JP3.9 SIMULATIONS OF THE SOUTHEAST LOUISIANA AND SOUTHERN MISSISSIPPI 0FLOOD OF MAY 8-10th, 1995 WITH A PENN STATE/NCAR MESOSCALE MODEL (MM5) AND GIS/RS TECHNOLOGY

Suseela Reddy Remata*, Mallikharjun V Vatti[1], Paulinus Chigbu[2], Paul Croft[3]
[1]Department of Computer Science, Jackson State University, Jackson, MS 39217
[2]Department of Biology, P.O.Box 18540, Jackson State University, Jackson, MS 39217
[3]Department of Geosciences, University of Louisiana, Monroe

Abstract *- The NCAR/Penn State Mesoscale model (MM5) is used to study the effects of warm sea surface temperature anomalies, sea surface pressures and winds on the precipitation characteristics of "The Historic Southeast Louisiana and Southern Mississippi flood activity during May 8-10th, 1995". Mesoscale model simulations are used for forecasting and to perceive better understanding of the physics associated with the flood event. Each component is modified to accommodate the detailed study of the flood event. For the preliminary model run, a doubly nested domain centered over the Central Gulf of Mexico with grid spacing of 90 km and 30 km is employed. MM5 is run for every 6 hr periods, from the initial storm development - May 8th and through May 10th. NCEP/NCAR reanalysis data is used for constructing the initial and boundary conditions. Later simulations use GIS/Remote sensing data for model initializations. Model simulations are then compared with the satellite and synoptic observations. In this regard GIS, with its ability to pull spatial data from different sources into an integrated environment, coupled with Remote Sensing is used to evaluate and analyze multiple data layers and attributes. A major goal now is to unify our understanding of similar historic events into a more comprehensive Integrative framework from different disciplines meteorology, marine biology, environmental sciences etc, and develop a system of Integrated Environmental Risk Assessment for the Gulf Coast, which is ultimately used for operational use.*

1. INTRODUCTION

Weather simulations play an important role in helping us understand the key components and aspects that determine our weather, particularly extreme events (R.S.Reddy & Mallikharjun Vatti, 2002). By carefully understanding the key variables and correctly manipulating them gives us additional insight into how a particular weather pattern is produced. Throughout the 1900's, Southeast Louisiana and Southern Mississippi experienced a vast array of weather episodes. These episodes serve to reflect on what has happened in the past, how much we have learned and improved upon, and how to prepare for what can potentially happen in the future. So we are primarily focusing on analyzing the meteorological conditions that led to the development of "The Historic Southeast Louisiana and Southern Mississippi flood of May 8-10th, 1995 " using the Pennsylvania State University/ National Center for Atmospheric Research (PSU/NCAR) fifth-generation mesoscale model (MM5). The flood event was so severe that the people of Louisiana and Mississippi remember it for a longer time. Both from meteorological and human perspective, the event was historic, catastrophic and devastating. By visualizing this event's, and other similar events' weather conditions and patterns, we hope to perceive a better understanding of why they occur.

* Corresponding author's address:
Suseela Reddy Remata, Department of Physics, Atmospheric and General Sciences, Jackson State University, Jackson, MS – 39217; email: rsreddy@ccaix.jsums.edu

2. OVERVIEW OF THE EVENT

The May 1995 Southeast Louisiana and southern Mississippi flood is considered to be one of the significant hydrological events to impact the states of Louisiana and Mississippi. The professionals called it a 100-year rainfall event. A 40 hr heavy rain event took place across the middle Gulf of Mexico coast region of Louisiana and Mississippi. On May 8, 1995, up to 20 inches of rain fell in the New Orleans metropolitan area, causing $1 billion in damages. Extreme rainfall continued along the Gulf Coast, where May 9-10 totals reached 15.75 inches in Slidell, LA, 14.56 inches in Biloxi, MS, and 9.18 inches in Mobile, AL. In all, the event lasted 40 hours and damaged several homes and businesses. Many deaths were directly related to the flooding event. This was the costliest single non-tropical weather related episode to affect the United States on record.

The weather pattern (Figures 1(a) & 1(b)) of surface analysis, leading up to the event was recognized to be a synoptic-type event (Maddox et al. 1979) during the initial 24 hr of the episode, but it evolved into a frontal type heavy rain event on day 2. A modified Pacific maritime cold front approached the region from the west, preceded by a squall line. The airmass that entered western Louisiana on May 8th exhibited considerably lower dew points than the tropical airmass across East Louisiana and Southeast Mississippi. However, the mid-level short wave that accompanied the cold front quickly exited the region to the northeast. By the evening of May 9, the cold front had dissipated in the vicinity of Baton Rouge. The remnant frontal trough served as a focusing axis for the heavy precipitation that continued into the late morning hours of May 10 (Figures 1(a) & 1(b)) (NOAA Technical Memorandum NWS SR-183). The Slidell sounding at 0000 UTC on May 10th indicated a CAPE of 4323 J/Kg along with an 850 mb theta-e value of 344K.

3. MODELING CONFIGURATION

The model is initialized at 0000 UTC on May 8th, 1995 and completes 72-hr simulation with graphical output available every six hours. The simulations are non-hydrostatic on two two-way nested domains with horizontal resolutions of 90km and 30 km, centered over the Central Gulf of Mexico at 29°N and 95°W. The model utilizes a terrain-following sigma coordinates in the vertical and has 23 vertical levels. Thirty-second USGS terrain, land-use and land-water boundaries data are used. NCEP/NCAR reanalysis model fields are used as a first guess. Explicit moisture schemes include Dudhis`s simple Ice on 90km grid and Schultz microphysics on 30km grid, Betts-Miller and Grell cumulus parameterizations on 90km and 30km grids respectively, and a high resolution Blackadar planetary boundary scheme.

4. RESULTS AND DISCUSSION

The MM5 Model results for sea-level pressure; sea-surface winds, sea-surface temperatures and accumulated precipitation are shown in figures 2 - 5. The study has pointed out the following:

(i) MM5 Model is suitable for numerical studies of severe flood events and it is capable to capture the precipitation and synoptic features of the flood event.

(ii) The model predicted the sea-surface temperatures greater than 27ºC. The warmer sea supplied the moisture in the vicinity and favored synoptic conditions for developing and producing squall lines.

(iii) Model also predicted a stronger pressure gradient oriented from southeast to northeast and produced maximum wind circulations. This orientation of pressure is associated with a meso-high as observed in the surface analysis.

(iv) Model depicted to produce quite a heavy amount of precipitation in the study area of interest.

(v) The surface analysis exhibited a maritime cold front approached from the west and raising tropical air mass from the southeast of the Gulf of Mexico.

(vi) The observations of surface analysis also support the Model predictions of "The Historic Southeast Louisiana and Southern Mississippi flood of May 8-10th, 1995 ".

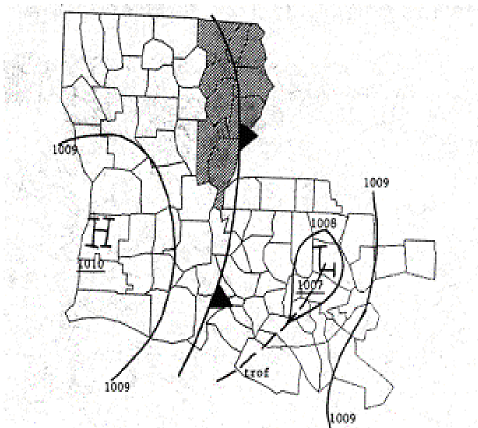

FIGURE 1a. SURFACE ANALYSIS FOR 0600 UTC MAY 9, 1995

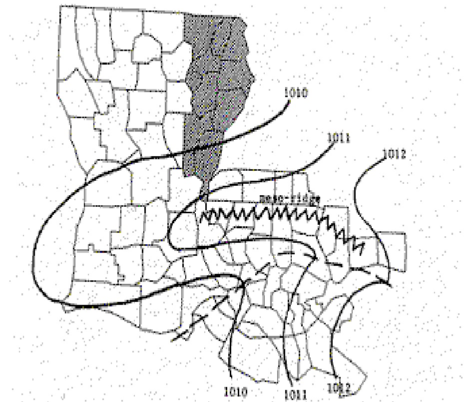

FIGURE 1b. SURFACE ANALYSIS FOR 0600 UTC MAY 10, 1995

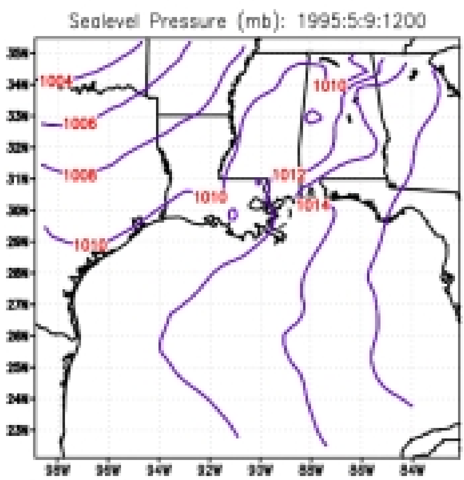

Figure 2. Sea level Pressure (mb) at 1200 UTC May 9, 1995

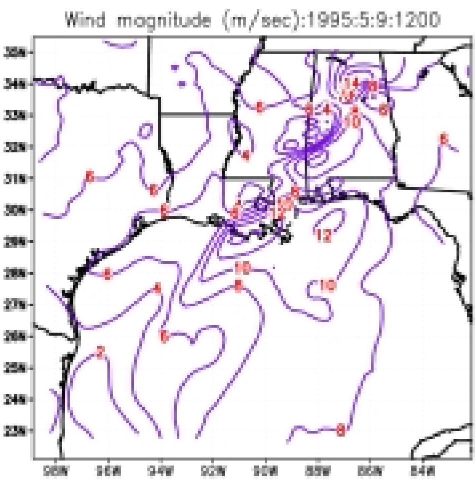

Figure 3. Wind Magnitude (m/s) at 1200 UTC May 9, 1995

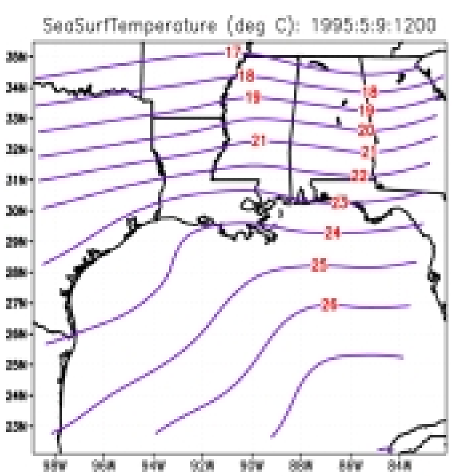

Figure 4. SeaSurfaceTemperature (degC) at 1200 UTC May 9, 1995

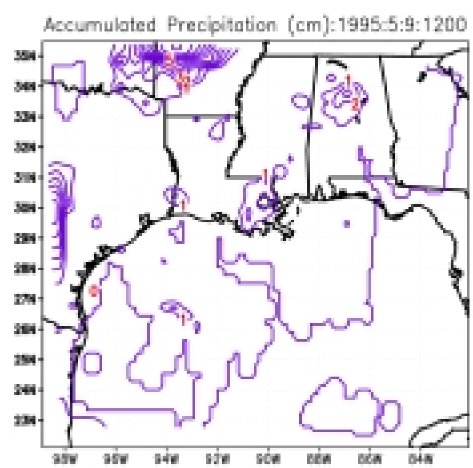

Figure 5. Accumulated Precipitation (cm) at 1200 UTC May 9, 1995

5. FUTURE OUTLOOK

We have performed preliminary model runs using the latest release of the Penn State/NCAR MM5 modeling system looking at "The Historic Southeast Louisiana and Southern Mississippi flood of May 8-10th, 1995 ". Further increase in the model resolution leads to dramatic changes in the vertical structure of the simulated atmosphere, producing significantly different representations of rainfall, wind velocities, and other parameters critical to the assessment of impacts of climatic change. At present, we have used the NCEP/NCAR reanalysis model fields as a first guess, but future work will incorporate additional observations such as satellite data, GIS/Remote Sensing data to improve model initializations. A full operational GIS linked with hydraulic and hydrological model, will be used to simulate flooding from severe rainfall. Hence, overall the modeling work will help in simulating the weather, climate and atmospheric transport processes that led to one of the most catastrophic and devastating events ever seen. We try to unify our understanding of similar historic events into a more comprehensive Integrative framework from different disciplines - meteorology, biology, environmental sciences etc. This analysis is the starting point for our team to design a National model of Environmental Risk Assessment Integrative System for the Operational Depiction and Assessment of coastal risk as related to the impacts (ranging from water quality to fish populations dynamics) of heavy rains and flooding. Future simulations could potentially provide a means to assess the impacts of future climate changes on both natural and human systems.

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