P1.62 ENSO AND NAO SIGNALS ON THE ISTHMUS OF TEHUANTEPEC WINDS

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1. INTRODUCTION

The Isthmus of Tehuantepec, located in southeast Mexico, is a narrow region that separates the Gulf of Mexico from the Pacific Ocean (Fig. 1). The mountain range Sierra Madre del Sur has a mean height of 2000 m above sea level, but at the central part of the Isthmus the mean height drastically drops to 250 m forming a gap of approximately 40-km width. The high pressure systems formed over the Great Plains of North America that move southeastward and reach the Bay of Campeche, develop a large pressure difference between the Gulf of Mexico and the Gulf of Tehuantepec (GT) producing strong northerly winds through the mountain gap (Roden 1961; Lavín et al. 1992; Schultz et al. 1997; Chelton et al. 2000; and references within). Here, the statistical character-istics of the winds at the Isthmus of Tehuantepec are reviewed and their relationship with the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO) phases is analyzed.

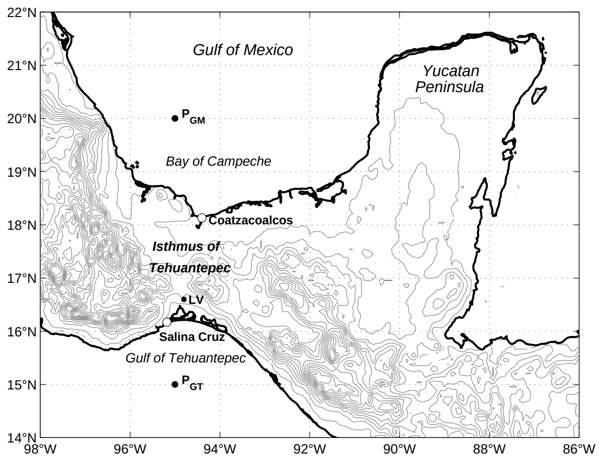

Fig. 1. Location of the Isthmus of Tehuantepec and sites of interest. The first two contour lines correspond to 50 and 200 m respectively, and the following contours are every 250 m. Here, LV stands for La Venta station.

2. Data

Wind speed and direction and sea level pressure (slp) data from the Salina Cruz observatory, and slp data from the Coatzacoalcos observatory were obtained from the Servicio Meteorologico Nacional (Mexican Na tional Weather Service). The Salina Cruz observatory is located approximately 300 m away from the GT shore and 50 km SSW from the mountain gap.

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The winds were measured 10 m above the ground using a conventional anemograph and the wind data series extends from 1964 to 1988 with several periods of missing data. High-quality wind speed and direction from La Venta anemometric station, located close to the southern end of the mountain gap, were measured 26.5 m above the ground and the hourly data records are complete from January 1964 to December 1995. Twice-daily records of slp from the National Climatic Data Center (NCDC) at points 20°N, 95°W (P_{GM}) and 15°N, 95°W (P_{GT}) for January 1964-April 1995, and 4-daily records of slp from the National Centers for Environmental Prediction (NCEP) reanalysis at points 37°N, 25°W and 65°N, 20°W for 1964-2003 are used in this study.

3. Results

Observations show that the monthly mean wind speeds have a strong seasonal signal, with maximum values during December–January, minimum during May–June, and a relative maximum in July. The frequency distribution of wind speed at La Venta is bimodal, a feature that is closely related to the wind direction, with northerly winds being stronger (see Romero-Centeno et al. 2003). The relationship between the winds at La Venta and the pressure differences between the Salina Cruz and Coatzacoalcos observatories (ΔP) is shown in Fig. 2. The scatterplot shows two clusters of points, which are related to the wind direction. The percentage of occurrence of northerly winds (winds from NNW, N and NNE) as a function of ΔP is shown in Fig. 3. Based on these results a statistical model is developed to get a reconstruction of 12-hourly winds through the Isthmus of Tehuantepec for 1964–95 (see Romero-Centeno et al. 2003).

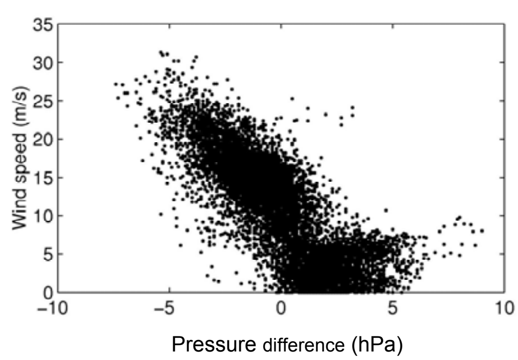

Fig. 2. Scatterplot of wind speed at La Venta and slp differences between Salina Cruz and Coatzacoalcos.

The model reproduces fairly well the main characteristics of the observed winds. Modeled winds show that the high frequency of northerly winds in July is associated with weaker winds than those observed in winter. The summer maximum seems to be related with the westward displacement and strengthening of the Bermuda high during this time of the year.

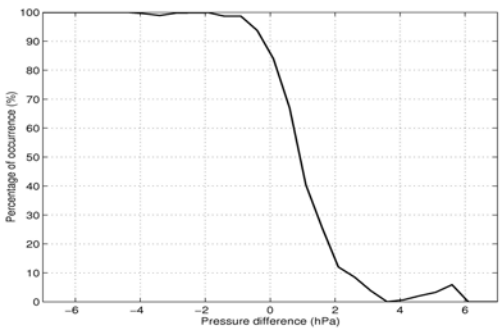

Fig. 3. Percentage of occurrence of northerly winds at La Venta as a function of the pressure differences between the observatories.

3.1 ENSO and NAO influence

The ENSO impact on the interannual variability of the winds at the Isthmus of Tehuantepec, based on the modeled winds, is represented in Fig. 4a,b. The long-term monthly mean wind speeds show larger values during El Niño years compared with La Niña years.

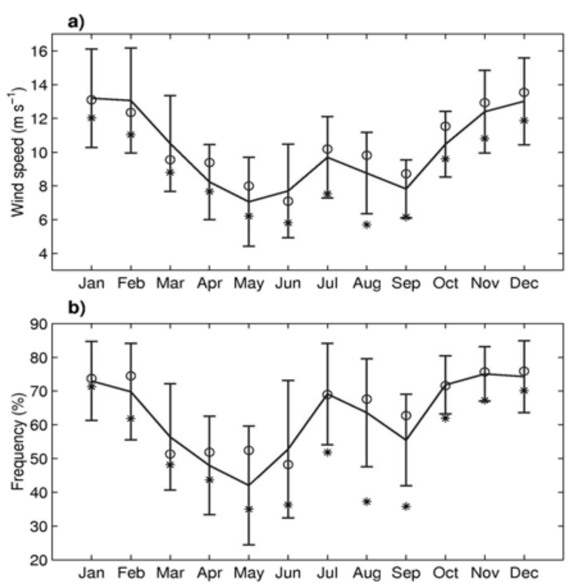

Fig. 4. (a) Long-term mean wind speeds, and (b) frequency of northerly winds from model estimates at La Venta, considering neutral (line), El Niño (circles), and La Niña (asterisks) years for 1964-1995.

During La Niña years winds are significantly weaker than in neutral years for February–March, June–September, and November, and the percentage of occurrence of northerly winds is significantly lower than in neutral years from June to November. The larger occurrence of northerly winds during El Niño years compared with neutral years is statistically significant only for May and September.

The NAO index (Azores High (AZ) minus Iceland Low (IC)) has a seasonal signal very similar to that of the mean winds and frequency of northerly winds through the Isthmus. This similarity suggests that may be some link between the NAO index and the wind anomalies at the Isthmus. A simple correlation using a 12-month moving average of the normalized NAO index and the pressure differences between P_{GM} and P_{GT} does not show a clear relationship, but the analysis of the time series (Fig. 5) suggests that there are some similarities. One is the scale of variability that is energetic in the 1 to 3-yr time scale, which may be checked analyzing the spectra. On longer time scales, the pressure differences between P_{GM} and P_{GT} have very large variability, with an outstanding maximum in 1966 and a minimum in 1973, a similar jump is observed between early and middle 90's. The estimated winds for the late 60's (Romero-Centeno et al., 2003) does no show that maximum, which may be an error in the reanalysis data. The strong decrease in the late 90's does have a similar signal on the estimated winds. Therefore, more research should be done to understand the links between the North Atlantic pressure field and the Tehuantepec winds.

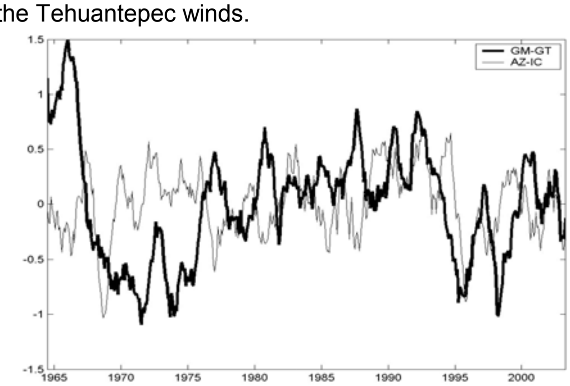

Fig. 5. Time series of the 12-month moving average of the NAO index (AZ-IC) and pressure differences between the Gulf of Mexico and the Gulf of Tehuantepec (GM – GT).

4. References

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