

# **HURRICANE FRANCES CHARACTERISTICS and STORM TIDE EVALUATION**

(DRAFT)

**By**

**Robert Wang and Michael Manausa**

**Sponsored by**

**Florida Department of Environmental Protection,  
Bureau of Beaches and Coastal Systems**



**Submitted by**

**Beaches and Shores Resource Center  
Institute of Science and Public Affairs  
Florida State University**

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## I. Synoptic History

Hurricane Frances developed from a tropical wave from the coast of Africa on 21 August, 2004, and gradually became organized into a tropical depression near 0000UTC 25 August. Figure 1 illustrates the track of Hurricane Frances. The depression moved westward and intensified, becoming a tropical storm later on 25 August. Frances turned west-northwestward on 26 August as it became a hurricane with winds near 80 mph. Frances reached a first peak intensity estimated of 132 mph on 28 August, located 690 miles east of the Leeward Islands and moving northwest at a speed near 9 mph. Frances reached a second peak intensity of 144 mph (Category 4) late on 31 August as it passed north of the Leeward and Virgin Islands.

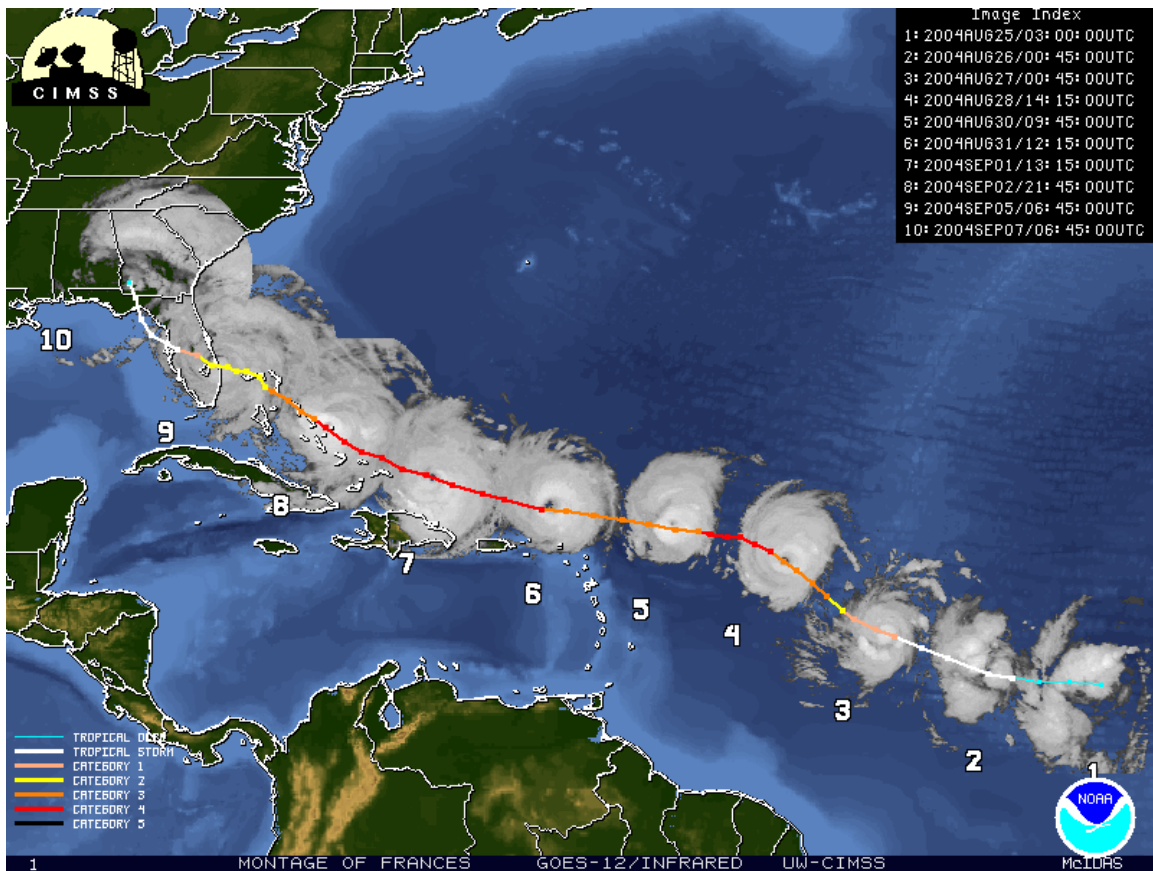


Figure 1. Hurricane Frances Track, 21 August – 6 September 2004.  
(Source: CIMSS, UW-Madison)

On 1 September, Hurricane Frances passed through the Turks and Caicos Islands and advanced into the Bahamas with maximum winds near 140 mph. Frances weakened for the next two days as it passed over the central Bahama Islands on 2-3 September with winds of 115 – 125 mph (Category 3). It weakens to a Category 2 hurricane with winds of 98 - 104 mph when it passed over the northwestern Bahamas on 3 - 4 September. Frances made landfall over the southern end of Hutchinson Island, Florida at 0430 UTC, 5 September, as a Category 2 hurricane with winds of 104 mph (Figures 2 and 3).



Figure 2. Hurricane Frances Track Passing over the Florida Coast.

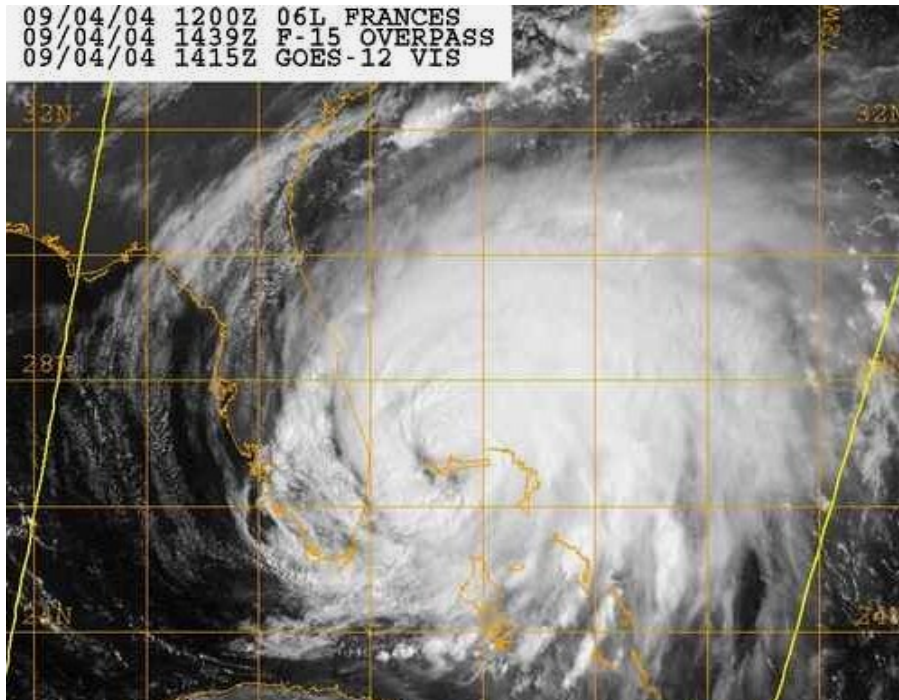


Figure 3. Eye of Hurricane Frances before Landfall (Source: Naval Research Laboratory).

Frances gradually weakened as it slowly moved west-northwestward across the Florida Peninsula, becoming a tropical storm just before emerging into the northeastern Gulf of Mexico near New Port Richey early on 6 September. Frances did not strengthen over the Gulf, with maximum sustained winds remaining at 58 – 63 mph with a pressure near 982 mb. It moved northwestward and made a final landfall east of the St. Marks River at 1800 UTC, 6 September (Beven II, 2004).

The winds of Frances during landfall are presented in the wind swath map show in Figure 4. The data was prepared and provided by the Hurricane Research Division (HRD) at the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the National Oceanographic and Atmospheric Administration. The graph given in Figure 5 depicts the best track central barometric pressure and wind speed history for Frances based on data obtained from Tropical Cyclone Report of Hurricane Frances, National Hurricane Center (Beven II, 2004). Wind speed dropped and central pressure rose dramatically right after landfall.

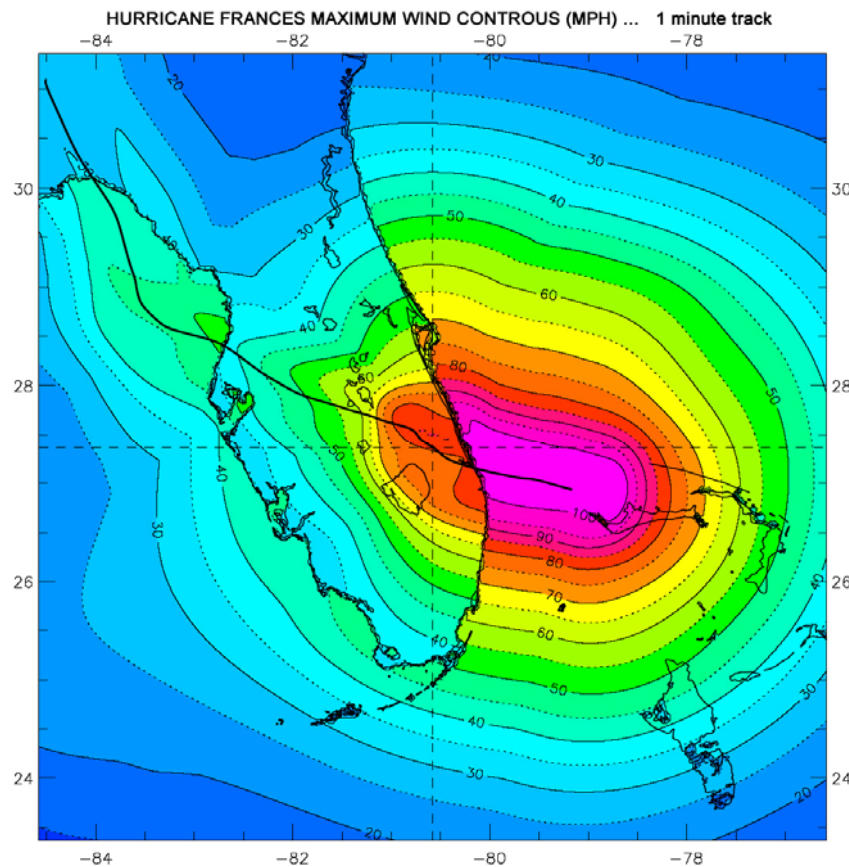


Figure 4. Surface Wind Fields Associated with Hurricane Frances at Landfall.

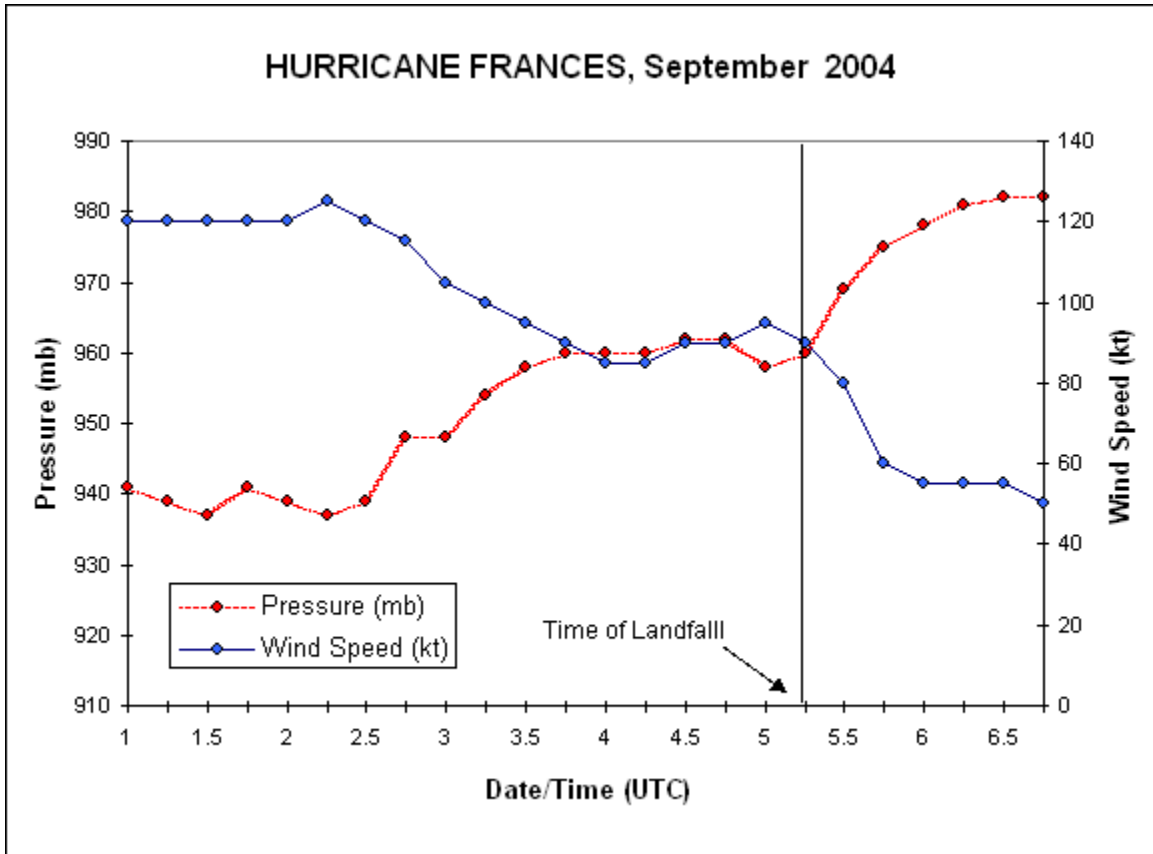


Figure 5. Best Track Pressure and Wind Speed for Hurricane Frances, 1 - 6 September, 2004.

## II. Storm Tide Records

Hurricane Frances was the second of four hurricanes to hit the State of Florida during the 2004 season, just 3 weeks after Hurricane Charley made landfall in Lee County. Frances moved slowly at 5 – 6 mph and before landfall carried a large Radius to the Maximum Wind (RMW) of approximately 35 miles. The storm tide caused by Hurricane Frances as a Category 2 hurricane reached a wide area which included St. Lucie, Indian River and Brevard counties.

URS Group, Inc. was contracted by the Federal Emergency Management Agency (FEMA) to collect and survey Coastal High Water Marks (CHWMs) in the Frances Impacted areas. A total of 21 CHWMs were surveyed in the study areas which include St. Lucie (4), Indian River (11) and Brevard (6) counties (FEMA, 2005).

The NOAA tide gauge at Trident Pier was in operation during the time of the hurricane. The Peak Elevation was measured at 5.2 feet above NGVD.

For the purpose of this report, only the interior High Water Mark (HWM) data from beach areas or flooded areas with wave setup were selected to evaluate the storm tide associated with Hurricane Frances. Only one inside HWM data observation is available from FEMA's report located at Sebastian and Indian River counties. There was a mud line marked on an inside wall which measured 6.0 feet above NGVD.

### **III. Storm Tide Evaluation**

Since there is only one interior HWM data available on the bay side at the present time for Hurricane Frances, it is not possible to generate a trend line of the storm tide distribution. It is, however, possible to predict that Indian River County and nearby areas received the worst impact by maximum wind and associated storm surge from its track and the RMW, which was estimated as 35 miles (Bean II, 2005).

To provide the un-surveyed area with the predicted storm tides, the 2-D Storm Surge Model of BSRC was employed to calculate the total storm tide, i.e. surge generated from barometric pressure and wind stress plus dynamic wave setup and astronomical tide. The 2-D grid systems and associated hydrological data of St. Lucie, Indian River and Brevard counties from the CCCL study were used to cover the study area. Hurricane track, pressure deficit and RMW of Frances for the 36 hours before and 12 hours after landfall were input to the 2-D Storm Surge Model. The model calculated the total storm tide for 13 locations in the study area. Figures 6 to 9 display the results of the model calculated total storm tides and the surveyed HWM data.



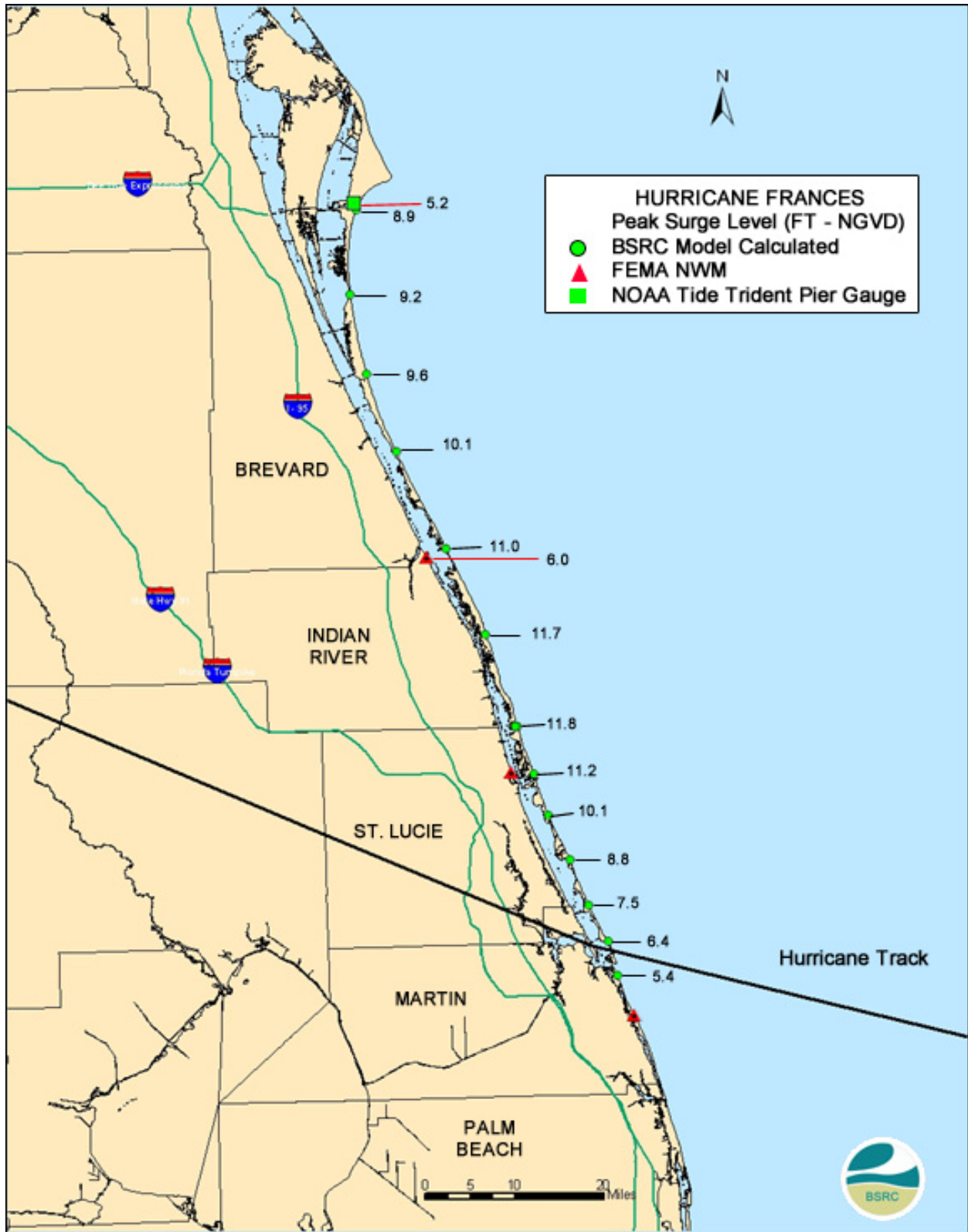


Figure 6. Peak Surge Levels along the Atlantic coast for Hurricane Frances.

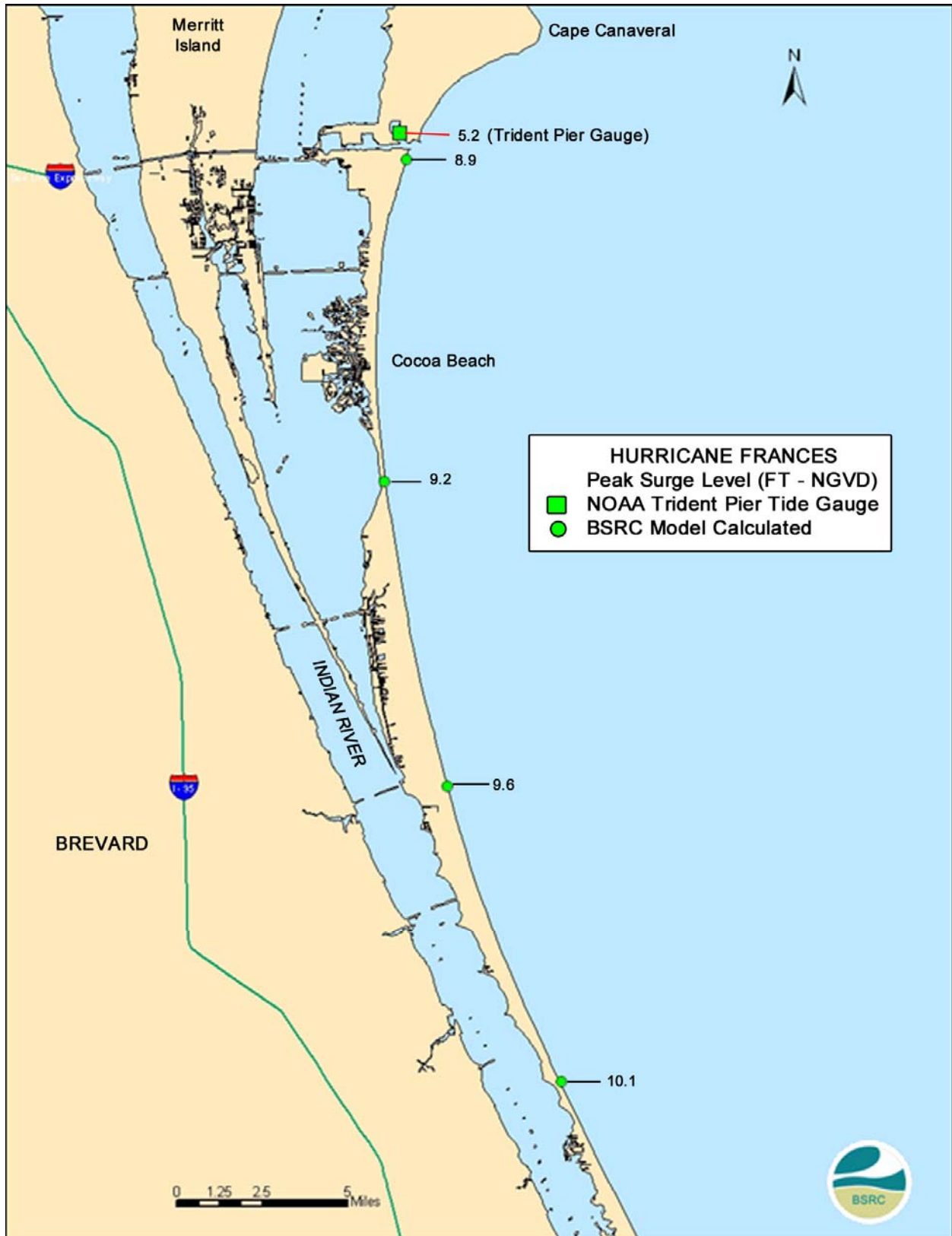


Figure 7. Peak Surge Level in the Brevard County area for Hurricane Frances.

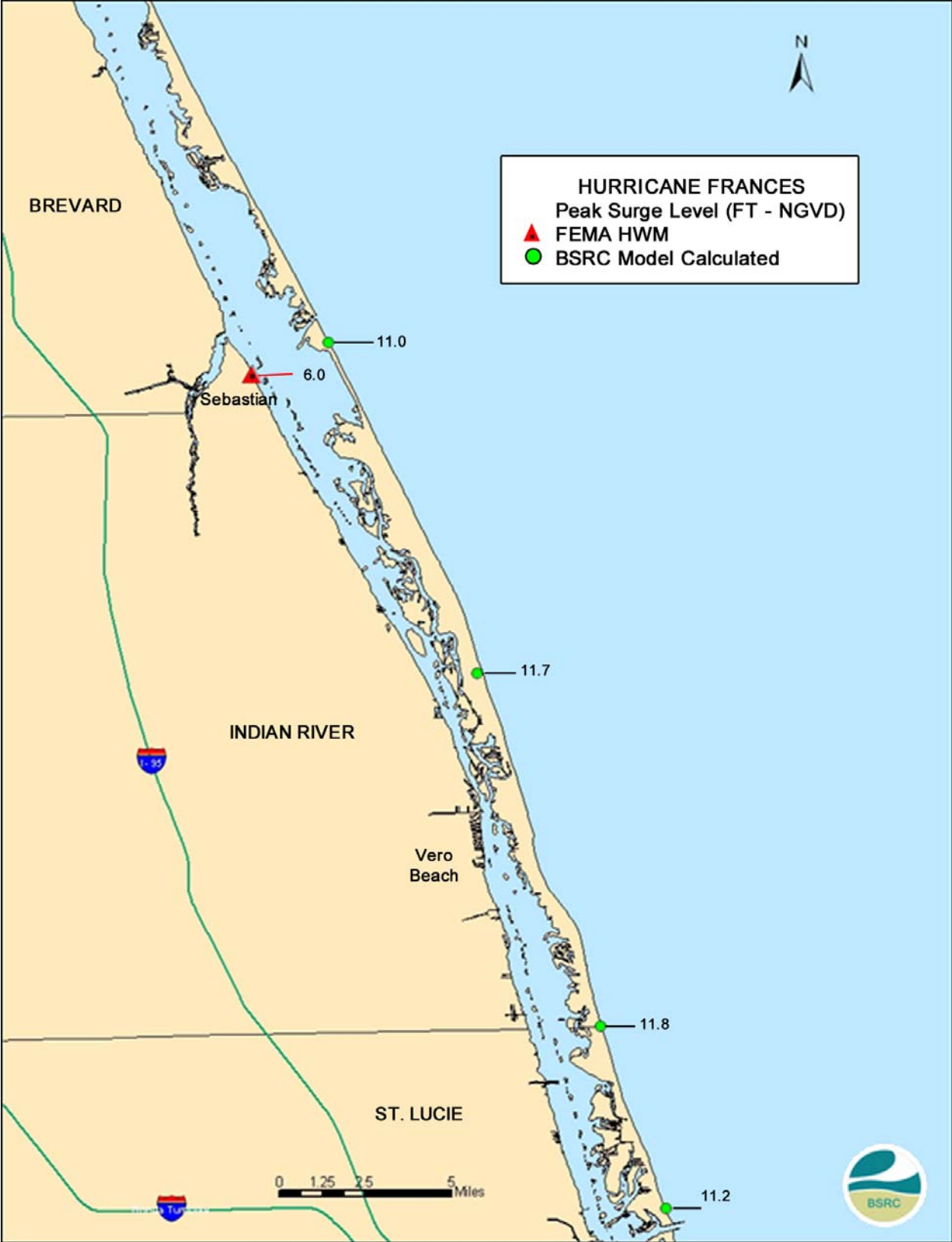


Figure 8. Peak Surge Levels in the Indian River County areas for Hurricane Frances.

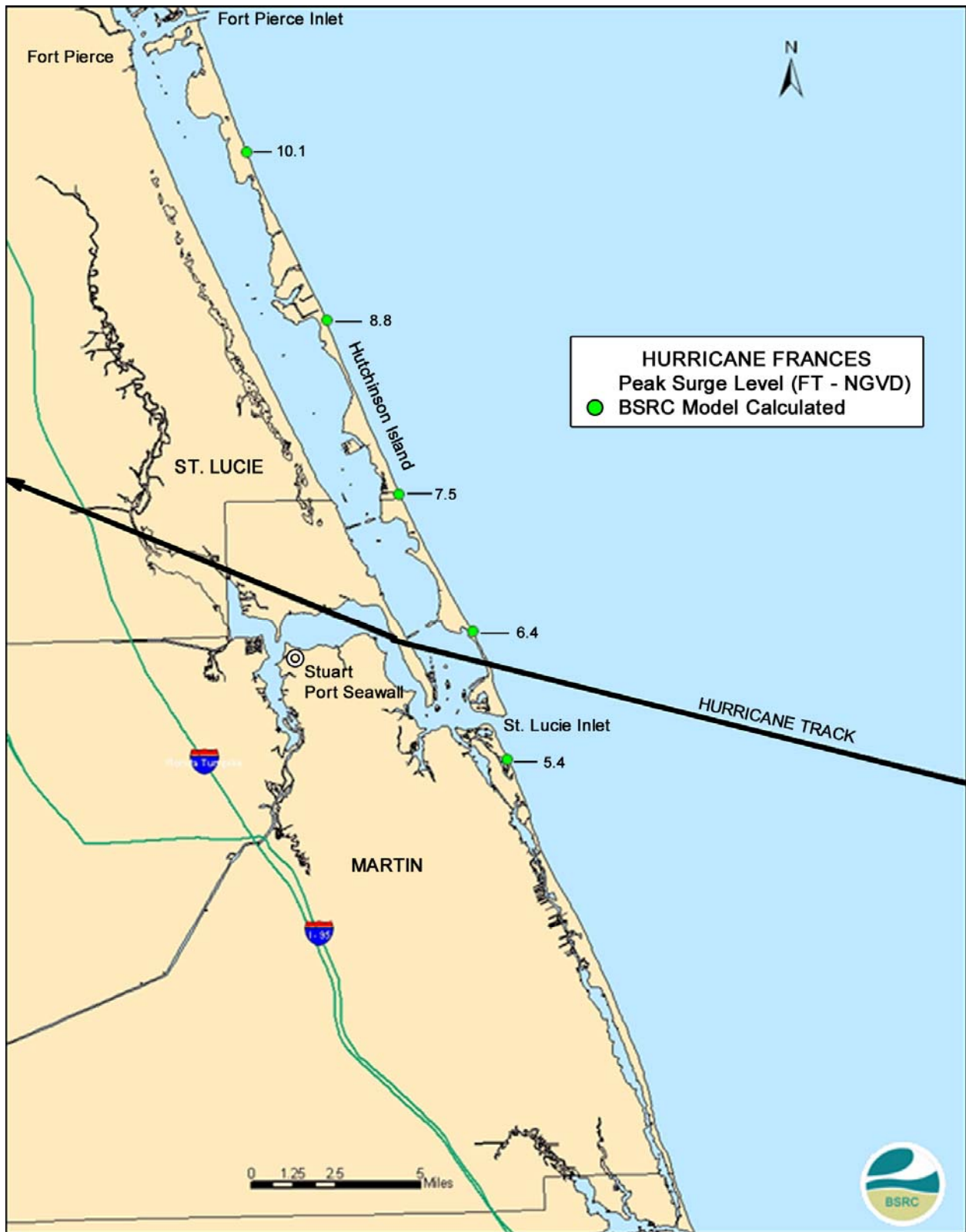


Figure 9. Peak Surge Level in the Hurricane Frances landfall areas.

#### IV. Storm Tide Return Period

The total tide values for various return periods in the CCCL study for St. Lucie, Indian River and Brevard counties were used to provide a storm tide return period for the BSRC model calculated storm tide during Hurricane Frances.

A total of 27 storm tides in 9 profile transact lines from the CCCL studies for St. Lucie, Indian River and Brevard counties were selected to generate return periods of 20, 50 and 100 years. Figure 10 depicts a comparison between the calculated storm tide for Frances and the CCCL's total storm tide for various return periods. It shows that the BSRC model predicted that Hurricane Frances would have generated a storm tide ranging between 20 and 100 years return period for most of the study area. In Indian River County, storm tide was calculated as 11.0 to 11.8 feet above NGVD and was consistent with the 100 years return period. The predicted storm tides return period gradually reduced from 100 years at Indian River County's northern boundary to 20 to 50 years at Brevard County's northern profile. The storm tide return period dropped quickly from 100 years at the Indian River County's southern boundary to below 20 years at St. Lucie County's southern boundary.

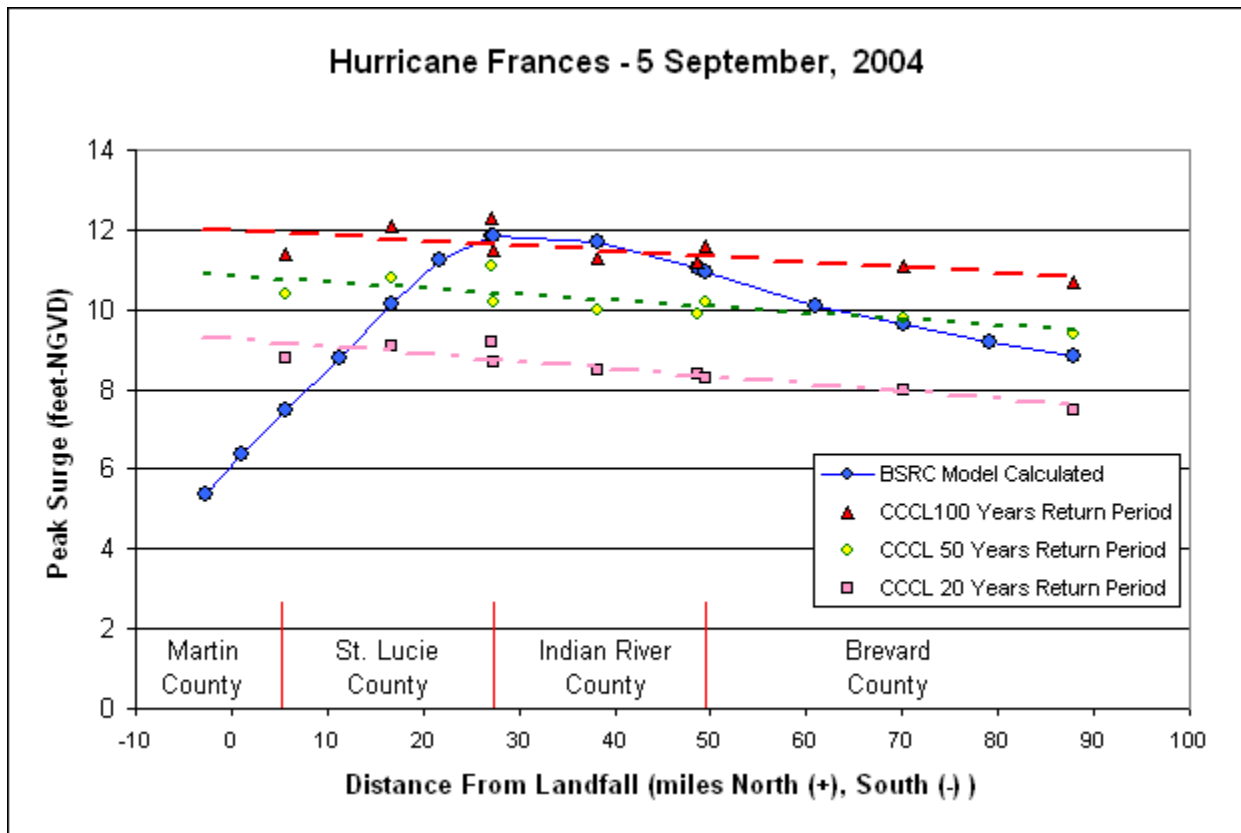


Figure 10. Hurricane Frances Storm Tide Return Period.

## **V. Reference**

Beven II, J. L., "Tropical Cyclone Report, Hurricane Frances, 25 August - 8 September, 2004", Tropical Prediction Center, National Hurricane Center, December 2004.

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FEMA, "Hurricane Frances Rapid Response, Florida Coastal High Water Mark (CHWM) Collection, Task Order 326, Final Report", FEMA-1539-DR\_FL, November 2004.