Frontal features over the Southern Ocean

Ian Simmonds

School of Earth Sciences
The University of Melbourne
Victoria, 3010, Australia
simmonds@unimelb.edu.au

Cyclonic systems are intimately tied up with the maintenance of climate. There are now a number of sophisticated objective identification and tracking schemes which can be applied to analyses and model output (e.g., Simmonds and Keay 2000, Simmonds et al. 2003, Lim and Simmonds 2007) to diagnose all the relevant characteristics of these features. The automated identification of *frontal* structures is a much more difficult problem. While algorithms have been proposed (e.g., Hewson 1998, Kašpar 2003) these tend to work best when high resolution quality analyses are available. There is clearly a need for *complementary* frontal identification schemes which can be used when data quality is an issue.

We here show some experimental results obtained using a 'single point' approach with ERA-40 for 8 December 2001 18UTC. In Fig. 1 mobile fronts are identified over the southern Indian Ocean sector using a simple Eulerian **thermal** criteria. In the Figure grid points at which the 1000 hPa temperature decreases by more that 2ºC in 6 hours (i.e., for which dT (6 hrs) < -2ºC) are indicated by a '1' and blue colouring. Points for which dT (12 hrs) < -4ºC are indicated by a '2' and dark green colouring. Points at which both these criteria are satisfied are denoted by a '3' and light green colouring. In an analagous fashion Fig. 2 displays the result for the same synoptic case when a simple **dynamic** criteria is used. Those points for which the surface wind direction changes over 6 hours from the NW to the SW quadrant are indicated by '1' (blue colouring). At each of those identified points if the change in the *meridional* component of the wind exceeds 2 ms^{-1} the point is now indicated by '2' (dark green). The points which are flagged when this criterion is increased to 4 ms^{-1} and 6 ms^{-1} are marked with '3' (light green) and '4' (very light green), respectively. These basic experiments indicate that mobile frontal structures may be identified by rather simple algorithms.

Our present work is addressing the extent to which a combination of simple Eulerian criteria based on thermal, dynamic and other considerations can be of value in identifying these important frontal features.

Hewson, T. D., 1998: Objective fronts. *Meteor. Appl.*, **5**, 37-65.

Kašpar, M., 2003: Objective frontal analysis techniques applied to extreme/non-extreme precipitation events. *Studia Geophysica et Geodaetica*, **47**, 605-631.

Lim, E.-P., and I. Simmonds, 2007: Southern Hemisphere winter extratropical cyclone characteristics and vertical organizaton observed with the ERA-40 reanalysis data in 1979-2001. *J. Climate*, **20**, 2675-2690.

Simmonds, I., and K. Keay, 2000: Mean Southern Hemisphere extratropical cyclone behavior in the 40-year NCEP-NCAR reanalysis. *J. Climate*, **13**, 873-885.

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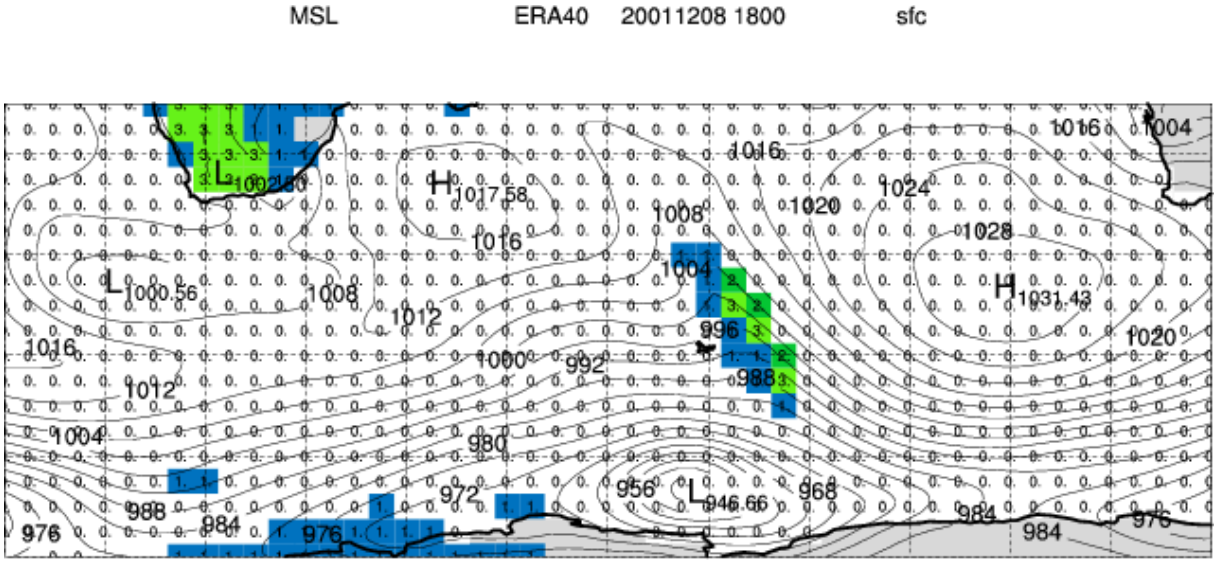

Figure 1: The fronts identified over the southern Indian Ocean sector on 8 December 2001 (18UTC) when using simple thermal criteria. Grid points at which the 1000 hPa temperature decreases by more that 2ºC in 6 hours (i.e., for which dT (6 hrs) < -2ºC) are indicated by a '1' and blue colouring. Points for which dT (12 hrs) < -4ºC are indicated by a '2' and dark green colouring. Points at which both these criteria are satisfied are denoted by a '3' and light green colouring.

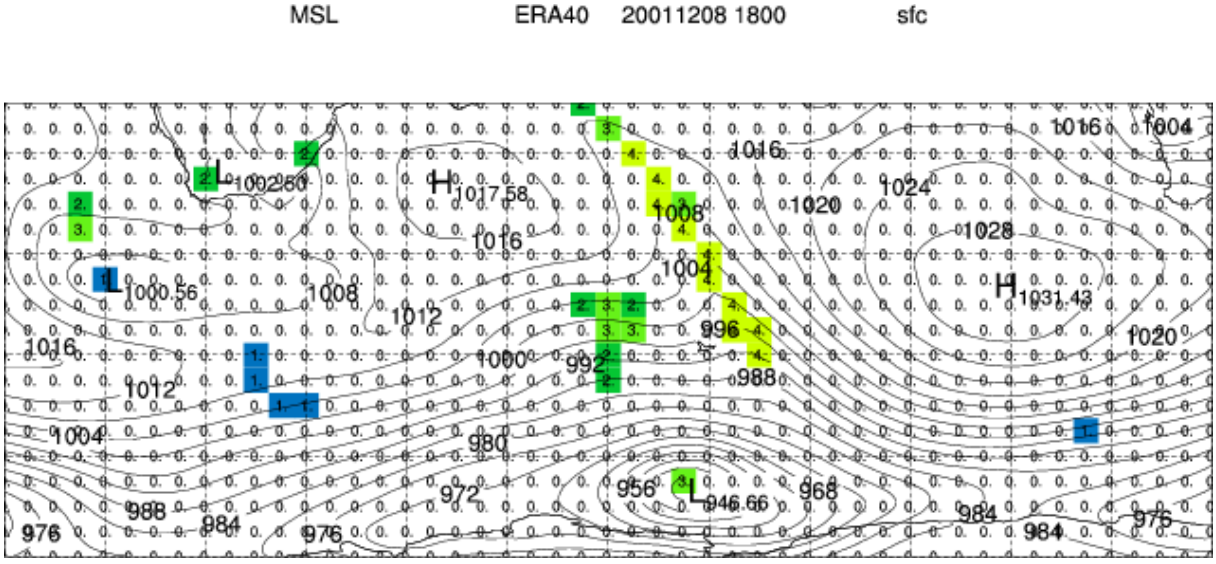

Figure 2: Fronts identified for the same case as in Figure 1, but using simple dynamic criteria. Those points for which the surface wind direction changes over 6 hours from the NW to the SW quadrants are indicated by '1' (blue colouring). All of these points for which, in addition, the change in the *meridional* component of the wind exceeds 2 ms^{-1} are indicated by '2' (dark green). The points which are flagged when this threshold is increased to 4 ms^{-1} and to 6 ms^{-1} are marked with '3' (light green) and '4' (very light green), respectively.