ANGULAR MOMENTUM AND TORQUES DURING THE 1982–83 EL NIÑO

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In January 1983, during the mature phase of the major 1982–83 El Niño event, atmospheric angular momentum (AAM), or more precisely its relative component M_r associated with the zonal circulation, reached the highest values on record (Rosen et al. 1994). From angular momentum conservation principles, the observed positive anomalies in M_r implied a source of AAM at the lower boundary. Mechanisms available for AM exchanges include the friction torque T_f, associated with tangential stresses at the lower surface, and the mountain torque T_m, related to pressure gradients acting on topography (e.g., Ponte et al. 1994). Wolf and Smith (1987), based on a limited pressure dataset, concluded that mountain torques on the Rockies were responsible for the sharp rise in M_r during January 1983, but they could not explain the subsequent decay of M_r values to normal levels. Ponte et al. (1994), based on output from climate model simulations of the 1982–82 El Niño, found both T_f and T_m to be important in general, but differences in the details of simulated and observed AAM evolutions precluded definite conclusions on the nature of the AAM transfers.

Using recently available M_r estimates based on the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis (Salstein and Rosen 1997) and a concurrent torque dataset produced by K. Weickmann and his group at NOAA's Climate Diagnostics Center in Boulder (Huang et al. 1999), we have reexamined the AAM evolution during the 1982–83 El Niño, with a focus on determining the torque mechanisms involved in the AAM anomalous behavior. Values of M_r, T_f, and T_m for the El Niño period (June 1982–June 1983) are shown in Figure 1, together with their respective climatological values obtained by averaging 29 years of data (1968–96).

Anomalies in M_r are mostly positive for the period examined, but they more than double in amplitude during a rapid, 2-week increase in mid January 1983. Values of M_r in late January 1983 are more than 3 standard deviations above climatological levels for the period. After reaching its peak value, M_r gradually decreases to near normal values by April 1983. The anomalous torque mechanisms responsible for this behavior can be discerned by examining the time series of T_f and T_m in Figure 1. Anomalies in T_m change sign on weekly or shorter time scales. There is, however, an approximate 2-week period with sustained large positive anomalies that coincides with the January rise in M_r. Anomalies in T_f are mostly positive for this period, but substantially weaker than those in T_m. In contrast, the decrease of M_r to near normal values by April 1983 is clearly related to sustained negative anomalies in T_f.

The complex interplay of torque mechanisms apparent in Figure 1 is explored in greater detail by Ponte and Rosen (1999). In particular, their regional analysis of the torque data confirms the importance of mountain torques on the Rockies to the January 1983 increase in AAM, as seen by Wolf and Smith (1987), but finds evidence for equally important contributions from mountain torques on Eurasian topography. Similarly, the negative anomalies in T_f responsible for the decay of M_r from February to April are mainly due to signals in the northern subtropics. A discussion of the relation between

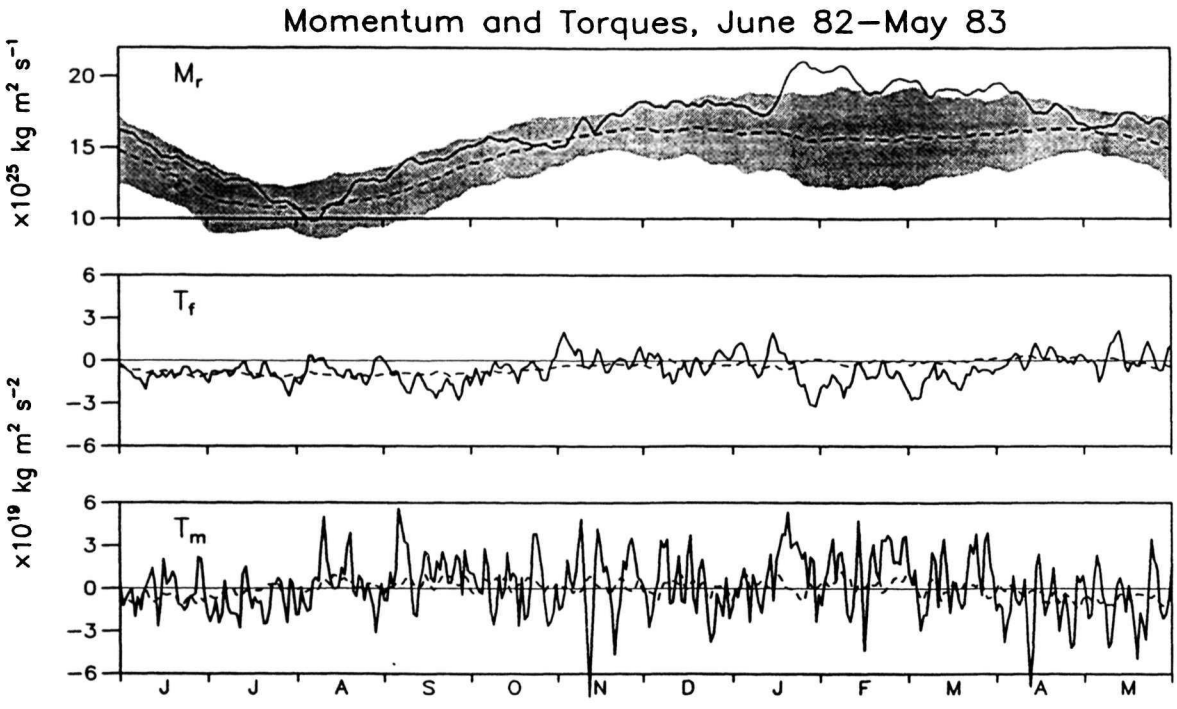

Figure 1. Time series of daily averaged M_r, T_f, and T_m, from top to bottom, displayed as solid lines, for the 1-year period starting on June 1, 1982, together with respective climatological means plotted as dashed lines. Shading around mean M_r curve represents anomalies smaller than ±2 standard deviations.

M_r and torque anomalies and the general state of the atmosphere during the 1982–83 El Niño is provided in Ponte and Rosen (1999). A comparison of the 1982-83 El Niño event to the most recent 1997–98 event should prove useful in establishing any potential common aspects of the evolution of AAM during the strongest two El Niño events of recent decades.

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