Gulf Coast Natural Disaster and Weather

DEVELOP

The Utilization of NASA Satellite Data to Analyze Tropical Cyclone Wind Speed and Cloud Height in the Gulf of Mexico to Assist CHILI in Hurricane Landfall Research

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OBJECTIVES

- Compare wind speed data from the QuikSCAT and Aqua satellites to wind speed data from buoys
- Demonstrate the utility of satellite wind speed data
- Study the relationship between cloud top heights and near-surface wind speeds in tropical cyclones
- Create 3D visualizations using the HIVE (Highly-portable Immersive Virtual Environment)
- Inform the public of the dangers of hurricane-force winds and storm surge

STUDY AREA

A study area ranging from 20˚ N to 31˚ N latitude and from 79˚ W to 99˚ W longitude was selected to include all pertinent buoys in the Gulf of Mexico.

PROJECT PARTNERS

Center for Hurricane Intensity and Landfall Investigation

National Data Buoy Center

EARTH OBSERVATION SOURCES

Aqua

CloudSAT

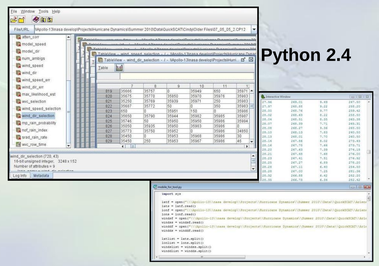
QuikSCAT

ABSTRACT

As tropical cyclones make landfall, most of the immediate structural damage is caused by strong winds. Instruments such as anemometers, thermometers, and barometers on buoys in the Gulf of Mexico provide real-time data as a storm approaches land. Unfortunately, these instruments occasionally fail in extreme weather conditions such as high wind velocities. In hurricane research, satellite data can be utilized alongside this data. Several satellite instruments monitor wind speed and direction. This project utilized the Advanced Microwave Scanning Radiometer-EOS (AMSR-E) aboard the NASA Aqua satellite and the SeaWinds instrument aboard the NASA QuikSCAT satellite to monitor wind speed and direction of select storms that tracked through the Gulf of Mexico between 2002 and 2009. Ancillary wind speed data was retrieved from the National Data Buoy Center (NDBC). Satellite and buoy data were compared to assess strengths and limitations of each data type. Cloud height data in six storms from 2006 to 2009 was obtained from the Cloud Profiling Radar (CPR) instrument aboard the NASA CloudSAT satellite. Correlation between cloud heights and wind speed was assessed. A methodology for satellite data acquisition, processing, and analysis was produced to be utilized by the Center for Hurricane Intensity and Landfall Investigation (CHILI) in future research. Wind vector maps and cloud height imagery were produced. Visualizations were also formatted for HIVE (Highly-portable Immersive Virtual Environment) viewing.

METHODOLOGY

HDF

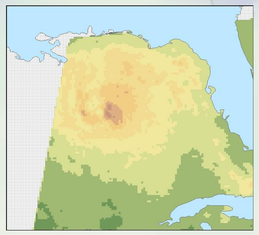


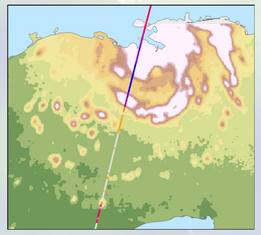
Python 2.4

QuikSCAT, AMSR-E, and CloudSAT data was downloaded in HDF format. From this individual tables were exported to text files. Text files were compiled into a single file using a script written in Python 2.4.

Python generated text files were imported into Excel for analysis. QuikSCAT and AMSR-E files were imported into ArcGIS and interpolated to create wind speed distribution maps.

When applicable, CloudSAT tracks were overlaid onto their respective AMSR-E wind speed distribution maps. Using the “Extract Values to Point” function, interpolated wind speed values were extracted along the CloudSAT track. This allowed for further analysis of the wind speed data and cloud top height data.





CONCLUSIONS

- QuikSCAT provides more accurate wind speed data than Aqua’s AMSR-E sensor. On average, QuikSCAT deviates from the buoy data by 2.80% and AMSR-E deviates by more than 100%.
- AMSR-E is useful when reporting wind speed data outside of tropical cyclone conditions. Under this condition, AMSR-E deviates from the buoy data by 12.46% on average.
- Strongest wind speeds correspond to the highest cloud top heights.
- A follow up mission to the QuikSCAT satellite is recommended.

TEAM MEMBERS

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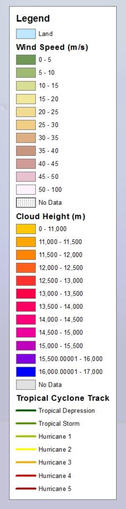
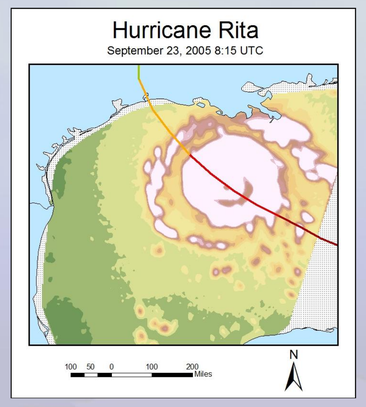
NATIONAL APPLICATION AREAS

Natural Disasters

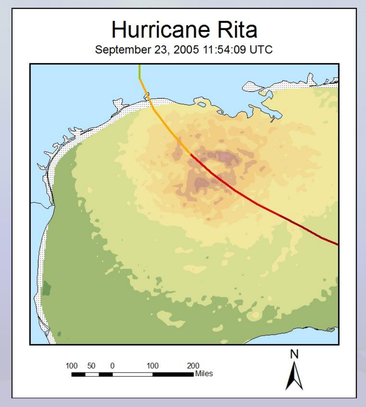
Weather

RESULTS

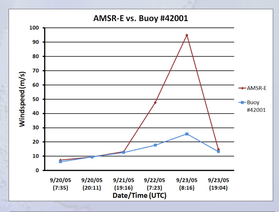


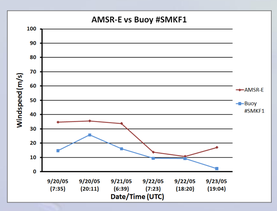


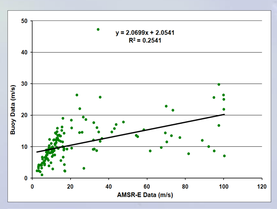
Interpolated Aqua AMSR-E wind speed data showing the wind field and wind speed distribution of Hurricane Rita

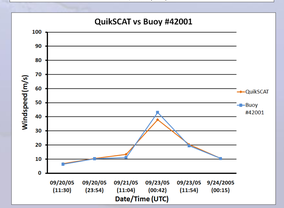


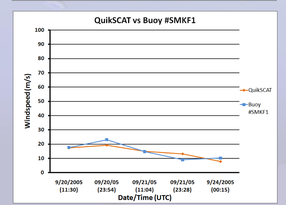
Interpolated QuikSCAT SeaWinds wind speed data showing the wind field and wind speed distribution of Hurricane Rita

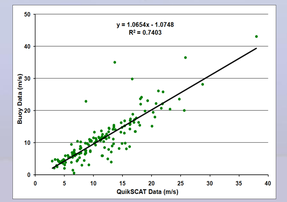




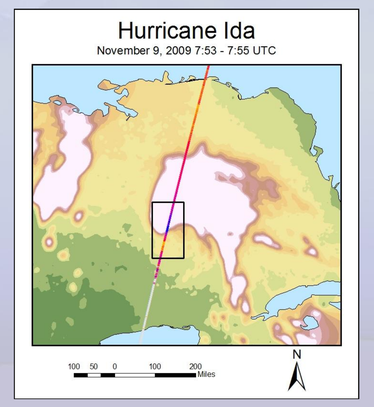


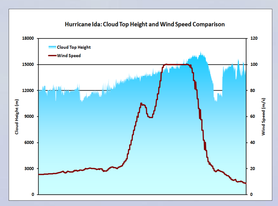


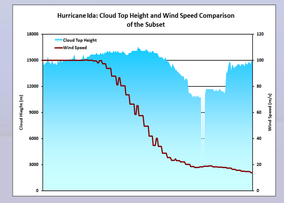




The line graphs compare AMSR-E and QuikSCAT wind speed data to the #42001 and #SMKF1 buoy wind speed data in Hurricane Rita. The scatter plots account for all AMSR-E and QuikSCAT data collected and compares it with the associated buoy readings. R^2 values indicate that QuikSCAT is a better indicator of wind speed than the AMSR-E sensor.







The map shows a CloudSAT track overlaid on top of its associated AMSR-E wind speed interpolation. The top graph displays wind speed and cloud height for the length of Hurricane Ida. The bottom graph displays a subset of the first graph.