Numerical weather prediction model performance summary January to June 2003

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Introduction

This summary, covering the six-month period January to December 2003, continues the series reporting on the performances of numerical weather prediction (NWP) models used operationally, in the Bureau of Meteorology.

NWP models verified

The models considered in this performance summary are from the NMOC (National Meteorological and Oceanographic Centre) in Melbourne, ECMWF (European Centre for Medium-range Weather Forecasts), NCEP (National Centers for Environmental Prediction, USA), UKMO (Met Office, United Kingdom) and JMA (Japan Meteorological Agency).

Three local models, from NMOC, are considered, viz.: LAPS (Limited Area Prediction System) – run over the Australian region on a 0.375° latitude/longitude grid, with 29 vertical levels, and using one-dimensional variational retrievals (1DVAR) and multivariate statistical interpolation in the assimilation; TLAPS (Tropical Limited Area Prediction System) – run over an extended tropical domain on a 0.375° latitude/longitude grid, with 29 vertical levels, and multivariate statistical interpolation in the analysis; and GASP (Global ASsimilation and Prediction) – run over a global domain at the Triangular spectral truncation resolution T239 in the horizontal, and 29 levels in the vertical, together with 1DVAR and multivariate statistical interpolation in the assimilation. These basic features have remained unchanged since the last summary (Stewart 2003).

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The following four overseas global models are included in the comparisons (where the associated acronyms, used in the figures below, are shown in parentheses): ECMWF Assimilation and Spectral Model (ECSP) – run at the resolution: T511 and 60 levels, with a 4DVAR multivariate analysis procedure; NCEP Global Forecast System (USAVN) – run at T254 and 64 levels (for the forecast times processed below), with 3DVAR and a multivariate Spectral Statistical Interpolation analysis scheme; UK Meteorological Office Grid Point model (UKGC) – run on a 0.5555° latitude/0.8333° longitude grid and 38 levels, with a 3DVAR analysis scheme; and JMA Global Spectral Model (JMAGSM) – run at T213 and 40 levels, with a 3DVAR assimilation scheme.

Recent changes to the NWP models

Local models

NOAA-17 data was assimilated into GASP (in January) and LAPS (in June). The atmospheric CO_2 concentration and solar constant number were updated in all the local models during the period. In the early part of the period, the processing of METARs over higher topographic regions was improved in LAPS.

Overseas models

In January, a number of changes were made to ECMWF's global assimilation and forecasting system including the assimilation of GOES WV and SSM/I radiances, and MODIS winds, and upgrades to the convective scheme and numerics. In March there was a major technical upgrade associated with the move to a new IBM high-performance computing system (see http://www.ecmwf.int/publications/newsletters). The UK Met Office made some improvements to the tropical convection scheme and model stability during the period (see http://www.metoffice.com/research/nwp/publications). The JMA system remained basically

Fig. 1(a) MSLP S1 skill-score comparison, for different forecast periods, between LAPS, TLAPS and GASP (January to March 2003).

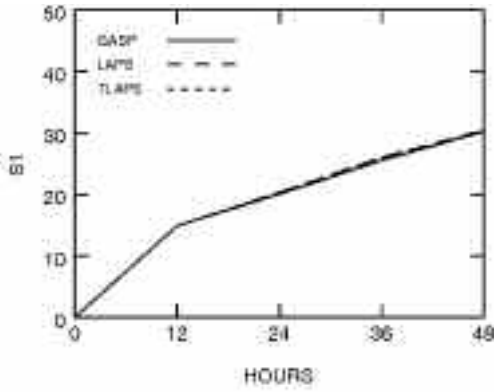


Fig. 1(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between LAPS, TLAPS and GASP (January to March 2003).

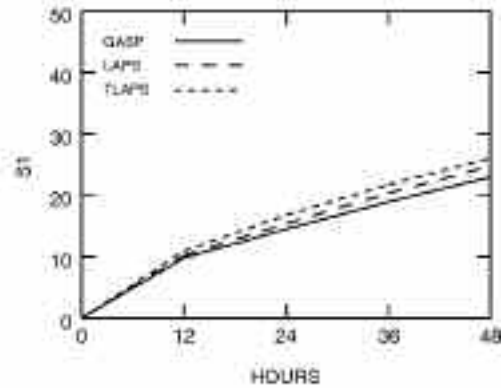


Fig. 2(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, ECSP, USAVN, UKGC and JMAGSM (January to March 2003).

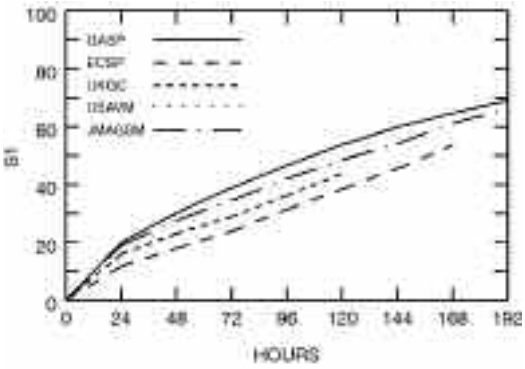
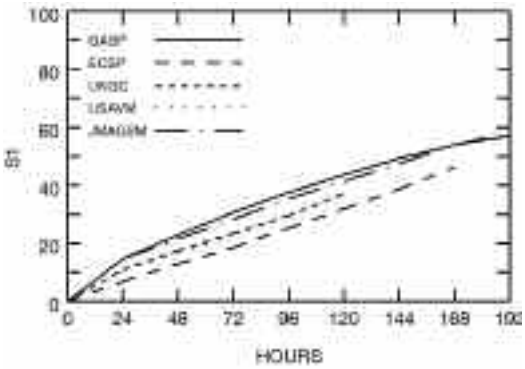


Fig. 2(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, ECSP, USAVN, UKGC and JMAGSM (January to March 2003).



unchanged (see http://www.jma.go.jp/JMA_HP/jma/jma-eng/jma-center/nwp/nwp-top.htm). The US reported that NOAA-17 1B radiances were assimilated (and that NOAA-16 AMSU radiances were restored) as well as making changes to their handling of QuikSCAT winds (see http://www.emc.ncep.noaa.gov/modelinfo).

Verification method

A description of the S1 skill-score, as applied in the National Meteorological and Oceanographic Centre (NMOC), can be found in an earlier article (Skinner 1995). All results have been calculated within NMOC Melbourne, where the models were verified against their own analyses. From the large number of objective verification results routinely produced, the statistics presented here cover only the 500 hPa geopotential height and mean sea level pressure (MSLP) fields over the irregular Australian verification area (Miao 2003). It is noted that this particular verification grid has southerly points that are outside the TLAPS domain and, hence, the TLAPS scores are not strictly compatible with those from GASP and LAPS. The results for the 00 and 12 UTC base-times have been combined. The results are presented, at this stage, for forecast periods out to a maximum of 192 hours.

The NMOC limited area operational models are run several hours before GASP (for a given base date-time). This earlier data cut-off could affect their skill relative to GASP. Also, the US, UK and JMA models run with a short data cut-off time of about 3 hours, compared with 7 hours for GASP and 10 hours for ECMWF, which again makes the intercomparison not strictly compatible.

Fig. 3 Anomaly Correlation of MSLP comparison, for different forecast periods, between GASP, ECSP, USAVM, UKGC and JMAGSM (January to March 2003).

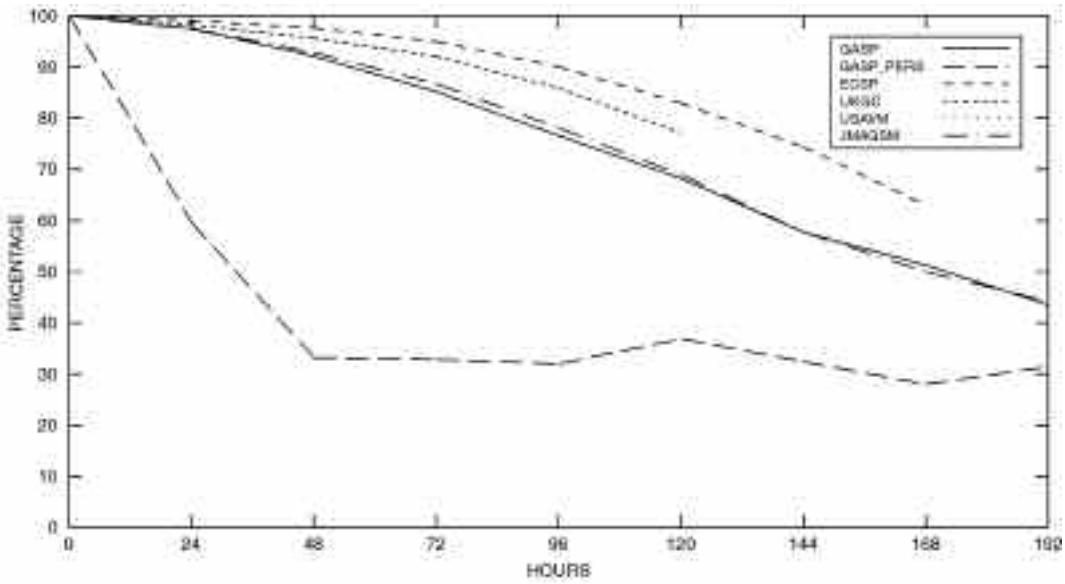


Fig. 4(a) MSLP S1 skill-score comparison, for different forecast periods, between LAPS, TLAPS and GASP (April to June 2003).

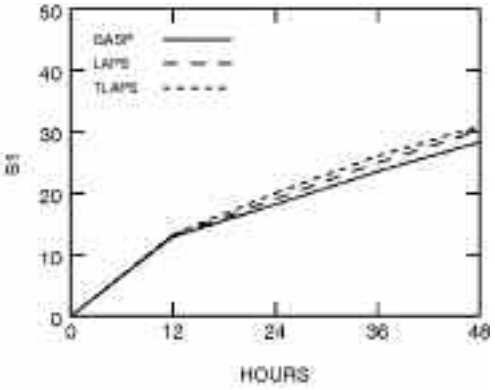


Fig. 4(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between LAPS, TLAPS and GASP (April to June 2003).

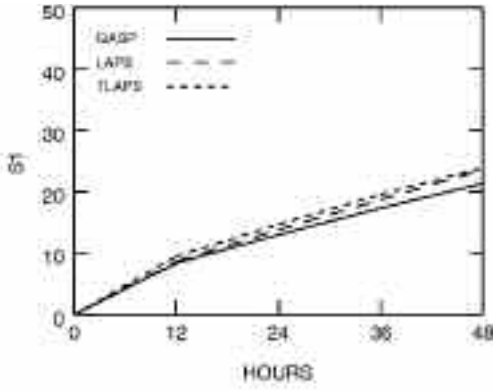


Fig. 5(a) MSLP S1 skill-score comparison, for different forecast periods, between GASP, ECSP, USAVN, UKGC and JMAGSM (April to June 2003).

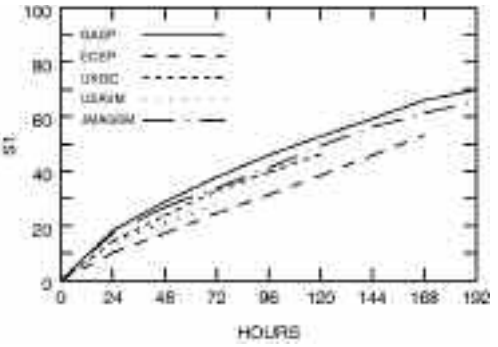


Fig. 5(b) 500 hPa geopotential height S1 skill-score comparison, for different forecast periods, between GASP, ECSP, USAVN, UKGC and JMAGSM (April to June 2003).

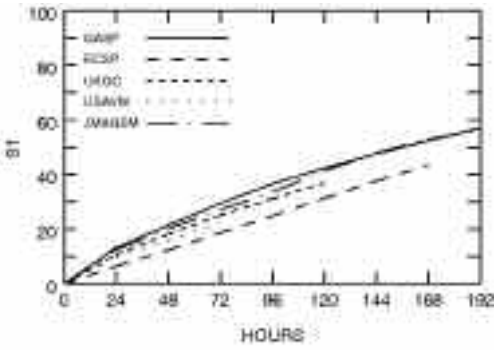
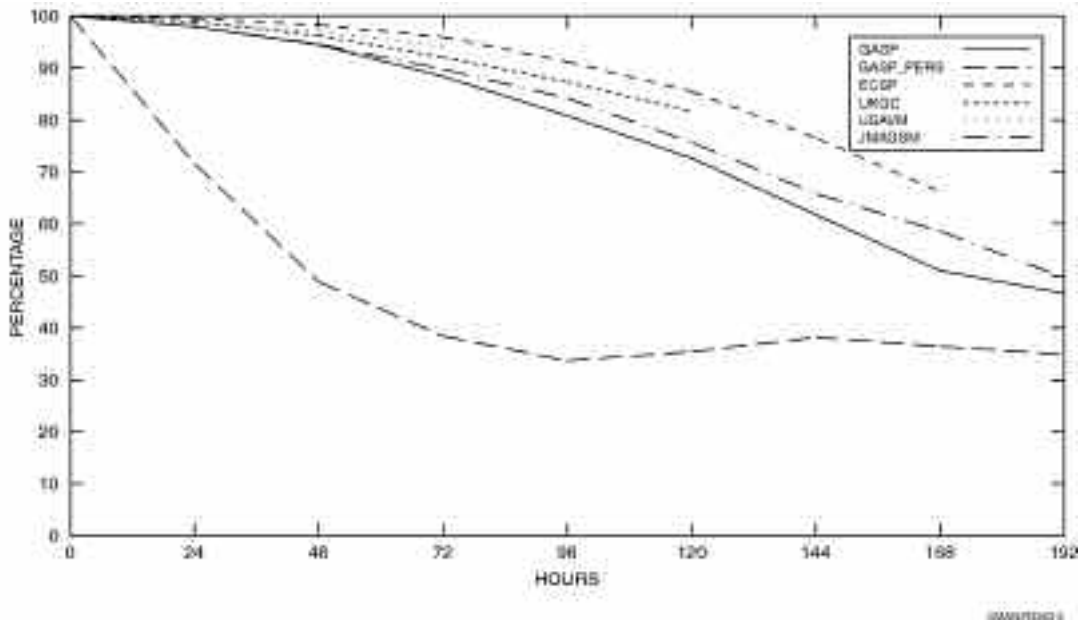


Fig. 6 Anomaly Correlation of MSLP comparison, for different forecast periods, between GASP, ECSP, USAVM, UKGC and JMAGSM (April to June 2003).



Review of performance – January to June 2003

Local models (GASP, TLAPS, LAPS)

During the January – March quarter (Fig. 1a), the local models performed much the same as each other at MSLP; whereas, in the April – June quarter (Fig. 4a), GASP performed better than the limited area systems. With respect to the 500 hPa geopotential height field (Fig. 1b and 4b), GASP performed better than both LAPS and TLAPS, for the whole of the six-month period January to June.

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

The global intercomparison verification results for the period January to June (Figs 2 and 5) show that ECMWF (ECSP) continues to outperform the other global systems, with respect to mean sea level pressure and the 500 hPa geopotential height.

The relative performance, using the anomaly correlation for mean sea level pressure (Figs 3 and 6), is consistent with the S1 skill score results. (PERS refers to Persistence in the Figures.) Assuming the commonly used cut-off of 60 per cent as the criterion for useful forecasts, it is seen that, of the products processed, the ECMWF consistently produced useful guidance out to at least 7 days, whereas GASP produced useful guidance out to 6 days and JMA varied between 6 and 7 days.

References

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

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

Stewart, P. 2003. Numerical weather prediction model performance summary October to December 2002. *Aust. Met. Mag., 52*, 137-9.