Quarterly Numerical Weather Prediction Model Performance Summary – April to June 2015

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Introduction

This summary, covering the three-month period from April to June 2015, continues the series reporting on the performances of NWP (Numerical Weather Prediction) models used operationally in the Australian Bureau of Meteorology.

NWP models – April to June 2015

Local Models

No changes have been reported for the Bureau's ACCESS systems during this verification period.

Details on the configurations of the Bureau's models are described in an earlier summary (Wu 2014). For more details about the ACCESS systems, please refer to http://www.bom.gov.au/australia/charts/bulletins/apob83.pdf, http://www.bom.gov.au/australia/charts/bulletins/apob90.pdf, http://www.bom.gov.au/australia/charts/bulletins/apob93.pdf, http://www.bom.gov.au/australia/charts/bulletins/apob99.pdf and http://www.bom.gov.au/nwp/doc/access/NWPData.shtml.

Overseas Models

The following four operational global models which are run by overseas forecast centres are verified in this article. The European Centre Spectral Prognosis (ECSP) refers to the European Centre for Medium-Range Weather Forecasts (ECMWF) system, UKGC to the Unified Model from the UK Met Office, United States Aviation Model (USAVN) to the Global Forecast System (GFS) from National Centers for Environmental Prediction (NCEP) and Japan Meteorological Agency Global Spectral Model (JMAGSM) to the global assimilation and forecast model from JMA.

On 12 May 2015 ECMWF operationally implemented a new IFS (Integrated Forecast System) Cycle 41r1. The main changes in this cycle include new surface climate fields; new CO2/O3/CH4 climatology from latest MACC-II (Monitoring Atmospheric and Composition & Climate) reanalysis produced at ECMWF; revised semi-Lagrangian extrapolation reducing stratospheric noise; revised interpolation of moist variables in the upper troposphere/lower stratosphere; cloud scheme change of rain evaporation, auto-conversion/accretion, riming and precipitation fraction; improved representation of supercooled "freezing" rain; modified convective detrainment; activation of the lake model; active use of wave modified stress in couple mode; revised se-ice minimum threshold, sea-ice roughness length and consistency between SST and sea ice concentration.

On 19 May 2015 ECMWF operationally implemented a revised set of forecast output fields for the ocean waves. These were based on a new method to split the second ocean wave spectrum into its principle components. The new scheme splits the wave spectrum into one wind waves and up to three swell partitions (significant height, mean wave direction and mean wave period of first, second and third swell partitions).

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On 25 June 2015 JMAGSM started to use the assimilation of Megha-Tropiques/SAPHIR sounding instrument. SAPHIR is a sounding instrument with 6 channels near the absorption band of water vapor at 183 Ghz.

For further information on the improvements made to overseas NWP assimilation and forecast models refer to web references given below. Details on the configurations of the forecast models are described in an earlier summary (Wu 2014).

Verification method

A description of the S1 skill-score, as applied in the Bureau, can be found in the paper by Skinner (1995). All results have been calculated within the Bureau, where each of the models was verified against its own analysis. From the large number of objective verification results routinely produced, the statistics presented here cover only the mean sea level pressure (MSLP) and 500 hPa geopotential height fields over the irregular Australian verification area (Miao 2003). It is noted that the results for the 00 and 12 UTC base-times have been combined. For the locally run, limited-area models, the verified forecast periods go out to a maximum of 72 hours and for the global models to a maximum of 192 hours.

Review of performance – April to June 2015

Fig. 1 to Fig. 3 are the plots covering the verifying period from April to June 2015.

Local models (ACCESS-G and ACCESS-R)

The intercomparisons of the S1 skill scores of the MSLP forecasts for the two local models covering the verifying period April to June 2015 are shown in Figure 1(a). The S1 skill-scores are averaged over the three-month period for various forecast periods ranging from 0 to 72 hours. S1 skill-score comparisons of the 500 hPa geopotential height forecasts are shown in Figure 1(b). In general, the coarser-resolution global model outperforms the finer-resolution limited area models. This result is partly due to the later data cut-off of the assimilation for the global models. It is also due to the disadvantage suffered by the limited area models which obtain their initial first guess and boundary conditions from the earlier run of the global model forecasts. Forecasts from earlier runs tend to be poorer than forecasts produced from later runs. One other contributing factor for the better-than-expected scores for the global models is the verification method used here, which disadvantages finer resolution models through "double penalty" scoring. For example, a location error of a deep low pressure system from a more realistic high resolution forecast is counted once for misplacing the low where the verifying analysis does not have it and twice for not placing it where the verifying analysis does. Care needs to be taken to filter out scales below which a verification method was not intended to measure if models that are run at different resolutions are to be objectively compared.

Fig. 1(a) MSLP S1 skill-score comparison, for different forecast periods, between ACCESS-G and ACCESS-R (April to June 2015).

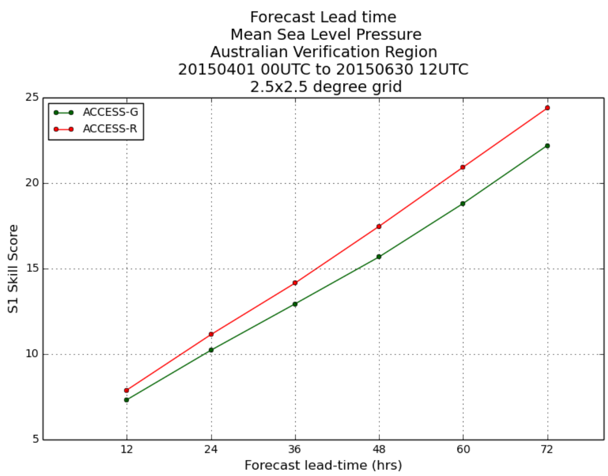
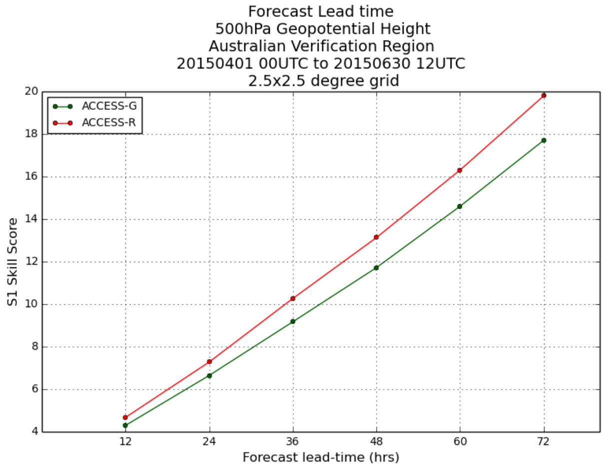


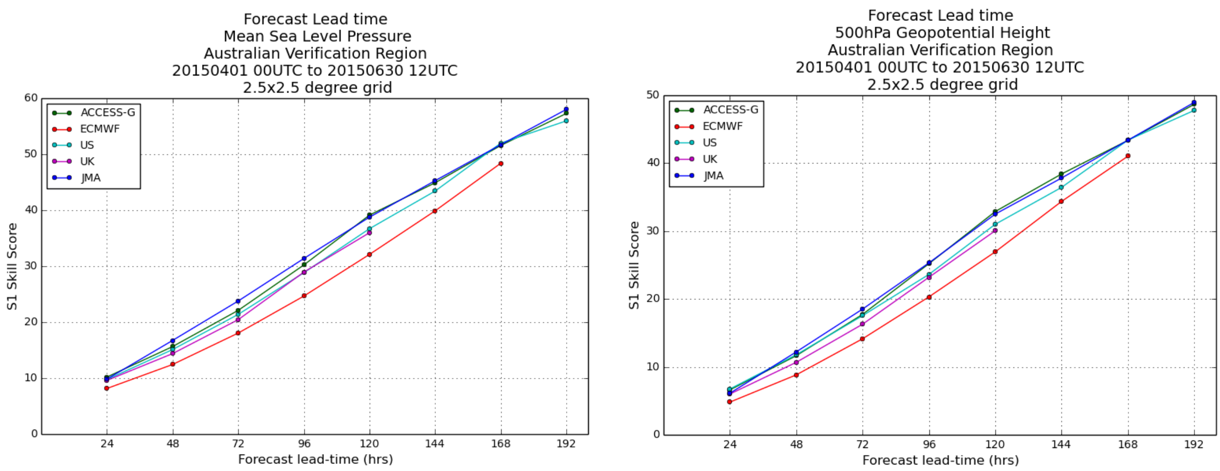
Figure 1(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between ACCESS-G and ACCESS-R (April to June 2015).



Global models (ACCESS-G, ECSP, UKGC, USAVN, JMAGSM)

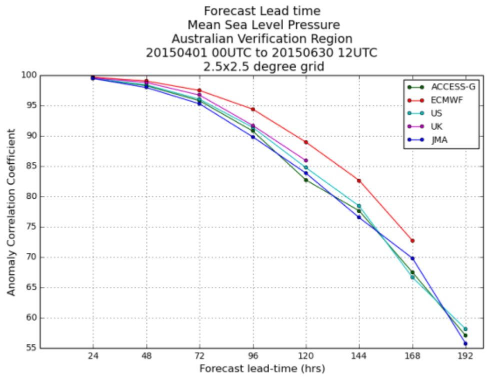
The Bureau's new operational global spectral model ACCESS-G and the four global models from overseas NWP centres are operationally used by forecasters. The outputs from the models are also postprocessed to produce various objective guidance products used in and outside of the Bureau. Hence their forecast performance is of great interest to the forecasters and other users. The S1 skill scores for MSLP and 500 hPa geopotential height forecasts for the period April to June 2015 are presented in Figure 2. Anomaly correlations for the MSLP forecasts are shown in Figure 3.

Figure 2 (left) MSLP S1 skill-score comparison, for different forecast periods, between ACCESS-G, ECSP, UKGC, USAVN, and JMAGSM (April to June 2015), (right) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between ACCESS-G, ECSP, UKGC, USAVN and JMAGSM (April to June 2015).



Assuming the commonly used cut-off of 60% as the criterion for useful forecasts (Murphy and Epstein 1989), for the April to June 2015 period the anomaly correlation scores for ACCESS-G, ECMWF, JMAGSM and USAVN show useful skill to beyond seven days. ACCESS-G has similar skill as USAVN and outperforms JMAGSM up to 4 days, then becomes less skillful than USAVN and JMAGSM at day 5 but outperforms JMSGSM again at day 6. UKGC and ECMWF perform consistently better than other models up to 5 days and 7 days respectively.

Figure 3 Anomaly correlation of MSLP comparison, for different forecast periods, between ACCESS-G, ECSP, UKGC, USAVN and JMAGSM (April to June 2015).



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Miao, Y. 2003. Numerical prediction model performance summary July to September 2002. *Aust. Met. Mag*., *52*, 73-75.

Murphy, A. and Epstein E. S. 1989. Skill Scores and Correlation Coefficients in Model Verification. *Mon. Wea. Rev.*, 117, 572-581.

Skinner, W. 1995. Numerical prediction model performance summary April to June 1995. *Aust. Met. Mag*., *44*, 309-312.

Web reference

For ECMWF:

http://www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model

For UKMO:

http://www.metoffice.gov.uk/research/modelling-systems/unified-model

For NCEP:

http://www.emc.ncep.noaa.gov/gmb/STATS/html/model_changes.html

For JMA:

http://www.wis-jma.go.jp/ddb/latest_modelupgrade.txt

For ACCESS:

http://www.bom.gov.au/australia/charts/bulletins/apob83.pdf

http://www.bom.gov.au/australia/charts/bulletins/apob90.pdf

http://www.bom.gov.au/australia/charts/bulletins/apob93.pdf

http://www.bom.gov.au/australia/charts/bulletins/apob98.pdf

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http://www.bom.gov.au/nwp/doc/access/NWPData.shtml