Distinctive modes of variability associated with active versus subdued Atlantic tropical cyclone activity

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1. Introduction

The upper- and lower-level atmospheric anomalies are investigated for active and subdued tropical cyclone (TC) seasons in the Atlantic basin (Fig. 1). The tropical cyclone records were obtained from the archives of The National Hurricane Center. The atmospheric and sea surface temperature data were from the re-analyses of the National Centers of Environmental Prediction. In this study, only a portion of the Atlantic cyclone records, from 1968 to 1998, is investigated. This is done in order to line up with the more reliable period of the reanalyzed tropospheric data. A highly asymmetrical association is revealed.

2. Upper- and lower-level atmospheric modes

For subdued seasons, the anomaly over the cyclone prone basin is found to be a manifestation of a much larger global-scale variability, with its center located at the eastern equatorial Pacific and the mode of variability resembles the anomaly during the El Nino boreal summers (Fig. 2). On the other hand, for active seasons, the favorable atmospheric anomalies are primarily confined to the lower troposphere in the western North Atlantic region (Fig. 2) and appears to be associated with the local underlying warm sea surface temperature (SST) anomaly. Hence, there is a distinctive association of the active versus subdued TC season with a regional versus an El Nino mode of variability. The La Nina associated atmospheric variability does not appear to play a role (Fig. 1).

3. Sea surface temperature mode

The influence of the lower boundary SST conditions in both the Pacific and the Atlantic sectors is also found to be distinct and highly non-linear. While a local warm SST anomaly promotes TC activity, a local cool anomaly does not play a role in inhibiting it. By the same token, while a remote Pacific warm SST anomaly produces unfavorable atmospheric conditions, a cool La Nina event does not play the opposite role of promoting the Atlantic TC activity (Fig. 3). An implication of these findings is that the conventional linear correlation analysis, or other linear tool such as the empirical orthogonal function analysis, is most likely to be inadequate to address and depict this highly non-linear phenomenon.

4. Long-range predicative capability

The long-lead predicative capability of tropical cyclone's interannual variability by SST's antecedent modes of variability is compared with that of the other variables, such as sea level pressure, lower- and upper-level atmospheric flows, and vertical wind shear. The former variable appears to be a better contender. In general, the SST precursor is already in place in April or May, way ahead of the ensuing peak season of the TC activity, which falls in August to October.

Fig.1 Interannual variability of tropical cyclone activity & ENSO association of active v. subdued TC seasons

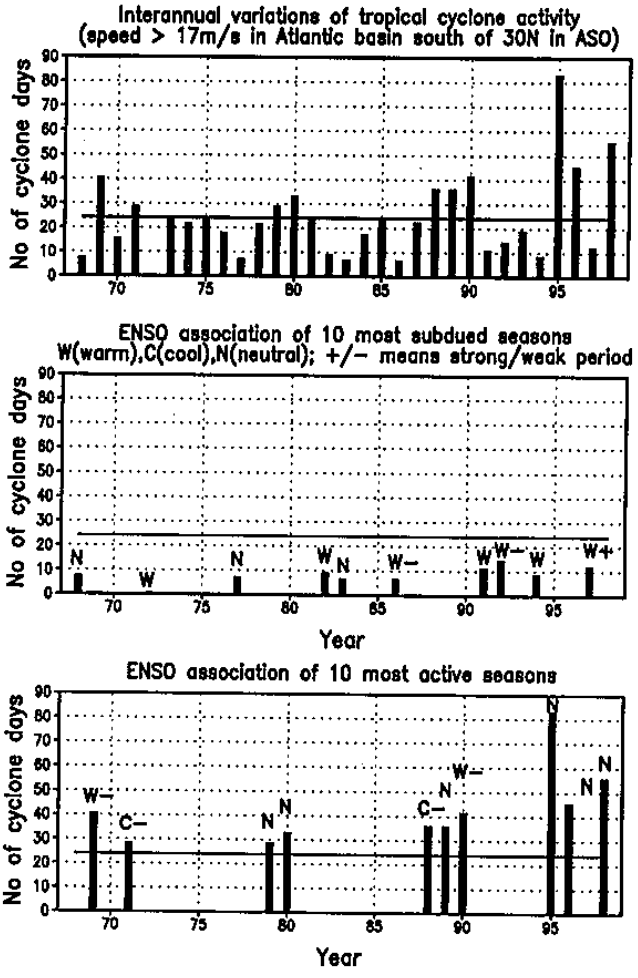

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Figure 2 Distinctive mode of vertical shear variability associated with active/subdued ASO tropical cyclone seasons
(standardized anomaly composites)

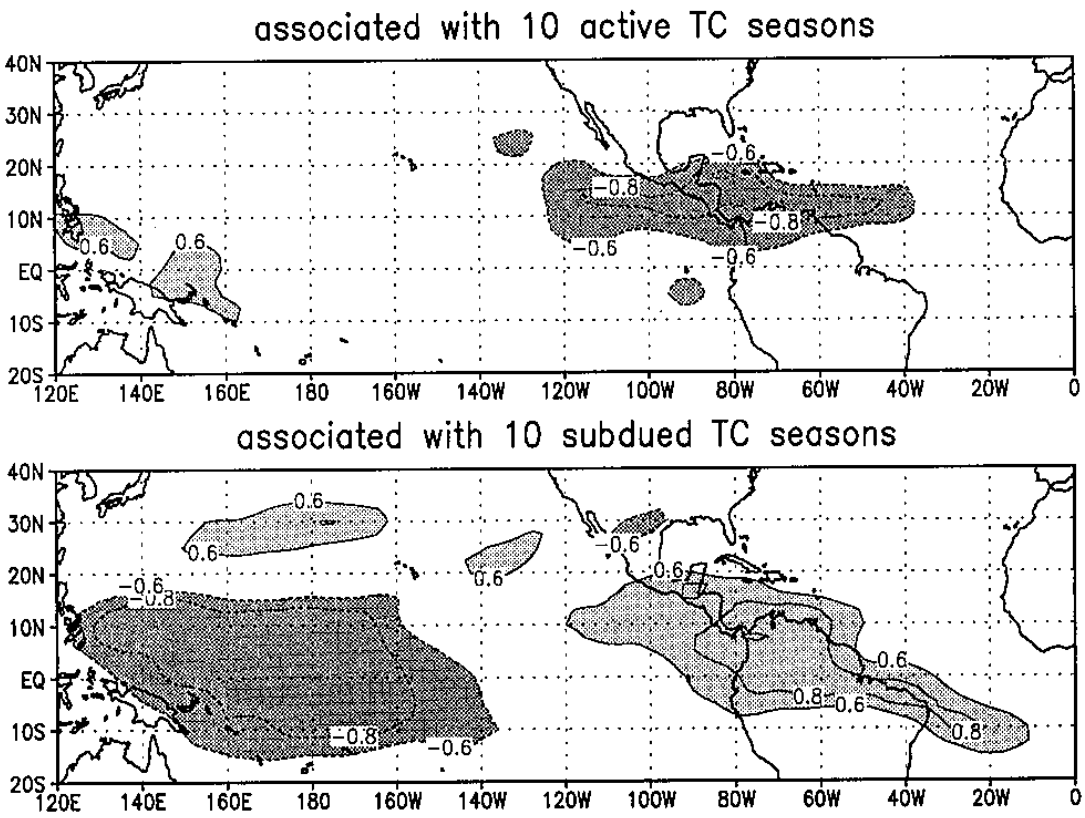

Fig. 3 Distinctive mode of sea surface temperature variability associated with active/subdued ASO tropical cyclone seasons
(shaded area: confidence > 90%)