P. 762

Towards Improved High-Resolution Forecasts of Tropical Storm Development and Intensity Changes

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1. Introduction

As detailed in Avila and Cangialosi (2011) "Hurricane Irene hit Crooked, Acklins and Long Island in the Bahamas as a category 3 hurricane (on the Saffir-Simpson Hurricane Wind Scale) but gradually weakened after crossing the Bahamas. It made landfall in North Carolina as a category 1 hurricane and caused widespread damage across a large portion of the eastern United States as it moved north-northeastward, bringing significant effects from the mid-Atlantic states through New England. The most severe impact of Irene in the northeastern United States was catastrophic inland flooding in New Jersey, Massachusetts and Vermont." Nevertheless, Irene was not what it was "cut-out" to be.

2. *The* Forecast for Irene

Here was a typical report/forecasts for Irene: "Irene grew into a Category 2 hurricane late Monday and the U.S. National Hurricane Center in Miami said it could reach Category 3 as early as Tuesday and possibly become a monster Category 4 storm within 72 hours."

"'We didn't anticipate it gaining this much strength this early,' said center meteorologist Chris Landsea, adding that the ocean's warm temperatures and the current atmosphere is "very conducive" to energizing storms (from: http://www.msnbc.msn.com)." Maximum winds were forecast to intensify just prior to making landfall along the North Carolina Coast about 12 UTC on 27 August 2011. However, it was not to be.

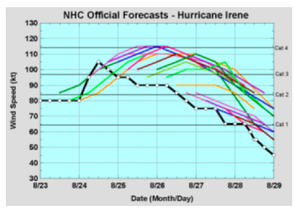

Figure 10: Official NHC intensity forecasts for Irene every 6 h from 1200 UTC 23 August to 0600 UTC 28 August..

Reference

Tropical Cyclone Report Hurricane Irene (AL092011) 21-28 August 2011 Lixion A. Avila and John Cangialosi National Hurricane Center 14 December 2011

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3. What Really Happened with Irene

Irene passed the Bahamas wound tightly around its center of low pressure. However, outer rainbands developed in its northern quadrant, which then appear to become a distinct area all by themselves. Maximum winds were reached prior to the development of more distinct outer rain bands in (b), and minimum pressure was reached just prior to the time shown in (c) below. Did dust incurions play a role? We thought that aerosol precipitation interactions might have been a large reason for the forecast error. However, there are other possibilities (see 4.)

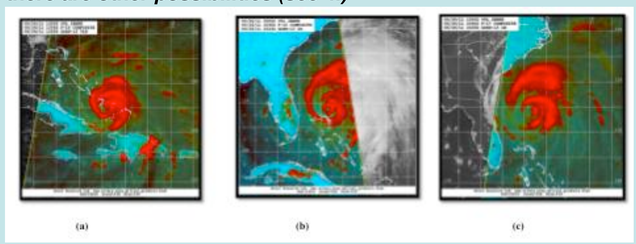


Figure 5:SSMI/S 91 GHz color composite images at (a) 1308 UTC 24 August 2011, near time of peak intensity, (b) 2536 UTC 25 August, and (c) 1040 UTC 26 August 2011, near the time of lowest pressure. Image courtesy of the Naval Research Laboratory , Monterey California

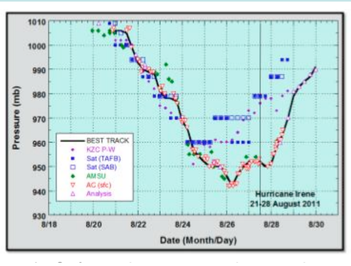


Figure 3: Selected pressure observations and best track minimum central pressure curve for Hurricane Irene 21-18 August 2011.

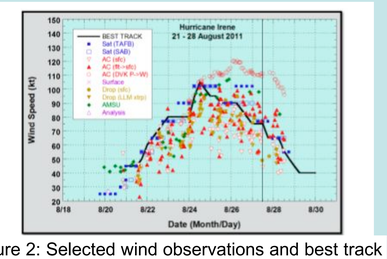
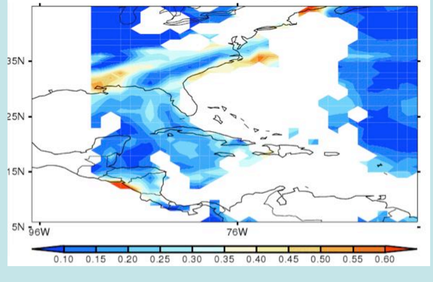
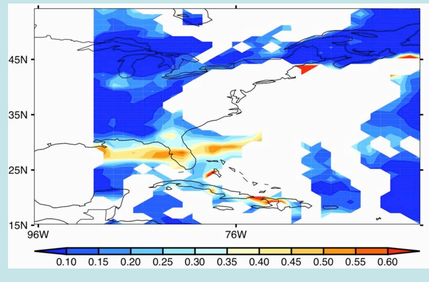


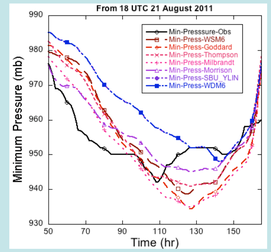
Figure 2: Selected wind observations and best track maximum sustained surface and wind speed curve for Hurricane Irene, 21-28 August 2011.

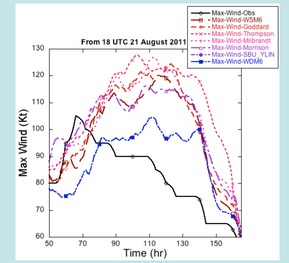


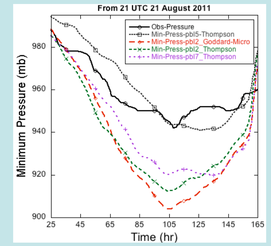


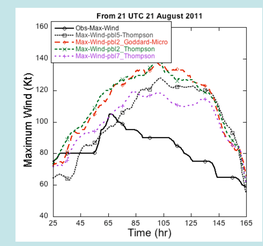
Aerosol index during the development of Irene; left: 12 UTC 25 August 2011; right: 00 UTC 27 August 2011. White areas indicate clouds. The conclusion: Irene was surrounded by dust particle aerosols from the Saharan African Dust Layer.

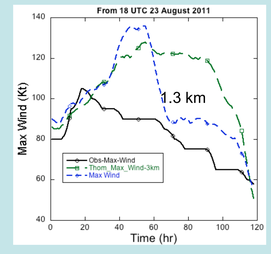
4. Impact of Model Configuration (WRF 3 km (1 km) forecasts)

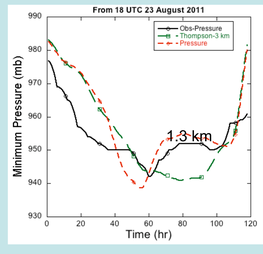


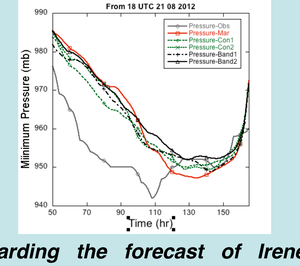


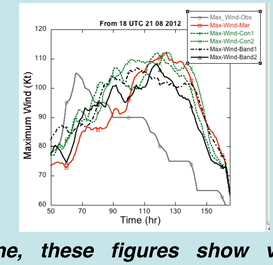












Regarding the forecast of Irene, these figures show very strong sensitivity to choice of microphysics (top) and boundary layer scheme, and combinations of these two can lead to very unrealistic deepening (middle-top). The use of the Thompson microphysics at 1 km grid resolution (blue curve) instead of 3 km resolution improves the forecast in detailed, but important ways (middle-bottom). The potential impact of the aerosols, as forecast with Spectral (bin) Microphysics was also apparent, but was most likely not the reason for the NHC forecast error..