2.21 Inter El Niño variations in the atmospheric circulation of the South Pacific, part II - modelling.

Tom Lachlan-Cope* and Steve Harangozo

British Antarctic Survey
High Cross
Madingley Rd
Cambridge
UK

1. INTRODUCTION

The response of the Hadley Centre atmosphere-only model (HadAM3) in the southeast Pacific and Antarctic Peninsula to El Niño forcing is investigated. An ensemble of model runs has been made forced by imposing observed tropical sea surface temperatures (SSTs) for individual El Niño events.

This approach allows the effect of different individual El Niño events on the extra tropical circulation in the South Pacific to be studied. It is thought that the role of convection in the tropical Pacific, within the models, is playing a major role in forcing the observed Rossby wave train.

2. METHOD

The atmosphere only version of the Hadley Centre climate model (HadAM3) (Cullen 1993) is forced with SST anomalies in the tropical Pacific. The background SST forcing in the model is the yearly repeating climatological SSTs. The SST anomalies for El Niño periods are calculated from the Global sea-Ice and Sea Surface Temperature (GISST) data set. These anomalies for the area +20 to –20° S in the Pacific are added to background SST fields. The model is then run several times, each using slightly different starting conditions, to form an ensemble of runs for each El Niño event. In this report will concentrate on the El Niño that occurred in late 1997 and early 1998. The SSTs in the El Niño 3.4 area (see Trenbeth 1997) for this period are shown in figure 1. Nine ensemble members have been run.

*Corresponding author address: Tom Lachlan-Cope, British Antarctic Survey, Cambridge, UK
e-mail: tlc@bas.ac.uk

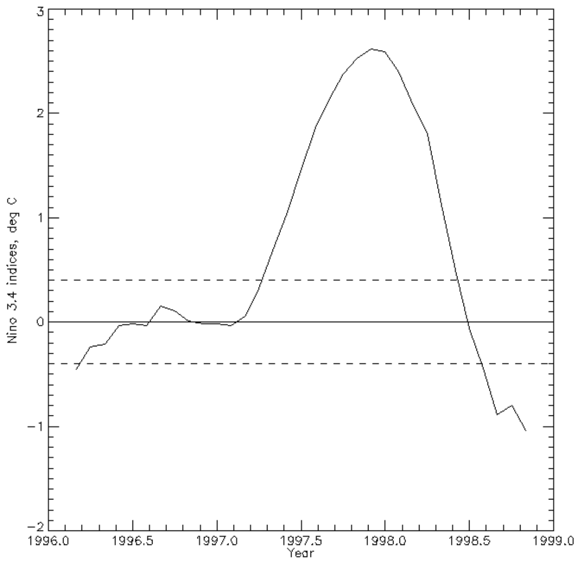

Figure 1. Niño 3.4 SST anomalies using GISST data relative to a base period from 1950 to 1979. Periods exceeding a 0.4°C threshold indicate El Niños.

2. RESULTS

The average MSLP anomaly during September, October and November 1997, for the nine ensemble members, when the Niño 3.4 index is highest, is shown in figure 2. A large area of positive anomaly dominates the Bellingshausen Sea. This positive anomaly seems to be associated with a stationary Rossby wave (Hoskins and Karoly 1981) generated by the imposed temperature anomalies near the equator. However the individual ensemble members show a large variability between members. Some members showing almost no high pressure anomaly in the Bellinghausen while most show the high pressure area to be much deeper, but in a very variable location.

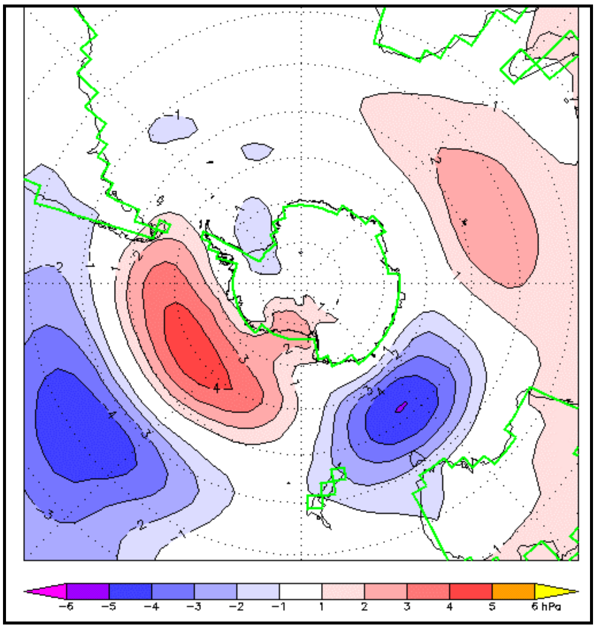

Figure 2. The average MSLP anomaly for September/October/November 1997 over all nine ensemble members.

We have also looked at the M2 index developed by Harangozo (2000) shown in figure 3. This index is given by the pressure difference between 75°W and 60°W at 65°S and represents the pressure gradient over the Antarctic Peninsula and gives a measure of the meridional component of the wind in this region. This has been used by Harangozo (2000) as a measure of the strength of the Rossby wave train. However, the variability of this index within the nine ensemble members is very large.

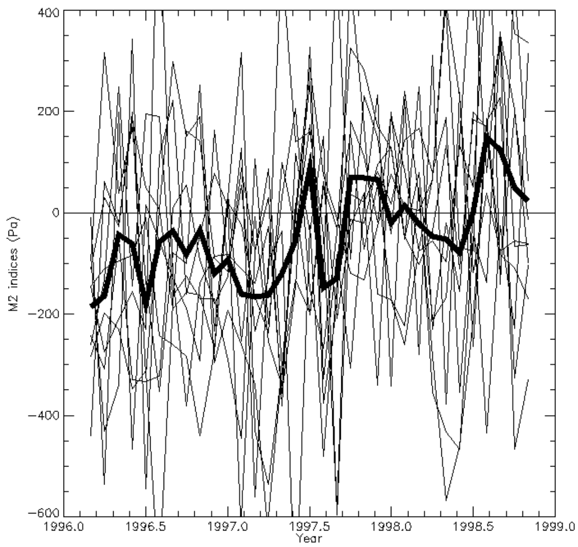

Figure 3. M2 index for the period 1996 to 1998 for the nine ensemble members. The average is shown as a heavy line.

It would be expected that when there is a high pressure anomaly over the Bellinghausen sea the M2 index will be positive. While there is some indication of the M2 index becoming positive during the last half of 1997 and during the start of 1998 there is still a large amount of variability. The M2 index does not seem to be a good measure of the existence of a high pressure anomaly in the Bellingshausen Sea in the model runs reported here because the location of the anomalies is so variable

3. CONCLUSIONS

The observations (see Harangozo 2000) do not seem to show the large variability in the position and size of the Bellingshausen Sea pressure anomaly, for the same tropical forcing, that we observe between the ensemble members in this study. Here we have only reported the results for one El Niño event but similar runs for other events show similar variability.

The cause of the large variability within the model runs is not known. However we suspect that atmospheric conditions in the tropical Pacific are modulating the deep convection that is necessary for the formation of a Rossby wave train. So the tropical deep convection is not being properly represented within the model.

References

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