

Numerical prediction model performance summary April to June 1995

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Introduction

This summary, as the first of an ongoing series, briefly introduces the numerical weather prediction (NWP) models that will feature in this and subsequent issues. An explanation of forecast verification methods is also provided. In future issues, much of this explanatory material will be covered by reference to the present summary, and there will be a greater emphasis on discussion of interesting aspects of model performances during the quarter.

National Meteorological Centre (NMC) Melbourne NWP models

RASP is a regional, grid-point primitive equation (PE), assimilation and prognosis model. It has 12 analysis and 17 prognosis vertical levels and a horizontal resolution of 75 km. The domain is 10°S–55°S and 95°E–180°E (Mills and Seaman 1990). The model is run daily from base times 0000 UTC and 1200 UTC for forecast periods up to +36 h. Operational runs take boundary values from GASP fields.

GASP is a global spectral assimilation and prognosis model. Its horizontal resolution is rhomboidal 53 (approx. 177 km) and it uses 19 vertical levels for both analysis and prognosis (Seaman et al. 1995). It is run daily at base times 0000 UTC and 1200 UTC for forecast periods out to seven days.

TAPS is a tropical analysis and prediction grid system whose domain is 37°N–45°S and 85°E–176°E. Horizontal resolution is 95 km and vertical

resolution is 15 levels for analysis, 19 levels for prognosis. Boundary values are derived from GASP (Puri et al. 1992). It, too, is run twice daily for base times 0000 UTC and 1200 UTC but forecasts go out to +48 h.

Global models from other operational centres

ECSP is the spectral assimilation and prognosis model issued by the European Centre for Medium Range Weather Forecasts (ECMWF) daily for base time 1200 UTC. Its current horizontal resolution is triangular 213 (approx. wave number R151, 62 km), with 31 vertical levels (Simmons et al. 1989). Forecasts are verified in NMC Melbourne to +144 h for mean sea-level pressure (MSLP) and 500 hPa geopotential only.

USAVM is the spectral assimilation and prognosis model issued by NMC Washington for aviation. It uses triangular 126 resolution (approx. wave number R90, 105 km) in the horizontal and 18 vertical levels (Kanamitsu et al. 1991). Base times are 0000 UTC and 1200 UTC with NMC Melbourne verifications to +72 h for MSLP and 500 hPa only.

UKGC is a grid PE model from Bracknell, UK, of approx. 92 km horizontal resolution, 20 vertical analysis levels and 19 prognosis levels (Cullen 1993). Base times are 0000 UTC and 1200 UTC with NMC Melbourne verifications to +120 h for MSLP and 500 hPa.

Verification methods

Verification entities referred to in this summary are skill score and root mean square (rms) error.

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Teweles S1 skill-score (Teweles 1954)

$$SI = 100 \frac{\sum e_g}{\sum G_L}$$

rms error

$$rmse = \sqrt{\frac{1}{n} \sum (x_f - x_v)^2}$$

where

$$e_g = \left\{ \left| \frac{\partial(x_f - x_v)}{\partial x} \right| + \left| \frac{\partial(x_f - x_v)}{\partial y} \right| \right\}$$

$$G_L = \max \left(\left| \frac{\partial x_f}{\partial x} \right|, \left| \frac{\partial x_v}{\partial x} \right| \right) + \max \left(\left| \frac{\partial x_f}{\partial y} \right|, \left| \frac{\partial x_v}{\partial y} \right| \right)$$

and x_f = the forecast values of the parameter in question; x_v = the corresponding observed (verifying) value. The verification is over a 2.5 by 2.5 degree lat./long. grid.

The Australian verification area is an irregular one covering the rectangle 15°–45°S, 100°–170°E with additional points to 55°S between 130°–170°E. The method uses 58 points at MSLP and 48 points at upper levels. TAPS does not cover the southern portion of this grid, and so a subset of grid-points is used. Skill score measures the accuracy of a forecast gradient with lower values showing greater skill. Scores are therefore best for higher levels and shorter time intervals.

Fig. 1(a) Comparison for RASP/TAPS/GASP from April to June 1995 S1 skill scores at MSLP for combined base times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

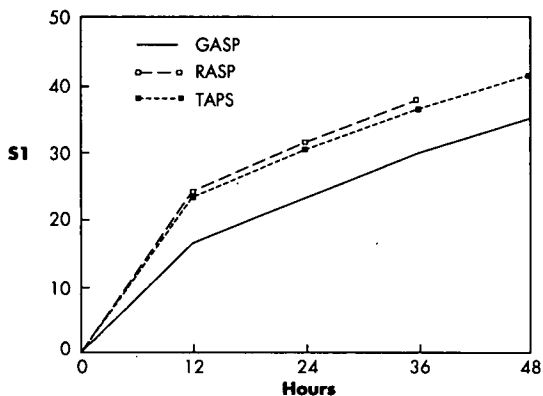


Fig. 1(b) Comparison for RASP/TAPS/GASP from April to June 1995 rms errors (hPa) at MSLP for combined base times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

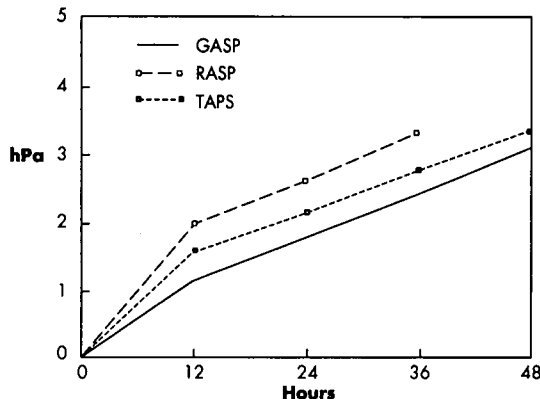


Fig. 1(c) Comparison for RASP/TAPS/GASP from April to June 1995 S1 skill scores at 500 hPa combined base times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

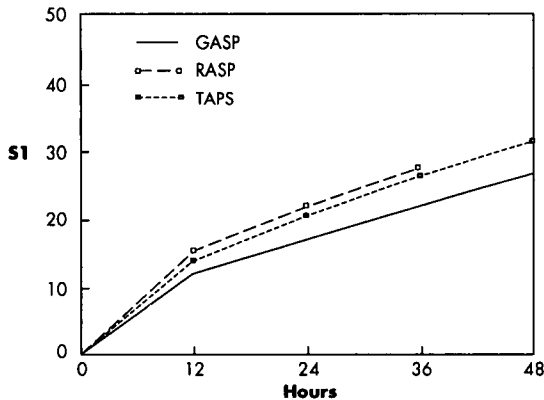


Fig. 1(d) Comparison for RASP/TAPS/GASP from April to June 1995 rms error (m) at 500 hPa for combined base times 0000 UTC/1200 UTC and intervals +12, +24, +36, +48 h over the irregular Australian verification grid.

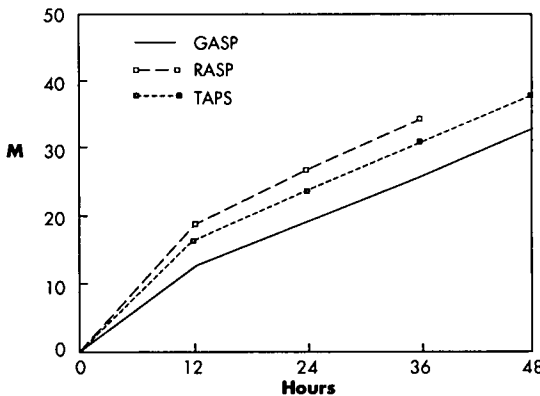


Fig. 2(a) Comparison for GASP/EC/US/UK from April to June 1995 S1 skill scores at MSLP for combined base times 0000 UTC/1200 UTC and +24 h intervals to +168 h over the irregular Australian verification grid.

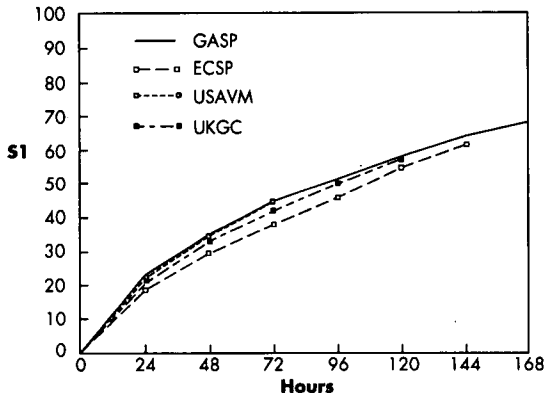


Fig. 2(d) Comparison for GASP/EC/US/UK from April to June 1995 rms errors (m) at 500 hPa for combined base times 0000 UTC/1200 UTC and +24 h intervals to +168 h over the irregular Australian verification grid.

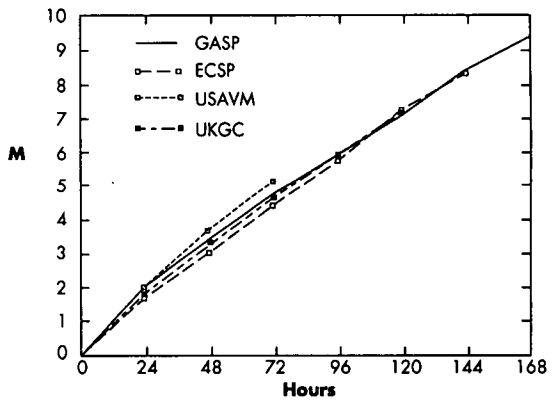


Fig. 2(b) Comparison for GASP/EC/US/UK from April to June 1995 rms errors (hPa) at MSLP for combined base times 0000 UTC/1200 UTC and +24 h intervals to +168 h over the irregular Australian verification grid.

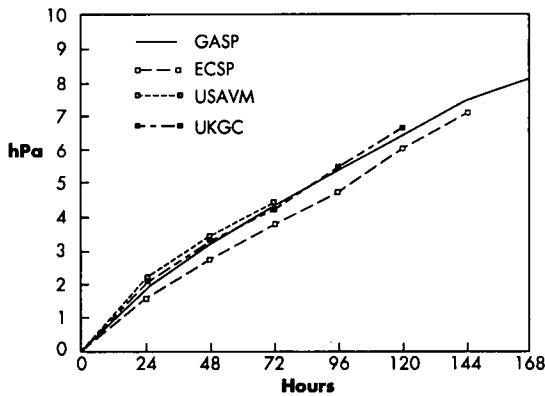
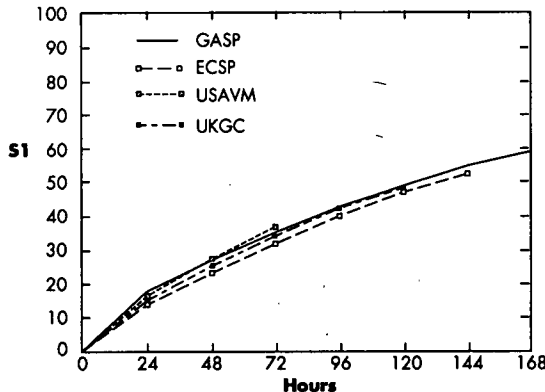


Fig. 2(c) Comparison for GASP/EC/US/UK from April to June 1995 S1 skill scores at 500 hPa for combined base times 0000 UTC/1200 UTC and +24 h intervals to +168 h over the irregular Australian verification grid.



April to June 1995 intercomparisons

Comparisons of the three local models, GASP, RASP and TAPS for skill score and rms errors at MSLP (Fig. 1(a),(b)) and 500 hPa (Fig. 1(c),(d)) all show superiority of GASP over TAPS and of TAPS over RASP. In fact, GASP at +36 and +48 scores better than RASP does at +24 and +36 at both levels. Similarly, GASP skill scores at MSLP are better than TAPS skill scores for a twelve-hour shorter interval.

Comparison of global models MSLP skill scores (Fig. 2(a)) (over Australian region only) ranks them from best to worst as: ECSP, UKGM, USAVM and GASP. This pattern is modified at 500 hPa (Fig. 2(c)) with GASP showing better skill than USAVM from +48 h onwards and equal or slightly better skill than UKGC from +96 h. Root mean square errors (Fig. 2(b)) also indicate ECSP as a clear winner at MSLP, with GASP and UKGM almost equal to each other. GASP seems to gain an advantage for intervals longer than +96 h. At 500 hPa the rms errors of the models (Fig. 2(d)) show ECSP and UKGM superior to GASP, and GASP to USAVM out to +72 h. For intervals longer than +96 h, GASP shows slight improvement over ECSP and UKGM.

References

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