Evaluation of isotopic variability in an NCAR-CAM3 reanalysis

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An invaluable resource for the modern climate researcher is the information derived from global reanalysis products that provide a vast array of observational atmospheric data assimilated onto regular gridded fields. The coverage over the relatively poorly observed southern hemisphere is of particular interest given that there is a greater dependence in this region upon the assimilation algorithms being used.

A model that routinely incorporates reanalysis data is a version of NCAR-CAM3 that has recently been fitted with an isotopic module (Noone, personal communication). The scheme simulates the fractionation of the stable water isotopes $H_2^{18}O$ and $^1H^2HO$ during phase changes throughout the hydrological cycle. The relative abundance of these stable isotopes are useful tracers of moisture history and atmospheric circulation within the model.

As part of a broader study of isotopic variability across southeastern Australia, a special run of NCAR-CAM3 was performed for a period during which rainfall amount and isotopic composition was sampled by the Melbourne University Network of Isotopes in Precipitation (MUNIP) (Barras et al. 2005). This provided an opportunity to test the reanalysis output on a local scale against the detailed observations taken during June 9, 2004. The model was initialised with initial conditions from the NCEP/NCAR reanalysis (Kalnay et al. 1996) and run at a resolution of T42L28 for 6 hours before an adjustment of the atmospheric circulation towards the reanalysis fields and so on.

The rain event over southeastern Australia on June 9, 2004 was characterised by a period of steady rainfall during the day followed by an outbreak of severe storms ahead of a cold front that passed over Melbourne during the late evening. The storms formed with the development of a low pressure system slightly eastwards of the main front with the advection of cold air aloft (Fig. 1a). A comparison of the mean sea level pressure field for this period shows that the subtlety of the circulation observed over southeastern Australia does not seem to be captured by the NCAR-CAM3 model (Fig. 1b). The effect of this is that NCAR-CAM3 maintains continuous stratiform precipitation throughout the entire event.

Model output was also obtained at 20 minute intervals for a column of 3×3 gridpoints centred over a 'Melbourne' gridpoint (37S 145E) to resemble the sampling times of the MUNIP observations. The observations of $\delta^{18}O$ show a clear separation between the stratiform and convective precipitation (Fig. 2a). There are a number of small scale effects contributing to the variability of these observations, however a more gradual depletion of the stratiform rainfall is noticable in the earlier samples when compared to the later samples of convective rainfall. The gradual depletion of the simulated isotopes (Fig. 2b) resembles the early stratiform rainfall of the MUNIP observations and this trend remains throughout the period. Despite the lack of fine detail, the simulated variability of isotopes in precipitation for this event is very good given the relatively coarse resolution of NCAR-CAM3 being applied to such a restricted area.

References

Barras V., I. Simmonds and D. Etheridge, Moisture transport across south eastern Australia using stable isotopes in precipitation, in *Research activities in atmospheric and oceanic modelling*, J.Côté (Ed.), Report No. 35, 2.01-2.02, 2005.

Kalnay E. et al., The NCEP/NCAR 40-year reanalysis project, *Bull. Amer. Met. Soc.*, **77**, 437-471, 1996.

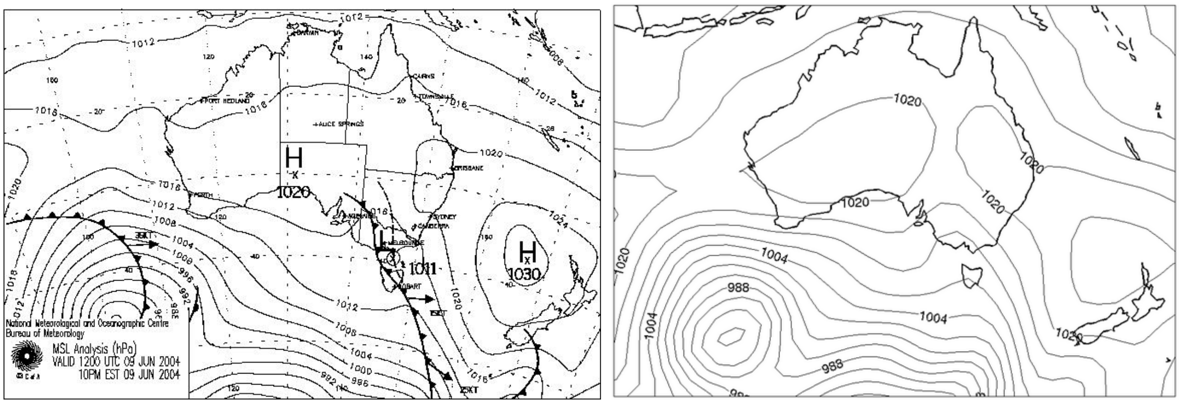

Figure 1: Mean sea level pressure charts for June 9, 2004 valid at 12UTC (22:00 AEST) (a) analysis from observations (courtesy Australian Bureau of Meteorology) (b) NCAR-CAM3 reanalysis.

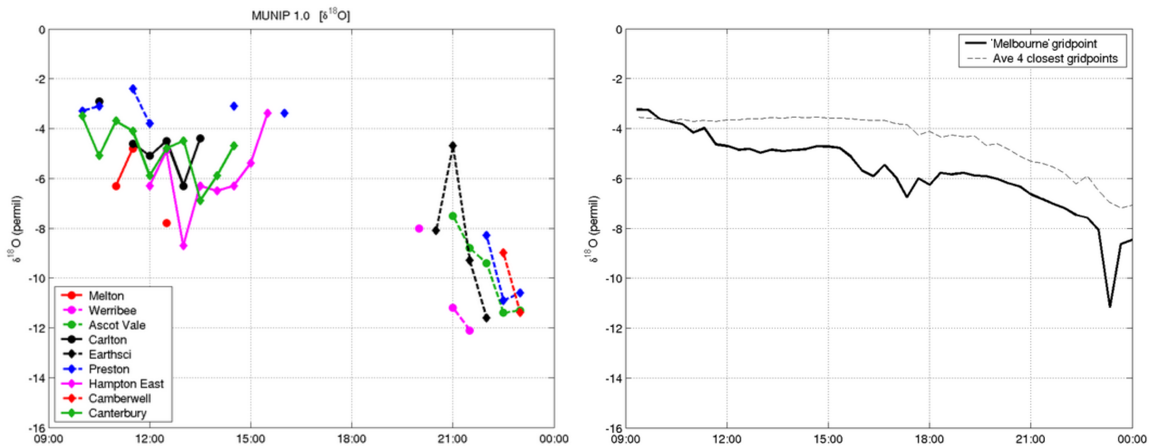

Figure 2: δ^{18}O in precipitation for June 9, 2004 from (a) MUNIP sample observations and (b) 20 minute output from NCAR-CAM3 isotope scheme. Local times are indicated (AEST).