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Reply to comments on "The origin and evolution of low-level potential vorticity anomalies during a case of Tasman Sea cyclogenesis"

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1. Background

Hopkins and Holland (1997), hereafter referred to as HH, have pointed out that the sea surface temperature (SST) used in the paper by Revell and Ridley (1995), hereafter referred to as RR, does not resolve the detailed temperature structure off the east Australian coast. They go on to suggest that this may have lead to a misrepresentation of the effects of SST gradients and surface fluxes on the development of the storm described in RR.

While we accept that the monthly mean SST at 2° resolution used by RR did not resolve the east Australian current, we note the following points.

- Despite the lack of resolution in the SST field used in RR, the simulation was quite realistic, possibly indicating a lack of sensitivity to details of the SST for this case.
- In RR, we concluded that the surface fluxes of heat and moisture played a secondary role to latent heating *at the time of maximum development*. We suggested that surface fluxes may play a role in preconditioning the low-level environment prior to this.
- Our own work and that of Graham Mills of the Australian bureau of Meteorology (personal communication) indicates that in its initial stages, this storm is being forced very strongly by the upper level potential vorticity anomaly.

Rather than speculate further about the possible ramifications of lack of resolution in the SST field, we have repeated the simulations of RR using high resolution SSTs.

2. Model rerun with high resolution SST

The model used for these reruns was the latest version 3b of the RAMS mesoscale model. All other details were as in RR except for the high resolution SST field shown in Fig. 1. This was

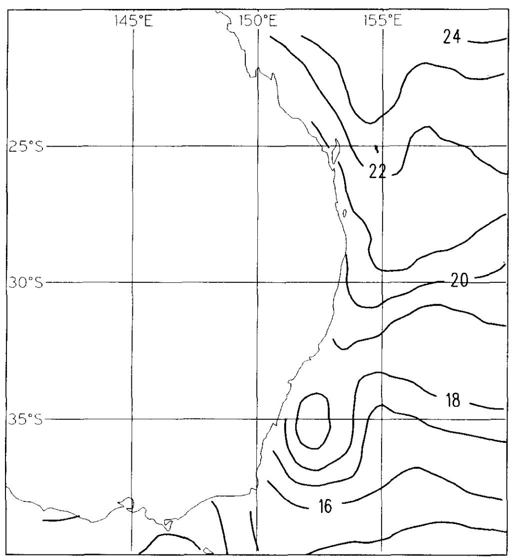

Fig. 1. The 7-day mean (ending August 2, 1990) SST field used in the reruns, derived from 18-km data supplied by JPL. Contours every °C.

derived from weekly-averaged multichannel sea-surface temperatures from the NOAA Advanced High Resolution Radiometer. These data, obtained by ftp from the Jet Propulsion Laboratory (JPL) and prepared by the University of Miami/Rosenstiel School of Marine and Atmospheric Sciences, originally with a resolution of approximately 18 km by 18 km at the equator, were subsequently interpolated to our 40 km grid. The results of these runs are summarised in Table 1.

With the full physics and the more detailed SSTs, the central pressure now reaches 988 hPa at 00 UTC on 3 August, with a mimimum of 987 hPa 3 hours later. According to HH, based on 3-hourly analysed MSLP charts from the Sydney Regional Forecast Centre, a minimum central pressure of 986 hPa was reached at 02 UCT on 3 August 1990. Thus, the effect of the higher resolution SST is to further deepen the storm by about 1.5 hPa. The track as before is very well represented.

Removing all surface fluxes (including momentum) makes very little difference to the path or intensity of the storm. In fact the lack of surface friction means the storm now becomes 1 hPa deeper than for the full physics run. As in the RR simulation, the surface fluxes appear to be playing a minor role at the time of most rapid deepening for this particular storm.

Retaining the surface fluxes but removing the effect of latent heat release, as in the RR simulation, has a major impact on both the intensity and track of the storm. The central pressure never gets below 998 hPa and the track never comes within 250 km of the coast.

Table 1. *Central pressure (hPa) and low position (lat, lon E) of model runs with (a) full physics, (b) no surface fluxes and (c) no latent heating*

Experiment	Time	Position	Central pressure
(a)	12/2	(−31.3,157.4)	1003
	15/2	(−33.9,154.7)	998
	18/2	(−34.4,153.3)	993
	21/2	(−34.2,152.1)	989
	00/3	(−33.5,151.9)	988
	03/3	(−32.8,152.2)	987
	06/3	(−32.0,153.2)	989
(b)	12/2	(−31.3,157.4)	1003
	15/2	(−33.9,154.8)	998
	18/2	(−34.4,153.3)	993
	21/2	(−34.3,152.3)	988
	00/3	(−33.9,152.0)	987
	03/3	(−32.8,152.1)	986
	06/3	(−32.2,153.0)	989
(c)	12/2	(−31.3,157.4)	1003
	15/2	(−33.1,155.1)	1000
	18/2	(−33.6,154.1)	999
	21/2	(−34.1,153.6)	998
	00/3	(−34.3,153.2)	999
	03/3	(−34.6,153.0)	999
	06/3	(−34.8,153.0)	999

3. Summary

In summary, we agree with HH that the SSTs used in the RR simulation do not resolve the details due to the east Australian current. Using more realistic SST values in the model simulation with full physics does deepen the storm by a further 1.5 hPa. However, for this storm, our conclusions regarding the greater importance of latent heat release over surface fluxes remain unchanged. Whether this is true in general for Australian "east coast lows" can only be determined by studying further such cases.

4. Acknowledgements

Hard copy of high resolution SSTs off the east coast of Australia were kindly supplied by Graham Mills and Geof Feren of the Australian Bureau of Meteorology. The digitised SST values actually used in the reruns were obtained by ftp from podaac.jpl.nasa.gov/pub. This work was supported by the New Zealand foundation for research, science and technology.

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