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Quarterly numerical weather prediction model performance summary – July to September 2009

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Introduction

This summary, covering the three-month period from July to September 2009, continues the series reporting on the performance of numerical weather prediction (NWP) models used operationally in the Australian Bureau of Meteorology.

Verified NWP models and their upgrades during the July to September 2009 period

Local models

The Australian Bureau of Meteorology has been planning to replace all the existing operational NWP systems with the new Australia Community Climate Earth-System Simulator (ACCESS), a joint initiative led by the Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in cooperation with the university community of Australia. The initial version of ACCESS is based on the United Kingdom Meteorological Office (UKMO) Unified Model assimilation and prediction code. For more information about ACCESS, please refer to http://www.accessimulator.org.au/.

On 1 September 2009 the National Meteorological and Oceanographic Centre (NMOC) declared the ACCESS-G (Global domain) and ACCESS-R (Regional domain) systems operational. ACCESS-G and ACCESS-R will replace the existing GASP and LAPS_PT375 systems, however at present GASP and LAPS_PT375 will continue to run in parallel with the new ACCESS systems until they are turned off in early 2010.

The domains, temporal resolutions and forecast hours of ACCESS-G/R systems remain the same as the current GASP/LAPS_PT375 systems. The main changes in the new ACCESS systems include the use of a four-dimensional variational data assimilation scheme (4DVAR); the use of a hybrid vertical level structure; the horizontal and vertical staggering of fields on the native model grids; precipitation fields being accumulated from the start of the assimilation window and omega (Pa/s) being replaced by vertical velocity (m/s) to represent vertical motion in the atmosphere.

ACCESS-G and ACCESS-R are expected to provide better forecast guidance than GASP and LAPS_PT375. The quarterly intercomparison plots among ACCESS, GASP/LAPS and other overseas global models as seen here in the review of performance section will be produced in the next issue for the October to December period.

For more details about the ACCESS systems running in the Bureau, please refer to the NMOC Operations Bulletin No. 80 at http://www.bom.gov.au/nmoc/bulletins/nmc_bulletin.shtml.

Overseas models

Products from four global models run by overseas operational forecast centres are received in NMOC and their verifications are shown 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 the National Centers for Environmental Prediction (NCEP) and Japan Meteorological Agency Global Spectral Model (JMAGSM) to the global assimilation and forecast model from JMA.

On 8 September 2009 ECMWF introduced a new Integrated Forecast System (IFS) cycle 35r3. The main changes in this cycle include a non-orographic gravity wave scheme; a new trace gas climatology derived from the Global and regional Earth-system (Atmosphere) Monitoring using Satellite and *in situ* data (GEMS) project; assimilation of cloud-affected radiances for infrared instruments; improved assimilation of land-surface sensitive channels; assimilation

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of total-column water vapour data from the MEdium Resolution Image Spectrometer (MERIS) instrument (over land) and variational bias corrections for ozone satellite data.

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 assimilation and forecast models are described in an earlier summary (Lee 2005).

Verification method

A description of the S1 skill score, as applied in NMOC, can be found in the paper by Skinner (1995). All results have been calculated within NMOC Melbourne, 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 this particular verification grid has southerly points that are outside the TXLAPS_PT375 domain (25°N – 25°S, 100°E – 160°E) and, hence, the TXLAPS_PT375 scores are not strictly comparable with those from GASP and LAPS_PT375. Also the results for the 0000 and 1200 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 – July to September 2009

Local models (GASP, LAPS, TXLAPS)

The intercomparison of the S1 skill scores of the MSLP forecasts for the three local models covering the period July to September 2009 is shown in Fig. 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 comparison of the 500 hPa geopotential height forecasts is shown in Fig. 1(b). In general, the coarser-resolution GASP outperforms the finer-resolution limited area models. This result is partly due to the later data cut-off of the GASP assimilation. 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 GASP 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 GASP 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 GASP, LAPS_PT375 and TXLAPS_PT375 (July to September 2009).

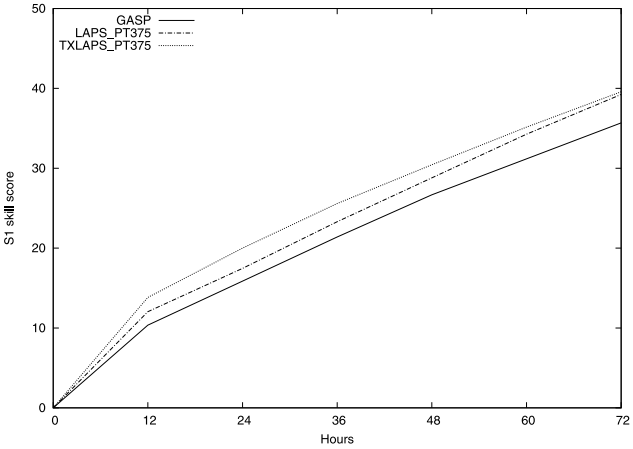
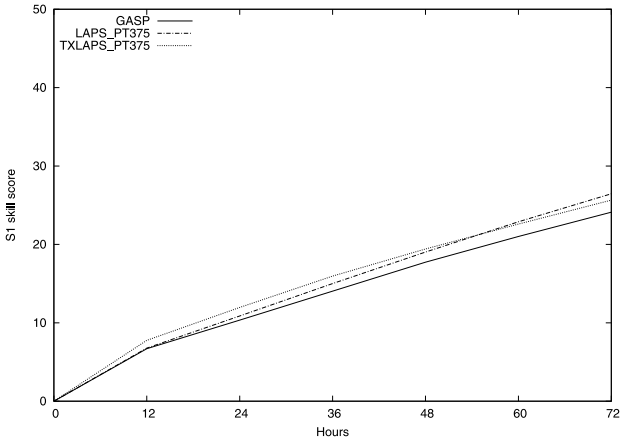


Fig. 1(b) 500 hPa geopotential height S1 skill score comparison, for different forecast periods, between GASP, LAPS_PT375 and TXLAPS_PT375 (July to September 2009).



Global models (GASP, ECSP, UKGC, USAVN, JMAGSM)

The Bureau's own operational global spectral model, GASP, and the four global models from overseas NWP centres are used operationally 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 July to September are presented in Figs 2(a) and 2(b). Anomaly correlations for the MSLP forecasts are shown in Fig. 3. All the global models are verified using a common 2.5 latitude/longitude grid except USAVN which is verified on a 2.5 latitude/5.0 longitude grid. However this use of coarser grid spacing for USAVN is not thought to have affected the intercomparison.

Fig. 2(a) MSLP S1 skill score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2009).

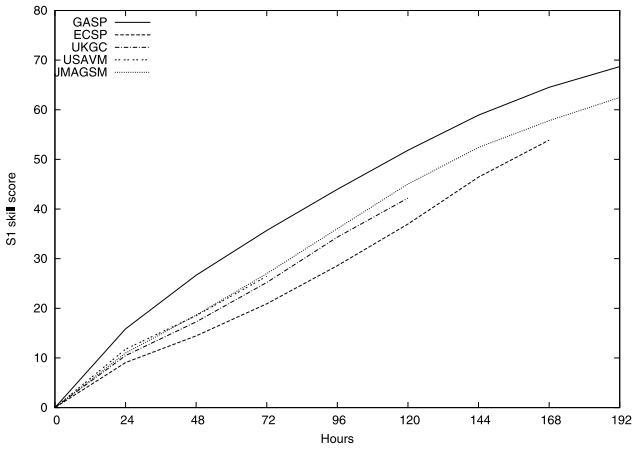
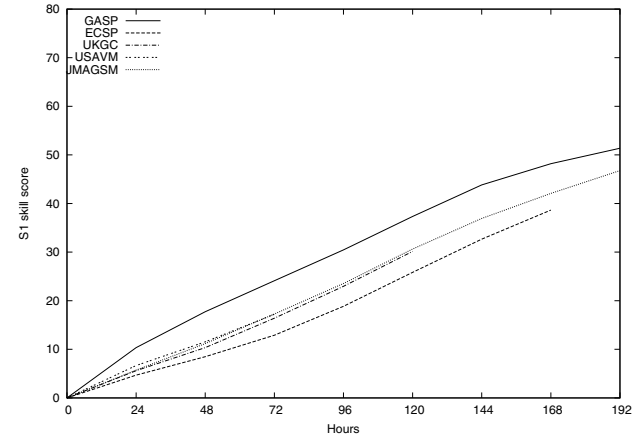
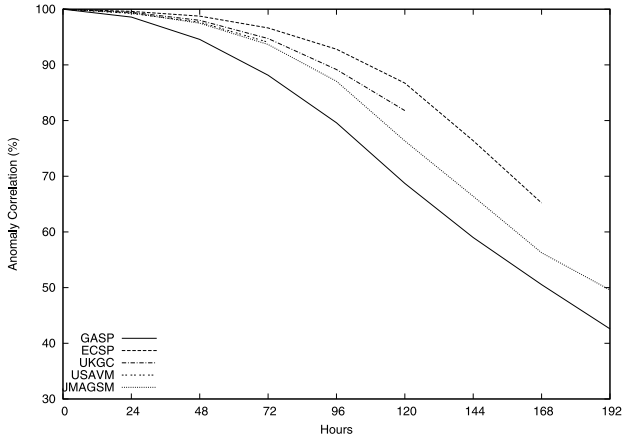


Fig. 2(b) 500 hPa geopotential height S1 skill score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2009).



Assuming the commonly used cut-off of 60 per cent as the criterion for useful forecasts (Murphy and Epstein 1989), the anomaly correlation scores for the ECMWF show useful skill to beyond seven days, JMA also shows useful skill to around six to seven days and GASP around six days. The UKGC is marginally better than JMA and USAVN at the shorter lead times but clearly better than JMA in the longer term up to five days.

Fig. 3 Anomaly correlation of MSLP comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2009).



Acknowledgments

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References

Lee, J. 2005. Quarterly numerical weather prediction model performance summary – July to September 2005. Aust. Met. Mag., 54, 253-61.

Miao, Y. 2003. Numerical prediction model performance summary July to September 2002. Aust. Met. Mag., 52, 73-5.

Murphy, A. and Epstein, E.S. 1989. Skill scores and correlation coefficients in model verification. Mon. Weath. Rev., 117, 572-81.

Skinner, W. 1995. Numerical prediction model performance summary April to June 1995. Aust. Met. Mag., 44, 309-12.

Web reference:

For ECMWF:

http://www.ecmwf.int/publications/newsletters

http://www.ecmwf.int/products/data/technical/model_id/index.html

For UKMO:

http://www.metoffice.gov.uk/research/nwp/publications

For NCEP:

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

For JMA:

http://ddb.kishou.go.jp

For ACCESS:

http://www.accessimulator.org.au/

http://www.bom.gov.au/nmoc/bulletins/nmc_bulletin.shtml