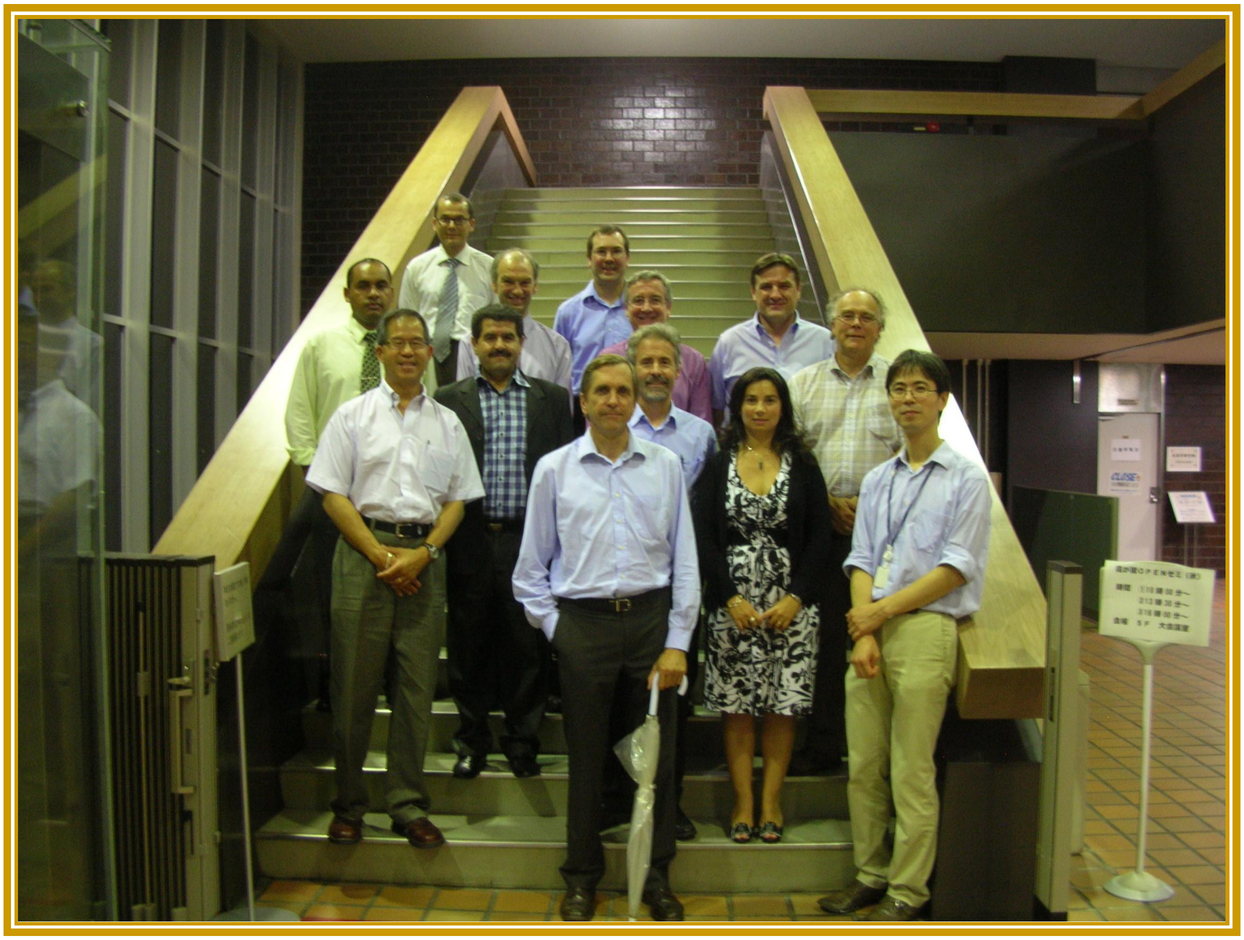
WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

CBS IMPLEMENTATION COORDINATION TEAM OF THE OPEN PROGRAMME AREA GROUP (OPAG) ON DATA-PROCESSING AND FORECASTING SYSTEMS (ICT-DPFS)

TOKYO, JAPAN, 13-17 SEPTEMBER 2010

FINAL REPORT



(Back row) Laurent Perron, David Richardson
(Upper central row) David Moncada Serquen, Ken Mylne, Chris Ryan, René Servranckx
(Lower central row) Bachir Hamadache, Richard Graham, André Method
(Front row) Peter Chen, Bernard Strauss, Alice Soares, Yuki Honda

EXECUTIVE SUMMARY

The Meeting of the CBS Implementation Coordination Team of the Open Programme Area Group (OPAG) on Data-Processing and Forecasting Systems (ICT-DPFS) was held in Tokyo, Japan, from 13 to 17 September 2010.

The ICT discussed the future evolution of the Severe Weather Forecasting Demonstration Project (SWFDP) and developed a strategy for the SWFDP, which encompasses possible approaches for developing technical aspects, including for other application areas, sustaining matured projects, and funding.

The ICT reviewed the outcomes of the meetings of the OPAG-DPFS Expert Teams (ETs) and Coordination Groups (CGs) and agreed on their future work programmes, which would be recommended to CBS-Ext.(10), in November 2010. The ICT also reviewed the structure of the OPAG on DPFS, including its ETs and CGs, and their respective Terms of Reference (ToRs), to reflect priorities and progress achieved. The ICT concluded that it would recommend to CBS-Ext.(10) to keep the current structure for the OPAG on DPFS, as well as the ToRs of its CGs, ETs and rapporteurs, except the ToRs for the Expert Team on Extended- and Long-Range Forecasting (ET-ELRF), which would consider the recent development of the Global Framework for Climate Services (GFCS). The ICT discussed and developed a proposal for a strategic direction for undertaking the activities in the future work programme for the OPAG on DPFS, taking into account the WMO priority areas.

The ICT reviewed the status and evolution of the GDPFS, including the "Joint WMO Technical Progress Report on the GDPFS, including NWP Research Activities", and recognizing the difficulties in maintaining up-to-date this information, it discussed other options to get information from Members and review the summary table. In this context, the ICT recommended more engagement of the Regional Rapporteurs in this process.

The ICT reviewed the outline of a Revised Manual on the GDPFS (WMO-No. 485) proposed by the CBS Expert Meeting on the Review of the Manual on the GDPFS (Geneva, April 2010), and agreed to recommend it to CBS-Ext.(10), in November 2010.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The Meeting of the CBS Implementation Coordination Team of the Open Programme Area Group (OPAG) on Data-Processing and Forecasting Systems (ICT-DPFS) was opened by its chairperson, Mr Bernard Strauss (Météo-France), at 09.00 hours on Monday, 13 September 2010, at the Headquarters of Japan Meteorological Agency (JMA), in Tokyo, Japan. Mr Strauss welcomed participants to the meeting, and thanked JMA for hosting this meeting. He introduced Dr Mitsuhiko Hatori, Director-General of the Forecast Department of JMA, to address the meeting.

1.2 Dr Hatori noted the significant progress made in Numerical Weather Prediction, including atmospheric dispersion of hazardous substances, in the last ten years, which led to increasingly skilful short-range to seasonal forecasting and warning services. He highlighted that, through the successful Severe Weather Forecasting Demonstration Project (SWFDP) led by WMO/CBS, many National Meteorological and Hydrological Services (NMHSs), in Least Developed Countries (LDCs) and developing countries, began to realize the usefulness of sophisticated outputs from NWP systems implemented in advanced centres, in improving their severe weather forecasting and warning services. Dr Hatori informed the meeting that JMA had been operating a suite of NWP systems and, as one of the advanced centres, had been disseminating NWP products to other WMO Members in fulfilling its responsibility as Regional Specialized Meteorological Centre (RSMC). He noted that JMA had also been receiving a number of NWP products and information from other centres, which had been contributing to improving its forecasting and warning systems and services. He also noted that JMA had been participating in Environmental Emergency Response (EER) activities, under the coordination of WMO and IAEA.

1.3 Dr Hatori acknowledged that the Global Data-Processing and Forecasting System (GDPFS) has been well coordinated by the Commission for Basic Systems (CBS), through its OPAG on DPFS, and therefore expressed his gratitude, on behalf of JMA, to all experts of the Teams and Group in the OPAG on DPFS, who had been dedicating their substantial and voluntary efforts to support and improve the GDPFS activities. JMA also expressed its appreciation to the strong support provided by WMO Secretariat in assisting WMO Members and coordinating GDPFS activities. He concluded by wishing everyone a successful meeting and a pleasant stay in Japan.

1.4 Mr Peter Chen, on behalf of the Secretary-General of the WMO, Mr Michel Jarraud, welcomed participants to the meeting and expressed the gratitude and appreciation of WMO to the Government of Japan, the Japan Meteorological Agency, and Dr Mitsuhiko Hatori for hosting this meeting in Tokyo and for providing these excellent facilities. Mr Chen also thanked Mr Yuki Honda and Mr Kosuke Ono of JMA for their work in organizing the local arrangements.

1.5 Mr Chen explained the context of the work of the OPAG in WMO/CBS that addresses the NWP systems and forecasting processes that are implemented by WMO Members, as part of the GDPFS of the World Weather Watch (WWW) programme, including the Emergency Response Activities (ERA) programme. The GDPFS and ERA programmes are both operational and contribute to Disaster Risk Reduction (DRR). In terms of the WMO result-based management and strategic planning, DPFS activities are directly associated with Expected Results 1 (production of weather forecasts and warnings), 2 (climate information and prediction), 6 (disaster risk reduction), 7 (service delivery), and 9 (capacity building).

1.6 Mr Chen recalled that CBS, at its fourteenth session (CBS-XIV, Dubrovnik, 2009), noted the significant progress made in many areas such as severe weather forecasting, especially through the Severe Weather Forecasting Demonstration Project (SWFDP), ensemble prediction systems, extended- and long-range forecasting, very short-range forecasting, and emergency response activities. CBS-XIV agreed to maintain the organizational structure with some adjustments to the work programme of the OPAG on DPFS.

1.7 Mr Chen pointed out that, in advance of CBS-Ext.(10), in November 2010, this meeting would review the work of the OPAG and develop appropriate recommendations to the coming session, and thereby to the sixteenth session of the World Meteorological Congress (in May 2011), including adjustments to its future structure and work programme, paying special attention to how it would contribute to WMO high priority areas.

1.8 In concluding, on behalf of WMO, Mr Chen expressed gratitude to the chairpersons of the OPAG's Teams and Groups, and Rapporteurs for their dedication and efforts to the work that was assigned under their individual and collective leadership, which will continue to assist WMO to provide even better assistance to its Members in facing challenges of improving their forecasting systems and services. At the same time, he encouraged effective interaction with regional programme aspects of the implementation of the GDPFS.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The ICT adopted the provisional agenda without change, as provided in Annex I to this report.

2.2 Working arrangements

2.2.1 All documents submitted for the meeting are referenced and hyperlinked in the Documentation Plan (INF. 1), which had been posted on the WMO web site at:

http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/ICT-DPFS_DocPlan.html

2.2.2 The ICT agreed its hours of work and other practical arrangements for the meeting. The list of participants in the meeting is provided in Annex II to this report.

3. INTRODUCTION AND BACKGROUND / REVIEW OF DECISIONS OF THE WMO GOVERNING BODIES AND STATEMENTS ADOPTED BY CBS RELATED TO THE OPAG on DPFS

3.1 The ICT was presented with background information related to the OPAG on DPFS, including recalling statements adopted by the fourteenth session of the Commission for Basic Systems (CBS-XIV, March-April 2009), recommendations of the eleventh session of the CBS Management Group (March 2010), and relevant decisions of the sixty-session of the WMO Executive Council (EC-LXII, June 2010).

3.2 The ICT noted that CBS-XIV recognized progress and made a number of recommendations on DPFS activities, including on severe weather forecasting and the SWFDP, very-short-range forecasting, extended- and long-range forecasting, probability forecasting and Ensemble Prediction Systems and Applications, NWP forecast verification, including possible establishment of lead centres for deterministic NWP verification, and on emergency response activities – atmospheric transport modelling. CBS-XIV recommended an amendment to the Manual on the GDPFS (WMO-No. 485) and also a major revision of the Manual on the GDPFS, to align with quality management principles. These recommendations were endorsed by WMO Executive Council, at its sixty-first session (EC-LXI, June 2009). The ICT noted that detailed information on progress made against these recommendations would be provided under the related agenda items.

3.3 In relation to the requested by the Executive Council to review the WMO Technical Note 170, entitled: "Meteorological and Hydrological Aspects of Siting and Operations of Nuclear Power Plants", the ICT noted that the CBS Management Group (MG) requested the WMO Secretariat to clarify which parts of the Technical Note are relevant to CBS and to report to EC accordingly. At the same time, the MG stressed the need for continuing collaboration with the International Atomic

Energy Agency (IAEA) in relation to their current revision of their Safety Guide: "Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations", and noted the involvement of a WMO Commission for Climatology expert in this work. The ICT noted that the CG-NERA, at its meeting in May 2010, reviewed the WMO Technical Note 170 and concluded that this document was out of date in many aspects. The ICT noted that only Sections 2.2.4 and 2.2.5 of the document are related to CBS/DPFS and that the CG-NERA meeting recommended that these sections be thoroughly reviewed in order to facilitate a document that was of greater relevance to users. The ICT also noted that other sections of the document are more relent to climatology and therefore recommended that CBS reports to EC accordingly.

3.4 The ICT noted that the Executive Council, at its sixty-second session (EC-LXII, June 2010), established an Inter-Commission Task Team (ICTT) on Meteorological Support for Humanitarian Agencies. The first meeting of the ICTT was held in Geneva, in August-September 2010. The Team noted the major challenges with providing specialized support to those agencies are associated with weather forecasts, climate, and flood monitoring and forecasting services. The ICT supported the active participation of the OPAG on DPFS in the work of this ICTT.

3.5 The ICT noted that EC-LXII wholeheartedly supported the SWFDP and its expansion to other WMO regions and of its successful framework to include all severe weather-related phenomena, and other components that would benefit and guide WMO Members, especially those in LDCs and developing countries, in their severe weather forecasting and warning services programmes, and decision-making processes. At the same time, EC-LXII stressed the need for ensuring the long-term sustainability of the benefits gained with the SWFDP, through making the transition into routine operations of the project's successful elements. EC-LXII therefore requested CBS to further develop the strategy and appropriate documentation related to the SWFDP, including possible options for collaborating with existing infrastructure, regional operational centres and committees, for the further expansion of the project. The strategy and document should be developed for consideration by CBS-Ext.(10) (November 2010), and subsequently by the Sixteenth WMO Congress (May 2011), which would ensure the long-term sustainability of the benefits gained, in terms of a process for continual improvement of mature projects and expansion and implementation of the SWFDP through all WMO Regional Associations. The ICT agreed to address this issue under agenda item 4.

3.6 The ICT noted that EC-LXII approved the WMO Position Paper on the Global Framework for Climate Services (GFCS), which highlights the role of GPCs in the GFCS, as a key building block of the Climate Services Information System (CSIS) component. The ICT noted that, within the GFCS, GPCs would be expected to play a major role in providing global climate predictions from seasonal to longer time-scales, and therefore agreed that this issue should be carefully discussed under agenda item 6.

3.7 The ICT noted that EC-LXII agreed that the priority areas for the sixteenth financial period (2012-2015) should be the Global Framework for Climate Services (GFCS), Capacity Building, WMO Integrated Observations and Information Systems, Disaster Risk Reduction, and Aviation Meteorology. The ICT also noted that EC-LXII recommended that the WMO Secretary-General prepares for consideration by the Sixteenth WMO Congress a budget for the sixteenth financial period that provides adequate resources within the range of proposals which should address effectively the five priority areas. In this context, the ICT agreed that a strategic direction and vision for the DPFS should be developed under agenda item 12.

4. SEVERE WEATHER FORECASTING

4.1 The Secretariat briefed the meeting on the progress of the Severe Weather Forecasting Demonstration Project (SWFDP), including the progress and major achievements of the regional subprojects in Southern Africa and in the South-west Pacific, the recent development of new subprojects for South-east Asia and for Eastern Africa, and the outcomes of the third meeting of the Steering Group for the SWFDP (SG-SWFDP).

Progress and Major Achievements of the Regional Subprojects in Southern Africa and for the South Pacific Islands

4.2 The ICT recalled that the SWFDP was currently in progress in two regions: (a) sixteen countries of the southern Africa region ("SWFDP – Southern Africa"); and (b) four countries of the South Pacific Islands, known as the Severe Weather Forecasting DRR Demonstration Project ("SWFDDP – South Pacific Islands") in a pilot phase.

4.3 The ICT noted that the SWFDP – Southern Africa had been implemented to span all seasons, and to include a number of meteorological and related hazards (heavy rain, strong winds, large waves, cold temperatures, etc.). It further noted that the RSMC Pretoria had extended its regional guidance role to include forecasting of marine hazards, and had been working towards the incorporation of additional aspects, such as flash flood forecasting, and a Web-based system for exchange and display warnings in the region. The ICT noted that some participating countries had been experiencing some difficulties to fully participate in the SWFDP and recommended that specific training be provided to these countries focusing on their gaps and weaknesses, in order to bring them fully on board.

4.4 The ICT noted that the SWFDP for the South Pacific Islands had commenced its pilot phase in November 2009, focusing on forecasting and warning services in relation to heavy rain, strong winds and damaging waves for four Island States; Fiji, Samoa, Solomon Islands, and Vanuatu. The ICT also noted that the full demonstration was planned to begin in November 2010.

Outcomes of the Third Meeting of the SG-SWFDP

4.5 The ICT noted that the SG-SWFDP considered the information provided in regional reports regarding possible new regional subprojects for the future, in the timeframe of the next few years, and concluded with a prioritized list of possible new subprojects. In this context, the ICT was pleased to note that from the three high priority subprojects, plans had already initiated for the development of two new subprojects: (1) an SWFDP in Southeast Asia, involving Cambodia, People's Democratic Republic of Lao, Thailand and Viet Nam, and with the active participation of Japan, China and the Republic of Korea; and (2) an SWFDP for Eastern Africa, involving countries bordering on Lake Victoria (United Republic of Tanzania, Kenya and Uganda) and other possible surrounding countries (including Rwanda, Burundi and Ethiopia), and with the active engagement of the RSMC Nairobi as the lead regional centre, and global NWP products being possibly generated and issued by Met Office (UK), NOAA African Desk (USA), and ECMWF, and support to regional modelling provided by DWD (Germany) and possibly by the Met Office UK. The ICT noted with concern that there is a significant increase of the resources required to support these subprojects and any other new potential subprojects, both in terms of funding and people. It therefore stressed that EC-LXII request to expand the SWFDP into other WMO regions could not be addressed without expansion of resource allocation mechanism to the project, and agreed that a strategy for the SWFDP should consider these aspects.

4.6 At the same time, the ICT noted that new regional subprojects, in particular the SWFDP for Eastern Africa, would have a focus on extending range of user application areas (e.g. agriculture and fisheries). The ICT agreed that these application areas could be considered in different stages of development of the SWFDP, depending on the region. It therefore highlighted that these applications will come as new elements in the SWFDP framework without diminishing in any respect the importance of the original focus. The ICT noted the importance to move the SWFDP forward with a phased approach, starting with most feasible elements, taking into account local requirements, and scientific and technical feasibilities towards its successful implementation. In this context, the ICT agreed that in the initiation of new regional subprojects, the number of participating countries should be limited, ideally, to 3 or 4 countries, and the focus should be on strong winds and heavy precipitation, with possible expansion to additional countries and other weather-related hazards for consideration in a second phase.

4.7 The ICT noted that the *SWFDP Overall Project Plan* and the *SWFDP Guidebook on Developing Regional Subprojects* had been updated during the SG-SWFDP meeting to include additional aspects on the following areas: (1) Public Weather Services (PWS); (2) Disaster Risk Reduction (DRR); (3) Training; (4) Verification; and (5) Collaboration with GIFS-TIGGE. The ICT reaffirmed that the initiation of new regional subprojects should follow the guidelines provided in these documents.

4.8 The ICT noted that a document on verification of forecasts and warnings was completed by Mr Lawrence Wilson and soon would be incorporated as part of the *SWFDP Guidebook on Developing Regional Subprojects*. While noting that verification activities contribute to the quality assurance (i.e. QMF processes) in the production of forecasts and warnings, the ICT agreed that there was still a lot to do in terms of verification of warnings. In this context, the ICT encouraged the engagement of the PWS programme in providing guidance to NMHSs on verification of warnings.

4.9 The ICT reaffirmed that the SWFDP framework represents a systematic approach for building capacity and for transferring knowledge and skills to NMHSs, especially those of developing countries, and agreed that the project and its approach could be used to implement a series of ready-for-production enhancements to the forecasting process and to provide benefits to other scientific and technological developments that are intended for operational implementation. In this context, the ICT was pleased to note that a joint session SG-SWFDP – GIFS-TIGGE WG was held during the third meeting of the SG-SWFDP meeting, which concluded that the SWFDP regional projects could well serve as a trialing environment for promising outputs from GIFS-TIGGE, and the implementation of new products, and supported that Mr Mylne, chairperson of the ET-EPS, continue to represent CBS at the GIFS-TIGGE WG in order to ensure the liaison between the SWFDP and GIFS developments.

4.10 The ICT noted that the SG-SWFDP discussed main issues and challenges from the current subprojects and identified the need for tools for very short-range forecasting, including nowcasting, the rapid onset of localized severe thunderstorms, heavy precipitation and strong winds, in absence of weather radar coverage. The ICT noted that, following the recommendation by the SG-SWFDP, coordination between the SG-SWFDP with the CBS Expert Team on Satellite Utilization and Products (ET-.SUP) had been established as of the fifth meeting of ET-SUP (March 2010), which discussed opportunities for interaction between the two groups, including aspects related to training, satellite information (data and products, and dissemination mechanisms) required to support the project, and collaborating arrangements to formally establish a liaison between the SG-SWFDP and ET-SUP. As a further follow-up action, the Secretariat had provided document input to the annual meeting of the Coordination Group on Meteorological Satellites, in relation to SWFDP developments, suggesting possible collaboration on improved uptake by forecasting centres of satellite products, on training activities (e.g. sharing training resources, including the Virtual Laboratory (VLab)) and on satellite dissemination of SWFDP products.

4.11 The ICT noted that matured projects (for example in southern Africa) needed to make the transition into routine operations the project’s successful elements, and in this regard the SG-SWFDP developed an additional project phase entitled: “Continuing Development Phase”, when the project has developed sufficiently its framework through its initial phases for it to be fully assumed under the responsibility of the respective Regional Association including the raising of necessary resources to sustain the project. The ICT agreed that this Phase IV should be included as part of a strategy for the SWFDP.

Strategy for the SWFDP

4.12 The ICT noted that EC-LXII recognized the need for ensuring the long-term sustainability of the benefits gained with the SWFDP. Following the request by EC-LXII to CBS, the ICT initiated the development of a strategy for the SWFDP, to be completed in collaboration with PWS, for consideration by CBS-Ext.(10) in November 2010, which would ensure the long-term sustainability of the benefits gained, in terms of a process for continual improvement of mature projects, and the expansion and implementation of the SWFDP through all WMO Regional Associations. The draft strategy is presented in Annex III.

4.13 The ICT recognized that training was necessary to ensure that forecasters from Regional Centres and NMHSs participating in an SWFDP are able to correctly interpret the various NWP/EPS and guidance products made available for the SWFDP regional subprojects and to prepare user-focused information. The ICT agreed that training activities within the framework of the SWFDP should ideally be carried out regularly (e.g. annually), to cover new developments and the normal cycling in of new operational weather forecasters.

4.14 At the same time, the ICT recognized that support for the subprojects, including training and commitments made by global and regional centres, were putting pressure on limited funding and human resources, and therefore expressed concern about the growing demand with more regional subprojects being developed and implemented simultaneously in several WMO Regions. This issue needs to be considered in the strategy for the SWFDP.

5. VERY SHORT-RANGE FORECASTING

5.1 The ICT recalled the outcome of a DPFS expert meeting that was held in 2007, including its view that a suitable blending of the use of real-time observational data sets and nowcasting methods, with high-resolution NWP outputs is possible. Investment in improving observational data sets would support improved nowcasting, and also statistical post-processing of NWP outputs and verification of forecasts. The meeting also recalled that a shortcoming identified early from the SWFDP was the lack of severe weather forecasting tools in the first 12 hours of the forecasting range, in particular to monitor and predict rapid onset of severe convective storms.

5.2 The ICT agreed that the table of possible blending approaches (see CBS-XIV report), should be further developed or applied, for example in relation to SWFDP regional subprojects where clearer requirements have been identified, such as for guidance to flash flood forecasting. The ICT suggested exploring this work opportunistically with groups or projects involved in nowcasting, high-resolution NWP, and statistical post-processing.

6. EXTENDED- AND LONG-RANGE FORECASTING

6.1 The Chairperson of the Expert Team on Extended- and Long-Range Forecasting (ET-ELRF), Dr Richard Graham (UK), reported on the outcomes of the meeting of the Expert Team (Exeter, June/July 2010), highlighting: progress made with respect to Multi-Model Ensemble (MME) for Long-Range Forecasts and the important functions performed by the Lead Centres for MME and for Verification, designations of additional Global Producing Centres (GPC) and the first two Regional Climate Centres (RCC, in coordination with CCl), and the use of GPC products to meet seasonal forecasting needs of RCCs, Regional Climate Outlook Forums (RCOF), and National Meteorological Centres. The full report is available at:
http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/documents/Doc-6-1-ETELRF.doc.

Global Producing Centres (GPC), including Compliance against Designation Criteria

6.2 The ICT noted that significant progress had been made in developing the GPC network and services, including designation of additional GPCs bringing the present total to twelve (Beijing, CPTEC, ECMWF, Exeter, Melbourne, Montreal, Moscow, Pretoria, Seoul, Tokyo, Toulouse, and Washington); and active engagement of some GPCs with RCCs and RCOFs in promoting and assisting use of GPC products (examples include activities at the Beijing and Tokyo Climate Centres, and at the GHACOF and PRESAO RCOFs). The ICT also noted that a number of GPCs had made and were making significant enhancements to their prediction systems. Following the request by CBS-XIV regarding the review of GPC compliance with designation criteria, the ICT noted that all GPCs were providing forecast products such as temperature and precipitation and appropriate verification to make prudent use of these forecasts; however, it acknowledged that some GPCs were not fully compliant with the designation criteria. While expressing concerns, the ICT requested the ET-ELRF to review the list of mandatory criteria to make sure that they properly and realistically address the most essential aspects of GPC functions.

6.3 Noting the outcomes of the survey on the use of GPC products, the ICT supported the recommendations by ET-ELRF to improve accessibility and use of the products, including development of a ‘flyer’ describing GPC services, development of clearer navigation to and identification of GPC websites, development of training material, a review of the completeness of GPC products for RCC use, and active engagement of GPCs in the process of developing regional forecasts at RCCs and RCOFs.

Global Framework for Climate Services (GFCS)

6.4 The ICT noted the decision at the World Climate Conference 3 (WCC-3) to develop a Global Framework for Climate Services (GFCS). The ICT also noted that the ET-ELRF had been contributing to a number of activities that would secure the foundation of the GFCS. These include: (a) the role of GPCs and associated lead centres in the Climate Services Information System (CSIS) component of the GFCS; (b) the definition of the mandatory and high recommended functions of Regional Climate Centres (RCCs) as part of the GDPFS, and formation of a joint CCl-CBS on RCCs; and (c) the use of GPC, LC-LRFMME and LC-SVSLRF products in preparation of regional consensus forecasts used at RCOFs. The ICT noted that the ET-ELRF reviewed the description and role of GPCs, as a key building block of the CSIS, within the WMO draft Position Paper, and agreed to bring to the attention of CBS, at its upcoming session, the comments from the GPCs, which consist of the main points below:

- The concept and components of the framework are generally laid out very well in the position paper;

- The role of GPCs could be made clearer. Currently the role of GPCs (and potential expansion within the GFCS for some GPCs) is not as fully expressed as it is for RCOFs and RCCs. Suggestions of where additional paragraphs could be inserted to achieve this have been made;

- There is a lack of clarity in the definition of Global Climate Centres, which has led to concern, that the different responsibilities of WMO monitoring and prediction centres may get confused, i.e. will the new remit of GPCs also include provision of monitoring services?

- The use of timescales is not always consistent through the document. Sometimes seasonal- to-interannual is specified, elsewhere seasonal-to-interannual and decadal. Also there is little mention of monthly (extended) timescales;

- When discussing the operational delivery, further acknowledgment of developing capacity in some areas (e.g. decadal prediction) could be made – to avoid over-raising of expectations.

Provision of Hindcast Data

6.5 The ICT acknowledged that, particularly in the context of the GFCS, EC-LXII had urged GPCs to make their hindcasts available to users. It noted that nine GPCs were providing their hindcasts to the LC-LRFMME and that others were making hindcasts available on a case-by-case basis through active engagement at RCOFs. It was noted that since the 2008 ET-ELRF meeting, one additional GPC had decided to make its hindcasts available to the LC-LRFMME. The ICT recognized that partly because of data policy issues, some GPCs had been unable to provide hindcast information to the LC-LRFMME, and therefore ‘core’ LC-LRFMME products were defined (at ET-ELRF, 2008) that do not require provision of hindcasts. Although useful, such provision limits the potential to develop e.g. probability forecasts and ‘skill-weighted’ multi-model combinations. In this regard, the 2008 ET-ELRF meeting also defined ‘additional’ LC-LRFMME products to be generated using data from those GPCs able to provide hindcasts. Such products (that include probability products) were scheduled as a ‘phase 2’ activity. It is important that such products are now generated to provide appropriate support for the GFCS, and at the 2010 ET-ELRF meeting, the LC-LRFMME was urged to proceed with phase 2, even though some centres continue to be unable to provide hindcasts.

Global Seasonal Climate Update (GSCU)

6.6 The ICT noted that the proposed WMO Global Seasonal Climate Update (GSCU) would summarize the current status (monitoring) and the expected future behaviour (prediction) of major general circulation features and large-scale oceanic anomalies around the globe (e.g., ENSO, North Atlantic Oscillation, Indian Ocean Dipole, etc.) and discuss briefly likely impacts on continental-scale temperature and precipitation patterns. The GSCU would represent an expansion of the existing WMO El Niño/La Niña Updates and would be generated using similar consensus methods. The ICT welcomed this initiative and noted that a number of developments to GPC and LC products would help to assist the preparation of GSCUs including: development of new LC-LRFMME probability products, verification of LC-LRFMME multi-model products and possible centralized calculation of verification scores for individual GPC products. In this context, the ICT noted the ET-ELRF had urged the GPCs and LCs to review the feasibility and make progress on these issues. The ICT further noted that GPCs would participate in the scoping workshop for GSCUs (under joint auspices of CCl and CBS), which would be held in Geneva from 12 to 15 October 2010.

Standardized Verification System for the Long-Range Forecasts (SVSLRF)

6.7 The ICT noted that the ET-ELRF had realized that RCCs were being encouraged to make use of the set of verification scores embodied and documented in the SVSLRF, and concluded that the Manual on the GDPFS, Part II, Attachment II.8, required some revision since it currently addressed only requirements on GPCs. In addition, the ET-ELRF concluded that Level 3 verification scores should no longer be mandatory for GPCs as such scores are more meaningful when generated at regional level. The ET-ELRF had prepared amendments to Attachment II.8 on these and other issues, which are considered under agenda item 10.2.

Extended-Range Prediction

6.8 The ICT noted that a number of GPCs had been making significant developments to their extended-range prediction systems, and recognized the potential high value of predictions at this range. The ICT agreed with the ET-ELRF recommendation that advances in evaluation and use of these forecasts would be best addressed, at this time, through GPCs conducting pilot studies with users. In this context, and taking into account new proposals for SWFDP regional subprojects, such as the one for Eastern Africa, had a strong focus on the agriculture sector, the ICT suggested that the SWFDP – Eastern Africa could consider including monthly forecast products.

Multi-Annual and Decadal Prediction

6.9 The ICT recalled that within the context of the GFCS, Global Climate Centres (including some designated GPCs) would be expected to play a major role in providing global climate predictions from seasonal to longer time-scales. In this context, the ICT noted that the ET-ELRF welcomed the offer from GPC Exeter to contribute by coordinating international collaboration in, and reviewing research on decadal prediction and, through the ET-ELRF, to report back to CBS (through the ICT-DPFS) on the potential for multi-annual prediction and to CCl OPACE-3 on potential for predictions of greater-than-two-year range.

6.10 The ICT, in response to the request of EC-LXII, reviewed and included an additional item in the terms of reference for the ET-ELRF in this regard (see agenda item 12).

7. PROBABILISTIC FORECASTING AND ENSEMBLE PREDICTION SYSTEMS, AND APPLICATIONS

7.1 The Chairperson of the Expert Team on Ensemble Prediction Systems (ET-EPS), Mr Ken Mylne (UK), reported on the outcomes of the meeting of the Expert Team (Exeter, October 2009), highlighting progress made with respect to EPS-based products, probabilistic forecasting methods, and applications, coordination with THORPEX/GIFS-TIGGE especially related to implementation issues, and other aspects related to the ET's Terms of Reference. The full report is available at: http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/documents/Doc-7-1-ETEPS-rev1.doc.

Progress of Operational EPS

7.2 The ICT noted that while a limited number of GDPFS centres run EPS operationally, many NMHSs were exploring various applications, and others were seeking to build capacity for their forecasters to access and effectively use EPS products in their forecasting process as well as to deliver services that are based on probabilistic forecasting methods. In particular, EPS application to support early warning of severe weather is of the highest priority, in contributing to disaster risk reduction.

7.3 The ICT noted that significant progress had been made in terms of resolution, ensemble size, length of integration and frequency of forecast cycles. The horizontal resolution was increased from about 90-110km to 50-70km for most global EPS while ECMWF was working towards 30-km. The number of vertical levels was also increasing, with the length of integration extending to 10 - 15 days at most centres. The ICT also noted that higher resolution regional EPS and those that focus on specific high-impact phenomena, post-processing products, and multi-centre ensembles continue to develop.

THORPEX/TIGGE-GIFS Developments and Plans

7.4 The ICT noted that the ET-EPS chairperson had been acting as the principal liaison, on behalf of CBS, with the research activities of THORPEX-TIGGE, which was exploring the concept of grand global ensemble methods. The ICT was informed about the development and planning of a Global Interactive Forecast System, which would provide new promising products for near-operational trial, via relevant RSMCs, using the SWFDP framework. In this context, the ICT noted that the joint SG-SWFDP – GIFS-TIGGE WG meeting agreed on collaborating arrangements to formally establish liaison between the SWFDP and GIFS-TIGGE developments for using SWFDP regional subprojects as a trialing environment.

7.5 The ICT noted that results from recent TIGGE research showed a small potential benefit from multi-system ensembles. Most studies take the best-performing ECMWF EPS as a reference and consider whether the multi-system ensemble can outperform the ECMWF EPS. The ICT also noted that a TIGGE multi-model composed of all single model ensembles does not provide significantly better forecasts than the ECMWF EPS on its own. However, combining only the three best single models (ECMWF, Met Office and NCEP) can improve the forecasts compared to the single ECMWF EPS, in particular for surface variables like 2-m temperature. The ICT also noted that an ECMWF study had shown that if the ECMWF EPS is calibrated using re-forecasts (which they generate operationally for the purpose of training calibration systems) then the calibrated ensemble forecasts are competitive with the multi-system ensembles in generating single-variable probability forecasts; both techniques are similarly successful in reducing systematic errors and correcting for spread deficiencies. However, where more complex forecasts are required the multi-model ensemble has an advantage in retaining covariance between weather variables and spatial locations, which is not available from the calibrated forecasts. The ICT further noted that for the time being many WMO Members do not have access to such calibrated forecasts, and in this case the multi-system approach could provide higher quality forecasts than available from single-model systems.

7.6 The ICT noted that operational flood forecasting systems, including coastal flood forecasting due to storm surge, were increasingly moving towards the adoption of EPS to drive their predictions. In particular, the ICT noted that the availability of several global ensemble weather prediction systems through the TIGGE archive had been providing an opportunity to explore new dimensions in flood forecasting and the potential to provide early warnings.

Use of EPS by NMHSs

7.7 The ICT noted the difficulty for NMHSs to make use of ensemble fields made available in real-time by the producing centres for downloading. It further noted that many NMHSs, especially those of developing countries and LCDs, did not have the computing facilities or capability to generate products from ensemble fields. Noting that EPS outputs needed to be post-processed into specific products required by "non-producing" NMHSs, the ICT recognized that useful products could only be developed and produced by those centres that have the data processing or data transfer capacity to do so. This could likely imply that RSMCs might act as the primary producers of national-level EPS products destined for national end-users, shifting from the present practice of EPS centres providing "raw" ensemble output datasets as basic construction material for NMHSs' further development and production. The ICT noted that this approach could imply data policy issues.

EPS in Severe Weather Forecasting, including SWFDP

7.8 The ICT agreed that the application of EPS to predict severe or high-impact weather events is among the most important topics, e.g., the propagation of the weather forecasts into impact models. The ICT reaffirmed that EPS continues to be a critical component of the guidance data provided to SWFDP subprojects from the global centres. The subprojects in Southern Africa and the South-west Pacific had been supplied with EPS data by ECMWF, the Met Office UK and NCEP, and the use of EPS data was included in plans for the SWFDP subprojects being initiated in Southeast Asia and in Eastern Africa. The ICT agreed that training workshops carried out as part of the SWFDP subprojects had proven one of the most effective ways of providing training on the use of EPS, as the training had been provided in conjunction with ongoing access to operational EPS data. However, the ICT expressed concerns regarding the resources (both funding and human resources) required to maintain regular and updated training for current and new subprojects.

7.9 The ICT noted that extreme events are often predicted towards the extreme end of the forecast probability distribution, and it is therefore essential to take account of low probabilities of occurrence of severe events in order to make effective use of the forecasts and ensure that warnings capture the more extreme events. To be fully effective, this requires a fundamental change of thinking whereby alerts, watches and even warnings become more probabilistic in nature to represent the risks associated with high-impact weather and related phenomena. The ICT agreed that effective communication of the meaning of low probabilities of high-impact events is essential to ensure effective use. In this context, the ICT suggested that PWS could consider addressing this issue within the SWFDP framework, as close discussion with users and stakeholders is required to create an effective balance between capturing extreme events while avoiding excessive "false alarms" generated by low probability alerts.

7.10 The ICT noted that there was an ongoing need for further research to develop improved tools for severe weather prediction (e.g. diagnostics to aid the identification of the potential for severe convective events from global EPS fields, particularly in the Tropics). There is scope for much research in the ability of EPS to provide useful predictability for tropical phenomena such as monsoon circulations, the MJO, Easterly Waves etc. In this context, the ICT was informed that the joint SG-SWFDP – GIFS-TIGGE WG meeting agreed that developed products and tools from the GIFS-TIGGE Tropical Cyclone Ensemble Track Information should feed into the SWFDP subprojects in Southern Africa and in the South-west Pacific. However, it stressed that these products should be evaluated at the regional and national levels during the course of the demonstration phase before transitioning into full operations.

Developing Guidance for Forecasters

7.11 The ICT noted that very little guideline information had been developed for probabilistic forecasting, and that while many forecasters had developed their own methods through substantial experience, many other forecasters had little experience and were inadequately prepared to use EPS products, even in countries with very good access to these EPS products. The ICT agreed that understanding statistics and probability science should be reinforced, and that EPS training should be included in continuous learning programmes as well as in the initial training for new forecasters. The ICT was pleased to note that transfer of knowledge and skills had taken place through dedicated training events and through the SWFDP regional projects. In addition, the ICT noted that CBS had adopted the "Guidelines on using information from EPS in combination with single higher resolution NWP forecasts", which the ET-EPS had developed. The Guidelines can be found on the WMO Web site at:
http://www.wmo.int/pages/prog/www/DPFS/Documentation/Guidelines_ET-EPS2006.pdf.

7.12 The ICT noted that ET-EPS also drafted a series of notes upon which guidance on how to use EPS in their routine forecasting process could be further developed for use by trainers and forecasters. The ICT agreed that this guideline could be further developed and improved if examples are provided as part of the guideline. At the same time, the ICT recognized that further development of additional guidelines on other topics would be very useful to many forecasters, as EPS products are being introduced into forecasting centres. The ICT agreed that EPS-related guidelines would be beneficial for general forecasting, severe weather forecasting, development of EPS post-processing, and on how to focus training to better support the use of EPS products. It therefore supported the work of ET-EPS in this regard, and encouraged them to continue to work on developing general guidelines. Once completed the Secretariat would make them available to all Members, and via SWFDP projects.

Verification of EPS

7.13 The ICT recalled that verification of EPS is a function of the designated Lead Centre (JMA). While noting that the number of centres providing verification data to the site had improved in the last few months (including now: JMA, ECMWF, CMA, KMA and CPTEC), the ICT noted that a number of global centres were still unable to supply the required verification data, mainly due to lack of resources, and inability to calculate required parameters. The ICT noted that ET-EPS discussed possible solutions to improve the situation, including (a) adding CRPS score to the list of required verification; and (b) using the TIGGE database. The ICT noted that ECMWF was already doing this for some parameters and hopefully would be able to provide these verification data to JMA in a near future. The ICT also noted that no centre was providing precipitation verification to JMA, and that ET-EPS discussed possible alternatives to allow some comparisons of precipitation scores, such as using short-range precipitation forecasts to validate medium-range forecasts. In order to further improve the EPS verification, the ET-EPS proposed amendments to the Manual on the GDPFS, which were considered under agenda item 10.2.

Uncertainty Analysis

7.14 The ICT noted that the Presidents of Technical Commissions (PTC) had established an Inter-Commission Working Group (ICWG) on Uncertainty Analysis to establish a WMO agreed methodology for the estimation and expression of uncertainty. It also noted that the ICWG proposed a demonstration project for the estimation of uncertainties and their propagation from measurements, to data assimilation, to numerical models such as in NWP systems. Even noting that the estimation of uncertainties had been differently interpreted by meteorologist and hydrologist, the ICT enquired about the motivation of this initiative. The ICT noted that in meteorology the way of objectively estimating and calculating uncertainties had been the subject of very substantial research and development work over the last 20 years, with the introduction of ensemble prediction systems. In addition, it was noted that a structure for expressing uncertainty had been developed for the IPCC, which was also included in the development of the PWS

"Guidelines on Communicating Forecast Uncertainty" (2008, WMO/TD No.1422; http://www.wmo.int/pages/prog/amp/pwsp/documents/TD-1422.pdf). The ICT therefore expressed that more information was required on the proposed demonstration project before a suitable DPFS contribution could be defined. It agreed that its co-chair Mr Yuki Honda would continue to act as its focal point in this matter.

8. FORECAST VERIFICATION

8.1 The Chairperson of the Coordination Group on Forecasting Verification (CG-FV), Mr David Richardson (ECMWF), reported on the outcomes of the meeting of the Coordination Group (Reading, November 2009), including the status of NWP Verification, as well as progress in coordinating with and participating at the Commission for Atmospheric Sciences' Joint Working Group on Forecast Verification Research (JWGFVR) regarding surface weather verification, and the Working Group on Numerical Experimentation (WGNE) for precipitation verification. The full report is available at:
http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/documents/Doc-8-CGFV.doc.

Review of Standard Verification Procedures

8.2 The ICT noted that the CG-FV, following the request by CBS-XIV, had reviewed the existing standard for deterministic NWP verification as defined in the Manual on the GDPFS, Volume I, Part II, Attachment II.7, Table F. The ICT agreed that performing NWP without verification is inconsistent with Quality Management principles, does not provide necessary quality information to forecasters, and would result in an unreliable and unsustainable activity. The ICT further agreed that verification can act as a tool for managing changes in the operational forecasting system. The ICT noted that the CG-FV had agreed that some essential parts of the recommended actions for verification should be made mandatory, and that efficient and systematic verification systems should be run in real-time to accumulate and produce useful information, for quick availability, for use by the model developers as well as for the forecasters.

8.3 The ICT noted that the CG-FV discussed the various aspects of the verification system that required updating, including the need for clearer specifications and guidance on how to ensure a consistent implementation by all the global NWP Centres. The ICT further noted that the CG-FV recommended that the present focus should be on updating the verification of upper air fields, however CG-FV would in the future also examine the verification of surface parameters. In this context, the CG-FV developed an updated standard verification system, thereby proposed amendments to the Manual on the GDPFS, which were considered under agenda item 10.2.

8.4 While noting that the proposed updated standard verification system describes mandatory aspects for verification and that the CG-FV recommended that the updated system be included in the Manual on the GDPFS as a new Appendix, the ICT agreed that all sections related to verification (deterministic, EPS and LRF) should remain in their current location in the Manual. These sections would be relocated into a suitable location in the new structure of the revised Manual, while respecting mandatory and non-mandatory functions.

8.5 The ICT noted that to ensure consistency between results from different centres, the CG-FV recommended that a common climatology be used for those scores requiring a climatology. The ICT also noted that the ERA-interim climatology was the recommended candidate. The agreed-upon climatology would be made available for WMO Members for implementing their standard verification system.

Verification of Surface Parameters

8.6 While noting that the CG-FV recommended that the present focus should be on updating the verification of upper air fields, the ICT agreed that in the future the CG-FV should also develop procedures for verification of surface parameters. The ICT noted that the CG-FV would consider the recommendations that were forthcoming from a review of verification procedures at ECMWF, as well as seek guidance from the WWRP/WGNE Joint Working Group on Forecast Verification Research (JWGFVR).

Establishment of a Lead Centre for Deterministic NWP Verification (LC-DNV)

8.7 Following CBS' request for the establishment of a Lead Centre(s) for Deterministic NWP Verification (LC-DNV), the ICT considered under agenda item 10.2, the proposed list of functions expected for such a Lead Centre, which was developed by the CG-FV. Noting that the establishment of such a centre was discussed at the ECMWF Council, which unanimously endorsed the proposal that ECMWF offers to act as lead centre, the ICT anticipated with appreciation that the ECMWF would propose this to CBS-Ext.(10), in November 2010, with suitable supporting documentation.

9. EMERGENCY RESPONSE ACTIVITIES (ERA)

9.1 Nuclear ERA

9.1.1 The Chairperson of the Coordination Group on Nuclear Emergency Response Activities (CG-NERA), Mr René Servranckx (Canada), reported on the outcomes of the meeting of the Coordination Group (Beijing, May 2010), and progress made with respect to Nuclear ERA, including improved product distribution / access methodologies, and the implementation of the joint ATM response system with CTBTO. The full report is available at:
http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/documents/Doc-9-1-nERA.doc.

Status of Implementation

9.1.2 The ICT noted that there are presently nine designated RSMCs (Beijing, Exeter, Melbourne, Montréal, Obninsk, Offenbach, Tokyo, Toulouse and Washington) that are operationally prepared to provide specialized atmospheric dispersion model products for environmental emergency response and / or backtracking. In addition, the RTH Offenbach provides the telecommunications link for notification and information by the International Atomic Energy Agency (IAEA) Incident and Emergency Centre (IEC) to the WMO Members. The Team noted that quarterly exercises with the IAEA are performed, and annual status reports of the RSMCs and RTH Offenbach are prepared and posted on the WMO ERA programme Web pages. Noting that the WMO Secretary-General received a correspondence from Austria indicating that Austria was prepared to seek a WMO designation of its NMC Vienna to become an RSMC in Activity Specialization in Atmospheric Transport Modelling / backtracking, the ICT anticipated that Austria would propose this to CBS-Ext.(10), in November 2010, with suitable supporting documentation.

9.1.3 The ICT noted that in the Terms of Reference for the CG-NERA approved at CBS-XIV (Dubrovnik, March-April 2009), the CG-NERA was tasked to explore the operational availability of radiological monitoring data for use in RSMC operational environment. While noting that these data may be available to some NMHSs, depending on the national arrangements with their radiological monitoring authorities, the ICT recognized that the operational availability of radiological monitoring data to the RSMC network is largely very difficult to attain. It therefore recommended that NMHS should be encouraged to strengthen their contacts with radiological monitoring authorities and explore the possibility of making radiological data available to the relevant RSMCs which are providing the emergency response support during an incident.

Improved Product Distribution / Access Methods

9.1.4 The ICT noted that all RMSCs use web-based technologies to exchange information and products. Many RSMCs have the common-look-and-feel mirrored but independent password protected web pages and the transfer of standard image products. The ICT agreed that there are benefits associated with this approach that allows accessibility to the RSMC products even when one server is down. The ICT supported the recommendation by the CG-NERA that all RSMCs should, where local policy permits, implement the mirrored Web site, and FTP their RSMC products to all existing mirrored Web sites. The ICT noted that IAEA would ask the RSMCs to transmit their products by FTP transfers when its new web site, currently under development, comes online.

RSMC Products and Services for Nuclear Emergencies

9.1.5 Recalling that faxing remains the official product transmission method of RSMC products, the ICT recognized that this presents a number of important challenges as maintaining updated fax numbers and contact points is difficult and time consuming, and agreed that e-mail distribution and retrieval from Web pages of the standard products is preferred. The ICT noted that, following the recommendation by CBS-XIV, the CG-NERA had developed an implementation plan for the migration of RSMC products from fax distribution to e-mail/Internet distribution. The implementation would commence this year, and be completed in 2011. The ICT agreed with this approach, however pointed out that the fax distribution should be continued for a certain period, in particular for regions where Internet capabilities are still limited.

Review of Requirements for RSMC Products / Services

9.1.6 The ICT noted that the CG-NERA had identified a number of improvements to the existing RSMC products and therefore proposed (1) the establishment of a lower cut off limit to display results on charts for time integrated air concentrations and for total deposition; (2) the use of the same colour to display specific contour interval for a particular set of maps; and (3) the addition of two additional total accumulated deposition maps valid at 24 and 48 hours. The ICT agreed to consider these proposed amendments to the Manual on the GDPFS (WMO-No. 485) under agenda item 10.2

Cooperation between CTBTO and WMO

9.1.7 The ICT noted that the successful CTBTO-WMO collaboration of the last decade continues. Over 30 CTBTO requests (exercises and real events) had been answered by WMO Centres since the implementation of the operational backtracking system on 1 September 2008. The ICT noted that these arrangements allow the CTBTO Provisional Technical Secretariat (PTS) to request and obtain, semi-automated and in near-real-time, atmospheric transport modelling (ATM) results from WMO Centres in case of Treaty-relevant detections at radionuclide (RN) sampling stations of the International Monitoring System (IMS) to supplement its own computations. The ICT noted that discussions were underway between CTBTO and WMO to evaluate possible modifications to existing arrangements. These include new protocols for ftp transfer of the backtracking results and calculations with extended time periods and on higher resolution grids.

9.1.8 The ICT noted that in recent years, WMO Members had shown a great interest in using the meteorological data from the CTBTO International Monitoring System Radionuclide stations (IMS/RN). Data from over 50 IMS/RN stations had been transmitted by CMC on the GTS however the system does not have operational robustness and problems have been occurring from time to time. The ICT appreciated that discussions are underway with CTBTO and NMC Vienna to develop a new data transfer process that would result in a robust real-time fully supported 24/7 system to ensure timely delivery and quick resolution of problems.

Cooperation between ICAO and WMO

9.1.9 The ICT noted that enhancement procedures applicable as of 15 November 2010 (Amendment 75 to Annex 3 - Meteorological Service for International Air Navigation) had been established between the International Civil Aviation Organization (ICAO) and WMO. After an IAEA notification concerning the release of radioactive material to the atmosphere, information would be transferred to Area Control Centres (ACCs). As of the above noted date, RSMC Exeter, via London Volcanic Ash Advisory Centre (VAAC), would provide direct notification to ACCs.

9.2 Non-nuclear ERA

9.2.1 The Chairperson of the Expert Team on Applications of Atmospheric Transport Modelling (ATM) for Non-nuclear ERA (ET-nNERA), Mr Christopher Ryan (Australia), reported of the outcomes of meeting of the Expert Team (Toulouse, December 2009), as well as progress of atmospheric transport modelling technologies for use in support of environmental emergency response, working arrangements with relevant International Organizations, the ATM-backtracking experiment and plans, and development of operational procedures. The full report is available at: http://www.wmo.int/pages/prog/www/DPFS/Meetings/ICT-DPFS_Tokyo2010/documents/Doc-9-2-NNERA.doc.

ATM Ensemble Techniques

9.2.2 The ICT recalled that CBS-XIV requested consideration of the creation of a lead centre for ATM ensemble development. While recognizing that such technological developments would be relevant for ERA, the ICT noted that there is resource issues associated. In this context, the ICT noted that no member was prepared and had volunteered, at this stage, to act as a lead centre for ATM ensembles in the context of non-nuclear ERA. In addition, the ICT noted that probabilistic forecast and uncertainty information are worthwhile to be considered by the users for planning activities, but can be difficult to apply in emergency response. The ICT noted that, in the context of exchanging digital files of dispersion fields, the ET-nNERA tasked the RSMC Washington with the establishment of the format for exchange of these fields (e.g. by GRIB files), including its definition, and an agreement on exchange, collection and display.

WMO Sand and Dust Storm Warning and Advisory and Assessment System (SDS-WAS)

9.2.3 The ICT noted that the Commission for Atmospheric Sciences (CAS) developed a draft Implementation Plan for the SDS-WAS. Following the request by CBS-XIV, the OPAG on DPFS reviewed this document (for further details, see agenda item 13). In addition to the comments provided by CBS, the ICT noted that ET-nNERA provided additional comments for consideration by CAS and CBS, including the following:

- Operational implementation must respect operational requirements including product standards and deadlines expressed by users. Both the products and their delivery must be reliable and meet the established standards, as well as be subject to regular performance review (e.g. by season or annually);

- It is unclear whether the mode of production is to be that of a daily run similar to the mode of operations of air quality modelling in most centres, or that of on-demand runs based on triggering criteria with prescribed source(s), or both?

- Identifying what kinds of observations could be used as verification data sets to better define the verification system;

- Establishing a definition of sand and dust storms, including severity (light, medium, severe), and vertical extent of the phenomena, which might form the basis for triggering criteria for advisories or warnings;

- Consult with users and develop or update their specific requirements for SDS-WAS products and services from WMO Regional specializing centres, for example using another follow-up survey;

- Specify NMHS users as target for the training (see Annex IV, paragraph 6 (3) of CBS' review);

- Operational SDS-WAS product specifications should specify spatial resolution required, and number of bins in the classification of particle-size distribution;

- Address uncertainty or errors associated with the predictions;

- How and what body should monitor the production by designated regional centres, i.e., status of implementation relative to the designation criteria for a regional centre (see Annex IV, paragraph 11 of CBS' review);

- The potential of sand and dust transport modelling to improve NWP systems through interaction with the radiation physics.

Development of Operational Procedures for Non-Nuclear ERA

9.2.4 The ICT noted that the ET-nNERA decided to develop operational procedures for "significant incidents" where a NMHS could request and receive the ATM support from an RSMC or another regional centre. Guidelines for the development of operational procedures were agreed at the 2009 ET-nNERA meeting, and a demonstration experiment would be conducted first before a proposed procedure is finalized.

Backtracking Demonstration Experiments

9.2.5 The ICT noted that the ET-nNERA had coordinated an ATM-backtracking experiment by four RSMCs in 2008 with the goals of (a) demonstrating to WMO Members and relevant international organizations the new operational backtracking capabilities and products that the RSMCs can provide; and (b) exploring the concept of operations for the requesting and the provision of backtracking products and services. The ICT noted that the experiment results were not calculated in real-time, so operational procedures were not exercised. Following the encouragement by CBS-XIV, and noting that the backtracking capability was not presently appropriate for a chemical incident or non-nuclear events that are of a very local or short-fused nature, or where there are no real-time monitoring networks for the hazardous substance, the ET-nNERA planned to carry out a second demonstration experiment in the first half of 2011, with the following objectives:

- To test and develop possible operational procedures for request-reply for regional centre ATM support for a significant chemical incident;

- To demonstrate and illustrate to NMHSs the use of ATM in a significant incident for supporting decision-making;

- To demonstrate to CBS that this programme area continues to make progress;

- To examine and explore how to integrate results from a few RSMCs and to provide guidance to NMHSs.

Cooperation with Other International Organizations

9.2.6 While the potential areas of collaboration with agencies such as UN/OCHA, WHO, UNITAR/UNOSAT, etc. had been well recognized, it had proven difficult to establish practical arrangements or plans. The ICT noted that the ET-nNERA had re-defined its strategies for the establishing collaboration arrangements, including: (a) make opportunistically for example training and capacity building activities of mutual interest; (b) target discussions with specific international organizations; (c) use a case study to demonstrate the usefulness of ATM in supporting operational decisions in environmental emergency response; and (d) inform other international organizations of the plans for the second demonstration experiment. In addition, the ICT recalled the establishment of the Inter-Commission Task Team (ICTT) on Meteorological Support for Humanitarian Agencies, which could constitute an opportunity for further interaction with other international organizations in this field. Progress had been made in developing cooperation with ICAO, with the participation of an ICAO observer in the 2009 ET-nNERA meeting.

10. GDPFS

10.1 Status and evolution of the GDPFS, including annual reporting process

10.1.1 The Secretariat briefed the meeting on the functions and status of implementation of the Global Data-Processing and Forecasting System (GDPFS), and the Emergency Response Activities (ERA) programmes. The Team noted that Numerical Weather Prediction (NWP) systems are now implemented at 88 centres, including 84 NMHSs worldwide with increasing resolution. This was assembled based on the information provided by WMO Members and other specialized centres (such as the ECMWF) to the Secretariat in their 2009 annual report. While noting that the "Joint WMO Technical Progress Report on the GDPFS, including NWP Research Activities" consists on an excellence source of information for WMO Members, the Team recognized the difficulties in maintaining up-to-date this information, including the summary table. In this context, the Team discussed priorities and ways to update and maintain the information for Members, including the technical documentation related to the GDPFS.

10.1.2 At the same time, the Team recognized that this annual reporting process has not been the appropriate mechanism for gathering the information from developing countries and LDCs, which is extremely useful in the context of the SWFDP, and other capacity building activities, including RCOFs. The Team noted that the WMO Regional Office carries out regularly fact-finding missions for evaluating institutional capabilities in these countries. It agreed that the reports from these missions could provide useful information and requested the Secretariat to evaluate the best possible way to include this information in the summary table.

10.1.3 The Team discussed other options to get information from Members and review the summary table, and recommended that the Regional Rapporteurs work closely with the Secretariat to keep this information up-to-date for Members. It also suggested that Regional Associations consider adding the role of getting and assembling the information at regional level in the Terms of Reference for the Regional Rapporteurs.

10.2 Review of the *Manual on the GDPFS*

Proposed amendments to the Manual on the GDPFS (WMO-No. 485)

10.2.1 The ICT noted that all expert teams and coordination groups had reviewed their relevant parts of the *Manual on the GDPFS* (WMO-No. 485) and proposed changes or revisions as appropriate. The proposed amendments to the *Manual on the GDPFS* – Volume I, which are detailed in Annex V, relate to the aspects below:

- Designation of RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part I, Appendix I-1;

- Exchange of products between centres: amendments to Part II, section 5 – this section would be incorporated into the future *Manual on the WIS*;

- Data provision by RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part II, Appendix II-7;

- Designation of Regional Climate Centres (RCCs) and RCC-Networks for climate sensitive areas that fall within the responsibilities of more than one Regional Association (e.g. Polar Regions): amendments to Part II, Appendix II-10;

- Standardized verification of deterministic NWP products: amendments to Part II, Attachment II.7, Table F;

- EPS verification requirements: amendments to Part II, Attachment II.7, Table F;

- Standardized Verification System for Long-Range Forecasting, taking into consideration the establishment of RCC and RCC-Network: amendments to Part II, Attachment II.8;

- Lead Centre for Deterministic NWP Verification (LC-DNV): Part II, new Attachment II.14.

Revised Manual on the GDPFS (WMO-No. 485)

10.2.2 The ICT agreed that there are a number of sections in the Manual on the GDPFS that were out of date and the challenges associated with the updating process. Following the request by CBS-XIV, the ICT noted that a CBS Expert Meeting on the Review of the Manual on the GDPFS was held in Geneva, in April 2010, which the major outcome was the development of an outline for a revised Manual. The ICT reviewed this document, and agreed that it would recommend to CBS-Ext.(10) that the new Manual on the GDPFS should be based on the outline found in Annex VI. Following recommendations by the expert meeting, the ICT agreed that:

- The new Manual should be based on the above-mentioned outline, and consider experiences of the SWFDP;

- Volume II of the Manual should be discontinued; however a list of products and the possibility of designation of RSMCs for the Polar Regions should be retained and incorporated in Part II of the new Manual. The ICT noted that the Executive Council Panel of Observations, Research and Services (EC-PORS) would facilitate the required information;

- A wiki should be used for the development of content of the new Manual. The ICT noted that the Secretariat had produced a first version of the new Manual with the existing content that will be retained, using a wiki (see http://www.wmo.int/pages/prog/www/WIS/wiswiki/tiki-index.php?page=DPFS_Manual). The ICT encouraged its members to initiate the process of updating their parts of the Manual as soon as they get access to the wiki pages. It also requested its members to identify the relevant experts to work on the review process of the Manual, to whom would be provided a username and password to access to the wiki pages;

- Coordination with other WMO programmes, primary WIGOS and WIS, is required and noted with appreciation that the Secretariat had already initiated working with the relevant programmes to ensure that observational and data managements aspects related to the GDPFS are included in the WIGOS and WIS regulatory documentation;

- The current version of the Manual should be maintained and kept in force in parallel with the development of the new Manual until its completion, hopefully by mid-2012;

- The new Manual would be developed in accordance with quality management principles, which would ensure its sustainability as part of the WMO Quality Management Framework.

11. REGIONAL PERSPECTIVE ON NWP/EPS SYSTEMS, PRODUCTS AND INFRASTRUCTURE

11.1 The six Regional Rapporteurs on DPFS, each of whom have been appointed by their respective Regional Associations (RAs), reported on the status of implementation and activities related to NWP and weather forecasting infrastructure in their respective Regions. The ICT agreed that these rapporteurs could assist the Secretariat in gathering and confirming information on the status of implementation of the respective RAs' NWP systems at NMHSs.

11.2 The following points related to the implementation of GDPFS were noted:

- Significant progress was made in all RAs in relation to the implementation of the GDPFS, both in terms of the increased number of countries running global and/or LAM models, as well as in relation to improvements of these models (e.g. resolution, ensemble size, length of integration and frequency of forecast cycle, etc.);

- While the SWFDP is emphasizing a Cascading Forecasting Process to benefit NMHSs of developing countries and LDCs, wherein the emphasis is on improving access to, and making better use of products from existing NWP/EPS systems, there was a steady increase in the number of LAMs implemented in these NMHSs;

- Capacity building and training remained critical for all RAs. Training opportunities for weather forecasting and NWP systems and products needed to be better known and coordinated, as well as the WMO Regional Training Centres (RTCs) needed to be the revitalized in these subject areas. In this context, and in order to meet the regional needs, the syllabus of training courses on NWP should to be updated, resource persons/lecturers should be identified within each RA, and training materials should be developed in different languages. Centres involved on NWP training activities (e.g. ECMWF, Environment Canada, Météo-France, DWD, etc.) could make their syllabus available to help revitalizing the RTCs;

- Regional NWP verification is an important activity that is integral to NWP operations, and needs careful implementation. New focus on the assessment of performance of high resolution models and the prediction of severe or high impact weather (e.g. precipitation) require suitable datasets and new methods;

- Feedback should be considered as an important part of improvement and quality assurance of NWP products provided by all GDPFS centres.

11.3 The ICT agreed that the regional reports should also include reference to LRF activities within their regions.

12. FUTURE WORK PROGRAMME, INCLUDING STRATEGIC DIRECTION, STRUCTURE, TERMS OF REFERENCE, ETC.

12.1 The ICT reviewed the structure of the OPAG on DPFS, including its coordination groups, expert teams and rapporteurs, and their respective Terms of Reference (ToRs), to reflect priorities and progress achieved. The ICT concluded that it would recommend to CBS-Ext.(10) to keep the current structure for the OPAG on DPFS, as well as the ToRs of its coordination groups, expert teams and rapporteurs, except the ToRs for the Expert Team on Extended- and Long-Range Forecasting (ET-ELRF), which would consider the recent development of the GFCS. The proposed structure and recommended ToRs are given in Annex VII.

12.2 The ICT discussed a strategic direction for undertaking the activities in the future work programme for the OPAG on DPFS, taking into account the WMO priority areas, and developed a proposal which is found in Annex VIII.

13. ANY OTHER BUSINESS (AOB)

WMO Sand and Dust Storm Warning and Advisory and Assessment System (SDS-WAS)

13.1 In addition to the discussions under agenda item 9.2, the ICT noted that the WMO Executive Council, at its sixtieth session (EC-LX, June 2008), welcomed the establishment of two SDS-WAS regional centres, one in Asia and another in Europe/North Central Africa/ Middle East, and requested CBS to develop to work with the Commission for Atmospheric Sciences (CAS) in developing operational procedures and functions for those centres. Following the request by CBS-XIV, the OPAG on DPFS reviewed the draft Implementation Plan for the SDS-WAS, developed by CAS, which is detailed in Annex IV (see also item 9.2).

13.2 Following its proposal, the ICT noted that a small ad hoc CAS-CBS task team was established, and that Mr Chris Ryan (Australia, chairperson of the ET-nNERA) and Mr Yuki Honda (Japan, co-chairperson of the OPAG on the GDPFS) would act in the task team on behalf of the OPAG. Representatives from CAS would be Mr Schultz (Norway) and Prof Soon-Ung Park (Republic of Korea), as chairpersons of the Regional Steering Groups for the SDS-WAS. Noting that the draft Implementation Plan for the SDS-WAS was research-oriented, the ICT expressed some concerns regarding way forward on the development of the operational component of the SDS-WAS and therefore requested the OPAG's representatives in the above-mentioned task team to ensure that these operational aspects are developed in accordance with the GDPFS purpose and principles.

Other Business

13.3 No other issues were considered under this agenda item.

14. CLOSING

14.1 The Meeting of the CBS Implementation Coordination Team of the Open Programme Area Group (OPAG) on Data-Processing and Forecasting Systems (ICT-DPFS) closed at 14.05 on Friday, 17 September 2010.

Annex I

AGENDA

1. **OPENING**

2. **ORGANIZATION OF THE MEETING**
   2.1 Adoption of the agenda
   2.2 Working arrangements

3. **INTRODUCTION AND BACKGROUND / REVIEW OF DECISIONS OF THE WMO GOVERNING BODIES AND STATEMENTS ADOPTED BY CBS RELATED TO THE OPAG on DPFS**

4. **SEVERE WEATHER FORECASTING**

5. **VERY SHORT-RANGE FORECASTING**

6. **EXTENDED- AND LONG-RANGE FORECASTING**

7. **PROBABILISTIC FORECASTING AND ENSEMBLE PREDICTION SYSTEMS, AND APPLICATIONS**

8. **FORECAST VERIFICATION**

9. **EMERGENCY RESPONSE ACTIVITIES (ERA)**
   9.1 Nuclear ERA
   9.2 Non-nuclear ERA

10. **GDPFS**
    10.1 Status and evolution of the GDPFS, including annual reporting process
    10.2 Review of the Manual on the GDPFS

11. **REGIONAL PERSPECTIVE ON NWP/EPS SYSTEMS, PRODUCTS AND INFRASTRUCTURE**

12. **FUTURE WORK PROGRAMME, INCLUDING STRATEGIC DIRECTION, STRUCTURE, TERMS OF REFERENCE, ETC.**

13. **ANY OTHER BUSINESS (AOB)**

14. **CLOSING**

LIST OF PARTICIPANTS

Mr Bernard **STRAUSS** ***Chairperson, ICT-DPFS*** Météo-France 42, avenue Gaspard Coriolis 31057 TOULOUSE Cédex 1 **France**	Tel: +(33 5) 6769 8703 Fax: +(33 5) 6769 8709 Email: bernard.strauss@meteo.fr
Mr Bachir **HAMADACHE** ***RA I Rapporteur*** Office Nationale de la Météorologie Avenue Khemisti B.P. 153, Dar El Beida ALGER **Algeria**	Tel: +(213) 21 50 89 53 Fax: +(213) 21 50 88 49 Email: b.hamadache@meteo.dz
Mr Chris **RYAN** ***Chairperson, ET-nNERA*** ***RA V Rapporteur*** Bureau of Meteorology G.P.O. Box 1289 MELBOURNE, VIC 3001 **Australia**	Tel: +(61 3) 9669 4030 Fax: +(61 3) 9662 1222 Email: c.ryan@bom.gov.au
Mr André **METHOT** ***RA IV Rapporteur*** Canadian Meteorological Centre (CMC) Meteorological Service of Canada Environment Canada 2121 Trans-Canada Highway DORVAL, Quebec H9P 1J3 **Canada**	Tel: +(1 514) 421 4654 Fax: +(1 514) 421 4679 Email: andre.methot@ec.gc.ca
Mr René **SERVRANCKX** ***Chairperson, CG-NERA*** Canadian Meteorological Centre (CMC) Meteorological Service of Canada Environment Canada 2121 Trans-Canada Highway DORVAL, Quebec H9P 1J3 **Canada**	Tel: +(1 514) 421 4704 Fax: +(1 514) 421 4679 Email: rene.servranckx@ec.gc.ca
Mr Laurent **PERRON** ***RA VI Rapporteur*** Météo-France 42, avenue Gaspard Coriolis 31057 TOULOUSE Cédex 1 **France**	Tel: +(33 5) 6107 8210 Fax: +(33 5) 6107 8209 Email: laurent.perron@meteo.fr
Mr Yuki **HONDA** ***Co-chairperson, ICT-DPFS*** ***RA II Rapporteur***	Tel: +(81 3) 3212 8341 ext. 3305 Fax: +(81 3) 3211 8407

Japan Meteorological Agency 1-3-4, Otemachi Chiyoda-ku TOKYO 100-8122 **Japan**	Email: honda.yuuki@met.kishou.go.jp
Ing David Alfredo **MONCADA SERQUEN** ***RA III Rapporteur*** Meteorological and Hydrological National Service of Peru General Office of Statistics and Computing Jiron Cahuide 785 Jesus Maria LIMA **Peru**	Tel: +(511) 614 1414 Fax: +(511) 471 7287 Email: dmoncada@senamhi.gob.pe
Mr Ken **MYLNE** ***Chairperson, ET-EPS*** Met Office FitzRoy Road EX1 3PB EXETER **United Kingdom of Great Britain and Northern Ireland**	Tel: +(44 1392) 886 070 Fax: +(44 1392) 885 681 Email: ken.mylne@metoffice.gov.uk
Dr David **RICHARDSON** ***Chairperson, CG-FV*** ECMWF Shinfield Park READING, RG2 9AX **United Kingdom of Great Britain and Northern Ireland**	Tel: +(44 118) 949 9420 Fax: +(44 118) 986 9450 Email: david.richardson@ecmwf.int
Mr Richard **GRAHAM** ***Chairperson, ET-ELRF*** Met Office FitzRoy Road EX1 3PB EXETER **United Kingdom of Great Britain and Northern Ireland**	Tel: +(44 132) 886 361 Fax: +(44 132) 885 681 Email: richard.graham@metoffice.gov.uk
WMO Secretariat 7 bis avenue de la Paix Case postale 2300 1211 GENEVE 2 *Switzerland*	**WWW website** www.wmo.int/web/www/www.html
Mrs Alice **SOARES**	Tel: +(41 22) 730 8449 Fax: +(41 22) 730 8021 Email: asoares@wmo.int
Mr Peter **CHEN**	Tel: +(41 22) 730 8231 Fax: +(41 22) 730 8021 Email: pchen@wmo.int

Annex III

DRAFT STRATEGY FOR THE SWFDP

Background

The SWFDP was originally designed in 2004. The two main ideas driving the project are still valid today:

- ensure that valuable forecast information readily available in the WWW regarding severe weather occurrence was effectively used in operations by developing countries, and

- develop the potential of the 3-layer structure of the GDPFS, with the so-called Cascading Forecasting Process.

Initially the goals set for the SWFDP were:

- improve severe weather forecasting,
- improve lead-time of warnings,
- improve interaction of NMHSs with media and with disaster management and civil protection authorities,

and also:

- improve the skill of products from GDPFS Centres through the provision of feedback.

They were encompassed in the WMO "Vision of Improved Severe Weather Forecasting in Developing Countries" which was stated by Cg-XV in 2007:

> *"NMHSs in developing countries are able to implement and maintain reliable and effective routine forecasting and severe weather warning programmes through enhanced use of NWP products and delivery of timely and authoritative forecasts and early warnings, thereby contributing to reducing the risk of disasters from natural hazards."* (Cg-15, 2007)

The SWFDP contributes directly to two of WMO's highest priorities as recommended by EC-LXII (2010), i.e., capacity building and disaster risk reduction.

It is widely recognized that the development of the SWFDP so far has been highly successful. Two regional subprojects have been implemented, in 2006 in Regional Association I and in 2009 in Regional Association V, and the first one is now reaching a stage where transition to full operational status can be envisaged. These two projects have been a significant step forward in the direction of the stated goals of the project; furthermore, they have demonstrated that within the SWFDP framework a tremendous contribution to transfer from R&D to Operations can be achieved.

It is worth analyzing the reasons of the success of the SWFDP so far. One of them is that an efficient management framework has been put in place: each subproject has been managed at the right level, namely in this case the regional level, with appropriate guidance from the project Steering Group, and with considerable and highly efficient support from the WMO Secretariat. Good project management practices have been encouraged, including the setting up of a continuous improvement cycle, with regular reporting and evaluation of progress and objective identification of technical gaps

A second reason for success is technical, in that the initial choice to develop and build upon a 3-layer cascading process has proven to be a good one, perfectly well in line with today's operational meteorology.

At this point it should be strongly underlined that the most critical condition for success has been the engagement of high quality and efficient leading centres at the regional level. The role and functions of these centres as focal point and central hub for all information exchange between the various global, regional and national partners have been essential, including the production of coordinated forecast guidance. The experience acquired with the SWFDP will actually be used to redefine the role of a regional centre.

Another important aspect explaining the positive outcome of the SWFDP is that it is highly cost-effective. The budget of the project has been rather on the frugal side, and even taking into account the substantial in-kind contributions of the global and regional centres involved, the overall total cost is much less than what is generally expected for this type of project resulting in this level of outcome.

One can recall that the expectations regarding the SWFDP were very high almost from the start, to a point that a failure to achieve the goals would have been rather disappointing. This is so because some of today's main challenges were at stake, namely, the potential for disaster risk reduction and for capacity building in the actual meteorological world. The SWFDP concept was tailored to contribute to meet these challenges in an efficient cost-effective way, and it is very satisfactory that its validity could be demonstrated in a rather short period of time.

Future

EC-LXII gave various directions regarding the SWFDP's further development. The goals of the project should be updated as follows.

- The main target should still be to contribute to DRR and to capacity building;
- Therefore improving severe weather forecasts, including accuracy and lead time, should remain a priority area,
- and so is the case for improving severe weather warning services, including accuracy and lead time, according to identified user needs. This implies also to further develop the use of probabilistic information, and to continue the effort to enhance the feedback loop with end-users.
- Other applications should be targeted as well, progressively extending the scope to include, e.g., Marine, Agriculture, and Hydrology. Aviation should also be considered.
- Finally, special attention should be given to ensuring sustainability, after appropriate conclusion of a demonstration phase.

To work towards these updated goals some extensions to the existing project mechanism are required.

1. On the technical side:

   - Increased use should be made of high resolution NWP (as it becomes available) and of ensemble products. The SWFDP framework has been identified as highly suitable for the evaluation of products developed by GIFS-TIGGE, this should be actively pursued.

   - Nowcasting and very short-range forecasting tools should be introduced into the projects, including satellite-based products.

   - A special effort on training should continue to be made, and even be further developed, focused on the needs of the individual subprojects. Relevant local case studies should be used. It should be noted that, among many other benefits, this would help to enhance the feedback loop with the users at the national level, which is one the relative weaknesses identified up to now.

2. Regarding DRR developments:

- Explore new or enhanced formulation of warnings, including the use of uncertainty estimations;

- Extend the range of warning services, in particular, establish continuous interactions with disaster management organizations

- Again further effort on training is required, with the same comment on the need to enhance the provision of feedback

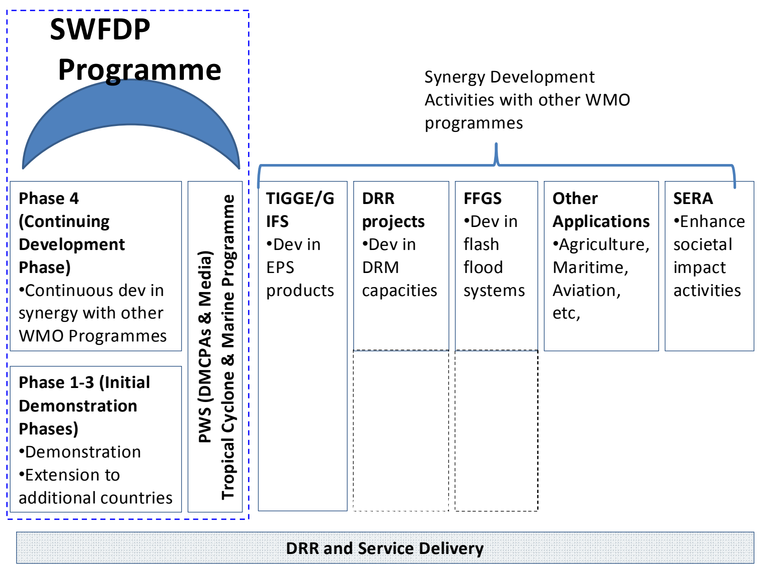
3. Developments for other applications

The range of targeted applications should be progressively extended, resources permitting, in synergy with other WMO programmes (e.g. tropical cyclones etc.) according to local needs and priorities without distracting from central focus on severe weather.

4. Sustainability:

The project Steering Group recommended the introduction of a "Phase 4" concept in the Overall Project Plan, namely, a transition phase of matured regional projects into a fully operational activity. Ongoing training will be needed, which should take place on an annual basis and should become sustainable within the Regions.

During this phase 4 the management of the activity should be transferred to the normal operational management structure within the Regional Association. The overall structure of the extended SWFDP concept is illustrated by the diagram below.



5. Funding:

Substantial in-kind contributions from participating global and regional centres are expected to continue, as will the regular budget allocations from relevant programmes and VCP for project management, initial training and workshops. However, these are far from being sufficient to support the coming phases of the SWFDP, and anticipated development of new projects, as the difficulties already experienced in the previous phase abundantly demonstrate. Additional funding is critical to sustain the necessary enhancement to the training effort. Support to correct critical deficiencies in technical capacities at some participating NMHs will also be required.

Extrabudgetary funding should be sought from those sources that have shown interest in investing in developing NMHS of developing countries for disaster risk reduction goals. To achieve this, WMO needs to invest in promoting the SWFDP and its successes via coordinated resource mobilization mechanisms at international and regional levels.

Finally, two important milestones are suggested for the continuation of the project. The first one would mark the introduction of at least one project in every RA, and this could happen before the end of 2013. The second one would correspond to the transition to operations (phase 4) of again at least one project in every RA, and this could be reached by the time of or soon after Congress-XVII in 2015.

CBS REVIEW OF THE DRAFT SDS-WAS IMPLEMENTATION PLAN
(CBS OPAG-DPFS)

The GDPFS

1. The purpose of the GDPFS (Global Data Processing and Forecasting System) is to generate and make available to WMO Members a set of analysis and forecast products produced by numerical weather prediction modelling systems, and related information about the current and future state of the atmosphere. These products range from numerical guidance for forecasters to the actual forecasts for the general public, as well as specialized products for various applications and customers of different socio-economic sectors. The main clients of the GDPFS are NMHSs who in turn serve many and various users beyond the meteorological community.

2. The features of the GDPFS are specified in the Manual on the GDPFS ("Manual", WMO-No. 485); the Manual is intended to facilitate cooperation among Members, to specify obligations of Members in the implementation of the system, and to ensure adequate standardization in the good practices and procedures of the forecasting and data processing functions of all Members, and for relevant international organizations.

Organization of the GDPFS

3. The GDPFS consists of various types of Centres which have accepted operational responsibilities, at the global, regional or national levels, for general purpose or for specialized activities corresponding to the various Programmes carried out by WMO or jointly with relevant international organizations. The operational activities of the Sand and Dust Storm Warning and Advisory (SDS-WAS) will constitute a new specialization within the GDPFS.

SDS-WAS Regional Centre as GDPFS Specific Centre

4. Considering the proposed structure of the SDS-WAS and the functions of its components, the SDS-WAS Regional Centres (SDS-WAS RC) will be qualified as GDPFS Centres with specialization in SDS-WAS activities. This means that the operational functions and responsibilities required from the SDS-WAS RCs will be specified in the Manual on the GDPFS. When a SDS-WAS regional node contains centres other than the Regional Centre performing operational functions, then these should be referred to as well in the Manual.

Geographical Area of Responsibility of SDS-WAS RC

5. The SDS-WAS RC and its partners (operational centres / universities / research institutes etc.) are the possible components of a regional node. The geographical area covered by each node (e.g. extent of the SDS impacted region, or the participating countries) will need to be defined and specified in the Manual.

Mandatory Functions of SDS-WAS RC

6. As with any other type of GDPFS centre, the mandatory functions to be performed by the SDS-WAS RCs will need to be specified in the Manual. Typically, the mandatory functions are operational activities, products and services, and training, such as:

(1) operational products / activities
   - (a) generation of mandatory SDS products : observation, analysis and forecast
   - (b) interpretation and assessment of mandatory SDS products
   - (c) generation of warning advisories based on mandatory SDS products
   - (d) verification and evaluation of mandatory SDS products

(2) operational services
   - (a) dissemination of SDS products and warning advisories through the WMO Information System (WIS) and on the Internet to partners/users
   - (b) dissemination of the verification of SDS products
   - (c) ongoing technical support (maintenance)

(3) technical information and training in the use of SDS products and services
   - (a) provision of the information on methodologies and product specifications of mandatory

SDS products
(b) provision of guidance on their use
(c) organising training

It should be noted that research activities, while absolutely necessary for the development of the SDS-WAS, do not fall within the scope of the GDPFS as such and are not covered in the Manual.

7. Considering the roles of SDS-WAS RC and partners within a regional node, a SDS-WAS RC does not need to generate all mandatory SDS products by itself. A SDS-WAS RC, however, takes the operational responsibility for delivering the mandatory SDS products and services produced by its partners.

Specifications of the Mandatory SDS-WAS Products

8. The mandatory SDS-WAS products are the minimum dataset that the SDS-WAS RC is committed to produce and maintain operationally. Information such as forecast elements, forecast time, forecast frequency and other basic specifications of the SDS-WAS products will need to be listed in the Manual.

Verification Method

9. A standard verification method needs to be agreed to assess the mandatory SDS-WAS products and services. This method will be briefly described in the Manual.

Regional Characteristics of SDS-WAS RC

10. Minimum global criteria for the designation of SDS-WAS RC should be established and included in the Manual. At the same time region-specific characteristics of SDS products, services and organization, may also be included as regional criteria for each SDS-WAS RC

Monitoring of SDS-WAS RC activities

11. The SDS-WAS Steering Committee (SDS-WAS SC) is responsible for monitoring the operational activities of all SDS-WAS RCs, and to report to CBS accordingly. Problems of an operational nature, especially those of an urgent nature should be resolved within the structure of the regional nodes.

Way forward for the preparation of the necessary reference documentation

12. To prepare an amendment to the Manual covering the various aspects of the SDS-WAS as part of the GDPFS, collaborative work between suitable experts of CAS and CBS is required. Therefore it is proposed to establish a small ad-hoc joint task team with representatives from the CBS OPAG-DPFS, and suggested to include representation from CAS such as from the declared SDS-WAS RC(s), in order to prepare for the next session of CBS.

13 Oct 2009

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO LONG-RANGE FORECASTS, VOLUME I, (WMO-No. 485)

(Updates to the Manual on Global Data Processing and Forecasting System are in shaded text and deleted parts are crossed out)

The proposed amendments to the Manual on the GDPFS, Volume I, relate to the aspects below:

- Designation of RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part I, Appendix I-1;
- Exchange of products between centres: amendments to Part II, section 5 (this section would be moved in a near future to the Manual on WIS (WMO-No. 1060), Volume I, section 6.2 on Data Exchange in support of GDPFS);
- Data provision by RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part II, Appendix II-7;
- Designation of Regional Climate Centres (RCCs) and RCC-Networks for climate sensitive areas that fall within the responsibilities of more than one Regional Association (e.g. Polar Regions): amendments to Part II, Appendix II-10;
- Standardized verification of deterministic NWP products: amendments to Part II, Attachment II.7, Table F;
- EPS verification requirements: amendments to Part II, Attachment II.7, Table F;
- Standardized Verification System for Long-Range Forecasting, taking into consideration the establishment of RCC and RCC-Network: amendments to Part II, Attachment II.8;
- Lead Centre for Deterministic NWP Verification (LC-DNV): Part II, new Attachment II.14.

Part I: Appendix I-1, section 3 (The RSMCs with activity specialization are the following:), add "RSMC Vienna (backtracking only)" to the list of RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking), as follows:

3. The RSMCs with activity specialization are the following:

[…]

Provision of atmospheric transport modelling (for environmental emergency response and/or backtracking)

RSMC Beijing
RSMC Exeter
RSMC Melbourne
RSMC Montreal
RSMC Obninsk
RSMC Offenbach (backtracking only)
RSMC Tokyo
RSMC Toulouse
RSMC Vienna (backtracking only)
RSMC Washington

Part II: section 5 (Exchange of products between centres), in paragraph 5.1 (Times of availability of products), items 5.1.1 and 5.1.2 shall be merged and amended to read: (delete NOTE)

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 timescale. Both observational and processed data shall therefore be handled rapidly by both the GDPFS and the WIS/GTS ~~(see also paragraph 2.3.2)~~. On the WIS/GTS, transmission of observational data shall have priority over the transmission of processed data.

Part II: section 5 (Exchange of products between centres), in paragraph 5.2 (Programmes of output products), shall be amended to read:

5.2.2 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 WIS/GTS operational arrangements required ~~capability of the GTS~~ to handle and distribute these products.
[…]
5.2.3 In order to avoid overloading the WIS/GTS, Members should limit requests by their NMCs for products, taking into account the following considerations:
[…]
~~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.~~

Part II: section 5 (Exchange of products between centres), in paragraph 5.3 (Transmission priorities for GDPFS products), insert new sub-paragraph 5.3.1 instead of a NOTE, and rename sub-paragraphs 5.3.1 to 5.3.11 accordingly. Paragraph 5.3 shall be amended to read:

5.3.1 Transmission priorities for GDPFS products~~NOTE: The priorities listed~~ described in this section are intended as guidance to GDPFS centres on providing observational data and output products to the WIS/GTS in the proper sequence. As regards the relay and distribution of information by WIS centres~~automated telecommunication centres~~, the provisions of the Manual on the Global Telecommunication System and the Manual on WIS apply.

5.3.2~~1~~ Transmission priorities for global and regional model products ~~from WMCs and RSMCs~~ **(merge existing sub-paragraphs 5.3.1 and 5.3.2; delete NOTE)**
5.3.2~~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~~ 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~~.

5.3.3 Transmission priorities after transmission outages on the MTN and its branches **(merge items (a) and (b), and rename them as sub-paragraph 5.3.3.1; delete NOTES (1 and (2))**
~~(a)~~ In case of WIS centre or communication link failure, WIS/GTS provisions for backup apply. After transmission outages that have disrupted the normal information exchange, 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.

5.3.4 Transmission priorities for global and regional model products ~~from WMCs and RSMCs~~ after outages **(merge existing sub-paragraphs 5.3.4 and 5.3.5; delete NOTE)**

5.3.4.1 Global and regional model products from RSMCs accumulated due to circuit communication link disruption should be transmitted with the least possible delay. 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.

5.3.56 Priority of observational data over processed data **(merge existing sub-paragraphs 5.3.6 and 5.3.7; delete existing sub-paragraphs 5.3.7.2 and 5.3.8, and NOTE)**
5.3.56.1 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, GRID and/or BUFR 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.

NOTES:
(1) Members are encouraged to transmit processed information in the GRID, GRIB and/or BUFR GRIB code forms.
(2) A minimum list for transmission of products in binary, alphanumeric and pictorial form is given in Attachment II.6.
(23) As Members develop the capability at their RSMCs centres for transforming these products from GRID, GRIB and/or BUFR GRIB to pictorial form, the pictorial transmission will be discontinued, where appropriate.

5.3.79 Procedures and formats for the exchange of monitoring results
[…]

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

5.3.810.1 The designated RSMCs with activity specialization in the provision of international services for atmospheric transport modelling in radiological environmental emergency response shall implement agreed standard procedures and products. NOTE: Standards in the provision of international services by RSMCs for atmospheric transport modelling, for radiological environmental emergency response are, given in Appendix II-7.

5.3.911 Standards in the provision of international services by Regional Specialized Meteorological Centres (RSMCs) for atmospheric transport modelling in backtracking

5.3.911.1 The designated RSMCs with activity specialization in the provision of international services for atmospheric transport modelling in backtracking shall implement agreed standard procedures and products. NOTE: Standards in the provision of international services by RSMCs for CTBT Verification support are given in Manual on GDPFS, Appendix II-9.

Part II: section 5 (Exchange of products between centres), delete paragraph 5.4 (Responsibilities of Members for providing information on their real-time data-processing activities)

Part II: Appendix II-7, section 2 (Basic set of products) shall be amended to read:
2. Basic set of products
Five Seven 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 each of the three forecast periods ~~the dispersion model forecast~~.

Part II: Appendix II-7, section 5 (General rules for displaying results), paragraph 4 (Specific guidelines for concentration and deposition maps:), item (a) shall be amended to read:

5. General rules for displaying results

[…]

Specific guidelines for concentration and deposition maps:

(a) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10 with minimum values not less than 10^{-20} Bq s m^{-3} for time-integrated airborne concentrations and not less than 10^{-20} Bq m^{-2} for total deposition;

Part II: Appendix II-7, section 5 (General rules for displaying results), paragraph 4 (Specific guidelines for concentration and deposition maps:), insert new items (b) and (c) after item (a), and rename existing items (b) to (f) as items (d) to (h). The new paragraphs shall read as follows:

(b) For a particular set of time-integrated airborne concentrations maps, use the same colour for a specific contour interval. Therefore additional colours will be used on consecutive maps (e.g. t+48 hours and t+72 hours) as different concentration values become applicable;

(c) For a particular set of total deposition maps, use the same colour for a specific contour interval. Therefore additional colours will be used on consecutive maps (e.g. t+48 hours and t+72 hours) as different total deposition values become applicable;

Part II: Appendix II-10 (Designation and mandatory functions of Regional Climate Centres (RCCs) and RCC-Networks), insert a new paragraph after paragraph 1, and rename paragraphs 2 and 3 as paragraphs 3 and 4. The new paragraph shall read as follows:

2. WMO RCCs or WMO RCC-Networks might be established, by request of the Regional Associations concerned, for climate-sensitive areas that fall within the responsibilities of more than one Regional Association (e.g. Polar Regions).

Part II: Attachment II.7, Table F, sections I (Verification Against Analysis) and II (Verification Against Observations) shall be replaced by a single new section I (Standardized Verification of Deterministic NWP Products); and rename section III (Standard Verification Measures of EPS) as section II. The new section I shall read as follows:

I – STANDARDIZED VERIFICATION OF DETERMINISTIC NWP PRODUCTS

1. Introduction

This section presents detailed procedures for the production and exchange of a standard set of verification scores for deterministic NWP forecasts produced by GDPFS centres. The goal is to provide consistent verification information on the NWP products of GDPFS participating centres for forecasters in the NMHSs and to help the GDPFS Centres compare and improve their forecasts. Scores will be exchanged between the participating producing centres via the Lead Centre for DNV. The Lead Centre functions, as described in Attachment II.14, include creating and maintaining a website for Deterministic NWP verification information, so that potential users will benefit from a consistent presentation of the results.

The term “deterministic NWP” refers to single integrations of NWP models providing products defining single future states of the atmosphere (as distinct from ensemble prediction systems where multiple integrations provide a range of future states).

The standardized verification should provide key relevant information appropriate to the state-of-the-art in NWP, while being as simple and as easy to implement as possible, and ensuring a consistent implementation across participating centres, in particular in the interpolation to verification grid, and use of a common climatology and set of observations.

2. Verification statistics

The following subsections define two sets of verification statistics. A minimum mandatory set shall be provided by all participating centres. A set of additional recommended statistics is also defined which all centres should provide if possible. The current specifications are for the verification of upper-air fields. The specifications will be expanded as recommended procedures for surface parameters are developed and in response to changing user requirements. The detailed procedures are required to ensure it is possible to compare results from the different participating centres in a scientifically valid manner.

3. Parameters

Extra-tropics

Mandatory

- Mean sea-level pressure
- Geopotential height at 850, 500 and 250 hPa
- Temperature at 850, 500 and 250 hPa
- Wind at 850, 500 and 250 hPa

Additional recommended

- Geopotential height, temperature, wind at 100 hPa
- Relative humidity at 700 hPa

Tropics

Mandatory

- Geopotential height at 850 and 250 hPa
- Temperature at 850 and 250 hPa
- Wind at 850 and 250 hPa

Additional recommended

- Relative humidity at 700 hPa

4. Forecast times

Scores shall be computed daily for forecasts initialised at 00 UTC and 12 UTC separately. For those centres not running forecasts from either 00 UTC or 12 UTC, scores may be provided for forecasts initiated at other times and must be labelled as such.

5. Forecast steps

Mandatory: forecast steps 24h, 48h, 72h, … 240h or end of forecast
Additional recommended: 12-hourly throughout forecast (12h, 24h, 36h, …)

6. Verification against analyses

6.1 Grid and interpolation

All parameters shall be verified against the centre’s own analysis on a regular 1.5° x 1.5° grid.

In selecting the verification grid, consideration has been given to the variety of resolutions of current global NWP models, the resolved scales of models (several grid-lengths), the resolution of the available climatologies, the potential to monitor long-term trends in performance (including earlier, lower resolution forecasts) and computational efficiency.

Interpolation of higher resolution model fields to the verification grid shall be performed to retain features at the scale of the verification grid but not to introduce any additional smoothing. The following procedures shall be used:

- Spectral fields: truncate to equivalent spectral resolution (T120) for verification grid
- Grid point fields: use area-weighting to interpolate to verification grid

For scores requiring a climatology the climatology is made available via the LC-DNV website on the verification grid and needs no further interpolation.

6.2 Areas

Northern hemisphere extra-tropics	90°N - 20°N, inclusive, all longitudes
Southern hemisphere extra-tropics	90°S - 20°S, inclusive, all longitudes
Tropics	20°N - 20°S, inclusive, all longitudes
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

7. Verification against observations

7.1 Observations

All parameters shall be verified against a common set of radiosondes. The list of radiosonde observations for each area is updated annually by the CBS Lead Centre for radiosonde monitoring. The chosen stations’ data must be available to all the centres and be of sufficient quality on a regular basis. Consultation with all centres (usually by electronic mail) is desirable before establishing the final list. The current list is available via the website of the LC-DNV. The LC-DNV will contact all participating centres when the new list is available and inform them of the date from which the new list shall be used.

The observations used for verification shall 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 verification statistics.

7.2 Interpolation

Verification shall be made using the nearest native model grid point to the observation location.

7.3 Areas

The seven networks used in verification against radiosondes consist of radiosonde stations located in the following geographical areas:

Northern hemisphere extra-tropics	90°N - 20°N, inclusive, all longitudes
Southern hemisphere extra-tropics	90°S - 20°S, inclusive, all longitudes
Tropics	20°N - 20°S, inclusive, all longitudes
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

The list of radiosonde stations to be used for each area is updated annually by the CBS Lead Centre for radiosonde monitoring (see subsection 7.1)

8. Scores

The following scores are to be calculated for all parameters against both analysis and observation.

Wind

Mandatory:

- rms vector wind error

Other parameters:

Mandatory

- Mean error
- Root mean square (rms) error
- Correlation coefficient between forecast and analysis anomalies (not required for obs)
- S1 score (for MSLP only)

Additional recommended

- mean absolute error
- rms forecast and analysis anomalies
- standard deviation of forecast and analysis fields

8.1 Score definitions

The following definitions should be used

Mean error $$M = \sum_{i=1}^{n} w_i (x_f - x_v)_i$$

Root mean square (rms) error $$rms = \sum_{i=1}^{n} w_i (x_f - x_v)_i^2$$

Correlation coefficient between forecast and analysis anomalies

$$r = \frac{\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i (x_v - x_c - M_{v,c})_i}{\left(\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i^2\right)^{1/2} \left(\sum_{i=1}^{n} w_i (x_v - x_c - M_{v,c})_i^2\right)^{1/2}}$$

rms vector wind error $$rms = \sum_{i=1}^{n} w_i (\vec{V}_f - \vec{V}_v)_i^2$$

Mean absolute error $$MAE = \sum_{i=1}^{n} w_i \left| x_f - x_v \right|_i$$

rms anomaly $rmsa = \sum_{i=1}^{n} w_i (x - x_c)_i^2$

standard deviation of field $sd = \sum_{i=1}^{n} w_i (x - M_x)_i^2$ where $M_x = \sum_{i=1}^{n} w_i x_i$

S1 score $S_1 = 100 \frac{\sum_{i=1}^{n} w_i (e_g)_i}{\sum_{i=1}^{n} w_i (G_L)_i}$

Where:

x_f = the forecast value of the parameter in question

x_v = the corresponding verifying value

x_c = the climatological value of the parameter

n = the number of grid points or observations in the verification area

$M_{f,c}$ = the mean value over the verification area of the forecast anomalies from climate

$M_{v,c}$ = the mean value over the verification area of the analysed anomalies from climate

$\vec{V}_f$ = the forecast wind vector

e_g = $\left\{ \left| \frac{\partial}{\partial x}\left(x_f - x_v\right) \right| + \left| \frac{\partial}{\partial y}\left(x_f - x_v\right) \right| \right\}$

G_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 computed on the verification grid.

The weights w_i applied at each grid point or observation location are defined as

Verification against analyses: $w_i = \cos\phi_i$, cosine of latitude at grid point i

Verification against observations: $w_i = 1/n$, all observations have equal weight

9. Exchange of scores

Each centre shall provide scores monthly to the LC-DNV. Details of the procedure and the required format for the data are provided on the website of the LC-DNV. All scores (daily or 12-hourly) for all forecasts verifying within a month shall be provided as soon as possible after the end of that month.

10. Climatology

To ensure consistency between results from different centres a common climatology shall be used for those scores requiring a climatology. All centres shall use the climatology provided via the LC-DNV website.

A daily climatology of upper-air parameters are available for both 00 UTC and 12 UTC. This provides an up-to-date estimate of climate characteristics for each day of the year, including climate mean, standard deviation and selected quantiles of the climate distribution. These latter statistics are required for the CBS standardized verification of EPS forecasts.

The data is made available in Grib format. Information on access to the data and further documentation are provided on the LC-DNV website.

11. Monthly and annual averaged scores

Where average scores are required over a defined period, the averaging shall be made using the following procedures:

Linear scores (mean error, mean absolute error) - mean
Non-linear score should be transformed to appropriate linear measure for averaging
  mean of MSE;
  Z-transform for correlation

For a defined period, the average shall be computed over all forecasts verifying during the period. Averages shall be computed separately for forecasts initiated at 00 UTC and 12 UTC and both sets of average values provided.

Annual averages of the daily scores are included 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 areas) as well as the rms error of geopotential heights at 500 hPa (all the areas except for tropics). A table of the number of observations per month should also be part of the yearly report.

12. Confidence Intervals

Bootstrapping*. Will be done by LC-DNV if daily scores are provided.

Note*: Introduction:
Any verification score must be regarded as a sample estimate of the "true" value for an infinitely large verification dataset. There is therefore some uncertainty associated with the score's value, especially when the sample size is small or the data are not independent. Some estimate of uncertainty (i.e. confidence intervals) must be used to set bounds on the expected value of the verification score. This also helps to assess whether differences between competing forecast systems are statistically significant. Typically confidence intervals of 5% and 95% are used.

Suggested method to calculate the Confidence Intervals (CI):
Mathematical formulae are available for computing CIs for distributions which are binomial or normal. In general, most verification scores cannot be expected to satisfy these assumptions. Moreover, the verification samples are often spatially and temporally correlated, especially at longer forecast ranges. A non-parametric method such as the block bootstrap method handles spatially or temporally correlated data.
As described in Candille et al.(2007), a bootstrap technique for computing CIs involves recomputing scores numerous times after randomly extracting samples from the data set and then replacing them, again randomly, from the original data set. The correlation between forecasts on subsequent days is accounted for by extracting and replacing blocks of samples from the data set, rather than individual

samples. Based on a calculation of the autocorrelation between forecasts on subsequent days, it is concluded that blocks of 3 days may be used to calculate the 5% and 95% confidence intervals.

References:

- WMO/TD No. 1485 Recommendations for verification of QPF.
- G. Candille, C. Côté, P. L. Houtekamer, and G. Pellerin, 2007: Verification of an Ensemble Prediction System against Observations, Monthly Weather Review, Vol. 135, pp2688-2699

13. Documentation

Participating centres shall provide to the LC-DNV information on their implementation of the standardized verification system annually, shall confirm to the LC-DNV any changes to its implementation (including the annual change of station list, changes in additional statistics) and changes in their NWP model.

Part II: Attachment II.7, Table F, section III (Standard Verification Measures of EPS), renamed as section II, shall be amended to read:

[…]

Probabilities

Probabilistic scores (excluding the CRPS) are exchanged in the form of reliability tables. Details of the format of the exchange of verification data ~~reliability tables~~ are provided on the website of the Lead Centre for verification of EPS.

List of parameters

[…]

Observations for EPS verification should be based on the GCOS list of surface network (GSN). Verification of precipitation may alternatively be against a proxy analysis i.e. short range forecast from the control or high-resolution deterministic forecast, e.g. 12-36h forecast to avoid spin-up problems.

[…]

Scores

Brier Skill Score (with respect to climatology) (see definition below*)
Relative Operating Characteristic (ROC)
Relative economic value (C/L) diagrams
Reliability diagrams with frequency distribution
Continuous Rank Probability Score (CRPS)

NOTES: 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 and Forecasting System.

In the case of CRPS, centres are encouraged to submit this for both EPS and the deterministic (control and high-resolution) forecast as well - CRPS for deterministic forecast is equal to the mean absolute error.

Part II: Attachment II.8, Executive Summary shall be amended to read:

[…]

1.1 Diagnostics. The SVS includes ~~Information required incorporates~~ derived diagnostic measures and contingency tables. Estimates of the statistical significance of the scores achieved are also ~~required~~ included. 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. Levels 1 and 2 define the core SVS and are mandatory for GPCs.:

Level 1: Diagnostic measures aggregated over regions and for indices
Level 2: Diagnostic measures evaluated at individual grid-points
Level 3: Contingency tables provided for individual grid-points.

[…]

1.4 System details. Details of of the individual forecast systems employed.

1.5 Exchange of verification information and the Lead Centres for SVSLRF

~~The~~ SVSLRF verification results generated by GPCs are made available through a web site maintained by the Lead Centre. The functions of the Lead Centre for SVSLRF include creating and maintaining ~~coordinated Web sites~~ a website for the LRF verification information so that potential users would benefit from a consistent presentation of the results. The address of the web site is http://www.bom.gov.au/wmo/lrfvs/.

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 Score~~s~~ 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 by GPCs. Tabulated information at grid-point resolution is also ~~part of the core SVS~~ included but is not part of the core SVS. The tabulated information ~~will~~ may allow reconstruction of scores for user defined areas and calculation of other diagnostic measures such as economic value.

[…]

2.3 Mean Square Skill Score and decomposition. To be used in verification of deterministic forecasts. For Level 1, an overall bulk Mean Square Skill Score (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 should be provided. Additional terms relating to MSSS ~~are required as~~ form part of the Level 3 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~~ SVSLRF 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.

[…]

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.

Forecast can be made using different levels of post-processing typically no-post-processing (raw or uncalibrated), simple correction of systematic errors (calibrated, i.e. calibration of mean and of variance) and more complex correction using hindcast skill (recalibrated, e.g. Model Output Statistics or perfect prog model approaches). Most centres are currently issuing forecasts resulting from a simple calibration and so for sake of comparison on the Lead Centre web site scores for forecasts that were raw or calibrated (as specified in respective skill score section) are to be submitted. At the moment the team prefer to exclude forecast that were recalibrated, but GPCs are encouraged to apply the SVSLRF methodology and to display the results on their recalibrated forecasts on their web site. Forecast producers should conduct verification on the forecast output provided to users (e.g. on the final product after application of post-processing). GPCs should provide verification on the final GPC products (which may include post-processing) to the LC-SVSLRF. In this way forecast verification match the products which are made available by GPCs to RCC and NMHS.

3.1 Level 1: Diagrams and scores to be produced for regions

GPCs should supply Ddiagrams (e.g. ROC and reliability curves) are to be supplied in digital format as specified on the Lead Centre for SVSLRF website.

3.1.1 Atmospheric parameters. Predictions for:

T2m (Screen Temperature) anomalies with standard regions (for GPCs):
[…]

Precipitation anomalies with standard regions (for GPCs):
[…]

[…]

3.1.3 Scores to be used for deterministic forecasts

Mean Square Skill Score (MSSS) with climatology as standard reference forecast.

[…]

3.2 Level 2: Grid point data for mapping

3.2.1 Grid point verification data to be produced for each of the following variables. Verification should be provided on a 2.5°x2.5° grid.

T2m (Screen Temperature)T2m
Precipitation
SST (Sea Surface Temperature)

3.2.2 Verification parameters to be produced for deterministic verification
The necessary parameters for reconstructing the MSSS decomposition, the number of forecast/observation pairs, the MSE of the forecasts and of climatology and the MSSS are all part of the core SVS. Significance estimates for the correlation, variance, bias, MSE and MSSS terms should also be supplied.

[…]

3.4.1 Indices to be verified

Verification of Niño3.4 region SST anomalies is mandatory for GPCs. Other indices may ~~be added in due course~~ also be provided.

~~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) 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.~~

Part II: Attachment II.8, section 1 (Introduction) shall be amended to read:
The following sections present the detailed specifications for the development of a Standardised 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~~ evolve and grow as more requirements are adopted.

Part II: Attachment II.8, section 2 (Definitions), item 2.1 (Long-Range Forecasts) shall be amended to read:
[…]
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). Twelve rolling seasons are also defined e.g. MAM, AMJ, MJJ. 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 recognised that in some countries long-range forecasts are considered to be climate products.~~
This attachment is mostly concerned with the three-month or 90-day outlooks and the seasonal outlooks.

Part II: Attachment II.8, section 3 (SVS for Long-Range Forecasts) shall be amended to read:
Forecast can be made using different levels of post-processing typically no-post-processing (raw or uncalibrated), simple correction of systematic errors (calibrated, i.e. calibration of mean and of variance) and more complex correction using hindcast skill (recalibrated, e.g. Model Output Statistics or perfect ~~programme~~ prognosis approaches). Forecast producers should conduct verification on the forecast output provided to users (e.g. on the final product after application of post-processing). GPCs should provide verification on the final GPC products (which may include post-processing) to the LC-SVSLRF. ~~Most centres are currently issuing forecasts resulting from a simple calibration and so for sake of comparison on the Lead Centre web site scores for forecasts that were raw or calibrated (as specified in respective skill score section) are to be submitted. At the moment the team prefer to exclude forecast that were recalibrated, but GPCs are encouraged to apply the SVSLRF methodology and to display the results on their recalibrated forecasts on their web site.~~

3.1 Parameters to be verified
Verification of the ~~The~~ following parameters is mandatory for GPCs ~~are to be verified~~:
[…]
c) ~~Sea Surface Temperature (~~SST~~)~~ anomaly

[…]

It is recommended that three levels of verification be done (with level 1 and 2 being mandatory for GPCs):
[…]
3.1.1 Aggregated verification (level 1)
Large scale verification statistics are required in order to evaluate the overall skill of the ~~models~~ LRFs and ultimately for assessing their improvements over time. These are bulk numbers calculated by aggregating verification scores over all grid points within large regions; they will not necessarily reflect skill for any sub-region. For GPCs, ~~This~~ aggregated verification for the following ~~is performed over three~~ regions is mandatory:
[…]
3.1.2 Grid point verification (level 2)
The grid point verification is recommended for a regionalised assessment of the skill of the model. The verification latitude/longitude grid is recommended as being 2.5° by 2.5°, with origin at 0°N, 0°E. GPCs~~Verification~~ should ~~be~~ supply grid point verification ~~ied~~ to the Lead Centre for visual rendering. The formats for supplying derived verification are specified on the Lead Centre website.
[…]
3.1.3 Contingency tables (level 3)

Level 1 (mandatory for GPCs)			
Parameters (minimum for GPCs)	**Verification regions (minimum for GPCs)**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			
Level 2 (mandatory for GPCs)			
Parameters	**Verification regions**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			
Level 3			
Parameters	**Verification regions**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			

3.1.4 Summary of the ~~Core~~ SVS
The following gives a summary of parameters, validation regions and diagnostics that form the ~~core~~ SVS. The required periods, lead-times and stratification against the state of ENSO are given in section 3.2.
The number of realisations of LRF is far smaller than in the case of short term numerical weather prediction forecasts. Consequently it is essential 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 by prioritizing implementation of verification at 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.~~

In order to handle spatial forecasts, predictions for each point within the verification grid should be treated as having an 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~~ 10 or more years, for example).
Stratification of the verification data is based on forecast period, lead time and verification area. Stratification by forecast period should, for T2m and precipitation, be by 4 conventional seasons for Level 1. For Levels 2 and ~~&~~3 stratification should be on 12 rolling seasons (section 2.1) if available, otherwise 4 conventional seasons should be used. Verification results for different seasons should not be mixed. ~~Stratification by lead-time should include a minimum of two leadtimes, with lead-~~

time not greater than 4 monthsVerification should be provided for all periods and lead times for which forecasts are supplied. Forecasts with different lead times are similarly to be verified separately. Stratification according to the state of ENSO (where there are sufficient cases) should be as follows:

[…]

3.3 Verification scores

The following verification scores are to be usedThe MSSS and ROC verification skill scores are to be used.:

1) Mean Square Skill Score (MSSS)
2) Relative Operating Characteristics (ROC).

[…]

⇒ 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. For the exchange of scores via the Lead Centre web site the MSSS and its decomposition term should be calculated using the raw forecasts and preferably not the calibrated ones.

3.3.2 Contingency tables and scores for categorical deterministic forecasts

For two- or three-category deterministic forecasts the core SVSLRF includes full contingency tables, 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 may cover all should be provided for every combinations of parameters, lead times, target months or seasons, and ENSO stratification (when appropriate) at every verification point for both the forecasts and (when appropriate) damped persistence. […]

[…]

Contingency tables such as the one in Table 3 are mandatory for level 3 verification in the core SVS.

[…]

⇒ Contingency tables for deterministic categorical forecasts (such as in Table 3) form part of 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

[…]

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 Relative Operating Characteristics (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

[…]

⇒ Contingency tables for probabilistic forecasts (such as in Tables 5 and 6) form part of are mandatory for level 3 verification in the core SVS. For GPCs 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.

3.4 Hindcasts

In contrast to short- and medium-range dynamical Numerical Weather Prediction (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. The recommended period for the exchange of scores is ~~advertised~~ provided on the Lead Centre web site (http://www.bom.gov.au/wmo/lrfvs/).

[…]

⇒ Verification results over the hindcast period are mandatory for the exchange of LRF verification scores. Producing centres have to send new hindcast verification results ~~as soon as~~ when their forecast system is changed.

3.5 Real-time monitoring of forecasts

It is recommended that there be regular monitoring of the real time ~~long range forecasts~~ LRFs. 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.

Real-time monitoring of forecast performance is an activity for the GPCs rather than the ~~Lead Centre~~ LC-SVSLRF. GPCs are free to choose the format and content of real-time monitoring information.

Part II: Attachment II.8, section 4 (Verification data sets) shall be amended to read:

The same data should be used to generate both climatology and verification data sets, although the forecast issuing Centres/Institutes own analyses or reanalyses and subsequent operational analyses may be used when ~~other data are not available~~ these are locally preferred.

Many LRFs 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.

[…]

Part II: Attachment II.8, section 5 (System Details) shall be amended to read:

Information must be provided on the system being verified. This information should include (but is not restricted to):

1. Whether the forecast system is numerical, empirical or hybrid.
2. Whether the system forecasts ~~is~~ are deterministic or probabilistic
3. Model type and resolution.
4. Ensemble size (if applicable).

[…]

Part II: Attachment II.8, section 6 (Lead Centres for SVSLRF) shall be amended to read:

6. EXCHANGE OF VERIFICATION INFORMATION AND THE LEAD CENTRES FOR SVSLRF

The WMO Fourteenth Congress endorsed the designation by CBS (Ext. 02) of WMC Melbourne and the Canadian Meteorological Centre Montreal as Co-Lead Centres for verification of long-range and ~~SI forecast activities Congress~~ forecasts. The co-lead centre functions include creating and maintaining coordinated Web sites for the display of GPC LRF verification information, so that potential users would benefit from a consistent presentation of the results. The goal is to help the RCCs and NMHSs to have a tool for improving the long-range forecasts delivered to the public. Congress urged all Members to actively participate in that activity as either users or producers of LRF verification information to assure the use of the best available products.

6.1 Role of lead centre

6.1.1 Create, develop and maintain web-site (the "SVSLRF web site") to provide access to the GPC LRF verification information. The address of the web site is http://www.bom.gov.au/wmo/lrfvs/. The web-site will:

(i) Provide access to standardized software for calculating scoring information (ROC curves, areas, contingency table scores, hit rates, …).

(ii) provide consistent graphical displays of the verification results from ~~participating centres~~ GPCs through processing of digital versions of the results;

(iii) contain relevant documentation and links to the web sites of global-scale producing centres (GPCs);

[…]

In Part II, add new Attachment II.14 as follows:

ATTACHMENT II.14

FUNCTIONS OF LEAD CENTRE FOR DETERMINISTIC NWP VERIFICATION (LC-DNV)

The Lead Centre functions include creating and maintaining a website for Deterministic NWP verification information, so that potential users will benefit from a consistent presentation of the results. The goal is to provide verification information on the NWP products of GDPFS participating centres for forecasters in the NMHSs and help the GDPFS Centres improve their forecasts. Congress urged all Members to actively participate in that activity as either users or producers of Deterministic NWP verification information to assure the best use of the available products.

Note: * The "deterministic NWP" refers to single integrations of NWP models providing products defining single future states of the atmosphere (as distinct from ensemble prediction systems where multiple integrations provide a range of future states).

The purpose of the LC-DNV shall be to create, develop and maintain the website to provide access to the Deterministic NWP verification information. The choice of verification statistics, the content of the documentation, the information on interpretation and use of the verification data will be determined and revised by the CBS. The address of the website is ……………..

1. The LC-DNV shall:

a) Provide the facility for the GDPFS participating Centres to automatically deposit their verification statistics in the agreed format, and give all participating Centres access to these verification statistics

b) Maintain an archive of the verification statistics to allow the generation and display of trends in performance

c) provide specifications defining the format of the data to be sent by the GDPFS participating Centres to the LC-DNV (specification to be defined in consultation with the CG-FV)

d) Monitor the received verification statistics and consult with the relevant participating centre if data is missing or suspect

e) Provide on its website access to the standard procedures required to perform the verification

f) Provide access to standard data sets needed to perform the standard verification, including climatology and lists of observations and keep this up to date according to CBS recommendation

g) Provide on its website

- **consistent up-to-date graphical displays of the verification results from participating Centres through processing of the received statistics**
- **relevant documentation and links to the websites of GDPFS participating Centres;**
- **contact details to encourage feedback from NMHSs and other GDPFS Centres on the usefulness of the verification information**

2. The LC-DNV may also:
(a) Provide access to standardized software for calculating scoring information.

OUTLINE OF A REVISED MANUAL ON THE GDPFS

Ref.: CBS XIV parag's. 6.3.49 to 6.3.56

PART I - PURPOSE AND ORGANIZATION OF THE WMO GLOBAL DATA PROCESSING AND FORECASTING SYSTEM (GDPFS)

1. PURPOSE OF THE GDPFS

The Global Data Processing and Forecasting System is the world wide network of operational centres operated by WMO Members, delivering a wide range of products for applications related to weather, climate, water and environment. The functions, organizational structure and operations of the GDPFS are designed in accordance with Members' needs and their ability to contribute to, and benefit from, the system. A key objective is to facilitate cooperation and the exchange of information, thereby also contributing to building capacity amongst Members from developing country.

This shall be achieved through:

- Making available numerical weather prediction products (analysis and forecast, including probabilistic information) and climate modelling and prediction information
- Making available specialized products tailored for specific applications
- Ensuring that the necessary additional information is available for an appropriate use of the above. This includes non real time information such as:
    - Systems and products description and characteristics
    - Verification and monitoring results.

The GDPFS is a results-oriented structure, aimed at ensuring that scientific and technological advances made in meteorology and related fields are transferred as efficiently as possible in operational conditions for the benefit of WMO members. It provides a framework to ensure that products and services delivered within its scope meet stated requirements, agreed at the appropriate level, on operational quality and reliability.

The GDPFS makes full use of the latest research and development in numerical weather prediction. The advances in NWP since the previous full edition of this Manual in 1992 have been tremendous: higher accuracy, higher resolution, longer lead-time, wider range of relevant applications. Consequently the emphasis in operational meteorology has shifted towards the implementation of more and more sophisticated and diverse numerical models and applications, for an ever increasing variety of users.

The main support for the exchange and delivery of GDPFS products is the WIS. One of the key features of the WIS compared to the GTS is the expansion of the range of centres which can connect to the system; this feature will help to support the continuous increase in the range of GDPFS applications.

2. ORGANIZATION OF THE GDPFS

The GDPFS is composed of a variety of operational centres committed to perform specific operational activities, and to enable WMO Members to benefit from them. The activities can be either for general purpose or specialized for various types of applications; operational coordination activities (often referred to as Lead Centre activities) are also part of the GDPFS. The functions and commitments associated to each category of activity are detailed in part II of the Manual.

- General purpose activities:
    - 2.1.1. Global NWP

      Run deterministic global numerical weather prediction operationally and make it available on the WIS
    - 2.1.2. Limited area NWP
    - 2.1.3. Global ensemble prediction
    - 2.1.4. Limited area ensemble prediction
    - 2.1.5. Nowcasting

      Post-processing of observation and numerical model output
    - 2.1.6. Seasonal and climate numerical prediction

      GPC business
    - 2.1.7. Wave and storm surges numerical forecasting
- Specialized activities:
    - 2.2.1. Coordination of high impact weather forecasts (e.g. Pretoria in the SWFDP for SE Africa)
    - 2.2.2. Climate prediction and information

      RCC business
    - 2.2.3. Generation of LRF MME products
    - 2.2.4. Tropical Cyclone forecasting
    - 2.2.5. Volcanic ash warning and prediction for aviation
    - 2.2.6. Response to Marine Environmental Emergencies
    - 2.2.7. Response to Nuclear Environmental Emergencies
    - 2.2.8. Response to non-Nuclear Environmental Emergencies
    - 2.2.9. Sand and Dust Storm warning and prediction
    - 2.2.10. ...
- Coordination activities:
    - 2.3.0. Coordination of deterministic NWP verification

      Collect standard verification statistics from GDPFS centres producing global NWP and make them available on a dedicated web site
    - 2.3.1. Coordination of EPS verification results
    - 2.3.2. Coordination of LRF verification results
    - 2.3.3. Coordination of wave forecast verification
    - 2.3.4. Coordination of GOS observation monitoring results (surface, upper-air, etc.)
    - 2.3.5. Coordination of GCOS observation monitoring results (GSN and GUAN)
    - 2.3.6. ...

A given GDPFS centre can perform several types of GDPFS activities.

Where appropriate, the centres contributing to an activity of a given type can be organized as a coordinated network, or sub-system. A given GDPFS centre can contribute to several sub-systems.

3. COORDINATION WITH OTHER SYSTEMS OR PROGRAMMES

In many cases the activities undertaken by GDPFS centres are constitutive of the operational component of a system developed under another structure or programme, either by WMO on its own or jointly with other international organisations. In such cases, the regulations pertaining to these activities should cover both

- the specific requirements defined by the relevant structure (e.g. CCl for the Regional Climate Centres, ICAO/??? for the VAAC)
- and the general GDPFS criteria regarding operational quality and reliability, verification, documentation and compliance (cf. II.1).

The coordination mechanism to that effect is not the same across all the categories of activity; it is specified for each activity in part II of the Manual.

PART II – SPECIFICATIONS OF THE GDPFS ACTIVITIES

1. OVERALL REQUIREMENTS

Description in general terms of the functions which are always required (details to be given in para. 2):

1.1. Acquisition of observational data
   i. Real time quality control
   ii. Non real time monitoring and reporting

1.2. Product dissemination via the WIS

1.3. Products verification *(in accordance with specific procedures where available, e.g. SVS-LRF)*

User oriented

1.4. Providing and keeping up-to-date documentation on system and products *(preferably on a web site)*

1.5. Reporting on compliance *(preferably by maintaining appropriate status of implementation information available on a web site)*

2. SPECIFIC FUNCTIONS

For every activity listed in part I (2.1.1 to 2.3.6):

- *Le cas échéant:* designation of the system or network involved (e.g. GMDSS, VAAC, SDS-WAS)
- Description of the required functions and implied commitments, or reference to appropriate documentation where it exists:
  - Mandatory functions
    - Geographical area of responsibility where appropriate
  - Mandatory product dissemination
  - Mandatory verification results
  - Mandatory status of implementation information

Additional recommended functions and products to be mentioned in Attachment

<u>Example for activity 2.1.1</u>, global NWP

- The centres participating in activity 2.1.1, global NWP, shall:
  - Prepare global analyses of the three-dimensional structure of the atmosphere
  - Prepare global forecast fields of basic and derived atmospheric parameters
  - Make available on the WIS a range of these products. The minimum list to be made available, including parameters, forecast range, time steps, production time window and frequency, is given in Appendix XXX
  - Prepare verification statistics according to the standard defined in Appendix XXX', and make them available to the centre(s) participating in the coordination of deterministics NWP verification
  - Make available on a web site up-to-date information on the characteristics of its global NWP system. The minimum information to be provided is given in Appendix XXX''

<u>Example for activity 2.3.1</u>, coordination of deterministic NWP verification

- The centre(s) participating in activity 2.3.1, coordination of deterministic NWP verication, shall be designated as Lead Centre(s) for deterministic NWP verification
- These centre(s) shall:
  - Provide the facility for the GDPFS Centres producing global NWP to automatically deposit their standardized verification statistics as defined in appendix XXX, and give all participating Centres access to these verification statistics
  - Maintain an archive of the verification statistics to allow the generation and display of trends in performance
  - Monitor the received verification statistics and consult with the relevant participating centre if data is missing or suspect

- Provide access to standard data sets needed to perform the standard verification, including climatology and lists of observations and keep this up to date according to CBS recommendation
- Provide on its (their) website(s):
  - consistent up-to-date graphical displays of the verification results from participating Centres through processing of the received statistics
  - relevant documentation including access to the standard procedures required to perform the verification, and links to the websites of GDPFS participating Centres
  - contact details to encourage feedback from NMHSs and other GDPFS Centres on the usefulness of the verification information

- These centre(s) may also provide access to standardized software for calculating scoring information.

3. PROCEDURES FOR MODIFICATIONS

For every activity listed in part I (2.1.1 to 2.3.5):

- Indication of the body responsible for defining the requirements listed in para.2

  In case of joint responsibility : indication of the coordination mechanism (e.g. for RCCs : joint CCl - CBS/DPFS task team ; for VAAC : ???, etc.)

Example for activity 2.1.1, global NWP

- The functions required from GDPFS centres running global NWP shall be proposed by the ICT of the CBS OPAG on Data Processing and Forecasting Systems, subject to CBS approval and EC decision

Example for activity 2.3.1, coordination of deterministic NWP verification

- The functions required for the coordination of deterministic NWP verification shall be proposed by the CBS coordination group on forecast verification, subject to CBS approval and EC decision

- Indication of the body responsible for monitoring compliance

Example for activity 2.1.1, global NWP

- The compliance of the GDPFS centres running global NWP shall be monitored by the ICT of the CBS OPAG on Data Processing and Forecasting Systems, who will report to CBS accordingly

Example for activity 2.3.1, coordination of deterministic NWP verification

- The compliance of the centre(s) participating in the coordination of deterministic NWP verification shall be monitored by the CBS coordination group on forecast verification, who will report to CBS accordingly

PART III – GDPFS IMPLEMENTATION

1. *For every activity listed in part I (2.1.1 to 2.3.6):*

- List of centres and relevant web address with status of implementation information

2. *For every centre contributing to the GDPFS:*

- List of activities undertaken

Annex VII

PROPOSED STRUCTURE ANS RECOMMENDED TORs

Implementation Coordination Team on Data-Processing and Forecasting System

(a) Identify new emerging requirements (input required from RAs and other bodies);
(b) Determine how GDPFS Centres can best contribute to fulfil emerging requirements;
(c) Participate in THORPEX planning groups as appropriate to advise on conditions and requirements for practical implementations in operational systems;
(d) Identify needs for training through workshops and other means of delivery;
(e) Coordinate the implementation of decisions by CBS related to GDPFS;
(f) Review of Expert Teams and rapporteurs and make recommendations to CBS concerning future work.

Coordination Group on Forecast Verification

(a) In consultation with the relevant Expert Teams, review procedures for verification of the performance of forecasting systems to ensure that they are adequate and meet CBS needs;
(b) Ensure that verification systems are appropriate to emerging forecast types such as probabilistic forecasts, very high resolution NWP products, and nowcasting products;
(c) Develop suitable verification procedures for severe weather forecasts and warnings;
(d) Review Lead Centre activities and provide guidance as appropriate;
(e) Liaise with WWRP/WGNE as required;
(f) Provide guidance on how to implement verification systems.

Expert Team on Ensemble Prediction Systems

(a) Provide advice on EPS in relation to probabilistic forecasts in the context of short- and medium-range EPS products, focusing on applications concerned with all aspects of the EPS systems which forecast the weather on a daily basis;
(b) Review progress on EPS and its application to severe weather forecasting including progress on multi-centre ensembles and on regional model based EPS, and prepare ways to make best operational usage of these developments;
(c) Propose guidance for the generation of EPS products (e.g. EPS-grams, presentation of cyclone tracks and strike probabilities, hazard maps, calculation of probability, calibration methodologies, etc.) to ensure compatibility of EPS products supplied to WMO Members by different centres;
(d) Develop education and training material for forecasters including rationale of concepts and strategies of EPS, and on the nature, interpretation and application of EPS products;
(e) In consultation with the Coordination Group on verification, review verification system for EPS products and provide guidance on the interpretation of verification;
(f) Support the further development of the Lead Centre on Verification of EPS by reporting on verification measures and determining the best way of presenting skill of ensemble forecasting systems. Provide relevant software to NMHSs through the Lead Centre Website;
(g) To review the Manual on the GDPFS (WMO-No. 485) and propose updates as necessary concerning EPS;
(h) Develop specifications for the introduction of probabilistic information into products from RSMCs with geographical specialization;
(i) Participate in THORPEX Working Groups:
    (i) To ensure that the proposed GIFS (Global Interactive Forecast System) is suitable for operational implementation and application;
    (ii) To review progress on the use of EPS for targeting of observations.

Rapporteur on Infrastructure for Numerical Weather Prediction (NWP)

(a) In consultation with the relevant Expert Teams and in coordination with the Regional Rapporteurs on GDPFS, provide guidance on the NWP products to be exchanged on the GTS (WIS);
(b) Review the need for establishing standards and guidelines for the provision of initial and boundary conditions to NMCs for limited area models for operational NWP;
(c) Communicate the resulting user requirements to the OPAG/ISS to help them determine appropriate technical means of meeting these requirements;
(d) Provide guidance on the benefits of different options for capacity building concerning the infrastructure requirements for operational implementation of new NWP systems.

Expert Team on Extended- and Long-range Forecasting

(a) On the basis of requirements from Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and NMHSs, and in the context of the Global Framework for Climate Services (GFCS), guide future development, outputs and coordination of components in the production of LRF. The components include Global Producing Centres (GPCs), Lead Centres for Long-range Forecast Multi-model Ensembles (LC-LRFMME), and the Lead Centre for the Standardized Verification System for Long-range Forecasts LC-SVSLRF);
(b) In coordination with CCl, promote the use of GPC and LC forecast and verification products by RCCs, RCOFs and NMHSs, develop new interpretation guidance to facilitate their use, and encourage feedback on usefulness and application;
(c) Report on production, access, dissemination and exchange of LRF products and provide recommendations for future consideration and adoption by CAS, CCl, CBS and other appropriate bodies;
(d) In consultation with relevant experts in CAS and CCl and with the Coordination Group on Forecast Verification, review developments in verification scores and practices with a view to updating the Standardized Verification System for Long-range Forecasts (SVSLRF);
(e) Assess applications for GPC status against the designation criteria and make recommendations on designation to CBS;
(f) Review the rules regarding user access to GPC and LC-LRFMME forecast products;
(g) Review the status of extended-range forecasting activities and promote the exchange of extended-range forecasts and verification products;
(h) Review research on initialized predictions for timescales longer than seasonal and report on potential for operational predictions to CBS and CCl;
(i) Review the *Manual on the GDPFS* (WMO-No. 485) and propose updates as necessary concerning extended and long-range forecasts.

Coordination Group on Nuclear Emergency Response Activities (ERA)

(a) Test and improve the collective ability of all RSMCs, the IAEA, the RTH Offenbach and NMHSs in the ERA to fulfil the operational requirements specified in global and regional arrangements, according to adopted standards and procedures;
(b) Implement and explore further improved distribution/access methods for specialized products to NMHSs, and the IAEA in collaboration with the IAEA and other relevant organizations;
(c) Collate the individual capabilities of RSMCs to produce enhanced products in support of nuclear emergencies, including ensemble techniques;
(d) Explore the operational availability of radiological monitoring data for use in the RSMC operational environment;
(e) Develop concepts of operational arrangements for atmospheric transport modelling backtracking products;
(f) Continue testing and evaluating the operational arrangements with CTBTO.

Expert Team on Modelling of Atmospheric Transport for Non-nuclear ERA

(a) Monitor the needs of the NMHSs for atmospheric transport modelling and identify those areas in which RSMCs can be of assistance;
(b) Identify and promote technical resources which can assist NMHSs in developing their atmospheric transport modelling capabilities, particularly for limited area non-nuclear emergencies such as chemical releases to the atmosphere;
(c) Monitor the atmospheric transport modelling capabilities of RSMCs and other centres for support to transboundary non-nuclear emergencies, related to emissions from various sources such as volcanic eruptions, dust storms, large fires, and biological incidents, with the goal of improving operational arrangements;
(d) Develop strategies to strengthen operational links with international organizations relevant to non-nuclear ERA, and between NMHSs and relevant national authorities.

Rapporteur on the Application of NWP to Severe Weather Forecasting

(a) Review the application of NWP to severe and high impact weather forecasting at all ranges in consultation with relevant expert teams;
(b) Report on new developments and advances in severe and high impact weather forecasting;
(c) Provide advice on the proposed demonstration project(s).

STRATEGIC DIRECTION FOR THE OPAG ON DPFS

Background

Priority Areas (*PA*) for WMO for the next financial period (2012-2015):

1. Global Framework for Climate Services – climate change, variability and adaptation
2. Capacity Building
3. WIGOS/WIS
4. Disaster Risk Reduction
5. Aviation Meteorology, including QMF

Links to these priorities highlighted by PA numbers below.

Vision – in 10 years time

The GDPFS will be developed and expanded to cover all timescales from short to multi-annual range. By focusing on services for Disaster Risk Reduction and on capacity building, the GDPFS will continue to support and build members' capabilities for:

- Timely warning of severe and high impact weather;
    - Emergency response to nuclear and non-nuclear incidents;
    - Early warning of climate anomalies on monthly, seasonal and longer timescales.

Specific aims:

- Sustain and enhance quality and reliability of existing operational services including ERA.
- Make core set of high quality NWP Products (incl EPS) accessible to all NMHSs (*PA 2, 3)*
    - Enhanced information access through interactive web tools supported at RSMCs or global centres – allow interactive access to NWP/EPS data (*PA 2, 3)*
    - Enhanced preparedness for environmental change (*PA 1)*
    - Focus on "*what counts*" high-impact thresholds (e.g. freezing point, 10 degrees) for verification and calibration (*PA 2, 5)*
    - Wide availability of improved convection-allowing model forecasts
- Consolidate SWFDP into sustainable operational services (*PA 2, 4*)
    - Enhanced information access through web tools supported at RSMCs or global centres from any bandwidth internet connection (*PA 2, 3)*
    - Support sustainable usage – annual training funded and resourced (*PA 2)*
- Dynamical monthly, seasonal and multi-annual products are well understood by members and integrated in production of national and regional services, and informing adaptation to climate variability and change (*PA 1, 2, 4)*
    - Expand operational long-range forecast services in response to the requirements of members, as part of the development of the GFCS
    - Existing GPC and Lead Centre services further developed
    - Consolidate data exchange between GDPFS nodes (regional climate centres)
    - Capacity building and demonstration projects
- ERA for non-nuclear hazards to reach same level of operational maturity as nuclear ERA (*PA 4, 5)*
    - Regional arrangements established including with other international organisations
- Increased usage of NWP in applications of meteorology (flash floods, coastal flooding aviation, marine, …) (*PA 1, 4)*
    - Hi-resolution NWP including convection-allowing to meet the needs of air traffic management
    - cascading SWFDP-like framework (Global Centres and RSMCs) for sand and dust-storms (*PA 1, 2, 5)*
    - Air quality (maybe Global centres only)

  - Working with other organisations for risk reduction and post-event disaster relief (e.g. UN Agencies, NGOs) (*PA 1, 2, 4)*
- Establish a Quality Management Framework for maintenance and sustainability (*PA 5)*
  - Improved efforts and exchange of verification (deterministic, EPS and long-range) to:
    1. inform users of forecast performance and aid decision-making;
    2. identify deficiencies requiring further NWP development.