



Post Storm Data Acquisition Aerial Wind Mapping Mission Hurricane Ivan - 2004



Overview

Hurricane Ivan made landfall during the early morning hours of 16 September 2004 near Gulf Shores, Alabama. Significant storm surge and resultant beach erosion were associated with Ivan's landfall. However, this portion of the Post Storm Data Acquisition (PSDA) will focus on the damage associated with Ivan's winds. Two aerial wind mapping missions were conducted in support of the PSDA with the primary focus being on areas nearer the center of Ivan. A secondary focus was on the numerous tornadoes, which were spawned both prior to, and after Ivan's landfall. Aerial photography was taken of the Panama City, Florida and Blountstown, Florida, tornadoes; however the affected NOAA National Weather Service (NWS) Forecast Offices will determine the final wind damage assessments associated with these tornadoes.

Flight Tactics and Mission Objectives

The inherent difficulties associated with using aerial photography to construct wind estimates over areas where Fujita Scale (F) 0 and low-end F1 damage occurs led to the mission objective of focusing on areas most likely to have received wind gusts at or above 100 mph.

The first flight of the PSDA mission was flown 18 September 2004 focusing on the coastal region and locations immediately inland from Mobile, Alabama to Pensacola, Florida. The second flight was flown 19 September 2004 focusing on the coastal region from Pensacola, Florida to Panama City, Florida. Additionally, the second flight successfully sought and photographed the tracks of tornadoes that affected Panama City, Florida and Blountstown, Florida.

The United States Air Force Auxillary Civil Air Patrol (CAP) provided the pilots and aircraft for both missions. An on-board meteorologist directed the flight path, and was also responsible for the video data collection. Digital video imagery was taken during both missions to maximize the area covered for later analysis.

Data Collection

Digital video imagery was the primary mode of data collection, with imagery obtained from altitudes of 1000 to 2000 feet above ground level. Concurrent with the video imagery, Global Positioning System (GPS) data was logged in a laptop computer. Times on the laptop and video camera were synchronized with that of the GPS receiver to facilitate the review of the position sensitive imagery.

Data collection during the first mission was hampered by poor GPS signal strength due to a lack of upward facing windows in the airplane. Additionally, issues with the external power supply with the aircraft limited laptop performance during both missions,

resulting in a lack of real-time detailed aircraft locations. A secondary GPS position logger was tested during both missions, and proved invaluable as it provided a secondary source of GPS locations and associated time stamps. This secondary source of position data allowed both flights to continue with successful data collection.

Data and Analysis

Digital imagery recorded during the PSDA missions was combined with the recorded GPS position and time data to perform a more detailed estimate of the winds associated with Ivan's landfall. Wind estimates were assigned using subjective estimation techniques associated with determining Fujita Scale damage ratings. Such techniques can be used to estimate peak wind values that are considered to be 3 to 5 second gusts. Wind estimates were calibrated from available surface observations where possible. However, observation density and instrument failure limited the degree of calibration within the region of strongest estimated winds.

Peak gust analysis from aerial surveys is limited by available knowledge of building construction quality, soil conditions, and vegetation characteristics. Additionally, Ivan's storm surge, and its associated damage, increased the uncertainty of the wind estimates along the coastline. Considering these uncertainties, the following wind analysis should be considered as only one input to a final wind analysis of Hurricane Ivan.

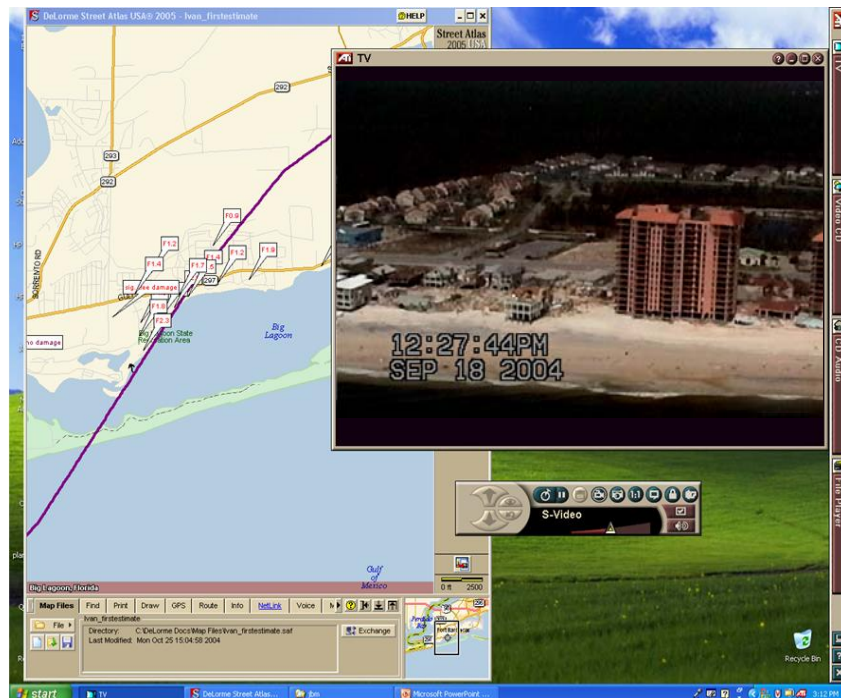


Figure 1: Display showing example analysis procedure of using time-stamped digital imagery to map F-scale damage.

Wind Analysis

The wind analysis from the two Hurricane Ivan PSDA aerial wind mapping missions suggests maximum wind gusts of 130 mph were present during Ivan's landfall (see Fig. 2). These winds were estimated to be located near the Big Lagoon State Recreation Area located in the extreme western Florida peninsula. Wind speeds in excess of 110 mph were estimated to extend from near Gulf Shores, Alabama to near Gulf Breeze, Florida. Appendix A provides a detailed mapped peak wind wind analysis. Noteworthy are the inherent uncertainties mentioned earlier which could yield wind estimates +/- 20 mph within each contoured value.

The location of strongest estimated winds was characterized by damage clearly related to winds, with portions of roofs well removed from the parent structure. The damage pattern as it related to the parent structure was used as the primary mode for determining between storm surge and wind related damage. The majority of damage noted along the immediate coastline outside the axis of strongest winds was deemed to be predominately surge related with imbedded wind damage signals.

Surface observations along with coordination from the NWS Forecast Offices in Mobile, Alabama, and Tallahassee, Florida, were the primary sources of input for the wind analysis outside of 100 mph. Timber damage estimates obtained from the Alabama Forestry Commission were also utilized to estimate wind speeds further inland. Finally, NWS Doppler Radar data in the vicinity of Ivan's landfall was investigated, but only after the initial wind estimates were made.



Figure 2: Broad scope of Hurricane Ivan's swath of maximum winds.

Appendix A: Hurricane Ivan Maximum Wind Gust Analysis



Hurricane Ivan Maximum Wind Gusts



Peak Gust Analysis

- 100 mph Derived from visual inspection of aerial video tape shot during PSDA missions. Speeds should be interpreted as 3 to 5 second gusts.
 - 110 mph
 - 120 mph
 - 130 mph
- Arrows represent apparent direction of peak winds.

LEGEND

- State
- County
- Lake/Pond/Ocean
- Expressway
- Highway
- Connector
- Stream
- Military Area
- National Park
- City
- County

Scale 1:456839

0 5 10 15 20 25 mi

0 5 10 15 20 25 km

*average--true scale depends on monitor resolution