Quarterly numerical weather prediction model performance summary – July to December 2007

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Introduction

This summary, covering two quarters, from July to December 2007, continues the series reporting on the performances of numerical weather prediction (NWP) models used operationally in the Australian Bureau of Meteorology.

Verified NWP models and their upgrades during the July to December 2007 period

Local models

The Bureau's Limited Area Prediction System (LAPS_PT375) provides initial and boundary conditions for a number of high-resolution models as well as providing inputs to numerous forecast guidance systems. The operational system was upgraded from a 51 to a 61 vertical-level version in the National Meteorological and Oceanographic Centre (NMOC) on 30 October 2007. The upgrade enables the use of higher quality global and direct read-out (i.e. locally received and processed) ATOVS satellite radiance data from more satellite instruments during data assimilation, along with enhanced surface grid fields and physics.

On 11 September 2007 the Bureau's Global Analysis and Prediction System (GASP) was also upgraded. Changes included an increase in the number of model levels from 33 to 60, model tops raised from 10 hPa to 0.1 hPa, the number of satellites used increased from 3 to 5 and the use of higher quality data from more satellite instruments. The new system aims to improve forecast guidance.

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A new 61 level Mesoscale Assimilation LAPS system (MALAPS) with improved horizontal resolution to 10 km became operational in NMOC on 11 December 2007. It performs a high-resolution data assimilation to supply more details of mesoscale features such as frontal changes than previous models. Model forecasts are produced out to +48 hours twice a day from 0000 UTC and 1200 UTC base times. Data assimilation is performed every three hours prior to these forecasts.

Overseas models

Products from four global models run by overseas operational forecast centres are received in NMOC and are verified in this article. For this article 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 Global Forecast System (GFS) from National Centers for Environmental Prediction (NCEP) and Japan Meteorological Agency (JMA) Global Spectral Model (JMAGSM) to the global assimilation and forecast model from JMA.

JMA upgraded the Global Spectral Model (GSM) on 21 November 2007 and increased the resolution from TL319L40 to TL959L60 with the topmost level raised from 0.4 hPa to 0.1 hPa. A new high-resolution analysis system for sea-surface temperatures and sea-ice concentration is employed as ocean-surface boundary conditions and the surface snow-depth data from a domestic-dense observational network are used in the global snow-depth analysis. A convective triggering scheme was introduced into the deep convection parametrisation and a new two-dimensional aerosol climatology is derived from satellite radiation observations. The resolution of the inner loop model

of four-dimensional variational (4D-Var) data assimilation system is increased from T106L40 to T159L60. The forecast runs out to 84 hours at 0000, 0600 and 1800 UTC daily.

On 7 November ECMWF introduced Cycle 32r3 which contains significant changes to the model physics, including the convection scheme. This new cycle is expected to beneficially increase the model skill globally, particularly in the tropics. Associated with this new cycle, the Ensemble Prediction System (EPS) has also been improved.

For further information on the improvements made to overseas NWP assimilation and forecast models refer to the web reference 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 and, hence, the TXLAPS_PT375 scores are not strictly compatible 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 2007 to December 2007

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 2007 is shown in Fig. 1(a). The S1 skill-scores are averaged over the three-month period and for various forecast periods ranging from 0 hour to 72 hours. S1 skill-score comparison of the 500 hPa geopotential height forecasts is shown in Fig. 1(b). Similar plots for the October to December quarter are shown in Figs 2(a) and 2(b). The differences between

Fig. 1(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, LAPS_PT375 and TXLAPS_PT375 (July to September 2007).

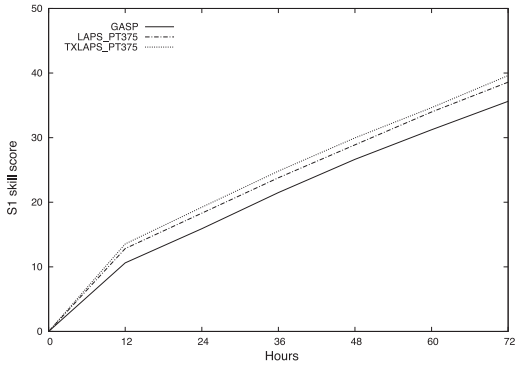
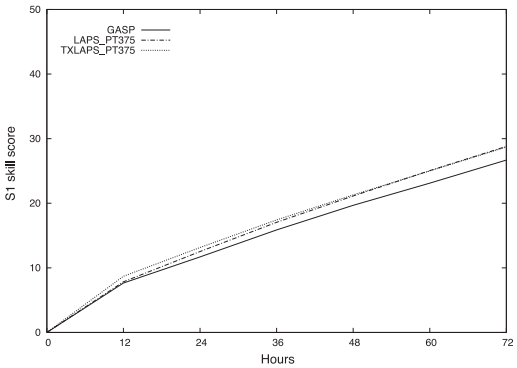


Fig. 1(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, LAPS_PT375 and TXLAPS_PT375 (July to September 2007).



LAPS and TXLAPS for the October-December quarter are much bigger than for the July-September quarter. This may be related to the upgrade of LAPS in October 2007. In general, the coarser-resolution GASP generally outperforms the finer-resolution limited area models. This result is partly due to longer 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

Fig. 2(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, LAPS_PT375 and TXLAPS_PT375 (October to December 2007).

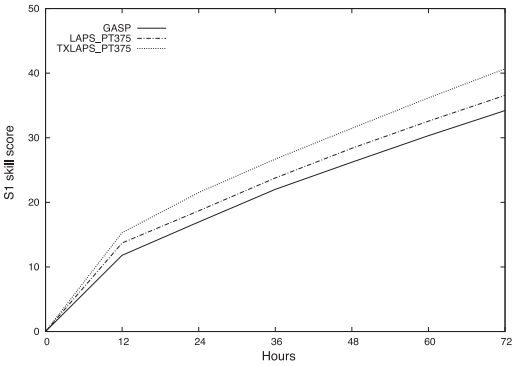


Fig. 2(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, LAPS_PT375 and TXLAPS_PT375 (October to December 2007).

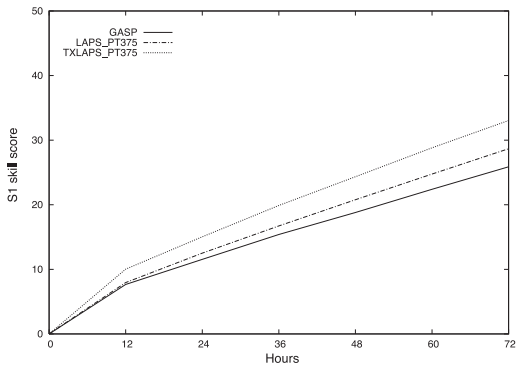


Fig. 3(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2007).

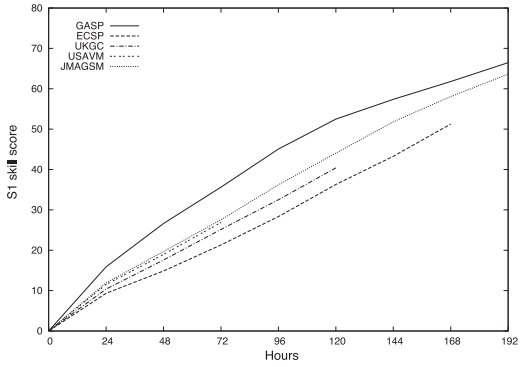
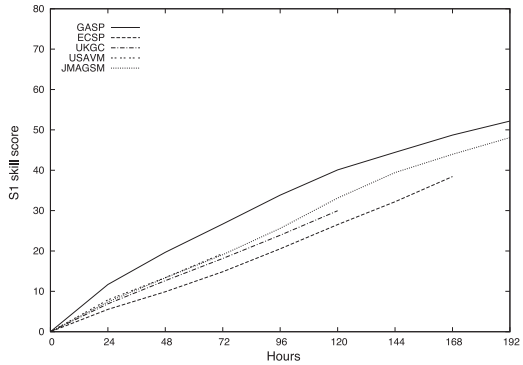


Fig. 3(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2007).



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 which are run at different resolutions are to be objectively compared.

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

The Bureau's 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 post-processed to produce various objective guidance products used by users 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 December are presented in Figs 3 and 4. Anomaly correlations for the MSLP forecasts are shown in Figs 5 and 6. 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. 4(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (October to December 2007).

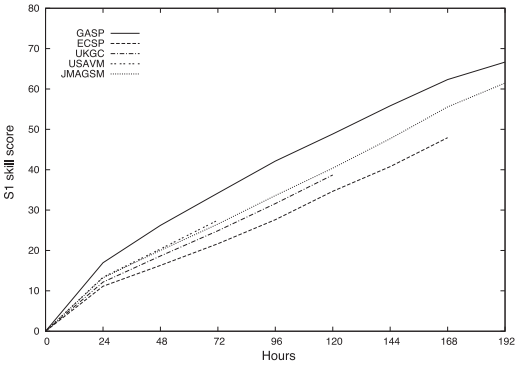
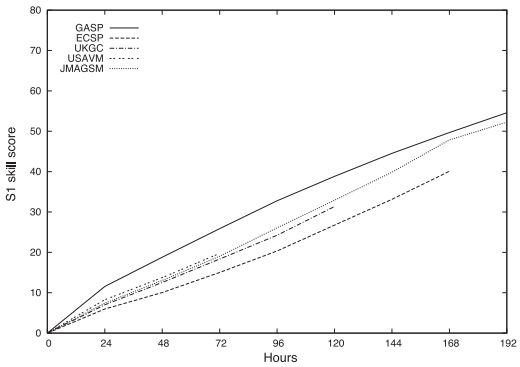


Fig. 4(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (October to December 2007).



Assuming the commonly used cut-off of 60% 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 show useful skill to around seven days and the GASP model has shown a marginal improvement in skill from the July–September quarter to the October–December quarter to about six days. S1 skill-scores show the JMA and ECMWF models have improved slightly from the July-September quarter to the October–December quarter. This may be related to the model upgrades in November 2007. Similarly GASP was upgraded in September and it has also shown a small improvement over the two quarters.

Fig. 5 Anomaly correlation of MSLP comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (July to September 2007).

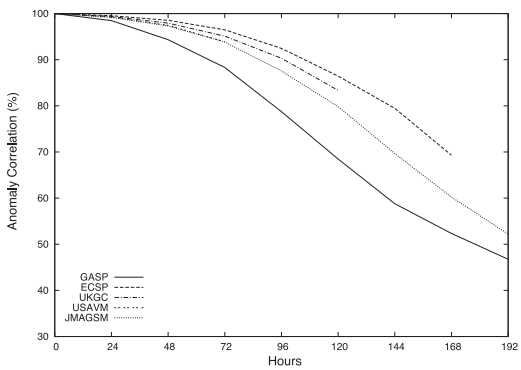
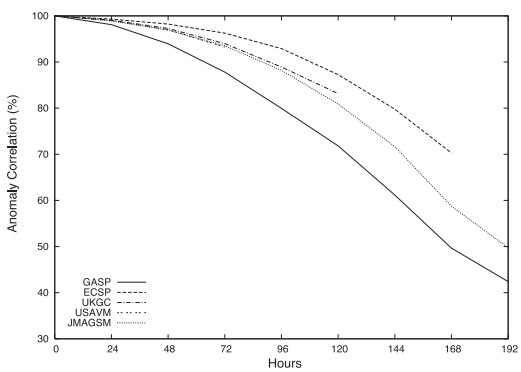


Fig. 6 Anomaly correlation of MSLP comparison, for different forecast periods, between GASP, ECSP, UKGC, USAVN and JMAGSM (October to December 2007).



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Web reference

For ECMWF: http://www.ecmwf.int/publications/newsletters and http://www.ecmwf.int/products/data/technical/model_id/index.html

For UKMO: http://www.meto.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