Mesoscale Modeling Investigation of Air-Sea Interaction over the Gulf of Mexico for a Case Study of Hurricane Gordon

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Abstract

The NCAR/Penn State Mesoscale Model (MM5) is used to study the role of warm sea surface temperature anomalies and surface fluxes including heat, momentum, and latent heat may play in the hurricane intensification of Gordon, which formed during September 14-18, 2000. Mesoscale model simulations are used for forecasting and to receive better understanding of the formation and development of hurricane activity. The components used for simulations by the mesoscale model are TERRAIN, REGRID, RAWINS, INTERPF, Program MM5, and GRAPH. Each component is modified to accommodate the detailed study of Hurricane Gordon as it traveled across the Gulf of Mexico. The model is run on a doubly nested domain centered over the central Gulf of Mexico, with grid spacing of 90 km and 30km. MM5 is run for 12 hr periods, from the initial storm development on September 17th through landfall on the Florida Coast on September 18th. Model simulations will be compared with the satellite and buoy observations along with other buoy data.

1.Introduction

Air-sea interactions including heat, momentum and moisture fluxes play a vital role in the formation and intensification of the hurricanes/tropical cyclones (Reddy et.al., 1999). Hurricane Gordon was category 2 storm that formed in the eastern Gulf of Mexico, reaching hurricane status at 1200Z on 17 September 2000. While over an area of extremely warm water (28.8° C), it rapidly intensified attaining maximum wind speeds 13.5 m/s. The role of surface fluxes in feeding the storm dynamics during rapid intensification can most readily be examined by analysis of the mesoscale modeling. Hence we are using the Penn State/NCAR MM5 modeling version 3 modeling system for diagnostic studies of the surface fluxes (sensible heat, momentum, and latent heat) relevant to the air–sea interactions in the vicinity of the intense hurricane. (Loren and Reddy, 2001)

2. History of Hurricane Gordon

On September 15th The Air Force Reserve indicated that the previously discovered tropical depression had moved off the north coast of the Yucatan to The Gulf of Mexico. With the discovery of vertical alignment in mid-level circulations, the tropical depression became Tropical Storm Gordon on September 16th. As Tropical Storm Gordon strengthened and moved across The Gulf towards Florida, it became Hurricane Gordon on September 17th. Gordon reached its peak later on September 17th before weakening to a tropical storm within a few hours then making landfall near Cedar Key, Florida. As Gordon continued to weaken, it became a tropical depression later on this same day and eventually ended the cycle.

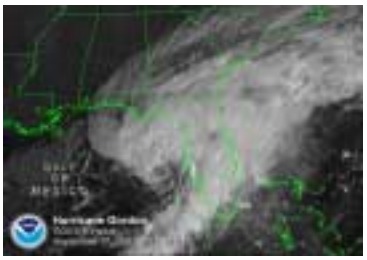

Figure 1 Hurricane Gordon, September 17, 2000

3. Overview of Mesoscale Model

MM5 numerical model originated at Penn State/NCAR in the early 70's. Mesoscale Model version 3 consists of several modules performing various tasks. MM5 (version 3) can be used for a broad spectrum of theoretical and real-time studies, including applications of both predictive simulation and four-dimensional data assimilation to monsoons, hurricanes, and cyclones. The MM5 model consists of five modules: TERRAIN, REGRID, LITTLE_R/RAWINS, INTERPF, MM5, and GRAPH. In this model, the objective module LITTLE_R has been used instead of RAWINS. In its configuration, the model consists of two domains with horizontal resolution of grid 90km and 30km.

This capability makes MM5 an excellent research tool in many areas of atmospheric sciences. In this case, the model is applied to sea breeze circulation over the Central Gulf Coast region.

4. Modeling Frame Work

Our MM5 configuration features two nested domains over The Gulf of Mexico, with horizontal grid spacing of 90km and 30km. Nesting between the grids is two-way. Physics options selected include: non-hydrostatic; Grell cumulus parameterization on 90km grid; modified Mellor-Yamada boundary layer parameterization; and a cloud resolving radiation scheme. Gridded analyses from NCAR are used to construct initial and boundary condition files. Simulations will be done covering the period from 00Z September 17th to September 18th, 2000.

5. Results

The results of the study are shown in Figures 2-5 and the discussions are presented below:

1. The sea-surface temperature was high at about 28.8 °C during formation of hurricane Gordon**.**
2. Relative Humidity was 98% along the track of the storm.
3. MM5 produced simulations of hurricane Gordon at 1200Z on September 17, 2000 with central pressure of 988 mb and wind speed of 13.5 m/s.

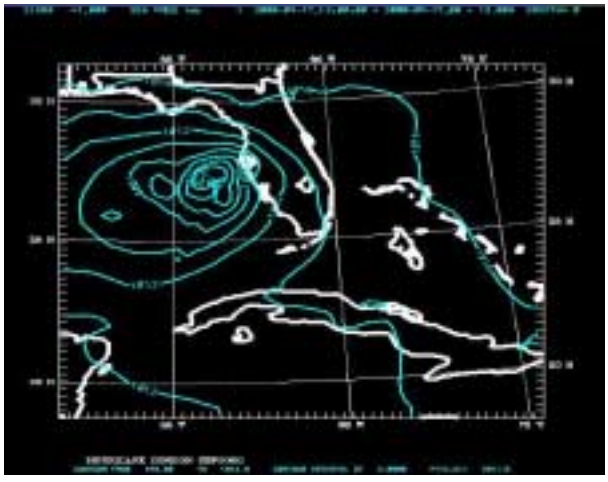

Figure 2: Surface Central Pressure (mb) at 1200Z

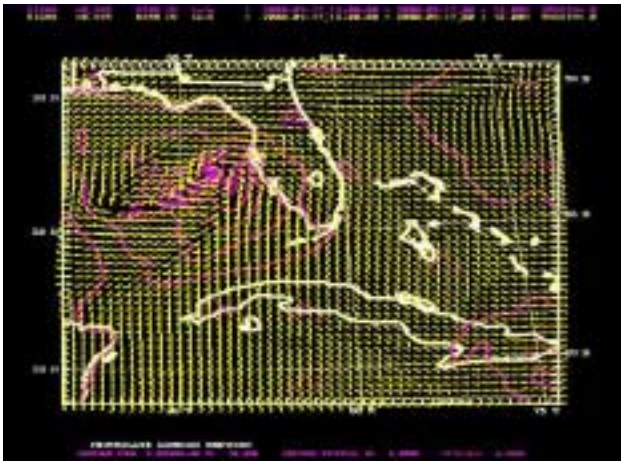

Figure 3: Surface Wind Speeds (m/s) at 1200Z

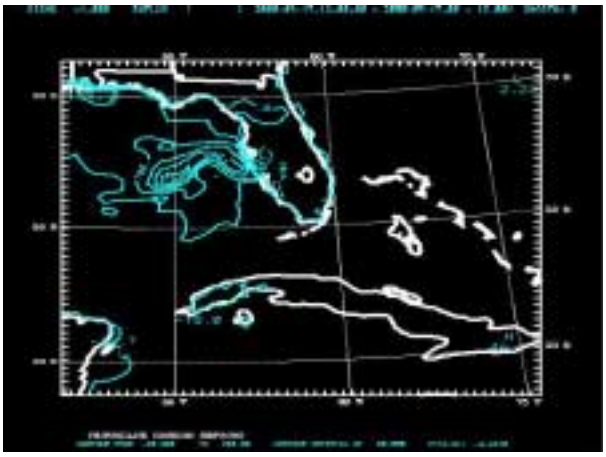

Figure 4: Surface Heat Flux (W/m^2) at 1200Z

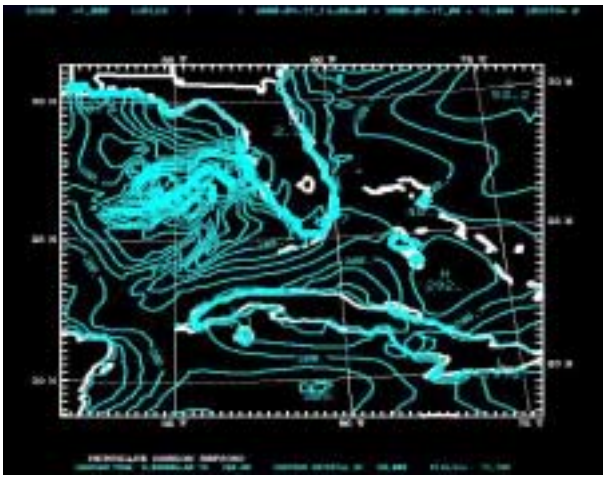

Figure 5: Surface Latent Heat Flux (W/m^2) at 1200Z

4. Surface heat fluxes were at a maximum of 200 watts per meter squared at the southwest and southeast sectors of the storm.
5. Latent heat fluxes were extremely high along the line of the storm.

6. Acknowledgments

The authors gratefully acknowledge support from the NASA/FAR Program Grant –NAS13 –99012. The author would like to thank Ms. Jamese Simms, Ms. Praveena Remata, and Mr. Alexander Schwartz for preparing this manuscript.

7. References

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