The life span of intraseasonal atmospheric anomalies: dependence on the phase relationship with the ocean.

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Using 19 years (1980-1998) of 5-day average data from the NCEP/NCAR reanalysis data (Kalnay et al 1996) we studied the duration of low-level circulation anomalies in terms of whether the anomalies occur simultaneously with the local SST and in terms of the phase relationship between both fields. Previous observational and modeling studies have indicated a strong influence of the tropical SST on the monthly and seasonal average of the atmospheric circulation. Likewise, the influence of the extratropical atmosphere on the ocean has been demonstrated (e.g. Palmer and Sun, 1985). In general, when the atmosphere forces the ocean a cyclonic (anticyclonic) atmospheric vorticity anomaly overlays a cold (warm) SST anomaly. When the ocean forces the atmosphere a cyclonic (anticyclonic) atmospheric vorticity overlays a warm (cold) SST anomaly (e.g. Mo and Kalnay, 1991; Wallace and Jiang, 1987). Here we investigate, in a case-by-case basis, the duration of atmospheric anomalies for each of the two scenarios: "atmosphere forcing the ocean" and "ocean forcing the atmosphere" as defined by the phase relationships. The anomalies considered are those whose departure exceeds one standard deviation from the annual cycle; their life span is defined as the time interval that continuously exceeded this threshold.

The zonal average of the number of atmospheric vorticity anomalies over the ocean per grid point distributed according to their life span is given in Figure 1 (left). Classification of locally coupled (those that occur simultaneously with SST anomalies) and uncoupled atmospheric anomalies are given at the center and right of Figure 1, respectively. The distribution shows that locally coupled anomalies account for essentially all the long lasting anomalies, whereas the uncoupled atmospheric anomalies have a very short life-span. Note that this result is independent of the phase relationship discussed above. The figure also shows that the average life span of anomalies decreases poleward for the coupled cases while it is independent of latitude for the uncoupled cases. The same statistics were computed for the El Niño/Non-El Niño years to see whether these events could yield a different distribution of anomalies but no influence was apparent.

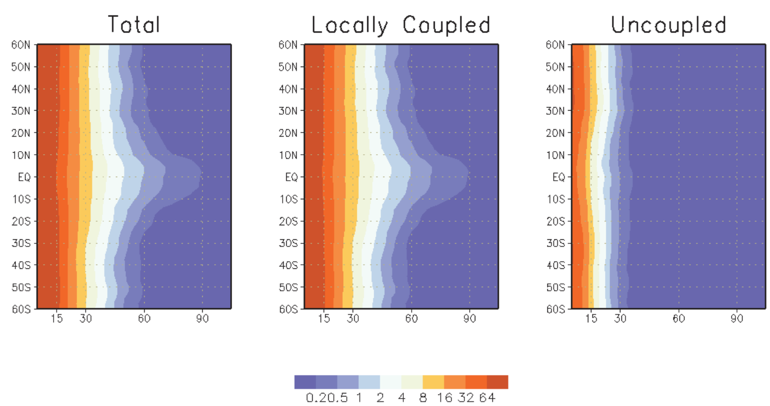

Figure 1. Distribution of the zonal average of the number of 850-hPa relative vorticity anomalies, in terms of their life span (abscissa axis in days); (a) total number (b) locally coupled, and (c) uncoupled cases. Data from 5-day average of daily NCEP-NCAR reanalysis data.

The dependence of the life span of atmospheric anomalies on the local phase relationship is presented in Figure 2. The figure shows the difference in number of cases with ocean-forcing minus atmosphere-forcing to enhance the signal and it is restricted to positive SST anomalies for the sake of brevity. The figure indicates that the "anticyclonic over warm" (atmosphere-forcing) phase predominates in the extratropics while "cyclonic over warm" (ocean-forcing) phase predominates in the deep tropics. These results are consistent with past studies that suggest that the ocean tends to drive the atmosphere in the tropics while the atmosphere tends to drive the ocean in the extratropics. Figure 2 also shows that anomalies with the opposite phase, e.g. "cyclonic over warm" (ocean forcing) in the extratropics, do exist but tend to decay much faster. We have applied this methodology (Pena et al, 2001,

2002) to data from an SST-prescribed atmospheric model (referred to as AMIP runs, Gates et al, 1999), in which the ocean always forces the atmosphere. We found that, as could be expected, more “ocean driving” cases than in the reanalysis, especially in the extratropics. More importantly, in the AMIP run the simulated atmospheric anomalies in the extratropics tend to decay faster than observed in the Reanalysis. The inaccurate accelerated damping of anomalies in the model is evidently due to the neglect of the atmospheric feedback to the ocean. We are studying the mechanisms that maintain the long lasting anomalies in the coupled case and hope to find from these results guidance on how to improve the coupling of ocean and atmosphere models.

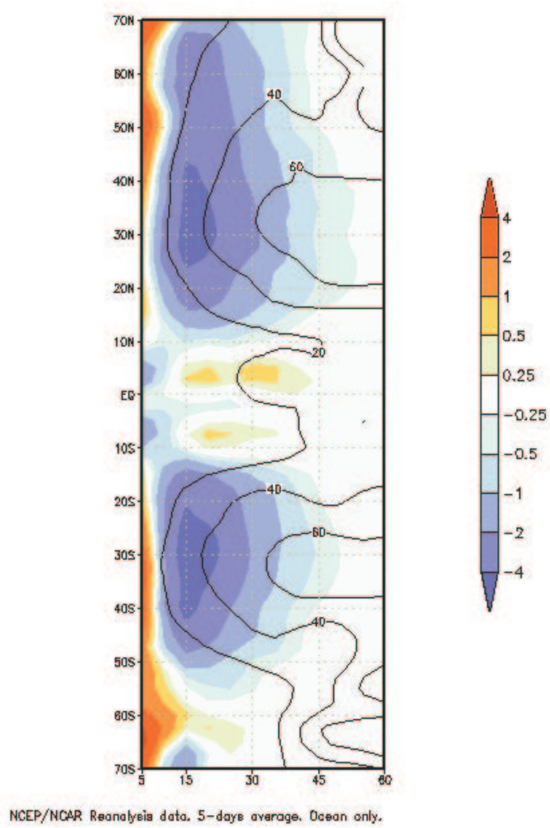

Figure 2. Difference in the number of ocean-forcing anomalies minus atmosphere-forcing anomalies, zonally averaged, for positive SST anomalies. Contours show the percentage of the difference with respect to atmosphere-forcing cases.

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