3.9 # CLIMATE CHANGE, TROPICAL CYCLONES AND ENSO

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## 1. INTRODUCTION

Some progress has been made over the past several years regarding the effect of global warming on tropical cyclones (e.g. Knutson and Tuleya 2004; Walsh 2004). Increases in maximum tropical cyclone intensities in a warmer world have been predicted using both theoretical and simulation techniques. Yet formation of tropical cyclones in many regions of the tropics is strongly affected by ENSO (e.g. Hastings 1990; Lander 1994; Goldenberg and Shapiro 1996; Chia and Ropelewski 2002). Therefore, any prediction of changes in tropical cyclone numbers in these regions as a result of global warming must also make some prediction about the future state of ENSO.

So far, a definitive understanding of the effect of climate change on ENSO has not been achieved (e.g. Hoerling and Kumar 2003). Opinions on this topic differ (Tsonis et al. 2003; Karl and Trenberth, 2003). A number of climate model simulations indicate a change to a more "El Niño-like" climate in a warmer world (e.g. Giorgi et al. 2001), but climate models do not yet simulate all aspects of ENSO in the current climate, making their predictions less reliable.

Nevertheless, it is important to assess the performance of existing climate models to determine whether they are correctly simulating ENSO in the current climate, in order to determine their potential for use in climate change predictions. Here we examine the performance of a new climate modeling system that has the capability to simulate tropical cyclones of reasonable intensity and has a model-generated ENSO of comparable amplitude to observations.

## 2. METHODS

The numerical study is carried out using the conformal cubic atmospheric model (CCAM), described in McGregor (2004). This is a semi-implicit, hydrostatic primitive equation model on a global, variable-resolution, conformal cubic grid. A combination of semi-Lagrangian and bi-cubic spatial interpolation is used for the horizontal advection. The variable-resolution grid enables fine horizontal resolution in the region of interest, while coarse resolution elsewhere enables the model to be run economically. The CCAM model's main advantage over the traditional limited-area model approach (e.g. McGregor et al. 1993) is that since CCAM has no boundaries, there are no issues involving discontinuities at these boundaries, as there are when using limited area models. In the area of finest resolution, which in this case is off the coast of northern Australia, the horizontal resolution is as fine as 14 km (see Fig. 1). The CCAM model is nudged by the model output of the CSIRO Mark 3 GCM (Gordon et al. 2002), a coupled ocean-atmosphere model with a horizontal resolution of T63. In this GCM, the typical amplitude of Nino 3.4 SST anomalies is comparable to those observed, but the periodicity tends to be shorter. The GCM is run without flux correction and has a slight drift (about one degree per century).

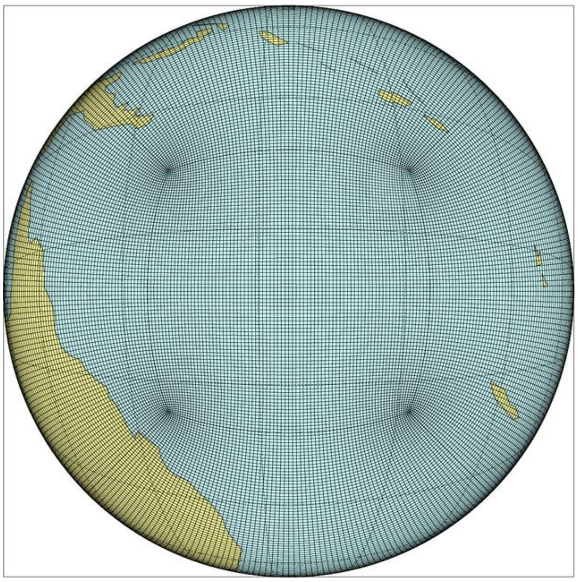

**Figure 1**. CCAM model grid over the region of finest horizontal resolution (off the east coast of Australia).

## 3. RESULTS

Preliminary results are presented here. The modeling system has been run for several Januaries and numerous tropical cyclone-like vortices have been simulated. An example of one of these is shown in Fig. 2. The central pressure of the storm is around 989 hPa, and it follows the typical track of a tropical cyclone in this region, making landfall just south of Broome on the western Australian coastline.

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Another system of similar intensity, this time off the coast of Queensland, is shown in Fig. 3. This storm traveled to the east of New Caledonia and gradually moved southwards, weakening as it did so.

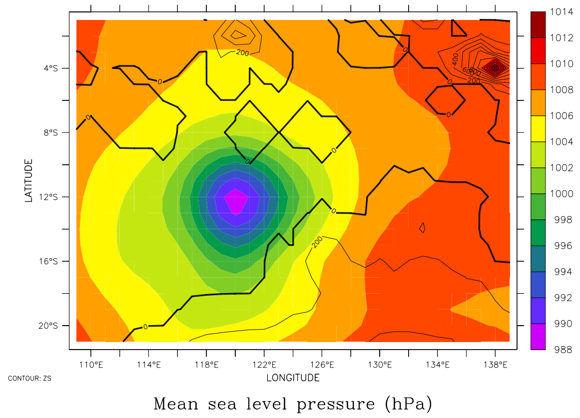


**Figure 2**. Simulation of a tropical cyclone-like vortex near the northwest coast of Australia.

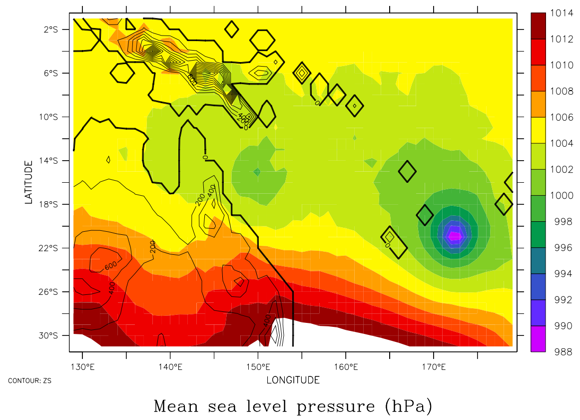


**Figure 3**. The same as Fig. 2 but for a system over the Coral Sea.

## 4. CONCLUSIONS

Preliminary results show that the modelling system is able to produce numerous tropical cyclone-like vortices of considerable intensity. Longer simulations are currently under way that will produce a climatology of tropical cyclone formation using this modeling system. These results will be discussed at the conference.

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