports performed before quality control?	Are bulletins and reports counted only if received or transmitted on the GTS channels?	Are duplicated bulletins disregarded?	Are bulletins including only NIL reports counted?	Are bulletins including COR or CCx counted in addition to bulletins to be corrected?	Are duplicated reports included in bulletins having the same abbreviated heading disregarded?	Are duplicated reports included in bulletins having a different abbreviated heading disregarded?	Are NIL reports disregarded?	Are reports included in in bulletins including the indicator COR or CCx disregarded in addition to reports to be corrected?	Are all AIREP/ AMDAR reports made at different positions during the flight counted as different reports?
Reply: (yes or no)											

NOTE: Monitoring procedures should be implemented at centres in such a way that all replies to the questions included in Format J are positive (reply: yes)

Comments: .....

.....

FORMAT K

SUSPENSION OF OBSERVING PROGRAMMES AT OBSERVING STATIONS

Monitoring centre: ..... *Monitoring period*: .....

Station index IIiii	*Details of suspension and reasons*	*Number of reports (*SYNOP, TEMP *or* PILOT*) not made for each observation time*				
		Type of report	*00 UTC*	*06 UTC*	*12 UTC*	*18 UTC*

Example of entry:

Station index IIiii	*Details of suspension and reasons*	*Number of reports (*SYNOP, TEMP *or* PILOT*) not made for each observation time*				
		Type of report	*00 UTC*	*06 UTC*	*12 UTC*	*18 UTC*
IIiii	Delayed delivery of balloons	TEMP	2		1	
IIiii	Delayed delivery of caustic soda	PILOT	5	5	5	4
	Lack of manpower	SYNOP	7	7	7	7

FORMAT L

SUSPENSION OF TRANSMISSION ON CIRCUITS

Monitoring centre: ..... *Monitoring period*: .....

Circuit suspended	*Duration of suspension*	*Remarks*

Example of entry:

Circuit suspended	*Duration of suspension*	*Remarks*
(1) IIiii — NMC	48 hours from 0645 UTC, 2 October	Failure of transmitter
(2) NMC —NMC (NMC — RTH) (RTH — RTH)	15 hours from 0900 UTC, 3 October	Poor HF propagation

NOTE: In cases where reasons of suspension are known, details should be given in column "Remarks".

TABLE E

Techniques for monitoring the quality of observations

1. Compilation of statistics on the difference between observed values and the analysis and first-guess field;
2. Compilation of statistics on observations which fail the routine quality-control checks;
3. Examination of time series of observations from a particular station (particularly useful in data-sparse areas);
4. Compilation of statistics on the differences between reported values of geopotential height and geopotential height recalculated from significant level data for radiosonde stations, using common formulae for all stations;
5. For surface stations which report both mean sea-level pressure and station-level pressure, compilation of statistics on differences between reported mean sea-level pressure and mean sea-level pressure recomputed from reported station-level pressure and temperature and published values of station elevation;
6. Compilation of co-location statistics.

TABLE F

Factors and methods used in standardized verification of NWP products

I – VERIFICATION AGAINST ANALYSIS

Area Northern hemisphere extratropics (90°N – 20°N) (all inclusive)
Tropics (20°N – 20°S) (all inclusive)
Southern hemisphere extratropics (20°S – 90°S) (all inclusive)

Grid Verifying analysis is the centre's on a latitude–longitude grid 2.5° × 2.5°; origin (0°, 0°)

Variables Mean sea-level pressure, geopotential height, temperature, winds

Levels Extratropics: Mean sea-level, 500 hPa, 250 hPa
Tropics: 850 hPa, 250 hPa

Time 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, 240 h ...

Statistics Mean error, root-mean-square error (rmse), anomaly correlation, S_1 skill score, root-mean-square vector wind error ($rmse_v$)

The following definitions should be used:

mean error

$$M_{f,v} = \frac{\sum_{i=1}^{n}(x_f - x_v)_i \cos\varphi_i}{\sum_{i=1}^{n}\cos\varphi_i}$$

rms error

$$rmse = \sqrt{\frac{\sum_{i=1}^{n}(x_f - x_v)_i^2 \cos\varphi_i}{\sum_{i=1}^{n}\cos\varphi_i}}$$

correlation coefficient between observed and forecast anomalies

$$r = \frac{\sum_{i=1}^{n}(x_f - x_c - M_{f,c})_i (x_v - x_c - M_{v,c})_i \cos\varphi_i}{\sqrt{\sum_{i=1}^{n}(x_f - x_c - M_{f,c})_i^2 \cos\varphi_i} \cdot \sqrt{\sum_{i=1}^{n}(x_v - x_c - M_{v,c})_i^2 \cos\varphi_i}}$$

rms vector wind error

$$rmse_v = \sqrt{\frac{\sum_{i=1}^{n}(\vec{V}_f - \vec{V}_v)_i^2 \cos\varphi_i}{\sum_{i=1}^{n}\cos\varphi_i}}$$

S_1 skill score (mean sea-level pressure and geopotential height only)

$$S_1 = 100 \cdot \frac{\sum_{i=1}^{n}(e_g)_i \cos\varphi_i}{\sum_{i=1}^{n}(G_L)_i \cos\varphi_i}$$

where: x_f = the forecast value of the parameter in question;

x_v = the corresponding verifying value (analysed);

n = the number of grid points in the verification area;

$\cos \varphi_i$ = cosine of latitude of grid point i;

x_c = the climatological value of the parameter;

$M_{f,\,c}$ = the mean value over the verification area of the forecast climate anomalies;

$M_{v,\,c}$ = the mean value over the verification area of the analysed climate anomalies;

$\overrightarrow{V_f}$ = the forecast wind vector;

$\overrightarrow{V_v}$ = the verifying (analysed) wind vector.

$$e_g = \left\{\left|\frac{\partial}{\partial x}(x_f - x_v)\right| + \left|\frac{\partial}{\partial y}(x_f - x_v)\right|\right\}$$

$$G_{\mathrm{L}} = \max\left(\left|\frac{\partial_{x_f}}{\partial_x}\right|, \left|\frac{\partial_{x_v}}{\partial_x}\right|\right) + \max\left(\left|\frac{\partial_{x_f}}{\partial_y}\right|, \left|\frac{\partial_{x_v}}{\partial_y}\right|\right)$$

where the differentiation is approximated by differences on a 2.5° × 2.5° latitude/longitude grid.

NOTES:

(1) Values for these statistics should be computed daily (0000 UTC and 1200 UTC separately) for each specified area. Monthly averages should then be computed from the daily values of all forecasts verifying within the relevant month. For those centres not running forecasts from either 0000 or 1200 UTC, tables may alternatively be provided for 0600 UTC and 1800 UTC and should be labelled as such.

(2) The number of runs (daily statistics) forming the monthly means should be exchanged in the monthly report.

(3) Annual averages of daily verification are inlcuded in the yearly *Technical Progress Report on the Global Data-processing System*. These statistics are for the 24, 72 and 120 h forecast and include the rms vector wind error at 850 hPa (tropics area only) and 250 hPa (all three areas) as well as the rms error of geopotential heights at 500 hPa (northern and southern hemispheres).

(4) To the extent possible, horizontal and vertical interpolations from model to verifying grids should not involve multiple steps or explicit smoothing.

II – VERIFICATION AGAINST OBSERVATIONS

Network The seven networks used in verification against radiosondes consist of radiosondes stations lying within the following geographical area:

North America	25°N–60°N	50°W–145°W
Europe/North Africa	25°N–70°N	10°W–28°E
Asia	25°N–65°N	60°E–145°E
Australia/New Zealand	10°S–55°S	90°E–180°E
Tropics	20°S–20°N	all longitudes
Northern hemisphere extratropics	20°N–90°N	all longitudes
Southern hemisphere extratropics	20°S–90°S	all longitudes

Stations The list of radiosonde stations to be used in each network is updated annually by the lead centre for radiosondes. The chosen stations must be available to all the centres and provide quality data on a regular basis. Consultation with all centres (usually by electronic mail) is desirable before establishing the final list. This list is published in the monthly WWW *Operational Netwsletter*, as appropriate.

Variables Geopotential height, temperature, winds

Levels 850 hPa, 500 hPa, 250 hPa

Time 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, 240 h ...

Statistics Mean error, root-mean-square error (rmse), trend correlation, root-mean-square vector wind error (rmse_v)

The following definitions should be used:

mean error $$M_{f,v} = \frac{1}{n}\sum_{i=1}^{n}(x_f - x_v)_i$$

rms error $$rmse = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_f - x_v)_i^2}$$

correlation coefficient between observed and forecast trends $$r = \frac{\sum_{i=1}^{n}(x_f - x_{f_o} - M_{f,f_o})_i(x_v - x_{v_o} - M_{v,v_o})_i}{\sqrt{\sum_{i=1}^{n}(x_f - x_{f_o} - M_{f,f_o})_i^2}\cdot\sqrt{\sum_{i=1}^{n}(x_v - x_{v_o} - M_{v,v_o})_i^2}}$$

rms vector wind error $$rmse_v = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\overrightarrow{V_f} - \overrightarrow{V_v})_i^2}$$

where: x_f = the forecast value of the parameter in question;
x_v = the corresponding verifying value (observed);
x_{f_o}, x_{v_o} = same as above, but for the initial time;
n = the number of observations in the verification area;
M_{f,f_o} = the mean value over the verification area of the forecast trends;
M_{v,v_o} = the mean value over the verification area of the observed trends;
$\overrightarrow{V_f}$ = the forecast wind vector;
$\overrightarrow{V_v}$ = the verifying (observed) wind vector.

NOTES:

(1) The observations used for verification should be screened to exclude those with large errors. In order to do this, it is recommended that centres exclude values rejected by their objective analysis. Moreover, centres which apply a correction to the observations received on the GTS to remove biases (e.g. radiation correction), should use the corrected observations to compute statistics.

(2) Values for these statistics should be computed daily (0000 UTC and 1200 UTC separately) for each specified network. Monthly averages should then be computed from the daily values of all forecasts verifying within the relevant month. For those centres not running forecasts from either 0000 or 1200 UTC, tables may alternatively be provided for other base times and should be labelled as such.

(3) The number of runs (daily statistics) forming the monthly means should be exchanged in the monthly report, as well as the average number of observation points used in the computations.

(4) Annual averages of daily verification are inlcuded in the yearly *Technical Progress Report on the Global Data-processing System*. These statistics are for the 24, 72 and 120 h forecast and include the rms vector wind error at 850 hPa (tropics network only) and 250 hPa (all seven networks) as well as the rms error of geopotential heights at 500 hPa (all the networks except for tropics). A table of the number of observations per month should also be part of the yearly report.

(5) To the extent possible, horizontal and vertical interpolations from model to verifying observations should not involve multiple steps or explicit smoothing.

III – STANDARD VERIFICATION MEASURES OF EPS

EXCHANGE OF SCORES

Monthly exchanges:

Ensemble mean

For verification of ensemble mean, the specifications in this table of the attachment for variables, levels, areas and verifications should be used.

Spread

Ratio of standard deviation over RMS error of the ensemble mean averaged over the same regions and variables as used for the ensemble mean.

Probabilities

The reliability table of the same format as defined for the SVS for long-range forecasts should be exchanged.

List of parameters

PMSL ± 1, ± 2 standard deviation with respect to centre's own climatology

Z500 with thresholds as for PMSL.

850 hPa wind speed with thresholds of 10, 15, 25 m s^{-1}.

T850 anomalies with thresholds ± 4, ± 8 degrees with respect to a centre specified climatology. Verified for areas defined for verification against analysis.

Precipitation with thresholds 1, 5, 10, and 25 mm/24 hours every 24 hours verified over areas defined for deterministic forecast verification against observations.

Observations for EPS verification should be based on the GCOS list of surface network (GSN).

Scores

Brier Skill Score (with respect to climatology) (see definition below*)
Relative economic value (C/L) diagrams
Reliability diagrams with frequency distribution

NOTE: Annual and seasonal averages of the Brier Skill Score at 24, 72, 120, 168 and 240 hours for Z500 and T850 should be included in the yearly Technical Progress Report on the Global Data-processing System.

---

* The Brier Score is most commonly used for assessing the accuracy of binary (two-category) probability forecasts. The Brier Score is defined as:

$$PS = \frac{\sum_{ij} \left(F_{ij} - O_{ij} \right)^2}{N}$$

where the observations O_{ij} are binary (0 or 1) and N is the verification sample size. The Brier Score has a range from 0 to 1 and is negatively-oriented. Lower scores represent higher accuracy.

The Brier Skill Score (BSS) is in the usual skill score format, and may be defined by:

$$BSS = \frac{PS_C - PS_F}{PS_C} \times 100 = \left[1 - \frac{\sum_{ij} \left(F_{ij} - O_{ij} \right)^2}{\sum_{ij} \left(C_{ij} - O_{ij} \right)^2} \right] \times 100$$

where C refers to climatology and F refers to the forecast.

ANNEX

Content and format of monthly verification report

A report is prepared each month by the centres and exchanged electronically among the participants. The prescribed content and format have followed closely in order to facilitate the processing of verification data at the receiving end of the communication:

Content

A – Verification against analysis

Each region is represented by the table first number:

TABLE 1.x NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)
TABLE 2.x TROPICAL VERIFICATION AGAINST ANALYSIS (20°N–20°S)
TABLE 3.x SOUTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°S)

Within each region, specific table numbers are assigned to variables and levels.

For northern and southern hemispheres (Tables 1.x and 3.x):

TABLE x.1 MEAN SEA LEVEL PRESSURE
TABLE x.2 500 HPA GEOPOTENTIAL HEIGHT
TABLE x.3 250 HPA GEOPOTENTIAL HEIGHT
TABLE x.4 500 HPA TEMPERATURE
TABLE x.5 250 HPA TEMPERATURE
TABLE x.6 500 HPA WIND
TABLE x.7 250 HPA WIND
TABLE x.8 and more reserved

For tropics (Tables 2.x):

TABLE 2.1 850 HPA GEOPOTENTIAL HEIGHT
TABLE 2.2 250 HPA GEOPOTENTIAL HEIGHT
TABLE 2.3 850 HPA TEMPERATURE
TABLE 2.4 250 HPA TEMPERATURE
TABLE 2.5 850 HPA WIND
TABLE 2.6 250 HPA WIND
TABLE 2.7 and more reserved

B – Verification against observations

Each network is represented by the table first number:

TABLE 4.x NORTH AMERICA VERIFICATION AGAINST RADIOSONDES
TABLE 5.x EUROPE/NORTH AFRICA VERIFICATION AGAINST RADIOSONDES
TABLE 6.x ASIA VERIFICATION AGAINST RADIOSONDES
TABLE 7.x AUSTRALIA/NEW ZEALAND VERIFICATION AGAINST RADIOSONDES
TABLE 8.x TROPICS VERIFICATION AGAINST RADIOSONDES
TABLE 9.x NORTHERN EXTRATROPICS VERIFICATION AGAINST RADIOSONDES
TABLE 10.x SOUTHERN EXTRATROPICS VERIFICATION AGAINST RADIOSONDES

Within each region, specific table numbers are assigned to variables and levels:

TABLE x.1 850 HPA GEOPOTENTIAL HEIGHT
TABLE x.2 500 HPA GEOPOTENTIAL HEIGHT
TABLE x.3 250 HPA GEOPOTENTIAL HEIGHT
TABLE x.4 850 HPA TEMPERATURE
TABLE x.5 500 HPA TEMPERATURE
TABLE x.6 250 HPA TEMPERATURE
TABLE x.7 850 HPA WIND
TABLE x.8 500 HPA WIND
TABLE x.9 250 HPA WIND
TABLE x.10 and more reserved

Format

Format of exchange of WMO standards scores by electronic media

(Examples of a number of tables are given)

Columns

0 1 2 3 4 5 6 7 8

123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

- n1 blank line see note 4

VERIFICATION TO WMO STANDARDS

CENTRE NAME MMMMMMMMM YYYY

MODEL NAME AND CHARACTERISTICS

- File header see note 1

Comment line : missing cases must be reported here.
Comment line

- n2 blank line see note 4

TABLE 1.1 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

MEAN SEA LEVEL PRESSURE SEPTEMBER 1997

- Table header 11 lines see note 2

FORECAST PERIOD ------------- (HOURS)	MEAN ERROR (hPa)		RMSE (hPa)		ANOM. CORR.		SKILL SCORE	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
144	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
168	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
192	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
216	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
240	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

- m data line see note 3

- n3 blank line see note 4

TABLE 1.2 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

----

500 HPA GEOPOTENTIAL HEIGHT SEPTEMBER 1997

FORECAST PERIOD ------------- (HOURS)	MEAN ERROR (m)		RMSE (m)		ANOM. CORR.		SKILL SCORE	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
etc.								

0 1 2 3 4 5 6 7 8

123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

Columns

0 1 2 3 4 5 6 7 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TABLE 1.4 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

500 HPA TEMPERATURE SEPTEMBER 1997

FORECAST PERIOD	MEAN ERROR (K)		RMSE (K)		ANOM. CORR.	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC
(HOURS)						
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

etc.

TABLE 1.6 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

500 HPA WIND SEPTEMBER 1997

FORECAST PERIOD	MEAN SPEED ERROR (m/s)		RMSEV (m/s)	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC
(HOURS)				
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

etc.

TABLE 4.1 NORTH AMERICA VERIFICATION AGAINST RADIOSONDES

850 HPA GEOPOTENTIAL HEIGHT SEPTEMBER 1997

FORECAST PERIOD	MEAN ERROR		RMSE		TREND CORR.	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC	0000 UTC	1200 UTC
(HOURS)						
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

etc.

TABLE 4.7 NORTH AMERICA VERIFICATION AGAINST RADIOSONDES

850 HPA WIND SEPTEMBER 1997

FORECAST PERIOD (HOURS)	MEAN SPEED ERROR		RMSEV	
	0000 UTC	1200 UTC	0000 UTC	1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

etc.

NUMBER OF OBSERVATIONS USED 0000 UTC = xxxx 1200 UTC = xxxx – see note 7

0 1 2 3 4 5 6 7 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

NOTE 1: (File header)

Underlining is optional.

Line 1: Fixed title (A80).

Line 4, columns 17 to 48: Centre name.

Line 4, columns 49 to 64: Month and year in full (6X, A32, AI6).

Line 7: Model name or characteristics (A80).

NOTE 2: (Table header)

Underlining is optional.

Line 1, columns 11 to 16: Table number.

Line 1, columns 17 to 80: Table name (10X, F6.0, A64).

Line 3, columns 17 to 48: Parameter name.

Line 3, columns 49 to 64: month and year in full (16X, A32, AI6).

Line 7: Score names (10X, 4 (IX, A16)).

Line 8: Units (optional) (10X, 4 (IX, A16)).

Line 9: Times (10X, 4 (2X, A7, IX, A7).

NOTE 3: (Data lines)

m depends on forecast length.

Examples of specifying data are given.

xxxxxxx represents any numeric value.

Missing data should be left blank.

Reading data: (IX, I5, 4X, 4 (2X, F7.0, IX, F7.0)).

Searching for missing data: (10X, 4 (2X, A7, 1X, A7)).

NOTE 4:

n1, n2, n3 may be variable.

NOTE 5:

A line beginning # is treated as a comment.

A comment line should not occur within the file header, table header, or between data lines.

Comment lines can be used to give information on abnormal events, and/or any significant changes introduced into the NWP system during the month.

*Missing cases must be reported in comment lines after the file header.

NOTE 6: All characters should be in ASCII representation.

*NOTE 7: (Number of observations used)

Reading data: (57X, I4, 12X, I4).

_____

* Proposed modification to current procedures.

ATTACHMENT II.8

VERIFICATION SYSTEMS FOR LONG-RANGE FORECASTS — REVISED EXPERIMENTAL SCORES TO BE EXCHANGED

1. FORMULATION

The standardized verification system (SVS) is formulated in four parts:

1.1 **Diagnostics.** Diagnostic information required incorporates derived diagnostic measures and contingency tables. Three diagnostic measures are included and are closely defined. Estimates of the statistical significance of the scores achieved are also required. Additional diagnostic measures are suggested but are not incorporated into the core SVS as yet. Use of the additional diagnostics is optional.

1.2 **Parameters.** Key variables and regions are proposed. However producers are not limited to these key parameters. Thus all producers can contribute regardless of the structure of individual forecast systems. The parameters to be verified are defined on three levels:

Level 1: Diagnostic measures aggregated over regions,

Level 2: Diagnostic measures evaluated at individual grid-points,

Level 3: Contingency tables provided for individual grid-points.

The SVS makes provision for a staged implementation of the three levels of information and the inclusion estimates of skill significance over a two-year period (Section 4).

1.3 **Verification data sets.** Key data sets of observations against which forecasts may be verified are proposed.

1.4 **System details.** Details of forecast systems employed.

2. DIAGNOSTICS

Three diagnostic measures are incorporated in the core SVS; relative operating characteristics; reliability diagrams and accompanying measure of sharpness; and mean square skill scores with associated decomposition. Estimates of the statistical significance in the diagnostic scores are also included in the core SVS. The three diagnostics permit direct intercomparison of results across different predicted variables, geographical regions, forecast ranges, etc. They may be applied in verification of most forecasts and it is proposed that, except where inappropriate, all three diagnostics are used on all occasions. Tabulated information at grid-point resolution is also part of the core SVS. The tabulated information will allow reconstruction of scores for user-defined areas and calculation of other diagnostic measures such as economic value.

2.1 **Relative operating characteristics (ROC).** To be used for verification of probability forecasts, calculation details are discussed in Attachment II-9. For Level 1 information (measures aggregated over regions), the ROC curve and the standardized area under the curve (such that perfect forecasts give an area of 1 and a curve lying along the diagonal gives 0.5) should be provided. Probability values should be labelled on any ROC curves. For Level 2 information (gridded values), the standardized area under the ROC curve should be provided, both in rendered map format and in digital format (see Section 3).

2.2 **Reliability diagrams and frequency histograms.** To be used in assessment of probability forecasts, the construction of these diagrams and histograms is discussed in Attachment II-9. They are required as part of the Level 1 information only.

2.3 **Mean square skill score (MSSS) and decomposition.** To be used in verification of deterministic forecasts, calculation details are discussed in Attachment II-9. For Level 1, an overall bulk MSSS value is required and will provide a comparison of forecast performance relative to "forecasts" of climatology. The three terms of the MSSS decomposition provide valuable information on phase errors (through forecast/observation correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias. For Level 2, quantities pertaining to the three decomposition terms (see Attachment II-9) should be provided as rendered maps for selected seasons. Additional terms relating to MSSS and its decomposition are required as tabulated information.

2.4 **Contingency tables.** In addition to the derived diagnostic measures, contingency table information provided at grid-points for both probability and categorical deterministic forecasts form part of the core SVS. This information constitutes Level 3 of the exchange and will allow RCCs and NMHSs (and in some cases end-users) to derive ROC, reliability, other probability-based diagnostics and scores for categorical deterministic forecasts for user-defined geographical areas.

A number of recommended contingency table-based diagnostics are listed in the Annex. The Hanssen-Kuiper score is the deterministic equivalent to the area under the ROC curve, and thus provides a useful measure for comparing probabilistic and deterministic skill. The Gerrity score is one recommended score for overall assessment of forecasts using two or more categories. Calculation details for the Hanssen-Kuipers and Gerrity scores are provided in Attachment II-9.

3. PARAMETERS

The key list of parameters in the core SVS is provided below. Any verification for these key parameters should be assessed using the core SVS techniques wherever possible. Many long-range forecasts are produced which do not include parameters in the key list (for example, there are numerous empirical systems that predict seasonal rainfall over part of, or over an entire, country). The core SVS diagnostics should be used to assess these forecasts also, but full details of the predictions will need to be provided.

3.1 Diagrams and scores to be produced for regions

3.1.1 **Atmospheric parameters.** Predictions for:

T2m screen temperature with standard regions:

Tropics 20°N to 20°S
Northern extratropics >=20°N
Southern extratropics <=20°S

Precipitation with standard regions:

Tropics 20°N to 20°S
Northern extratropics >=20°N
Southern extratropics <=20°S

3.1.2 Scores and diagrams to be produced for probabilistic forecasts

Reliability diagram and frequency histograms
The ROC curve and the standardized area under the curve
Estimations of error (significance) in the scores

The above scores and diagrams to be produced for equi-probable tercile categories.

3.1.3 Scores to be used for deterministic forecasts

MSSS with climatology as standard reference forecast

3.1.4 Stratification by season

Four conventional seasons: March/April/May (MAM), June/July/August (JJA), September/October/November (SON), December/January/February (DJF)

3.1.5 Lead time

Preferred minimum: two lead times, one preferably to be two weeks or greater, with a lead time not greater than four months.

3.2 Verification to be produced in map format on 2.5° × 2.5° grid

3.2.1 Verification maps to be produced for each of the following variables

T2m
Precipitation
Sea-surface temperature

3.2.2 Scores to be calculated for probabilistic forecasts

ROC area for three tercile categories
Significance of the ROC scores should also be calculated and shown on the ROC area map, or on an accompanying map

3.2.3 Scores to be calculated for deterministic forecasts

The three terms of the Murphy decomposition of MSSS, produced with climatology as standard reference forecast. As a second, optional, control it is recommended that damped persistence be used.

Significance estimates for each of the three Murphy decomposition terms should also be calculated and shown on the relevant map or an accompanying map.

3.2.4 Stratification by season

Four conventional seasons: MAM, JJA, SON, DJF

3.2.5 Lead time

Preferred minimum: two lead times, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.2.6 Stratification according to the state of *El Niño*/Southern Oscillation (ENSO)

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;
(*b*) Seasons with *El Niño* active;
(*c*) Seasons with *La Niña* active.

3.3 Tabulated information to be exchanged

Tabular information to be provided for grid-points of a 2.5 × 2.5 grid.

3.3.1 Contingency tables

Contingency tables to be produced for each of the following variables:

T2m
Precipitation
Sea-surface temperature

3.3.2 Tables to be produced for probabilistic forecast verification.

The number of forecast hits and false alarms to be recorded against each ensemble member or probability bin for each of three equi-probable categories (terciles). It is recommended that the number of bins remains between 9 and 20. The forecast providers can bin according to percentage probability or by individual ensemble members as deemed necessary. No latitude weighting of the numbers of hits and false alarms is to be applied in the contingency tables.

The user is encouraged to aggregate the tables over grid-points for the region of interest and to apply methods of assessing statistical significance of the aggregated tables.

3.3.3 Tables to be produced for deterministic forecasts

3 × 3 contingency tables comparing the forecast tercile with the observed tercile, over the hindcast period.

3.3.4 Stratification by season

If available 12 rolling three-month periods (e.g. MAM, AMJ, MJJ). Otherwise four conventional seasons (as specified in Section 3.1.4).

3.3.5 Leadtime

Preferred minimum: two leadtimes, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.3.6 Stratification according to the state of ENSO

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;
(*b*) Seasons with *El Niño* active;
(*c*) Seasons with *La Niña* active.

3.4 Grid-point data for mapping

The information requested in this section is the digital data required to produce the maps described in Section 3.2, with some additional information associated with the MSSS diagnostic. This will allow maps to be generated by users (or the lead centre) in a consistent format and allow access to maps for 12 rolling seasons rather than the four conventional seasons specified in Section 3.2.

3.4.1 Grid-point verification data to be produced for each of the following variables

T2m
Precipitation
Sea-surface temperature

3.4.2 Verification parameters to be produced for deterministic verification

The necessary parameters for reconstructing the MSSS decomposition, the number of forecast/observation pairs, the mean square error of the forecasts and of climatology and the MSSS are all part of the Core SVS (as specified in Attachment II-9). Significance estimates for the correlation, variance, bias, MSE and MSSS terms should also be supplied.

3.4.3 Verification to be provided for probability forecasts

ROC area for three tercile categories.

Significance of the ROC scores should also be provided.

3.4.4 Stratification by season

If available 12 rolling three-month periods (e.g. MAM, AMJ, MJJ). Otherwise four conventional seasons (as in specified in Section 3.1.4).

3.4.5 Leadtime

Preferred minimum: two leadtimes, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.4.6 Stratification according to the state of ENSO

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;
(*b*) Seasons with *El Niño* active;
(*c*) Seasons with *La Niña* active.

3.5 Verification for indices

3.5.1 Indices to be verified

NIÑO3.4 region SST anomalies. Other indices may be added in due course.

3.5.2 Scores to be calculated for probabilistic forecasts

ROC area for three tercile categories. Where dynamical forecast models are used, scores should be aggregated over all grid-points of the verification data set in the NINO3.4 region. It is recommended that significance of the ROC scores should also be calculated.

3.5.3 Scores to be calculated for deterministic forecasts

The three terms of the Murphy decomposition of MSSS, produced with climatology as standard reference forecast. As a second, optional, control it is recommended that damped persistence be used.

Where dynamical models are used, the MSSS decomposition should be calculated for the grid-point averaged NIÑO3.4 anomaly.

Significance estimates should accompany each of the three terms.

3.5.4 Stratification by month

Verification should be provided for each calendar month.

3.5.5 Lead time

Verification for each month should be provided for six lead times. Namely zero-lead and leads of 1, 2, 3, 4 and 5 months. Additional lead times are encouraged if available.

4. Staged implementation

In order to ease implementation, producers may stage the provision of the elements of the core SVS according to the following recommendation:

(*a*) Initial exchange: verification at Levels 1 and 2;
(*b*) Six-months after initial exchange: verification at Level 3;
(*c*) Twelve-months after initial exchange: inclusion of estimates of skill significance for verification at Levels 1 and 2.

5. VERIFICATION DATA SETS

The key list of data sets to be used in the core SVS for both climatological and verification information is provided below. The same data should be used for both climatology and verification, although the centre's analysis (where available) and the ECMWF and NCEP/NCAR Reanalyses and subsequent analyses may be used when other data are not available. Many seasonal forecasts are produced that may not use the data in either the key climatology or verification data sets (for example, there are numerous systems which predict seasonal rainfall over part of, or over an entire, country). Appropriate data sets should then be used with full details provided.

5.1 Sea-surface temperature

Reynolds OI, for the period 1981 to present. The data set of Smith, *et al*. (1996) for the period 1971-1980.

5.2 Precipitation

Xie-Arkin and/or the Global Precipitation Climatology Project.

5.3 T2m screen temperature

UKMO/CRU T2m data set.
When gridded data sets are used, a 2.5° × 2.5° grid is recommended.

6. SYSTEM DETAILS

Information will be requested for the exchange of scores concerning the following details of the forecast system:

1. Is the system numerical/hybrid/empirical?
2. Is the system deterministic/probabilistic?
3. List of parameters being assessed.
4. List of regions for each parameter.
5. List of forecast ranges (lead times) and periods (e.g. seasonal average) for each parameter.
6. The number of hindcasts/predictions incorporated in the assessment and the dates of these hindcasts/predictions.
7. Details of climatological and verification data sets used (with details of quality controls when these are not published).
8. If appropriate, resolution of fields used for climatologies and verification.

References

Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions, *Journal of Climate*, Volume 9, Number 6, June 1996, pp. 1403-1420.

ANNEX
ADDITIONAL DIAGNOSTICS

1. CATEGORICAL FORECASTS
   Linear error in probability space for categorical forecasts (LEPSCAT)
   Bias
   Post agreement
   Per cent correct

2. PROBABILITY FORECASTS OF BINARY PREDICTANDS
   Brier score
   Brier skill score with respect to climatology
   Continuous rank probability score

3. PROBABILITY OF MULTIPLE CATEGORY PREDICTANDS
Ranked probability score
Ranked probability skill score with respect to climatology

4. CONTINUOUS FORECASTS IN SPACE
Murphy-Epstein decomposition (phase error, amplitude error, bias error) including the anomaly correlation

———————

ATTACHMENT II.9

STANDARDIZED VERIFICATION SYSTEM (SVS) FOR LONG-RANGE FORECASTS (LRF)

1. INTRODUCTION

The WMO Commission for Basic Systems (CBS) noted that there has been considerable progress in the development of long-range forecasting activities but that no comprehensive documentation of skill levels measured according to a common standard was available. It was noted that assessments of the scientific quality of long-range forecasts were not generally made available to users, apart from simple measures of skill and warning provided along with Internet products from some issuing centres/institutes.

Long-range forecasts are being issued from several centres/institutes and are being made available in the public domain. Forecasts for specific locations may differ substantially at times, due to the inherent limited skill of long-range forecast systems. The Commission acknowledged the scientific merit of those differences and encouraged the various approaches as a means to spur progress on the research front. However, concerns were raised that this situation tended to lead to confusion amongst users, and ultimately was reflecting back on the science behind long-range forecasts.

There was agreement on the need to have a more coherent approach to verification of long-range forecasts. The Commission agreed that its role was to develop procedures for the exchange of verification results, with a particular focus on the practical details of producing and exchanging appropriate verification scores.

This document presents the detailed specifications for the development of a standardized verification system (SVS) for long-range forecasts (LRF) within the framework of a WMO exchange of verification scores. The SVS for LRF described herein constitutes the basis for long-range forecast evaluation and validation, and for exchange of verification scores. It will grow as more requirements are adopted.

2. DEFINITIONS

2.1 Long-range forecasts

LRF extend from 30 days up to two years and are defined in Table 1.

Table 1
Definition of long-range forecasts

Monthly outlook:	Description of averaged weather parameters expressed as departures from climate values for that month
Three-month or 90-day outlook:	Description of averaged weather parameters expressed as departures from climate values for that three-month or 90-day period
Seasonal outlook:	Description of averaged weather parameters expressed as departures from climate values for that season

Seasons have been loosely defined in the northern hemisphere as December–January–February (DJF) for winter (summer in the southern hemisphere), March–April–May (MAM) for spring (fall in the southern hemisphere), June–July–August (JJA) for summer (winter in the southern hemisphere) and September–October–November (SON) for fall (spring in the southern hemisphere). In the Tropical areas, seasons may have different definitions. Outlooks over longer periods such as multi-seasonal outlooks or tropical rainy season outlooks may be provided.

It is recognized that in some countries, long-range forecasts are considered to be climate products.

This document is mostly concerned with the three-month or 90-day outlooks and the seasonal outlooks.

2.2 Deterministic long-range forecasts

Deterministic LRF provide a single expected value for the forecast variable. The forecast may be presented in terms of an expected category (referred to as categorical forecasts, e.g. equiprobable terciles) or may take predictions of the continuous variable (non-categorical forecasts). Deterministic LRF can be produced from a single run of a numerical weather prediction (NWP) model or a general circulation model (GCM), or can be produced from the grand mean of the members of an ensemble prediction system (EPS), or can be based on an empirical model.

The forecasts are either objective numerical values such as departure from normal of a given parameter or expected occurrences (or non-occurrences) of events classified into categories (above/below normal or above/near/below normal for example). Although equi-probable categories is preferred for consistency, other classifications can be used in a similar fashion.

2.3 Probabilistic long-range forecasts

Probabilistic LRF provide probabilities of occurrences or non-occurrences of an event or a set of fully inclusive events. Probabilistic LRF can be generated from an empirical model, or produced from an EPS.

The events can be classified into categories (above/below normal or above/near/below normal for example). Although equi-probable categories are preferred for consistency, other classifications can be used in a similar fashion.

2.4 Terminology

There is no universally accepted definition of forecast period and forecast lead time. However, the definition in Table 2 will be used in this document.

Table 2
Definitions of forecast period and lead time

Forecast period:	Forecast period is the validity period of a forecast. For example, long-range forecasts may be valid for a 90-day period or a season.
Lead time:	Lead time refers to the period of time between the issue time of the forecast and the beginning of the forecast validity period. Long-range forecasts based on all data up to the beginning of the forecast validity period are said to be of lead zero. The period of time between the issue time and the beginning of the validity period will categorize the lead. For example, a winter seasonal forecast issued at the end of the preceding summer season is said to be of one season lead. A seasonal forecast issued one month before the beginning of the validity period is said to be of one month lead.

Figure 1 presents the definitions of Table 2 in graphical format.

Forecast range determines how far into the future LRF are provided. Forecast range is thus the summation of lead time and forecast period.

Persistence, for a given parameter, stands for persisting the anomaly which has been observed over the period of time with the same length as the forecast period and immediately prior to the LRF issue time (see Figure 1). It is important to realize that only the anomaly of any given parameter can be persisted. The persisted anomaly is added to the background climatology to retrieve the persisted parameter. Climatology is equivalent to persisting a uniform anomaly of zero.

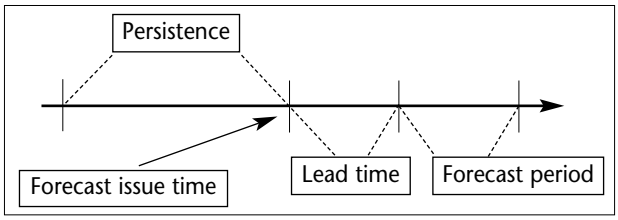

Figure 1 — Definition of forecast period, lead time and persistence as applied in a forecast verification framework

3. SVS FOR LONG-RANGE FORECASTS

3.1 Parameters to be verified

The following parameters are to be verified:

(*a*) Surface air temperature (T2m) anomaly at screen level;

(*b*) Precipitation anomaly;

(*c*) Sea-surface temperature (SST) anomaly.

In addition to these three parameters, the Niño3.4 Index, defined as the mean SST anomaly over the Niño-3.4 region from 170°W to 120°W and from 5°S to 5°N, all inclusive, is also to be verified.

It is recommended that three levels of verification be done:

(*a*) Level 1: large scale aggregated overall measures of forecast performance (see section 3.1.1).

(*b*) Level 2: verification at grid-points (see section 3.1.2).

(*c*) Level 3: grid-point by grid-point contingency tables for more extensive verification (see section 3.1.3).

Both deterministic and probabilistic forecasts are verified if available. Level 1 is applicable to T2m anomaly, Precipitation anomaly and Niño3.4 Index. Levels 2 and 3 are applicable to T2m anomaly, precipitation anomaly and SST anomaly.

3.1.1 Aggregated verification (level 1)

Large-scale verification statistics are required in order to evaluate the overall skill of the models and ultimately for assessing their improvements. These are bulk numbers calculated by aggregating verification at grid-points and should not be used to assess regionalized skill. This aggregated verification is performed over three regions:

(*a*) Tropics: from 20°S to 20°N all inclusive;

(*b*) Northern extratropics: from 20°N to 90°N, all inclusive;

(*c*) Southern extratropics: from 20°S to 90°S, all inclusive.

The verification of Niño3.4 Index is also part of level 1 verification.

3.1.2 Grid-point verification (level 2)

The grid point verification is recommended for a regionalized assessment of the skill of the model. The appropriate way to make these verifications available is by visual rendering. The verification latitude/longitude grid is recommended as being 2.5° × 2.5°, with origin at 0°N, 0°E.

3.1.3 Contingency tables (level 3)

It is recommended to make available the raw verification material used for the grid-point verification in section 3.1.2. This data is provided in contingency tables to allow users to perform more detailed verifications and generate statistics that are relevant for localized regions. The contingency tables are defined in sections 3.3.2 and 3.3.3. It is recommended to code all contingency tables at all grid-points into a single file. Forecasts producers are required to provide a complete description of the format to ensure proper decoding of these contingency table files.

3.1.4 Summary of the core SVS

The following chart gives a summary of what is part of the core SVS:

Parameters	*Verification regions*	*Deterministic forecasts*	*Probabilistic forecasts*
		Level 1	
T2m anomaly Precipitation anomaly	Tropics Northern extratropics Southern extratropics	MSSS (bulk number)	ROC curves ROC areas Reliability diagrams Frequency histograms
	(section 3.1.1)	(section 3.3.1)	(sections 3.3.3 and 3.3.4)
Niño3.4 Index	N/A	MSSS (bulk number)	ROC curves ROC areas Reliability diagrams Frequency histograms
		(section 3.3.1)	(sections 3.3.3 and 3.3.4)
		Level 2	
T2m anomaly Precipitation anomaly SST anomaly	Grid-point verification on a 2.5° by 2.5° grid	MSSS and its three-term decomposition at each grid-point in graphic representation number of forecast-observation pairs mean of observations and forecasts variance of observations and forecasts correlation of forecasts and observations	ROC areas at each grid-point in graphic representation
	(section 3.1.2)	(section 3.3.1)	(section 3.3.3)
		Level 3	
T2m anomaly Precipitation anomaly SST anomaly	Grid-point verification on a 2.5° by 2.5° grid	3 by 3 contingency tables at each grid-point	ROC reliability tables at at each grid-point
	(section 3.1.2)	(section 3.3.2)	(section 3.3.3)

The number of realizations of LRF is far smaller than in the case of short-term numerical weather prediction forecasts. Consequently it is mandatory as part of the core SVS, to calculate and report error bars and level of significance (see section 3.3.5).

In order to ease implementation, participating LRF producers may stage the introduction of the core SVS according to the following priorities:

(*a*) Verification at levels 1 and 2 in the first year of implementation;

(*b*) Verification at level 3 by the middle of the year following implementation of levels 1 and 2;

(*c*) Level of significance by the end of the year following implementation of levels 1 and 2.

Other parameters and indices to be verified as well as other verification scores can be added to the core SVS in future versions.

3.2 Verification strategy

LRF verification should be done on a latitude/longitude grid, and at individual stations or groups of stations representing grid boxes or local areas as defined in section 3.1.1. Verification on a latitude/longitude grid is performed separately from the one done at stations.

The verification latitude/longitude grid is recommended as being 2.5° × 2.5°, with origin at 0°N, 0°E. Both forecasts and the gridded verifying data sets are to be interpolated onto the same 2.5° × 2.5° grid.

In order to handle spatial forecasts, predictions for each point within the verification grid should be treated as individual forecasts but with all results combined into the final outcome. The same approach is applied when verification is done at stations. Categorical forecast verification can be performed for each category separately.

Similarly, all forecasts are treated as independent and combined together into the final outcome, when verification is done over a long period of time (several years for example).

Stratification of the verification data is based on forecast period, lead time and verification area. For example, seasonal forecast verification should be stratified according to season, meaning that verification results for different seasons should not be mixed. Forecasts with different lead times are similarly to be verified separately. It is also recommended to stratify verification according to warm and cold ENSO events (see Section 7 for definitions).

3.3 Verification scores

The following verification scores are to be used:

(*a*) Mean square skill score (MSSS);

(*b*) Relative operating characteristics (ROC).

MSSS is applicable to deterministic forecasts only, while ROC is applicable to both deterministic and probabilistic forecasts. MSSS is applicable to non-categorical forecasts (or to forecasts of continuous variables), while ROC is applicable to categorical forecasts either deterministic or probabilistic in nature.

Verification methodology using ROC, is derived from signal detection theory. This methodology is intended to provide information on the characteristics of systems upon which management decisions can be taken. In the case of weather/climate forecasts, the decision might relate to the most appropriate manner in which to use a forecast system for a given purpose. ROC is applicable to both deterministic and probabilistic categorical forecasts and is useful in contrasting characteristics of deterministic and probabilistic systems. The derivation of ROC is based on contingency tables giving the hit rate and false alarm rate for deterministic or probabilistic forecasts. The events are defined as binary, which means that only two outcomes are possible, an occurrence or a non-occurrence. It is recognized that ROC as applied to deterministic forecasts is equivalent to the Hanssen and Kuipers score (see section 3.3.2).

The binary event can be defined as the occurrence of one of two possible categories when the outcome of the LRF system is in two categories. When the outcome of the LRF system is in three (or more) categories, the binary event is defined in terms of occurrences of one category against the remaining ones. In those circumstances, ROC has to be calculated for each possible category.

3.3.1 MSSS for non-categorical deterministic forecasts

Let x_{ij} and f_{ij} (i=1,...,n) denote time series of observations and continuous deterministic forecasts, respectively, for a grid-point or station j over the period of verification (POV). Then, their averages for the POV, $\overline{x}_j$ and $\overline{f}_j$ and their sample variances s_{xj}^2 and s_{fj}^2 are given by:

$$\overline{x}_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij}, \quad \overline{f}_j = \frac{1}{n}\sum_{i=1}^{n} f_{ij}$$

$$s_{xj}^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij}-\overline{x}_j\right)^2, \quad s_{fj}^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(f_{ij}-\overline{f}_j\right)^2$$

The mean squared error of the forecasts is:

$$MSE_j = \frac{1}{n}\sum_{i=1}^{n}\left(f_{ij} - x_{ij}\right)^2$$

For the case of cross-validated (see section 3.4) POV climatology forecasts where forecast/observation pairs are reasonably temporally independent of each other (so that only one year at a time is withheld), the mean squared error of climatology forecasts (Murphy, 1988) is:

$$MSE_{cj} = \frac{n-1}{n} s_{xj}^2$$

The MSSS for j is defined as one minus the ratio of the squared error of the forecasts to the squared error for forecasts of climatology:

$$MSSS_j = 1 - \frac{MSE_j}{MSE_{cj}}$$

For the three domains described in section 3.1.1 it is recommended that an overall MSSS be provided. This is computed as:

$$MSSS = 1 - \frac{\sum_j w_j MSE_j}{\sum_j w_j MSE_{cj}}$$

where w_j is unity for verifications at stations and is equal to $\cos(\theta_j)$, where θ_j is the latitude at grid point j on latitude-longitude grids.

For either $MSSS_j$ or MSSS a corresponding root mean square skill score (RMSSS) can be obtained easily from:

$$RMSSS = 1 - \left(1 - MSSS\right)^{1/2}$$

$MSSS_j$ for forecasts fully cross-validated (with one year at a time withheld) can be expanded (Murphy, 1988) as:

$$MSSS_j = \left\{ 2\frac{s_{fj}}{s_{xj}} r_{fxj} - \left(\frac{s_{fj}}{s_{xj}}\right)^2 - \left(\frac{\left[\bar{f}_j - \bar{x}_j\right]}{s_{xj}}\right)^2 + \frac{2n-1}{(n-1)^2} \right\} \Bigg/ \left\{ 1 + \frac{2n-1}{(n-1)^2} \right\}$$

where r_{fxj} is the product moment correlation of the forecasts and observations at point or station j.

$$r_{fxj} = \frac{\frac{1}{n}\sum_{i=1}^{n}\left(f_{ij} - \bar{f}_j\right)\left(x_{ij} - \bar{x}_j\right)}{s_{fj} s_{xj}}$$

The first three terms of the decomposition of $MSSS_j$ are related to phase errors (through the correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias error, respectively, of the forecasts. These terms provide the opportunity for those wishing to use the forecasts for input into regional and local forecasts to adjust or weight the forecasts as they deem appropriate. The last term takes into account the fact that the climatology forecasts are cross-validated as well.

Note that for forecasts with the same amplitude as that of observations (second term unity) and no overall bias (third term zero), $MSSS_j$ will not exceed zero (i.e. the forecasts squared error will not be less than for climatology) unless r_{fxj} exceeds approximately 0.5.

It is recommended that maps of the correlation, the ratio of the square roots of the variances, and the overall bias be produced for all forecast parameters and leads for each of the conventional seasons:

Map: r_{fxj}, $\frac{s_{fj}}{s_{xj}}$, $\left|\bar{f}_j - \bar{x}_j\right|$, all parameters, leads, and target months and seasons.

In addition to the bulk measures of MSSS and the maps of the three quantities just described, it is recommended that a table be produced for every parameter, lead, and target containing for every station or grid point *j* the following quantities:

$$n,\ \bar{f}_j,\ \bar{x}_j,\ s_{fj},\ s_{xj},\ r_{fxj},\ MSE_j,\ MSE_{cj},\ MSSS_j$$

As an additional standard against which to measure forecast set performance, cross-validated damped persistence (defined below) should be considered for certain forecast sets. A forecast of ordinary persistence, for a given parameter and target period, stands for the persisted anomaly (departure from cross-validated climatology) from a period immediately preceding the start of the lead time for the forecast period (see Figure 1). This period must have the same length as the forecast period. For example, the ordinary persistence forecast for a 90-day period made 15 days in advance would be the anomaly of the 90-day period beginning 105 days before the target forecast period and ending 16 days before. Ordinary persistence forecasts are never recommended as a standard against which to measure other forecasts if the performance or skill measures are based on squared error, like herein. This is because persistence is easy to beat in this framework.

Damped persistence is the optimal persistence forecast in a least squared error sense. Even damped persistence should not be used in the case of extratropical seasonal forecasts, because the nature of the interannual variability of seasonal means changes considerably from one season to the next in the extratropics. For all other cases, damped persistence forecasts can be made in a cross-validated mode (section 3.4) and the skill and performance diagnostics based on the squared error described above (bulk measures, maps, and tables) can be computed and presented for these forecasts.

Damped persistence is the ordinary persistence anomaly $x_{ij}\ (t - \Delta t) - \bar{x}_{ij}^{m}\ (t - \Delta t)$ damped (multiplied) towards climatology by the cross-validated, lagged product moment correlation between the period being persisted and the target forecast period.

$$r_{\Delta,j}^{m}\left[x_{ij}(t-\Delta t)-\bar{x}_{ij}^{m}(t-\Delta t)\right]$$

Damped persistence forecast:

$$r_{\Delta,j}^{m}=\frac{\frac{1}{m}\sum_{m}\left[x_{ij}(t-\Delta t)-\bar{x}_{ij}^{m}(t-\Delta t)\right]\left[x_{ij}(t)-\bar{x}_{ij}^{m}(t)\right]}{s_{xj}^{m}(t-\Delta t)\,s_{xj}^{m}(t)}$$

where t is the target forecast period, t-Δt the persisted period (preceding the lead time), and m denotes summation (for $r_{\Delta,j}^{m}$, $\bar{x}_{ij}^{m}$, s_{xj}^{m}) at each stage of the cross-validation over all i except those being currently withheld (section 3.4).

⇒ MSSS, provided as a single bulk number, is mandatory for level 1 verification in the core SVS. MSSS, together with its three-term decomposition, are also mandatory for level 2 verification in the core SVS.

3.3.2 Contingency tables and scores for categorical deterministic forecasts

For two- or three-category deterministic forecasts, it is recommended that full contingency tables be provided (digitally not graphically), because it is recognized that they constitute the most informative way to evaluate the performance of the forecasts. These contingency tables then form the basis for several skill scores that are useful for comparisons between different deterministic categorical forecast sets (Gerrity, 1992) and between deterministic and probabilistic categorical forecast sets (Hanssen and Kuipers, 1965), respectively.

The contingency tables should be provided for every combination of parameter, lead time, target month or season, and ENSO stratification (when appropriate) at every verification point for both the forecasts and (when appropriate) damped persistence. The definition of ENSO events is provided in Section 7.

If x_i and f_i now denote an observation and corresponding forecast of category i (i = 1,...,3), let n_{ij} be the count of those instances with forecast category i and observed category j. The full contingency table is defined as the nine n_{ij}. Graphically, the nine-cell counts are usually arranged with the forecasts defining the table rows and the observations the table columns:

Table 3
General three-by-three contingency table

		Observations			
		Below normal	*Near normal*	*Above normal*	
Forecasts	Below normal	n_{11}	n_{12}	n_{13}	$n_{1\bullet}$
	Near normal	n_{21}	n_{22}	n_{23}	$n_{2\bullet}$
	Above normal	n_{31}	n_{32}	n_{33}	$n_{3\bullet}$
		$n_{\bullet 1}$	$n_{\bullet 2}$	$n_{\bullet 3}$	T

In Table 3, $n_{i\bullet}$ and $n_{\bullet i}$ represent the sum of the rows and columns respectively; T is the total number of cases. Generally about at least 90 forecast/observation pairs are required to estimate properly a three-by-three contingency table. Thus it is recommended that the provided tables be aggregated by users over windows of target periods, like several adjacent months or overlapping three-month periods, or over verification points. In the case of the latter, the weights W_i should be used in summing n_{ij} over different points i (see discussion on Table 4). W_i is defined as:

$W_i = 1$ when verification is done at stations or at single grid-points within a 10 degree box; $W_i = \cos(\theta_i)$ at grid point i, when verification is done on a grid and θ_i the latitude at grid-point i.

On a 2.5 degree latitude-longitude grid, the minimally acceptable sample is easily attained even with a record as short as $n = 10$ by aggregating over all grid points with a 10 degree box. Or alternatively in this case, an adequate sample can be achieved by aggregation over three adjacent months or overlapping three-month periods and within a 5 degree box. Regardless, scores derived from any contingency table should be accompanied by error bars, confidence intervals or level of significance.

Contingency tables such as the one in Table 3 are mandatory for level 3 verification in the core SVS.

The relative sample frequencies p_{ij} are defined as the ratios of the cell counts to the total number of forecast/observation pairs N (n is reserved to denote the length of the POV):

$$p_{ij} = n_{ij}/N$$

The sample probability distributions of forecasts and observations, respectively, then become:

$$p\left(f_i\right) = \sum_{j=1}^{3} p_{ij} = \hat{p}_i \; ; \; i = 1, \ldots, 3$$

$$p\left(x_i\right) = \sum_{j=1}^{3} p_{ji} = p_i \; ; \; i = 1, \ldots, 3$$

A recommended skill score for the three-by-three table which has many desirable properties and is easy to compute is the Gerrity skill score (GSS). The definition of the score uses a scoring matrix s_{ij} ($i = 1,\ldots,3$), which is a tabulation of the reward or penalty every forecast/observation outcome represented by the contingency table will be accorded:

$$GSS = \sum_{i=1}^{3} \sum_{j=1}^{3} p_{ij} s_{ij}$$

The scoring matrix is given by:

$$s_{ii} = \frac{1}{2}\left(\sum_{r=1}^{i-1} a_r^{-1} + \sum_{r=i}^{2} a_r\right)$$

$$s_{ij} = \frac{1}{2}\left[\sum_{r=1}^{i-1} a_r^{-1} - (j-1) + \sum_{r=j}^{2} a_r\right]; \; 1 \le i < 3, \; i < j \le 3$$

where:

$$a_i = \frac{1 - \sum_{r=1}^{i} p_r}{\sum_{r=1}^{i} p_r}$$

Note that GSS is computed using the sample probabilities, not those on which the original categorizations were based (i.e. 0.33, 0.33, 0.33).

The GSS can be alternatively computed by the numerical average of two of the three possible two-category, unscaled Hannssen and Kuipers scores (introduced below) that can be computed from the three-by-three table. The two are computed from the two two-category contingency tables formed by combining categories on either side of the partitions between consecutive categories: (*a*) above normal and a combined near and below normal category; and (*b*) below normal and a combined near and above normal category.

The GSS's ease of construction ensures its consistency from categorization to categorization and with underlying linear correlations. The score is likewise equitable, does not depend on the forecast distribution, does not reward conservatism,

utilizes off diagonal information in the contingency table, and penalizes larger errors more. For a limited subset of forecast situations it can be manipulated by a forecaster to his/her advantage (Mason and Mimmack, 2002), but this is not a problem for objective forecast models that have not been trained to take advantage of this weakness. For all these reasons it is the recommended score.

An alternative score to the GSS for consideration is LEPSCAT (Potts, *et al.*, 1996).

Table 4 shows the general form for the three possible two-by-two contingency tables referred to above (the third is the table for the near normal category and the combined above and below normal category). In Table 4, *T* is the grand sum of all the proper weights applied on each occurrence and non-occurrence of the events.

Table 4
General ROC contingency table for deterministic forecasts

		Observations		
		Occurrences	*Non-occurrences*	
Forecasts	Occrrences	O_1	NO_1	O_1+NO_1
	Non-occurrences	O_2	NO_2	O_2+NO_2
		O_1+O_2	NO_1+NO_2	T

The two-by-two table in Table 4 may be constructed from the three-by-three table described in Table 3 by summing the appropriate rows and columns.

In Table 4, O_1 represents the correct forecasts or hits:

$$O_1 = \Sigma W_i\,(OF)_i$$

(OF) being 1 when the event occurrence is observed and forecast; 0 otherwise. The summation is over all grid-points or stations.

NO_1 represents the false alarms:

$$NO_1 = \Sigma W_i\,(NOF)_i$$

(NOF) being 1 when the event occurrence is not observed but was forecast; 0 otherwise. The summation is over all grid-points or stations.

O_2 represents the misses:

$$O_2 = \Sigma W_i\,(ONF)_i$$

(ONF) being 1 when the event occurrence is observed but not forecast; 0 otherwise. The summation is over all grid-points or stations.

NO_2 represents the correct rejections:

$$NO_2 = \Sigma W_i\,(NONF)_i$$

(NONF) being 1 when the event occurrence is not observed and not forecast; 0 otherwise. The summation is over all grid-points or stations.

$W_i = 1$ when verification is done at stations or at single grid-points; $W_i = \cos(\theta_i)$ at grid-point i, when verification is done on a grid and θ_i the latitude at grid-point i.

When verification is done at stations, the weighting factor is one. Consequently, the number of occurrences and non-occurrences of the event are entered in the contingency table of Table 4.

However, when verification is done on a grid, the weighting factor is $\cos(\theta_i)$, where θ_i is the latitude at grid point i. Consequently, each number entered in the contingency table of Table 5, is, in fact, a summation of the weights properly assigned.

Using stratification by observations (rather than by forecast), the hit rate (HR) is defined as (referring to Table 4):

$$HR = O_1/(O_1 + O_2)$$

The range of values for HR goes from 0 to 1, the latter value being desirable. An HR of one means that all occurrences of the event were correctly forecast.

The false alarm rate (FAR) is defined as:

$$FAR = NO_1/(NO_1 + NO_2)$$

The range of values for FAR goes from 0 to 1, the former value being desirable. A FAR of zero means that in the verification sample, no non-occurrences of the event were forecast to occur.

Hanssen and Kuipers Score (see Hanssen and Kuipers, 1965 and Stanski, *et al.*, 1989) is calculated for deterministic forecasts. The Hanssen and Kuipers Score (KS) is defined as:

$$KS = HR - FAR$$
$$= \frac{O_1 NO_2 - O_2 NO_1}{(O_1 + O_2)(NO_1 + NO_2)}$$

The range of KS goes from -1 to +1, the latter value corresponding to perfect forecasts (HR being 1 and FAR being 0). KS can be scaled so that the range of possible values goes from 0 to 1 (1 being for perfect forecasts):

$$KS_{scaled} = \frac{KS + 1}{2}$$

The advantage of scaling KS is that it becomes comparable to the area under the ROC curve for probabilistic forecasts (see section 3.3.3) where a perfect forecast system has an area of 1 and a forecast system with no information has an area of 0.5 (HR being equal to FAR).

⇒ Contingency tables for deterministic categorical forecasts (such as in Table 3) are mandatory for level 3 verification in the core SVS. These contingency tables can provide the basis for the calculation of several scores and indices such as the Gerrity Skill Score, the LEPSCAT or the scaled Hanssen and Kuipers Score and others.

3.3.3 ROC for probabilistic forecasts

Tables 5 and 6 show contingency tables (similar to Table 4) that can be built for probabilistic forecasts of binary events.

Table 5
General ROC contingency table for probabilistic forecasts of binary events with definitions of the different parameters. This contingency table applies when probability thresholds are used to define the different probability bins

Bin number	*Forecast probabilities*	*Observed occurrences*	*Observed non-occurrences*
1	$0–P_2$ (%)	O_1	NO_1
2	$P_2–P_3$ (%)	O_2	NO_2
3	$P_3–P_4$ (%)	O_3	NO_3
•••	•••	•••	•••
n	$P_n–P_{n+1}$ (%)	O_n	NO_n
•••	•••	•••	•••
N	$P_N–100$ (%)	O_N	NO_N

In Table 5, n = number of the n^{th} probability interval or bin n; n goes from 1 to N; P_n = lower probability limit for bin n; P_{n+1} = upper probability limit for bin n; N = number of probability intervals or bins.

$$O_n = \Sigma W_i\,(O)_i$$

(O) being 1 when an event corresponding to a forecast in bin n, is observed as an occurrence; 0 otherwise. The summation is over all forecasts in bin n, at all grid points or stations.

$$NO_n = \Sigma W_i\,(NO)_i$$

(NO) being 1 when an event corresponding to a forecast in bin n, is not observed; 0 otherwise. The summation is over all forecasts in bin n, at all grid-points i or stations i.

W_i = 1 when verification is done at stations or at single grid points; W_i = cos (θ_i) at grid-point i, when verification is done on a grid; θ_i the latitude at grid-point i.

Table 6
General ROC contingency table for probabilistic forecasts of binary events with definitions of the different parameters. This contingency table applies when the different probability bins are defined as function of the number of members in the ensemble

Bin number	*Member distribution*	*Observed occurrences*	*Observed non-occurrences*
1	F=0, NF=N	O_1	NO_1
2	F=1, NF=N–1	O_2	NO_2
3	F=2, NF=N–2	O_3	NO_3
•••		•••	•••
n	F=n–1, NF=N–n+1	O_n	NO_n
•••		•••	•••
N+1	F=N, NF=0	O_{N+1}	NO_{N+1}

In Table 6, n = number of the n^{th} bin; n goes from 1 to N+1; N = number of members in the ensemble; F = the number of members forecasting occurrence of the event; NF = the number of members forecasting non occurrence of the event. The bins may be aggregated:

$$O_n = \Sigma W_i\,(O)_i$$

(O) being 1 when an event corresponding to a forecast in bin n is observed as an occurrence; 0 otherwise. The summation is over all forecasts in bin n, at all grid-points i or stations i.

$$NO_n = \Sigma W_i\,(NO)_i$$

(NO) being 1 when an event corresponding to a forecast in bin n is not observed; 0 otherwise. The summation is over all forecasts in bin n, at all grid points i or stations i.

W_i = 1 when verification is done at stations or at single grid points; W_i = cos (θ_i) at grid-point i, when verification is done on a grid and θ_i the latitude at grid-point i.

To build the contingency table in Table 6, probability forecasts of the binary event are grouped in categories or bins in ascending order, from 1 to N, with probabilities in bin n-1 lower than those in bin n (n goes from 1 to N). The lower probability limit for bin n is P_{n-1} and the upper limit is P_n. The lower probability limit for bin 1 is 0%, while the upper limit in bin N is 100%. The summation of the weights on the observed occurrences and non-occurrences of the event corresponding to each forecast in a given probability interval (bin n for example) is entered in the contingency table.

Tables 5 and 6 outline typical contingency tables. It is recommended that the number of probability bins remains between 9 and 20. The forecast providers can bin according to per cent thresholds (Table 5) or ensemble members (Table 6) as deemed necessary. Table 6 gives an example of a table based on ensemble members.

Hit rate and false alarm rate are calculated for each probability threshold P_n (see Tables 5 and 6). The hit rate for probability threshold P_n (HR_n) is defined as (referring to Tables 5 and 6):

$$HR_n = \sum_{i=n}^{N} O_i \Big/ \sum_{i=1}^{N} O_i$$

and the false alarm rate (FAR_n) is defined as:

$$FAR_n = \sum_{i=n}^{N} NO_i \Big/ \sum_{i=1}^{N} NO_i$$

where n goes from 1 to N. The range of values for HR_n goes from 0 to 1, the latter value being desirable. The range of values for FAR_n goes from 0 to 1, zero being desirable. Frequent practice is for probability intervals of 10% (10 bins, or N=10) to be used. However the number of bins (N) should be consistent with the number of members in the EPS used to calculate the forecast probabilities. For example, intervals of 33% for a nine-member ensemble system could be more appropriate.

Hit rate (HR) and false alarm rate (FAR) are calculated for each probability threshold P_n, giving N points on a graph of HR (vertical axis) against FAR (horizontal axis) to form the ROC curve. This curve, by definition, must pass through the points (0,0) and (1,1) (for events being predicted only with >100% probabilities (never occurs) and for all probabilities exceeding 0%, respectively). No-skill forecasts are indicated by a diagonal line (where HR=FAR); the further the curve lies towards the upper left-hand corner (where HR=1 and FAR=0) the better.

The area under the ROC curve is a commonly used summary statistics representing the skill of the forecast system. The area is standardized against the total area of the figure such that a perfect forecast system has an area of one and a curve lying along the diagonal (no information) has an area of 0.5. The normalized ROC area has become known as the ROC score. Not only can the areas be used to contrast different curves, but they are also a basis for Monte Carlo significance tests. It is proposed that Monte Carlo testing should be done within the forecast data set itself. The area under the ROC curve can be calculated using the Trapezium rule. Although simple to apply, the Trapezium rule renders the ROC score dependent on the number of points on the ROC curve, and care should be taken in interpreting the results. Other techniques are available to calculate the ROC score (see Mason, 1982).

⇒ Contingency tables for probabilistic forecasts (such as in Tables 5 and 6) are mandatory for level 3 verification in the core SVS. ROC curves and ROC areas are mandatory for level 1 verification in the core SVS while ROC areas only are mandatory for level 2 verification in the core SVS.

3.3.4 Reliability diagrams and frequency histograms for probabilistic forecasts

It is recommended that the construction of reliability curves (including frequency histograms to provide indications of sharpness) be done for the large-sampled probability forecasts aggregated over the tropics and, separately, the two extratropical hemispheres. Given frequency histograms, the reliability curves are sufficient for the ROC curve, and have the advantage of indicating the reliability of the forecasts, which is a deficiency of the ROC. It is acknowledged that the ROC curve is frequently the more appropriate measure of forecast quality than the reliability diagram in the context of verification of long-range forecasts because of the sensitivity of the reliability diagram to small sample sizes. However, because measures of forecast reliability are important for modellers, forecasters, and end-users, it is recommended that in the exceptional cases of the forecasts being spatially aggregated over the tropics and over the two extratropical hemispheres, reliability diagrams be constructed in addition to ROC curves.

The technique for constructing the reliability diagram is somewhat similar to that for the ROC. Instead of plotting the hit rate against the false alarm rate for the accumulated probability bins, the hit rate is calculated only from the sets of forecasts for each probability bin separately, and is plotted against the corresponding forecast probabilities. The hit rate for each probability bin (HR_n) is defined as:

$$HR_n = \frac{O_n}{O_n + NO_n}$$

This equation should be contrasted with the hit rate used in constructing the ROC diagram.

Frequency histograms are constructed similarly from the same contingency tables as those used to produce reliability diagrams. Frequency histograms show the frequency of forecasts as a function of the probability bin. The frequency of forecasts (F_n) for probability bin n is defined as:

$$F_n = \frac{O_n + NO_n}{T}$$

where T is the total number of forecasts.

⇒ Reliability diagrams and frequency histograms are mandatory for level 1 verification in the core SVS.

3.3.5 Level of significance

Because of the increasing uncertainty in verification statistics with decreasing sample size, significance levels and error bars should be calculated for all verification statistics. Recommended procedures for estimating these uncertainties are detailed below.

ROC AREA

€ In certain special cases, the statistical significance of the ROC area can be obtained from its relationship to the Mann–Whitney U-statistic. The distribution properties of the U-statistic can be used only if the samples are independent. This assumption of independence will be invalid when the ROC is constructed from forecasts sampled in space because of the strong spatial (cross) correlation between forecasts (and observations) at nearby grid-points or stations. However, because of

the weakness of serial correlation of seasonal climate anomalies from one year to the next, an assumption of sequential independence may frequently be valid for long-range forecasts, and so Mann–Whitney U-statistic may be used for calculating the significance of the ROC area for a set of forecasts from a single point in space. An additional assumption for using the Mann–Whitney U-test is that the variance of the forecast probabilities (not that of the individual ensemble predictions themselves) for when non-events occurred is the same as those for when events occurred. The Mann–Whitney U-test is, however, reasonably robust to violations of homoscedasticity which means that the variance of the error term is constant across the range of the variable, and so significance tests in cases of unequal variance are likely to be only slightly conservative.

If the assumptions for the Mann–Whitney U-test cannot be held, the significance of the ROC area should be calculated using randomization procedures. Because the assumptions of permutation procedures are the same as those of the Mann–Whitney U-test, and because standard bootstrap procedures assume independence of samples, alternative procedures such as moving block bootstrap procedures (Wilks, 1997) should be conducted to ensure that the cross- and/or serial-correlation structure of the data is retained.

ROC CURVES

Confidence bands for the ROC curve should be indicated, and can be obtained either by appropriate bootstrap procedures, as discussed above, or, if the assumption of independent forecasts is valid, from confidence bands derived from a two-sample Kolmogorov-Smirnov test comparing the empirical ROC with the diagonal.

MSSS

Appropriate significance tests for the MSSS and the individual components of the decomposition again depend upon the validity of the assumption of independent forecasts. If the assumption is valid, significance tests could be conducted using standard procedures (namely the F-ratio for the correlation and for the variance ratio, and the t-test for the difference in means), otherwise bootstrap procedures are recommended.

⇒ Level of significance is mandatory in the core SVS. A phased-in introduction of level of significance in the SVS may be used (see section 3.1.4).

3.4 Hindcasts

In contrast to short- and medium-range dynamical NWP forecasts, LRF are produced relatively few times a year (for example, one forecast for each season or one forecast for the following 90-day period, issued every month). Therefore the verification sampling for LRF may be limited, possibly to the point where the validity and significance of the verification results may be questionable. Providing verification for a few seasons, or even over a few years only may be misleading and may not give a fair assessment of the skill of any LRF system. LRF systems should be verified over as long a period as possible in hindcast mode. Although there are limitations on the availability of verification data sets and in spite of the fact that validating numerical forecast systems in hindcast mode requires large computer resources, the hindcast period should be as long as possible. Because of verification data availability, it is recommended to do hindcast over the period from 1981 to present. If data is available, it is recommended to extend the period back to 1971.

Verification in hindcast mode should be achieved in a form as close as possible to the real-time operating mode in terms of resolution, ensemble size and parameters. In particular, dynamical/empirical models must not make any use of future data. Validation of empirical models, dynamical models with post-processors (including bias corrections), and calculation of period of verification means, standard deviations, class limits, etc. must be done in a cross-validation framework. Cross-validation allows the entire sample to be used for validation (assessing performance, developing confidence intervals, etc.) and almost the entire sample for model and post-processor building and for estimation of period of verification climatology. Cross-validation proceeds as follows:

1. Delete 1, 3, 5, or more years from the complete sample;
2. Build the statistical model or compute the climatology;
3. Apply the model (e.g. make statistical forecasts or post-process the dynamical forecasts) or the climatology for one (usually the middle) year of those deleted and verify;
4. Replace the deleted years and repeat 1–3 for a different group of years;
5. Repeat 4 until the hindcast verification sample is exhausted.

Ground rules for cross-validation are that every detail of the statistical calculations be repeated, including redefinition of climatology and anomalies, and that the forecast year predictors and predictands are not serially correlated with their counterparts in the years reserved for model building. For example, if adjacent years are correlated but every other year is effectively not, three years must be set aside and forecasts made only on the middle year (see Livezey, 1999 for estimation of the reserved window width).

The hindcast verification statistics should be updated once a year based on accumulated forecasts.

⇒ Verification results over the hindcast period are mandatory for the exchange of LRF verification scores.

3.5 Real-time monitoring of forecasts

It is recommended that there be regular monitoring of the real-time long-range forecasts. It is acknowledged that this real-time monitoring is neither as rigorous nor as sophisticated as the hindcast verification; nevertheless it is necessary for forecast production and dissemination. It is also acknowledged that the sample size for this real-time monitoring may be too small to assess the overall skill of the models. However, it is recommended that the forecast and the observed verification for the previous forecast period be presented in visual format to the extent possible given the restrictions on availability of verification data.

4. VERIFICATION DATA SETS

The same data should be used to generate both climatology and verification data sets, although the forecasts issuing centres/institutes own analyses or ECMWF reanalyses and subsequent operational analyses may be used when other data are not available. Use of NCEP reanalysis data is also another option.

Many LRF are produced that are applicable to limited or local areas. It may not be possible to use the data in either the recommended climatology or verification data sets for validation or verification purposes in these cases. Appropriate data sets should then be used with full details provided.

It is recommended to use:

1. UKMO/CRU for surface air temperature anomaly at screen level (T2m).
2. Xie-Arkin and/or GPCP for precipitation anomaly.
3. Reynolds OI for sea-surface temperature (SST) anomaly. Prior to 1981, the reconstructed SST database using EOF of Smith, *et al*., 1996 can be used.

4.1 Status of the verification data sets

The following paragraphs give the status of the various proposed verification data sets:

4.1.1 XIE-ARKIN

Availability:	• NOAA
Period:	• 1979–1998
Type:	• Rain gauges, satellites and model precipitation amount values • Choice of grids with missing values in the polar regions or completed with model data • Monthly means
Grid:	• 2.5° by 2.5°
Update frequency:	• Every 3 to 6 months
Climatology:	• None
Reference:	• Xie, Pingping, Phillip A. Arkin, 1997: Global precipitation: a 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. *Bulletin of the American Meteorological Society*. Volume 78, Number 11, pp. 2539–2558.
Web site:	• http://www.cdc.noaa.gov/cdc/data.cmap.html

4.1.2 GPCP

Availability:	• NASA
Period:	• 1987–1999
Type:	• Similar to Xie-Arkin data
Grid:	• 2.5° by 2.5°
Update frequency:	• Unknown
Climatology:	• None
Reference:	• Huffman, George J., Robert F. Adler, Philip Arkin, Alfred Chang, Ralph Ferraro, Arnold Gruber, John Janowiak, Alan McNab, Bruno Rudolf, Udo Schneider, 1997: The Global Precipitation Climatology Project (GPCP) combined orecipitation dataset. *Bulletin of the American Meteorological Society*. Volume 78, Number 1, pp. 5–20.
Web site:	• http://orbit-net.nesdis.noaa.gov/arad/gpcp/

4.1.3 UKMO/CRU

Availability:	• UKMO/Hadley Centre
Period:	• 1851–1998
Type:	• Monthly surface air temperature (T2m) anomalies from 1961–1990 climate
Grid:	• 5° by 5°
Update frequency:	• Monthly
Climatology	• 1961–1990

Reference:
- Jones, P. D., M. New, D. E. Parker, S. Martin and I. G. Rigor, 1999: Surface air temperature and its changes over the past 150 years. *Review of Geophysics*, 37, pp. 173–199.

Web site:
- http://www.cru.uea.ac.uk/cru/data/temperature/

These data sets are available for use in scientific research upon the signing of a short license agreement.

4.1.4 Reynolds OI

Availability:
- NOAA/CDC

Period:
- 1981–1998

Type:
- Weekly or monthly sea-surface temperature (SST) means

Grid:
- 1° by 1°
- 2° by 2°

Update frequency:
- 2–4 times a year

Climatology:
- None

Reference:
- Reynolds, R. W. and T. M. Smith, 1994: Improved global sea surface temperature analyses using optimum interpolation. *Journal of Climate*, 7, pp. 929-948.
- Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions. *Journal of Climate*, pp. 1403–1420.

Web site:
- http://www.cdc.noaa.gov/cdc/data.reynolds_sst.html

5. SYSTEM DETAILS

Information must be provided on the system being verified. This information should include (but is not restricted to):

1. Whether the system is numerical, empirical or hybrid.
2. Whether the system is deterministic or probabilistic.
3. Model type and resolution.
4. Ensemble size.
5. Boundary conditions specifications.
6. List of parameters being assessed.
7. List of regions for each parameter.
8. List of forecast ranges (lead times) and periods for each parameter.
9. Period of verification.
10. The number of hindcasts or predictions incorporated in the assessment and the dates of these hindcasts or predictions.
11. Details of climatological and verification data sets used (with details on quality control when these are not published).
12. If appropriate, resolution of fields used for climatologies and verification.

Verification data for the aggregated statistics and the grid-point data should be provided on the Web. The contingency tables should be made available by the Web or anonymous FTP. The lead centre will take responsibility for defining a common format for displaying the verification scores. Real-time monitoring should be done as soon as possible and made available on the Web.

6. REFERENCES

Gerrity, J. P. Jr., 1992: A note on Gandin and Murphy's equitable skill score. *Monthly Weather Review*, 120, pp. 2707-2712.

Hanssen A. J. and W. J. Kuipers, 1965: On the relationship between the frequency of rain and various meteorological parameters. *Koninklijk Nederlands Meteorologist Institua Meded*. Verhand, 81-2-15.

Livezey, R. E., 1999: Chapter 9: Field intercomparison. *Analysis of Climate Variability: Applications of Statistical Techniques*, H. von Storch and A. Navarra, Eds, Springer, pp. 176-177.

Mason I., 1982: A model for assessment of weather forecast. *Australian Meteorological Magazine*, 30, pp. 291-303.

Mason, S. J., and G. M. Mimmack, 2002: Comparison of some statistical methods of probabilistic forecasting of ENSO. *Journal of Climate*, 15, pp. 8-29.

Murphy, A. H., 1988: Skill scores based on the mean square error and their relationships to the correlation coefficient. *Monthly Weather Review*, 16, pp. 2417-2424.

Potts J. M., C. K. Folland, I. T, Jolliffe and D. Sexton, 1996: Revised "LEPS" scores for assessing climate model simulations and long-range forecasts, *Journal of Climate*, 9, pp. 34-53.

Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions, *Journal of Climate*, pp. 1403-1420.

Stanski H. R., L. J. Wilson and W. R. Burrows, 1989: Survey of common verification methods in meteorology. *World Weather Watch Technical Report No. 8*, WMO/TD-No. 358, 114 pp.

Wilks, D. S., 1997: Resampling hypothesis tests for autocorrelated fields. *Journal of Climate*, 10, pp. 65-92.

7. DEFINITION OF ENSO EVENTS

The following table gives the definition of the ENSO events. The following list of cold *(La Niña*) and warm (*El Niño*) episodes has been compiled to provide a season-by-season breakdown of conditions in the tropical Pacific. The data underlying the following table have been taken from NOAA/NCEP/CPC at www.cpc.ncep.noaa.gov and have been subjectively interpolated to fit the conventional seasons DJF, MMA etc.

Years	*DJF*	*MAM*	*JJA*	*SON*	*Years*	*DJF*	*MAM*	*JJA*	*SON*
1950	C	C	C	C	1976	C	N	N	N
1951	C	N	N	N	1977	N	N	N	N
1952	N	N	N	N	1978	N	N	N	N
1953	N	N	N	N	1979	N	N	N	N
1954	N	N	N	C	1980	N	N	N	N
1955	C	N	N	C	1981	N	N	N	N
1956	C	C	C	N	1982	N	N	W	W
1957	N	N	N	W	1983	W	W	N	N
1958	W	W	N	N	1984	N	N	N	N
1959	N	N	N	N	1985	N	N	N	N
1960	N	N	N	N	1986	N	N	N	W
1961	N	N	N	N	1987	W	W	W	W
1962	N	N	N	N	1988	N	N	N	C
1963	N	N	N	W	1989	C	N	N	N
1964	N	N	N	C	1990	N	N	N	N
1965	N	N	W	W	1991	N	N	W	W
1966	W	N	N	N	1992	W	W	N	N
1967	N	N	N	N	1993	N	W	W	N
1968	N	N	N	N	1994	N	N	W	W
1969	W	N	N	N	1995	W	N	N	N
1970	N	N	N	C	1996	N	N	N	N
1971	C	N	N	N	1997	N	W	W	W
1972	N	N	W	W	1998	W	W	N	C
1973	W	N	N	C	1999	C	C	N	C
1974	C	C	N	N	2000	C	N	N	N
1975	N	N	C	C	2001	N	N	N	N

ATTACHMENT II.10

PROCEDURES AND FORMATS FOR THE EXCHANGE OF MONITORING RESULTS

1. GENERAL REMARKS

1.1 Centres participating in the exchange of monitoring results will implement standard procedures and use agreed formats for communicating the information both to other centres and to the data providers. The following list is incomplete and requires further development in the light of practical experience. Guidance will be given through the initiative of the lead centres in their corresponding fields of responsibility.

1.2 Lead centres who are informed of remedial actions being taken should provide this information to all participating centres. The WMO Secretariat shall forward, every six months, the information it receives to the relevant lead centres. All lead centres shall produce for the WMO Secretariat a yearly summary of information made available to them and/or of those actions taken within their area of responsibility.

2. UPPER-AIR OBSERVATIONS

2.1 Monthly exchange for upper-air observations should include lists of stations/ships with the following information.

2.1.1 List 1: GEOPOTENTIAL HEIGHT

Month/year
Monitoring centre
Standard of comparison (first-guess/background field)

Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST THREE LEVELS WITH 10 OBSERVATIONS DURING THE MONTH AND 100 M WEIGHTED RMS DEPARTURE FROM THE FIELD USED FOR COMPARISON BETWEEN 1 000 hPa AND 30 hPa.

The gross error limits to be used for observed minus reference field are as follows:

Level	Geop
1 000 hPa	100 m
925 hPa	100 m
850 hPa	100 m
700 hPa	100 m
500 hPa	150 m
400 hPa	175 m
300 hPa	200 m
250 hPa	225 m
200 hPa	250 m
150 hPa	275 m
100 hPa	300 m
70 hPa	375 m
50 hPa	400 m
30 hPa	450 m

Weights to be used at each level are as follows:

Level	Weight
1 000 hPa	3.70
925 hPa	3.55
850 hPa	3.40
700 hPa	2.90
500 hPa	2.20
400 hPa	1.90
300 hPa	1.60
250 hPa	1.50
200 hPa	1.37
150 hPa	1.19
100 hPa	1.00
70 hPa	0.87
50 hPa	0.80
30 hPa	0.64

Data to be listed for each station/ship should include:

WMO identifier
Observation time
Latitude/longitude (for land stations)
Pressure of the level with largest weighted RMS departure
Number of observations received (including gross errors)
Number of gross errors
Percentage of observations rejected by the data assimilation
Mean departure from reference field
RMS departure from reference field (unweighted)

Gross errors should be excluded from the calculation of the mean and RMS departures. They should not be taken into account in the percentage of rejected data (neither the numerator nor denominator).

2.1.2 List 2: TEMPERATURE

Besides the geopotential height, temperature monitoring should be included at standard levels. As an initial criteria, the gross error thresholds to be considered could be:

15 (K) for p > 700 hPa
10 (K) for 700 > = 50 hPa
15 (K) for p < = 50 hPa

2.1.3 List 3: WIND

Month/year
Monitoring centre
Standard of comparison (first-guess/background field)

Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST ONE LEVEL WITH 10 OBSERVATIONS DURING THE MONTH AND 15 m s^{-1} RMS VECTOR DEPARTURE FROM THE FIELD USED FOR COMPARISON, BETWEEN 1 000 hPa AND 100 hPa.

The gross error limits to be used are as follows:

Level	**Wind**
1 000 hPa	35 m s^{-1}
925 hPa	35 m s^{-1}
850 hPa	35 m s^{-1}
700 hPa	40 m s^{-1}
500 hPa	45 m s^{-1}
400 hPa	50 m s^{-1}
300 hPa	60 m s^{-1}
250 hPa	60 m s^{-1}
200 hPa	50 m s^{-1}
150 hPa	50 m s^{-1}
100 hPa	45 m s^{-1}

Data to be listed for each selected station/ship should include:

WMO identifier
Observation time
Latitude/longitude (for land stations)
Pressure of the level with largest RMS departure
Number of observations received (including gross errors)
Number of gross errors
Percentage of observations rejected by the data assimilation
Mean departure from reference field for u-component
Mean departure from reference field for v-component
RMS vector departure from reference field

Gross errors should be handled in the same way as for List 1.

2.1.4 List 4: WIND DIRECTION

The method used for computing the wind direction bias should be included in the reports (clockwise or aniclockwise)

Month/year
Monitoring centre
Standard of comparison (first-guess/background field)
Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST FIVE OBSERVATIONS AT EACH STANDARD LEVEL FROM 500 hPa TO 150 hPa, FOR THE AVERAGE OVER THAT LAYER, MEAN DEPARTURE FROM REFERENCE FIELD AT LEAST +/- 10 DEGRESS, STANDARD DEVIATION LESS THAN 30 DEGREES, MAXIMUM VERTICAL SPREAD LESS THAN 10 DEGREES.

Same limits for gross errors as above. Data for which the wind speed is less than 5 m s^{-1}, either observed or calculated, should also be excluded from the statistics.

Data to be listed for each selected station/ship should include:

WMO identifier
Observation time
Latitude/longitude (for land stations)
Minimum number of observations at each level from 500 hPa to 150 hPa (excluding gross errors and data with low wind speed)
Mean departure from reference field for wind direction, averaged over the layer
Maximum spread of the mean departure at each level around the average
Standard deviation of the departure from reference field, aveaged over the layer

(To be completed with information from other lead centres)

NOTES:

(1) The responsiblity for updating this attachment rests with the lead centres.

(2) Urgent changes to this attachment recommended by the lead centres shall be approved, on behalf of the Commission for Basic Systems, by the president of the Commission.

2.1.5 The profilers should be monitored (suspect platforms) using the same criteria as for the radiosondes.

3. LAND SURFACE OBSERVATIONS

3.1 The criteria for the production of monthly list of suspect stations are as follows:

3.1.1 List 1: MSL PRESSURE

Element: MSL pressure, surface synoptic observations at 0000, 0600, 1200 or 1800 UTC compared to the first-guess field of a data assimilation model (usually a six-hour forecast).

Number of observations: at least 20 for at least one observation time, without distinguishing between observation times.

One or more of the following:

Absolute value of the mean bias ≥ 4 hPa
Standard deviation ≥ 6 hPa
Percentage gross error ≥ 25 per cent (gross error limit: 15 hPa).

3.1.2 List 2: STATION-LEVEL PRESSURE

The criteria for station-level pressure monitoring is the same as for MSL pressure above.

3.1.3 List 3: GEOPOTENTIAL HEIGHT

Element: geopotential height, from surface synoptic observations or derived from station-level pressure, temperature and published station elevations at 0000, 0600, 1200 or 1800 UTC compared to the first-guess field of a data assimilation model (usually a six-hour forecast).

Number of observations: at least five for at least one observation time, without distinguishing between observation times.

One or more of the following:

Absolute value of the mean bias ≥30 m
Standard deviation ≥40 m
Percentage gross error ≥25 per cent (gross error limit: 100 m).

3.1.4 PRECIPITATION

General guidance reflecting Global Precipitation Climatology Centre (GPCC) procedures for precipitation quality monitoring is given in section 6.3.3.1 of the *Guide on the Global Data-processing System*.

NOTES:

(1) All monitoring centres are asked to conform to the above specified criteria. These monthly lists should be prepared for at least the regional association of the lead centres and, if possible, for other regional associations. Consolidated lists of suspect stations should be produced every six months by the lead centres (January–June and July–December) and forwarded to the WMO Secretariat for further action.

(2) The stations on these consolidated lists should be those appearing on all six-monthly lists of the lead centres. Other stations could be added to the consolidated list if the lead centres judges that there is sufficient evidence for their inclusion. Each centre should send its proposed consolidated list to all participating monitoring centres for comment. The final list would then be forwarded to the WMO Secretariat.

4. SURFACE MARINE OBSERVATIONS

4.1 Monthly exchange for surface marine observations should include lists of 'suspects' ships/buoys/platforms with the following additional information:

Month/year
Monitoring centre
Standard of comparison: first-guess/background field of a global data assimilation model often a six-hour forecast, but the background values may be valid at the observation time for non-main hour data using 4-D VAR or time-interpolation of T+3, T+6, T+9 forecasts; for SST, the first-guess/background filed may be from a previous analysis.

All surface marine data may be included, not just observations at the main hours of 0000, 0600, 1200, 1800 UTC.

4.2 The elements to be monitored should include:

Mean sea level pressure
Wind speed
Wind direction
and, where possible:
Air temperature
Relative humidity
Sea-surface temperature

4.3 Data to be listed for each ship/buoy/platform and each element should include:

WMO identifier observation time (if not all times latitude/longitude for buoys and platforms)
Number of observations received (including gross errors)
Number of gross errors
Percentage of observations rejected by the data assimilation quality control
Mean departure from reference field (bias)
RMS departure from reference field

Gross errors should be excluded from the calculation of the mean and RMS departures. They should not be taken into account in the percentage of rejected data (neither the numerator nor denominator).

4.4 The criteria for the production of the monthly list of suspect stations are as follows:

4.4.1 List 1: MEAN SEA-LEVEL PRESSURE

Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias ≥ 4 hPa
Standard deviation ≥ 6 hPa
Percentage gross error ≥ 25 per cent (gross error limit: 15 hPa)

4.4.2 List 2: WIND SPEED

Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias ≥ 5 m s^{-1}
Percentage gross error ≥ 25 per cent (25 m s^{-1} vector wind)

4.4.3 List 3: WIND DIRECTION

Data for which the wind speed is less than 5 m s^{-1}, either observed or calculated, should be excluded from the statistics.
Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias ≥ 30°
Standard deviation ≥ 80°
Percentage gross error ≥ 25 per cent (gross error limit: 25 m s^{-1} vector wind)

4.4.4 List 4: AIR TEMPERATURE

Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias > 4°C
Standard deviation > 6°C
Percentage gross error > 25 per cent (gross error limit: 15°C)

4.4.5 List 5: RELATIVE HUMIDITY

Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias > 30 per cent
Standard deviation > 40 per cent
Percentage gross error > 25 per cent (gross error limit: 80 per cent)

4.4.6 List 6: SEA-SURFACE TEMPERATURE

Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias > 3°C
Standard deviation > 5°C
Percentage gross error > 25 per cent (gross error limit: 10°C)

5. AIRCRAFT DATA

5.1 The criteria for the production of the monthly list of suspect aircraft temperatures and winds observations are as follows:

5.1.1 Automated aircraft observations, both AMDAR and ACARS, will separately be listed as suspect for temperatures and winds in three pressure categories if the data statistics exceed the criteria defined in paragraph 5.1.2. The three pressure categories are: low surface to 701 hPa; mid to 700 to 301 hPa; and high to 300 hPa and above. To be considered suspect, the number of observations must meet minimal counts and the data statistics versus the guess must exceed at least one criterion or the gross rejection rate must exceed 2 per cent. Thus, if the magnitude of the temperature or speed bias exceed the criterion or the RMS differences to the guess exceed the limit for the pressure category, then the aircraft is listed as suspect for that pressure category. Observations differing from the guess by amounts larger than gross check limits will be considered gross and not used in computing bias and RMS differences. If the number of gross observations (NG) for a pressure category exceeds 2 per cent of the total number of checked observations, then the aircraft will be listed as suspect. After data thinning for assimilation, the remaining number of observations is NT. The number of rejected observations excluding thinning (NR) is an optional statistic for information, and for which operational practice should be documented.

List: Temperature and wind

Month/year
Monitoring centre
Standard of comparison (first guess/background field)

Each aircraft that is suspect will be listed as follows in one line:

Aircraft ID
Pressure category
Total number of available observations (NA)
NG
NT
NR
Bias
RMS difference to the guess
For wind reports, the number of exactly calm winds (NC).

5.1.2 Suspect automated aircraft temperatures and winds observations criteria

Variable	*Low*	*Mid*	*High*
Gross temperature (K)	15.0	10.0	10.0
Temperature bias (K)	3.0	2.0	2.0
Temperature RMS (K)	4.0	3.0	3.0
Minimum count	20	50	50
Gross wind (m s^{-1})	30.0	30.0	40.0
Wind speed bias (m s^{-1})	3.0	2.5	2.5
Wind RMS (m s^{-1})	10.0	8.0	10.0
Minimum count	20	50	50

5.1.3 AIREP

Monthly exchange for AIREP observations should include lists of airlines with the following information:

Month/year
Monitoring centre
Standard of comparison (first guess/background field)
Selection criteria
    Number of observations > = 20
Levels monitored
    300 hPa and above
Elements monitored
    Wind and temperature
Data to be listed for each airline
    Airline ID
    Number of observations
    Number of rejected observations
    Number of gross errors
    Number of calm winds (<5 m s^{-1})
    RMS excluding gross errors
    Bias excluding gross errors (wind speed and temperature)
    Gross error limits are:
        Wind 40 m s^{-1}
        Temperature 10 degrees °C

6. SATELLITE DATA

Satellite data monitoring criteria are as specified in the following table

Geostationary satellite wind (SATOB or BUFR code, as assimilated, centres must clarify this and channels shown)	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring layers	Upper (101–400 hPa) Middle (401–700 hPa) Lower (701–1 000 hPa)
Minimum observation count	20 (in 10 deg box), 10 (in 5 deg box)
Gross error limit (m s^{-1})	60
Availability map (averaged observation number in 24 hours)	10degX10deg OR 5degX5deg for all levels
Map: wind observed value	10degX10deg OR 5degX5deg for each layer
Map: O-FG wind vector difference (bias)	10degX10deg OR 5degX5deg for each layer
Map: O-FG wind speed difference (bias)	10degX10deg OR 5degX5deg for each layer
Map: O-FG RMS of wind vector difference	10degX10deg OR 5degX5deg for each layer
Table: Statistics as defined in the *Proceedings of the Third International Winds Workshop* (1996), Menzel, p. 17. EUMETSAT, Darmstadt, EUMP18, with reference to the first guess	The following statistics for all levels, high, medium and low in all regions, N and S extratropics and tropics for satellite in use and selected channels: MVD = Mean vector difference RMSVD = Vector difference RMS BIAS = Speed bias SPD = FG/background wind speed NCMV = Number of disseminated SATOB winds
Orbital satellite SATEM	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring parameters	Thickness layers (850–1 000, 100–300, 30–50) hPa
Gross error limit (m)	150 (1 000–850), 400 (300–100), 500 (50–30) hPa
Availability map (averaged observation number in 24h)	5degx5deg OR 10degX10deg for each layer
Map: O-FG thickness difference (bias)	5degx5deg OR 10degX10deg for each layer
Map: O-FG RMS of thickness difference	5degx5deg OR 10degX10deg for each layer
Orbital satellite Atmospheric soundings	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring parameters	Uncorrected brightness temperatures primarily, plus corrected
Monitoring channels	The lead centre will recommend a selection of channels to be monitored
Availability map (averaged observation number in 24 hours)	5degx5deg OR 10degX10deg for each satellite
Map: O-FG difference (bias)	5degx5deg OR 10degX10deg for each satellite
Map: O-FG SD of difference	5degx5deg OR 10degX10deg for each satellite

Sea-surface wind (e.g. scatterometers, SSM/I)	*Recommended criteria* Follow guidelines as above for satellite winds where possible, but applied to surface only
Any other satellite product	*Recommended criteria* The pioneering centre can set the initial standard, based on the above guidelines for similar parameters, or a new standard for a new product. Report back to the lead centre for information

PART III

DATA MANAGEMENT ASPECTS

1. STORAGE OF DATA

1.1 Data (observations, analysis and forecast fields) should be organized as much as possible in database structures for easy cataloguing and preparing inventories, in order to facilitate exchange of data and request-reply processing.

1.2 Where possible the storage of data for non-real-time users should be within a database structure with the following characteristics:

(*a*) There should be a table structure present within the database which provides users with the ability to identify easily the contents of the database (some form of automatic cataloguing system);

(*b*) The database should facilitate the easy inter-comparison of diverse elements contained within it;

(*c*) The ability to store a wide variety of data with flexibility in adding new types;

(*d*) Easy access from application programmes to the stored data.

2. COLLECTION, ARCHIVING AND RETRIEVAL OF DATA IN THE GDPS

2.1 Data to be stored for non-real-time uses

2.1.1 **The following operational data shall be stored within the GDPS:**

(*a*) All direct observations or values calculated from these observations by simple methods;

(*b*) Selected derived data which cannot be easily reconstituted from observed data;

(*c*) Selections of analyses and forecasts including verification results.

2.1.2 The types of material to be stored at WMCs, and RSMCs should correspond broadly to those required by investigators of problems on the planetary, large, meso and small scales, respectively.

NOTE: Responsibilities for storage of data at WMCs, RSMCs are given in Attachments III.1 and III.2, respectively. Guidelines for storage and retrieval of satellite data at RSMCs and NMCs are given in Attachment III.4. In meeting these responsibilities, Members should ensure that their centres observe necessary co-ordination with existing archiving systems for marine, aeronautical and satellite data to avoid unnecessary duplication of stored data.

2.1.3 Members should ensure that their NMCs archive and retrieve all data originating from their national observing networks and facilities.

NOTE: Members may wish their NMCs to store additional data of regional, or even global, coverage to satisfy national requirements.

2.2 National arrangements for storage of climatological data

2.2.1 Each Member should collect all its climatological records in its appropriate meteorological archives.

2.2.2 Each Member should maintain an up-to-date inventory of the climatological data available in its archives and also of any other climatological data available in its territory.

2.2.3 Each Member should arrange for the transfer of climatological data from its stations to media capable of being processed by automatic methods.

2.3 Collection of data to be stored

2.3.1 Where urgency for immediate processing of non-real-time data exists, data collection should be by the GTS, subject to available capacity.

2.3.2 Where such urgency, or sufficient capacity, does not exist, collection should be by the safest most economical means or media available.

2.3.3 Where data are available completely through the GTS, the resulting collection should serve research or non-real-time requirements as well as real-time requirements. Collection of the same data by other methods should, in this case, not be necessary if adequate standards of quality control are achieved for the data collected by the GTS.

3. NON-REAL-TIME QUALITY CONTROL

3.1 Quality control of data to be stored

3.1.1 In addition to the real-time quality control, but prior to their storage for retrieval purposes, all data should be subject to the quality control necessary to ensure a satisfactory standard of accuracy for users.

NOTE: Minimum standards for non-real-time quality control of data to be stored by WWW centres are given in Attachment III.3.

3.1.2 The primary responsibility for non-real-time quality control should rest with Members which operate the centres that store the data. This control should be performed on a routine basis and should begin as soon as possible after the data have been received at the centre.

3.1.3 Prior to placing data in storage, all suspect values and proposed corrections should be appropriately marked for future users of data.

3.1.4 Where possible, Members should employ, and constantly improve, computerized methods used at their centres for re-examination of real-time data to detect and correct errors before storage of data.

4. CLASSIFICATION AND CATALOGUING OF STORED DATA

4.1 Catalogue of stored data

4.1.1 All Members should publish and keep up-to-date catalogues of the data which they store at their centres. A descriptive list of such catalogues should be compiled and disseminated to all Members who request it.

4.1.2 The WMO Secretariat should serve as an information centre on the availability of stored meteorological and related data.

4.1.3 The classification and cataloguing scheme for WWW data should be made as compatible as possible with methods used by data centres of related disciplines.

5. MEDIA AND FORMATS FOR THE EXCHANGE OF STORED DATA

5.1 Media for exchange

5.1.1 To the extent possible, all data should be stored in digital form on technical carriers. When this is not possible they should be stored in the most convenient form until such time as they can be transferred to technical carriers. The following common standards should be used for purposes of international exchange (and also for national use except when there are important reasons for using other technical carriers). For data stored on magnetic tape, the main requirement is to ensure that magnetic tapes produced on the computers of one country can be read on the computers of another. Member countries should adhere to the following magnetic tape specifications:

(*a*) Tapes are to be $^1/_2$ inch (12.7 mm) wide with a maximum reel diameter of $10^1/_2$ inches (266.7 mm) and a maximum tape length of 2 400 feet (732 m);

(*b*) Tapes should be 9-track, 6 250 or 1 600 or 800 cpi (character per inch), odd parity, unlabelled, and data blocksize less than 32 000 bytes.

NOTE: Many Member countries now have the capability of higher density magnetic tape devices that allow tapes to be written at recording densities of 1 600, 6 250 cpi, phase encoded. Members are therefore encouraged to explore the exchange of data at these higher densities to achieve greater compaction of data. Also by mutual agreement between the exchanging parties, data may be exchanged on floppy disk, compact disk read only memory (CD-ROM), magnetic cartridges, or through direct computer-to-computer link.

5.1.2 WMCs should provide for the exchange of data in media set forth in paragraph 5.1.1 above. RSMCs and NMCs should provide for the exchange of data on at least one of the standard media set forth in paragraph 5.1.1 above. The desires of the recipient should be considered to the extent possible.

5.1.3 Members operating meteorological satellites should make available, through the WMO Secretariat, information on media and formats used to store data from their satellites.

5.2 Formats

5.2.1 Exchange of stored data by physical media should be in the standard formats recommended by WMO. The data records should be based on GRIB (FM 92) and BUFR (FM 94) codes wherever possible.

5.3 Responsibilities of Members for the exchange of non-real-time data

5.3.1 Each Member shall be responsible for meeting requests from other Members for non-real-time data stored in its national Service in accordance with the functions laid down in Part II of this *Manual*.

5.3.2 Members should exchange non-real-time data in the standard media given in paragraph 5.1 above and in the standard formats given in paragraph 5.2 above.

NOTE: Each Member should make appropriate financial arrangements with other Members who wish to obtain copies of non-real-time data stored within its national Service.

5.3.3 Each Member shall provide the Secretariat with a summary of the data stored in its national Service, including the media and formats used.

5.4 Responsibilities of the WMO Secretariat

5.4.1 The WMO Secretariat shall provide information to Members on the availability of non-real-time data, through the following publications:

(*a*) WMO Publication TD-No. 293, *Catalogue of Climate System Data Sets*;

(*b*) WMO Publication No. 9, Volume B, *Data Processing*.

ATTACHMENT III.1

DATA TO BE STORED AT WMCs

1. Members operating WMCs have responsibility for collecting data from areas as indicated:

Melbourne – southern hemisphere
Moscow – northern hemisphere
Washington – northern hemisphere

This in no way prohibits a WMC from collecting and archiving data from a larger area.

2. The types and frequency of basic meteorological data that should be stored by the WMCs are:

Type	*Frequency*
Synoptic surface observations	00, 06, 12, 18 UTC
Ship reports	00, 06, 12, 18 UTC
Reports from fixed ocean stations	00, 06, 12, 18 UTC
Arctic floating stations	00, 06, 12, 18 UTC
Buoys	00, 06, 12, 18 UTC
PILOT/TEMP	00, 12 UTC
PILOT SHIP/TEMP SHIP	00, 12 UTC
Selected aircraft reports	
Selected satellite data	
Meteor trail winds	
Rocketsonde data	

3. Members operating WMCs should archive surface and upper-air meteorological analyses of sufficient vertical resolution, at least two times a day for the assigned hemisphere and at least once a day for as much of the globe as practicable.

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ATTACHMENT III.2

DATA TO BE STORED AT RSMCs

1. Members should ensure that their RSMCs provide for the storage and retrieval of basic observational data received through the GTS and/or other means for the zones of responsibility as indicated below:

RSMC	ZONE OF RESPONSIBILITY
Region I	
Antananarivo	To be decided later
Algiers	The zone of responsibility of RTH Algiers for collection of observational data
Cairo	The zone of responsibility of RTH Cairo for collection of observational data
Dakar	The zone of responsibility of RTH Dakar for collection of observational data
Lagos	To be decided later
Nairobi	The zone of responsibility of RTH Nairobi for collection of observational data
Tunis/Casablanca	To be decided later

NOTE: Certain RSMCs are not proposed for any specific zone of responsibility because of the need to avoid unwarranted duplication and to achieve the best compatibility of RSMC zones with RTH zones, considering the capabilities and arrangements of the GTS.

Region II	
Beijing	The zone of responsibility of RTH Beijing for collection of observational data
Jeddah	The zone of responsibility of RTH Jeddah for collection of observational data
Khabarovsk	The zone of responsibility of RTH Khabarovsk for collection of observational data
New Delhi	The zone of responsibility of RTH New Delhi for collection of observational data
Novosibirsk	The zone of responsibility of RTH Novosibirsk for collection of observational data
Tashkent	The zones of responsibility of RTHs Tashkent and Tehran for collection of observational data
Tokyo	The zones of responsibility of RTHs Tokyo and Bangkok for collection of observational data
Region III	
Brasilia	The zones of responsibility of RTHs Brasilia and Maracay for collection of observational data
Buenos Aires	The zone of responsibility of RTH Buenos Aires for collection of observational data
Region IV	
Washington	All Region IV (acting for RSMCs Miami and Montreal)
Region V	
Melbourne	The zone of responsibility of WMC/RTH Melbourne for collection of observational data (acting for RSMC Darwin)
Wellington	The zone of responsibility of RTH Wellington for collection of observational data
Region VI	
Bracknell	The zone of responsibility of RTH Bracknell for collection of observational data
Moscow	The zones of responsibility of WMC/RTH Moscow and RTHs Prague and Sofia for collection of observational data
Norrköping	The zone of responsibility of RTH Norrköping for collection of observational data
Offenbach	The zone of responsibility of RTHs Offenbach, Vienna and Paris for collection of observational data
Rome	The zone of responsibility of RTH Rome for collection of observational data

2. The types and frequency of basic meteorological data to be stored by the RSMCs are as indicated below:

Type	*Frequency*
SYNOP	3-hourly
SHIP	6-hourly
PILOT/TEMP	6- or 12-hourly
PILOT SHIP/TEMP SHIP	6- or 12-hourly
Selected aircraft reports	
Selected satellite data	
DRIFTER	

3. Members should ensure that their RSMCs archive the following analyses for their zones of responsibility:

(*a*) Surface analyses twice per day;

(*b*) Upper-air analyses for at least four of the standard isobaric surfaces listed in paragraph 3.2.1 of Part II of this *Manual*.

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ATTACHMENT III.3

MINIMUM STANDARDS FOR NON-REAL-TIME QUALITY CONTROL

(See Appendix II-1)

ATTACHMENT III.4

GUIDELINES FOR STORAGE AND RETRIEVAL OF SATELLITE DATA

(*a*) RSMCs and NMCs should store a representative set of satellite observations and derived products which they are able to receive and process with their available facilities.

NOTE: Some duplication with the data stored in the larger archives of the satellite operators may be necessary.

(*b*) Data stored at RSMCs and NMCs should include imagery (digital or photos), raw radiance data for SATEM or SATOB messages and high-resolution sounding data.

(*c*) Media for exchange of satellite data should be standardized in so far as possible.

(*d*) The catalogue of archived satellite data should be published and updated by the Meteorological Service operating the centre.

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WORLD METEOROLOGICAL ORGANIZATION

MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM

VOLUME II

REGIONAL ASPECTS

1992 edition

WMO–No. 485

Secretariat of the World Meteorological Organization – Geneva – Switzerland
1992

CONTENTS

INTRODUCTION

1. The *Manual on the Global Data-processing System** is issued in accordance with a decision of Seventh Congress.

2. This *Manual* is designed:

   (*a*) To facilitate co-operation in data processing between Members;

   (*b*) To specify obligations of Members in the implementation of the World Weather Watch (WWW) Global Data-processing System (GDPS);

   (*c*) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (*a*) and (*b*) above.

3. The *Manual* consists of:

   (*a*) Volume I – Global Aspects, constituting Annex IV to the WMO *Technical Regulations*. It contains the standard and recommended practices for the WWW Global Data-processing System;

   (*b*) Volume II – Regional Aspects, containing the regional and national aspects of the WWW Global Data-processing System based on the practices and procedures adopted by the regional associations and by Members concerned as well as relevant decisions of Congress, the Executive Council and the Commission for Basic Systems.

4. The material contained in Volume II does not form part of the WMO *Technical Regulations* and is applicable only to the Members of the regional associations concerned. The words "shall" and "should" mentioned in this volume have their dictionary meanings and do not have the regulatory character mentioned in the general introduction to the WMO *Technical Regulations*.

5. To avoid duplication, as far as practicable, between the contents of the two volumes of the *Manual*, cross-references are made in Volume II to the relevant paragraphs in Volume I whenever the texts of the global and regional provisions are identical.

6. Volume II is divided into sections corresponding to the six Regions of the World Meteorological Organization, namely:

- Region I Africa;
- Region II Asia;
- Region III South America;
- Region IV North and Central America;
- Region V South-West Pacific;
- Region VI Europe;

each of which is divided into three parts:

- Part I: Real-time data processing – regional and national aspects;
- Part II: Non-real-time processing – regional and national aspects;
- Part III: Monitoring of the Global Data-processing System – regional and national aspects.

A section is also provided on data-processing activities and meteorological services in the Antarctic.

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* Following the recommendation of CBS-Ext.(02) and the decision of Fourteenth Congress, the Global Data-processing System (GDPS) is renamed Global Data-processing and Forecasting System (GDPFS).

REGION I (AFRICA)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

The existing minimum global standards are satisfactory for both observational and processed data. No regional standard is required.

NOTE: Minimum standards for quality control of data for real-time use in the GDPS are given in Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

No agreement exists between Members for the quality control of real-time data in the Region.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

Standards established nationally are included in WMO Publication No. 9, Volume B – *Data processing*.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required from within the Region

Types of observational data required from within the Region, as noted by the eighth session of Regional Association I, are obtained from:

(*a*) The regional basic synoptic network: the Regional Association has agreed (final report VIII-RA I, general summary, paragraph 4.1.2.2) to the following observing programme for surface and upper-air observations:

(i) All surface stations included in the regional basic synoptic network should make surface observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. Any surface station that cannot carry out the full observational programme should give priority to the carrying out of the observations at the main standard times;

(ii) All upper-air stations included in the regional basic synoptic network should carry out radiosonde and radiowind observations reaching regularly* at least the 30 hPa level at 00 and 12 UTC, and radiowind observations reaching regularly* at least the 70 hPa level at 06 and 18 UTC. The carrying out of radiowind observations at 00 and 12 UTC should receive priority over radiowind observations at 06 and 18 UTC:

NOTE: Information on the state of implementation of the RA I regional basic synoptic network is given in WMO Publication No. 217.

(*b*) Mobile ships;

(*c*) Aircraft weather reports for synoptic purposes;

(*d*) Radar stations;

(*e*) Near-polar-orbiting meteorological satellites;

(*f*) Geostationary (environmental) meteorological satellites.

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* The expression "regularly" means that the levels indicated should be reached with a frequency of at least 90 per cent of the ascents.

2.2 Types of observational data required from outside the Region

2.2.1 *Data which are included in the global exchange programme*

Special requirements indicated by certain Members are as follows:

(*a*) Ethiopia:

(i) The surface synoptic data for 06 and 12 UTC from parts of Region II and Region VI;

(ii) All upper-air data for 00, 06, 12 and 18 UTC from the same area as above;

(*b*) Morocco:

(i) Vertical sounding data obtained by satellite;

(ii) AIREP data from Region III, Region IV and Region VI;

(*c*) Tanzania:

(i) SYNOP, TEMP, PILOT, SHIP and AIREP data from Region VI and the western part of Region II;

(ii) Near-polar-orbiting and geostationary meteorological satellite data from the same areas as above;

(*d*) Zambia:

(i) The surface data from the western part of Region II, southern part of Region VI and adjacent oceanic areas;

(ii) All upper-air data from the same area as above.

NOTE: The types of observational data for global exchange are listed in Volume I, Attachment II.2 of this *Manual* and in Volume I of the *Manual on the GTS*, Attachment I-3.

2.2.2 *Data which are not included in the global exchange programme*

NOTE: Stations for the regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS*, Attachment I-1.

2.3 Times of receipt of observational data

Requirements as described in Volume I of this *Manual*, Part II, Attachment II.3 are acceptable. No special requirements are indicated by the Members.

NOTE: Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

Special practices followed by certain Members are given below:

(*a*) Kenya:

(i) Scale 1 = 7 500 000, 1 = 15 000 000, 1 = 20 000 000 for the surface and 850 hPa level;

(ii) Scale 1 = 25 000 000, 1 = 30 000 000 for other levels;

(*b*) Morocco: Region I, Mercator projection;

(*c*) Tanzania:

(i) Mercator projection at 22.5° latitude, scale 1 = 15 000 000 for the surface;

(ii) Mercator projection at 22.5° latitude, scale 1 = 25 000 000 for the upper air.

NOTE: A selection of scales which should be used for weather charts in the GDPS is given in Volume I, Part II, paragraph 4.1.2.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

NOTE: Symbols used for pictorial representation of data, analyses and forecasts, on meteorological charts are given in Volume I, Attachment II.4.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

NOTE: The global standard and recommended practices and procedures concerning the programmes of output products, the transmission priorities and the responsibilities of Members for providing information on their real-time data-processing activities are laid down in Volume I, Part II, paragraphs 5.2, 5.3 and 5.4 respectively. Several lists dealing with WMC/RSMC output products are given in the attachments to paragraphs 5.2 and 5.3. Detailed information on the programmes for preparation of output products by WWW centres is given in WMO Publication No. 9, Volume B – *Data processing*.

4.1 Requirements for WMC and RSMC output products from outside the Region

The requirements are the same as those given in Attachments II.8 to II.12 of Volume I.

4.2 Requirements for WMC and RSMC output products from inside the Region

See paragraph 4.1 above.

4.3 Transmission priorities for WMC and RSMC output products exchanged on the regional segments of the GTS

Priority list of products in support of aviation to be exchanged within Region I:

First priority: Area Forecast System forecasts valid for 12, 18, 24 and 30 hours after (00 and 12 UTC). The WAFS data set comprises:

(*a*) Significant weather charts for the 150–400 hPa layer and up to 70 hPa where required for SST operations;

(*b*) Wind and temperature forecasts for flight levels 50 (850 hPa), 100 (700 hPa), 180 (500 hPa), 240 (400 hPa), 300 (300 hPa), 340 (250 hPa), 390 (200 hPa) and 450 (150 hPa);

Wind and temperature forecasts for flight levels 530 (100 hPa) and 600 (70 hPa) when and where required for SST operations;

(*c*) Tropopause height and maximum wind forecasts.

Second priority: Products from GDPS centres (beyond H + 30):

- Surface prognoses from the RSMCs/WMC;
- 850 hPa prognoses from the RSMCs/WMC;
- 700 hPa prognoses from the RSMCs/WMC;
- 500 hPa prognoses from the RSMCs/WMC;
- 250/200 hPa prognoses from the RSMCs/WMC;
- 100 hPa prognoses from the RSMCs/WMC.

Third priority: Analyses/other forecasts:

- Analyses and forecast products up to and including H + 30 from the RSMCs and WMCs.

Fourth priority: Other processed data.

4.4 WMC and RSMC output products which must be exchanged in pictorial form within the Region

(To be developed.)

4.5 WMC and RSMC output products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII GRAF codes

(To be developed.)

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. DATA TO BE STORED AT CENTRES (RSMCs AND NMCs) WITHIN THE REGION

NOTE: The general responsibilities for storage of data at RSMCs are given in Volume I, Part III, paragraph 2.1.2 and Attachment III.2.

1.1 Responsibilities for storage of observational and processed data at RSMCs within the Region

A few Members have suggested that there is a need to store more frequent meteorological data and satellite and sea-surface observations as well as processed data at the RSMCs within the Region. These data should be easily available to any NMC within the Region.

1.2 Special requirements for storage of observational and processed data at NMCs within the Region

Certain Members have provided statements as follows:

(*a*) Kenya: Global and regional data are stored at its NMC as analysed charts for ten years. After ten years they are available on microfilm. Other products are stored for one year;

(*b*) Tanzania: Analysis of the tropical belt, including:

- Satellite winds;
- Sea-surface temperature;
- 30-day prognosis SHS:
- Surface and upper-air charts;

(*c*) Zambia: Storage of charts and surface and upper-air data in numerical form is essential, since most of the data from RA I are not available for real-time use.

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 Regional standards for quality control

The existing minimum global standards are satisfactory for both observational and processed data. No regional standard is required.

2.2 Agreements between Members for quality control

No agreement exists between Members for quality control of non-real-time data in the Region.

2.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

No national standard has been established in the Region.

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 establishes recommended procedures for the classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

No regional procedure has been established. It is recommended that suitable regional practices be established later.

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

See paragraph 3.1 above.

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for the exchange of stored data.

4.1 Media for exchanging stored data within the Region

The following media are recommended for use within the Region:

(*a*) Magnetic tape with 9 tracks, $^1/_2$ inch with 800 BPI and/or 1600 BPI;

(*b*) Standard paper tape with five or eight tracks, using international alphabets Nos. 2 and 5 respectively.

(To be developed)

4.2 Formats for exchanging stored data within the Region

(To be developed)

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

(To be developed)

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II.14 contains the Plan for Monitoring the Operation of the WWW. In this plan general guidelines and priorities are given for both real-time and non-real-time-monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunications procedures. There are two items which can be considered as involving real-time data processing, namely:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

The following recommendations are made for use in the Region:

(*a*) Periodic automatic and manual checks should be undertaken by the centre;

(*b*) NMCs should be responsible for meteorological checking of information collected and should ensure adherence to regional coding procedures before insertion on the GTS;

(*c*) Monitoring should be carried out as specified in Volume I, Attachment II.14. In particular, the heading, the correct number of groups and the correct number of figures of all messages should be checked.

1.2 Evaluation of processed information received at RSMCs and NMCs

The following recommendations are made for use in the Region:

(*a*) Analysed charts should be checked by examining the correct positioning of the Lows and Highs and direction of the streamlines;

(*b*) Processed data should be reviewed or re-analysed prior to storage;

(*c*) Automated validation should be carried out and standard flags set on suspect data.

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

See paragraph 1.2 above.

REGION II (ASIA)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

NOTE: Minimum standards for quality control of data for real-time use in the GDPS are given in Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

Within the south-east Asian countries as well as within countries represented on the WMO/ESCAP Panel on Tropical Cyclones, an interim basis real-time quality control of data in the Region is being established.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

None.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required from within the Region

Types of observational data required from within the Region are obtained from:

(*a*) The regional basic synoptic network (including principal land stations and automatic weather stations): the Regional Association has agreed (final report VI-RA II, general summary, paragraph 4.1.2.4) to the following observing programme for surface and upper-air observations:

(i) All surface stations included in the regional basic synoptic network should make surface observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. Any surface station that cannot carry out the full observational programme should give priority to the carrying out of the observations at the main standard times;

(ii) All radiowind stations of the regional basic synoptic network should attempt to make and disseminate upper-wind observations which reach the 70 hPa level as appropriate;

(iii) During the cyclone season, the radiowind stations which are in the field of a tropical cyclone should attempt to make upper-wind observations to as high a level as possible at 06 and 18 UTC and disseminate them. These observations should reach the 70 hPa level as appropriate. The carrying out of radiowind observations at 00 and 12 UTC should receive priority over radiowind observations at 06 and 18 UTC;

(iv) All radiosonde stations of the regional basic synoptic network should make observations of pressure, temperature and humidity up to as high a level as possible at 00 and 12 UTC and disseminate them. These observations should reach the 70 hPa level as appropriate;

(*b*) Fixed ocean stations;

(*c*) Selected supplementary and auxiliary ships;

(*d*) Aircraft;

(*e*) Weather radar;

(*f*) Near-polar-orbiting meteorological satellites;

(*g*) Geostationary (environmental) meteorological satellites;

(*h*) Direct read-out stations.

2.2 Types of observational data required from outside the Region

2.2.1 *Data which are included in the global exchange programme*

NOTE: The types of observational data for global exchange are listed in Volume I, Attachment II.2, of this *Manual* and in Volume I of the *Manual on the GTS*, Attachment I-3.

2.2.2 *Data which are not included in the global exchange programme*

NOTE: Stations for the regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS*, Attachment II-1.

2.3 Times of receipt of observational data

NOTE: Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

Special practices followed by certain Members are given below:

India: Mercator projection, 1:20 000 000 true at latitude 22.5 degrees

The above scale is as per GDPS standard given in Volume I, Part II, paragraph 4.1.2.

NOTE: A selection of scales which should be used for weather charts in the GDPS is given in Volume I, Part II, paragraph 4.1.2.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

Special practices followed by certain Members are given below:

China: Wind speed is represented by a barb, the full barb representing 4 m s^{-1} or 8 knots, the half-barb 2 m s^{-1} or 4 knots;

Japan: The direction of swell, specified in Attachment II.4 to Volume I as an arrow with a wavy shaft, is represented as a straight arrow because of programming for automatic plotting.

NOTE: Symbols used for pictorial representation of data, analyses and forecasts on meteorological charts are given in Volume I, Attachment II.4.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

NOTE: The global standard and recommended practices and procedures concerning the programmes of output products, the transmission priorities and the responsibilities of Members for providing information on their real-time data-processing activities are laid down in Volume I, Part II, paragraphs 5.2, 5.3 and 5.4 respectively. Several lists dealing with WMC/RSMC output products are given in the attachments to paragraphs 5.2 and 5.3. Detailed information on the programmes for preparation of output products by WWW centres is given in WMO Publication No. 9, Volume B – *Data processing*.

4.1 Requirements for WMC and RSMC output products from outside the Region

(To be completed later.)

4.2 Requirements for WMC and RSMC output products from inside the Region

The requirements are the same as those given in Attachments II.8 to II.12 of Volume I.

4.3 Transmission priorities for WMC and RSMC output products exchanged on the regional segments of the GTS

A list of minimum requirements for various types of output products from WMCs and RSMCs to be exchanged on the GTS is given in the attachment to this paragraph.

4.4 WMC and RSMC output products which must be exchanged in pictorial form within the Region

(To be developed.)

4.5 WMC and RSMC output products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII GRAF codes

(To be developed.)

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. DATA TO BE STORED AT CENTRES (RSMCs AND NMCs) WITHIN THE REGION

NOTE: The general responsibilities for storage of data at RSMCs are given in Volume I, Part III, paragraph 2.1.2 and Attachment III.2.

1.1 Responsibilities for storage of observational and processed data at RSMCs within the Region

(*a*) Members are responsible for collection for storage and dissemination the basic observational data received through the GTS and/or otherwise, for their area of responsibility:

RSMC Beijing: Area of responsibility of RTH Beijing for the collection of observational data;

RSMC Jeddah: Area of responsibility of RTH Jeddah for the collection of observational data;

RSMC Novosibirsk: Area of responsibility of RTH Novosibirsk for the collection of observational data;

RSMC New Delhi: Area of responsibility of RTH New Delhi for the collection of observational data;

RSMC Tashkent: Area of responsibility of RTH Tashkent and RTH Tehran for the collection of observational data;

RSMC Tokyo: Area of responsibility of RTH Tokyo and RTH Bangkok for the collection of observational data;

RSMC Khabarovsk: Area of responsibility of RTH Khabarovsk for the collection of observational data.

(The functions of RSMC Novosibirsk and RSMC Khabarovsk for the collection, storage and dissemination of TEMP data are undertaken by RSMC Tashkent.)

(*b*) Basic SYNOP and TEMP data should be stored on magnetic tapes;

(*c*) Analysed products should be stored on cards, magnetic tapes or microfilm;

(*d*) Observational data should be stored permanently and processed data for at least five years.

1.2 Special requirements for storage of observational and processed data at NMCs within the Region

(*a*) See remarks under paragraph 1.1 (*b*) – (*d*);

(*b*) The functions of RSMC Novosibirsk, RSMC Tashkent and RSMC Khabarovsk for the storage and dissemination of basic observational data are also undertaken by WDC Obninsk.

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 Regional standards for quality control

Regional standards for quality control of non-real-time data are as specified in Volume I, Attachment II.1.

2.2 Agreements between Members for quality control

There are no agreements between Members for quality control in the Region.

2.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

There are no national standards.

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 establishes recommended procedures for the classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

(*a*) No regional procedures exist. It is recommended that stored data be classified into two categories, namely:

(i) Basic surface and upper-air data;

(ii) Analysed data in the form of surface and upper-air charts;

(*b*) A catalogue should be maintained at one or more centres in Region II.

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

See remark under paragraph 3.1.

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for the exchange of stored data.

4.1 Media for exchanging stored data within the Region

For the exchange of data in the Region, magnetic tape with nine tracks, $^1/_2$ inch in width, with 800, 1600 or 6250 BPI is recommended.

4.2 Formats for exchanging stored data within the Region

For exchanging data in the Region, the standard WMO formats set out in Publication No. 469 should preferably be used.

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

(*a*) Each Member should meet the requirements of other Members as regards making available non-real-time data stored in its national Service;

(*b*) Each Member should make available to the Secretariat information concerning the data in its national Service.

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II.14 contains the Plan for Monitoring the Operation of the WWW. In this plan general guidelines and priorities are given for both real-time and non-real-time-monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunications procedures. There are two items which can be considered as involving real-time data processing, namely:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

(To be included later.)

1.2 Evaluation of processed information received at RSMCs and NMCs

(To be developed after CBS, in consultation with CAS, has elaborated verification procedures for use in the GDPS.)

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

See paragraph 1.2 above.

ATTACHMENT

MINIMUM REQUIREMENTS FOR VARIOUS TYPES OF OUTPUT PRODUCTS FROM WMCs AND RSMCs TO BE EXCHANGED ON THE GTS

(*Ref. Part I, paragraph 4.3*)

First priority:

1. Area Forecast System charts, issued four times daily in accordance with the appropriate ICAO regional air navigation plan, to include:

(*a*) Surface and significant weather 400–150 hPa (in one chart);

(*b*) At least two charts selected from the following:

(i) 300 hPa, 250 hPa, 200 hPa;

(ii) Tropopause/maximum wind;

(iii) Tropopause/vertical wind shear;

(*c*) 100 hPa and appropriate significant weather information as and when required for scheduled SST operations.

2. Area Forecast System charts to serve international general aviation operations up to FL 200 in accordance with the appropriate ICAO regional air navigation plan, to include:

(*a*) Surface

(*b*) Significant weather;

(*c*) 850 and/or 700 and/or 500 hPa.

3. Other products:

(*a*) 850 hPa;

(*b*) Winds and temperatures up to FL 250.

Second priority:

Products from RSMCs inside the Region: surface, 500 hPa and 250 hPa 24-hour prognoses.

Third priority:

Products from RSMCs outside the Region: 500 hPa and 300 hPa analyses from RSMC Melbourne for Area "B".

Fourth priority:

Products from WMCs: Surface and 500 hPa: analyses and 48- and 72-hour prognoses.

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REGION III (SOUTH AMERICA)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

The existing minimum global standards are satisfactory for both observational and processed data. No regional standard is required.

NOTE: Minimum standards for quality control of data for real-time use in the GDPS are given Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

No agreement exists between Members for quality control of real-time data in the Region.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

No national standard of interest to other Members.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required from within the Region

Types of observational data required from within the Region, as noted by the eighth session of Regional Association III, are obtained from:

(*a*) Regional basic synoptic network: the Regional Association has agreed (final report VIII-RA III, general summary, paragraph 4.1.3.2) to the following observing programme for surface and upper-air observations:

(i) All surface stations included in the regional basic synoptic network should make surface observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. The carrying out of the observations at the main standard time should be given first priority;

(ii) All upper-air stations included in the regional basic synoptic network should carry out radiosonde and/or radiowind observations at 00 and 12 UTC. The stations which are unable to carry out the full upper-air observing programme should give priority to making observations at 12 UTC:

(iii) The upper-air stations marked with an asterisk should carry out radiosonde and radiowind observations up to at least the 10 hPa level and should be prepared to repeat soundings which do not reach the 200 hPa level in favourable weather conditions;

(*b*) Voluntary Observing Ships;

(*c*) Aircraft weather reports;

(*d*) Radar stations;

(*e*) Near-polar-orbiting meteorological satellites;

(*f*) Geostationary meteorological satellites;

(*g*) Automatic land station.

2.2 Types of observational data required from outside the Region

2.2.1 *Data which are included in the global exchange programme*

Special requirements indicated by certain Members are as follows:

(*a*) Argentina:

(i) The surface synoptic data over ocean area of octants 5 and 6:

(ii) Southern hemisphere surface synoptic data. See Volume I, Attachment II-2, (*g*) and (*h*);

(*b*) Guyana:

(i) The oceans adjacent to the north, east and west coasts of South America:

(ii) Tropical zones, especially Region I, Blocks 60, 61 and 65 west of 5°W. See Volume I, Attachment II.2, 1 (*a*) to (*k*).

NOTE: The types of observational data for global exchange are listed in Volume I, Attachment II.2 and Volume I of the *Manual on the GTS,* Attachment I-3.

2.2.2 *Data which are not included in the global exchange programme*

NOTE: Stations for the regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS*, Attachment III-1.

2.3 Times of receipt of observational data

Requirements as described in Volume I, Attachment II.3 of this *Manual* are acceptable. No special requirements are indicated by the Members.

NOTE: Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

Special practices followed by certain Members are given below:

(*a*) Colombia: Part of hemisphere, Mercator projection, scale 1 = 20 000 000;

(*b*) Guyana: 5°W to 105°W longitude and 44°N to 23°S latitude, Mercator projection at $22^1/_2$°N and $22^1/_2$°S, scale 1 = 12 500 000 for surface analysis, scale 1 = 25 000 000 for upper-air analysis.

NOTE: A selection of scales which should be used for weather charts in the GDPS is given in Volume I, Part II, paragraph 4.1.2.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

Guyana uses the following special symbol in plotting: in the regional code (Section 3) in the group $56D_LD_MD_H$ small arrows indicating the direction of cloud drift (Code table 0700) can be plotted to the left or immediately above the cloud symbols.

NOTE: Symbols used for pictorial representation of data, analyses and forecasts on meteorological charts are given in Volume I, Attachment II.4.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

NOTE: The global standard and recommended practices and procedures concerning the programmes of output products, the transmission priorities and the responsibilities of Members for providing information on their real-time data-processing activities are laid down in Volume I, Part II, paragraphs 5.2, 5.3 and 5.4 respectively. Several lists dealing with WMC/RSMC output products are given in the attachments to paragraphs 5.2 and 5.3. Detailed information on the programmes for preparation of output products by WWW centres is given in WMO Publication No. 9, Volume B – *Data processing*.

4.1 Requirements for WMC and RSMC output products from outside the Region

The requirements are the same as those given in Attachments II.8 to II.12 of Volume I.

4.2 Requirements for WMC and RSMC output products from inside the Region

The requirements are the same as those given in Attachments II.8 to II.12 of Volume I.

4.3 **Transmission priorities for WMC and RSMC output products exchanged on the regional segments of the GTS**

Priority list of products in support of aviation to be exchanged within Region III:

First priority: Area Forecast System forecasts valid for 12, 18, 24 and 30 hours after (00 and 12 UTC). The WAFS data set comprises:

(*a*) Significant weather charts for the 150–400 hPa layer and up to 70 hPa where required for SST operations;

(*b*) Wind and temperature forecasts for flight levels 50 (850 hPa), 100 (700 hPa), 180 (500 hPa), 240 (400 hPa), 300 (300 hPa), 340 (250 hPa), 390 (200 hPa) and 450 (150 hPa);

Wind and temperature forecasts for flight levels 530 (100 hPa) and 600 (70 hPa) when and where required for SST operations;

(c) Tropopause height and maximum wind forecasts;

Second priority: Products from GDPS centres (beyond H + 30):

- Surface prognoses from the RSMCs/WMC;
- 850 hPa prognoses from the RSMCs/WMC;
- 700 hPa prognoses from the RSMCs/WMC;
- 500 hPa prognoses from the RSMCs/WMC;
- 300/250/200 hPa prognoses from the RSMCs/WMC;
- 100 hPa prognoses from the RSMCs/WMCs;

Third priority: Analyses/other forecasts:

- Analyses and forecast products up to and including H + 30 from the RSMCs and WMCs;

Fourth priority: Other processed data.

4.4 **WMC and RSMC output products which must be exchanged in pictorial form within the Region**

Satellite products are required covering South America and surrounding oceans, namely:

(*a*) Cloud coverage;

(*b*) Sea-surface temperatures.

Specification of other requirements to be developed.

4.5 **WMC and RSMC output products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII GRAF codes**

(To be developed.)

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. **DATA TO BE STORED AT CENTRES (RSMCs AND NMCs) WITHIN THE REGION**

NOTE: The general responsibilities for storage of data at RSMCs are given in Volume I, Part III, paragraph 2.1.2 and Attachment III.2.

1.1 **Responsibilities for storage of observational and processed data at RSMCs within the Region**

(To be developed.)

1.2 Special requirements for storage of observational and processed data at NMCs within the Region

Suriname needs to store more detailed weather facsimile charts and sea-surface temperature analysis maps of the tropical Atlantic region.

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 Regional standards for quality control

The existing minimum global standards are satisfactory for both observational and processed data.

2.2 Agreements between Members for quality control

No agreement exists between Members for quality control of non-real-time data in the Region.

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 establishes recommended procedures for the classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

No regional procedure has been established.

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

No regional procedure has been established.

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for the exchange of stored data.

4.1 Media for exchanging stored data within the Region.

The following media are laid down for use within the Region:

(*a*) Magnetic tape with 9 tracks, $^1/_2$ inch and 800 BPI or 1600 BPI;

(*b*) Standard paper tape with five or eight tracks, using international alphabets Nos. 2 and 5 respectively.

4.2 Formats for exchanging stored data within the Region

(To be developed.)

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

(To be developed.)

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II.14 contains the Plan for Monitoring the Operation of the WWW. In this plan general guidelines and priorities are given for both real-time and non-real-time monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunications procedures. In addition real-time monitoring is required as regards:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

(*a*) Periodic automatic and manual checks should be undertaken by the centre;

(*b*) NMCs should be responsible for meteorological checking of information collected and should ensure adherence to regional coding procedures before insertion on the GTS;

(*c*) Monitoring should be carried out as specified in Volume I, Attachment II-14. In particular, the heading, the correct number of groups and the correct number of figures of all messages should be checked.

1.2 EVALUATION OF PROCESSED INFORMATION RECEIVED AT RSMCs AND NMCs

(To be developed.)

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

(To be developed.)

REGION IV (NORTH AND CENTRAL AMERICA)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

NOTE: Minimum standards for quality control of data for real-time use in the GDPS are given in Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

NOTE: The USA issues routine teletype notifications of discrepancies in SYNOP, TEMP and PILOT data in real time to several Member countries.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

USA: Programming completed for the following automated/interactive real-time quality control:

(*a*) Bulletin formatting and correctness;

(*b*) Garbled reports;

(*c*) Inter-parameter compatibilities;

(*d*) Gross errors;

(*e*) Space compatibility;

(*f*) Hydrostatic and vertical consistency (TEMP/PILOT);

(*g*) Diurnal temperature variation (surface);

(*h*) Specific validation of air temperature, dew points, extreme temperatures, past/present weather and precipitation amounts.

Canada: Main effort has been toward error prevention rather than error correction. All RAOB/RAWIN reports are made by automated systems, thus eliminating human (although not instrumental) errors. Transmission is by 8-channel self-correcting teletype. All Canadian SYNOPs are checked automatically for 180 possible errors and the originating station is informed in real time. The terminal on which SYNOPs are entered makes a first-level verification and informs the operator of any need for checking. As well, the communications switching computer performs additional checks and can request operator regeneration. Temporal and spatial verification and correction are not yet possible before transmission to the GTS.

Bahamas: All national traffic is plotted, checked by a meteorologist for temporal and spatial consistency and corrected, when necessary, before onward transmission.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required from within the Region

Types of observational data required from within the Region are obtained from:

(*a*) The regional basic synoptic network;

(*b*) Mobile ship stations;

(*c*) Automatic marine stations;

(*d*) Aircraft weather reports;

(*e*) Automatic meteorological data aircraft reporting (ASDAR);

(*f*) Ground weather radars;

(*g*) Near-polar-orbiting meteorological satellites;

(*h*) Geostationary (environmental) meteorological satellites.

NOTES: (l) The Regional Association has agreed to the following observing programme for surface and upper-air observations:

(*a*) All surface stations in the regional basic synoptic network should make surface synoptic observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. The carrying out of the observations at the main standard times should be given first priority;

(*b*) All upper-air stations in the regional basic synoptic network should carry out radiosonde and rawinsonde observations up to the 10 hPa level at 00 and 12 UTC. The stations which are unable to carry out the full observing programme should give priority to the carrying out of the observations at 12 UTC.

(2) In addition to the data types specified in Volume I, Part II, paragraph 2.2, most Members require:

(*a*) SI for all surface stations;

(*b*) SN, METAR or "hourly (SA)" for all surface stations;

(*c*) PILOT Parts B and D for all capable stations;

(*d*) HYDRA for all capable stations.

2.2 Types of observational data required from outside the Region

2.2.1 *Data which are included in the global exchange programme*

NOTE: The types of observational data for global exchange are listed in Volume I, Attachment II.2 of this *Manual* and in Volume I of the *Manual on the GTS,* Attachment I-3.

2.2.2 *Data which are not included in the global exchange programme*

NOTE: Stations for the regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS,* Attachment IV-1.

2.3 Times of receipt of observational data

NOTES: (1) Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

(2) To ensure the timely and efficient operation of the regional telecommunication and data-processing systems, SM, SI, SN, METAR and SHIP reports from within the Region should be received at WMC Washington within 15 minutes of the observing station filing time. Parts A and B of TEMP and PILOT reports are required at H+l hour and Parts C and D at H+2 hours.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

Scales for weather charts are as given in Volume I, Part II, paragraph 4.1.2. Mercator projection is used for tropical regions and polar stereographic elsewhere.

NOTE: Analyses including plotted observational data are normally represented on a scale of 1:20 000 000.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

Symbols for plotting are as given in Volume I, Attachment II.4.

NOTES: (l) In the USA degrees Fahrenheit are used for surface temperature and dew point.

(2) Plotting models for upper-air observations have not been standardized.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

4.1 Requirements for WMC and RSMC output products from outside the Region

There are no requirements for WMC or RSMC products from outside the Region.

4.2 **Requirements for WMC and RSMC output products from inside the Region**

WMC and RSMC products required from within the Region are those listed without asterisks in Volume I, Attachments II.8 and II.9.

4.3 **Transmission priorities for WMC and RSMC output products exchanged on the regional segments of the GTS**

NOTE: Transmission priorities for WMC and RSMC output products are listed in Volume I, Attachments II.10, II.ll and II.12.

4.4 **WMC and RSMC output products which must be exchanged in pictorial form within the Region**

All required output products must be exchanged in pictorial form.

4.5 **WMC and RSMC output products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII GRAF codes**

NOTE: The full set of output products from WMC Washington is available for exchange within the Region using the FM 47-V GRID code.

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. DATA TO BE STORED AT CENTRES (RSMCs AND NMCs) WITHIN THE REGION

1.1 **Responsibilities for storage of observational and processed data at RSMCs within the Region**

WMC Washington, acting for RSMCs Miami and Montreal, is responsible for the storage of all data from the Region.

NOTE: In addition to the basic data given in Volume I, Part III, Attachment III.2, archives include SA, METAR and SN reports for Region IV, SM and SI for the globe, including national and regional supplementary data, and CLIMAT reports for the globe.

1.2 **Special requirements for storage of observational and processed data at NMCs within the Region**

NOTE: Responsibility for storage of climatological data is given in Volume I, Part III, paragraphs 2.2.1 – 2.2.3. Storage of additional data is according to the needs of the individual Member.

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 **Regional standards for quality control**

WMC, RSMCs and NMCs should carry out routine standardized feedback of discrepancy information to data sources and record repositories for non-real-time observational record corrections.

2.2 **Agreements between Members for quality control**

NOTE: Routine reports of synoptic and upper-air deficiencies are mailed monthly by WMC Washington to all Members for inspection and resolution of data discrepancies.

2.3 **Standards established nationally, not included in global or regional standards, and of interest to other Members**

NMC Washington operates automatic systems for assessing and summarizing TEMP, PILOT, SYNOP and other types of data receipts, losses and/or discrepancies.

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 gives recommended procedures for classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

Regional procedures for classifying and cataloguing data stored at RSMCs are not established.

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

Regional procedures for classifying and cataloguing data stored at NMCs are not established.

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for the exchange of stored data.

4.1 Media for exchanging stored data within the Region

Regional practices shall conform with Volume I, Part III, paragraph 5.1.

NOTE: The exchange of data on 7-track tape is not recommended.

4.2 Formats for exchanging stored data within the Region

Regional practices shall conform with Volume I, Part III, paragraph 5.2, except in the case of bilateral agreements between Members.

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

NOTE: The responsibilities of Members for exchange of non-real-time data within the Region are given in Volume I, Part III, paragraph 5.3.

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II-14 contains the Plan for Monitoring the Operation of the WWW. In this plan general guidelines and priorities are given for both real-time and non-real-time monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunications procedures. There are two items which can be considered as involving real-time data processing, namely:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

Members should avoid to the maximum possible extent any deviations from international coding procedures.

NOTE: No system for monitoring adherence to international coding procedures has been developed.

1.2 Evaluation of processed information received at RSMCs and NMCs

NOTE: WMC Washington has a number of verification programmes which may or may not be applicable to other countries. These include verification of winds, temperatures and height of numerical forecasts at various levels against rawinsonde reports for several networks or regions, using standard statistics. These regions include Central and North America.

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

NOTE: See note to paragraph 1.2 above.

REGION V (SOUTH WEST PACIFIC)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

Regional standards for real-time quality control of both observational and processed data should be the same as the existing minimum global standards.

NOTE: Minimum standards for quality contol of data for real-time use in the GDPS are given in Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

No agreements exist between Members for quality control of real-time data in the Region. However, agreements made for the FGGE on an interim basis (by the USA) have been continued.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

In the USA, real-time standards have been established with respect to the receipt time deadlines, completeness of reports and integrity of data. Standards vary according to data type and boundaries of models.

NOTE: Standards established nationally are included in WMO Publication 9, Volume B – *Data processing*.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required within the Region

2.1.1 Types of observational data required from within the Region are obtained from:

(*a*) Regional basic synoptic network: the Regional Association has agreed to the following observing programme for surface and upper-air observations:

(i) All the surface stations included in the regional basic synoptic network should make surface synoptic observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. Any surface station which cannot carry out the full observational programme should give priority to the carrying out of the observations at the main standard times;

(ii) All the radiowind stations included in the regional basic synoptic network should make upper-wind observations up to the 10 hPa level at 00, 06, 12 and 18 UTC;

(iii) All the radiosonde stations included in the regional basic synoptic network should make observations of pressure, temperature and humidity up to the 10 hPa level at 00 and 12 UTC;

(iv) Any radiosonde stations which cannot carry out at present their full programmes should give priority to making and disseminating the 00 UTC observations (Rec. 21 (CBS-VI));

NOTE: Information on the state of implementation of the Region V basic network of observing stations is given in WMO Publication No. 217.

(*b*) Mobile ships;

(*c*) Aircraft weather reports for synoptic purposes;

(*d*) Ground weather radar stations;

(*e*) Near-polar-orbiting meteorological satellites, in particular the following:

(i) Vertical temperature and moisture soundings;

(ii) Sea-surface temperature;

(iii) Imagery;

(*f*) Geostationary environmental meteorological satellites and certain WEFAX products received from WMC Washington, in particular:

(i) Wind vectors;

(ii) Imagery.

2.1.2 In addition, types of observational data required within the Region include:

Hourly or three-hourly surface observations from land and sea stations, exchanged regionally or according to bilateral agreements.

2.2 Types of observational data required from outside the Region

Same as those for global exchange listed in Volume I, Attachment II.2 and Volume I of the *Manual on the GTS*, Attachment I-3.

NOTE: Stations for regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS,* Attachment V-1.

2.3 Times of receipt of observational data

(*a*) From within the Region

SYNOP	to be received by	H + 2h
TEMP and PILOT	to be received by	H + 3h

(*b*) From outside the Region

SYNOP	to be received by	H + 4h
TEMP and PILOT	to be received by	H + 4h

NOTE: Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

Special practices followed by certain Members are given below:

Indonesia: For stream and stream-function charts between latitude 20°N and 15°S, Mercator projection is used, scale 1:20 000 000;

New Caledonia: Tropical and temperate regions: Mercator projection
Polar regions: stereographic projection

USA: Scales: polar stereographic 1:20 000 000 1:40 000 000
Mercator 1:20 000 000 1:40 000 000

NOTE: A selection of scales which should be used for weather charts in the GDPS is given in Volume I, Part II, paragraph 4.1.2.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

Same as those given in Volume I, Attachment II.4.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

NOTE: The global standard and recommended practices and procedures concerning the programmes of output products, the transmission priorities and the responsibilities of Members for providing information on their real-time data-processing activities are laid down in Volume I, Part II, paragraphs 5.2, 5.3 and 5.4 respectively. Several lists dealing with WMC/RSMC output products are given in the attachments to paragraphs 5.2 and 5.3. Detailed information on the programmes for preparation of output products by WWW centres is given in WMO Publication No. 9, Volume B – *Data processing*.

4.1 Requirements for WMC and RSMC output products from outside the Region

The following special requirements have been indicated by Members:

(*a*) Extended-period forecasts from global models run by northern hemisphere centres, e.g. European Centre of Medium Range Weather Forecasts – ECMWF (by Australia);

(*b*) All processed data of satellite imageries (GOES-W) concerning the South Pacific (upper winds, temperature, state of sea) produced by WMC Washington (by French Polynesia);

(*c*) The following data from ECMWF (by Malaysia);

(i) Objectively analysed upper-air data at grid points;

(ii) Predicted upper-air data at grid points.

4.2 Requirements for WMC and RSMC output products from inside the Region

4.2.1 The requirements are the same as those given in Attachments II.8 to II.12 of Volume I.

4.2.2 The following special requirements have been indicated by Members:

(*a*) Observational and processed data for the area Equator to 20°N (Pacific Islands) for safety of international flights towards Tokyo (by New Caledonia);

(*b*) Reports of solar energy, soil temperature and soil moisture observations to be used in developing agricultural weather products (by the USA);

(*c*) Consistent reports of 24-hour precipitation amounts, extreme temperatures, state of the ground, snow depth and new snowfall (by the USA);

(*d*) Southern hemisphere analysis and prognosis for MSL and 500 hPa (by New Zealand).

4.3 Transmission priorities for WMC and RSMC output products exchanged on the regional segments of the GTS

First priority: Area Forecast System charts, issued in accordance with the appropriate ICAO Regional Air Navigation Agreements, including prognoses for:

- 500, 300, 250, 200 and 100 hPa (if required for SST operations);
- Tropopause/maximum wind;
- Tropopause/vertical wind shear;
- Significant weather charts;

Second priority: Analyses and prognoses from the WMC and RSMCs in Region V;

Third priority : Certain critical analyses and prognoses required from RSMCs outside Region V;

Fourth priority: A selection of WMC products.

4.4 WMC and RSMC output products which must be exchanged in pictorial form within the Region

(To be developed.)

4.5 WMC and RSMC output products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII GRAF codes

(To be developed.)

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. DATA TO BE STORED AT CENTRES (RSMCS AND NMCS) WITHIN THE REGION

NOTE: The general responsibilities for storage of data at RSMCs are given in Volume I, Part III, paragraph 2.1.2 and Attachment III.2.

1.1 Responsibilities for storage of observational and processed data at RSMCs within the Region

(*a*) Members concerned ensure that their RSMCs provide for the storage and retrieval of basic observational data received through the GTS for the zones of responsibility as indicated below:

RSMC Melbourne: The zones of responsibility of WMC/RTH Melbourne for collection of observational data (acting for RSMC Darwin)

RSMC Wellington: The zone of responsibility of RTH Wellington for collection of observational data;

(*b*) The following regional practices are recommended:

(i) Basic SYNOP and TEMP data should be stored on magnetic tapes;

(ii) Analysed products should be stored on microfilm;

(iii) A thorough archive of observational and numerical model data needs to be constructed;

(iv) Observational data should be stored permanently and processed data for at least 20 years. Processed data such as numerical model forecasts or analyses need to be stored for only 10–15 years.

1.2 Special requirements for storage of observational and processed data at NMCs within the Region

(*a*) Observational and processed data at the NMCs should be stored on magnetic tape or disc in a standardized international digital format;

(*b*) See remark under 1.1 (*b*)(iv).

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 Regional standards for quality control

Regional standards for quality control of non-real-time data are the same as those specified in Volume I, Attachment II.l.

2.2 Agreements between Members for quality control

New Zealand performs on an interim basis non-real-time quality control of data on behalf of Cook Islands, Kingdom of Tonga, Kiribati and Tuvalu.

2.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

In the USA, standards have been established nationally based on relative performance among reporting locations. Standards are continuously raised by concentrating on below-average stations and communication links. Performance evaluations are issued weekly, fortnightly, monthly, semi-annually, and annually. Substandard performance is identified, evaluated and corrected.

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 establishes recommended procedures for classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

No regional procedures exist. It is recommended that:

(*a*) The stored data be classified into two categories, namely:

(i) Basic surface and upper-air data;

(ii) Analysed data such as surface and upper-air charts.

The first category can be further classified into hourly, daily and monthly data types, while the second category can be classified into daily and monthly mean charts;

(*b*) A catalogue at one or more centres in Region V be maintained;

(*c*) Suitable regional practices be formulated by *ad hoc* panels representing global, regional and national interests.

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

See remarks under paragraph 3.1.

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for exchange of stored data.

4.1 Media for exchanging stored data within the Region

The following medium is recommended for use in the Region:

Magnetic tape with 9 tracks, $^1/_2$ inch wide, with 800 or 1600 BPI.

4.2 Formats for exchanging stored data within the Region

The standard format as given in WMO Publication No. 469 is recommended.

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

The following recommendations are made for use in the Region:

(*a*) Inventories of stored data should be produced and disseminated by Members to facilitate easy reference;

(*b*) Routine CLIMAT and CLIMAT TEMP messages should be exchanged;

(*c*) Stored data exchanged within the Region should be published in a suitable WMO publication and provided to Members.

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II.14 contains the Plan for Monitoring the Operation of the WWW. In this plan, general guidelines and priorities are given for both real-time and non-real-time monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunication procedures. There are two items which can be considered as involving real-time data processing, namely:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

The following recommendations are made for use in the Region:

(*a*) Periodic automatic and manual checks should be undertaken by the centre;

(*b*) NMCs should be responsible for meteorological checking of information collected and should ensure adherence to regional coding procedures before insertion on the GTS;

(*c*) Monitoring should be carried out as specified in Volume I, Attachment II.14. In particular, the heading, the correct number of groups, and the correct number of figures of all messages should be checked.

1.2 Evaluation of processed information received at RSMCs and NMCs

The following recommendations are made for use in the Region:

(*a*) Analysed charts should be checked by examining the correct positioning of the Lows and Highs and direction of the streamlines;

(*b*) Processed data should be reviewed or re-analysed prior to storage;

(*c*) Automated validation of data should be carried out and standard flags set on suspect data.

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

See paragraph 1.2 above.

REGION VI (EUROPE)

PART I

REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. MINIMUM STANDARDS FOR QUALITY CONTROL OF REAL-TIME DATA IN THE REGION

1.1 Regional standards for quality control

The existing minimum global standards are satisfactory for both observational and processed data. No regional standard is required.

NOTE: Minimum standards for quality control of data for real-time use in the GDPS are given Volume I, Attachment II.1.

1.2 Agreements between Members for quality control

No agreement exists between Members for quality control of real-time data in the Region.

1.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

No national standard of interest to other Members.

2. OBSERVATIONAL DATA REQUIREMENTS AND TIMES OF RECEIPT OF OBSERVATIONAL DATA FOR REGIONAL EXCHANGE IN THE REGION

NOTE: The global standard practices and procedures concerning requirements for observational data and times of receipt of observational data are laid down in Volume I, Part II, paragraphs 2.2 and 2.3.

2.1 Types of observational data required from within the Region

Types of observational data required from within the Region, as noted by the seventh session of Regional Association VI, are obtained from:

(*a*) Regional basic synoptic network: the Regional Association has agreed (Res. 2 (VII-RA VI) to the following observing programme for surface and upper-air observations:

(i) All surface stations included in the regional basic synoptic network should make surface observations at the four main standard times of observation, i.e. 00, 06, 12 and 18 UTC, and at the four intermediate standard times of observation, i.e. 03, 09, 15 and 21 UTC. Any surface station that cannot carry out the full observational programme should be given priortiy to the carrying out of the observations at the main standard time;

(ii) All the upper-air stations included in the regional basic synoptic network should carry out radiosonde and radiowind observations reaching regularly* at least the 30 hPa level at 00 and 12 UTC, and radiowind observations reaching regularly* at least the 70 hPa level at 06 and 18 UTC. The carrying out of radiowind observations at 00 and 12 UTC should receive priority over radiowind observations at 06 and 18 UTC;

NOTE: Information on the state of implementation of the RA VI regional basic synoptic network is given in WMO Publication No. 217.

(*b*) Fixed sea stations;

Minimum requirements of four ocean weather stations is as follows:
Station L: 57°00′N, 20°00′W
Station M: 66°00′N, 02°00′E
Station R: 47°00′N, 17°00′W
Station C: 52°45′N, 35°30′W

(*c*) Mobile ships;

(*d*) Aircraft

(*e*) Radar observations;

(*f*) Near-polar-orbiting meteorological satellites;

(*g*) Geostationary meteorological satellites;

_____

* The expression ‘regular’ means that the levels indicated should be reached with a frequency of at least 90 per cent of the ascents.

2.2 Types of observational data required from outside the Region

2.2.1 *Data which are included in the global exchange programme*

Special requirements indicated by certain Members are as follows:

NOTE: The types of observational data for global exchange are listed in Volume I, Attachment II.2 of this *Manual* and in Volume I of the *Manual on the GTS* Attachment I-3.

2.2.2 *Data which are not included in the global exchange programme*

(*a*) DRIBU reports
(*b*) ROCOB reports
} as required for inter-regional exchange

NOTE: Stations for the regional exchange of SYNOP reports at the main standard times of observation are listed in Volume II of the *Manual on the GTS*, Attachment III-1.

2.3 Times of receipt of observational data

(*a*) From within the Region:

SYNOP
TEMP and PILOT
} to be received by { H + $1^1/_2$h
H + $1^1/_2$h

(*b*) From outside the Region:

SYNOP
TEMP and PILOT
} to be received by { H + $2^1/_2$h
H + $3^1/_2$h

NOTE: Times of receipt of observational data for use in the GDPS are given in Volume I, Attachment II.3.

3. PICTORIAL REPRESENTATION OF INFORMATION – REGIONAL AND NATIONAL ASPECTS IN THE REGION

3.1 Scales and projections of meteorological charts

NOTE: A selection of scales which should be used for weather charts in the GDPS is given in Volume I, Part II, paragraph 4.1.2.

3.2 Symbols for pictorial representation of data, analyses and forecasts on meteorological charts

NOTE: Symbols used for pictorial representation of data, analyses and forecasts on meteorological charts are given in Volume I, Attachment II.4.

4. EXCHANGE OF PROCESSED PRODUCTS BETWEEN CENTRES – REGIONAL PRACTICES IN THE REGION

NOTE: The global standard and recommended practices and procedures concerning the programmes of output products, the transmission priorities and the responsibilities of Members for providing information on their real-time data-processing activities are laid down in Volume I, Part II, paragraphs 5.2, 5.3 and 5.4 respectively. Several lists dealing with WMC/RSMC output products are given in the attachments to paragraphs 5.2 and 5.3. Detailed information on the programmes for preparation of output products by WWW centres is given in WMO Publication No. 9, Volume B – *Data processing*.

4.1 Requirements for processed products from outside the Region

(See paragraph 4.5 below.)

4.2 Requirements for processed products from inside the Region

(See paragraph 4.5 below.)

4.3 Transmission priorities for processed products exchanged on the regional segments of the GTS

(See paragraph 4.5 below.)

4.4 Processed products which must be exchanged in pictorial form within the Region

A provisional list of products which must be exchanged in pictorial form within the Region is given in Attachment I.

4.5 Processed products which are to be exchanged within the Region using the FM 47-V GRID and/or FM 49-VII Ext. GRAF codes

(*a*) The guidelines on the general exchange of numerical products on the GTS in RA VI are given in Attachment II;

(*b*) The standard regional products in RA VI are given in Attachment III.

PART II

NON-REAL-TIME DATA PROCESSING – REGIONAL AND NATIONAL ASPECTS

1. DATA TO BE STORED AT CENTRES (RSMCs AND NMCs) WITHIN THE REGION

NOTE: The general responsibilities for storage of data at RSMCs are given in Volume I, Part III, paragraph 2.1.2 and Attachment III.2.

1.1 Responsibilities for storage of observational and processed data at RSMCs within the Region

(To be developed.)

1.2 Special requirements for storage of observational and processed data at NMCs within the Region

The followin are special requirements for storage of data at NMCs with the Region:

(*a*) Hungary: SYNOP from Europe four times a day, from Carpathian basin eight times a day;

(*b*) Sweden: Globa ship observations carried out by Swedish ships;

(*c*) Yugoslavia: Data needed for Alpine databank used for ALPEX.

2. MINIMUM STANDARDS FOR QUALITY CONTROL OF NON-REAL-TIME DATA IN THE REGION

NOTE: Minimum standards for quality control of data for non-real-time use in the GDPS are given in Volume I, Attachment II.l.

2.1 Regional standards for quality control

(To be developed.)

2.2 Agreements between Members for quality control

(To be developed.)

2.3 Standards established nationally, not included in global or regional standards, and of interest to other Members

(To be developed.)

3. CLASSIFICATION AND CATALOGUING OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraph 4 establishes recommended procedures for the classification and cataloguing of stored data.

3.1 Regional procedures for classifying and cataloguing data stored at RSMCs

(To be developed.)

3.2 Regional procedures for classifying and cataloguing data stored at NMCs

(To be developed.)

4. MEDIA AND FORMATS FOR EXCHANGE OF STORED DATA IN THE REGION

NOTE: Volume I, Part III, paragraphs 5.1 and 5.2 give recommended media and formats for the exchange of stored data.

4.1 Media for exchanging stored data within the Region.

The following media are recommended for use within the Region:

(*a*) Magnetic tape with 9 tracks, $^1/_2$ inch wide, with and 800 BPI;

(*b*) Standard paper tape with 5 or 8 tracks, using international alphabets Nos. 2 and 5 respectively.

4.2 Formats for exchanging stored data within the Region

(To be developed.)

4.3 Responsibilities of Members for exchange of non-real-time data within the Region

(To be developed.)

PART III

MONITORING OF THE GDPS – REGIONAL AND NATIONAL ASPECTS

NOTE: Volume I, Attachment II.14 contains the Plan for Monitoring the Operation of the WWW. In this plan general guidelines and priorities are given for both real-time and non-real-time monitoring. Most of the items included in the monitoring programme are concerned with the quality of observations (see section 1 of Part I and section 2 of Part II above) and with telecommunications procedures. In addition real-time monitoring is required as regards:

(*a*) Adherence to regional coding procedures;

(*b*) Evaluation of processed information received at RSMCs and NMCs.

1. REGIONAL PROCEDURES FOR CARRYING OUT REAL-TIME MONITORING OF THE GDPS

1.1 Adherence to regional coding procedures

(To be included later.)

1.2 Evaluation of processed information received at RSMCs and NMCs

(To be developed after CBS, in consultation with CAS, has elaborated verification procedures for use in the GDPS.)

2. REGIONAL PROCEDURES FOR CARRYING OUT NON-REAL-TIME MONITORING OF THE GDPS

2.1 Evaluation of processed information prior to storage

(See paragraph 1.2 above.)

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ATTACHMENT I (PROVISIONAL)

LIST OF PRODUCTS WHICH MUST BE EXCHANGED IN PICTORIAL FORM

(*Ref. Part I, paragraph 4.4*)

1. There are certain output products which need to be exchanged in pictorial form because of the following characteristics:

(*a*) Plotted data indicated on the chart;

(*b*) Frontal symbols indicated by curves;

(*c*) Isohypses or contour lines combined with plotted data;

(*d*) Jet stream marked and direction of flow indicated;

(*e*) Symbols which cannot be described by grid-point data;

(*f*) Products in pictorial form intended to be received on board ships or at other locations unable to handle digital data.

2. The list of these products is as follows:

- Surface plotted data;
- Upper-air plotted data;
- Surface analysis with plotted data and/or fronts;
- Surface forecast with fronts;
- Upper-air charts with plotted data
- Tropopause and maximum wind charts;
- Significant weather charts;
- Nephanalyses.

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ATTACHMENT II

GUIDELINES ON THE GENERAL EXCHANGE OF NUMERIAL PRODUCTS ON THE GTS IN RA VI

(*Ref. Part I, paragraph 4.5 (a)*)

The guidelines should not inhibit the exchange of other products on a bilateral basis where communications capacity is available. In certain cases exchanges agreed on a bilateral basis may have to take prority over the general exchange products (e.g. for back-up arrangements). Products should be exchanged only when there is a requirement.

1. **Medium-range products (beyond H + 72 and all ECMWF)**

Sea-level/near surface	H/P	T	W	R
850 hPa	H	T	W	R
500 hPa	H	T	W	R
250/200 hPa	H	T	W	

2. **Products beyond H + 36, up to and including H + 72**

Sea-level/near surface	H/P	T	W	R
850 hPa	H	T	W	R
700 hPa	H	T	W	R
500 hPa	H	T	W	R
250/200 hPa	H	T	W	
100 hPa	H	T	W	

3. **Analysis and forecast products up to and including H + 36**

Sea-level/near surface	H/P	T	W	R
850 hPa	H	T	W	R
700 hPa	H	T	W	R
500 hPa	H	T	W	R
400 hPa	H	T	W	
300 hPa	H	T	W	
250 hPa	H	T	W	
200 hPa	H	T	W	
150 hPa	H	T	W	
100 hPa	H	T	W	
Tropopause and maximum wind	H/P	T	W	
Vertical velocity				
Precipitation				
Wave and swell				

4. **Validity times**

(*a*) Moscow, Bracknell, Offenbach, Paris
00 UTC and 12 UTC
H + 0, 6, 12, 18, 24, 30, 36, 48, 60, 72, 96, 120 (where available)

(*b*) Washington
00 UTC and 12 UTC H + 0, 12, 24, 36, 60, 72
00 UTC only H + 84, 96, 108, 120

(*c*) ECMWF
12 UTC only H + 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, 120

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NOTE: H/P, geopotential height/pressure; T, temperature; W, wind; R, humidity.

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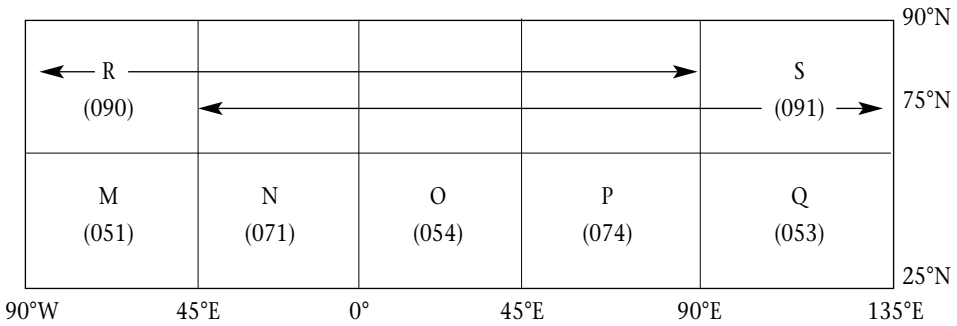
ATTACHMENT III

STANDARD REGIONAL PRODUCTS IN RA VI

(*Ref. Part I, paragraph 4.5 (b)*)

1. **Areas**

There are seven standard areas as shown.



2. **Resolution**

Areas M – Q $2^1/_2° \times 2^1/_2°$.

Areas R and S $2^1/_2° \times 10°$

3. **Boundaries**

The grid points lying on the boundary between two areas are included in both areas.

4. **Reference points**

The reference points are at the north-west corners of the areas.

5. **Area catalogue numbers (NNN)**

The catalogue numbers 051, 071, 054, 074, 053, 090, 091 are used for areas M – S shown above. For areas M – Q, the numbers have been derived from those used (001–012) for standard global/hemispheric products (areas A – L), by adding 050 for the western part and 070 for the eastern part. A separate series, beginning at 090, has been instituted for the polar areas.

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THE ANTARCTIC

DATA-PROCESSING ACTIVITIES AND METEOROLOGICAL SERVICES IN THE ANTARCTIC

1. It is proposed that data-processing and meteorological service functions be carried out by the following stations in the Antarctic:

Casey (Davis carried out this responsibility up to October 2003)
McMurdo
Marambio
Presidente Frei
Rothera

2. The functions proposed for stations in the Antarctic providing data-processing and other meteorological services, including services for shipping, aircraft, local operations and research, are:

(*a*) Preparation of meteorological analyses and prognoses for the whole of the Antarctic or for defined sectors thereof, and making them promptly available to other stations inside or outside the Antarctic;

(*b*) Preparation of specialized meteorological forecasts for users (marine and aviation interests, traverse parties, etc.), and making them promptly available to other stations inside or outside the Antarctic. Products that may be required should include for the relevant areas and subject to seasonal variation:

- Surface analyses with frontal positions and present weather at 0000, 0006, 1200 and 1800 UTC;
- Surface prognostic charts showing frontal positions and weather forecast for up to two days and longer where possible;
- Local area forecasts in support of remote aircraft operations on request;
- Upper-air analysis for 0000 and 1200 UTC for the standard levels (H, W, T);
- Uppeer-air forecasts for the standard levels for up to two days and longer where possible (H, W, T);
- Swell and wave (sea state) analysis for 0000 and 1200 UTC and forecasts for up to two days;
- Sea-ice analysis at about 20 km resolution or better with prognoses for up to two days;
- Local sea-ice analyses on request;
- Satellite orbital data in the appropriate code form on request;

(*c*) Preparation and distribution of warnings of dangerous weather conditions for the area for which the station prepares analyses, prognoses or specialized forecasts; products that may be required should include forecasts of icing conditions and other dangerous weather for surface, ship and air operations;

(*d*) Support for research activities as required.

3. Criteria for inclusion of an Antarctic station in the list of stations proposed in paragraph 1 are:

(*a*) That the station is willing to carry out the functions indicated in paragraph 2 above to the maximum extent possible;

(*b*) That the station has, or will have in the near future, the capability of carrying out the functions adequately;

(*c*) That at least one other station inside or outside the Antarctic requires the processed information available from the station;

(*d*) That the station should have adequate telecommunication facilities to receive observational data and exchange and distribute processed information with other stations as required.

NOTE: It is recognized that the carrying out of these functions indicated in paragraph 2 above is subject to seasonal variations between the austral summer and winter.