P5.7 A STUDY OF AIR-SEA INTERACTIONS, HURRICANE PREDICTIVE INDEX, AND ASSOCIATED TROPICAL STORM BARRY OVER THE GULF OF MEXICO

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1. Introduction

Previous studies by Reddy (1) have indicated a strong ocean-atmospheric coupling during the formation and development of the tropical cyclone/hurricane activity over the Gulf of Mexico. We extended these investigations to the Tropical Storm Barry, which occurred and developed during August 1-6, 2001 in the Gulf of Mexico. NOAA GOES Satellite images (Figure 1), NDBC Buoy Data, and the Preliminary Reports from the NOAA National Hurricane Center for sea surface temperature and meteorological variables including air temperature, wind speed, and sea level pressure were used for computations. We computed heat, momentum, and moisture fluxes and the Hurricane Predictive Index for prediction of the formation and development of Tropical Storm Barry.

Figure 1: Tropical Storm Barry

Ocean-atmospheric interactions are very important in the formation and development of tropical storms/hurricanes. These interactions
are dominant in exchanging heat, momentum, and moisture fluxes. Heat flux is computed using a bulk equation. In this equation air-sea interface supplies heat energy to the atmosphere and to the storm. The more heat exchange, the more evaporation and the more intensity of the storm. Therefore, the latent heat energy is the prime source for maintaining the storm.

2. Methodology

1. The computations for heat (H), momentum (τ), and moisture (E) fluxes are given below:

$$H=\rho C_p C_H (T_s-T_a) u_a \quad (1)$$

$$E = \rho C_E (q_s-q_a) u_a \quad (2)$$

$$\tau = \rho C_D u_a^2 \quad (3)$$

Where ρ is density, q is specific humidity, u is wind speed, C_H, C_D, and C_E are drag co-efficients, and C_P is specific heat.

2. HPI is used to predict the formation and development of hurricanes over the Gulf of Mexico. When the calculated value is the least, the environment is most unstable and the environment is more vulnerable to storm conditions. Thus, the HPI can be used to predict intense storms and hurricanes. If the HPI value is –

15, the current storm will most likely produce a hurricane in the next two or three days. If the value suddenly drops, but not necessarily to –15, the current conditions may form at least a tropical storm.

The equation for the HPI is

$$\frac{1H\{(dT/dz)(dp/p_o)\}\{\frac{1}{2}(u)^2\}}{S^2Ts\{(du/dz)^2\}}$$

Where,

H = Scale Height, $H = RT / g_o$

R = Gas constant, 287J / kg / K

T = Layer Mean Temperature $(T_s-T_a) / 2K$

T_s = Sea Surface Temperature °C)

T_a = Air Temperature (°C)

S = Surface Layer Height, 10m

dT = Air-Sea Interface, T_s-T_a

dz = change in Height (approximated to 1m)

dp = Pressure tendency (mb);

$dp = \{p_{central} - p_\infty\}$

$p_{central}$ = central pressure

p_∞ = 1013 mb

p = Sea Level Pressure, 1000 mb

u = Wind Speed (m/s)

du = Change in wind speed (Approximated to 1 m/s)

g = Acceleration due to Gravity (9.8 m/s)

3. Results

The results of the study are given below. The values computed for heat, moisture, and momentum fluxes and for the HPI are given in Figures 2-5.

i. The maximum sea surface temperature observed was 29°C.

ii. An oscillation period of 3-5 days was observed in heat flux, moisture flux, and momentum flux during July 28-August 10, 2001, the time period of Tropical Storm Barry.

iii. The maximum heat flux, moisture flux, and momentum flux results were observed on August 5, 2001.

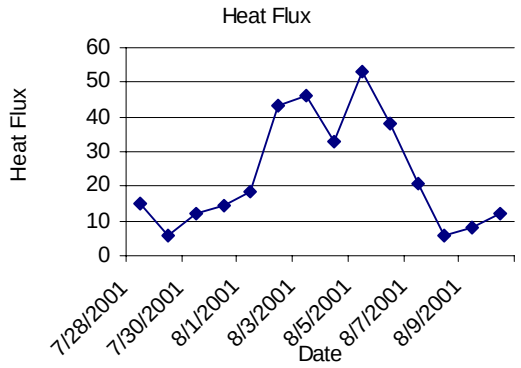

Figure 2: Heat Flux (watts / m²)

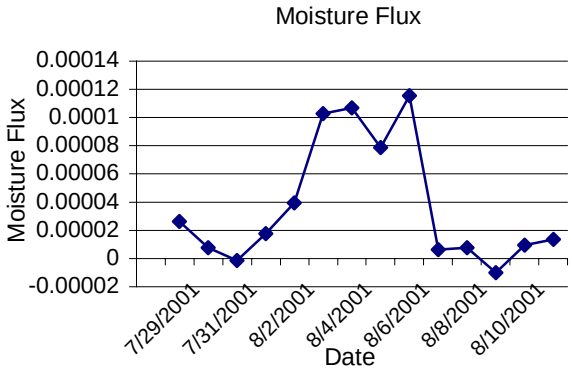

Figure 3: Moisture Flux (watts / m²)

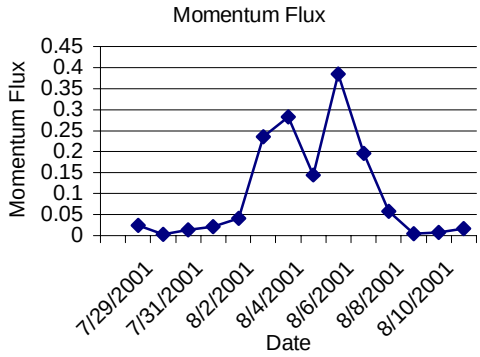

Figure 4: Momentum Flux (watts / m²)

iv. The HPI began to drop on August 3, 2001, thus predicting an intense storm in the next few days. Tropical Storm Barry occurred on August 5, 2001, thus the HPI was correct in predicting the growth of intensity in the current storm.

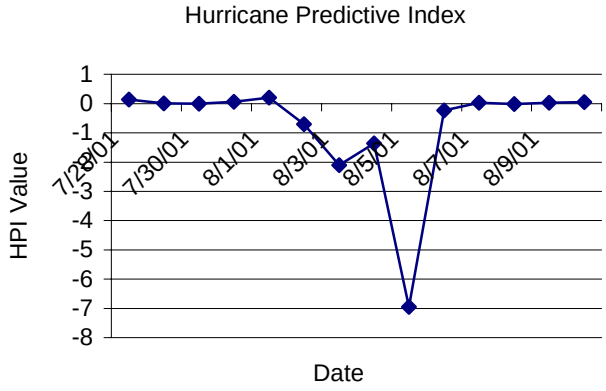

Figure 5: Hurricane Predictive Index

4. Conclusion

The results of this study determine that there is a strong correlation between air-sea interactions and the probability of tropical cyclones/hurricanes. These results show that observing surface fluxes while observing the value of the Hurricane Predictive Index will allow individuals to forecast tropical storms/ hurricanes in The Gulf of Mexico. These results will be tested with modeling efforts using Penn State/NCAR Mesoscale Model (MM5) (2).

5. Acknowledgements

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6. References

1. Previous studies (Reddy et. al, 1999 and Loren and Reddy, 2001)
2. Simulation of Hurricane Gordon Surface Fluxes with a Mesoscale Model (Jamese Sims, 2002)