JP4.1 USE OF QUIKSCAT IMAGERY IN THE DIAGNOSIS AND DETECTION OF GULF OF TEHUANTEPEC WIND EVENTS 1999-2002

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1. INTRODUCTION

The Gulf of Tehuantepec is a unique geographical area, which is located just south of the Isthmus of Tehuantepec. The Isthmus of Tehuantepec is the narrowest land area, about 220 km wide, between the Gulf of Mexico and the tropical Pacific Ocean. The area is unique because the Isthmus includes the Chivela Pass, a 40 km wide mountain gap in the Sierra Madre range. The Sierre Madre mountains are about 2000-3000 m high with the Chivela Pass only about 250 m above sea level (Stumpf, 1975). The break in the mountain chain allows strong northerly winds to be funneled from the Gulf of Mexico into the tropical Eastern Pacific.

Gulf of Tehuantepec wind events develop during the “cool” season when a strong high pressure center builds over the eastern United States and the Gulf of Mexico. As high pressure builds over the western Gulf of Mexico, a strong pressure gradient is concentrated along the northeast coast of the Sierre Madre mountain chain. The gradient is allowed to be “released” through the Chivela pass, as cold dense air is funneled through the pass into the Gulf of Tehuantepec (Stumpf). As the winds pass over the Gulf of Tehuantepec they veer northeast and can extend several hundred kilometers downwind. The events which are also known as “Tehuantepecers” can last for several days and often produce gale (34 to 47 kt) to storm (>48 kt) force winds.

With the launch of the SeaWinds/QuikSCAT satellite in June 1999, scatterometer data became readily available to marine forecasters at the Tropical Prediction Center (TPC). QuikSCAT data has provided valuable information on the strength, duration and areal extent of Tehuantepec wind events. From October 1999 through April 2002 nearly 50 Gulf of Tehuantepec gale or storm events have occurred. Based on Quikscat data, this study will attempt to provide a climatology of Tehuantepec gale and storm events and develop a conceptual model of synoptic scale precursor signatures.

2. DATA

Gulf of Tehuantepec gale or storm events were first identified by either a reliable ship observation or QuikSCAT data detecting 34 kt winds or greater. In many cases the events were well forecast by numerical forecast models and by marine forecasters at TPC. Once an event was identified QuikSCAT data was retrieved from an archive on the NOAA/NESDIS QuikSCAT world wide web page (manati.wwb.noaa.gov/quikscat/). The duration of each event was generally derived from QuikSCAT data and numerical weather prediction (NWP) model guidance.

After the events were identified, six-hourly sea level pressure trends from Brownsville, Texas; Tampico, Mexico; Veracruz, Mexico; and Coatzacoalcos, Mexico were examined beginning about 24 hours before each event through the entire event . The sea level pressures for each station were plotted to create a time-series of sea-level pressure during each Tehuantepec event. The maximum sea-level pressure at each station was examined and the strength and location of the surface high pressure center was also analyzed. Once the data was compiled a conceptual model for the synoptic scale precursor signatures was developed.

3. CLIMATOLOGY

During the period from October 1999 through April 2002 an average of 15 Tehuantepec gale or storm events have occurred during each “cool” season. The “cool” season is defined as beginning on 1 October and ending on 30 April. Over the past three years, about 2 events each season have been confirmed to reach storm force. Since, it is difficult to verify the storm events, it is believed that a few more events may briefly reach storm force each season.

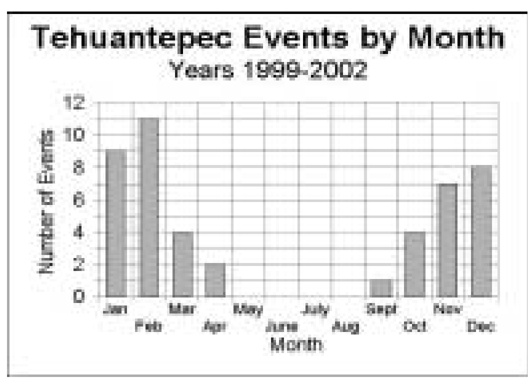

Figure 1. Gulf of Tehuantepec gale or storm events by month from Fall 1999 through Spring 2002.

The first event of each cool season typically occurs in mid-October with the last event occurring in late March or early April. One event did occur in late September 2000. The majority of Tehuantepec wind events occur between November and February with February being the most active month (Figure 1). From 1999-2002 eleven Tehuantepec events have occurred in February.

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January and December are also very active with 9 and 8 events occurring respectively over the last three years. The mean duration of each event is nearly 48 hours while the maximum duration was 132 hours or 5.5 days.

Figure 2 Tracks of anticyclones associated with the seven storm events in the years 2000-2002. Locations of the 4 representative surface stations are also indicated.

4. CONCEPTUAL MODEL AND SYNOPTIC SCALE PRECURSOR SIGNATURES.

Several synoptic scale precursor signals can be used to forecast the onset and maximum strength of a Gulf of Tehuantepec wind event. The precursor signatures and conceptual model described in this section have been compiled from the seven storm events over the past three cool seasons. The most useful precursor signature is the location and strength of the continental anticyclone. The location of the anticyclone is more critical that the actual strength of the anticyclone itself. The path that the anticyclone moves is key in driving the northerly fetch down the coast of Mexico and setting up the strong pressure gradient across the Isthmus of Tehuantepec. There was a distinct difference in the tracks of anticyclones for the gale events versus the storm events. During the gale events, surface anticyclones were located further north and tracked to the east across the Tennessee and Ohio River valleys. During the storm events (Figure 2) surface anticyclones tracked southward into Texas and northern Mexico with greater pressure rises over Mexico and the western Gulf of Mexico. The southward migration of the surface anticyclones in the storm events was also associated with a more amplified trough at 500 millibars.

Table 1 provides the average maximum sea level pressure at Brownsville, TX; Tampico, MX; Veracruz, MX; and Coatzacoalcos, MX during Tehuantepec gale and storm events. At Brownsville and Tampico the average maximum sea level pressure was a little over 4 mb higher during the seven storm events as compared to the gale wind events. At Veracruz and Coatzacoalcos the average maximum sea level pressure during storm events was 2.4 and 2.8 mb higher respectively than during the gale events.

Station	Gale Events	Storm Events
Brownsville	1028.6 mb	1032.8 mb
Tampico	1027.7 mb	1031.8 mb
Veracruz	1026.2 mb	1029.1 mb
Coatzacoalcos	1024.4 mb	1026.7 mb

Table 1. Average maximum sea level pressure (mb) during Gulf of Tehuantepec gale and storm events (October 1999-April 2002).

Figure 3 includes a six-hourly sea level pressure time series from a storm event which occurred on 4-6 January 2000. The time series depicts the dramatic pressure rise that occurs just behind the cold surge along the western Gulf Coast. The pressure rises at Brownsville and Tampico usually precede the Tehuantepec wind

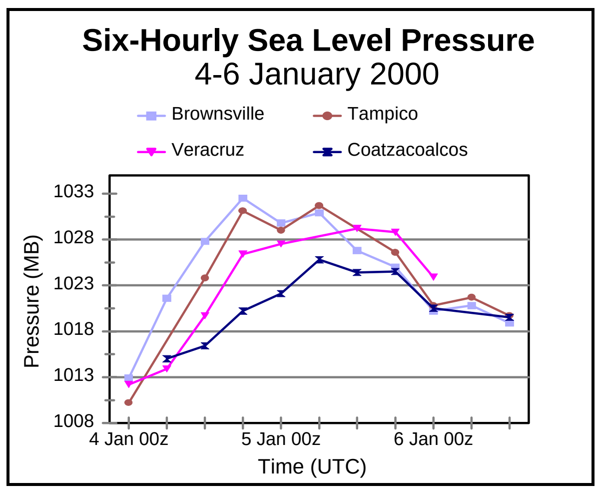

Figure 3. Six-hourly sea level pressure from Brownsville, Texas; Tampico, Mexico; Veracruz, Mexico; and Coatzacoalcos, Mexico between 4-6 January 2000.

event by about 12 to 18 hours. During this event the pressure in Brownsville rose from 1012.9 mb to 1032.5 mb between 0000 and 1800 UTC 4 January. QuikSCAT data from 0029 UTC 5 January, about 12 to 18 hours after the rise in pressure at Brownsville, detected 50 kt in the Gulf of Tehuantepec (Figure 4). Since the areal extent of

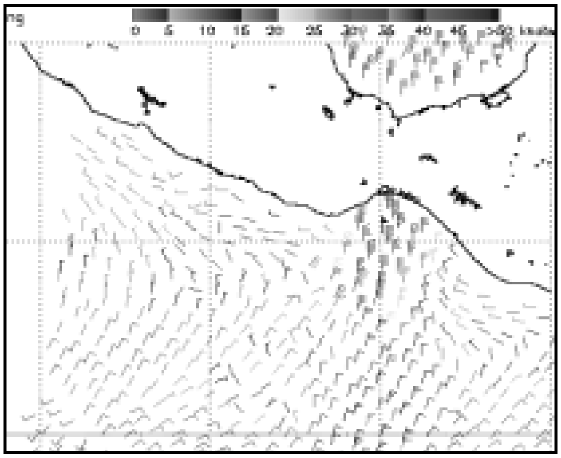

Figure 4. QuikSCAT data from 0029 UTC 5 January 2002. A 50 kt wind barb is detected in the Gulf of Tehuantepec.

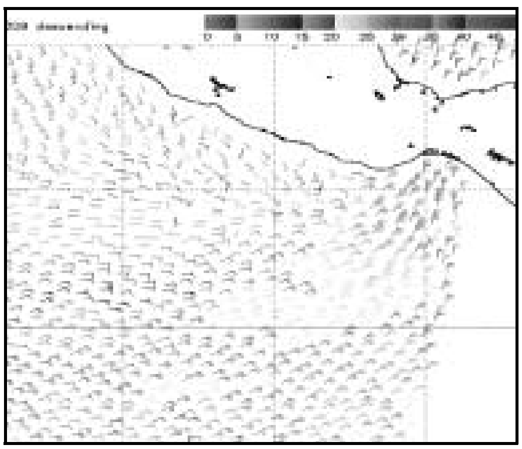

Figure 5. QuikSCAT data from 0052 UTC 9 February 2000. This is a typical example of the areal extent of the strong winds after about 24 hours of a gale event. Note the southwest extend of 20 to 25 kt winds.

the winds do not extend much beyond the Gulf of Tehuantepec, it appears that QuikSCAT captured the storm event shortly after it began.

During the life cycle of an event the area of gale and storm force winds is generally confined to the Gulf of Tehuantepec and the area immediately surrounding it. However, as the event continues the areal extent of 20 to 30 kt winds expand. Figure 5 illustrates the areal extent of 20 to 25 kt winds about 24 hours after the onset of an event. Notice that 20 to 25 kt winds extend several hundred miles downwind of the Gulf of Tehuantepec.

5. CONCLUSIONS AND FUTURE WORK

Before QuikSCAT data was readily available, forecasters had to rely on the occasional ship observation to confirm the presence of gale or storm force winds. Since, the advent of near real-time scatterometer data, marine forecasters at TPC have relied on QuikSCAT data to better understand and forecast Tehuantepec gap wind events. Forecasters now have a better knowledge of the exact location, magnitude, and duration of the Tehuantepec winds.

On average 15 gale force or greater wind events occur each cool season, with two events producing storm force winds. In order to correctly forecast the magnitude of an event it is very important to determine the eventual track of the surface high pressure. During the stronger storm events, it appears that the high pressure center moves farther south usually into south Texas or northern Mexico. The onset of gale force winds in the Gulf of Tehuantepec typically occurs about 12 to 18 hours after the abrupt surface pressure rise occurs at Brownsville, TX and Tampico, MX.

In the future, better spacial and temporal coverage of scatterometer data is planned with the launch of subsequent platforms. The additional scatterometer passes each day will provide a more detailed glimpse at winds over the ocean and would be extremely beneficial in monitoring small scale events such as Tehuantepec gap wind events. The authors hope that further studies of Tehuantepec wind events can be continued. Gap winds also occur in the TPC forecast area near the Gulf of Papaguyo along the coast of Central America. Additional understanding of these events would greatly improve the accuracy of marine forecasts.

6. REFERENCES

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