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| WORLD METEOROLOGICAL ORGANIZATIONCOMMISSION FOR BASIC SYSTEMS OPAG on DPFS Meeting of the Expert Team on Operational Prediction from  Sub-seasonal to Longer-time Scales  Barcelona, Spain, 2-6 June 2018 |  | CBS-DPFS/ET-OPSLS /Doc. 4.1(4)  (22.III.2016)  \_\_\_\_\_\_\_  Agenda item : 4.1  ENGLISH ONLY |

**REVIEW OF THE WORK, FUNCTIONS AND SPECIFIC NEEDS OF THE GLOBAL PRODUCING CENTRES (GPCs)**

**STATUS / PROGRESS REPORT FOR EXETER**

*(Submitted by Jeff Knight/Craig MacLachlan)*

##### Summary and purpose of document

This document provides information on GPC Exeter’s GloSea5 seasonal prediction system; compliance with GPC requirements for forecast schedule, configuration, products and verification; additional information provided to members and capacity development activities.

##### Action Proposed

The meeting is invited to note and consider the contents.

**Reference(s):** MacLachlan, C., Arribas, A., Peterson, K. A., Maidens, A., Fereday, D., Scaife, A. A., Gordon, M., Vellinga, M., Williams, A., Comer, R. E., Camp, J., Xavier, P. and Madec, G. (2015), Global Seasonal forecast system version 5 (GloSea5): a high-resolution seasonal forecast system. Q.J.R. Meteorol. Soc., 141: 1072–1084. doi: 10.1002/qj.2396

Smith, D. and co-authors, 2012: Real-time multi-model decadal predictions. Clim. Dyn.

DOI 10.1007/s00382-012-1600-0

**STATUS / PROGRESS REPORT FOR EXETER**

**1. FORECASTING SYSTEM**

* 1. Description of the forecasting system specification

**The GloSea5 system**: GPC Exeter’s current prediction system, GloSea5, is described in MacLachlan et al. (2014). It is a fully coupled system with interactive sea ice. GloSea5 has atmospheric resolution of 0.83°E-W; 0.56° N-S; 85 vertical levels and ocean resolution of 0.25°; 75 vertical levels. Output is configured for both seasonal and subseasonal forecasting. In February 2015 a major upgrade to the model was made, incorporating the following scientific advances as below (Global Coupled 2.0; Williams et al. 2015).

* Implementation of new dynamical core ENDGAME:

<http://www.metoffice.gov.uk/research/news/2014/endgame-a-new-dynamical-core>

* Improvements to oceanic vertical mixing scheme to improve the mixed layer representation of the world's oceans, which is important to seasonal forecasting, marine ecosystems, and many other aspects of the climate system. Changes have also been made to the NEMOVAR assimilation scheme to improve the initialisation of sub-surface temperature and salinity.
* Improvements to the albedo and surface roughness of the sea ice to achieve a more realistic seasonal cycle of sea ice.

GPC Exeter and GPC Seoul now both run the GloSea5 system as their operational forecast system, as the first stage in developing a joint seasonal forecasting system. GPC Seoul also use the Global Coupled 2.0 configuration.

1.2 Content of basic forecast outputs *[response options in brackets; change or delete as appropriate. For non-compliant elements, please indicate intended date of compliance]*

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| --- | --- |
| Issue frequency: | *Monthly, sent to LC-LRFMME before 10th of the month* |
| Temporal resolution: | *Averages/accumulations over 3-month periods* |
| Spatial resolution: | *0.56° (N-S) x 0.83° (E-W) data sent to the LC is 1.0° x 1.0° res.* |
| GrahSpatial coverage: | *Global* |
| Lead time: | *1-, 2- and 3-month lead times* |
| Output types: | *Graphical images at :* [*http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks*](http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks) *and* [*www.wmolc.org*](http://www.wmolc.org)  *Digital data package available by agreement via ftp as well as on the IRI data library after agreeing terms and conditions using an online form (no commercial use):* <http://iridl.ldeo.columbia.edu/SOURCES/.UKMO/> |
| Verification as per WMO SVSLRF | *Yes*   1. *location :* [*http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks*](http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks) *and* [*http://www.bom.gov.au/wmo/lrfvs/*](http://www.bom.gov.au/wmo/lrfvs/) 2. *15-year hindcast? Yes, the current hindcast is 23 years (1993-2015)* 3. *Forecast and hindcast from the same system? Yes, apart from the ensemble size the hindcast and forecast systems are identical* |

**2. PRODUCTS** *[response options in brackets; change or delete as appropriate. For non-compliant elements, please indicate intended date of compliance]*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable: | | Probabilities for tercile categories of 2m temperature | Probabilities for tercile categories of precipitation | Probabilities for tercile categories of SST (coupled models only) |
| Spatial resolution: | | *0.56° (N-S) x 0.83° (E-W)* | *0.56° (N-S) x 0.83° (E-W)* | *0.56° (N-S) x 0.83° (E-W)* |
| Temporal Resolution: | | *3 months* | *3 months* | *3 months* |
| Coverage: | | *Global* | *Global* | *Global* |
| Issue frequency: | | *monthly* | *monthly* | *monthly* |
| Lead-time | L0 | *N* | *N* | *N* |
| L1 | *Y* | *Y* | *Y* |
| L2 | *Y* | *Y* | *Y* |
| L3 | *Y* | *Y* | *Y* |
| L4 | *N* | *N* | *N* |
| L4+ | *N* | *N* | *N* |
| Location of rendered images: | | [*http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks*](http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks) | | |
| Location of digital data (if available): | | Free and commercial data packages available (ftp) by agreement (monthly values free for no commercial use)  Monthly values also available on IRI Data Library (after online acceptance of terms and conditions) | | |
| *[For non-compliant elements, please indicate intended date of compliance]* | | None | | |

**3. VERIFICATION** *[response options in brackets; change or delete as appropriate. For non-compliant elements, please indicate intended date of compliance]*

3.1 SVSLRF Level 1 scores

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable: | 2m temperature | Precipitation | SST (coupled models only) | Niño region indices |
| Seasons: | *As for products (nominally 12 3-month seasons)* | *As for products (nominally 12 3-month seasons)* | *N* | *N* |
| Leads: | *All leads for which forecasts are issued* | *All leads for which forecasts are issued* | *N* | *N* |
| ROC curves: | *Northern extratropics, southern extratropics, tropics, other subregions* | *Northern extratropics, southern extratropics, tropics, other subregions* | *N* | *N* |
| ROC area: | *Northern extratropics, southern extratropics, tropics, other subregions* | *Northern extratropics, southern extratropics, tropics, other subregions* | *N* | *N* |
| Reliability curve: | *Northern extratropics, southern extratropics, tropics, other subregions* | *Northern extratropics, southern extratropics, tropics, other subregions* | *N* | *N* |
| Frequency histograms (sharpness) | *Northern extratropics, southern extratropics, tropics, other subregions* | *Northern extratropics, southern extratropics, tropics, other subregions* | *N* | *N* |
| MSSS | *Global\** | *Global\** | *N* | *N* |
| Location of scores: | [*http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks*](http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks)  *\* only available at LC-SVSLRF* [*http://www.bom.gov.au/wmo/lrfvs/*](http://www.bom.gov.au/wmo/lrfvs/) | | | |
| Scores’ availability on the LC-SVSLRF web site | *Subset* | *Subset* | *-* | *-* |
| *[For non-compliant elements, please indicate intended date of compliance]* | Note: Only 4 conventional seasons required for level 1 temperature and precip. |  | December 2019 | December 2019 |

3.2 SVSLRF Level 2 scores

|  |  |  |  |
| --- | --- | --- | --- |
| Variable: | 2m temperature | Precipitation | SST (coupled models only) |
| Seasons: | *As for products (nominally all 12 seasons)* | *As for products (nominally all 12 seasons)* | *As for products (nominally all 12 seasons)* |
| Leads: | *All leads for which forecasts are issued* | *All leads for which forecasts are issued* | *N* |
| ROC maps: | *Y* | *Y* | *N* |
| MSSS maps: | *Y* | *Y* | *N* |
| MSSS 1 maps: | *Y* | *Y* | *N* |
| MSSS 2 maps: | *Y* | *Y* | *N* |
| MSSS 3 maps: | *Y* | *Y* | *N* |
| Location: | [*http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks*](http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks)  *Note: MSSS maps available on LC-SVSLRF site only* [*http://www.bom.gov.au/wmo/lrfvs/*](http://www.bom.gov.au/wmo/lrfvs/) | | |
| *[For non-compliant elements, please indicate intended date of compliance]* |  |  | December 2019 |

**4. DISSEMINATION**

Graphical products are freely available at: <http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks>. Monthly-mean data products are freely available by ftp on request, or via the IRI Data Library (<http://iridl.ldeo.columbia.edu/SOURCES/.UKMO/> ) under agreement of non-commercial use.

**5. LRF MULTI-MODEL ENSEMBLE**

Data are contributed to the LC-LRFMME multi-model, the EUROSIP multi-model and Copernicus Climate Change Service (C3S). Nino indices are provided to the International Research Institute for Climate and Society (IRI) for their multi-model ‘plume’ forecasts. Nino indices and IOD indices are provided to the Australian Bureau of Meteorology’s climate model summary.

GPC-LRF Exeter has additionally been designated as the Lead Centre for Annual to Decadal Climate Prediction (LC-ADCP) at WMO EC-69 (May 2017). This is a new activity within WMO and builds on an informal exchange of real-time multi-annual to decadal forecasts between centres active in producing predictions on these timescales. The aim is to assess and understanding differences and similarities between forecasts, identifying a consensus (multi-model ensemble) view in order to prevent over-confidence in a single model, and establishing access to this kind of information for a wider range of members. This is also a step towards ensuring that this activity is incorporated into the Climate Service Information System (CSIS) of the GFCS. Seven informal exchanges have taken place so far: specifically for forecasts starting nominally on 1st January 2011-17. Details of the first two exchanges, including a description of forecasts and verification, are provided in Smith et al. 2012. Each exchange consists of up to 9 dynamical climate models and 3 empirical techniques (Table 1). Both initialized and uninitialized predictions are exchanged so that the impacts of initialization can be assessed. Analysis so far has focused on generating, for each individual model and the multi-model mean, global maps of forecast near-surface temperature averaged over the first year and subsequent 5 year periods. A new website for the LC-ADCP is under development, and a process to select producing centres (GPC-ADCP) is now underway.

**6. ADDITIONAL INFORMATION PROVIDED BY THE GPC**

Further additional real-time products currently available include:

* SST “plumes” showing the predicted monthly evolution of Nino3/3.4/4 (plumes for Indian Ocean and Tropical Atlantic SST indices are expected to be available by May 2016);
* Probability forecasts and SVSLRF verification for outer-quintile categories
* Tailored forecasts, including for specific regions, available at: <http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/forecasts>
  + Precipitation prediction for tropical North Africa; East Africa and NE Brazil;
  + North Atlantic tropical storm forecasts;
  + Arctic sea ice extent;
  + Experimental decadal predictions including next 5-year means (global coverage) and real-time verification.

**7. CAPACITY BUILDING AND TRAINING**

A modular seasonal forecast capacity development course has been further developed and used as part of a number of projects. The modules are centred on hands on training and include:

* familiarisation with climate drivers – using exercises with KMNI’s Climate Explorer online tool.
* familiarisation with output from dynamical ensemble prediction systems – using an interactive spreadsheet tool to study ensemble characteristics, measure hindcast skill of GPC systems for the region concerned (using SVSLRF skill measures) and generate regional real-time forecasts.
* Introduction to output from the WMO GPCs through the LC-LRFMME website
* Use of IRI’s Climate Predictability Tool (CPT) to carry out statistical post processing of GPC output – to discover and correct for systematic model biases and make (statistically) downscaled real-time forecasts.

This period has seen 4 training workshops in East Africa as part of the WISER programme and in collaboration with RCC ICPAC. The participants included both NMHS personnel as well as participants from Universities and Training Centres, the latter included to strengthen in-country sustainability of capacity. The WISER-SCIPEA project also included a post-workshop sustained training component by tasking participants to use the skills acquired in the workshops to analyse each new (monthly) update from the GPCs and submit results for review. Training materials from the workshops have been used to draft lesson modules that could be used by other trainers. Under the DFID BRACED-Burkina and WISER-ASPIRE project similar training has been delivered to Sahel countries – with sustained training undertaken by the ASPIRE “in-region” embedded consultant.

Andrew Colman of the Met Office is lead author of the seasonal forecasting chapter of the West Africa Forecasters handbook, published in 2017.

**8. SPECIFIC NEEDS**

Continued and strengthened support from WMO in emphasizing the need and value of global long-range forecast operations and research to improve systems would be helpful – particularly in the light of increasing demands on GPCs from the developing GFCS. Support with regard to the need for development of applications products and for capacity building would also be helpful to assist leverage of funding sources for these activities.

**9. FUTURE DEVELOPMENTS**

New versions of the underlying physical model that is used in the GloSea5 system are under test and there is a hope to implement these improved versions in 2019.

**10. USERS OF THE LRF**

Users include:

* National Meteorological and Hydrological Services and Regional Organisations, globally. Tailored information is supplied to African Regional Climate Organisations and associated RCOFs : ICPAC, ACMAD, SADC-DMC for the GHACOF, PRESAO and SARCOF meetings, respectively.
* Prediction centres/multi-models: LC-LRFMME, EUROSIP, IRI, BoM.
* 3-month outlooks are provided to UK government using information from GloSea5, EUROSIP and the LC-LRFMME as well as other observational and predictive information and expert assessment.
* Seasonal forecasts of Volta reservoir (Ghana) water volume inflow have been provided since 2003 for purposes of hydro-electric power generation management.
* Various other UK government and commercial organisations.

**References**

MacLachlan, C., Arribas, A., Peterson, K. A., Maidens, A., Fereday, D., Scaife, A. A., Gordon, M., Vellinga, M., Williams, A., Comer, R. E., Camp, J., Xavier, P. and Madec, G. (2015), Global Seasonal forecast system version 5 (GloSea5): a high-resolution seasonal forecast system. Q.J.R. Meteorol. Soc., 141: 1072–1084. doi: 10.1002/qj.2396

Smith, D. and co-authors, 2012: Real-time multi-model decadal predictions. Clim. Dyn.

DOI 10.1007/s00382-012-1600-0

Williams, K. D., Harris, C. M., Bodas-Salcedo, A., Camp, J., Comer, R. E., Copsey, D., Fereday, D., Graham, T., Hill, R., Hinton, T., Hyder, P., Ineson, S., Masato, G., Milton, S. F., Roberts, M. J., Rowell, D. P., Sanchez, C., Shelly, A., Sinha, B., Walters, D. N., West, A., Woollings, T., and Xavier, P. K.: The Met Office Global Coupled model 2.0 (GC2) configuration, Geosci. Model Dev., 8, 1509-1524, doi:10.5194/gmd-8-1509-2015, 2015.

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