15.1 WHY WAS SEPTEMBER 2001 TO SEPTEMBER 2002 A YEAR OF ANOMALOUSLY LOW PRESSURES OVER THE TASMAN SEA?

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1. INTRODUCTION

During the year following September 2001, 500 hPa heights over the Tasman Sea region were anomalously low compared to the NCEP 50 year climatological average. For many months prior to this time New Zealand weather had tended to be settled and dry as demonstrated by the major hydro storage lakes undergoing a long period of steady emptying. An abrupt change in weather regime during September lead to the lakes returning to above normal levels within the subsequent 2 months – as can be seen in Fig. 1.

In this paper we look for reasons for this change. We calculate a global streamfunction anomaly pattern for the relevant periods before and after September 2001 and show that the Tasman Sea anomaly is part of a larger scale wavelike signal which extends from the Australasian tropics across New Zealand and down towards South America. Considering this signal as a streamfunction anomaly about the average mean flow we solve for the divergence field that would make this anomaly a solution of the linearised barotropic vorticity equation. We compare this tropically dominated divergence field with OLR anomalies for the same periods and comment on the relevance of the major low frequency modes of atmospheric variation (e.g. Madden Julian Oscillation - MJO, El Nino Southern Osclliation - ENSO, South Pacific Wavetrain - SPW, High latitude mode HLM and Interdecadal Pacific Oscillation - IPO) in explaining this change of weather regime.

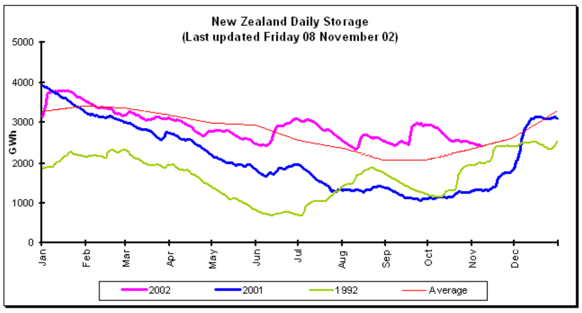

Figure 1. Daily total Hydro Lake storage in GW hours.

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2. REGIME CHANGE

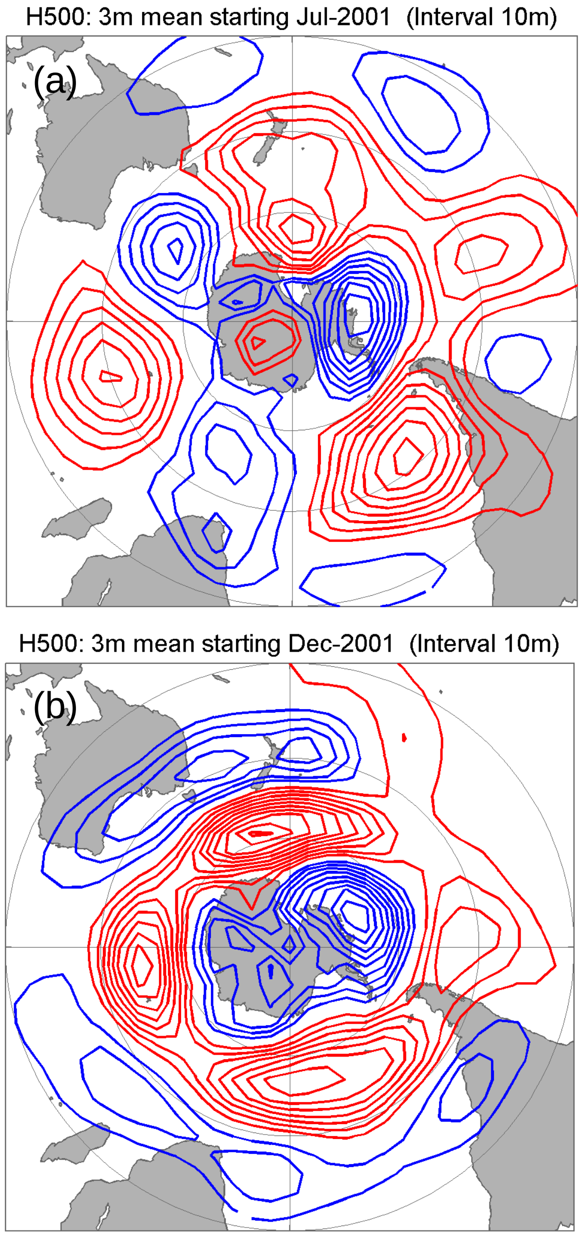

Figure 2. The 500 hPa height anomalies (a) before and (b) after the regime change in September 2001.

The 3 month 500 hPa height anomalies before and after the weather regime change are shown in Fig.2. Prior to September the anomaly pattern has a component like the SPW whereas after this time it has features of the HLM.

3. BAROTROPIC VORTICITY EQUATION

If we consider these anomalies as our perturbation vorticity ξ' and rotational velocity $\mathbf{v}'_\psi$ and the average background flow as the mean vorticity $\bar{\zeta}$ and rotational velocity $\bar{\mathbf{v}}_\psi$ then we can solve for the divergent wind that would make it a solution of the linearised BVE

$$\bar{\zeta}\nabla^2\chi' + \nabla\bar{\zeta} \bullet \nabla\chi' = F,$$

where,

$$F = -\partial\xi'/\partial t - \bar{\mathbf{v}}_\psi \bullet \nabla\xi' - \mathbf{v}'_\psi \bullet \nabla\bar{\xi} - \lambda\xi' + \mu\nabla^6\xi'.$$

All the terms in *F* are known so we can solve for χ' by relaxation following Revell et al. (2001).

4. DIVERGENCE/OLR

The results of this calculation are shown as divergent wind vectors in Fig. 3 for the periods before and after September 2001. The anomalous outgoing longwave radiation (OLR) patterns for the matching periods are shown in Fig. 4. Anomalous OLR can be viewed as a proxy for anomalous convection with low values corresponding to enhanced activity. By eye there appears to be some correspondence between Fig. 3 and 4. Correlating the calculated divergence with the observed OLR pattern in the dotted rectangle of Fig. 4, we get R = 0.31. This correlation is much smaller if we just consider the tropical region. If we compare OLR before September with divergence after or vice-versa, R drops to less than 0.03. We can thus explain about 9% of variance.

5. CONCLUSIONS

Although 9% is not large, it is probably typical of the variance explained by the various low frequency modes of atmospheric oscillation at intra-seasonal time scales. There are clearly other processes occurring, but some of the abrupt change in weather regime near New Zealand can be attributed to a repositioning of the active convective areas in the Tropics. What caused the change in location of tropical convection remains to be determined.

6. REFERENCES

Revell, M.J., J.W. Kidson and G.N. Kiladis, 2001: Interpreting low-frequency modes of southern hemisphere atmospheric variability as the rotational response to divergent forcing. *Mon. Wea. Rev.,* **129,** 2416-2425.

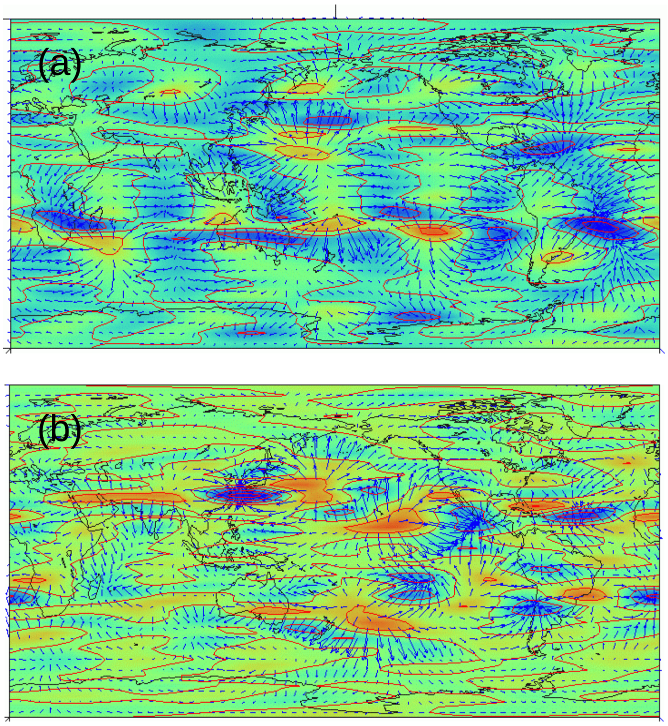

Figure 3. The divergent wind vectors and divergence as determined by solving the linearised BVE (a) before and (b) after the regime change in September 2001.

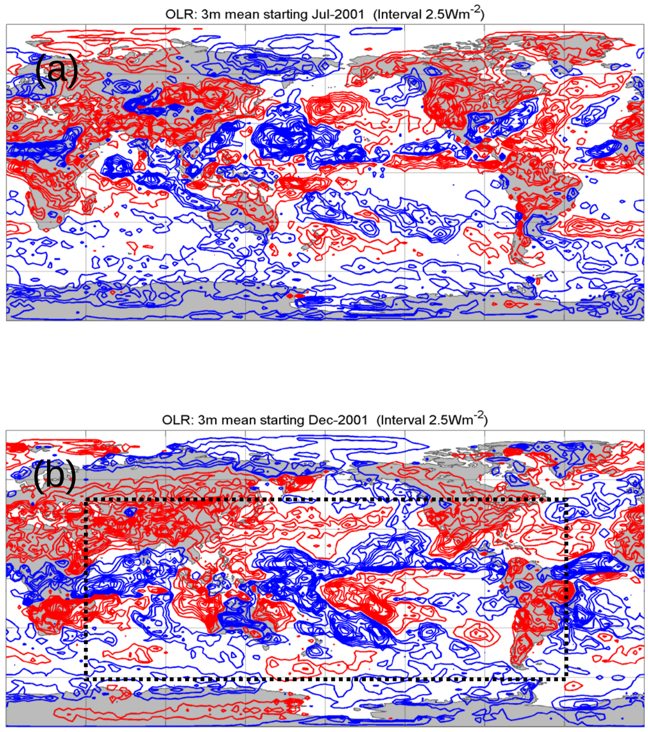

Figure 4. The 3 month mean anomalous OLR (a) before and (b) after the regime change in September 2001. The dotted rectangle indicates region of correlation calculation.