2.4 TEHUANTEPEC WIND AND PRESSURE CHANGES ASSOCIATED WITH TROPICAL CYCLONES

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1. INTRODUCTION

The first satellite images of the surface manifestation of Tehuantepec winds were observed with the NASA scatterometer (NSCAT) (Bourassa et al. 1999; Chelton et al. 2000a.b). Tehuantepec winds flow south through the Chivela Pass into the Gulf of Tehuantepec (Fig. 1), and during winter they extend more than 5 degrees into the Pacific. During winter, strong flow through Chivela Pass is usually associated with cold fronts penetrating deep into the Gulf of Mexico (Chelton et al. 2000a,b).

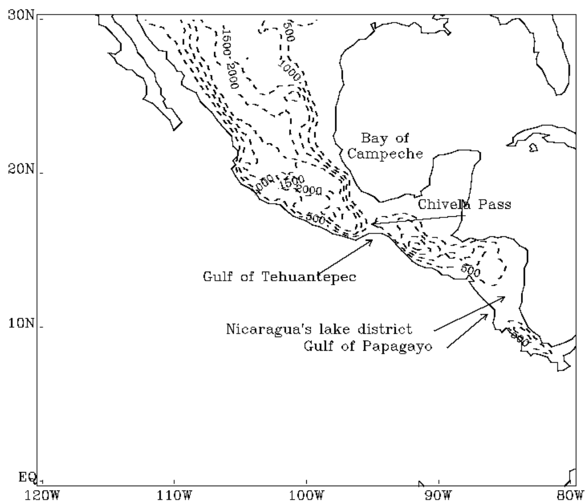

Fig. 1 Elevation contours (dashed) for Central America, and sea level pressure contours (solid) for Nov. 13, 1996.

It has also been demonstrated that tropical cyclones influence the strength of gap flow and the direction of flow in the Pacific Ocean (Bourassa et al. 1999). The zonal pressure gradient in the Pacific Ocean near the Gulf of Tehuantepec is often very weak, and the direction of the outflow can be well approximated as gradient flow (Clarke 1988). However, gap flow related to tropical cyclones can be highly non-inertial, and in one case has been observed to turn to the left, pass through the pass near the Gulf of Papagayo, and enter the Caribbean Sea (Bourassa et al. 1999).

Gap flow related to tropical cyclones is examined herein. During summer, fall, and early winter, strong gap flow is often associated with tropical cyclones. Preliminary results are described.

2. DATA

Wind observations from the SeaWinds scatterometer on the QuikSCAT satellite are used to create six-hourly 0.5°x0.5° fields of gridded winds. SeaWinds data is also used to estimate surface pressures. The accuracy of SeaWinds ocean vector winds is excellent (Bourassa et al. 2001).

3. METHODOLOGY

Spaceborne scatterometers provide a high spatial resolution (~25 to 50 km) within their observation swaths, but no observations outside the swaths. The construction of daily surface wind fields, based on oceanic observations, has not been practical prior to the period of NSCAT observations, for which approximately 10 research groups produced approximately daily wind fields. One such gridding technique developed (Pegion et al. 2000) has been slightly modified to produce wind fields from SeaWinds observations. The SeaWinds data set has been provided by Frank Wentz and Deborah Smith at Remote Sensing Systems. Further details are given in paper 1.3 of these proceedings.

The surface pressure is calculated on the grid resolution of the scatterometer observations (currently 25 km) through a technique that has been qualitatively shown to be effective (Zierden et al. 2000). This technique smoothly meshes the scatterometer derived pressure fields (in and near areas with scatterometer observations) with first guess (analysis or forecast) pressure fields in areas away from scatterometer observations. In other words, the pressure field is improved in and near the swath of vector wind observations. Pressure fields derived from scatterometer observations have also been shown to have the mesoscale features associated with fronts (Zierden et al. 2000).

Although surface pressure and winds are physically different data types, they are related

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through vorticity. A variational method solves for a new geostrophic stream function, minimizing the difference between the new geostrophic vorticity and old geostrophic vorticity where satellite data are present, and minimizing the difference between the new geostrophic vorticity and old geostrophic where no satellite data are present. The treatment of the scatterometer-derived relative vorticity as geostrophic ignores the ageostrophy of surface winds, which can be significant near fronts and jet streaks. However, this approximation is necessary in the absence of upper air thermal and mass fields.

4. RESULTS

The wind fields clearly show the evolution of Tehuantepec gap flow, and they show tropical cyclones in very early stages of development. Preliminary results indicate that even very weak tropical cyclones in the Caribbean Sea or stronger cyclones at similar latitudes in the Atlantic Ocean are often associated with southward flow through Chivela Pass (Fig. 2).

The direction of the gap flow, after it passes southward through Chivela Pass, is dependent on the pressure gradient and the position of the Inter-Tropical Convergence Zone (ITCZ). In the eastern Pacific Ocean, the ITCZ is far north of the equator during the boreal summer season. The winds move to the east, and when Tehuantepec outflow reaches the ITCZ is changes direction from westward to eastward. Another consideration is the change in the zonal pressure gradient, which is normally negligible; however, tropical cyclones can induce a substantial pressure gradient (Fig. 3).

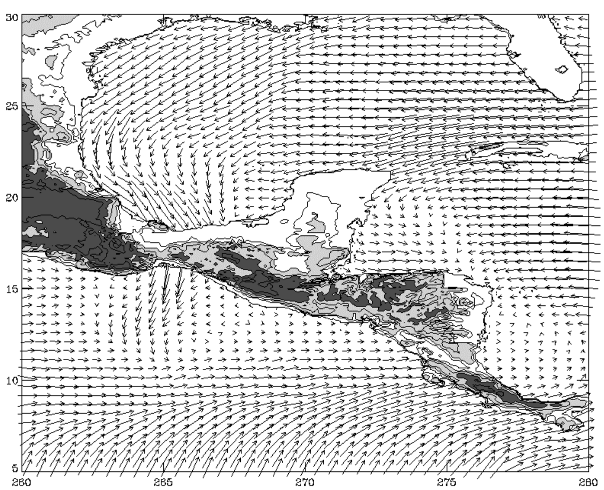

Fig.2 Tehuantepec gap flow (12Z Oct. 12, 1999), prior to the formation of Hurricane Irene in the Caribbean Sea.

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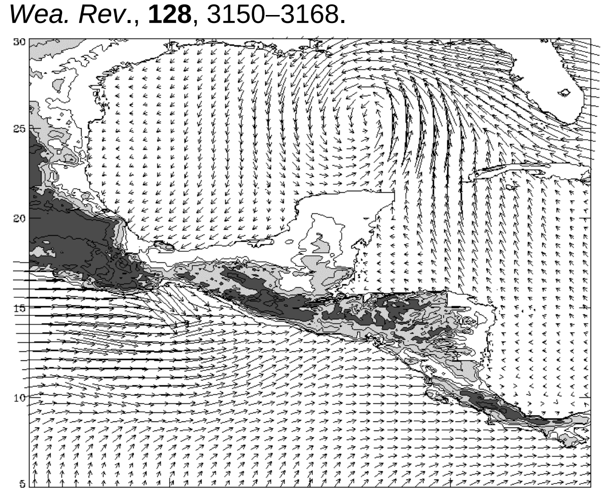

Fig. 3. TS Harvey at 18Z on Sept. 19, 1999.