# *EFFECTS OF CLIMATOLOGICAL DISTURBANCES ON THE SEA SURFACE TEMPERATURE IN THE GULF OF MEXICO*

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# ABSTRACT

The Advanced Very High Resolution Radiometer (AVHRR) is extensively used to measure Sea Surface Temperature (SST) for different regions in the world. SSTs profiles were developed with the use of the AVHRR for the Gulf of Mexico before, during and after Hurricane Brett's occurrence on September 18 and 19, 1999. Twelve (12) images were initially obtained from NOAA's satellite No. 12 at different occasions during Hurricane Brett's track along the Gulf. Three (3) images were finally selected based on locations, time of day and presence of clouds. The poor SST data obtained was largely due to the characteristic hurricane clouds accumulation which significantly limits its use for study purposes. However, SST spectral profiles may be developed at contiguous marine regions adjacent to the hurricane to assess potential threats to near land locations. Additional research is needed in developing advanced thermal radiation sensors operating without the clouds barriers to adequately assess the hurricane's effects.

# INTRODUCTION

The use of satellite sensors to measure sea surface temperature (SST) represents a major accomplishment in the study of the effects of climate disturbances over the marine ecosystems. Such remote sensing instrumentation can measure marine thermal variations, oceanic thermodynamic properties (Gentemann, Smith & Wentz, 2001), costal impacts (Gilbes, Armstrong, Webb & Müller, 2001) and the effects on the marine living organisms (Sumner, et al., 2002) as a result of the storm. AVHRR image data is readily available at the University of Puerto Rico in Mayaguez ground satellite antenna station. The images availability encompasses selections of the last 5 to 6 years obtained from the NOAA's (National Oceanic and Atmospheric Administration) AVHRR, and NASA's (National Aeronautic and Space Administration) SeaWifS (Sea-viewing Wide Field-of-view Sensor) installed at satellites in orbit. Although the spatial resolution provided by the AVHRR sensor is capable of defining high precision images, the presence of clouds greatly hampers the sensor's ability for adequate SST measurement (Sumner, Michael, Bradshaw, and Hindell, 2003). Several authors have explored the use of algorithms to define SST profiles at distinct time periods. Difficulties have also been reported in defining accurate image definition due to high clouds covering the satellite's view (Gentemann, et al., 1999).

# HURRICANE BRETT

Several storms were analyzed as candidates for study and rejected since they spent the majority of time over land. Hurricane Brett, was one of the strongest storms impacting the Gulf of Mexico during 1999. The storm was formed on Campeche bay and hit the city of Corpus Christi and Brownsville in Texas with sustained winds of approximately 140 miles per hour, causing several casualties due to flash flooding and storm surges. On September 18, 1999 the eye of hurricane Brett was located at open sea very near the coast of Texas where the AVHRR sensor obtained the referred images. The storm winds sustained by Brett classified it as a Class 4 hurricane in the Saffir-Simpson scale. The most destructive part of a hurricane is usually the storm surge. The surge effect is due to the winds of the hurricane pushing up a "dome" of water in front of the hurricane. As this surge of water hits the coastal area tides may be several tens of feet higher than normal. This wall of water works its way up rivers to cause damage far inland. The rise in water level happens at the same time as the heavy rains associated with hurricanes. The fall of ten inches or more of rain during the hurricane is not unusual. The tidal surge and the rainfall combine to cause flooding. The damage caused by the flooding of property is the largest cost to property owners due to hurricanes. Wind damages bring about the second highest cost, due to the physical power of the

hurricane. The costs due to the hurricane just start with the physical damage caused by the hurricane. Attempts to obtain accurate SST data from the storm's upwelling region were unsuccessful since the images obtained by the satellite could not provide a clear view of such zone at any of the locations evaluated.

## AVHRR PROPERTIES

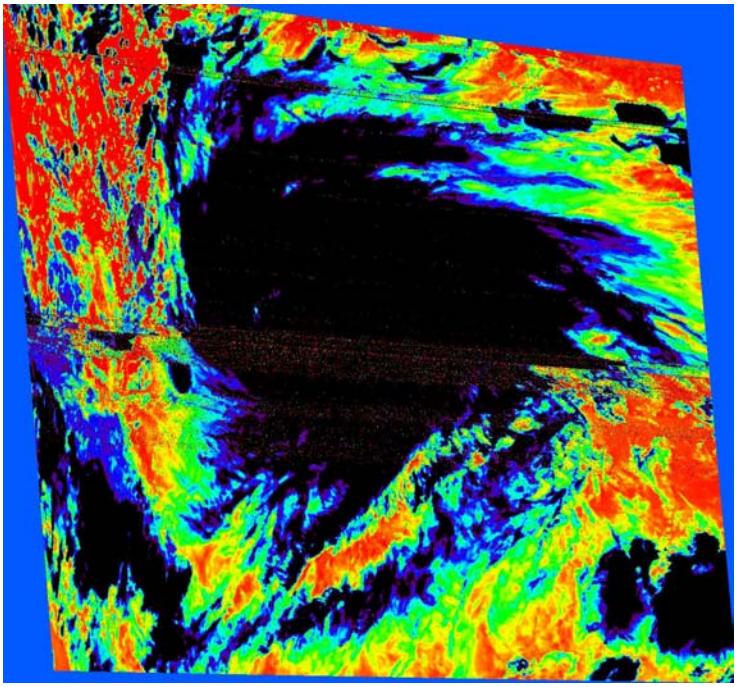
The AVHRR operates on 5 bands of the color spectra at wavelengths ranging from Operates with 5 spectral bands at wavelengths ranging from 0.58 to 12.5 $\mu$m. installed at the TIROS and NOAA series satellites. Others have obtained data from different related sensors, like the MCSST (Multi Channel Sea Surface Temperature (Sumner, Michael, Bradshaw & Hindell, 2003) for the study of marine living organisms. Our data was evaluated with the ENVI 3.5, AVHRR SST algorithm. Such sensor operates at the red, reflected infrared and infrared bands for both daytime and night-time measurements. The AVHRR has an image spatial resolution of 1-meter. While the high precision provided by the sensor is vital in obtaining accurate SST data, the information offered after the analyses reflected inconsistent results due to the clouds coverings dominating most of the studied regions. No manual corrections or calibrations were performed during the images processing,

and all but the upper portion of the September 18, 1999 image were geo-referenced.

# SST SPECTRAL PROFILE- HURRICANE

# BRETT'S EYE

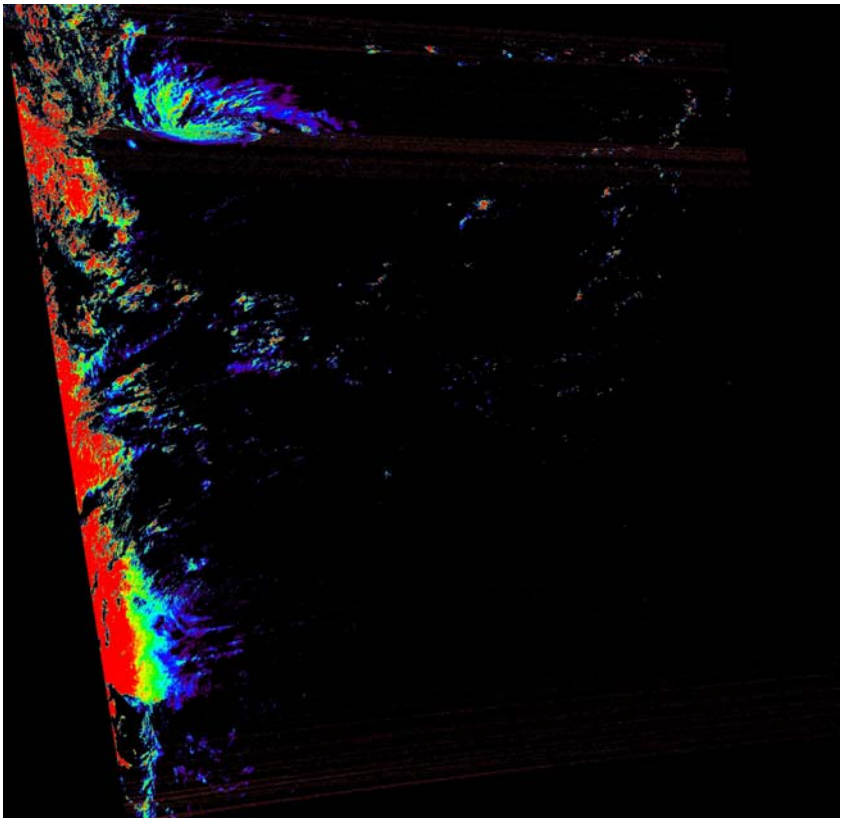
## September 18, 1999-3: 52 PM



| | |
|---|---|
| 0-160 | 260-320 |
| 160-210 | 320-390 |
| 210-260 | |

# HURRICANE BRETT-

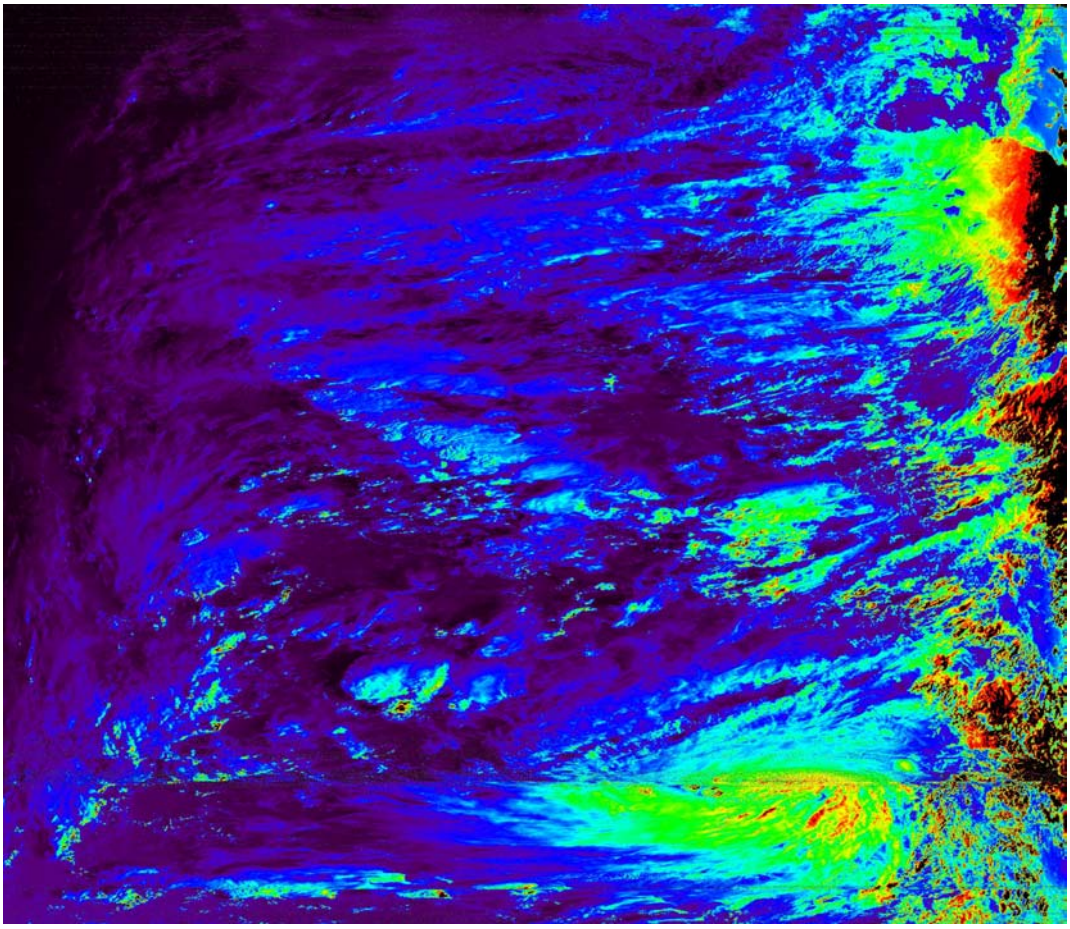
# SEPTEMBER 19, 1999-6:51PM



| | | | |
|---|---|---|---|
| | 0-160 | | 260-320 |
| | 160-210 | | 320-390 |
| | 210-260 | | |

# HURRICANE BRETT

## SEPTEMBER 19, 1999- 3:52PM



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| 0-160 | 260-320 |
| 160-210 | 320-390 |
| 210-260 | |

# CONCLUSIONS

(1) The above paper illustrated the effects of Hurricane Brett over the SST through the use of remote sensing. Accurate spectral profiles can be derived from the satellite images which may be used to assess possible adverse impacts to land and marine regions caused by the climate disturbance.

(2) Sufficient additional information must be available based on the oceanic thermodynamic properties and the storm's characteristics before a definite forecast is reached on any related impact.

(3) Images obtained with less cloud coverings are required to delineate a uniform SST profile over the evaluated area. While the results were inconclusive, spectral profiles can be anyway defined to identify possible stronger winds, or ocean upwelling locations.

(4) Increasingly higher temperature results are clearly defined nearer to the hurricane's eye reflecting a possible relation between the winds strength, storm's convection currents and the SST.

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Gentemann, C., Smith, D. and Wentz, F., Microwave SST Correlation with Cyclone Intensity, *Remote Sensing Systems,* 1A.4-5, 1999.