**WORLD METEOROLOGICAL ORGANIZATION**

**COMMISSION FOR BASIC SYSTEMS**

**EXPERT TEAM ON OPERATIONAL WEATHER FORECASING PROCESS AND SUPPORT (ET-OWFPS)**

**Beijing, China, 12-16 March 2018**



**FINAL REPORT**

****

**Executive Summary**

The meeting of the CBS Expert Team on Operational Weather Forecasting Process and Support (OWFPS) was held on 12-16 March 2018, in Beijing, China. ET-OWFPS discussed progress of its Task Teams on Development of Guidelines on High resolution NWP, Development of Guidelines for Nowcasting Techniques, and Surface Verification, as well as the Task Team on Revision of the Manual on GDPFS. The meeting noted with satisfaction the publication of the Guidelines for Nowcasting Techniques (WMO-No. 1198) and of the new edition of the Manual on GDPFS (WMO- No. 485). The ET-OWFPS reviewed the actions (see Annex III) from its previous meeting (May 2016) and, considering its work plan for 2016-2020 as approved by CBS-MG, discussed the progress since the last meeting and agreed on its future work, including the establishment of the TT on EPS Post Processing, implementation of the new edition of the Manual (including new standard surface verification and designation and audit of RSMCs) and the related Guide. A summary of actions and recommendations is given in Annex XII.

**1. OPENING**

1.1 The meeting of the CBS (DPFS) Expert Team on Operational Weather Forecasting Process and Support (ET-OWFPS) was opened by its Chairperson, Mr David Richardson (ECMWF), at 09.30 hours on Monday, 12 March 2018, at the China Meteorological Administration (CMA), Beijing, China. He thanked China for hosting the meeting and the members for attending. He also thanks CMA and local organisers, Mrs Jianjie Wang and Mr Guan Chenggong and the WMO secretariat for all the coordination work. He welcomed the new members of the team: Amin Erfani (Canada), Ken Mylne (UK), Hitoshi Sato (Japan) and Andrew Tupper (Australia).

1.2 After a tour de table of participants to introduce themselves he invited Mr Chen Yongqing, Director of Bilateral Cooperation Division of International Cooperation Department /CMA, to take the floor for his opening remarks. Mr Chen welcomed the team to Beijing and CMA and highlighted the important role of this Expert Team in helping Members improve their forecasting capabilities. He also highlighted the commitment of China to the work of WMO as demonstrated by hosting over 20 WMO’s specialized or regional centers and by its assessed contribution to WMO (3rd position) and its support for capacity building in Africa and some of Asian Countries, offering scholarship to over 55 trainees annually. He wished to the team excellent discussion for an enhanced collaboration on weather forecast operations.

1.3 The Chair thanked Mr Yongqing on behalf of the team for the hospitality. Mr Abdoulaye Harou, Chief/DPFS at WMO also thanked the government of China for agreeing, through the PR, to host the meeting and conveyed Professor Petteri Taalas’s (the WMO Secretary General) appreciations.

1.4 The Chair noted the departure of three members of the team and conveyed the appreciation of the work they have done: Mr Hamza Kabelwa (Tanzania), Mr Andre Methot (Canada) and Mr Pierre Eckert (Switzerland). He also noted the absence of Mr Thomas Haiden (ECMWF) who sent in his apologies of not being with the team at this meeting and of Mr Amin Erfani (Canada) due to illness and sent in his best wishes. He noted that Mr Erfani would join the morning sessions by video-link and thanked CMA for facilitating that remote participation.

1.5 The chair noted that a lot of work has been accomplished since last meeting in Montreal (May 2016), especially by the TTs and in revising the Manual on GDPFS. He indicated that the team will review actions of the last meeting and that this meeting will focus on the establishment of a TT on EPS Post Processing, Implementation of the Manual and the related Guide.

**2. ORGANIZATION OF THE MEETING**

**2.1 Adoption of the agenda**

2.1.1 The Team adopted the provisional agenda with the following changes/addition: move item on EPS verification under item 4.2; discuss the application of Honk Kong observatory (HKO) for designation as RSMC Nowcasting under item 5.2; inserted Ken Mylne’s talk to the National Meteorological Centre of CMA at 14:00 on Tuesday 13 March 2018. Mr Mylne was invited by National Meteorological Center of CMA to present the UK Met Office work on integrated post processing and verification for the convective scale (this also is part of the agenda item 7.1). The adopted Agenda is available at Annex I

**2.2 Working arrangements**

2.2.1 The Team agreed on its hours of work and other practical arrangements for the meeting. It was agreed that the meeting will start at 9:00 am and finish at 5:30pm. A morning coffee break will occur at 10:30 am. Lunch will occur between 12:30 pm and 2 pm and afternoon coffee breaks will at 3:30 pm for 30 min. One exception is on Wednesday 14 March 2018 where the team will attend the NMC morning briefing at 8 am followed by 30 min tour of the operation centre. It was also noted that CMA would host a reception on Monday at 6:30 pm.

2.2.2 All documents submitted for the meeting are referenced and hyperlinked in the Documentation Plan (INF. 1), which had been posted on the WMO website at: <http://www.wmo.int/pages/prog/www/BAS/CBS-meetings.html>

2.2.3 The list of Participants is provided in Annex II

**3. INTRODUCTION AND BACKGROUND, INCLUDING REVIEW OF RELEVANT OUTCOMES OF PREVIOUS MEETINGS**

**3.1 Outcomes of WMO Constituent Body sessions related or relevant to the Expert Team on Operational Weather Forecasting Process and Support (ET-OWFPS)**

3.1.1 The chair decided to briefly introduce the ET-OWFPS ToR in consideration of the new members of the team.

3.1.2 Mr Harou recalled that, since the last meeting of the ET in Montreal, Canada (May, 2016) a few major decisions were made by Constituent Bodies. Following Resolution 11 by the seventeenth Session of the World Meteorological Congress (Cg-17) to move “Towards a future enhanced integrated and seamless WMO Data-processing and Forecasting System”, EC-68 decided to establish a Steering Group (SG) on Seamless GDPFS, chaired by the President of CBS, to develop a plan for the implementation of S/GDPFS. CBS-16 (Nov 2016) recommended the publication of the revised Manual on GDPFS (WMO-No. 485) for approval by EC-69 (May 2017). EC-69 approved the publication of the revised Manual on GDPFS (WMO-No. 485) and the Vison for S/GDPFS. In addition, it requested the SG S/GDPFS to table an Implementation Plan at EC-70 and decided that the Executive Council Steering Group on the Seamless Data-processing be chaired jointly by the presidents of CBS and CAS;

**3.2 Review of Actions from last ET-OWFPS**

3.2.1 The team updated the list of actions from the previous meeting in Montreal (May 2016) as per Annex III. It agreed that all actions were completed and that any follow-up activities will be addressed in the relevant agenda items (as shown in Annex III).

**3.3 Outcome of ICT DPFS Meeting**

3.3.1 The Chair reported on the activities of the ET-OWFPS since its last meeting in May 2016 and summarized the relevant actions from ICT DPFS meetings in May 2016 and February 2018. This information is captured in Annex IV. The team was invited to take note of the revised list of activities and milestones for ET-OWFPS agreed by ICT DPFS and CBS Management Group (Annex V).

3.3.2 It was noted that the publication of the revised Manual on GDPFS and the Guidelines on Nowcasting Techniques was not publicized and the Secretariat was asked to inform Members using all means available such as “what is new” section on the WMO website, WMO bulletin and CBS Operational Newsletter.

3.3.2 ICT discussed the Audit Process related to Centre designation and agreed to keep this process simple as much as possible.

**4. PROGRESS ON VERIFICATION ACTIVITIES**

**4.1 Review progress on the implementation of Surface verification**

4.1.1 Tom Robinson briefed the meeting on the addition of standards for the exchange of surface verification data to the new Manual of the GDPFS, noting that some details of the information to be included in the Manual were different in the published version of the Manual. He documented the differences and the meeting agreed what will need to be included back into the Manual (Annex VI, and see 4.2.6). He also noted that the addition of two new parameters (2m Temperature, 10 m wind) in the list of parameters for EPS verification have been correctly added to the new Manual on GDPFS while the documentation on the score methodology definition (mathematical formulas) for both upper-air and surface has been made available on the LC-DNV.

**Action 1: Mr Robinson to work with the Secretariat to ensure the missing information related to surface and upper air information in the new Manual on GDPFS are put back in (Annex VI)**

**Action 2: Secretariat to send letter (drafted by LC-DNV) to all Producing Centres to initiate the exchange of their surface verification scores and to identify their respective point of contact.**

 **4.2 Review Lead Centre activities (deterministic and EPS)**

**LC-DNV**

4.2.1 Mr Robinson reported that apart from work on adding the surface scores (see item 4.1) there have been no major developments. Scores are being received from 9 centres (JMA, UKMO, NCEP, CMC, DWD, MF, BOM, KMA, RUS) on a regular basis. However, the data from NCEP is still in the validation phase (working toward surface verification). All centres except UKMO send both monthly and daily data. UKMO sends daily data only (although a monthly file was sent for January 2018), so LC-DNV computes the monthly dataset for them (for plotting, and for other centres to access).

4.2.2 He reported that the daily data was supposed to be used to construct confidence intervals but so far the LC-NDV has not managed to provide them, mostly because the plotting system on the LC-DNV page is too rigid and would require major changes.

4.2.3 Another issue is the use of ftp as a mode of transfer. NCEP cannot use ftp and have requested secure ftp (sftp). ECMWF does not provide this at the moment, so a solution is currently being sought.

**Action 3: Mr Robinson and LC-DNV to investigate short and long-term solutions to secure ftp issue (CMC may consider stepping in to help NCEP on the ftp issue); inform producing centres as necessary**

**Action 4: Mr Robinson and LC-DNV to send agreed set of questions (Annex VII) to the producing centres**

4.2.4 The status of implementation of the updated CBS procedure for the upper air verification is presented in Annex VIII.

4.2.5 Mr Robinson indicated that following publication of the new Manual of the GDPFS, some clean-up and updating of links was done to the LC-DNV wiki page. The page now links to the New Manual. The standards and procedures are clearly laid out and easy to find. He confirmed that, as per item 4.1 (TT-SV progress), the LC-DNV is fully prepared to accept surface verification scores from participating NWP Centres.

4.2.6 Mr Robinson reported that (as for the surface verification) some details of the information to be included in the Manual for upper-air verification were different in the published version of the Manual. He documented the differences, the most important of which is the omission of the list of mandatory and additional scores from Section 7. The meeting agreed what will need to be included back into the Manual (Annex VI) and also agreed that it would be acceptable to keep the mandatory forecast steps for upper-air verification as every 24 hours, with additional recommended verification at 12-hourly steps. **See Action 1 under 4.1.1.**

4.2.7 The team discussed a number of issues including the LC-DNV confidence intervals, the implementation of scores for each upper air station, matching of mandatory fields and mandatory verification, checking of all score on LC-DNV website and verification procedures. The discussion has resulted in the following actions:

**Action 5: LC-DNV to implement computation and display of confidence intervals for verification results**

**Action 6: Tom Robinson and LC-DNV to develop a plan for the implementation of scores for each upper air station** **as recommended in Manual**

**Action 7: LC-DNV to send email to Producing Centres requesting them to stop sending old scores (some centres still do) and to only provide the new ones from now on**

**Action 8: Mr Robinson to check all scores on LC-DNV web site to check for any issues**

**LC-EPS**

4.2.8 Mr Sato (Japan) reported on the current status of the exchange and the publication of global EPS verification results and the activities of the Lead Centre for EPS Verification. The Japan Meteorological Agency (JMA), as the Lead Centre for Ensemble Prediction System (EPS) Verification, promotes both exchanging of EPS verification reports and presenting the skill of EPS for a better use of EPS products. JMA has been operating two Internet sites, an FTP site and a Web site (<http://epsv.kishou.go.jp/EPSv/>), since January 2004. The FTP site is for the EPS producing centres to upload the statistics data for their EPS verification reports. The original verification statistics are also uploaded onto the Web site and available through the site.

4.2.9 The Web site shows the original verification statistics, their update and contents information, and their visualized figures, and, therefore, it is possible to compare the EPS skill of the EPS producing centres. It is also expected that the activities contributes to improvement of the performance of each EPS. Mr Sato also reported that the guidelines on the exchange and use of EPS verification reports are set by the Lead Centre (JMA) and are available openly to the National Meteorological and Hydrological Services (NMHSs) of WMO Members through the Web site (<http://epsv.kishou.go.jp/EPSv/guideline.pdf>). The latest guidelines are dated on 30th November 2012 and the registered centres are as follows:

- CMA (China Meteorological Administration; Dec. 2009)

- CMC (Canadian Meteorological Centre; Sep. 2004)

- CPTEC (Centro de Previsão de Tempo e Estudos Climáticos; Dec. 2005)

- DWD (Deutscher WetterDienst; Jun 2017)

- ECMWF (European Centre for Medium-Range Weather Forecasts; Jan. 2004)

- JMA (Jan. 2004)

- KMA (Korea Meteorological Administration; Jan. 2004)

- NCEP (National Centers for Environmental Prediction; Jun. 2012)

- RUMS (Hydrometeorological Centre of Russia; Dec. 2010)

- UKMO (United Kingdom Met Office; Jan. 2004)

**Action 9: In consideration of the published revised Manual on GDPFS, the LC-EPSV to update its website with the revised guidelines to match the new edition of the Manual on GDPFS) and to contact producing centres to provide required scores**

**Action 10: Ken Mylne to contact LC-EPS to propose update to implementation guidelines for verification of lagged EPS; update to be circulated to ET for approval**

**Action 11: LC-EPSV to consider possibility to extend functionality of web site, for example to allow more interactivity and ability to more easily compare scores from different producing centres**

**4.3 Establishment of Lead Centre for Ocean Wave Verification**

4.3.1 The Chair (Mr Richardson) reported on the status of the establishment of the Lead Centre for Ocean Wave Forecast Verification (LC-WFV): Routine inter-comparison of wave model forecast scores has been carried out since 1995 in the JCOMM Expert Team on Waves and Coastal Hazards (ETWCH) Wave Forecast Verification project (WFVP); the computation of scores and presentation of results has been carried out by ECMWF on behalf of the ETWCH. To formalize this (rather than continue as a “project”, a new designation Lead Centre for Wave Forecast Verification (LC-WFV) was introduced in the revised Manual on the GDPFS, 2017 edition (Part II, 2.2.3.4). The LC-WFV activities and designation of ECMWF as LC-WFC were adopted by CBS-16.

4.3.2 JCOMM adopted at its 5th Session (Geneva, Switzerland; October 2017) the draft Recommendation 9.5 (2)/1 (JCOMM-5) regarding Criteria for, and designation of, marine-related GDPFS centres. JCOMM recommended to EC-70 (June 2018) the formal designation of RSMC ECMWF for coordination of wave forecast verification and ECMWF has started a LC-WFV page at <https://software.ecmwf.int/wiki/display/WLW>. ECMWF has set up an archive for the wave forecasts from other centres. Data from ECMWF and one other centre is being archived, starting from 1 Feb 2018 onwards. It is hoped that other centres will soon start to provide their data (in grib format). Clicking on 'GRIB data specification' (lower down, under 'Data format') will lead to the full table of centres, domains, resolution, etc. The ones that are marked green (currently only ECMWF and METEOAM) are 'active'.

4.3.3 As soon as a few centres are sending data regularly, model intercomparison plots will be generated by the LC-WFV and presented on the LC-WFV page. It is expected to have the first intercomparison plots on the LC-WFV page in late summer 2018. In the meantime the WFVP scores are still computed and available: <https://www.ecmwf.int/en/forecasts/charts/catalogue/w_wave_intercomparison?facets=Range,Medium%20(15%20days)%3BType,Verification&time=2017112900,0,2017112900&area=All%20stations%20combined&statistics=Scatter%20Index>

4.3.4 It is noted that JCOMM didn’t reestablish Expert Team on Waves and Coastal Hazards Forecasting Systems (ETWCH) at its 5th Session (JCOMM-5). This team is supposed to be responsible for managing the information on RSMCs for numerical ocean wave prediction and (jointly with ET-OWFPS) for coordination of wave forecast verification. When the new structure of JCOMM is endorsed by EC, it will be necessary to replace it with an appropriate expert team of JCOMM in the revised Manual.

**4.4 Tropical cyclone verification (proposed Lead Centre) – (CMA, JMA)**

**Shanghai Typhon Institute (STI)**

4.4.1 Ms Hui Yu of STI reported on the progress on tropical cyclone verification activities led by Shanghai Typhoon Institute of CMA in recent years. She recalled that The ESCAP/WMO Typhoon Committee has a long history of fifty years and has been an example followed by countries of other regions affected by tropical cyclones. It is an intergovernmental body established in 1968 under the World Meteorological Organization (WMO) in order to promote and coordinate the planning and implementation of measures required for minimizing the loss of life and material damage caused by typhoons in ECAPE region. The Typhoon Committee is currently composed of 14 Members: Cambodia, China, Democratic People’s Republic of Korea, Hong Kong China, Japan, Lao People’s Democratic Republic, Macao China, Malaysia, the Philippines, Republic of Korea, Singapore, Thailand, Socialist Republic of Viet Nam and United States of America.

4.4.2 She also recalled that the Shanghai Typhoon Institute (STI) is a national-level institute specialized in tropical cyclone (TC) research and has been dedicated in TC forecast verification activity for over 40 years. With the authorization and support of WMO, STI built real-time and post-season verification systems as an outcome of WMO-Typhoon Landfall Forecast Demonstration Project (TLFDP) in 2011. Since 2012, metrics for verification, including TC genesis, ensemble probability, prediction system error, NWP characteristic analysis, and so on, have been developed and made available on a website. Annual verification report has been submitted to ESCAP/WMO Typhoon Committee since 2013.

4.4.3 STI developed a new capability in Track forecast Integral Deviation (TFID), Categorical score for the verification of TC intensity forecasts, Track Error Rose (TER) for the verification of TC track forecast and Bi-directional scatter plot for the verification of ensemble track forecasts. She has also reported on some relevant research activities including the WMO Typhoon Landfall Forecast Demonstration Project (WMO-TLFDP) and training and research fellowship projects on verification. STI future plan is to continue to enhance capacity on evaluation of TC track, intensity and genesis forecasts; to develop and improve methodologies for verifying forecasts of TC formation, structure, evolution and motion, particularly from high resolution and ensemble system which are now the foundation for most operational TC forecasts and; to strengthen international cooperation with JWGFVR by WMO-TLFDP and promote the exchange of TC forecast data and verification techniques.

**Japan Meteorological Agency -** **WGNE Intercomparison of Tropical Cyclone Forecasts**

4.4.4 Mr Sato provided a summary of WGNE tropical cyclone forecast verification, including recent verification activities and related results. He recalled that that the Working Group on Numerical Experimentation (WGNE) was established by the World Climate Research Programme (WCRP) Joint Scientific Committee (JSC) and the WMO Commission for Atmospheric Sciences (CAS). The group works to foster the advancement of atmospheric circulation models. As part of its contribution to WGNE, the Japan Meteorological Agency (JMA) has conducted intercomparison of tropical cyclone (TC) forecasts based on global numerical weather prediction (NWP) model output since 1991. At the beginning of the project, ECMWF, UKMO and JMA were the participating NWP centres, and the target region was limited to the western North Pacific. JMA enlarged the verification region to include the North Atlantic in 1999 and the eastern North Pacific in 2000, and has conducted TC verification for the whole tropical and mid-latitude region encompassing Central to South Pacific and Indian Ocean areas since 2002.

4.4.5 A total of 11 NWP centres are now involved in the project. Participating NWP centres are as follows:

* BoM (Australia)
* CMA (China)
* CMC (Canada)
* DWD (Germany)
* ECMWF
* FRN (France)
* JMA (Japan)
* KMA (South Korea)
* NCEP (USA)
* NRL (USA)
* UKMO (United Kingdom).

4.4.6 The verification methods and scores are consistent with those described in the new Manual on the GDPFS (WMO-No.485).

4.4.6 He reported that TC best-track data provided by individual RSMCs are used in verification, with focus on cyclones reaching tropical storm (TS) intensity with maximum sustained winds of 34 knots or stronger. The tropical depression (TD) stage of targeted TCs is also included in this verification, and TCs remaining at TD level throughout their lifespan are excluded. TCs are tracked using mean sea level pressure data provided by participating NWP centres. Under this method, the minimum value in the predicted mean sea level pressure field is used to determine the TC centre. For accurate identification, a surface fitting technique is employed. First, an initial TC centre (T (= Forecast lead time) + 0 hrs) within a 500 km radius of an analysis centre point based on best-track data is identified. Then, the TC centre for the first prediction time (T + 6 hrs) within a 500 km radius of the initial TC centre is identified. Subsequently, a TC centre within a 500 km radius of a reference point determined from linear extrapolation of these two predicted centre points is identified. In each step, the minimum pressure point nearest to each reference point is identified as the initial or predicted TC centre. Tracking ends when no appropriate minimum pressure point is found.

4.4.7 Scores are computed for forecasts initialized at 1200 UTC. Annual scores are computed for a year from 1 January to 31 December in the northern hemisphere and for a year from 1 September to 31 August in the southern hemisphere. Forecast steps are every 6 hours to 192 hours of the forecast range. Scores are calculated against the best-track dataset: (a) Detection rate; (b) Storm track verification- Position error: Distance between predicted and analysed TC centres and, along-track/cross-track (ATCT) bias ie bias in the direction of TC movement (AT) and bias in the direction perpendicular to TC movement (CT) and Bias of central pressure.

4.4.8 JMA has developed a tracking tool that can handle global forecast data in GRIB format on a regular latitude-longitude grid at any resolution and enables tracking of predicted TC centres based on the method outlined in 2.2. The tool outputs tracking results in text format. Verification tools for calculation and visualization of detection rates, position errors, ATCT-bias, and bias of central pressure against best-track data are also available. It also coordinate the exchange of forecast field data produced by participating NWP centres. Data are received via the Internet or on HDDs.

4.4.9 JMA operates a web server to support the provision of various verification results. The following scores in the pictorial form are available on the WGNE intercomparison of Tropical Cyclone Forecasts website (<http://nwp-verif.kishou.go.jp/wgne_tc/index.html>):

(a) Detection rate: The score is drawn every 12 hours until 120 hours;

(b) Storm track verification: Position error is shown every 12 hours until 120 hours; position error is also shown as a map every 24 hours until 192 hours; ATCT bias is shown in scatter-diagram form every 24 hours until 192 hours;

4.4.10 Mr Sato noted that in preparation for the designation as LC-TCFV, JMA will improve the following verification activities when it is designated as LC-TCFV:

1. Although calculated scores in the text or binary form are not available on the said WGNE intercomparison website, they will be available on the JMA’s Lead Centre for TCFV website.
2. The verification will be conducted for region by region using available data even before global TC best-track data from individual RSMCs are collected. The verification results will be uploaded onto the JMA’s LC-TCFV website soon after the verification is completed.

4.4.11 The meeting expressed its appreciation for the work done by both CMA and JMA. The meeting noted that CMA (STI) and JMA have applied for designation as LC TCV and welcome plan to discuss with each other in line with the recommendation of the ET to work together to come up with an agreement on shared role and responsibilities for LC TCV. The ET-OWFPS reaffirmed its view that this will overall provide a more comprehensive and valuable verification than would be feasible from a single centre. In particular the ET stressed that the verification of tracks and intensity provided by the producing centres for all regions/basins is important, since these are used operationally by Members, and that since use of ensemble forecasts is strongly encouraged, these should also be included in verification. While it recognised that these are not part of the current Manual, the ET encouraged CMA and JMA to consider these in their discussion with a view to possible future inclusion. The ET also asked that common standards should be agreed for any data requested from producing centres. The ET decided that, as a new activity, the verification of tropical cyclone forecasts, including the LC activities and potential future extension to include EPS, genesis and track/intensity forecasts directly from producing centres be reviewed at its next meeting.

**Action 12: Chair to ensure that TC verification, including LC-TCV activity and potential extension, is reviewed at next ET meeting**

**4.5 Use of Additional Observation types for verification**

4.5.1 The Chair recalled that verification is carried out against analysis or against observations. Currently the standard upper-air verification against observations is done against radiosondes, and surface verification against SYNOP. He noted that there are additional types of observations such as METAR, AMDAR, global satellite data etc., and that as models move to higher resolution, the need of high-resolution observational data for verification also increases. Other agenda items are also relevant for this discussion (for example the difference between verification against SYNOP and METAR, and potential changes to radiosonde launch times).

4.5.2 The meeting agreed that the current priority is to implement the changes introduced with the new edition of the Manual on the GDPFS (especially the new surface scores) and that it is therefore not be the right time to propose even more changes to the standard verification while the current system needs to be consolidated.

4.5.3 Nevertheless, the meeting recognized that there may be future needs and will seek research support in investigating a way forward in light of potential radiosonde reduction. It will also encourage centres to investigate the proper way in using these new opportunities.

**Action 13: Thomas Haiden to share with the JWG-FV the Team interest in the use of additional observation types for verification in the future.**

**4.6 Taking into account radiosonde position in verification**

4.6.1 Mr Robinson described the current state of this issue with respect to the CBS verification exchange and proposed further action for study and possible implementation. He noted that radiosonde observations in BUFR format provide a much richer data set than Traditional Alphanumeric Code (TAC) radiosonde bulletins. In particular, more detailed information regarding position and time of observations are included. These data are starting to be included in NWP assimilation systems and there are questions as to whether and how the additional information should be incorporated into NWP verification.

4.6.2 He reported that ECMWF will take into account radiosonde drift in the data assimilation for cycle 45r1 onwards. This will apply only to those ~30% of radiosonde stations who are reporting in BUFR, mostly from Europe, Australia+NZ, and the US. It has been shown that the drift significantly improves O-Bs for wind from 300 hPa upwards, into the stratosphere. Also, a better fit to GPSRO in the stratosphere has been found. Noticeable differences at D+1, and diminishing effects from D+2 onwards can be expected.

4.6.3 At CMC, version 6.1.0 of the GDPS (Global model), to run in parallel run though spring 2018, will similarly incorporate BUFR reports. The assimilation system will have a TAC vs BUFR selection algorithm designed to make itself obsolete when TAC bulletins disappear completely. Currently, there are bulletins being sent in TAC only, bulletins sent in BUFR format but which consist of reformatted TAC data (hence no drift information) and true BUFR data with the drift information included. In that context, the updated assimilation system will select BUFR profiles only if a) the number of observations in the BUFR profile is greater than in the TAC profiles; b) less than 10% of the profile contains suspicious drift positions and c)the dry energy norm of the BUFR profile is less than 1.3 the norm of the TAC profile. The system will take advantage of the high precision temperature and humidity observations and will include ECMWF rejection criteria for humidity, a revised saturation vapor pressure formula (AERK) and revised humidity limits in the analysis. To date, in pre-parallel run testing, the selection results in TAC profiles used in 83% of cases and BUFR in only 17%. There has been an overall increase of 7.6 percent in the number of radiosonde observations used in the assimilation. Pre-parallel run testing has indicated positive performance improvements out to day 5, though the additional radiosonde information is credited with improvements mainly in the short-range and especially in the winter months.

4.6.4 An experiment by Laroche and Sarrazin (2013), presented at a previous meeting, noted balloon drift at 10 hPa of 45 km in summer and 100 km in winter. At 100 hPa, the highest level for which verification data are exchanged, the drift was about 40 km in summer and 60 km in winter. ECWMF noted that: It is nontrivial to take the drift into account in the verification but if it is done, one should actually also consider the difference in verification time, which complicates things further. For a centre with a focus on the medium-range this is not such high priority to have in the operational verification as shown by the results of Laroche and Sarrazin (2013). However it would still be useful to have a tool which one can experiment with, and compare results with and without taking into account the drift. The lack of improvement in upper-air scores against radiosondes in the very short range (+12 h) could be due to radiosonde drift.

4.6.5 In consideration of the fact that there is only 30 percent of radiosondes in true BUFR format, the issue is found not critical as yet In the context of the CBS verification exchange, but will become increasingly important as BUFR coverage grows. It was felt premature to propose concrete solutions for incorporating position and time in the CBS exchange. However, it was felt useful to develop a plan of action for further study of the issue.

**Action 14: Mr Robinson to coordinate further study and report back at next meeting;**

**Action 15: Mr Robinson and LC-DNV to arrange for the relevant information to be available on the LCDNV web site**

4.6.6 Mr Robinson also reported on the verification application tool for experimentation called EMET developed by CMC and its research Branch, a tool designed to consolidate verification activities. It could be used for testing different verification scenarios.

**4.7 Implication of possible changes to radiosonde launch times for verification**

4.7.1 Mr Robinson reported comments on this issue from Dr Haiden. He indicated that there is a suggestion (specifically for the GUAN subset) to allow more flexibility about launch times of radiosonde. The reasoning is that in some areas 0000 and 1200 UTC are near dawn and dusk and it might be better to have definite night and day reports, ie use local time rather than GMT. Another reason is that it would be more useful to launch radiosondes at times when there are fewer aircraft (e.g. between midnight and early morning).

4.7.2 NWP is used to asynoptic data, but verification is somewhat 'tied' to 00/12 UTC so this might make radiosondes less useful for verification. At the moment, the 00/12 UTC times agree with the starting times of model runs. This means that for a given lead time, say 48 hours, one can aggregate scores from both runs and in this way make use of all radiosonde obs. If the additional times would be 06 and 18 UTC, for example, then in order to use all radiosonde obs as before, we would need to have 4 model runs per day. If the additional launch times could be any hour of the day, then it would not be possible to do a seamless verification out to day 10 or 15 anymore (since we produce 1-hourly model output only up to day 4). Such problems go away if scores within a 24-h window are all aggregated together. This appears reasonable at longer lead times but would definitely be a loss of information in the short range. Also, it would make score exchange (like for CBS) more cumbersome and comparison of models more difficult.

4.7.3 So far other global centres have not expressed opinion on this topic. Additional discussion may take place at the EUMETNET OBS-Set Meeting (April 2018).

4.7.4 Another issue that is currently being discussed: how high should radiosondes aim to go (eg 50, 30, 10 hPa; this has cost implications). Ideally there would be some "hard evidence" to support one choice or another.

4.7.5 Mr Robinson confirmed the view of CMC to maintain status quo for launch times. He noted that a look at radiosonde reception at CMC suggests there are already a number of radiosonde reports at launch times other than 00 or 12 UTC. Of 925 radiosonde stations with reports received in 2018 (up to February 28, 1200 UTC), only 546 were from either 0000 or 1200 UTC. Of the remaining observations, 215 were from near synoptic hour times of either 1100 or 2300, but a significant number (83) came from 0600 or 1800 and another 81 from other hours.

4.7.6 He noted that assimilation systems can handle observations from any time, but given that models tend to be run at 0000 and/or 1200 UTC, and given the importance of radiosonde observations due to the high quality of these data, the team should recommend that as many observations continue to be done at 0000 and 1200 UTC as possible.

4.7.7 The ET noted that different applications (for example data assimilation, verification, real-time weather information, climate monitoring) may have different priorities for these issue. It considered that a study of the impact of changes to radiosonde launch times would be helpful in this context.

**Action 16: Mr Robinson to study the impact on the standard verification of reduced synoptic radiosonde at 00Z and 12Z and to clarify whether or not 11Z and 23Z are used as 12Z and 00Z in the standard verification process by NWP centres**

**4.8 Extrapolation below orography**

4.8.1 Mr Robinson described a solution to the problem of verifying fields (forecast, analysis or climatology) which lie below the surface (for example, 1000 and 850 hPa in mountainous areas). He recalled that at its 2014 meeting, the ET-OWFPS noted the report from the LC-DNV that the procedure used to extrapolate below orography has a significant impact on Anomaly Correlation Coefficient over Himalayas, and requested LC-DNV and him to make proposal to address this in verification (mask out areas below orography?). The problem actually applies to all mountainous areas of the globe.

4.8.2 He reported that the Research Branch at CMC currently uses an approach in which the analysed surface pressure is used to determine values below the level being verified. These areas are then masked out of the analysis, forecast and climatology fields before calculating verification statistics.

4.8.3 He also reported that ideally, we should be taking into account the surface of all three fields (analysis, forecast and climatology) to assure that the points for all fields used for the verification are below the surface. However, a more pragmatic solution has been suggested by ECMWF, based on the ERA-Interim climatology, as follows: The issue occurs when scores are computed and which need a climatology, like for example anomaly correlation. Then the inconsistency between the extrapolations of temperature below orography in another centre’s model and in ERA-Interim affects the scores.

4.8.4 The proposal to address the issue is for ECMWF to construct a 0/1 mask on the 1.5 deg verification grid, based on the union of daily masks over a whole year in ERA-Interim. The daily masks are constructed by comparing the ERA-Interim Z850 with the ERA-Interim orography. The mask is then sent out to all contributing centres so that they can use it in their verification. He noted that It is possible that there would remain some points in either the analysis or forecast that will lie below the surface, however. Other solutions are also possible, but the above has the simplicity of providing a common mask for all participating centres to use.

**Action 17: ECMWF to implement the proposed mask for all participating centres to use to address issue related to extrapolation below orography. LC-DNV to contact centres when the mask is ready and co-ordinate implementation for use in standard verification by all centres.**

**4.9 Use of WIGOS identifiers for station id**

4.9.1 The Chair, Mr Richardson, reported that, with WIGOS opening the door to also bringing in non NMHSs data, the WMO traditional 5 digit station identifiers will soon not be able to handle additional stations. In order to address the issue, a block station id, similar to Internet protocol one (nnn.nnn.nnn.xxx) will be adopted. This would solve one problem but would create others: There is no national process for assigning the new IDs; Observation databases and NWP ingest software is often hard-coded for old-style WIGOS IDs; TAC cannot accommodate WIGOS IDs, which will force migration to BUFR. Guidance material is under development at the Secretariat and a Task Team on WIGOS IDs was established by ICG-WIGOS to help move this issue forward. Mr Richardson reported that he will be member of this TT.

**4.10 Observation Uncertainties – Effects on Verification**

4.10.1 Mr Robinson outlined various considerations with respect to the effects of observational uncertainty on verification results. He first recalled that there are a number of sources of observation error and uncertainty. These include, for examples, errors associated with observations such as measurements (e.g. instrument failure); Round-off and reporting procedures (precipitation reports in inches vs mm; no report when no precipitation); Quality Control (elimination of large values; rejection of precipitation under-catchment measurements in strong wind); Representativeness and sampling error (both in space and time) due observation representative of the (nearest) model grid-point value; homogeneity of observation network and representativeness of the region verified; Assumptions of remote-sensing retrieval algorithms and uncertainties introduced by interpolation / gridding procedures.

4.10.2 He indicated that with all these possibilities of errors one may wonder what are the effects of the observation uncertainties on verification results? Which observation uncertainties have the largest impacts? and How can one account for observation uncertainties in verification practices? To answer these questions, Ms Barbara Casati at CMC/MRB, ran an experimentation to identify observation uncertainties which have the largest impact on verification results. The experiment examined the performance of the CMC Regional Deterministic Prediction System (RDPS, a 10 km model) and High Resolution Deterministic Prediction System (HRDPS, a 2.5 km model) surface parameter forecasts under various conditions. Specifically, the study looked at performance against different observation networks (SYNOP vs METAR), the effects of spatial sampling (thinning) and Quality Control. Model performance was assessed with continuous and categorical verification scores, as appropriate to the quantity being assessed. The experiment was carried out using data over Canada for one summer and one winter season.

4.10.3 There is a large discrepancy in the density of SYNOP observations over Canada, with the province of Alberta and southern Ontario and Quebec having particularly dense networks. METAR distribution is more homogeneous. Thinning both networks along 2 degrees of latitude and longitude results in relatively equitable distributions. Performance was compared with no thinning, 1 degree and 2 degree thinning.

4.10.4 The result of the study shows that scoring against the different networks (SYNOP vs METAR) results in larger difference than does thinning. The more homogeneous spatial sampling and network size resulting from thinning at 2 degrees reduces the SYNOP / METAR difference. Bias curves against SYNOP are systematically higher than those against METAR, indicating more over-forecast than against METARs (it is noted that SYNOP stations are equipped with Stephenson screens while METAR stations may not be. Hence SYNOP observations may be colder than METAR observations. It was also noted that METARS report temperature to the nearest degree Celsius whereas SYNOPS report to the nearest 0.1 degree which might also contribute to different scores.

4.10.5 Quality control of precipitation observations results in numerous rejections by the Canadian Precipitation Analysis (CaPA) system, particularly in winter due to a significant under-catchment effect of solid precipitation under high winds with many North American precipitation gauges. In the summer case, there was no significant difference in verification scores when precipitation forecasts were evaluated with or without quality control, while scores were significantly affected in winter.

4.10.6 ECMWF tackled the issue of uncertainty in verifying ensemble forecast system and found (Zied Ben Bouallegue, ECMWF) that, a “perturbed-member” approach, whereby random noise based on the error of the verifying observations are added to each of the ensemble members prior to calculating the scores, the RSME/spread comparison is vastly improved and CRPS are significantly improved, particularly at shorter lead times. At CMC (Vincent Fortin et al, CMC) it was found that an apparent under-dispersion was due to calculating spread against the average of the standard deviation rather than the average of the variance. This led to a largely positive result and even a slight over-dispersion from day 12 on. There was still a question of a bias in the RMSE of the ensemble mean due to the error of the observations. As above, the errors of the observations are known quantities from the data assimilation system, so these were subtracted from the Mean Squared Error to determine true RMSE of the forecast:

MSE = RMSE2F + RMSE2O.

4.10.7 The meeting noted that relative humidity was added to the CBS verification exchange in the most recent standards. The parameter is directly observed by but is not reported. Instead, the humidity variable reported is the dew-point depression. If relative humidity were reported, its precision can be up to 0.1 percent. Similarly, geopotential height is reported to the nearest decameter (10m). GPS based radiosondes give a far more precise value for the position of the radiosonde.

4.10.8 The meeting noted that with increasing resolution and improving forecast skill, the impact of observation uncertainty on forecast skill is becoming more important. It is most important for short range, assessment of ensemble uncertainty and in comparison studies (eg of the impact on performance of model upgrades). The ET recognised that this is an area of active research that is not yet sufficiently mature to recommend particular changes to the standard verification procedures. The ET encouraged further research work on this topic with a view to potential future recommendations.

**Action 18: Thomas Haiden to encourage work including with JWGFVR on how to account for obs uncertainty; re-evaluate at next meeting and provide recommendation for future action**

**5. REPORTS BY TASK TEAMS**

**5.1 TT on HR-NWP (Guidelines on High Resolution NWP)**

5.1.1 The Chair apologized on behalf of Mr Honda, the chair of the TT, for not being able to join the meeting. He then briefed the ET on the status of the work of the TT. He recalled that a Task Team on Development of Guidelines for High-resolution NWP (TT-HR-NWP) was established at the 17th Session of the Commission for Basic Systems (CBS) Management Group (CBS-MG-17, 2017, Geneva) as successor of the Task Team on Development of Strategy to assist Members with improved access to high-resolution regional Numerical Weather Prediction.

5.1.2 The TT lost two of its members to retirement: Mr Methot (Canada) and Mr Ekert (Swiss). The rest of the Task Team members continue to work for the new Task Team. They are Mr Wong (Hong Kong, China), Ms Rozinkina (Russia), Mr Kabelwa (Tanzania), Dr Boyd (UK) and Mr Zhu (USA).

5.1.3 The Strategy for the implementation of high-resolution NWP based on the capacity of NMCs (6 levels of difficulty) was updated by the OPAG-DPFS Implementation Coordination Team (ICT-DPFS) at its meeting in 2016 (see Annex VI). At Level 6, a Centre can identify necessary resources by itself so that the required resources are not proposed by the Task Team.

5.1.4 The Task Team reviewed the schedule of drafting the guidelines and set a new goal to complete the draft by the end of 2018.

5.1.5 The meeting discussion concluded that these guidelines are very important and need to be published as soon as possible. It was felt that this would help with discussion with Members who want to implement high resolution NWP and also with potential Donors to help them understand the continuous resource requirement to sustain the NWP operation, and the potential alternatives that may be available. In this context, it was also felt that the guidelines should contain a clear message that NMHSs should focus first on the services they need to provide and that this should guide the consideration of requirements for how to support them.

5.1.6 Due to the urgency to complete the Guidelines and the loss of two of the original TT members, the following members of ET have offered to assist the TT on HR NWP: Ms Jianjie Wang (China), Mr Ken Mylne (UK), Mr Andrew Tupper (Australia) and Mr Amin Erfani (Canada).

5.1.7 The meeting also noted that there is an upcoming workshop with Donors at WMO Secretariat in April 2018 and suggested that the opportunity should be seized to discuss with them about the sustainability issue of running HR NWP, using the capacity levels and requirements developed by TT-HRNWP (see Annex IX).

**Action 19: The Chair to inform the Chair TT HR NWP of additional support offered by Ms Wang, Mr Mylne, Mr Tupper and Mr Erfani.**

**Action 20: Mr Harou (Secretariat) to facilitate understanding of Capacity level for HR NWP implementation at relevant meetings (e.g. Donors)**

**5.2 TT- Audit**

5.2.1 Mr Harou presented the document prepared by the Chair of TT- Audit (Mr Honda). He provided information on the status of the development of a new regular audit procedure of the Global Data-processing and Forecasting System Centres (GPFS) in line with the implementation of the revised Manual on GDPFS (WMO-No. 485).

5.2.2 He recalled that when the revised Manual on GDPFS (WMO-No.485) was adopted by the Executive Council (EC) through Resolution 18 (EC-69) at its 69th Session (2017), it also requested the Commission for Basic Systems (CBS) to develop performance requirements for monitoring GDPFS Centres for inclusion in the Manual and the Guide on the GDPFS and to also arrange for and maintain a rolling review of compliance of GDPFS Centres with the revised Manual. It was in response to this request that the TT-Audit was established on Development of Centre Audit Procedure and Review of the WMO Technical Progress Report on GDPFS and NWP Research.

5.2.3 The meeting noted that Mr Akira Shimokobe (Japan) was selected as a member to assist the Chair but the full team still needs to be established.

5.2.4 It was reported that the Implementation Coordination Team on Data-processing and Forecasting System (ICT-DPFS) agreed at its meeting in February 2018 that the audit process should be conducted once per 4 years at the same time of WMO Congress; be based on self-assessment by RSMCs and no on-site audit is necessary; and be conducted by experts who are independent from concerned RSMCs. ICT also agreed that If an RSMC does not meet the requirements, it will be asked to fix the problem as soon as possible or provide an improvement plan. If the plan is not followed the relevant ET may recommend the suspension of designation by EC or Congress.

5.2.5. Performance requirements for auditing the compliance especially on general requirements of RSMCs need to be developed for inclusion in the Guide on GDPFS (WMO-No.305).

5.2.6 The meeting agreed with the view of the ICT-DPFS that the audit process should be kept as light as possible and that the proposals by the ICT would facilitate a feasible auditing procedure. Mr Richardson and Mr Tupper offered to contribute to TT-Audit activities on behalf of ET-OWFPS

**Action 21: Mr Richardson to contact Mr Honda (Chair TT-Audit) to offer ET-OWFPS support for TT-Audit activities**

5.2.7 In line with the Auditing requirement and the designation requirements in the Manual on GDPFS, Mrs Jianjie Wang and Mr Yong Wang, Nowcasting experts, received and assessed the application of Hong Kong Observatory (HKO) for designation as RSMC for Nowcasting. They concluded that the HKO met all the requirements for designation as RSMC for Nowcasting as described in the revised Manual on GDPFS (WMO-No. 485).

**Action 22: Ms Jianjie Wang and Mr Yong Wang to provide the secretariat with a summary of their assessment of HKO and recommendations, for the secretariat to process**

**5.3 TT-Guide (Development of Guide, WMO-No. 305)**

5.3.1 Mr Andrew Tupper presented the issue of the development of the new Guide (WMO-No. 305) in line with the revised Manual on GDPFS (WMO-No. 485) and requested some guidance as to how to approach the work at hand. He noted that current Guide has not been significantly revised since 1993. It is a 204-page document, comprehensive for its time, and containing much detail on the principles and practices of numerical weather prediction and synoptic meteorology. An update in the same format might be considered as potentially a multi-year full-time effort and not feasible. He noted however, that the ICT-DPFS at his last meeting in Feb 2018, agreed that the Guide should not seek to be a comprehensive description of all aspects of the GDPFS, but should focus on areas where the text of the Manual requires additional advice or elaboration and practical guidance can be given, such as in relation to the operation of national GDPFS Centres. The ICT also advised the Task Team Chair to seek advice from the broader WMO community in preparing the Guide and seeking Task Team members.

5.3.2 In this context, the meeting reviewed the outline that was provided by the Secretariat. The meeting agreed that the new Guide must be designed in a way that it can be maintained and sustainably updated in line with the Manual, with a minimum of overlap between the two documents, and that the Guide should wherever possible refer to existing guidance material, rather than having the Guide as a stand-alone, comprehensive resource. Where such material does not currently exist the TT should consider whether it is most appropriate to develop as part of the Guide or to request development of appropriate additional guidance documentation.

**Action 23: Mr Tupper to revise the outline of the Guide based on discussion with ET-OWFPS and share with ICT-DPFS co-chairs for acceptance [revised ToC provided as Annex X]**

**Action 24: Mr Harou (Secretariat) to develop a one pager on procedure for application of Centres for designation**

**5.4**  **TT-Nowcasting (Development of guidelines)**

5.4.1 Mr Wang, Chair of TT Nowcasting, reported that the development of the guidelines on Nowcasting techniques has been completed and the Guidelines published under the publication number WMO-No. 1198. Mr Richardson and the ET members thanked the TT for their work and expressed their great satisfaction with the speedy completion of the task.

**Action 25: Mr Harou (Secretariat) to ensure publicizing the availability of the Guidelines on Nowcasting (WMO Bulletin summary will be written, and website for example)**

5.4.2 ET agreed to the continuation of the TT-Nowcasting in view of potential applications for designation of RSMC for Nowcasting, to respond to requests following publication of the guidelines and to consider potential standard procedures for verification. The meeting noted that the audit process will require review of verification from RSMCs for Nowcasting and that this may provide useful input in this context.

**Action 26: TT-Nowcasting to review, in context of the audit process operational verification carried out by RSMCs for Nowcasting, and to report on this and any relevant ongoing research activities (in coordination with JWGFVR) at next ET meeting with a view to possible recommendations for standard verification procedures for nowcasting**

**6. SEAMLESS GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS)**

**6.1 Update on S/GDPFS Implementation Plan**

6.1.1 Mr Harou briefed the meeting on the status of Seamless GDPFS. He explained that the whole idea came from Resolution 11 of Cg-17 (2015) to move to seamless and integrated Data-Processing and Forecasting System. Subsequent to Cg-17, in response to the Resolution 11, EC-68 (2016) established an EC SG on S/GDPFS (Chaired by the President CBS) which met twice in 2016 to develop the vision and a white paper. EC-69 (2017) approved the S/GDPFS Vision and requested the development of an Implementation Plan to be tabled at EC-70 (2018). In addition, considering the role of research in advancing the S/GDPFS, EC-69 also decided that the EC SG be co-led by the President of CBS and the President of CAS.

6.1.2 Mr Harou reported that subsequently a Drafting Team was established in December 2017 to help with the development of the Implementation Plan (IP). The work is ongoing and will hopefully be presented at TECO-CBS MG at the end of March 2018. The team noted that PTC/PRA was successfully briefed.

6.1.3 The ET strongly supported the views of the ICT on the development of the S/GDPFS, in particular that this essential activity should build on the existing structure and capabilities and that the substantial ongoing developments of GDPFS activities (demonstrated for example in the expanded activities included in the new edition of the Manual) should be acknowledged.

**6.2 Update on HIWeather and links to CBS**

6.2.1 Mr Harou briefed the meeting on the WWRP HIWeather project from the document provided by Paolo Ruti, Chief, WWRP. He explained that the HIWeather aims at improving the end-to-end-to-end forecasting and warning process for weather-related hazards through research in predicting urban flood, wildfire, disruptive winter weather, extreme local wind, urban heat and pollution and their human and economic impacts, and through developing best practice in communication of forecasts and warnings. He reported that HIWeather is anchored on 4 pillars:

1. Predictability and Processes. Research will be focused on the meteorological processes that influence the predictability of High Impact Weather
2. Multi-scale Forecasting of Weather-Related Hazards. Research covers the observations, nowcasting, data assimilation, modeling and post-processing required to forecast weather-related hazards using coupled numerical weather, land surface, ocean and chemistry models, including modeling of floods, landslides, bushfires, air pollution etc.
3. Human impacts, Vulnerability & Risk. Research will be led by social scientists, with a focus on the interface between the physical hazard and the human impact. It will cover modeling of the role of the built environment in hazards, and of the exposure and vulnerability of individuals, businesses and communities.
4. Communication. Research will focus on the choices of information content, language, format and media channels used, spatial and temporal precision, timeliness and context that together determine whether forecasts & warnings will be received, trusted, understood and acted on.

6.2.2 The meeting discussed the status of HIWeather, as to what projects have been initiated, funding etc. The meeting recognised that a number of activities are underway and that the establishment of a project office at the Chinese Academy of Meteorological Sciences would help to facilitate these. The ET looked forward to participating in the future work of the project. Mr Mylne referred to the links below for more information on the HIWeather Project:

Latest newsletter

<http://www.wmo.int/pages/prog/arep/wwrp/new/documents/HIWeather_news_Jan_2018.pdf>

Web page for news on HIW:

<http://www.wmo.int/pages/prog/arep/wwrp/new/high_impact_weather_project.html>

**6.3 Examples of Impact-based forecasting, incl for land transportation and urban areas**

6.3.1 Ms Li Wei, from National Meteorological Center of CMA, presented on CMA comprehensive activities in the areas of impact based forecasting. Their work involves urban meteorology, typhoon tracking, landslide using methodologies for risk-based warning which includes modelling (weather and hydrology), analogs and statistics. Color codes are used to convey information on the severity of hydrometeorological hazards.

6.3.2 Ms Xiaoling Zhang, from Severe Weather Prediction Centre of NMC/CMA, also presented on CMA activities in this area. Thunderstorms, High Winds, Precipitations, Tornadoes are all part of activities of the Centre. She indicated that conducting an experimental watch since 2015 for heavy rainfall (over 50mm/h) particularly over the southeastern China where monsoon can be intense. Plan is to issue by 2020 the 0-12h objective severe convective weather products with 1hr resolution and to issue seamless forecasts up to 3 days.

6.3.2 The chair conveyed the appreciation of the ET for these excellent presentations, especially when they had been provided at short notice.

**7. FORECASTING PROCESSES AND SYSTEMS**

**7.1 EPS Products and Post-Processing including Calibration (establish TT to produce guidelines for generation and application of EPS products)**

7.1.1 Mr Yuejian Zhu introduced a concept for classification of multi-model ensemble and the advantage and challenge of application. He recalled that since THORPEX (The Observing System Research and Predictability Experiment) program was initiated in 2004, the investigation and application of multi-model ensemble have been explored widely around world research community through THORPEX TIGGE (The International Grand Global Ensemble) project. In the meantime, the NAEFS (North American Ensemble Forecast System) has been implemented first operational exchange global ensemble data between NCEP (National Centers for Environmental Prediction) and CMC (Canadian Meteorological Center), then release the data for public access in real time in 2006. The interaction of the THORPEX program and the NAEFS project is typical R2O (research to operation) and O2R (operation to research). He noted, however, that a concept and study of multi-model ensemble has been introduced in the earlier work, that mainly focus on seasonal forecast.

7.1.2 He also noted that a definition of multi-model ensemble is varied from practical collection and generation of forecast, and applications. Users may be confused from different productions without a basic knowledge from the area of numerical weather prediction. He introduced the concepts of “grand ensemble”, “super-ensemble”, “lagged ensemble”, “blended forecasts” which often have different (and not always consistent) interpretations.

7.1.3 He also identified various post processing methods including a general approach based on decaying average or Kalman filter method, 1st  and 2nd moment calibration, analogy and MOS methods and position correction. He noted that challenges include reforecast or hindcast generation; inconsistent initial analysis, benefit of MME vs single model ensemble, precipitation and Tropical Storm track forecast.

7.1.4 Mr Zhu provided an update and summary of operational ensemble systems run by NOAA and its partners. He described the North American Ensemble Forecast System (NAEFS), the NCEP Global Ensemble Forecast System and the NCEP Global Forecast System.

7.1.5 Mr Zhu completed his presentations by discussing the NCEP Verification System of the NOAA deterministic forecast and ensemble forecast. He noted that the scores of NCEP GFS forecast are generated and contributed to WMO leading verification center (ECMWF) through NCEP NCO (NCEP Central Operation) that runs at 2.5 x 2.5 degree resolution for upper air only with limited variables. The responsibility of this activity has changed recently; EMC (Environmental Modeling Center) starts to lead this computation and contribution. The scores of NCEP GFS forecast will be calculated based WMO GDPFS guidance of documentation, higher resolution (1.25 x 1.25 degree globally), all requested variables for upper air and surface. The packages of scores are daily and monthly respectively. A set of upper air forecast scores have been sent to lead center for validation, then surface forecast scores (against observation) would follow this up.

7.1.6 On the Ensemble forecast verification, he informed the meeting that EMC is one of national centers to contribute global ensemble forecast verification scores to WMO ensemble verification leading center (JMA). These scores include RMS error of ensemble mean and ensemble spread; CRPS (continuous ranked probability score) for 500hPa height, 850hPa temperature, 850hPa u and v, 250hPa u and v. EMC will plan to contribute completely variables and scores to WMO after MET (Model Evaluation Tools) system is fully implemented at EMC.

7.1.7 He also explained how EMC routinely calculates TS (tropical storm) track verification for GFS and GEFS. All verification records are available for WMO collection. After WMO selects a leading center for this activity, EMC will contribute this verification scores.

7.1.8 Mr Zhu reported that the Next Generation Global Prediction System (NGGPS) program is organizing the development of a unified verification system, using the Model Evaluation Tools (MET+) software (developed by NCAR), in an effort to unify the numerical weather prediction community around using common verification metrics and software systems. Using community input and organization towards its design, the unified system will be used to evaluate new weather prediction models before transferring to operations, and to provide continued verification for operational models already in production. Ultimately, the system will provide metrics on a variety of spatial and temporal scales, from global to local, and from long-term seasons to minutes, to cover verification for all aspects of earth system modeling and to meet the variety of user needs across as many applications as possible (for example, space weather, aviation, severe storms, ocean shipping, tropical cyclones).

7.1.9 Ken Mylne gave a presentation to the meeting and to CMA staff on the development of a new post-processing system at the UK Met Office. This system, named IMPROVER, is designed to meet the needs of convective-scale modelling and ensembles; a key function is the use of neighbourhood methods to account for spatial uncertainty in a probabilistic sense from both deterministic and ensemble NWP systems. It also addresses the many challenges of processing and sharing huge quantities of frequently-updating data from hourly-cycling models and ensembles, and the blending of outputs from many NWP systems to provide a single set of probabilistic NWP guidance data. IMPROVER uses modern technologies and open-source code to facilitate sharing of data and code in common formats. Post-processing is built as a sequential modular process so that modules can be combined as required to provide the optimal performance. It starts with interpolation of all models to a common grid and format to decouple user applications and processing systems from the model formulations (Level 1); it then applies physical or statistical processing to fields to add detail, correct biases and derive additional parameters (Level 2); finally outputs from multiple models, ensembles and update cycles are blended in probability space to provide a single probabilistic forecast distribution (Level 3). All processing is done on the standard grid, with local site forecasts extracted at the end (Level 3) in order to ensure consistency between site and gridded forecasts. A critical feature is that verification is built in at every stage of the process, so that the benefits of each modular stage can be assessed, as well as performance of the complete system. IMPROVER will be able to run both in real-time operations and in trial mode to facilitate good science in developing and testing future upgrades. IMPROVER is designed to support the production of automated forecasts, for example through the Met Office website and App, but will also be used to support alerts of potential high-impact weather to forecasters to underpin guidance and warning services.

7.1.10 The meeting expressed its appreciation for the information provided by Mr Zhu and Mr Mylne. It recalled that one of the main approved actions of its work programme is to develop guidelines on post-processing, including calibration of model output and that a TT should be established to carry out this work. The meeting felt that the lack of Guidelines constitutes a serious gap in responding to the needs of users. The ET noted that the activities reported by Mr Zhu and Mr Mylne are examples of major operational and development efforts that could be useful inputs for the TT to consider.

7.1.11 The ET noted the opportunity to benefit from cooperation with other ongoing and planned activities on the same topic including a proposed EUMETNET activity to review postprocessing in Europe and also noted this will be one of the focal areas of a TIGGE-S2S workshop that is being planned for April 2019. It also noted that a book on the scientific state of the art of ensemble postprocessing will be published in summer 2018.

7.1.12 The ET agreed to establish the TT-EPSPP with Ken Mylne as Chair and Amin Erfani, David Richardson, Yong Wang and Yuejian Zhu as initial members. The TT will draft the scope of the work and an outline of contents for the Guidelines. Once agreed by ET-OWFPS, the TT may consider subsequent addition of Jing Chen (JWGFVR), and international post-processing experts eg Stephane Vannitsem and Tom Hamill who have respectively edited and contributed to a new book on ensemble post-processing. The TT will work mainly by email and video-conference, but will require a 1 week dedicated meeting to ensure completion of work, scheduled for 2020. The TT should be represented at the TIGGE/S2S workshop 2-5 April 2019.

**Action 27: Mr Mylne to establish the Task Team on Guidelines for the generation and application of EPS products and to develop scope, outline contents of guidelines and work plan for approval by ET-OWFPS**

**Action 28: Secretariat and Mr Mylne to plan resources for 1 week meeting of TT-EPSPP in 2019**

**7.2 Development of annual publication on predictability at global level**

7.2.1 Mr Richardson introduced this request from the Secretariat. The meeting acknowledged the interest in having available information about how far ahead skilful weather forecasts can be made, but stressed that this is a complicated topic that does not have a simple answer. Mr Richardson introduced the Forecast Skill Horizon (FSH) as one example of work to address this issue. The team discussed that the limit of predictability is not something that is easy to define: it will depend on the element being predicted, the limit that needs to be considered (e.g climatology in the presentation). It was emphasised that the FSH is a limit beyond which there is no skill but does not mean useful skill for all users up to this limit; different for different parameters, scores, spatial and temporal scales. Predictability limit depends strongly on use of forecast – either deterministic or probabilistically). It may nevertheless be helpful to give a bit of context, background, information to aid interpretation of the LC scores (both deterministic and EPS). The meeting noted that CRPS is being exchanged to show the quality of NWP centres products and could be a place to start in investigating the possibility to come up with a solution. It was felt that if this work has go ahead, it may need to be coordinated across ETs to cover all time ranges. The meeting also emphasised that there should be no need for any such report to be produced annually – the limit of predictive skill will not change substantially from year to year.

**Action 29: TT-SV to think about developing a discussion paper on the issue of the limit of predictive skill (lower priority compared to other actions on verification).**

**7.3 Update on WDQMS**

7.3.1Mr Richardson described theWIGOS Data Monitoring System (WDQMS), which includes monitoring, analysis and evaluation and incident management functions. Its objectives are to review and modernize the NWP-based monitoring of the conventional components of WIGOS, to provide real-time monitoring of the performance (data availability and quality) of observing stations, to be able to identify issues/problems and to take actions towards the supplier so that identified issues can be solved.

7.3.2 The meeting noted that the monitoring function of WDQMS relies on the monitoring information from Global NWP Centres. A pilot project on data quality monitoring was established to test this component of this system. Four Global Centres (ECMWF, NCEP, JMA and DWD) provides quality information based on their data assimilation (DA). Currently there is a quest for centres willing to run this on a permanent basis.

**8.0 MANUAL ON GDPFS**

8.1 Issues related to the Manual were already covered elsewhere (see 4.1.1, 4.2.6) The only proposal for changes to the Manual was to address specific omissions in the published version (see Annex VI)

**9.0 REVIEW OF ET-OWFPS TERMS OF REFERENCE**

9.1 The ET reviewed its Terms of Reference (Annex XI) and agreed these are still appropriate for the remit of the ET; no changes proposed.

**10. UPDATED ACTIONS AND PRIORITIES FOR FUTURE WORK**

10.1 The ET reviewed and agreed the actions from the meeting. A summary of the actions is provided in Annex XII

**Action 30: Chair and Secretariat to complete draft report of meeting, circulate to ET members for comment, then issue final report**

**11. ANY OTHER BUSINESS**

11.1 The ET discussed the timing of its next meeting. This is planned to be held in spring 2020 to prepare ET input for CBS which is expected to be later in 2020.

11.2 No others business was identified

**12. CLOSING**

12.1 The meeting closed at 11:35 hours on Friday 16 March 2018

**Annex I**

**Meeting of the CBS (DPFS) Expert Team on Operational Weather Forecasting Process and Support (ET-OWFPS), Beijing, China, 12-16 March 2018**

**AGENDA**

**1. OPENING**

**2. ORGANIZATION OF THE MEETING**

2.1 Adoption of the agenda

2.2 Working arrangements

**3. INTRODUCTION AND BACKGROUND, INCLUDING REVIEW OF RELEVANT OUTCOMES OF PREVIOUS MEETINGS**

3.1 Outcomes of WMO Constituent Body sessions related or relevant to the Expert Team on Operational Weather Forecasting Process and Support (ET-OWFPS)

3.2 Review for actions from last ET-OWFPS Meeting

3.3 Outcomes of ICT DPFS Meeting

**4. PROGRESS ON VERIFICATION ACTIVITIES**

4.1 Review progress on implementation of surface verification

4.2 Review Lead Centre activities (deterministic and EPS)

4.3 Ocean wave verification (including progress on establishing Lead Centre)

4.4 Tropical cyclone verification (proposed Lead Centre)

4.5 Use of additional observation types for verification

4.6 Use of radiosonde position for verification

4.7 Implication of possible changes to radiosonde launch times

4.8 Extrapolation below orography

4.9 Use of WIGOS identifiers for station id

4.10 Impact of observation uncertainty on verification

**5. REPORTS BY TASK TEAMS**

5.1 TT-HR-NWP (Guidelines on High-resolution NWP)

5.2 TT-Audit (Audit process – implementation of new Manual on GDPFS)

5.3 TT-Guide (Development of Guide, WMO-No. 305)

5.4 TT-Nowcasting (Development of guidelines)

**6. SEAMLESS GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS)**

6.1 Update on S/GDPFS Implementation Plan (incl. RRR)

6.2 Update on HIWeather and links to CBS

6.3 Examples of Impact-based forecasting, including for land transportation and urban

 areas (CMA to provide current status in CMA)

**7. FORECASTING PROCESSES AND SYSTEMS**

7.1 EPS Products and Post-Processing, including Calibration (Establish the TT to produce guidelines for generation and application of EPS products)

7.2 Development of annual publication on predictability at global level

7.3 Update on WDQMS

**8. MANUAL ON GDPFS**

**9. REVIEW OF THE ET-OWFPS TERMS OF REFERENCE**

**10. UPDATED ACTIONS AND PRIORITIES FOR FUTURE WORK**

**11 ANY OTHER BUSINESS**

**12. CLOSING**

**Annex II**

**List of Participants**

|  |  |  |
| --- | --- | --- |
| **Name** | **Country** | **Comments** |
| Richardson, Mr David | ECMWF | Chair |
| Wang, Dr Jianjie | China | Co-chair |
| Erfani, Mr Amin  | Canada  | Remote participation |
| Haiden, Dr Thomas | ECMWF | Absent (apologies) |
| Honda, Mr Yuki | Japan | Absent (apologies) |
| Mylne, Mr Ken | UK |  |
| Robinson, Mr Tom | Canada |  |
| Sato, Mr Hitoshi | Japan |  |
| Tupper, Dr Andrew | Australia |  |
| Wang, Dr Yong | Austria |  |
| Zhu, Dr Yuejian | United States |  |
| Harou, Mr Abdoulaye  | WMO Secretariat |  |

**Annex III**

**Updated list of Actions and Recommendations from ET-OWFPS meeting 9-13 May 2016**

|  |  |  |  |
| --- | --- | --- | --- |
| **Paragraph** | **ACTIONS** | **By Whom** | **Status March 2018****updated during the meeting** |
| 3.1.2 | report comments of ET on proposed DPFS structure to ICT | Chair | Done |
| 4.1.2 | Include the two new additional parameters (2m Temperature and 10m wind) in the list of parameters and be reflected in the New GDPFS Manual | Secretariat | Done |
| 4.1.2 | Clarify the relevant part of A.II.2.3.2 regarding these addition new parameters and update if necessary. | Mr Robinson | Done |
| 4.1.3 | Ensure the text in Annex V-b is included in the New GDPFS Manual (replacing the current text) | Mr Honda and Secretariat | Done (Appendix 2.2.24 of 2017 Edition of Manual); discrepancies and further action addressed under agenda items 4.1, 4.2 of current meeting |
| 4.1.4 | Mr Robinson to ensure that documentation on the score methodology definition (mathematical formulas) for both upper-air and surface is made available on the LC-DNV website | Mr Robinson | Done |
| 4.2.4 |  Mr Robinson to draw a list of questions to obtain the description of the configuration of their models and some specific aspects related to verification | Mr Robinson | Done (see 4.2 of this meeting) |
| 4.2.5 | Mr Robinson/Dr Haiden to collect information available on impact of observation uncertainty on verification and to report back at the next meeting |  | Done – see agenda item 4.10 |
| 4.2.5 | Mr Robinson to ensure link to JWGFVR website is provided from LC-DNV wiki pages |  | Done |
| 4.2.5 | Mr Robinson to review documentation on scores below orography and update in the Manual |  | Done -see agenda item 4.9 |
| 4.4.1 | ET-OWFPS to liaise with PWS program for further development of the Guidelines for Impact based forecasting and risk-based warnings | Mr Davies | Guidelines published – no further development yet |
| 4.4.3 | ET to raise with ICT-DPFS, the issue around objective calculation of impacts, where to store and how to verify. | Chair  | Done |
| 4.7.4 | ET-OWFPS to request ICT-DPFS to confirm the responsibility within DPFS for Sand and dust storm forecasting. ET-ERA has responsibility for the designation (as stated in the designation procedures, step 6 – see Annex VIII). Does ET-ERA also have responsibility for monitoring, review and relevant part of Manual?  | Chair | Done – responsibility is with ET-ERA |
| 5.2.2 | The Secretariat to check if OSCAR includes requirements for Nowcasting and for verification | Secretariat | Done seehttps://www.wmo-sat.info/oscar/applicationareas/view/3 |
| 5.3.3 | Chair of ET and Secretariat to keep watch on GIPPS progress | Chair/Sect | Done |
| 9.1.1 | Request ICT-DPFS to determine which ET should be handling the Operational Air quality forecast. | Chair | Done (ICT recognized this would be a major undertaking and may need new TT; recommended to CBS to work with WWRP to develop capabilities) |
|  |  |  |  |
|  | **RECOMMENDATIONS** |  |  |
| 4.2.5 |  Add score per station to the Manual as recommended at last ET meeting for upper air stations  |   | Done |
| 4.4.2 | ET-OWFPS to be represented at TT Impact  |  | No recent activity of TT-Impact |
| 4.6.1 | Include the proposed definition of Nowcasting in the new Manual of GDPFS |  | Agreed and recommended by ICT (but in the end not accepted for Manual) |
| 4.6.1 | establish link with PWS to review draft of the guidelines on impact based forecasting and risk-based warnings |  | Passed to ICT |
| 4.7.4 | the Barcelona Centre to update the documents on the evaluation of the dust models for the submission to the CBS-16 |  | Done |
| 5.1.1 | ICT to review the content of GDPFS report and consider the use of the WMO Country Profile Data-Base (CPDB) for Members to provide information on their models. |  | Strongly supported by ICT. Under review (by TT-Audit) |
| 6.1 | ICT: To ensure that the requirement to update the whole draft text of the new GDPFS Manual in accordance with technical regulation should not delay the approval of the Guidelines at the CBS-16. |  | Done |
| 6.1 | Question to the ICT: What should be done with the Guide on GDPFS WMO-No 305? |  | New Task Team on Guide(agenda item 5.3) |
| 6.1 | Question to the ICT: Which ET should be responsible for 1.8 of the new Manual (graphical representation)? |  | ICT considered mostly obsolete - passed to TT annual to review and decide what to keep |
| 9.1.1 | ET recommended the establishment of LC for Tropical Cyclone Verification |  | In progress – see agenda item 4.4 |

 **Annex IV**

**Outcomes of ICT DPFS Meetings and summary of ET-OWFPS activities since its last meeting**

1. **Summary of Activities**
	1. The last meeting of the Expert Team on Operational Weather Forecasting Process and Support (ET-OWFPS) was held from 9-13 May 2016, at the Meteorological Service of Canada Regional office, in Montreal, Canada. The outcomes of the meeting were reported to the ICT at its meeting in Exeter May 2016.
	2. The ET-OWFPS work plan developed at the last ET meeting was reviewed by the ICT in May 2016 and also in February 2017 (ICT teleconference). The revised work plan was approved by CBS Management Group (CBS-MG-17) and is given at Annex V
	3. Membership of the ET was revised following CBS-16 in 2016, and finalized at CBS-MG-17. The ET would like to thank the outgoing members (Pierre Eckert, Hamza Kabelwa and Andre Methot) for their active and important contributions to the work of the ET and its predecessors over many years.
	4. The next meeting of the ET-OWFPS will be held at CMA, Beijing, 12-16 March 2018. The agenda for the meeting is available on the meeting website and provided at Annex II. <http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-OWFPS_Beijing2018/DocPlan_001.html>
	5. A summary of recent activities of the ET since its last meeting is provided in the following sections. These were reported to the ICT DPFS at its meeting in February 2018 - a brief summary of relevant actions from the ICT DPFS meeting is included in the final section
2. **Review of ET-OWFPS activities**
	1. The ET contributed to the final revisions and checking of the new manual by reviewing all relevant sections and providing feedback to the TT-manual and Secretariat.
	2. The ET reviewed a number of applications for designation as RSMC according the criteria in the new Manual, in advance of EC-69. These are described on the next section.
	3. The Task Team on Nowcasting completed its work and the document Guidelines for Nowcasting Techniques has been published as WMO-No. 1198, and is available in the WMO library.
	4. The Task Team on Surface Verification and the Lead Centre for Deterministic NWP Verification (LC-DNV) have completed preparations for the implementation of verification of surface weather parameters that will be introduced with the new Manual on GDPFS. ECMWF and DWD have provided initial verification results to the LC-DNV. The Chair of the TT-SV has drafted a letter to be sent to all global NWP centres as soon as the new Manual is published, asking them to provide their results to the LC-DNV. The LC-DNV will be available to offer guidance and assistance to centres, on required format etc.
	5. ET was informed that the WMO Education and Training Department (ETR) has been working on the skills frameworks, and has asked the relevant DPFS Expert Team to review those related to operational forecasting, which includes the Radar, the Satellite and the NWP skills frameworks. The ET considered that the Satellite document was clearly structured, comprehensive and well-written. However, the ET considered that the other documents (and especially the NWP one) were at a much earlier stage of completion, and would benefit from further work.
3. **Review of applications for designation as RSMC according the criteria in the new Manual.**

The ET reviewed all initial applications in its remit; review carried out in March 2017, and recommendations passed back to Secretariat.

* 1. Mapping of current RSMCs with geographical specialization. The ET-OWFPS reviewed the applications for RSMC Offenbach, Rome, Moscow, Khabarovsk, Novosibirsk, and Pretoria to be designated as Regional Specialized Meteorological Centres (RSMCs) for Limited-area Deterministic Numerical Weather Prediction. The ET-OWFPS also reviewed the applications for RSMC Offenbach, Rome to be designated as Regional Specialized Meteorological Centres (RSMCs) for Limited-area Ensemble Numerical Weather Prediction. The ET-OWFPS considered that all these mappings are appropriate and that the centres all have the required capabilities to fulfil the designated requirements.
		1. The ET-OWFPS recognized that while all centres have the relevant capabilities, some did not yet (at time of review), meet all of the criteria required for full compliance. In particular, the full set of specified output fields to be made available via the WIS, providing required standard verification (to the LC-DNV where required), and providing the specific required documentation were not all available at that time. However, the ET-OWFPS considered that these can all be achieved within the specified transition period and that there are no major capacity issues.
		2. The ET-OWFPS therefore supported all the proposed designations.
		3. The ET-OWFPS noted audit of these centres for full compliance may be required in advance of Cg-18, following the procedures that will be developed by the ICT-DPFS Task Team on audit, and looks forward to receiving this guidance from the TT.
	2. New types of centre – Nowcasting. The ET-OWFPS reviewed the applications from Germany and Japan for designation of their centres (Offenbach and Tokyo) as RSMCs for Nowcasting. The information presented in the applications demonstrated compliance with the designation criteria in the Manual. The ET-OWFPS supported both the applications.
	3. New types of centre - Lead Centre for Coordination of Tropical Cyclone Forecast Verification. The ET-OWFPS has reviewed the applications from China and Japan for designation of their centres (Shanghai and Tokyo) as Lead Centre for Coordination of Tropical Cyclone Forecast Verification. Both centres have demonstrated that they have the capability and commitment to fulfil the role as required in the Manual. They both have been doing relevant TC verification for several years. The ET-OWFPS considered that both centres have excellent proposals and therefore is happy to support both applications. However, the ET-OWFPS also recognizes that there are a number of complementary aspects to the proposals, and for this reason recommended that the two centres develop a joint candidature, sharing the responsibilities. The ET-OWFPS considers that this will overall provide a more comprehensive and valuable verification that would be feasible from a single centre.
	4. In January 2018 the ET-OWFPS reviewed the application from DWD to become World Meteorological Centre. The application was reviewed by Chair and Co-chair and discussed at ICT in February 2018; review was passed to Secretariat for further action.
1. **Outcomes of ICT DPFS February 2018**

Brief summary of relevant ICT actions and discussion

* 1. ICT asked Secretariat and ET-OWFPS to publicise the recently published Guidelines for Nowcasting to make sure that Members are aware and benefit from them
	2. ICT passed on request from IPET-OSDE to identify Point of Contact for global NWP to be focal point for observations requirements.
	3. PWS is developing competency documents for operational forecasters. ICT agreed to review when available. The possibility to develop competencies for other activities was briefly discussed as a possible future development
	4. The work of auditing RSMC activities was discussed. ET-OWFPS has a role in reviewing compliance for a number of RSMC activities. The audit process will be developed by TT-Audit; the timeline for establishing and conducting the first round of audits needs to be confirmed
	5. ICT agreed that someone in OPAG DPFS should join WIGOS Regulatory Material Editorial Board to confirm the success transfer regarding observation monitoring functions. Agreed David Richardson would act as PoC to TT-WDQMS regarding the Manual
	6. The ICT discussed the Future Seamless GDPFS – this will be one of the major points to raise at the CBS TECO in March 2018. ICT noted that as stated in the draft WMO strategic plan for 2020-2023, the fundamental responsibility of GDPFS (Strategic Objective 2.3) will be to enable access to and use of the state-of-the-art numerical analysis and prediction products at all temporal and spatial scales. The purpose of a GDPFS is therefore to identify and develop these new approaches, looking ahead towards emerging technologies and techniques, looking sideways to learn from the wider world of science and technology, and looking inward to recognise and nurture our own existing capabilities and those that we wish to develop. ICT noted that the GDPFS is already expanding to address new activity areas, and developing guidelines and best practice to ensure all Members benefit from these developments.

**Annex V**

**Key activities and milestones for ET-OWFPS**

Updated version approved by ET May 2016 (Annex X of meeting report). Consolidated and agreed by ICT and CBS-MG (Feb 2017)

|  |  |
| --- | --- |
| Objectives for ICT-DPFS and all ETs |  |
| Activity  | Milestone | Comments |
| 1. Implementation of new Manual of GDPFS
 | 2018 | ET has reviewed all initial proposals for designation in its remit |
| 1. Rolling review of user requirements
 | S/GDPFS |  |
| 1. Cascading forecast process and seamless approach
 | S/GDPFS |  |
| 1. Review of guidelines on meteorological site assessment of NPP (used to be TN-170)
 | 2018 | ? Not relevant for ET-OWPFS |
| Objectives for ET-OWFPS |  |
| Activity  | Milestone | Comments |
| 1. Develop the guidelines for nowcasting technique
 | 2017 | Completed. Guidelines published |
| 1. Use of additional observation types for verification
 | 2019 | Will be discussed at next ET meeting. But first priority is to complete implementation of surface verification  |
| 1. Develop strategy to exchange of EPS products and guidelines on post-processing (incl. calibration of model output)
 | 2020 | Initial review at next ET meeting. New task team will be established to develop guidelines |
| 1. Implications throughout forecast chain for high-resolution NWP including data assimilation
 | 2018 | This is the work of the TT-High-resolution NWP, which will produce guidelines, including for verification. First TT meeting held April 2016, Tokyo. Work continues through 2018. |
| 1. Building on existing GDPFS to respond to user requirements (SG-S/GDPFS, ET-IMPACT) for impact-based forecasting and risk-based warnings (in staged approach)
 | Wait for requirements | This activity is dependent on the development of requirements, expected through the work on seamless GDPFS, and ET-Impact |

**Annex VI**

**Updates to Manual on GDPFS (2017 edition)**

**A number of changes were made to appendix 2.2.34 from the document that was accepted by the ET-OWFPS for inclusion in the new Manual at its previous meeting in May 2016. Most of the changes were editorial in nature, but some were more substantive. The ET-OWFPS recommended the following two changes**

**1. One premise accepted by the ET was coherence between the parameters to be included in the standardized verification of NWP products and the NWP products to be made available by NWP centres, as they appear in Appendix 2.2.1 of the new Manual. In order that Appendix 2.2.34 and 2.2.1 be consistent, the following parameters which were removed should be included in section 5.1 of Appendix 2.2.34:**

* **850 hPa relative humidity**
* **925 and 700 hPa winds**

**To correct this inconsistency, Section 5.1 of Appendix 2.2.34 should read as follows (changes in red):**

5.1 Parameters

Extra-tropics:

– Mandatory:

– MSLP (verification against analysis only);

– Geopotential height at 850, 500 and 250 hPa;

– Temperature at 850, 500 and 250 hPa;

– Wind at **925**, 850, **700**, 500 and 250 hPa.

– Additional recommended:

– Geopotential height, temperature, wind at 100 hPa;

– Relative humidity at **850** **and** 700 hPa.

Tropics:

– Mandatory:

– Geopotential height at 850 and 250 hPa;

– Temperature at 850 and 250 hPa;

– Wind at 850 and 250 hPa.

– Additional recommended:

– Relative humidity at **850** **and** 700 hPa.

**2. Of greater concern is that Section 5.7 (Scores) does not include the list of scores. The section should read as follows (changes in red):**

5.7 Scores

The following scores are to be calculated for all parameters against both analysis and (except mean sea-level pressure) observation.

Wind

 Mandatory

* rms vector wind error
* mean error of wind speed

Other parameters:

 Mandatory

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

 Additional recommended

* mean absolute error
* rms forecast and analysis anomalies (not required for observations)
* standard deviation of forecast and analysis fields (not required for observations)

The mathematical formulation of the scores is documented on the Lead Centre(s) LC-DNV website, together with supplementary information on score calculation.

**Annex VII**

**Information on implementation of standard verification at producing centres**

**LC-DNV to ask following questions to producing centres (LC-DNV to maintain and update list of questions as required)**

* Which radiosonde list is in use for the verification of your model and as of what date (see[https://software.ecmwf.int/wiki/display/WLD/Observation+lists](https://software.ecmwf.int/wiki/display/WLD/Observation%2Blists)for radiosonde lists)?
* Are the radiosonde observations used in your data assimilation bias corrected and if so, are the forecasts verified against these bias corrected observations?
* What method is used to interpolate
	+ - model forecast fields to the observation points for scores vs observations;
		- forecast and analysis fields to the target (1.5 x 1.5 deg) verification grid
* Provide a brief history of model updates (last 5 years, for example). Once provided, update the information annually. Providing a link to such information would be useful (for example in the case of CMC: <http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/changes_e.html>)

**Annex VIII**

**STATUS OF IMPLEMENTATION OF THE UPDATED CBS PROCEDURES FOR THE UPPER AIR VERIFICATION**

**(from** [**https://software.ecmwf.int/wiki/pages/viewpage.action?pageId=24316358**](https://software.ecmwf.int/wiki/pages/viewpage.action?pageId=24316358)**, with edits in red)**

The table shows centres disseminating verification reports. The current statuses and/or implementation plans are shown based on information received from respective centre by the LC-DNV.

|  |  |  |
| --- | --- | --- |
| **Centre** | **Implementation of updated computing procedures at centres** | **Availability of new scores in new file format via the LC-DNV ftp server** |
| BoM (Australia) | implemented in 2013 | since January 2013 (monthly means) |
| CMC (Canada) | implemented in April 2017 | since January 2014 (daily scores) and March 2013 (monthly means) |
| NCMRWF (India) | in progress |   |
| ECMWF | implemented in 2010 | since January 2012 (daily scores and monthly means) |
| DWD (Germany) | implemented in March 2016 | since April 2011 (scores against observations, daily scores and monthly means) |
| UK MetOffice (United Kingdom) | implemented in 2014 | since summer 2014 (daily scores and monthly means computed by LCDNV) |
| NCEP (USA) | in progress | since Jan 2017 (monthly means vs. analysis); Dec 2017 (daily scores vs analysis).  |
| Meteo-France (France) | implemented in 2013 | since September 2013 (daily scores and monthly means) |
| JMA (Japan) | implemented in 2012 | since December 2012 (daily scores and monthly means) |
| KMA (South Korea) | implemented in 2015 | since June 2015 (daily scores and monthly means) |
| RuMS (Russia) | implemented in 2012 | Since August 2012 (daily scores and monthly means) |

**Annex IX**

**Strategy for the Implementation of High-Resolution NWP based on the capacity of NMCs**

* Level 1 – Use of NWP products, including EPS, from global/regional NWP centres
	+ The purpose is to get the benefit of the latest advances in the science and technology of NWP.
	+ This is in consideration of global NWP systems going into finer resolution such as 10km…
	+ Use of graphical products as well as raw digital data
* Level 2 – Best use of NWP/EPS products from global/regional NWP centres
	+ The purpose is to add the value to the obtained NWP/EPS products
	+ Statistical downscaling and model post-processing techniques
* Level 3 – Downscaling regional model implementation
	+ The purpose is to add benefit beyond the performance of global NWP products.
	+ This is the dynamical downscaling with the resolution of 5km or less, considering high resolution of global NWP systems.
* Level 4 – Regional NWP including Data Assimilation
	+ The purpose is to improve the initial fields to consistently add forecast skill.
	+ Key observations: surface data, radar data, ground-based GNSS, aircraft data…
	+ Regular steps
		- 1. Adopt and setup appropriate assimilation system
		- 2. Monitor quality of observation
		- 3. Evaluate the impact of observation
* Level 5 – Regional EPS
	+ The purpose is to capture the uncertainty.
* Level 6 – Further direction: Regional Coupled NWP or rapidly updated NWP
	+ The purpose is to model the physical interactions with atmosphere, ocean, land surface, atmospheric composition and so on.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
| Resources |  |  |  |  |  |  |
| Minimum Human Resource | (NWP, Soft Engineer) 1-2 FTEs(IT) 1-2 FTEs | (NWP) 2-3 FTEs(SE) 1-2 FTEs(IT) 1-2 FTEs | (NWP) 3-5 FTEs(SE) 1-2 FTEs(IT) 2-3 FTEs | (NWP) 5-7 FTEs (Remark: additional 2FTEs for DA and QC)(SE) 2-3 FTEs(IT) 2-3FTEs | (NWP) 7-9 FTEs (Remark: additional 2FTEs for ENS system and Applications)(SE) 2-3 FTEs(IT) 2-3 FTEs |  |
| Computer Resource | Workstations | Workstations | HPC Cluster with performance to produce T+36 hour forecasts within two hours. | HPC Cluster with performance to produce T+36 forecasts within two hours. | HPC Cluster with performance to produce T+36 hour ensemble forecasts within two hours. |  |
| Communication Network | Broad enough to obtain graphical products. | Broad enough to obtain globa/regional NWP grid data sufficient for post-processing | Broad enough to obtain NWP grid data for initial and boundary conditions within one hour. | Additional capability to obtain local observation data (which are not available on WIS/GTS reliably.) | Possible additional capability to obtain grid data of ensemble members for boundary conditions. |  |
| Storage Resource |  |  |  |  |  |  |
| Modelling System |  |  |  |  |  |  |
| Data Assimilation | None | None | None | Nudging, 3/4DVarLand surface analysis | None(Downscale), 3/4DVar, EnKF, Hybrid DA |  |
| Forecast Model | None | None | Convection-permitting Model* Optimal nesting configuration – Direct nesting from global model or through intermediate model.
* Note) The resolution of grid data of available global model tends to be finer (-0.25degree)
* Note) Relationship with a Member provision global NWP data to obtain highest resolution grid data.
* Note) Communication infrastructure should accommodate the transfer of grid data within appropriate time period.

Option)10km Limited-area model* May need to be implemented because the time interval and space resolution of available global NWP data is not sufficient to drive Convection permitting model
* Difficult to obtain benefit rather than global NWP data.
 | Convection-permitting Model | Convection-permitting Model |  |
| Applications |  |  |  |  |  |  |
| Post Processing | None | Diagnostic variablesSite-specific BC | In addition…Grid-point BC | In addition…* Downscale based on high-density observation
* Downscale based on high-resolution analysis
* Blending with nowcasting to produce VSRF
 | Calibration of probabilistic forecasts to improve the reliability. |  |
| Verification |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Service & Products | Fundamental meteorological information to support forecasting operations and to provide guidance of severe weather. | Fundamental meteorological information to support forecasting operations and to provide guidance of severe weather. | * Enhanced support to forecasting operations and services to users.
* Specialized customer products
 | * Further enhanced support in terms of severe weather forecasting and warnings.
* Enhanced support to forecasting operations and services to users.
* Specialized customer products with more local feature.
 | * Impact-based forecast and Risk-based warning
* Probabilistic information representing forecast uncertainties (EFI and anomaly forecasts)
 |  |
| Notes |  |  |  |  |  |  |

**Annex X**

**Draft Table of Contents of revision of WMO Guide on the GDPFS (WMO-No. 305)**

**PART I. ORGANIZATION AND RESPONSIBILITIES**

* 1. The vision of the GDPFS *(Note: this section will seek to capture the articulated vision of the seamless GDPFS from relevant discussions and documents, in a way that assists the promotion of the GDPFS to the wider community)*
	2. Guiding principles of the GDPFS *(Note: the section will articulate foundational principles of the GDPFS that are not necessarily explained in the Manual to those less famililar with the GDPFS).*
	3. Organization of the GDPFS
	4. Compliance with required GDPFS functions
	5. Summary of required or recommended competencies for undertaking GDPFS functions
	6. Alignment with related WIS functions
	7. Alignment with related WIGOS functions
	8. Interaction among GDPFS centres
	9. Implementation of GDPFS, including interactions among technical commissions and programmes
	10. Summary of relevant Guidelines (further detail to be given in Part IV).

**PART II. ACTIVITIES SUPPORTED BY THE GDPFS**

2.1 General *(Note: this section will expand on the concise functional descriptions given in the Manual but to the extent possible without repeating Manual text. The language will still be kept simple and concise to ensure ease of translation)*

2.2 Functional architecture of GDPFS

2.3 Roles in and review of activities supported by the GDPFS

 2.3.1 General purpose activities

 2.3.2 Specialized activities

 2.3.3 Non-real time coordination activities

2.4 Functional requirements of a GDPFS centre *(Note: this includes 24/7, connection to WIS, back-up procedures, etc.)*

**PART III. DESIGNATION PROCEDURES FOR GDPFS CENTRES**

3.1 General

3.2 Procedure for a World Meteorological Centre *(Note: To include background, a service offer by a Member for potential WMC, demonstration of capabilities, designated WMCs)*

3.3 Procedure for a Regional Specialized Meteorological Centre *(Note: To include background, service offer by a Member for potential RSMC, demonstration of capabilities, designated RSMCs)*

3.4 Rolling review of GDPFS centres *(Note: references to detailed procedures will appear in Part IV)*

**PART IV. GUIDELINES AND FURTHER READING**

4.1 General

4.2 WMO Guidance *(Note: this section will draw the reader's attention to other WMO guidance essential for understanding the seamless GDPFS within the context of the greater whole, including relevant Guides and Guidance notes already extant and as they are further developed. Subjects covered might include quality control of incoming observations, data collection and product dissemination, including standards and specifications, procedures and formats for the exchange of data and products aligned with WIS technical specifications, data-processing, including long-term storage of data and products, verification, the audit process, training, and reporting.)*

4.3 Other references

**Annex XI**

**ET-OWFPS Terms of Reference – Updated in 2016**

**Expert Team On The Operational weather Forecasting Process And Support (ET-OWFPS)**

1. Review the Manual on the GDPFS(WMO-No. 485) and propose updates as necessary concerning nowcasting to medium range forecasting to ensure that procedures are adequate
2. Review GDPFS and Lead Centres' activities, support their developments and provide guidance as stated in the Manual;
3. Assess applications for GDPFS status against the designation criteria and make recommendations on designation to CBS;
4. Review new developments and advances in NWP and related systems, particularly with regard to severe and high impact weather forecasting and;
5. Liaise with relevant WMO Programmes, Technical Commissions and international organizations as required to advise on requirements for practical implementations in operational systems;
6. Provide advice to NMHSs on NWP products, including EPS and post-processing , particularly with regard to seamless forecasting of severe and high impact weather;
7. Monitor and review requirement for observation monitoring by NWP centres in collaboration with WIGOS.
8. Liaise with the PWS programme to promote and support the use and communication of NWP products, including EPS, available from the GDPFS Centres; develop interpretation guidance to facilitate their use, and encourage feedback on usefulness and application;
9. Promote and support the education and training of forecasters on the use and interpretation of NWP products, including EPS, and their strengths and weaknesses;
10. Provide guidance on capacity building concerning the implementation of operational NWP systems, including verification systems, and/or the use of NWP products.

**Annex XII**

**Actions from ET-OWFPS meeting 12-16 March 2018**

|  |
| --- |
| **ACTIONS** |
| Action number | Agenda item/ Paragraph | Action | responsible | Due date | Comments |
| 1 | 4.1/4.1.14.2/4.2.6 | Ensure the missing information related to surface and upper air information in the new Manual on GDPFS are put back in  | Tom Robinson and Secretariat | To go to EC-70 | Key thing is the list of mandatory and additional upper-air scores |
| 2 | 4.1/4.1.1 | Send letter to global NWP centres requesting them to send surface scores to LC-DNV and identify PoC | Thomas Haiden and Secretariat | March 2018 |  |
| 3 | 4.2/4.2.3 | Investigate short and long-term solutions to ftp, secure ftp issue | Tom Robinson and LC-DNV | Next meeting | CMC may provide interim solution to NCEP issue; involve producing centres in discussion as necessary |
| 4 | 4.2/4.2.3 | Send agreed set of questions to the producing centres | Mr Robinson and LC-DNV | April 2018 |  |
| 5 | 4.2/4.2.6 | Implement computation and display of confidence intervals for verification results | LC-DNV | Next meeting |  |
| 6 | 4.2/4.2.6 | Develop plan of how to implement exchange of scores for each station for upper-air fields as recommended in Manual | Tom Robinson and LC-DNV | Next meeting |  |
| 7 | 4.2/4.2.6 | send email to Producing Centres requesting them to stop sending old scores  | LC-DNV | April 2018 |  |
| 8 | 4.2/4.2.6 | check all scores on LC-DNV web site to check for any issues | Mr Robinson | July 2018 |  |
| 9 | 4.2/4.2.9 | LC-EPSV to update its website with the revised guidelines to match the new edition of the Manual on GDPFS) and to contact producing centres to provide required scores | LC-EPSV | July 2018 | Update website as soon as possible  |
| 10 | 4.2/4.2.9 | Ken Mylne to contact LC-EPS to propose update to implementation guidelines for verification of lagged EPS; update to be circulated to ET for approval | Ken Mylne | April 2018 |  |
| 11 | 4.2/4.2.9 | Consider possibility to extend functionality of LC-DNV web site | LC-DNV | Next meeting |  |
| 12 | 4.4/4.4.11 | Ensure that TC verification, including LC-TCV activity and potential extension, is reviewed at next ET meeting | Chair | Next meeting |  |
| 13 | 4.5/4.5.3 | Inform JWG-FV of the ET interest in the use of additional observation types for verification in the future. | Thomas Haiden | Next meeting of JWGFVR |  |
| 14 | 4.6/4.6.5 | Coordinate further study on use of radiosonde position and report back at next meeting | Mr Robinson | Next meeting |  |
| 15 | 4.6/4.6.5 | make relevant information on use of radiosonde position in verification available on the LCDNV web site | Mr Robinson and LC-DNV | July 2016 |  |
| 16 | 4.7/4.7.7 | Study the impact on the standard verification of reduced synoptic radiosonde at 00Z and 12Z and clarify whether or not 11Z and 23Z are used as 12Z and 00Z in the standard verification process by NWP centres | Mr Robinson | Next meeting |  |
| 17 | 4.8/4.8.4 | Implement the proposed mask for all participating centres to use to address issue related to extrapolation below orography.  | LC-DNV | July 2018 |  |
| 18 | 4.10/4.10/8 | Encourage work including with JWGFVR on how to account for obs uncertainty; reevaluate at next meeting and provide recommendation for future action | Thomas Haiden | Next meeting |  |
| 19 | 5.1/5.1.7 | Inform Chair TT HR NWP of additional support offered by Ms Wang, Mr Mylne, Mr Tupper and Mr Erfani. | Chair ET-OWFPS | March 2018 |  |
| 20 | 5.1/5.1.7 | Facilitate understanding of capacity level for HR NWP implementation at relevant meetings (e.g. Donors) | Mr Harou (Secretariat) | On-going wherever relevant |  |
| 21 | 5.2/5.2.6 | Contact Mr Honda (Chair TT-Audit) to offer ET-OWFPS support for TT-Audit activities | Mr Richardson  | March 2018 |  |
| 22 | 5.2/5.2.7 | provide the secretariat with a summary of ET assessment of HKO application for RSMC Nowcasting, for the secretariat to process | Jianjie Wang Yong Wang  | March 2018 |  |
| 23 | 5.3/5.3.2 | Revise outline of the Guide based on discussion with ET-OWFPS and share with ICT-DPFS co-chairs for acceptance | Mr Tupper | March 2018 | Done |
| 24 | 5.3/5.3.2 | Develop one-pager on procedure for application of Centres for designation | Mr Harou (Secretariat) | March 2018 |  |
| 25 | 5.4/5.4.1 | publicize availability of new Guidelines on Nowcasting (including WMO Bulletin and website) | Mr Harou (Secretariat) and Mr Wang (for Bulletin) | April 2018 |  |
| 26 | 5.4/5.4.2 | Review operational Nowcasting verification and relevant research and report to next ET meeting with view to possible recommendations for standard verification procedures  | TT-Nowcasting | Next meeting |  |
| 27 | 7.1/7.1.12 | Establish the Task Team on Guidelines for the generation and application of EPS products and to develop scope, outline contents of guidelines and work plan for approval by ET-OWFPS | Mr Mylne (Chair TT-EPSPP) | July 2018 |  |
| 28 | 7.1/7.1.12 | Plan resources for 1 week meeting of TT-EPSPP in 2019 | Secretariat and Mr Mylne | In line with 2019 budget planning  |  |
| 29 | 7.2/7.2.1 | Think about developing a discussion paper on the issue of the limit of predictive skill  | Thomas Haiden (Chair TT-SV) | Next meeting | Lower priority compared to other actions on verification |
| 30 | 10/10.1 | Complete draft report of meeting, circulate to ET members for comment, issue final report | Chair and Secretariat | Publish on WMO website April 2018 | 2 weeks for members to comment on draft  |