

Numerical prediction model performance summary July to September 1998

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Introduction

This summary continues the series comparing the performances of Numerical Weather Prediction (NWP) models.

Models and methods

A description of the Australian verification methods can be found in a previous article (Skinner 1995).

Models are from the National Meteorological Operations Centre (NMOC) Melbourne and from ECMWF (European Centre for Medium-Range Weather Forecasts), NCEP (National Centers for Environmental Prediction) and UKMO (United Kingdom Meteorological Office). Reference is also made to the JMA (Japan Meteorological Agency) model.

The three models considered from NMOC, Melbourne, are: LAPS (Limited Area Prediction System); TLAPS (Tropical Limited Area Prediction System); and GASP (Global Assimilation and Prediction).

Overseas global models included in the comparisons are: ECSP (ECMWF Spectral Assimilation); USAVM (NCEP Washington Spectral model for aviation); UKGC (UK Meteorological Office Grid PE model); and JMAGSM (JMA Global Spectral Model).

Very short summaries of the models can be found in the initial article (Skinner 1995) with updates in subsequent issues.

All results have been calculated within NMOC, Melbourne, where the models were verified against their own analyses for the irregular Australian verification area only.

The statistics are a measure of the skill in forecasting geopotential height at 500 hPa or mean sea-level pressure, MSLP. Other field types are not included in these summaries.

LAPS and TLAPS models are run several hours earlier than GASP and this premature data cut-off, particularly for satellite information, adversely affects their skill compared to GASP.

Note that the Australian region verification grid has southerly points which are outside the TLAPS grid. TLAPS scores are calculated without these points and are therefore not strictly comparable with those from other models.

Notes on NWP systems

USAVM

NCEP have advised that problems developed in the operational T170L42 system which was implemented on 15 June. The symptoms were a general decline in forecast quality as measured objectively and noted subjectively. It was also noticed that the analysis was not paying data as well as expected. Since limited computer resources restrict testing at full resolution, the system was switched to a reduced-resolution version on 7 October and the number of iterations in the analysis increased to enable it to draw closer to the observations. The operational system became T126L28 for the first seven days of the forecast and then T62 to day 16. The changes in physical parameterisations introduced on 15 June have been retained.

The T170L42 model was used for the whole of the period July to September 1998 to which this summary refers.

Further details of the model can be found on the web at <http://sgi62.wvb.noaa.gov:8080/tpb97/TPB98/test.419.html>

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July to September 1998 intercomparisons

Local models: (LAPS, TLAPS, GASP)

The pattern from previous three-monthly periods is still evident. GASP continues to provide the best scores at both MSLP and 500 hPa. (Fig. 1, Figs 3(a) and (b)).

LAPS generally outperforms TLAPS over this Australian region, although differences are small for 500 hPa geopotential height. (Figs 1 (c) and (d)). The

graphs showing averages for combined base-times 0000 UTC and 1200 UTC and for all forecast intervals, (Fig. 1) demonstrate this relative performance difference and it is confirmed by the 'snapshot' graphs (Figs 3(a) and (b)) which give the relationships for individual months at only one base-time and interval i.e. 1200 UTC +24 hours. Scores were generally best in September.

Figures 3(e) and (f) show a longer time series of skill-scores from July 1995.

Fig. 1(a) Comparison for LAPS/TLAPS/GASP from July to September 1998. S1 skill-scores of MSLP using combined base-times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

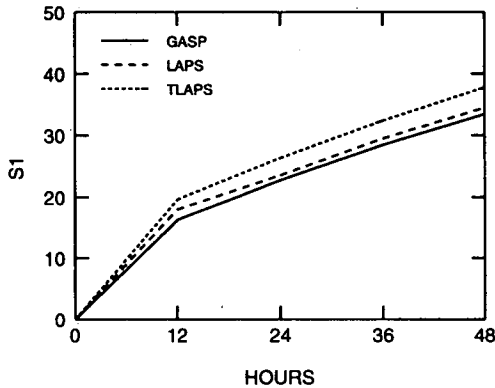


Fig. 1(c) Comparison for LAPS/TLAPS/GASP from July to September 1998. S1 skill-scores of 500 hPa geopotential height (m) for combined base-times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

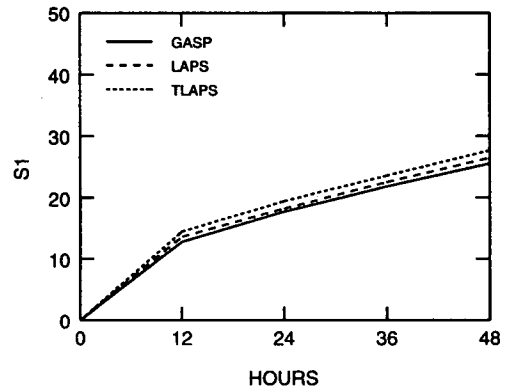


Fig. 1(b) Comparison for LAPS/TLAPS/GASP from July to September 1998. Root mean square errors of MSLP for combined base-times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

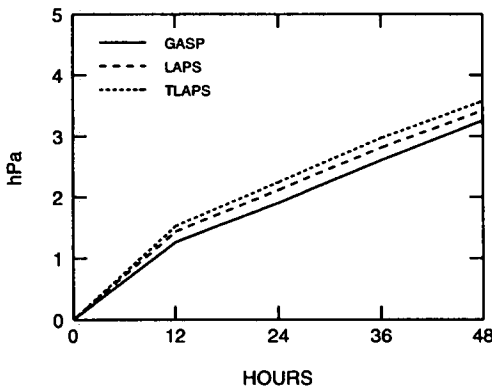


Fig. 1(d) Comparison for LAPS/TLAPS/GASP from July to September 1998. Root mean square errors of 500 hPa geopotential height (m) for combined base-times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

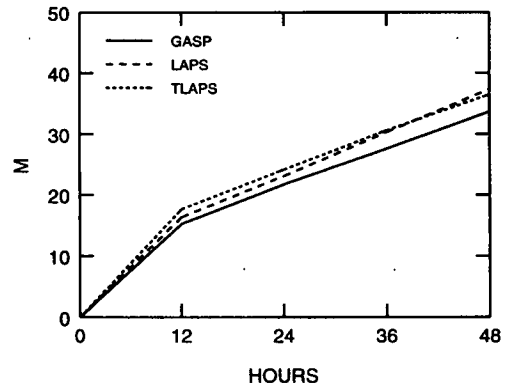


Fig. 2(a) Comparison for GASP/EC/US/UK/JMA from July to September 1998. S1 skill-scores of MSLP for combined base-times 0000 UTC/1200 UTC and intervals +24 h to +168 h over the irregular Australian verification grid.

Fig. 2(c) Comparison for GASP/EC/US/UK/JMA from July to September 1998. S1 skill-scores of 500 hPa geopotential height (m) for combined base-times 0000 UTC/1200 UTC and intervals +24 h to +168 h over the irregular Australian verification grid.

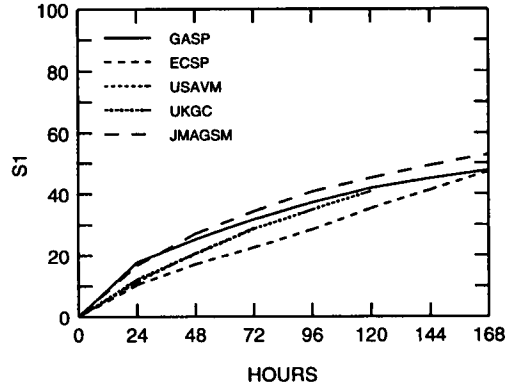
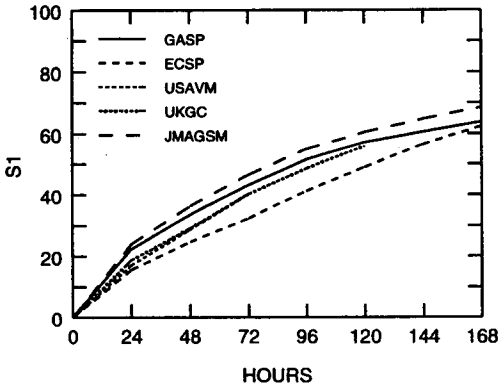
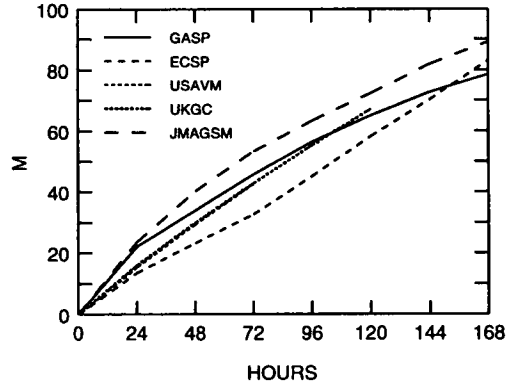
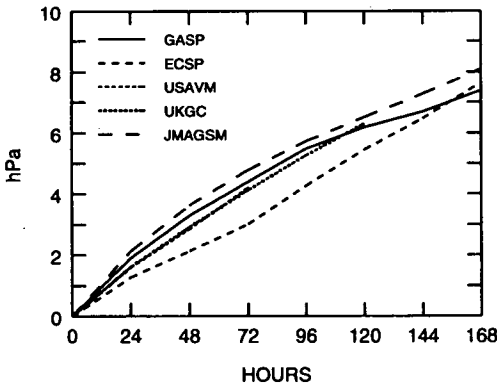


Fig. 2(b) Comparison for GASP/EC/US/UK/JMA from July to September 1998. Root mean square errors of MSLP for combined base-times 0000 UTC/1200 UTC and intervals +24 h to +168 h over the irregular Australian verification grid.

Fig. 2(d) Comparison for GASP/EC/US/UK/JMA from July to September 1998. Root mean square errors of 500 hPa geopotential height (m) for combined base-times 0000 UTC/1200 UTC and intervals +24 h to +168 h over the irregular Australian verification grid.



Synoptic overview for 24 h predictions

An examination of the 1100 UTC prognoses for +24 hours showed that out of the 92 examples between July and September, the number scoring more than 30 skill-score points was 7, 7 and 17 for GASP, LAPS and TLAPS respectively.

Only two of these poor scores occurred during September, confirming the improvement noted above for this month.

July and August tended to have periods of higher than average meridional flow and it seems that all mod-

els handle mobile southerly troughs better than cut-off and shearing situations.

On 4 of these occasions all three models scored badly simultaneously. These were for valid-dates 14 July and 10, 29 and 31 August.

On 14 July, the subtropical ridge was too strong and centred too far south. On 10 August, a low south of Western Australia was underestimated. The Western Australian trough intensity was also underestimated on 28 August. The ridge in the Bight was too strong on 31 August.

Fig. 3(a) Monthly S1 skill-scores of MSLP for LAPS/TLAPS/GASP from July to September 1998 for base-time 1200 UTC and interval +24 h over the irregular Australian verification grid.

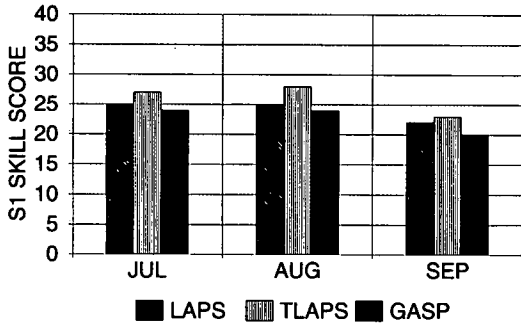


Fig. 3(d) Monthly S1 skill-scores of 500 hPa geopotential height (m) for GASP/EC/UK/US/JMA from July to September 1998 for base-time 1200 UTC and interval +72 h over the irregular Australian verification grid.

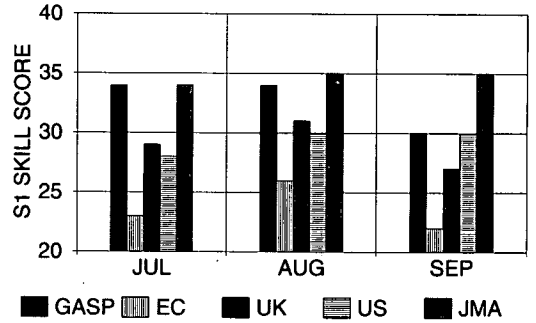


Fig. 3(b) Monthly S1 skill-scores of 500 hPa geopotential height (m) for LAPS/TLAPS/GASP from July to September 1998 for base-time 1200 UTC and interval +24 h over the irregular Australian verification grid.

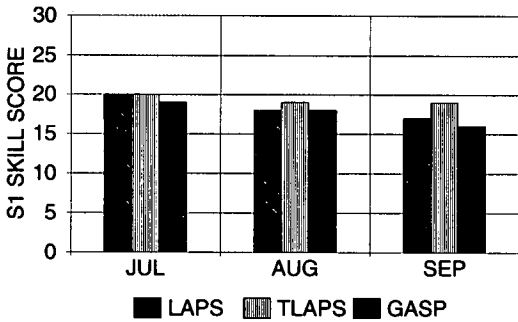


Fig. 3(e) Monthly S1 skill-scores of MSLP for RASP/LAPS/TAPS/TLAPS from July 1995 to September 1998 for base-time 1200 UTC and interval +24 h over the irregular Australian verification grid.

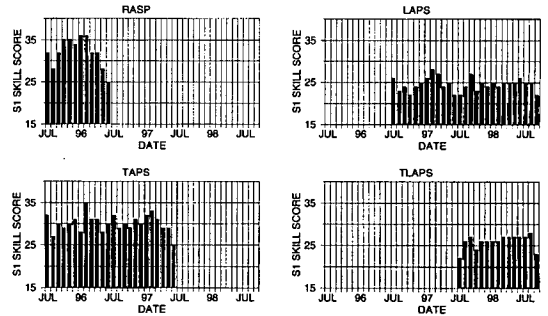


Fig. 3(c) Monthly S1 skill-scores of MSLP for GASP/EC/UK/US/JMA from July to September 1998 for base-time 1200 UTC and interval +72 h over the irregular Australian verification grid.

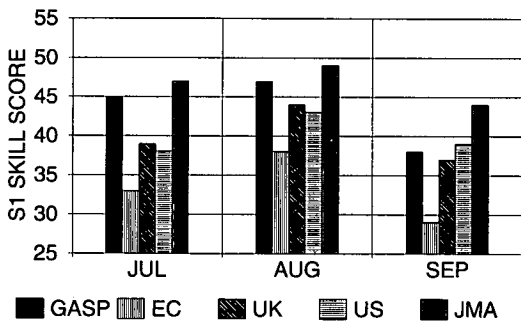


Fig. 3(f) Monthly S1 skill-scores of 500 hPa geopotential height for RASP/LAPS/TAPS/TLAPS from July 1995 to September 1998 for base-time 1200 UTC and interval +24h over the irregular Australian verification grid.

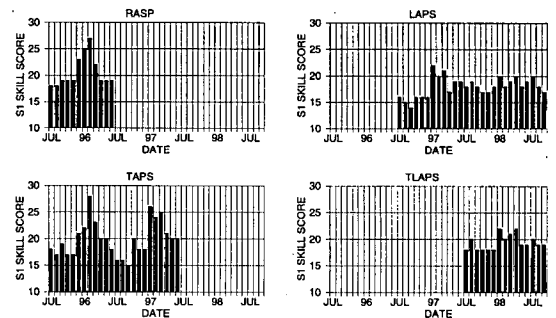


Fig. 3(g) Monthly S1 skill-scores of MSLP for GASP/EC/UK/US from January 1996 to September 1998 for base-time 1200 UTC and interval +72 h over the irregular Australian verification grid.

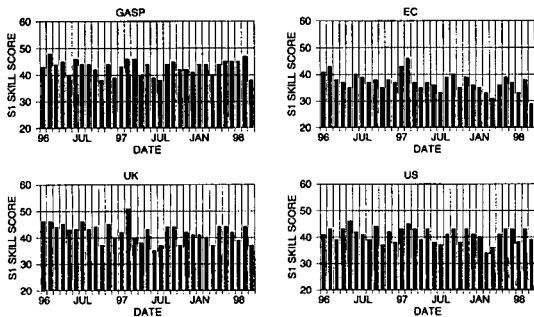
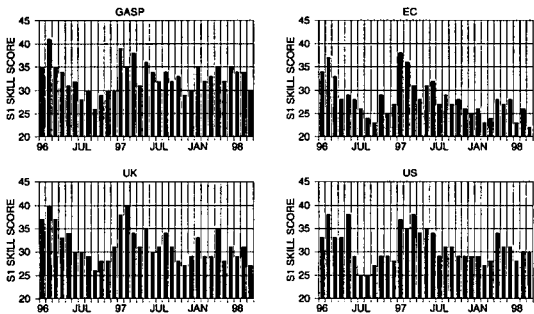


Fig. 3(h) Monthly S1 skill-scores of 500 hPa geopotential height for GASP/EC/UK/US from July 1996 to September 1998 for base-time 1200 UTC and interval +72 h over the irregular Australian verification grid.



Global Models: (GASP, ECSP, UKGC, USAVM, JMAGSM)

The skill-scores and rms errors (Fig. 2) clearly identify ECSP as the best overall of the five models.

USAVM is slightly better than UKGC at MSLP (Fig. 2(a)) but it is difficult to detect any difference between these two at 500 hPa.

GASP compares best with other models at the longer intervals.

The skill-scores at +72 h for individual months (Figs 3(c) and (d)), confirm ECSP and JMAGSM in their relative positions, but show considerable variability between UKGC and USAVM and may indicate the system problem in the USAVM noted above.

The time series of these relationships (Figs 3(g) and (h)) tells the same tale.

The Anomaly Correlation (Fig. 4) includes plots of persistence generated from GASP analyses. If the 60 per cent correlation line is taken as a measure of usefulness,

all models except JMAGSM are useful at +120 h and ECSP is still useful at +144 h. Longer interval forecasts are, on average, below this reference level although on an individual day, the forecast may be good. This represents an improvement of approximately 24 hours over the previous three-month period April to June 1998 when the common cut-off of usefulness was +96 h.

A comparison of 1200 UTC predictions from the global models

This section contains an assessment of the five-day predictions available to Bureau forecasters (i.e. GASP, JMAGSM, ECSP and UKGC). The focus is on the Australian region including the Bight, Tasman Sea and east Indian Ocean.

Continuing the pattern of the previous quarter, the synoptic situations for July-September contained a high number of mobile cut-off lows and easterly troughs particularly from late July to early September. These synoptic situations continued to test the five-day prediction performance of the NWP systems routinely monitored in NMOC.

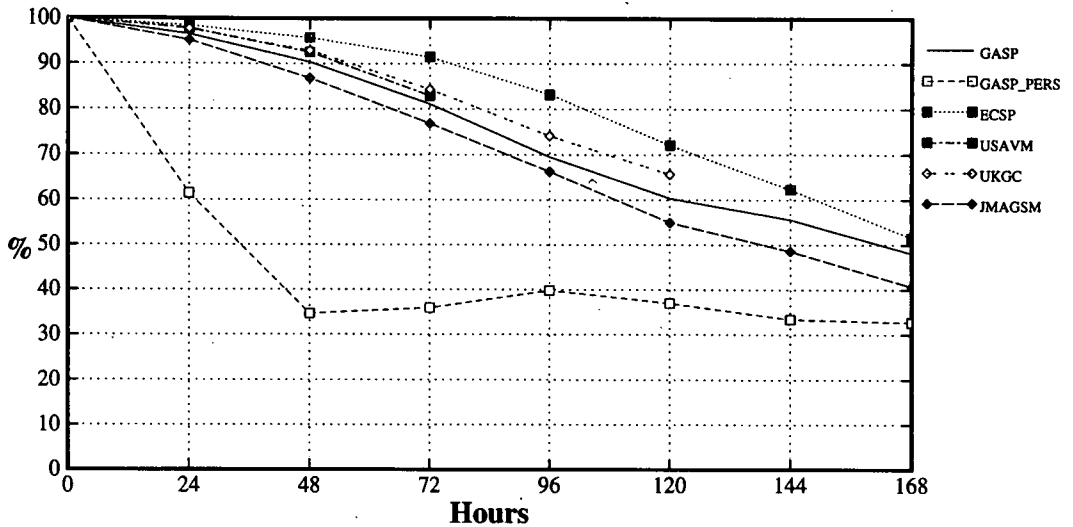
One notable case was for the five-day predictions valid at 1200 UTC 27 July. The analyses showed an extensive low pressure area south of eastern Australia with a centre of 980 hPa centred at 40°S 140°E. Only the ECSP predictions reasonably captured the intensity and structure of the low.

The predictions valid for 6 August began a sequence of poor predictions involving this type of synoptic feature whose occurrence alternated between the east and west of Australia. A low had developed off the northern NSW coast from an easterly dip present on 5 August. The ECSP predictions showed some initial development but GASP, JMAGSM and UKGC predicted weak features centred well to the south or southeast of the actual position.

Over the next two days all models failed to capture the intensity of the system and moved it rapidly south-eastwards. Only in the mature stage of a cut-off low drifting over the Tasman did the predictions regain a reasonable grasp of the situation, although GASP still linked the system too much to the higher latitude westerlies.

Meanwhile another cut-off low had developed over the eastern Indian Ocean and was approaching southwest Western Australia on 9 August. This system was also poorly captured in the model predictions over the next four days, and, if they showed it at all, showed it as a trough in the westerlies. An exception was the UKGC prediction on 10 and 11 August in which the predicted feature was too intense and too slow-moving. From 12 and 13 August most models did develop a feature of some kind, but by this time the actual system had decayed into a weak easterly dip over eastern Australia.

Fig. 4 Anomaly Correlation of MSLP for GASP/EC/US/UK/JMA from July to September 1998 for combined base-times 0000 UTC/1200 UTC over the irregular Australian verification grid.



On 17 August a low developed over the Coral Sea from an easterly dip which had been predicted in all four models to some degree. Over the next two days the low drifted slowly eastwards but all the models developed a closed low, or at least a deep trough, close to the NSW coast. The UKGC predictions again developed a centre much further south than the others, locating the main centre over eastern Bass Strait. For 18 August all maintained a system along the coast and, except for JMAGSM, showed the system considerably stronger than the actual. ECSP showed a low of 1003 hPa centred about 200 km northeast of Sydney on 17 August deepening it to a low of 995 hPa over the Tasman on 18 August.

Back in the west, early predictions were reasonable for another cut-off low which had developed southwest of Western Australia on 17 August. However, on 19 and 20 August an involuted pattern developed with a low at the head of the Bight and a high of 1032 hPa centred well southwest of Tasmania. This pattern was not captured at all well by any of the models. GASP and JMAGSM weakened the low but maintained the high, while ECSP and UKGC over-deepened the low to leave a substantially eroded high. For 20 August skill-scores on the standard Australian region for ECSP and UKGC predictions reached 90. (In contrast the highest score i.e. least skill, for ECSP five-day predictions during July was 63).

On 24 August all models missed a trough in the west-eries over the Bight and its subsequent development into an easterly dip over eastern Australia. This case was associated with the movement of a cold pool to far northern Australia with cold temperatures and heavy rainfall over inland areas of Queensland and northern

New South Wales. The ECSP predictions for 26 August did depict an easterly trough but others only showed a very weak feature.

In contrast to the above situations which generally showed under-prediction, the predictions for a trough over eastern Australia on 15 September were all over-active. While the verifying analyses showed a broad trough the predictions ranged from a sharpened trough to a fully cut-off low. The five-day predictions valid for both the previous and subsequent days were quite reasonable except for ECSP on 14 September which showed a similar tendency for over-development.

Some other notable cases of over-development were:

- ECSP on 11 July which developed a quite spurious low of central pressure 991 hPa south of Western Australia when reality showed a high. The other models showed a similar tendency but to a much lesser extent.
- ECSP and UKGC on 20 July in which both over-developed a low over southeastern Australia.

With the transition into spring GASP again started to overintensify the west Australian heat trough. A particular sequence of this symptom occurred from 4 to 7 September. In several of these cases the JMAGSM predictions appeared to show a similar tendency. The problem in GASP appears to be related to too much drying out of soil moisture and remedies are being considered.

References

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