WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

EXPERT MEETING ON THE REVISION OF THE MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS)

GENEVA, SWITZERLAND, 19-21 OCTOBER 2011

FINAL REPORT

David Richardson, Alice Soares, Peter Chen, Yuki Honda, Peter Kreft, Bernard Strauss

EXECUTIVE SUMMARY

The CBS Expert Meeting on the Revision of the Manual of the Global Data-Processing and Forecasting System (GDPFS) was held in Geneva, Switzerland, from 19 to 21 October 2011.

The meeting reviewed the extended layout of the revised *Manual on the GDPFS* using wiki, which was adopted by the sixteenth World Meteorological Congress (Cg-XVI, May 2011) in Resolution 6 (Session No. 3.1.3/2). It agreed on the template to describe the activities in the new Manual, and prepared draft new text for the revised Manual on:

(1) global NWP;
(2) coordination of deterministic NWP verification;
(3) limited area NWP;
(4) global ensemble prediction;
(5) coordination of EPS verification;
(6) limited area ensemble prediction;
(7) regional severe weather forecasting.

The new text would serve as example for guiding the continuation of the work.

The meeting agreed on a work programme for developing a first version of the revised *Manual*, as follows:

End-October 2011 – Secretariat to contact the identified experts to develop the various parts of the new *Manual*;

Mid-March 2012 – Identified experts to submit draft new text for the new *Manual* to the Secretariat;

End-March 2012 – Secretariat to make available the draft new text for the new *Manual on the wiki* for a peer review;

End-April 2012 – Identified expert(s) (P. Kreft, and possibly others) to submit revised text for the new *Manual*;

Mid-May 2012 – ICT-DPFS to review the text for the new *Manual*;

Sept or Nov 2012 – CBS-XV to consider the text for the new *Manual*.

The meeting agreed that draft text for the new *Manual* should be developed using the template (in Word) and decided that the wiki should be used for sharing all relevant documentation, including the text for the new *Manual*, prior to its peer review.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The CBS Expert Meeting on the Revision of the Manual of the Global Data-Processing and Forecasting System (GDPFS) was opened by the Chairperson of the CBS OPAG on Data Processing and Forecasting Systems (DPFS), Mr Bernard Strauss (France), at 09.30 hours on Wednesday, 19 October 2011, at the WMO Headquarters, in Geneva, Switzerland. The Assistant Secretary-General of WMO, Ms Elena Manaenkova welcomed the participants.

1.2 Ms Manaenkova informed the meeting that the World Meteorological Organization (WMO) and the Hong Kong Observatory (HKO) have launched *MyWeather* – a mobile application on *iPhone* platform featuring the World Weather Information Service (WWIS). It is the world's first ever location-specific weather service providing official city weather forecasts around the world for people on the move. She pointed out that this could only be achieved based on the GDPFS operated by WMO Members. Then, she placed the importance of the GDPFS, hence the *Manual on the GDPFS* (WMO-No. 485), into the context of the increasing demand for meteorological services provided by Members, a large part of which is based on numerical weather prediction systems and products.

1.3 Ms Manaenkova recalled that the *Manual* is the single source of technical regulations for all operational data-processing and forecasting systems of WMO Members, including their designated meteorological centres. There has been much development and evolution in the GDPFS since 1992, which is when the current edition of the *Manual* was adopted. While many amendments to the *Manual* have been adopted by Members over the years, the Manual needs to be reviewed and updated in its entirety. Finally, she pointed out that the revised *Manual* should facilitate introducing updates as frequently as required, and regional aspects' specificities should be incorporated in the main body of the *Manual* rather than in a separate volume, which is difficult to keep up-to-date.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The meeting adopted the agenda, which is found in Annex I.

2.2 Working arrangements

2.2.1 The meeting agreed on the organization of its work, including the working hours. All pre-session documents can be found via the Documentation Plan (INF. 1) which is posted on the WMO Web site linked to the banner for the meeting at:

http://www.wmo.int/pages/prog/www/BAS/CBS-meetings.html

2.2.2 The list of participants is found in Annex II.

3. REVIEW THE EXTENDED LAYOUT OF THE REVISED MANUAL USING WIKI

3.1 The meeting reviewed the extended layout of the revised *Manual on the GDPFS* (using wiki), which was adopted by the sixteenth World Meteorological Congress (Cg-XVI, May 2011) in Resolution 6 (Session No. 3.1.3/2). It noted that Cg-XVI agreed that the revised *Manual on the GDPFS* would facilitate introducing updates as frequently as required (to ensure that the content is kept up-to-date). The new *Manual* should be developed in accordance with quality management principles, which would ensure its sustainability as part of the WMO Quality Management Framework.

3.2 The meeting reviewed the outcomes of its previous meeting, including the table describing the parts of the text of the existing *Manual* that should be kept in the new *Manual*, those that should be reviewed / modified taking into account the new structure of the *Manual* and those that should not be included due either to avoid duplication and overlap with other WMO regulatory documentation or the content is obsolete. Taking into account the new vision for the GDPFS, the meeting discussed the possibility of retaining the description of the forecast ranges. It recognized that there was no need to use this terminology in the new *Manual*, however it agreed to consider keeping this information in the new *Manual* at a later stage, if required.

4. NEW VISION FOR THE GDPFS

4.1 The meeting noted that Cg-XVI agreed that there are fundamental changes under way in the Basic Systems and that the review of the *Manual on the GDPFS* should be done with the existing system of world, regional and national centres of the GDPFS, and the future evolution of the GDPFS in mind, such as the inclusion of all WMO operated meteorological centres that provide operational data-processing and forecasting services (including those coordinated by CBS and joint CBS-other Technical Commissions and/or WMO Programmes, as well as joint WMO-other international organizations centres). The review should take into account the developments in WIGOS and WIS, lessons learnt from SWFDP, and anticipated results of, and operational implications from the WWRP/TIGGE project “Global Interactive Forecast System”.

4.2 The meeting noted that the Global Framework for Climate Services (GFCS) may have implications for the GDPFS. It therefore agreed that the new *Manual* should be flexible enough to allow the future incorporation of and accommodate technical aspects that may be arisen from the GFCS.

4.3 The meeting noted that Cg-XVI decided that Volume II of the *Manual* (Regional Aspects), which has no regulatory status for WMO Members, should be reviewed and the relevant parts, including the designation of regional sub-structures and networks, list of products and the possibility of designation of a RSMC(s) for Polar Regions, and consortia should be incorporated in the new *Manual on the GDPFS*. In this context, the meeting reviewed the table of contents for the new *Manual*, and agreed on the text for Parts I, II and III as given in Annex III.

5. REVIEW DRAFT NEW TEXT FOR THE REVISED MANUAL

5.1 The meeting agreed on the template to describe the activities in the new Manual, as given in Annex IV. It reviewed and prepared draft new text for the revised Manual on:

(1) Global NWP;
(2) Coordination of deterministic NWP verification;
(3) Limited area NWP;
(4) Global ensemble prediction;
(5) Coordination of EPS verification;
(6) Limited area ensemble prediction;
(7) Regional severe weather forecasting;

which is given in Annexes V to XI, respectively. The new text would serve as example for guiding the continuation of the work.

6. 2012 WORK PROGRAMME FOR DEVELOPING A FIRST VERSION OF THE REVISED MANUAL

6.1 The meeting agreed on a work programme for developing a first version of the revised *Manual*, as follows:

End-October 2011 – Secretariat to contact the identified experts to develop the various parts of the new *Manual*;

Mid-March 2012 – Identified experts to submit draft new text for the new *Manual* to the Secretariat;

End-March 2012 – Secretariat to make available the draft new text for the new *Manual on the wiki* for a peer review;

End-April 2012 – Identified expert(s) (P. Kreft, and possibly others) to submit revised text for the new *Manual*;

Mid-May 2012 – ICT-DPFS to review the text for the new *Manual*;

Sept or Nov 2012 – CBS-XV to consider the text for the new *Manual*.

6.2 The meeting agreed that draft text for the new *Manual* should be developed using the template presented in Annex IV (in Word). It decided that the wiki should be used for sharing all relevant documentation, including the text for the new *Manual*, prior to its peer review.

7. ANY OTHER BUSINESS (AOB)

7.1 There were no other issues raised during the meeting.

8. CLOSING

8.1 The Expert Meeting on the Revision of the Manual on the Global Data-Processing and Forecasting System (GDPFS) closed at 16:30 on Friday, 21 October 2011.

ANNEX I

AGENDA

1. OPENING

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda
2.2 Working arrangements

3. REVIEW THE EXTENDED LAYOUT OF THE REVISED MANUAL USING WIKI

4. NEW VISION FOR THE GDPFS

- WMO GDPFS Centres
- WMO joint GDPFS-Other Programmes Centres
- Regional Sub-structures and Consortia
- Joint WMO-Other International Organizations Centres
- Polar Regions aspects

5. REVIEW DRAFT NEW TEXT FOR THE REVISED MANUAL

- Global NWP;
- Coordination of deterministic NWP verification;
- Limited area NWP;
- Global ensemble prediction;
- Coordination of EPS verification;
- Limited area ensemble prediction;
- Regional severe weather forecasting.

6. 2012 WORK PROGRAMME FOR DEVELOPING A FIRST VERSION OF THE REVISED MANUAL

7. ANY OTHER BUSINESS (AOB)

8. CLOSING

ANNEX II

LIST OF PARTICIPANTS

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ANNEX III

PARTS I, II AND III OF THE NEW *MANUAL*

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

1. PURPOSE OF THE GDPFS

1.1 General description

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 developing countries.
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 centres participating in the GDPFS are committed to perform specific operational activities, and to enable WMO Members to benefit from them.

The GDPFS makes full use of the latest research and development in numerical weather prediction and environmental modelling. 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. *[Move to a Forward]*

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. *[Move to a Forward]*

1.2. The functions of the GDPFS

The GDPFS covers a whole range of operational functions requiring meteorological information. The activities involved are mostly real time activities; they can be either for general purpose or specialized for various types of applications. Non real time operational coordination activities (often referred to as Lead Centre activities) are also part of the GDPFS. The list and overall description of every activity is given in this paragraph, while the detailed functions and associated commitments are specified in part II of the Manual.

General Purpose activities:

- Global NWP – Run deterministic global numerical weather prediction operationally and make it available on the WIS
- Limited area NWP
- Global ensemble prediction

- Limited area ensemble prediction
- Nowcasting – Post-processing of observation and numerical model output
- Seasonal and climate numerical prediction – GPC xxxx
- Wave and storm surges numerical forecasting

Specialized activities:

- Regional severe weather forecasting – xxxx
- Climate prediction and information – RCC xxxx
- Generation of LRF MME products
- Tropical Cyclone forecasting
- Volcanic ash warning and prediction for aviation
- Response to Marine Environmental Emergencies
- Response to Nuclear Environmental Emergencies
- Response to non-Nuclear Environmental Emergencies
- Sand and Dust Storm warning and prediction

Non real time coordination activities:

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

2. ORGANIZATION OF THE GDPFS

2.1. Centres and networks

The GDPFS is composed of a large variety of operational centres. In most cases these centres are NMHSs' main facilities, but they can also be from universities, international organisations, etc. The main meteorological centres of WMO Members are known as National Meteorological Centres (NMCs). GDPFS centres can also be labelled as Regional or Specialized Meteorological Centres (RSMCs), or World Meteorological Centres (WMCs), depending on the activities they undertake, as specified hereafter.

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

Where appropriate, an activity of a given type can be attributed to a group of two or more GDPFS centres, organized as a coordinated network. A given GDPFS centre can contribute to several such networks.

2.1.1 NMCs

WMO Members' National Meteorological Centres carry out functions to meet the national and international requirements of the Member. Each Member shall ensure that it has a National Meteorological Centre adequately staffed and equipped to enable it to play its part in the World Weather Watch (WWW) system.

The functions of a NMC shall include the preparation of forecasts and warnings at all ranges necessary to meet the requirements of the Member, and also, depending on the context, other activities such as production of:

(a) Special application-user products, including climate and environmental quality monitoring and prediction products;

(b) Non-real-time climate-related products;

(c) Specific products and their delivery in support of United Nations humanitarian missions as specified in ... *(appendix I-5 to be reviewed)*.

NMCs should have the capacity to make best use of GDPFS products in order to reap the benefits of the WWW system.

NMCs should be linked to the WIS to ensure suitable connection with other GDPFS centres in order to carry out inter-processing activities between centres, according to bilateral or multilateral agreements among Members.

2.1.2 WMCs and RSMCs

GDPFS centres which carry out at least the following activities to the specified standards described in Part II:

- Global NWP
- Global ensemble prediction
- and Seasonal and climate numerical prediction

shall be designated as World Meteorological Centres (WMC).

GDPFS centres which carry out at least one General Purpose or Specialized activity (listed in para. I.1.2) to the specified standards described in Part II shall be designated as Regional or Specialized Meteorological Centres (RSMC).

2.1.3 Networks

A GDPFS network, i.e., an association of GDPFS centres constituted to undertake an identified GDPFS activity, shall follow the same specifications and adhere to the same criteria and commitments as individual GDPFS centres carrying out the same activity. Appropriate documentation shall be produced and made available to distribute the tasks and responsibilities among the participating centres; an unique focal point shall be designated to answer requests from users of the network's products.

2.2. Designation process

The designation process of GDPFS centres depends on the type of activity and on the category of centre / network under consideration.

2.2.1 NMCs are designated by their respective WMO Members.

2.2.2 For centres other than NMCs, the designation of a GDPFS centre shall always include the designation of the activity (or activities) to be carried out:

- Requests for designation as GDPFS centre shall be put forward by the PR of the country of the candidate centre, or in the case of international centres by the relevant governing authority;
- Requests for designation as GDPFS network shall be put forward by the President of the relevant Regional Association, or in the case of networks established across two or more RAs, jointly by their Presidents;
- Depending on the type of activity, approval of Regional Association(s) and Technical Commission(s) shall be required. Details are given for each activity in part II.2 of the manual;

Joint responsibility with other International Organizations is described in paragraph I.3.

3. COORDINATION WITH OTHER SYSTEMS OR PROGRAMMES

The GDPFS shall support other WMO Programmes and relevant programmes of other international organizations in accordance with policy decisions of the Organization. In many cases the activities undertaken by GDPFS centres constitute 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 cover both

- the specific requirements defined by the relevant structure; and,
- the general GDPFS criteria regarding operational quality and reliability, verification, documentation and compliance (cf. II.1).

An appropriate coordination mechanism to that effect shall be implemented, depending on the context and characteristics of the various categories of activity; it is specified for each of them in part II of the Manual.

PART II – SPECIFICATIONS OF THE GDPFS ACTIVITIES

1. OVERALL REQUIREMENTS AND STANDARDS

1.1. Quality control of observational data

All GDPFS centres shall apply quality control to the incoming observations they use for GDPFS purposes. The objectives of the GDPFS quality control are:

i. To ensure the best possible quality of the data which are used in the real-time operations of the GDPFS;
ii. In non-real time, to protect and improve the quality and integrity of data destined for storage and retrieval within the GDPFS;
iii. To provide the basis for feedback of information on errors and questionable data to the source of the data.

The minimum standards for quality control of data include quality control at various stages of processing. They apply to both real-time and non-real-time processing and should lead to various records of quality-control actions.

An essential part of the quality-control system includes an exchange of information about data deficiencies between GDPFS centres and observation points in order to resolve those deficiencies and minimize their recurrence. The Lead Centres which participate in the coordination of observation monitoring results (II.2.3.5) play an essential role in this respect.

Reference to WIGOS required

1.2. Product dissemination

Reference to WIS required

1.3. Long-term storage of data and products

1.4. Product verification

1.5. Documentation on system and products

1.6. Training

1.7. Compliance reporting

1.8. Graphical representation of observations, analyses and forecasts

From Appendix II-4

2. SPECIFICATION OF FUNCTIONS AND PROCEDURES FOR MODIFICATIONS

2.1. General purpose activities

2.1.1. Global NWP
2.1.2. Limited area NWP
2.1.3. Global ensemble prediction
2.1.4. Limited area ensemble prediction
2.1.5. Seasonal and climate numerical prediction
2.1.6. Wave and storm surges numerical forecasting
2.1.7. Nowcasting

2.2. Specialized activities

2.2.1. Regional severe weather forecasting
2.2.2. Climate prediction and information
2.2.3. Generation of LRF MME products
2.2.4. Tropical Cyclone forecasting
2.2.5. Volcanic ash advisory services 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 advisory services

2.3. Non real time coordination activities

2.3.1. Coordination of deterministic NWP verification
2.3.2. Coordination of EPS verification
2.3.3. Coordination of LRF verification
2.3.4. Coordination of wave forecast verification
2.3.5. Coordination of observation monitoring

PART III – GDPFS IMPLEMENTATION

1. TABLE OF ACTIVITIES with indication of centres and networks, consortia etc.

2. TABLE OF CENTRES AND NETWORKS with indication of activities

ACRONYMS

ANNEX IV

TEMPLATE TO DESCRIBE ACTIVITIES IN THE NEW *MANUAL*

II.2.x.y. – < *Designation of activity* >

SPECIFICATION
Centres participating in activity 2.x.y, < *designation* >, shall:

- ...
- ...

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:			
To be approved by:			
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	RA (if required)	TC	IO (if required)
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:			
To be reported to:			

ANNEX V

NEW TEXT FOR THE REVISED MANUAL ON GLOBAL NWP

II.2.1.1 – Global Numerical Weather Prediction

SPECIFICATION

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 and frequency, is given in Appendix A.II.2.1.1-a
- Prepare verification statistics according to the standard defined in Appendix A.II.2.3.1, and make them available to the Lead Centre(s) for Deterministic 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 A.II.2.1.1-b

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/ICT-DPFS	CBS/CG-FV (for appendix II.2.3.1)	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	ICT-DPFS		
To be reported to:	CBS		

Appendix A.II.2.1.1-a

MINIMUM LIST OF PRODUCTS TO BE MADE AVAILABLE ON THE WIS

Parameter	Level	Resolution	Forecast range	Time steps	Frequency
Geopotential height	850/500/250	1.5º x 1.5º	Up to 3d / Beyond 3d up to 6d	Every 6h / Every 12h	Twice a day (00 and 12 UTC) / Once a day
Temperature	850/500/250				
u,v	925/850/700/500/250				
Relative humidity	850/700				
Divergence, vorticity	925/700/250				
MSL pressure	Surface				
2m Temp 10m u, 10m v Total precipitation	Surface				

Additional recommended products

- To be developed

Appendix A.II.2.1.1-b

CHARACTERISTICS OF GLOBAL NWP SYSTEMS

1. System
System name (version)
Date of implementation
2. Configuration
Horizontal resolution of the model, with indication of grid spacing in km
Number of model levels
Top of model
Forecast length and forecast step interval
Runs per day (Times in UTC)
Is model coupled to an ocean, waves, sea ice models? Specify which models
Integration time step
Additional comments
3. Initial conditions
Data assimilation method
Additional comments
4. Surface Boundary Conditions
Sea-surface temperature? If yes, briefly describe method(s).
Land surface analysis? If yes, briefly describe method(s).
Additional comments
5. Other details of model
What kind of soil scheme is in use?
How are radiations parametrized?
What kind of Large scale dynamics is in use (e.g. gridpoint semi-Lagrangian)?
Hydrostatic?
What kind of boundary layer parametrization is in use?
What kind of convection parametrization is in use?
What Cloud scheme is in use?
Other relevant details?
6. Further Information
Operational contact point
URLs for system documentation
URL for list of products

ANNEX VI

NEW TEXT FOR THE REVISED MANUAL ON COORDINATION OF DETERMINISTIC NWP VERIFICATION

II.2.3.1 – Coordination of deterministic NWP verification

SPECIFICATION

The centre(s) participating in activity 2.3.1, coordination of deterministic NWP verification, 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 A.II.2.3.1, and 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.

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/CG-FV	CBS/ICT-DPFS	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	CBS/CG-FV		
To be reported to:	CBS/ICT-DPFS	CBS	

Appendix A.II.2.3.1

I – STANDARDIZED VERIFICATION OF DETERMINISTIC NWP PRODUCTS

1. Introduction

This Appendix 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 II.2.3.1, 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 925, 850, 700, 500 and 250 hPa
- Relative humidity at 850 and 700 hPa
- Surface parameters (2m Temp, wind, total precipitation)

Additional recommended

- Geopotential height, temperature, wind at 100 hPa

Tropics

Mandatory

- Geopotential height at 850 and 250 hPa
- Temperature at 850 and 250 hPa
- Wind at 850 and 250 hPa
- Relative humidity at 850 and 700 hPa
- Surface parameters (2m Temp, wind, total precipitation)

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

Every 6h, up to 72 hours forecast.
Every 12h, beyond 72h forecast to the end of the forecast range.

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 *[move to Part II, 1.4]*

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

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.

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.

ANNEX VII

NEW TEXT FOR THE REVISED MANUAL ON LIMITED AREA NWP

II.2.1.2 – Limited area Numerical Weather Prediction

SPECIFICATION

Centres participating in activity 2.1.2, limited area NWP, shall:

- Prepare limited area analyses of the three-dimensional structure of the atmosphere
- Prepare limited area 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 and frequency, is given in Appendix A.II.2.1.2-a
- Prepare verification statistics according to the standard defined in Appendix A.II.2.3.1, adapted for the region covered by the model at a resolution of 0.5°, and make available consistent up-to-date graphical displays of the verification results on a web site
- Make available on a web site up-to-date information on the characteristics of its limited area NWP system. The minimum information to be provided is given in Appendix A.II.2.1.2-b

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/ICT-DPFS	CBS/CG-FV (for appendix A.II.2.3.1)	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	ICT-DPFS		
To be reported to:	CBS		

Appendix A.II.2.1.2-a

MINIMUM LIST OF PRODUCTS TO BE MADE AVAILABLE ON THE WIS

Parameter	Level	Resolution	Forecast range	Time steps	Frequency
Geopotential height	850/500/250	0.5° x 0.5°	1d	Every 6h	Twice a day
Temperature	850/500/250				
u,v	925/850/700/500/250				
Relative humidity	850/700				
Divergence, vorticity	925/700/250				
MSL pressure	Surface				
2m Temp 10m u, 10m v Total precipitation	Surface				

Additional recommended products

- Vertical velocity
- Cloud cover

Appendix II.2.1.2-b

CHARACTERISTICS OF LIMITED AREA NWP SYSTEMS

1. System
System name
Date of implementation
2. Configuration
Domain
Horizontal resolution of the model, with indication of grid spacing in km
Number of model levels
Top of model
Forecast length and forecast step interval
Runs per day (Times in UTC)
Is model coupled to an ocean, waves, sea ice models? Specify which models
Integration time step
Additional comments
3. Initial conditions
Data assimilation method
Additional comments
4. Surface Boundary Conditions
Sea-surface temperature? If yes, briefly describe method(s).
Land surface analysis? If yes, briefly describe method(s).

Additional comments
5. Lateral Boundary Conditions
Model providing lateral boundary conditions
Lateral boundary conditions update frequency
6. Other details of model
What kind of soil scheme is in use?
How are radiations parametrized?
What kind of Large scale dynamics is in use (e.g. gridpoint semi-Lagrangian)? Hydrostatic?
What kind of boundary layer parametrization is in use?

What kind of convection parametrization is in use?

What Cloud scheme is in use?

Other relevant details?
7. Further Information
Operational contact point
URLs for system documentation
URL for list of products

ANNEX VIII

NEW TEXT FOR THE REVISED MANUAL ON GLOBAL ENSEMBLE PREDICTION

II.2.1.3 – Global Ensemble Prediction

SPECIFICATION

Centres participating in activity 2.1.3, global Ensemble Prediction, shall:

- Prepare global ensemble 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 and frequency, is given in Appendix A.II.2.1.3-a
- Prepare verification statistics according to the standard defined in Appendix A.II.2.3.2, and make them available to the Lead Centre(s) for EPS Verification
- Make available on a web site up-to-date information on the characteristics of its global Ensemble Prediction System. The minimum information to be provided is given in Appendix A.II.2.1.3-b

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/ET-EPS	CBS/ICT-DPFS	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	CBS/ET-EPS		
To be reported to:	CBS/ICT-DPFS	CBS	

Appendix A.II.2.1.3-a

MINIMUM LIST OF PRODUCTS TO BE MADE AVAILABLE ON THE WIS

Parameter	Level	Thresholds	Resolution	Forecast range	Time steps	Frequency
Precipitation	Surface	1, 5, 10, 25, 50 mm and 100 mm/24 hours	1.5° x 1.5°	10d	Every 12h	Once a day
10 m sustained wind and gusts	Surface	10, 15 and 25 m s^{-1}				
Temperature anomalies	850	± 1, ± 1.5, ± 2 standard deviations with respect to a reanalysis climatology specified by the producing Centre				
Ensemble mean + spread (standard deviation) of Geopotential height	500					
Ensemble mean + spread (standard deviation) of MSL pressure	Surface					
Ensemble mean + spread (standard deviation) of vector wind	850/250					
Tropical storm tracks (lat/long locations from EPS members)						

Additional recommended products

- Location-specific time series of temperature, precipitation, wind speed, depicting the most likely solution and an estimation of uncertainty ("EPSgrams"). The definition, method of calculation and the locations should be documented.

Appendix II.2.1.3-b

CHARACTERISTICS OF GLOBAL EPS

1. Ensemble System

Ensemble name (version)

Date of implementation

2. Configuration of the EPS

Horizontal resolution of the model, with indication of grid spacing in km

Number of model levels

Top of model

Forecast length and forecast step interval

Runs per day (Times in UTC)

Is there an unperturbed control forecast included? (Y/N)

Number of perturbed ensemble members (excluding control)

Is model coupled to an ocean, waves, sea ice models? Specify which models

Integration time step

Additional comments

3. Initial conditions and Perturbations

Initial perturbation strategy

Optimisation time in forecast (if applicable)

Horizontal resolution of perturbations (if different from model resolution)

Initial perturbed area

Data assimilation method for control analysis

Are perturbations to observations employed? (Y/N)

Perturbations added to control analysis or derived directly from ensemble analysis

Perturbations in +/- pairs? (Y/N)

Additional comments

4. Model Uncertainty Perturbations

Is model physics perturbed? If yes, briefly describe method(s).

Do all ensemble members use exactly the same model version, or are, for example, different parameterization schemes used? Please describe any differences.

Is model dynamics perturbed? If yes, briefly describe method(s).

Are the above model uncertainty perturbations applied to the control forecast?

Additional comments

5. Surface Boundary Perturbations

Perturbations to sea-surface temperature? If yes, briefly describe method(s).

Perturbations to soil moisture? If yes, briefly describe method(s).

Perturbations to surface wind stress or roughness? If yes, briefly describe method(s).

Any other surface perturbations? If yes, briefly describe method(s).

Are the above surface perturbations applied to the control forecast?

Additional comments

6. Other details of model

What kind of soil scheme is in use?

How are radiations parametrized?

What kind of Large scale dynamics is in use (e.g. gridpoint semi-Lagrangian)? Hydrostatic?

What kind of boundary layer parametrization is in use?

What kind of convection parametrization is in use?

What Cloud scheme is in use?

Other relevant details?

7. Further Information

Operational contact point

URLs for system documentation

URL for list of products

ANNEX IX

NEW TEXT FOR THE REVISED MANUAL ON COORDINATION OF EPS VERIFICATION

II.2.3.2 – Coordination of EPS verification

SPECIFICATION

The centre(s) participating in activity 2.3.2, coordination of EPS verification, shall be designated as Lead Centre(s) for EPS verification.
These centre(s) shall:

- Provide the facility for the GDPFS Centres producing global EPS to automatically deposit their standardized verification statistics as defined in appendix A.II.2.3.2, and 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.

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/ET-EPS	CBS/ICT-DPFS	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	CBS/ET-EPS		
To be reported to:	CBS/ICT-DPFS	CBS	

Appendix A.II.2.3.2

STANDARD VERIFICATION MEASURES OF EPS

EXCHANGE OF SCORES

Monthly exchanges:

Ensemble mean
For verification of ensemble mean, the specifications in Appendix A.II.2.3.1 for variables, levels, areas and verifications shall be used.

Spread
Standard deviation of the ensemble averaged over the same regions and variables as used for the ensemble mean.

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

List of parameters

PMSL anomaly ± 1, ± 1.5, ± 2 standard deviation with respect to a centre-specified climatology
Verified for areas defined for verification against analysis

Z500 with thresholds as for PMSL. Verified for areas defined for verification against analysis

850 hPa wind speed with thresholds of 10, 15, 25 m s^{-1}. Verified for areas defined for verification against analysis

850 hPa u and v wind components with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology. Verified for areas defined for verification against analysis

250 hPa u and v wind components with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology. Verified for areas defined for verification against analysis

T850 anomalies with thresholds ± 1, ± 1.5, ± 2 standard deviation with respect to a centre-specified climatology. Verified for areas defined for verification against analysis

Precipitation with thresholds 1, 5, 10, and 25 mm/24 hours every 24 hours verified over areas defined for deterministic forecast verification against observations

Observations for EPS verification should be based on the GCOS list of surface network (GSN). 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.

NOTE: Where thresholds are defined with respect to climatology, the daily climate should be estimated.

Scores (computed by Lead Centre(s) based on reliability tables provided by participating centres)

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:

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.

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* The Brier Score (BS) is most commonly used for assessing the accuracy of binary (two-category) probability forecasts. The Brier Score is defined as: *[Move to Part II, 1.4]*

$$BS = \frac{\sum_{ij} \left(F_{ij} - O_{ij} \right)^2}{N}$$

where the observations *Oij* are binary (0 or 1) and *N* is the verification sample size. The Brier Score has a range from 0 to 1 and is negatively-oriented. Lower scores represent higher accuracy.

The Brier Skill Score (BSS) is in the usual skill score format, and may be defined by:

$$BSS = \frac{BS_C - BS_F}{BS_C} \times 100 = \left[1 - \frac{\sum_{ij} \left(F_{ij} - O_{ij} \right)^2}{\sum_{ij} \left(C_{ij} - O_{ij} \right)^2} \right] \times 100$$

where *C* refers to climatology and *F* refers to the forecast.

ANNEX X

NEW TEXT FOR THE REVISED MANUAL ON LIMITED AREA ENSEMBLE PREDICTION

II.2.1.4 – Limited Area Ensemble Prediction

SPECIFICATION

Centres participating in activity 2.1.4, Limited Area Ensemble Prediction, shall:

- Prepare limited area ensemble 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 and frequency, is given in Appendix A.II.2.1.4-a
- Prepare verification statistics according to the standard defined in Appendix A.II.2.3.2, adapted for the region covered by the model at a resolution of 0.5°, and make available consistent up-to-date graphical displays of the verification results on a web site
- Make available on a web site up-to-date information on the characteristics of its limited area Ensemble Prediction System. The minimum information to be provided is given in Appendix A.II.2.1.4-b

RESPONSIBILITY AND *(if required)* COORDINATION ***(Changes to Activity Specification)***			
To be proposed by:	CBS/ET-EPS	CBS/ICT-DPFS	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	CBS/ET-EPS		
To be reported to:	CBS/ICT-DPFS	CBS	

Appendix A.II.2.1.4-a

MINIMUM LIST OF PRODUCTS TO BE MADE AVAILABLE ON THE WIS

Parameter	Level	Thresholds	Resolution	Forecast range	Time steps	Frequency
Precipitation	Surface	1, 5, 10, 25, 50 mm and 100 mm/24 hours	0.5° x 0.5°	1d	Every 6h	Once a day
10 m sustained wind and gusts	Surface	10, 15 and 25 m s^{-1}				
Temperature anomalies	850	± 1, ± 1.5, ± 2 standard deviations with respect to a reanalysis climatology specified by the producing Centre				
Ensemble mean + spread (standard deviation) of Geopotential height	500					
Ensemble mean + spread (standard deviation) of MSL pressure	Surface					
Ensemble mean + spread (standard deviation) of vector wind	850/250					
Tropical storm tracks (lat/long locations from EPS members)						

Additional recommended products

- Location-specific time series of temperature, precipitation, wind speed, depicting the most likely solution and an estimation of uncertainty ("EPSgrams"). The definition, method of calculation and the locations should be documented.

Appendix II.2.1.4-b

CHARACTERISTICS OF LIMITED AREA EPS

1. Ensemble System

Ensemble name (version

Date of implementation

2. Configuration of the EPS

Horizontal resolution of the model, with indication of grid spacing in km

Number of model levels

Top of model

Forecast length and forecast step interval

Runs per day (Times in UTC)

Is there an unperturbed control forecast included? (Y/N)

Number of perturbed ensemble members (excluding control)

Is model coupled to an ocean, waves, sea ice models? Specify which models

Integration time step

Additional comments

3. Initial conditions and Perturbations

Initial perturbation strategy

Optimisation time in forecast (if applicable)

Horizontal resolution of perturbations (if different from model resolution)

Initial perturbed area

Data assimilation method for control analysis

Are perturbations to observations employed? (Y/N)

Perturbations added to control analysis or derived directly from ensemble analysis

Perturbations in +/- pairs? (Y/N)

Additional comments

4. Model Uncertainty Perturbations

Is model physics perturbed? If yes, briefly describe method(s).

Do all ensemble members use exactly the same model version, or are, for example, different parameterization schemes used? Please describe any differences.

Is model dynamics perturbed? If yes, briefly describe method(s).

Are the above model uncertainty perturbations applied to the control forecast?

Additional comments

5. Surface Boundary Perturbations

Perturbations to sea-surface temperature? If yes, briefly describe method(s).

Perturbations to soil moisture? If yes, briefly describe method(s).

Perturbations to surface wind stress or roughness? If yes, briefly describe method(s).

Any other surface perturbations? If yes, briefly describe method(s).

Are the above surface perturbations applied to the control forecast?

Additional comments

6. Other details of model

What kind of soil scheme is in use?

How are radiations parametrized?

What kind of Large scale dynamics is in use (e.g. gridpoint semi-Lagrangian)? Hydrostatic?

What kind of boundary layer parametrization is in use?

What kind of convection parametrization is in use?

What Cloud scheme is in use?

Other relevant details?

7. Regional Ensemble specifics

Regional domain descriptor (lat/long of boundaries)

Normal source of boundary conditions

Are boundary conditions perturbed?

Specification of boundary conditions required.

Are boundary condition requirements compatible with any other global models or standards? If so, please describe

Additional comments

8. Further Information

Operational contact point

URLs for system documentation

URL for list of products

ANNEX XI

NEW TEXT FOR THE REVISED MANUAL ON REGIONAL SEVERE WEATHER FORECASTING

II.2.2.1 – Regional severe weather forecasting

SPECIFICATION

This activity includes a Regional Centre(s) and associated National Meteorological Centres within a geographical region. Regional Centre(s) participating in activity 2.2.1, regional severe weather forecasting, shall:

- Identify targeted severe events and domain in agreement with associated NMCs
- Develop and maintain a dedicated web site and portal (with a password protection, as appropriate)
- Issue Daily Severe Weather Forecasting Guidance products for associated NMCs containing an interpretation of deterministic, EPS and satellite-based products
- Gather information on available resources of forecasting guidance, including NWP/EPS and satellite-based products, and assort all information on a dedicated web site and portal
- Facilitate real time coordination of warnings issued by associated NMCs

National Meteorological Centres (NMCs) associated in activity 2.2.1 shall:

- provide criteria for severe weather
- evaluate products, including the Daily Severe Weather Forecasting Guidance, and provide feedback to the Regional Centre(s)

RESPONSIBILITY AND *(if required)* COORDINATION *(Changes to Activity Specification)*			
To be proposed by:	CBS/SG-SWFDP	CBS/ICT-DPFS	
To be approved by:	CBS		
To be decided by:	EC / Congress		
DESIGNATION			
To be approved by:	CBS		
To be decided by:	EC / Congress		
COMPLIANCE			
To be monitored by:	CBS/SG-SWFDP		
To be reported to:	CBS/ICT-DPFS	CBS	