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MODULATION OF SOUTHERN HEMISPHERE STORM TRACK ACTIVITY BY THE MADDEN-JULIAN OSCILLATION

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1. INTRODUCTION

It is now well established that the Madden-Julian Oscillation (MJO) can exert a substantial influence on the low frequency intraseasonal circulation of either hemispheres at any time of the year (Madden and Julian, 1994). It is generally assumed that the primary mechanism responsible for these teleconnections involves a Rossby response to the mass circulation associated with the slow eastward propagation of the MJO convective envelope (e.g. Revell et al., 2001). The potential role of non-linear feedback via perturbations in the storm track has also been acknowledged (e.g. Renwick and Revell, 1999), but most studies have tended to focus on the effect of the MJO on lower frequency intraseasonal basic state perturbations which reflect the integrated effect of the associated synoptic scale variations.

In this study we examine the impact of the MJO on modulating transient activity over the Southern Hemisphere (SH). In many instances, although the mean low frequency basic state perturbation associated with the MJO may be small, there is a significant impact on the variance of the circulation, temperature, or precipitation at higher frequencies, which could be of importance for medium-range forecasting over the SH.

2. METHODOLOGY

MJO activity is isolated through an index of the space-time filtered OLR methodology developed by Wheeler and Kiladis (1999). In this case we choose a time series of OLR filtered to retain eastward propagating OLR perturbations of zonal wavenumbers 0 through 9, with periods between 30 and 96 days. For December-February (DJF) the MJO index is defined by using the filtered OLR at the point of maximum variance 10ºS, 110ºE; the point 10ºN, 95ºE is used during JJA.

High frequency activity of a given metric is defined as the < 30 filtered variance of that parameter. Using 200 hPa flow in Fig. 1 as an example, the < 30 filtered 200 hPa streamfunction is first squared at every grid point, then regressed against the MJO index for JJA 1979-2001. There is a clean scale separation between these quantities due to the filtering, so the approach effectively isolates the the modulation of the high frequency eddy activity windowed over the MJO time scale.

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3. RESULTS

Fig. 1 shows the mean 200 hPa circulation associated with MJO convection in the Indian Ocean, along with the variance of < 30 day streamfunction centered on the same time. In this phase of the MJO, convection is enhanced in a zonal band along the equator, and suppressed near and east of the Philippines. There is a cyclonic perturbation over Australia, which would be associated with a weakening of the climatological jet in that sector. The bottom panel shows that at the same time < 30 day wave activity is suppressed within the jet region, as might be expected. Wave activity is also suppressed over much of the Pacific sector, and enhanced at higher latitudes of the Indian Ocean. By assuming linear behavior between the positive and negative phases of the MJO, which is known to be a reasonable approximation, this result would imply an increase in storm activity over Australasia when MJO convection is moving into the western North Pacific, a result that will be confirmed in more detail by using other parameters, including surface observations.

Fig. 2 is a similar analysis for MJO convection over the Indian Ocean during DJF. There is again a mean cyclonic perturbation over Australia, although the largest anomalies are over the NH. Nevertheless, along the South Pacific subantarctic coast there is a substantial reduction in 500 hPa geopotential height variance, which is one traditional measure of storm track activity. This result also implies increased storm activity in that region when MJO convection reaches the SPCZ.

3. REFERENCES

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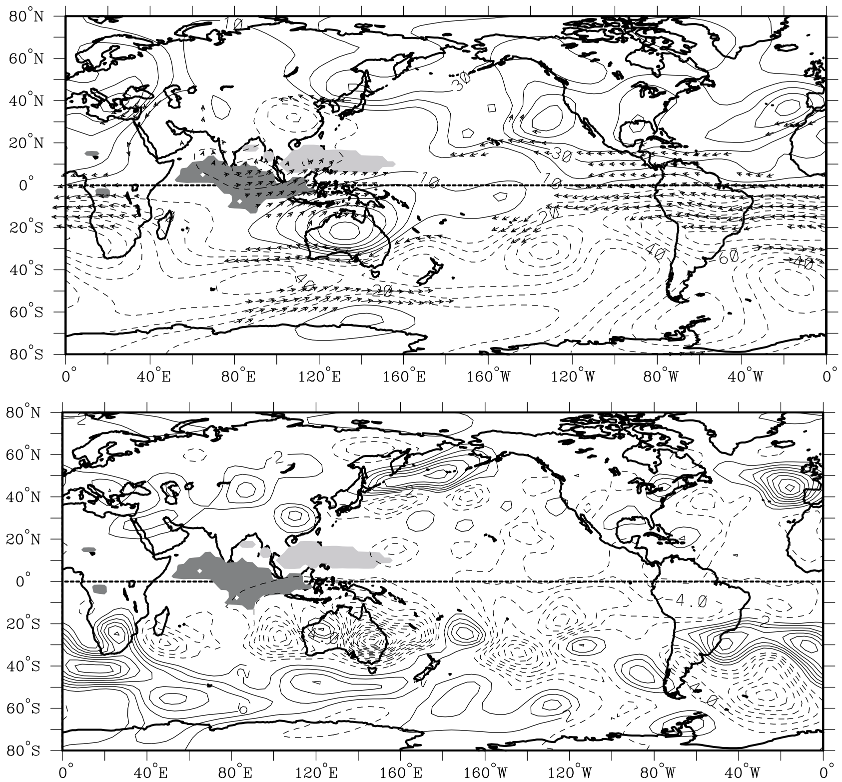

Fig. 1. (top) OLR and 200 hPa streamfunction and wind perturbations associated with MJO convection over the Indian Ocean for JJA 1979-01. Dark (light) shading corresponds to negative (positive) OLR perturbations greater than 8 W m^{-2}, contour interval is 10 X 10^5 m^2 s^{-1}. Wind vectors are shown where statistically significant. (bottom) as in the top figure except for <30 day filtered 200 hPa streamfunction variance. Contour interval is 2 X 10^{12} m^4 s^{-2}.

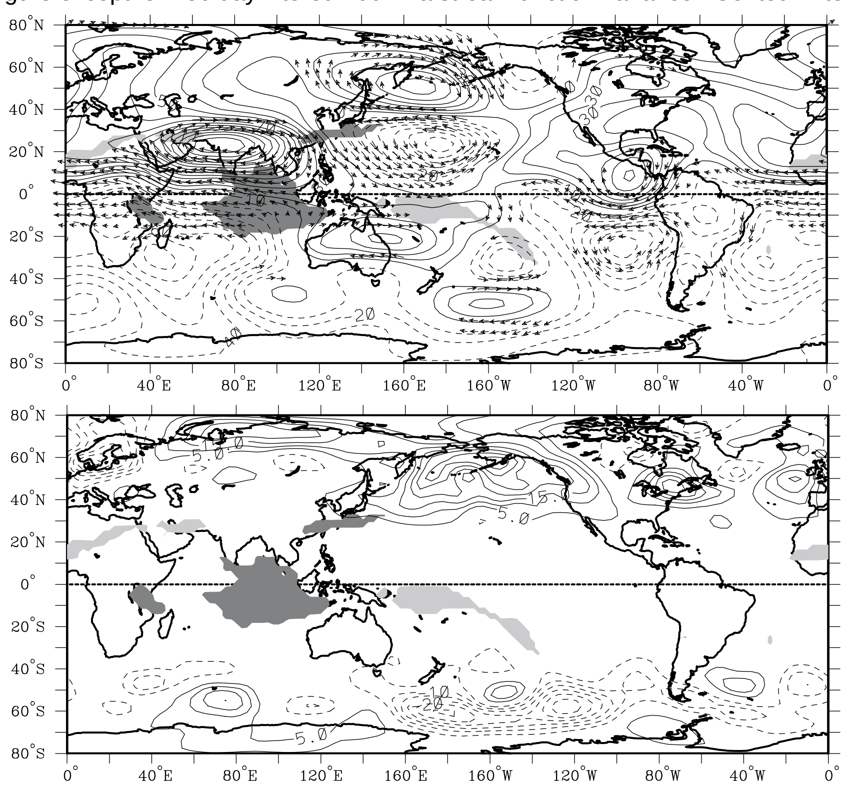

Fig. 2. As in Fig. 1, except for MJO convection during DJF. Bottom figure shows < 30 day 500 hPa geopotential height variance, contour interval is 5 X 100 m^2.