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| **WORLD METEOROLOGICAL ORGANIZATION**COMMISSION FOR BASIC SYSTEMSOPAG on DPFS**MEETING OF THE CBS (DPFS) EXPERT TEAM ON OPERATIONAL PREDICTIONS FORM SUB-SEASONAL TO LONGER-TIME SCALES (ET-OPSLS)**BARCELONA, SPAIN, 2 AND 4 TO 6 JUNE 2018 |  | DPFS/ET-OPSLS/Doc. 5.3(15.V.2018)\_\_\_\_\_\_\_Agenda item : 5ENGLISH ONLY |

**REPORT OF SUB-TEAM 3: SCOPING/IMPLEMENTATION OF SUB-SEASONAL FORECASTS**

*(Submitted by Kuhhee Cho /Yuhei Takaya)*

##### Summary and purpose of document

This document reports on activities relevant to the sub-team 3, specifically efforts to develop and implement an operational framework for sub seasonal forecasts.

##### Action Proposed

The meeting is invited to discuss the document and recommend further steps to formalize operational sub seasonal forecast activity in a part of GDPFS functions (LC-SSFMME and GPC-SSF).

**Annex(es):** -

**Reference(s):**

Prototype sub seasonal MME products (password required):

<https://www.wmolc.org/>
Task team 3 Exeter (2014) documents: <http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-OPSLS_Exeter2014/DocPlan.html>

Sub-team 4 Beijing (2016) documents (Agenda 6.3): <http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-OPSLS_Beijing2016/DocPlan.html>

**SCOPING/IMPLEMENTATION OF SUBSEASONAL FORECASTS**

In the last two intersession periods of the IPET-OPSLS, the sub-team 3 has made steady progress to put operational activity of the sub-seasonal forecast as a part of seamless GDPFS functions. Its goal is proposing establishment of Lead Centres for Multi-Model Ensemble of Sub-Seasonal Forecasts (LC-SSFMME) and Global Producing Centres of Sub-Seasonal Forecasts (GPC-SSF) alongside the seasonal and multiannual forecasts. The document reports activities relevant to the sub-team 3 (ST3) to consult the IPET members further steps required to establish the LC-SSFMME and GPC-SSF.

1. Background

It is generally recognized that the sub-seasonal forecast is now a valuable component in seamless weather/climate forecast services. The WMO bodies and ST3 have made considerable efforts to bring the sub-seasonal forecast services into operations as a part of GDPFS functions, are briefed below.

1.1 Setting up the Task Team 3 on the sub-seasonal forecasts (later renamed to ST3)

The Cg­XVI (2011) requested the LC­LRFMME to explore the possibility of extending its role to include exchange of extended­-range predictions, and invited GPCs to provide subseasonal forecast data to enable the LC­LRFMME to display sub­seasonal forecast products through the LC­LRFMME web pages. The Geneva ET-ELRF meeting (2012) recognized the need to coordinate this initiative with planned activities of the WWRP /WCRP research project on sub-seasonal to seasonal prediction (S2S), which involves research-based exchange of predictions. The meeting of the ICT-DPFS (Paris, 2013) set up a Task Team to scope the implementation of real-time sub-seasonal forecasts, and to establish the necessary links with the WWRP/WCRP S2S research project.

1.2 Planning a pilot exchange of the sub-seasonal forecasts in collaboration with the S2S project

With regard to the pilot exchange, the CBS-XV (2012) recommended a phased approach, starting with development of links with the S2S database enabling the LC‑LRFMME to generate and display a range of products. In addition to this pilot exchange, GPCs running extended-range forecasts were encouraged to display their products on their individual websites, to accelerate the availability of extended-range (defined as beyond 10 days and up to 30 days in the forecast) products to WMO Members. A list of proposed variables recommended for forecast display was developed by the ET-ELRF in the Geneva meeting (2012) and the team noted that additional variables (e.g. 500 hPa height) could be added to the list. The TT3 guided the scoping and implementation of a pilot repository and multi-model display of real-time sub-seasonal forecasts and to coordinate this activity with that of the S2S research project.

At the Exeter S2S steering group meeting (2014), which was attended by Mr Alberto Arribas, Mr Arun Kumar, and Mr Yuhei Takaya of TT3, the phased approach was adopted. At the meeting it was proposed to make use of the S2S research archive of sub-seasonal forecasts to develop a real-time multi-model display at the LC-LRFMME. Specifically, the operational centres participating in the S2S project would send their real-time forecasts to ECMWF, ECMWF would impose the agreed 3-week delay on public release of the forecasts, but allow LC-LRFMME access to an agreed subset of the data for use in preparing a display of real-time forecast on their website. This approach to the data flow would have the advantage that the operational centers would need to send their data only once (for S2S and for CBS), and relieve the workload of the LC for the demonstration. The S2S ICO at KMA could also play a role since the LC-LRFMME is hosted by KMA. The S2S steering group approved this proposal and it was recommended that the ET-OPSLS continue to liaise with the S2S planning group and with ECMWF with a view to gaining formal agreement.

At the Exeter (2014) meeting, it was proposed to coordinate the pilot exchange of sub-seasonal forecasts in parallel to the S2S project research activity. It was agreed that the pilot real-time activities would best be achieved with a small group of volunteering centres. It was also agreed that the display would not go ‘live’ until agreed by the ET-OPSLS following a review of methodologies and results. It was also noted that the multi-model approach for sub-sesasonal forecasts would be a challenge due to wide diversity among sub-seasonal modeling systems (in forecast issue time and frequency, hindcast frequency, ensemble size etc.). It was noted that centres participating in the S2S project had been requested to begin supplying data to the S2S database by July 2014. In accordance with a request at the Exter meeting, LC-LRFMME elaborated the plan of the pilot activity and request GPCs to participate in it. Four GPCs kindly agreed to join this activity (GPC ECMWF, GPC Exeter, GPC Tokyo, GPC Washington).

1.3 Discussion and reviews of sub-seasonal MME and ST3 responses

At Beijing (2016) meeting, the IPET was briefed on the pilot system for generation and display of the real-time sub-seasonal forecast exchange. Based on the agreement at the Exeter (2014) meeting, the pilot phase employs forecast and hindcast data of the four GPCs obtained from the ECMWF hosted S2S data archive for the S2S project. The real-time products were displayed with a password protection for reviews and feedback from IPET-OPSLS and relevant bodies (e.g. by requesting feedback from the S2S project Steering and Liaison Committee on the report prepared by the LC-LRFMME which was made available at the following link of the S2S wiki page of the S2S verification and products subproject: http://s2sprediction.net/file/documents\_reports/Report\_on\_subseasonal\_MME\_in\_LC-LRFMME\_MAY2016.pdf). The products included probabilities for anomaly relative to the climatology, tercile categories of 2-m temperature and precipitation as well as MJO and BSISO indices. Forecast verifications had also been generated using the hindcast data submitted to S2S.

The Brasilia workhop (2013), the First WMO Workshop on Operational Climate Prediction (OCP1) in Pune (2015) and the Second WMO Workshop on Operational Climate Prediction (OCP2) in Barcelona (2018) discussed the sub-seasonal forecast activity in S2S project and ST3 with participants from GPCs, RCCs, RCOFs and NMHSs as well as a representative from the research community (WGSIP). At the OCP2, Mr. Andrew Robertson discussed technical aspects and practices of sub-seasonal forecasts and Mr. Yuhei Takaya discussed on the research-operations linkages in the S2S forecast activity and how the S2S research deliverables could be undertaken by the operations currently discussed in the IPET-OPSLS. The idea of establishment of the operational sub-seasonal forecast component in the GDPFS functions and achievements by S2S projects were welcomed by attendees with great anticipation.

As summarized above, LC-LRFMME created prototype products and continued the demonstration for last four years. The products have been steadily generated on a routine basis. The demonstration period of the sub-seasonal forecasts is shorter than that of the Annual to Decadal Climate Prediction (ADCP, 7 years before formalized in the GDPFS manual), but the demonstration has been taken place every month, meaning that the real-time sub-seasonal exchange can be implemented to operations. At the Beijing (2016) meeting, the prototype products were reviewed in IPET-OPSLS. The IPET members discussed how the sub-seasonal forecast activity can be further developed in a framework of the seamless GDPFS. The main comments and suggestions were as follows.

a) The number of models used should be stabilized (GPC Beijing, GPC Melbourne, GPC Exeter and GPC Montreal agreed to join the real-time pilot)

b) The day of nominal issuance needs a further consideration to maximize a number of models used in MME (This was Wednesday, but a change to Thursday should be considered.)

c) New variables should be added in the prototype products, such as 500-hPa height and low-level wind (10 variables are exchanged: SST, 2-m temperature, precipitation, mean sea level pressure, 200-hPa wind, 500-hPa height, 850-hPa wind and outgoing long-wave radiation)

d) A larger sample of forecast verification statistics is required.

In accordance with the comments and suggestions at the Beijing (2016), some changes have been made by the LC;

- GPC-Montreal has been added to the pilot sub-seasonal MME since 2016.

- The definition of weekly average was changed from Thursday-Wednesday to Monday-Sunday.

- The newly requested additional products were included in the graphical products, such as 500-hPa height and low-level wind. Currently, deterministic MME products include variables (precipitation, 2-m temperature, mean sea level pressure, 500-hPa height, 850-hPa wind, 200-hPa wind, velocity potential, stream function), probabilistic MME and individual deterministic products include two variables (2-m temperature, precipitation).

- Comprehensive deterministic and probabilistic verifications were produced for the exchanged variables (precipitation, 2-m temperature, MSLP, 500-hPa height, 850-hPa wind, 200-hPa wind, velocity potential, stream function).

Currently 10 GPCs participate in the S2S project, and they could be candidates of future GPCs-SSF. The data are stably archived at the S2S data every month, indicating that stable operation of sub-seasonal forecasts at S2S participating centres.

2. Verification of the sub seasonal forecasts

To guide verification of sub-seasonal forecasts and define the mandatory of GPC-SSF, the current practices of sub-seasonal forecast verifications were compiled by sending a questionnaire to all GPCs-LRF period to the ET-OPSLS meeting in Beijing (2016). The questionnaires were summarized in the report of the Beijing (2016) meeting (Annex 7 in the report). Results of the questionnaire results indicated commonalities in general products and verification made among the centres, on the other hand, it also identified some differences. (For details, please refer to the Doc. 6.3(4) of the Beijing (2016) meeting.) This means that it is required to develop the standardized verification method of the sub-seasonal forecasts as a mandatory of GPC-SSF in the GDPFS manual. Technically, verification could be done at the LC-SSFLRF similarly as seasonal and decadal forecasts because most centres provided their hindcasts to the S2S project in the common formant. Based on the results of the questionnaires, a proposal of the mandatory verification will be prepared together with a proposed amendment of GDPFS manual to include functions of GPC-SSF and LC-SSFMME. The possible specification of the mandatory and recommended verifications would be as follows.

- Fields: (mandatory) 500-hPa height, 2-m temperature, precipitation

 (recommended) 200- and 850-hPa velocity potential, out-going long-wave radiation (OLR), SST

- Period: weekly, monthly (week 1-4) and week 3-4 (2nd fortnight)

- Hindcast: longer than 15 years

- Grid: 1.5 by 1.5 degrees regular grid

- Scores: mean bias, correlation, RMSE, area under ROC curve & Brier score (tercile)

- Verification dataset: ERA-interim, GPCP, HadISST

- Indices: (optional) Wheeler and Hendon MJO index and teleconnection indices (NAO, PNA etc.)

It is noted that the S2S Phase 1 sub-project on the verification and products widely reviewed the methodology currently employed to operational sub-seasonal forecasts and conducted the questionnaire on the verification of the sub-seasonal forecasts. This was of great help to develop the proposal of the standardized verification that could be implemented in the future GDPFS.

3. Future actions

The ST3 will continue its activity to elaborate a proposal of the establishment of LC- SSFMME and GPC-SSF, including the change of the nominal forecast initial date from Monday to Friday and producing the probabilistic MME products for mean sea level pressure, 500-hPa height, 850-hPa wind, 200-hPa wind, velocity potential, stream function. The draft proposal will be circulated in the IPET-OPSLS in 2020 for approval to make a recommendation to CBS and CCl.