A Climatology of Mountain Gap Wind Jets and Related Coastal Upwelling Based on Analysis of Satellite Climate Data Records

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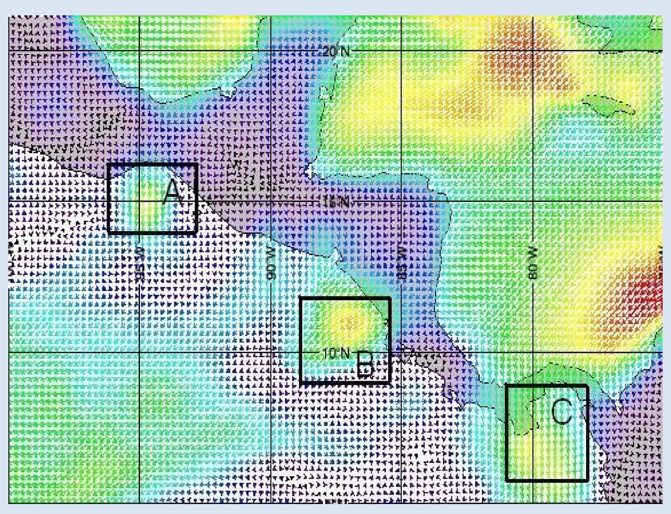
Abstract: Surface wind jets are infrequently-occurring weather events caused by synoptic scale systems and local topography. In the region of Central America, 3 wind jets exist mostly in the NH winter months. The winds blow strongly through gaps in the Sierra Madre Mountains and can flow hundreds of kilometers offshore. Often, cold water regions form from the intense vertical mixing caused by the high winds. The DISCOVER team, a NASA/ MEaSUREs project, has developed an automated intelligent algorithm to detect and extract the characteristics of these mountain gap winds and associated cold water upwelling. A passive microwave-based wind product, the Cross-Calibrated, Multi-Platform (CCMP) ocean surface wind product and the DISCOVER Optimally Interpolated Sea Surface Temperature (OISST) product are used in this analysis. The methods developed can be easily transferred to allow study of similar events in other regions. The resulting climatology of wind and SST details for the period of 1997 to present time will be available at the NASA Global Hydrology Resource Center (GHRC). This poster presents an overview of the data used, the algorithm developed for gap wind and upwelling event detection, a summary of the characteristics recorded in the climatology and an example of the findings.

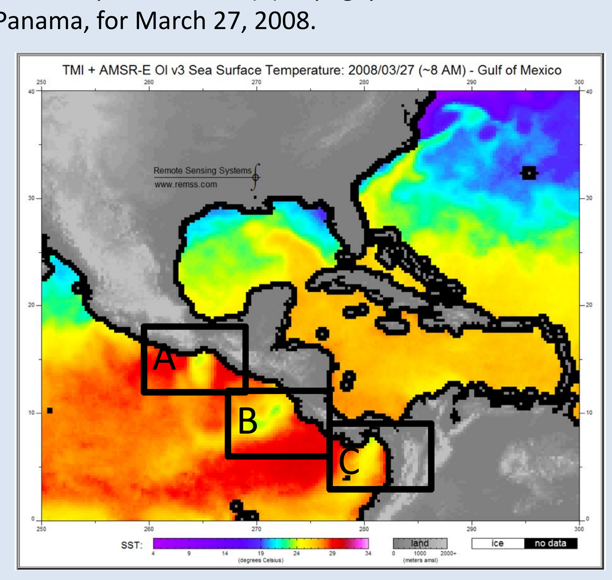
CDRs Used

Highly accurate, long-term, consistently processed, microwave climate data records from SSM/I, TMI, AMSR-E, SSMIS, WindSat, and QuikSCAT are used as input to the Cross-Calibrated, Multi Platform (CCMP) winds. (Atlas et al, 2011). This product uses a 4D-variational analysis method to blend satellite winds, in situ observations, and model winds into a 4x/day product. The CCMP winds are available at the PO.DAAC



CCMP data coverage of three Central American sites: (A) Tehuantepec, Mexico, (B) Papagayo, Costa Rico, and (C) Panama, for March 27, 2008.

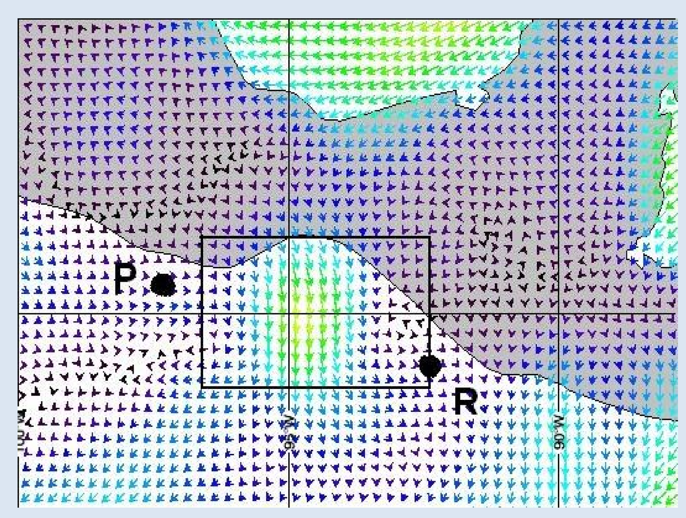
Beginning in 1997, the TMI instrument provided the first through-cloud sea surface temperatures (SST) (Wentz et al, 2000). An optimum interpolation scheme is used to produce a daily, diurnally-corrected SST product. The DISCOVER project releases this product via the web page www.remss.com/sst.



MW OI SST data coverage for same three Central American sites on March 27, 2008. The prolonged winds result in a drop in SST.

The three regions (A, B, and C) shown in the above figures experience high winds and ocean upwelling. In A) winds blow through the Chivela Pass out over the Gulf of Tehauntepec, in B) winds blow across the Nicaraguan Lake District and over the Gulf of Papagayo, and in C) winds blow through the Panama Canal area over the Gulf of Panama. CCMP and MW OISSTs are processed separately for each of these areas.

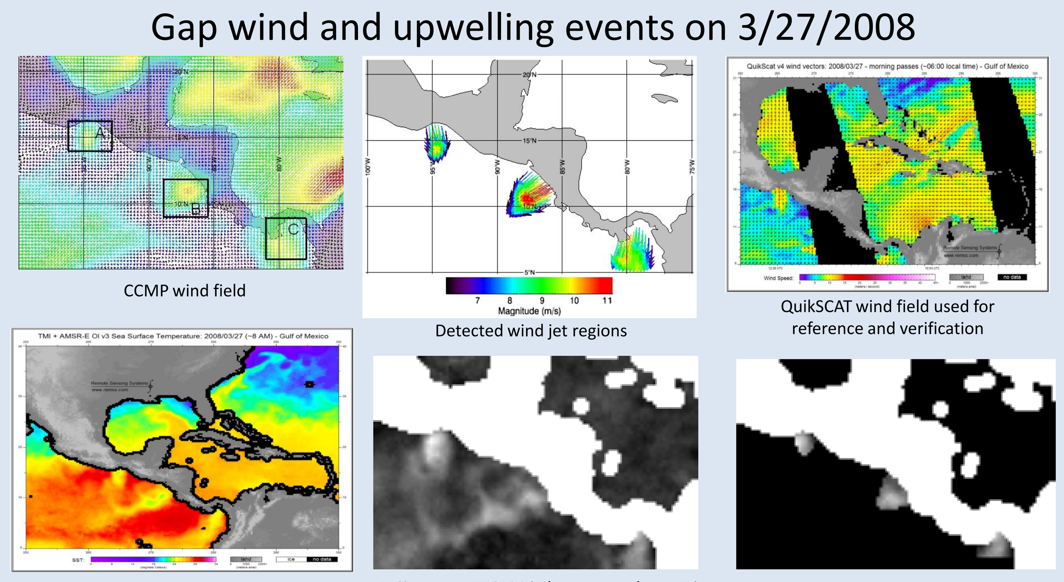
Methods Used



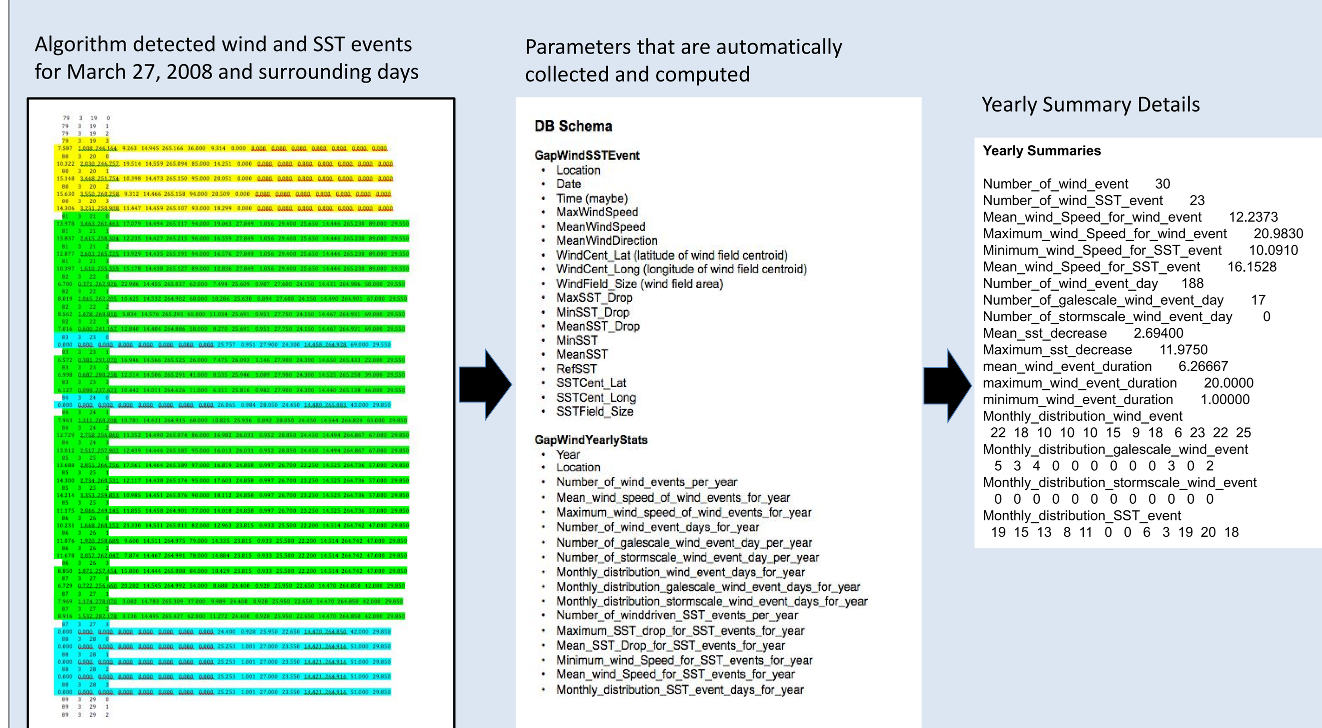
Close-up view of region A, Gulf of Tehauntepec. P and R are the reference points used to validate the gap wind. R is also an SST reference point for ocean upwelling validation.

Gap winds appear in the satellite imagery as long, narrow regions of high winds with specific wind directions dictated by the topography. A multi-step hierarchical thresholding technique with a threshold value set to each unique gap wind was developed. Minimum and maximum thresholds are pre-determined for each wind jet based on typical intensity. Reference locations (such as P and R in the figure at right) assist in event detection as we assume there will be a significant wind speed difference between the event cells and the reference locations. A region growing method is then used to group individual pixels into regions. QuikSCAT and Passive MW winds were used by scientists to identify and verify wind events during the algorithm development. We use the same approach for detecting the ocean upwelling regions. Ocean upwelling is restricted to wind gap region boundaries. A post processing step connects adjacent time steps into one event, thereby reducing gaps.

Gap wind and upwelling events on 3/27/2008

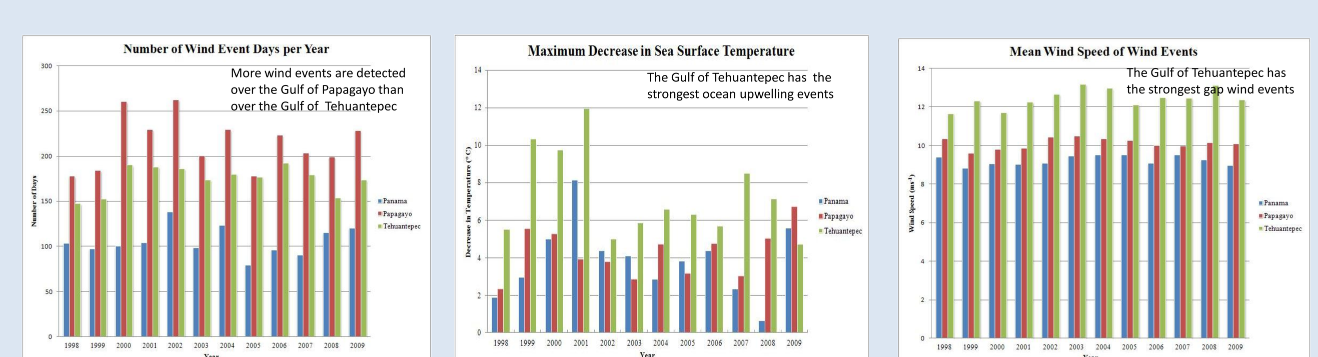


Mountain Gap Climatology Contents



A wind jet / ocean upwelling event can last from hours to days. Yearly statistics are calculated (see parameters listed at right) that allow for comparison between the 3 regions. The figures below show comparison plots for mean wind speeds, maximum decrease in SST, and the number of wind event days per calendar year.

Brennan et al. (2010) used 12.5 km QuikSCAT data from 1999 to 2009 to determine a climatology of the Tehuantepec gap wind. The results shown here somewhat agree with his findings (average of 11 gale events and 6 storm events per year – we find 21 and 2 events respectively). Different resolutions, model input and coarser resolutions all play a role in the differences found.



Gap Wind Event Statistics 1998 - 2009

The Climatology Available at GHRC –User Access and Visualization, Archive of Events, Monthly and Annual Statistics

Expected end-user application capabilities include:

Get Data for selected locations → Plot Statistics for specific dates and locations → Visualize inputs and results → Subscribe for new events

References:

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Wentz, F. J., C. L. Gentemann, D. K. Smith and D. B. Chelton, (2000) Satellite Measurements of Sea Surface Temperature Through Clouds, *Science, 288*(5467), 847-850.

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