P1.27 Seasonal to decadal variability of vertical shear over the tropical Atlantic

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1. Introduction

The issue of inter-annual and inter-decadal variability of tropical cyclone (TC) activity continues to attract attention from the scientific community. Past studies have indicated that local and remote environmental factors such as West African precipitation and SSTs over the eastern Pacific and the Atlantic have significant impact on the variability of TC activity, primarily through their influence on the vertical shear over the Atlantic (e.g., Landsea and Gray 1992; Goldenberg and Shapiro 1996). An examination of the dynamics of the processes that form the foundation of these associations is key to improving our understanding of TC variability.

In this study, we will use a hierarchy of diagnostic and modeling techniques in an attempt to isolate the physical relationships that lead to the variability in TC activity. This work is in progress, and at present we will begin with an overview of the climatology of the vertical shear within the main development region (MDR), the area where the majority of the Atlantic storms form (e.g., Goldenberg and Shapiro 1996).

2. Datasets

The primary data used in this study are the reanalyses datasets from the National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) as well as the European Centre for Medium-Range Weather Forecasts (ECMWF), Rain gauge precipitation dataset from the Climate Research Unit (Hulme, 1994) and sea surface temperature (SST) dataset (HADISST) from the Hadley Centre.

3. Results

Figure 1 shows the locations of all TCs that formed within the MDR during 1958-2001. The distribution of TC genesis points in the MDR is not uniform, with a greater concentration in the central and eastern Atlantic and relative sparseness in the Caribbean.

The long-term mean of June-October (JJASO) vertical shear (200-925 hPa) and its standard deviation (values > 1.5 ms^{-1} shaded) are shown in fig. 2. The climatological vertical shear within the entire MDR is greater than 10 ms^{-1} and indicates that, on average, the environmental shear in the MDR is not conducive for TC development (Gray et al. 1993; Goldenberg and Shapiro 1996). The vertical shear in the MDR is greatest over its southwest part, coincident with the climatological position of the low-level easterly Caribbean jet. This is also the region in the MDR with the lowest concentration of TC genesis (fig.1). From the standard deviation of the mean JJASO vertical shear (fig. 2), we note that the western part of the MDR exhibits a greater inter-annual variability than the eastern part.

Another measure of the range of values exhibited by the vertical shear is shown in fig. 3, which depicts the difference between the climatological maximum and minimum in the mean JJASO shear. The western half of the MDR is clearly associated with a much larger range of vertical shear as compared to the eastern half. This suggests the need to consider, in addition to the temporal variability, the spatial variability of the vertical shear within the MDR.

Fig. 4 shows the inter-annual variability in the anomalous vertical shear as well as the anomalous number of tropical cyclones that originated within the MDR during the JJASO months. The anomalies are defined relative to the 1958-2001 average MDR shear and TC numbers respectively.The linear correlation coefficient between these two time series is found to be –0.44. This anti-correlation between vertical shear and TC activity is consistent with results reported in past studies that have examined the inter-annual variability of tropical cyclones (e.g., Goldenberg and Shapiro 1996; Thorncroft and Pytharoulis 2001).

Additional analysis is underway to elucidate the dominant spatial and temporal patterns of variability of the vertical shear in the MDR and their relationship between local and remote factors such as SST and precipitation. The results will be reported at the conference.

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References

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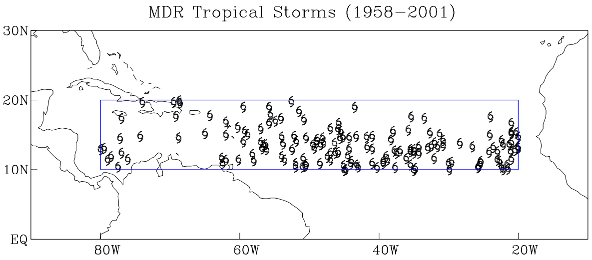

Fig. 1. Genesis locations (NHC best track) of all TCs originating within the MDR (demarcated by the box) during JJASO months of 1958-2001.

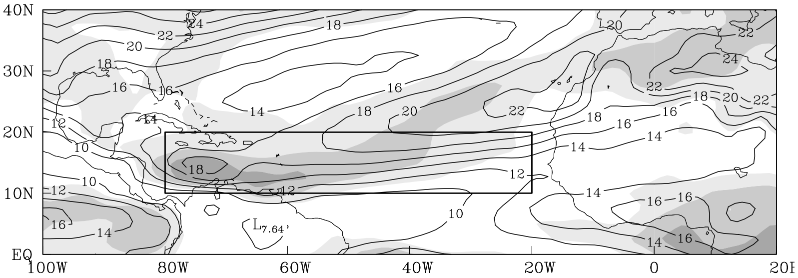

Fig. 2. Long-term mean (contours, interval of 2 ms^{-1}) and standard deviation (values greater than 1.5 ms^{-1} are shaded) of JJASO mean vertical shear.

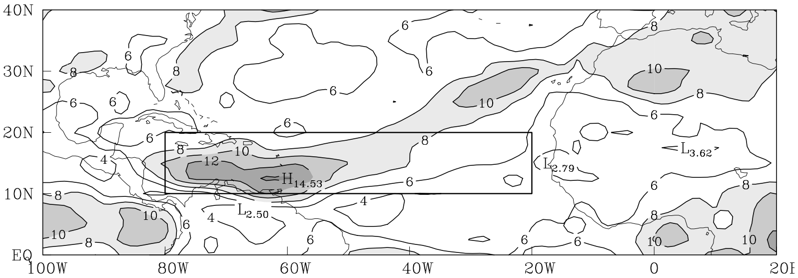

Fig. 3. Range of vertical shear, defined as the difference in the climatological maximum and minimum JJASO mean vertical shear. Contour interval is 2 ms^{-1}and values greater than 8 ms^{-1} are shaded.

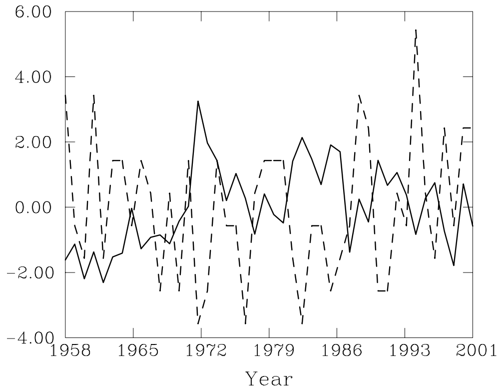

Fig. 4. Inter-annual variability of anomalous shear averaged within the MDR (solid line) and anomalous number of TCs (dashed) that formed within the MDR. The coefficient of linear correlation between the two time series is -0.44.