# WORLD METEOROLOGICAL ORGANIZATION

## COMMISSION FOR BASIC SYSTEMS

## COORDINATION GROUP ON FORECAST VERIFICATION (CG-FV)

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# FINAL REPORT

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## EXECUTIVE SUMMARY

The meeting of the Commission for Basic Systems (CBS) Coordination Group on Forecast Verification (CG-FV) was held in Montreal, Canada, from 24 to 27 January 2011.

The meeting reviewed its Terms of Reference (ToR) as adopted at CBS-XIV (2009) and re-endorsed at CBS-Ext.(10). It proposed no changes, while noting that the work that had been undertaken so far had been primarily focused on evaluating the performance of global models.

The meeting reviewed the updated standard verification system for deterministic NWP forecasts and agreed there was no need for any changes and/or improvements at this stage. The meeting discussed the way forward with the implementation of the updated system, including the milestones for a transitional period (run in parallel with the old system), and agreed on developments and specific needs, including those related to standard products and data formats, processing and monitoring of scores, display of verification results on the Lead Centre for Deterministic NWP Verification (LC-DNV) Web site, and the maintenance of standards. The meeting established a timeline for the implementation of the updated standard verification system, and agreed that a report on progress should be presented to the next meeting of the CG-FV.

The meeting noted that in general global NWP centres had been performing verification of surface fields. So far, operationally, the main focus had been on verification of precipitation, 2m temperature and 10m wind speed forecasts. Verification of other surface parameters (e.g. wind direction, clouds and dew point) was being done mostly on an experimental basis. Taking into account recommendations from the ECMWF's review of the verification of the ECMWF forecasting systems, and guidance from the WWRP/WGNE Joint Working Group on Forecast Verification Research (JWGFVR), the meeting developed recommendations and guidelines on the way forward and future work on scores and procedures for surface weather verification towards CBS-XV (2012). In particular, the meeting agreed that:

(a) SEEPS score, along with other possible/appropriate scores, should be computed for precipitation forecasts from global NWP centres and results should be made available on the LC-DNV Web site (password protected) on an experimental basis (one year trial) for evaluation/monitoring.

(b) for other surface parameters, more research and studies are required.

(c) for the purpose of model development and surface weather verification, more data, and more frequent data, should be exchanged on the GTS. Better quality control of observations, greater standardization of observing practices, and better precision of location of stations and their metadata are required.

(d) forecaster perception/evaluation from a synoptic point of view (chart verification) should be encouraged and feedback to global NWP centres should be provided.

The meeting had a general discussion on verification for severe weather and warnings. It agreed that this issue is very complicated. Within the context of its mandate and responsibilities, the meeting agreed that more research is required, before being able to provide any guidance. The meeting noted that some studies could be done for verification of deterministic forecasts, however it agreed that severe weather aspects should be addressed in a probabilistic forecast context, and in this regard, it suggested that this issue be followed up through the CBS ET on Ensemble Prediction Systems (ET-EPS).

The meeting had a general discussion on verification using NWP products from global and regional centres, including from the SWFDP experience. The meeting promoted the use of the

defined CBS scores (as stated in the Manual on the GDPFS) by NMHSs running LAMs. It noted that data from global NWP centres are mostly available in graphical format. In order to facilitate verification, the meeting encouraged cooperation between global NWP centres and individual NMHSs and RSMCs. The meeting agreed that the SWFDP provides an ideal framework for implementing collaborative arrangements between global NWP centres and individual NMHSs and RSMCs for verification, and suggested to use the SWFDP – Eastern Africa as a pilot.

## GENERAL SUMMARY OF THE WORK OF THE SESSION

## 1. ORGANIZATION OF THE MEETING

### 1.1 Opening of the meeting

1.1.1 The meeting of the Commission for Basic Systems (CBS) Coordination Group on Forecast Verification (CG-FV) was opened by its Chairperson, Mr David Richardson (ECMWF), at 09.25 hours on Monday, 24 January 2011, at the Canadian Meteorological Centre (CMC) of Environment Canada, in Montreal, Canada. Mr Richardson welcomed participants to the meeting, and introduced Mr André Méthot, Director of the National Prediction Development Division of Environment Canada, to address the meeting.

1.1.2 Mr Méthot welcomed all participants to the second meeting of the CBS Coordination Group in Forecast Verification and noted the importance of performing verification of weather forecasts. Recognizing that all NWP centres would need to provide quality information to forecasters and managers, he noted that verification would become a basic function for these centres. Mr Méthot emphasized the need for sharing such information with common standards in order to allow comparison among centres to help improving their own forecasting systems. He was pleased to note that ongoing work of the CG-FV on the development of verification procedures and defining standards for exchange of information. He concluded by welcoming all participants to Montreal, and by wishing them a very pleasant stay in Montreal and a very productive meeting.

1.1.3 Mr Peter Chen, on behalf of the Secretary-General of the WMO, Mr Michel Jarraud, welcomed participants to the meeting and expressed appreciation to Mr David Grimes, Permanent Representative of Canada with WMO, and his representative, Mr André Méthod, for hosting this meeting in Montreal and for providing these excellent facilities. Mr Chen also thanked Mr Tom Robinson of Environment Canada for its work in organizing the local arrangements, and Mr David Richardson, the Chairperson of the CG-FV, for guiding the work of this meeting.

1.1.4 Mr Chen noted that performing NWP without verification is inconsistent with Quality Management principles, and does not provide necessary quality information to forecasters. In this context, he recalled that the Commission for Basic Systems (CBS), at its fourteenth session (2009), had requested the Open Programme Area Group (OPAG) on Data-Processing and Forecasting Systems (DPFS), in particular its CG-FV, to review the existing standard for deterministic NWP verification as defined in the Manual on the Global Data-Processing and Forecasting System (GDPFS). Mr Chen also recalled that the first meeting of the CG-FV had reviewed the relevant parts of the Manual on the GDPFS, including updating the standard verification system. He noted that CBS, at its tenth extraordinary session (CBS-Ext.(10), November 2010), emphasized the importance of providing training to NWP centres to facilitate the implementation of verification requirements and best practices, as stated in the Manual on the GDPFS, so as to promote and ensure coordinated verification activities across these centres. Additionally, he noted that CBS-Ext.(10), agreed with the list of functions for a Lead Centre for Deterministic NWP Verification (LC-DNV) and recommended the ECMWF for designation. Finally, he noted that CBS-Ext.(10) also agreed that NWP verification activities should be maintained across the DPFS as a quality assurance and management measure for the GDPFS, thereby contributing to the WMO Quality Management Framework (QMF).

### 1.2 Approval of the agenda

1.2.1 The meeting adopted the provisional agenda, as provided in Annex I.

### 1.3 Working arrangements for the meeting

1.3.1 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/BAS/DocPlan_CG-FV2011.html

1.3.2 The participants agreed its hours of work and other practical arrangements for the meeting, including the tentative work programme. Noting that a number of participants were new to the CG-FV, they briefly introduced themselves, to facilitate interactions throughout the meeting. The list of participants in the meeting is provided in Annex II.

## 2. REVIEW THE TERMS OF REFERENCE OF THE COORDINATION GROUP ON FORECAST VERIFICATION (CG-FV)

2.1 While noting the background for the creation of the CG-FV, the meeting reviewed its Terms of Reference (ToR) as adopted at CBS-XIV (2009) and re-endorsed at CBS-Ext.(10). The Group proposed no changes to the ToR, as given in Annex III, while noting that the work that had been undertaken so far had been primarily focused on evaluating the performance of global models. The meeting stressed the need to address aspects related to verification of regional NWP, as well as NWP aspects of the verification of warnings in this meeting.

2.2 At the same time, the meeting recalled the major outcomes of its first meeting (2009), which are consistent with part of its ToR, including the revised standard verification procedures for upper air fields as part of the Manual on the GDPFS, and the definition of criteria, including a list of functions, for the establishment of a Lead Centre for Deterministic NWP Verification (LC-DNV). The development of suitable procedures for verification of surface fields and the provision of guidance on how to implement verification systems, which are also part of the ToR for the CG-FV, were briefly discussed at its first meeting.

2.3 The chairperson highlighted the general aims of this meeting, which cover all aspects referenced in the ToR for the CG-FV, including:

(a) establishing a timeline for the implementation of the updated standard verification system endorsed by CBS-Ext.(10), including milestones for a transitional period (run in parallel with the old system);

(b) defining a plan for promoting the implementation of the updated standard verification system and for ensuring that NWP centres participate in these verification activities (e.g. by exchanging their “mandatory” scores);

(c) deciding on developments and specific issues to be addressed by the LC-DNV, including those related to standard products and data formats, processing and monitoring of scores, display of verification results on the Web, and the maintenance of standards;

(d) developing recommendations and guidelines for the inclusion of surface parameters verification into the operational verification activity for WMO;

(e) discussing verification for severe weather and warnings and preparing a plan for future work of the CG-FV in this area; and,

(f) addressing aspects related to the provision of support and guidance (including training) to all WMO Members in implementing/performing verification activities.

## 3. REPORT ON THE OUTCOMES OF CBS-Ext.(10) RELATED AND/OR RELEVANT TO THE CG-FV

3.1 The meeting was presented with a report on the outcomes of CBS-Ext.(10) related and/or relevant to CG-FV. CBS-Ext.(10) had approved all recommendations by the CG-FV for inclusion in the Manual on the GDPFS, including the updated standard verification system, and the list of functions for a Lead Centre for Deterministic NWP Verification (LC-DNV), which were developed following the request by CBS-XIV (2009). CBS-Ext.(10) 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 information, for quick availability, especially for use by operational centres as well as model developers. In addition, CBS-Ext.(10) had received a briefing from, and the offer of ECMWF to act as LC-DNV, and agreed that it met the requirement as included in the list of functions, and recommended its designation. The meeting noted that the Sixteenth World Meteorological Congress (Cg-XVI, May 2011) would consider all CBS statements for implementation.

3.2 The meeting also noted that CBS-Ext.(10) requested: (a) to provide training to NWP centres, including GPCs and RCCs, to facilitate the implementation of verification requirements and best practices, as stated in the Manual on the GDPFS, so as to promote and ensure coordinated verification activities across these centres; and (b) that all EPS producing centres to provide verification data to the Lead Centre for EPS verification. While noting that these requests are mainly addressing ELRF and EPS, the meeting recognized that the same issues and concerns apply to the CG-FV and agreed to address these issues during this meeting.

3.3 The meeting noted that CBS-Ext.(10) agreed that NWP verification activities should be maintained across the DPFS as a quality assurance and management measure for the GDPFS. It noted that these activities would be the DPFS contribution to the WMO major initiative: the *Quality Management Framework (QMF)*.

## 4. CBS STANDARD PROCEDURES FOR VERIFICATION OF UPPER AIR FIELDS

4.1 The meeting recalled that the WMO *Manual on Global Data-Processing and Forecasting System* (GDPFS) (WMO-No. 485), attachment II-7, Table F: "Factors and methods used in standardized verification of NWP products", for deterministic NWP models, was revised by the CG-FV in its previous session (in 2009), focusing on verification of upper air fields. CBS-Ext.(2010) agreed that various aspects of the verification system required updating, including the need for clearer specifications and guidance on how to ensure a consistent implementation by all the global NWP centres, and therefore endorsed the updated standard verification system recommended by the CG-FV. In this context, the meeting reviewed the updated standard verification system. While noting that there were some comments regarding the potential application of CBS standard verification procedures for Polar Regions, and that some global NWP centres may not be as yet using the nearest native model grid point to the observation location for verification against observations, the meeting agreed there was no need for any changes and/or improvements at this stage. The meeting encouraged global NWP centres to explore the possibility of computing CBS scores for Polar Regions (north of 60ºN and south of 60ºS) **(Action: Explore the possibility of computing CBS scores for Polar Regions; global NWP centres; by early 2012)**.

4.2 The meeting discussed the way forward with the implementation of the updated standard verification system, including the milestones for a transitional period (run in parallel with the old system), taking into account the reports on the use and present CBS scores, including any associated problems, from the following NWP centres: DWD (Germany), CMC (Canada), JMA (Japan) Met Office (UK) and ECMWF. The full reports are available on the WMO Web site at: http://www.wmo.int/pages/prog/www/BAS/DocPlan_CG-FV2011.html

(item 4). The meeting noted that these centres were currently computing CBS scores but all would have to make some changes to implement the updated standard verification procedures.

4.3 The meeting noted that the CBS standard verification procedures require the use of a standard list of radiosonde stations, to be updated annually by the Lead Centre for radiosonde monitoring. However, the meeting noted that the procedures also require each centre to screen observations for gross errors and to apply operational bias correction. Therefore the centres will not use exactly the same observations in their verification. The meeting realized that there is at present no simple solution that will guarantee both the exclusion of poor data and that all centres use exactly the same observations. The meeting proposed a study to investigate the sensitivity of verification results to differences in observation usage in the verification between centres **(Action: Carry out a study to investigate the sensitivity of verification results to differences in observation usage in the verification between centres; lead: CMC, coordinating with ECMWF, UKMO and JMA; start by end February 2011 – final report by end 2011)**.

4.4 In addition, the meeting stressed that quality control of observations is critical for verification and for assimilation purposes, and therefore recommended that the CG-FV engage with ET-EGOS on aspects related to monitoring quality control of observations **(Action: Engage with the ET-EGOS; Chairperson; by June 2011)**.

4.5 The meeting noted that each global NWP centre produces its own analysis depending on the data assimilated and therefore the verification against analysis is not standardized across centres. In this context, the meeting recommended a study to evaluate the differences between different centres' analysis and estimate the uncertainty in the analysis errors (which are likely to vary with parameter and geographical area) **(Action: Explore the feasibility to carry out a study to evaluate the differences between different centres' analysis and estimate the uncertainty in the analysis errors; global NWP centres; review by June 2011)**.

4.6 The meeting was presented with a report by the Lead Centre for Deterministic NWP Verification (LC-DNV) –ECMWF, and agreed on developments and specific needs, including those related to standard products and data formats, processing and monitoring of scores, display of verification results on the Web site, and the maintenance of standards, as follow:

(a) LC-DNV ftp and web sites: **(Action: Set up the LC-DNV ftp and web sites; ECMWF; by February 2011)**

(1) the ftp site will be password protected. It will be used for the participating centres to deposit their verification statistics and to retrieve those from other centres. The climate fields to be used for verification (anomaly correlation) will be provided by ECMWF on this ftp site, as well as the current and historical (to track changes) lists of radiosonde stations to be used in the verification.

(2) the web site will contain the relevant documentation and contact details as well as graphical displays of the verification results. Initially the verification displays will be password protected while the products are developed. Once the site is ready, the access needs to be agreed; this could either be public access or available to WMO members only (password protected).

(b) climatology and new scores:

The required climate fields will be provided on the LC-DNV ftp site**(Action: Make available the climatology in the LC-DNV ftp site; ECMWF; by February 2011)**. These will initially be the daily climate mean fields that are required to compute the anomaly correlation in the verification against analyses. They will be provided initially in grib1 formats on 1.5 x 1.5 latitude longitude grid, as required by the new verification procedures; provision of grib 2 format will be investigated. These will be available via the ftp site, as well as the relevant documentation. Global NWP centres are

encouraged to retrieve and test the climatology. **(Action: Retrieve and test the climatology; 4 global NWP centres; by June 2011)** Complementary climate fields including standard deviation and quantiles of the climate distribution could also be produced. These are not required for the deterministic verification, but may be needed for the EPS verification. They may be made available in the same way in future.
Producing centres should implement the updated CBS standard verification procedures as stated in the Manual on the GDPFS, and endorsed by CBS-Ext.(10), as soon as possible, and send the results to the LC-DNV as specified in (c) **(Action: Report on the impact of changing climatologies in their scores; JMA; by end 2011)**. The LC-DNV will report to CG-FV by end 2011 on the results received from the global NWP centres **(Action: Report to CG-FV on the results received from the global NWP centres; ECMWF; by end 2011)**.

(c) verification data and formats:
Currently monthly means of scores of forecasts verifying in the given month are exchanged. The revised CBS procedures propose to modify this practice and to start exchanging daily values of scores. The data would be still sent in monthly batches but the monthly means would by computed by LC-DNV. The current verification scores are exchanged by email in a fixed ascii format. The meeting agreed that this will be replaced by CSV file format, which will improve automatic readability of the score files, while minimizing the technical work required to introduce a new format. The new format will be drafted by the LC-DNV and tested with some of the participating centres before finalizing; some adjustments will need to be made to allow for the extension to include daily scores and new parameters. The new format should be defined by March 2011 **(Action: Define the new format for the score files; ECMWF; by March 2011)** and producing centres are encouraged to test the new format for the score files **(Action: Test the new format for the score files; CMC and UKMO; from March to June 2011)**.
For initial development purposes the currently exchanged verification statistics (by e-mail, in ascii format) would be used in parallel with the ftp site. Producing centres would start sending the scores in the new file format (in CVS), by June 2011 **(Action: Send scores in the new format; 4 global NWP centres; start by June 2011)**. During the transitional period (from June to December 2011, or later), the old and the new exchange of formats would run in parallel.

(d) display of verification results:
A range of graphical displays of verification results from the participating centres will be developed and posted on the LC web site by June 2011 (initial results) **(Action: Display the verification results from the participating centres at the LC-DNV Web site, ECMWF, by June 2011)**. Initially the currently exchanged scores will be used to develop the displays. A more interactive display will be developed in the second half of 2011 **(Action: Develop a more interactive display for the verification results; ECMWF; second half of 2011)**. This will include the facility to select and compare different centres scores.

4.7 The meeting agreed to start the implementation of the updated CBS standard verification procedures with the four centres represented in the meeting (CMC, JMA, UKMO and ECMWF) for feasibility. However, it encouraged other global NWP centres to participate in this initiative as soon as they are ready. The meeting agreed to prepare a paper on the updated CBS standard verification procedures, focused on this CBS initiative rather than on the results (within a quality management framework). D. Richardson, T. Robinson and M. Mittermaier agreed to lead the preparation of this paper, and all global NWP centres were encouraged to participate **(Action: Prepare a paper on the updated CBS standard verification Procedures; D. Richardson, T. Robinson and M. Mittermaier, by early 2012, depending of**

**the availability of data and scores)**. Participating global NWP centres were also encouraged to present this initiative in various conferences, symposia and seminars.

## 5. VERIFICATION OF SURFACE FIELDS

5.1 The meeting recalled that its 2009 session recommended that the initial focus should be on updating the verification of upper air fields, however in a later stage, it would also develop procedures for verification of surface parameters, which are already part of the ToR for the CG-FV. The meeting agreed on the importance of the inclusion of surface parameters verification into the operational verification activity for WMO, and discussed how to achieve this, based on the work plan defined in its previous meeting.

5.2 In this context, the meeting noted that the ECMWF's Member States had recently completed a review of the verification of the ECMWF forecasting systems, under the auspices of a Subgroup of the ECMWF Technical Advisory Committee. One of the main objectives of the Subgroup was to review the verification of surface parameters and in particular to recommend an appropriate measure to monitor the long-term progress in the prediction of surface weather. Noting that CBS did not currently provide procedures for the verification of surface parameters for deterministic forecasts, and after considering a number of surface weather parameters, the Subgroup agreed that precipitation accumulated over 24 hours, verified against SYNOP observations from the GTS, would best meet the requirements for an overall headline score; and therefore made a number of recommendations on procedures to follow for the verification of precipitation, in relation to: (a) the method of interpolation to station location; (b) the availability and quality of observations; (c) the climate differences between stations; and (d) the geographical distribution of observations. Following these recommendations, the ECMWF developed a new verification score – SEEPS (Stable Equitable Error in Probability Space), which was specifically designed to look at long-term trends of precipitation forecast skill rather than on severe weather. Detailed information can be found in a summary report on the ECMWF review, which is available on the WMO Web site at: http://www.wmo.int/pages/prog/www/BAS/DocPlan_CG-FV2011.html (item 5).

5.3 While noting that the SEEPS score allows the evaluation of the performance of the precipitation forecast through verification against station observations, the meeting stressed that with any verification against observations the issues of observation error, representativeness (intrinsic differences between the model grid box value and an observation at a single location) and inhomogeneity of the geographical distribution of observations must all be taken into account. In order to mitigate these effects, the meeting agreed that a high quality global gridded precipitation analysis (in near real-time) is highly desirable for the verification. The meeting also noted that if a model is used in the generation of this analysis then it may have some impacts on scores for different models. The meeting learned that the DWD (Germany) operates a Global Precipitation Climatology Centre (GPCC), whose main focus is on precipitation climate monitoring over Earth's land surfaces (see http://gpcc.dwd.de). The GPCC deals with worldwide collection and re-analysis of rain gauge data, as well as quantitative precipitation estimation for Germany based on many observational systems. It maintains monthly analyses and annual review of global precipitation. The meeting agreed that discussions with the GPCC could explore the potential of obtaining high quality global gridded precipitation analyses for the purpose of verification, even if these analyses may not be available in real-time.

5.4 The meeting noted that since the CBS exchange of scores did not include any surface parameters, it had not been possible to make the same routine comparison of scores for any surface parameter as is done for the upper-air fields. However, it acknowledged that the ECMWF had recently started to receive global precipitation forecast fields from a number of global NWP centres, specifically for verification purposes, and had also computed the SEEPS score for precipitation forecasts from the JMA and the Met Office UK deterministic global

forecast models. The meeting encouraged other NWP centres to send/make available the global precipitation forecast fields from their models to ECMWF, who would compute the SEEPS score and display examples of the results in the Lead Centre web site on an experimental basis (password protected). The LC-DNV will also present a comparison with other scores. A paper will be written showing examples of comparisons between scores for precipitation forecasts from different NWP centres' models **(Action: Prepare an outline for a paper showing examples of comparisons between scores for precipitation forecasts from different NWP centres' models; ECMWF; by mid 2011)**.

5.5 Recognizing the potential benefits of using climatological thresholds for contingency table based verification (including the SEEPS score), the meeting encouraged other NWP centres to compute such a score using climatological thresholds. It stressed that for consistency the use of the same climatology for the synoptic stations is required. While noting that SYNOP observations are available on the GTS, the distribution of such climatology may not be allowed due to data policy and restrictions. Nevertheless, the meeting requested the ECMWF to consider making available such climatology on the Lead Centre ftp site (password protected) **(Action: Consider making available climatological thresholds based on SYNOP observations on the Lead Centre ftp site (password protected); ECMWF; as soon as possible)**, and the Secretariat to evaluate the feasibility of such request in accordance with the WMO Resolution 40 **(Action: Evaluate the feasibility of making available climatological thresholds based on SYNOP observations in accordance with the WMO Resolution 40; Secretariat; as soon as possible)**.

5.6 The meeting was presented with a report by the WWRP/WGNE Joint Working Group on Forecast Verification Research (JWGFVR) on its activities, which would guide the work of the CG-FV in further developing the CBS operational procedures for forecast verification. The meeting recalled that the JWGFVR had produced one document containing guidelines and describing methods for verification of quantitative precipitation forecasts (WMO technical report WMO/TD No. 1485: "Recommendations for the Verification and Inter-comparison of QPFs and PQPFs from Operational NWP Models") and noted its usefulness to the CG-FV discussions at its previous meeting and to the work of the ECMWF Subgroup on Verification. The meeting welcomed the work that was in progress by the JWGFVR to develop an equivalent document for cloud verification and expected this to again provide useful guidance to CG-FV. In addition, the meeting noted that the JWGFVR was preparing a document for verification of tropical cyclones, which would include a literature survey, with identification of promising methods. The meeting was also pleased to hear of the on-going work on the development and evaluation of verification methods for extreme events, including the studies to assess performance and sensitivity of the Extreme Dependency Score (EDS) and related scores and stressed the importance of this research in the context of providing guidance for appropriate verification procedures for severe or extreme weather.

5.7 The JWGFVR also carries out training activities, including organizing workshops to promote verification in research and operational activities. The meeting noted that the 5$^{th}$ International Verification Methods Workshop would be held in Melbourne, Australia, from 1 to 7 December 2011. The workshop would include 3 days of tutorial prior to the scientific conference, aimed at introducing basic concepts and scores to a group of about 40 students. The meeting encouraged the participation of forecasters from SWFDP countries and urged the Secretariat to seek for funds for their participation. In addition, the meeting noted that the JWGFVR had been focusing its work on developing web tools for verification, including EUMETCAL modules for distance learning activities (see www.eumetcal.org.uk/eumetcal/verification/www/english/courses/msgcrs/index.htm), and promoting best practice of verification.

5.8 The meeting noted in the report by the JWGFVR that the precipitation verification phase of the Spatial Verification Inter-comparison Project had been completed, with many new verification methods demonstrated. The meeting agreed that these new verification methods

and scores could be considered for inclusion in the CBS standard verification procedures at some stage. In this context, the meeting strongly recommended that the liaison between the CG-FV and the JWGFVR be continued and further explored.

5.9 The meeting discussed the availability, quality control, and use of surface observations in the verification of surface fields, based on the reports by the NWP centres from CMC (Canada), JMA (Japan), Met Office (UK), and TMA (Tanzania). Full reports are available on the WMO web site at http://www.wmo.int/pages/prog/www/BAS/DocPlan_CG-FV2011.html (item 5). The meeting noted that in general global NWP centres had been performing verification of surface fields. So far, operationally, the main focus had been on verification of precipitation, 2m temperature and 10m wind speed forecasts. Verification of other surface parameters (e.g. wind direction, clouds and dew point) was being done mostly on an experimental basis. The meeting agreed that verification of surface fields is very complex, in particular for those parameters (such as wind and temperature) that are significantly localized due to topographic and coastline effects. The meeting noted that due to these factors, a number of high altitude stations had not been considered in some of verification studies. In order to evaluate the differences on the number of synoptic stations being used/rejected by the global NWP centres for surface verification purposes, the meeting decided to share among them, their list of stations for a specific (or a few) days **(Action: Share the list of stations for a specific (or a few) days; 4 global NWP centres; report by next CG-FV meeting)**.

5.10 Based on discussions, the meeting developed recommendations and guidelines on the way forward and future work on scores and procedures for surface weather verification towards CBS-XV (2012). In particular, the meeting agreed that:

(a) SEEPS score, along with other possible/appropriate scores, should be computed for precipitation forecasts from global NWP centres and results should be made available on the Lead Centre Web site (password protected) on an experimental basis (one year trial) for evaluation/monitoring prior to a possible recommendation for inclusion in the CBS standard verification procedures.

(b) for other surface parameters (2m temperature, 10m wind speed and direction, clouds and dew point), more research and studies are required to allow recommendations to be developed. In particular, noting that the Met Office (UK) is preparing some studies and evaluations for cloud verification, and the JWGFVR is preparing a cloud verification document, the meeting encouraged (a) the Met Office (UK) to share its results among members of the CG-FV prior to the development of recommendations to CBS-XV (2012); and (b) the JWGFVR to provide its cloud verification document as soon as it is completed. In the same context, the meeting encouraged other global NWP centres to share their studies on surface weather verification with members of the CG-FV.

(c) for the purpose of model development and surface weather verification, more data, and more frequent data, should be exchanged on the GTS. The meeting stressed that availability (over some regions) and quality control of observations for verification are of concern and need to be taken into account in developing verification systems. Additionally, the meeting agreed that greater standardization of observing practices is also required, as well as better precision of location of stations and their metadata, including reference to manual/automatic weather stations. It therefore recommended this issue should be followed up through the appropriate WMO Expert Team(s) and/or Group(s), including the CBS ET on Evolution of the Global Observing System (ET-EGOS). The meeting also recommended that any other near-real-time data not being transmitted on the GTS be made available for verification purposes.

(d) forecaster perception/evaluation from a synoptic point of view (chart verification) should be encouraged and feedback to global NWP centres should be provided.

## 6. VERIFICATION OF SEVERE WEATHER AND WARNINGS

6.1 Reporting and verification of warnings of severe weather events are required: whether they were forecast or not, and when they were forecast, whether they occurred or not. With this context in mind, the meeting had a general discussion on verification for severe weather and warnings, taking into account Public Weather Services (PWS) initiatives that were being developed in the Met Office UK (the Warning Verification System) and in TMA (Tanzania), through the Severe Weather Forecasting Demonstration Project (SWFDP). In addition, the meeting noted that the ECMWF assists its Members States in forecasting high impact weather through the Extreme Forecast Index (EFI).

6.2 The meeting agreed that verification of severe weather and warnings is very complicated and noted that this issue had been addressed by a number of WMO programmes. Within the context of its mandate and responsibilities, the meeting agreed that more research is required, before being able to provide any guidance. The meeting noted that some studies could be done for verification of deterministic forecasts using EDS score, however it agreed that severe weather aspects should be addressed in a probabilistic forecast context, and in this regard, it suggested that this issue be followed up through the CBS ET on Ensemble Prediction Systems (ET-EPS).

6.3 Regarding verification of Tropical Cyclone (TC) tracks, which are primarily based on the output of the NWP models, the meeting noted that JMA (Japan) started the Tropical Cyclone Track Verification in 1992 and had reported the results at WGNE sessions every year since then. The WGNE recognized that the evaluation of TC track forecasts could indicate the performance of those models in the tropics and subtropics. The meeting noted that the TC track verification system had improved and nine NWP centres (BOM, CMC, DWD, ECMWF, JMA, France, NCEP, NRL, and UKMO) participated in the comparison in 2010. Additionally, the meeting recalled that the JWGFVR is preparing a document for verification of tropical cyclones, which would include a literature survey, with identification of promising methods. In this context, the meeting suggested that the WGNE verification study continues and be expanded to include TC intensity for an improved monitoring of the TC forecasting system.

6.4 The meeting noted that a number of systems being implemented through the PWS and SERA studies for verification of warnings are focused on user impacts, which are beyond the meteorological aspects. The meeting agreed that the CBS should address verification of severe weather and warnings only from the operational meteorological point of view, and evaluate performance of models taking into account climatological extremes for the relevant weather parameters.

## 7. VERIFICATION IN NMHSs USING NWP PRODUCTS FROM GLOBAL AND REGIONAL CENTRES, INCLUDING FOR SWFDP

7.1 The meeting had a general discussion on verification using NWP products from global and regional centres, including from the SWFDP experience, based on a report by a representative of an NMHS (TMA) and a briefing on SWFDP verification activities, including a guide on verification that was developed for the project, emphasizing the necessity of verification as an activity that supports the continuous improvement of the warning and forecasting system. The meeting noted that a number of NMHSs running LAMs would be able to perform verification as part of their activities and therefore promoted the use of the defined CBS scores as stated in the Manual on the GDPFS. These CBS scores were primarily

designed for verification of global models, however they can also be applied to LAMs. The meeting strongly encouraged verification by those NMHSs running LAMs. Additionally, the meeting noted that it had been working on the development of procedures for surface weather verification and encouraged those NMHSs using NWP products from global and regional centres to visit the Lead Centre Web site (as soon it becomes open) to see results of verification of surface fields.

7.2 The meeting also encouraged NMHSs to contribute additional surface observational data for verification purposes, by transmitting them through the GTS or making available via ftp servers.

7.3 Noting that global NWP centres compute CBS scores globally, the meeting encouraged NMHSs using global NWP products to perform verification of fields from global models at a regional level or for specific locations. However, it noted that data from global NWP centres are mostly available in graphical format. In order to facilitate verification, the meeting encouraged cooperation between global NWP centres and individual NMHSs and RSMCs that could be in different ways:

(a) For those NMHSs with the ability to collect the GRIB files and have observational data, and the capability to prepare the data for verification, the meeting encouraged the NMHSs to perform verification against observations and provide feedback to global NWP centres; or

(b) For those NMHSs unable to deal with global fields and have observational data, the meeting suggested that global centres provide time series of data for selected locations to NMHSs to allow them to perform verification and provide feedback to global NWP centres; or

(c) For those NMHSs unable to perform verification and have observational data, to provide these data to global NWP centres, who would use their data exclusively in the verification of model forecasts.

7.4 Within the framework of the SWFDP, the meeting noted that the verification activities at the NMHS level were improving steadily, and that most participating NMHSs were carrying out the verification according to the suggested methods (see guide document available on the WMO web site at: http://www.wmo.int/pages/prog/www/BAS/DocPlan_CG-FV2011.html (item 7). At the RSMC level, verification methods had been agreed, and work had started on the verification of the severe weather guidance charts. The meeting agreed that the SWFDP provides an ideal framework for implementing collaborative arrangements between global NWP centres and individual NMHSs and RSMCs for verification, and suggested to use the SWFDP – Eastern Africa as a pilot. In this context, the meeting encouraged the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP) to explore the feasibility of providing time series of numerical precipitation data for the synoptic stations in the region (wet season) for using in the verification session of the SWFDP training for Eastern Africa, which would be held in July 2011 (tentatively) **(Action: Explore the feasibility of providing time series of numerical precipitation data for the synoptic stations in Eastern Africa region (wet season) for using in the verification session of the SWFDP training; participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP), in liaison with L. Wilson on training aspects; by July 2011 (tentatively))**. The meeting also requested TMA to assist the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP) in identifying the list of relevant synoptic stations in Eastern Africa region **(Action: Assist the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP) in identifying the list of relevant synoptic stations in Eastern Africa region; TMA, in coordination with the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP), and in liaison with L. Wilson on training aspects; by July 2011 (tentatively))**.

## 8. ANY OTHER BUSINESS (AOB)

8.1 The meeting suggested that the next meeting of the CG-FV be held in early 2012, in order to review and propose amendments to the Manual on the GDPFS, especially for surface weather parameters, prior to their recommendation to CBS-XV.

8.2 There were no other issues raised during the meeting.

## 9. CLOSING

9.1 The meeting of the Commission for Basic Systems Coordination Group on Forecast Verification (CG-FV) closed at 13.57 on Thursday, 27 January 2011.

**Annex I**

# AGENDA

**1. ORGANIZATION OF THE MEETING**
- 1.1 Opening of the meeting
- 1.2 Approval of the agenda
- 1.3 Working arrangements for the meeting

**2. REVIEW THE TERMS OF REFERENCE OF THE COORDINATION GROUP ON FORECAST VERIFICATION (CG-FV)**

**3. REPORT ON THE OUTCOMES OF CBS-Ext.(2010) RELATED AND/OR RELEVANT TO THE CG-FV**

**4. CBS STANDARD PROCEDURES FOR VERIFICATION OF UPPER AIR FIELDS**

**5. VERIFICATION OF SURFACE FIELDS**

**6. VERIFICATION OF SEVERE WEATHER AND WARNINGS**

**7. VERIFICATION IN NMHSs USING NWP PRODUCTS FROM GLOBAL AND REGIONAL CENTRES, INCLUDING FOR SWFDP**

**8. ANY OTHER BUSINESS**

**9. CLOSING**

**Annex II**

## LIST OF PARTICIPANTS

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**Annex III**

## TERMS OF REFERENCE FOR THE CG-FV

**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.

**Annex IV**

## LIST OF ACTIONS

| Para | Action | By whom | When/target |
|---|---|---|---|
| 4.1 | Explore the possibility of computing CBS scores for Polar Regions | global NWP centres | by early 2012 |
| 4.3 | Carry out a study to investigate the sensitivity of verification results to differences in observation usage in the verification between centres | CMC, coordinating with ECMWF, UKMO and JMA | start by end February 2011 – final report by end 2011 |
| 4.4 | Engage with the ET-EGOS | Chairperson | by June 2011 |
| 4.5 | Explore the feasibility to carry out a study to evaluate the differences between different centres' analysis and estimate the uncertainty in the analysis errors | global NWP centres | review by June 2011 |
| 4.6 (a) | Set up the LC-DNV ftp and web sites | ECMWF | by February 2011 |
| 4.6 (b1) | Make available the climatology in the LC-DNV ftp site | ECMWF | by February 2011 |
| 4.6 (b2) | Retrieve and test the climatology | 4 global NWP centres | by June 2011 |
| 4.6 (b3) | Report on the impact of changing climatologies in their scores | JMA | by end 2011 |
| 4.6 (b4) | Report to CG-FV on the results received from the global NWP centres | ECMWF | by end 2011 |
| 4.6 (c1) | Define the new format for the score files | ECMWF | by March 2011 |
| 4.6 (c2) | Test the new format for the score files | CMC and UKMO | from March to June 2011 |
| 4.6 (c3) | Send scores in the new format | 4 global NWP centres | start by June 2011 |
| 4.6 (d1) | Display the verification results from the participating centres at the LC-DNV Web site | ECMWF | by June 2011 |
| 4.6 (d2) | Develop a more interactive display for the verification results | ECMWF | second half of 2011 |
| 4.7 | Prepare a paper on the updated CBS standard verification Procedures | D. Richardson, T. Robinson and M. Mittermaier | by early 2012, depending of the availability of data and scores |
| 5.4 | Prepare an outline for a paper showing examples of comparisons between scores for precipitation forecasts from different NWP centres' models | ECMWF | by mid 2011 |
| 5.5 | Consider making available climatological thresholds based on SYNOP observations on the Lead Centre ftp site (password protected) | ECMWF | as soon as possible |

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|---|---|---|---|
| 5.5 | Evaluate the feasibility of making available climatological thresholds based on SYNOP observations in accordance with the WMO Resolution 40 | Secretariat | as soon as possible |
| 5.9 | Share the list of stations for a specific (or a few) days | 4 global NWP centres | report by next CG-FV meeting |
| 7.4 | Explore the feasibility of providing time series of numerical precipitation data for the synoptic stations in Eastern Africa region (wet season) for using in the verification session of the SWFDP training | participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP), in liaison with L. Wilson for the training aspects | by July 2011 (tentatively) |
| 7.4 | Assist the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP) in identifying the list of relevant synoptic stations in Eastern Africa region | TMA, in coordination with the participating global centres in the SWFDP – Eastern Africa (ECMWF, Met Office UK and NCEP), and in liaison with L. Wilson for the training aspects | by July 2011 (tentatively) |