12 ASSIGNMENT

12.1 Test Case

The test case we are doing in the class is the 'Storm of the Century' case that occurred 12-14 March 1993. The date and time of our model simulation will start at 0000 UTC March 13, and the simulation will run for 24 hours till 0000 UTC March 14 1993. You can read more about the case at the end of this chapter.

12.2 Experiment Design

Figure 12.1 shows the model domain set up for this case. The domain configurations for the case study are summarize below.

Coarse domain (domain 1):

Centered at 36.0 N and 85.0 W (remember west longitude is negative). The grid size is 90 km, and the domain IX (north-south) and JX (east-west) dimensions are 35x41. Use expanded coarse domain for objective analysis. The expansion on each side of coarse domain is 360 km.

Nest domain 1 (domain 2):

Resides inside the coarse domain. Domain 2 dimensions are 49x52, and the grid spacing is 30 km. The location of (1,1) point of the fine mesh in the coarse mesh is 10 and 17, respectively.

12.3 Terrain and Land-Use Data

Run TERRAIN program on two domains according to Fig. 12.1 to obtain the terrain and land-use data for REGRID. Use either old 13 category landuse, or new landuse. Figure 12.2 shows the maps of terrain for the two domains.

12.4 Objective Analysis :

Use the NCEP ON84 first guess field and NCEP ON84 SST for REGRID. Obtain the first guess fields only on coarse domain at 10 mandatory pressure levels (default). The mandatory pressure levels are 100000, 85000, 70000, 50000, 40000, 30000, 25000, 20000, 15000, and 10000 Pascals, and new levels are 95000, 92500, 90000, 80000, 75000, 65000, 60000, 55000, 45000, 35000 Pascals. Define ptop_in_Pa = 10000 Pascals. Obtain first guess for 3 time periods: 93031300, 93031312, and 93031400. Use snow cover option. (Note, if you choose to run little_r later, you must create all new levels (see below) in REGRID.)

Run RAWINS (or little_r) only for coarse domain. Create surface FDDA file for coarse domain if you are running Rawins. Analyzed sea-level pressure fields are shown in Fig. 12.3.

12.5 Interpolation

Set the number of model vertical half σ levels to be 23 (KXS in parameter statement). The full σ levels are therefore 24, and are defined as 1., .99, .98, .96, .93, .89, .85, .8, .75, .7, .65, .6, .55, .5, .45, .4, .35, .3, .25, .2, .15,.1, 0.05, and 0.0. The parameter KXP is the sum of mandatory levels plus new levels. Use INTERP to obtain the initial and boundary files for domain 1 to run nonhydrostatic MM5 for the 3 time periods.

12.6 Model Simulation

Run the model on the desktop workstation, starting by obtaining the mm5 tar file.

Start the MM5 model at 0000 UTC 13 March, 1993, and integrate for 24 hours. Use the boundary and initial condition files from Interp, and domain 2 terrain input file from Terrain program output as input. Save files for restart and set SVLAST = .TRUE.. Set time step to be 270 sec.

Use the following physics in the MM5 simulation. Remember some switches are set in *configure.user* file, and some in *mm5.deck*.

1) Run 1 (This run requires about 40 Mb memory, and 2100 sec. if you are the only running):

- Grell convective scheme; simple explicit scheme with ice on domain 1 and 2.
- Cloud radiation scheme with radiation frequency of 30 minutes.
- MRF PBL with multi-layer soil model.
- Moist vertical diffusion in clouds.
- 3-D Coriolis force for nonhydrostatic MM5.
- Radiative top boundary condition.
- With surface fluxes.
- Cloud effect on radiation.
- Account for snow cover effects (IFSNOW = 1).
- No shallow convection.

2) Run 2 (optional):

Option 1:

•First run the model for 12 hours. Save files for restart.

•Restart the model at hour 12, and continue integration to 0000 UTC 14 March.

Option 2:

•Use all of above physics options.

•Do 3D (and surface analysis nudging if you ran Rawins and obtains an output file of the name raw4dsfc.out) on domain 1. No FDDA on domain 2.

Option 3:

•Use all of above physics options.

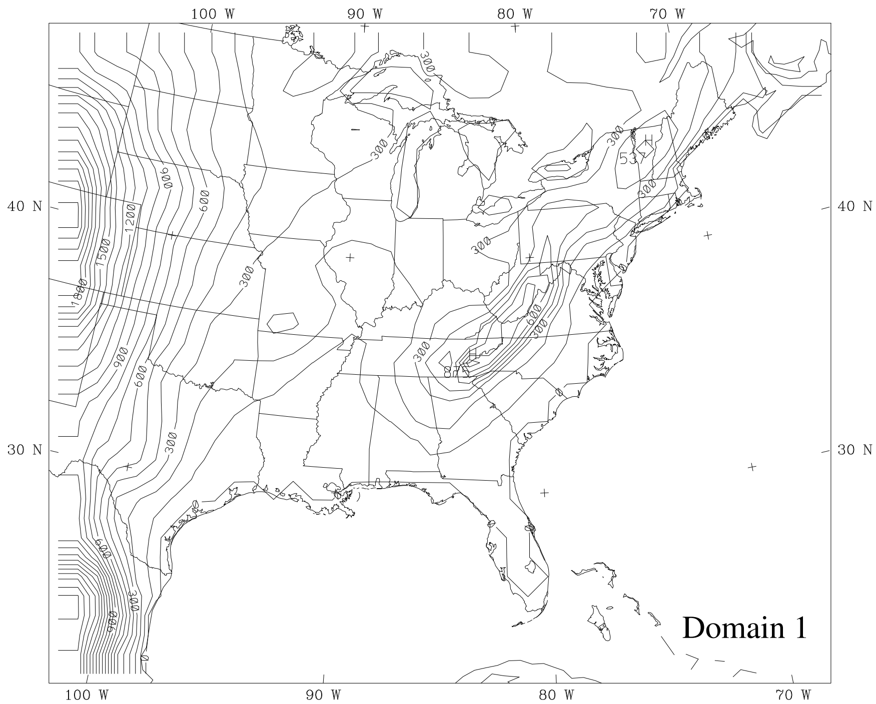
•Design and move the second domain at 3-h interval. Should use only the coarse mesh initial condition file and let model interpolate all fields to the fine mesh. Note, ideally when using the moving nest option, one should rerun terrain for 1 domain only.

MM5 simulated sea-level pressure and precipitation are shown in Fig. 12.4.

12.7 Viewing Model Output

Use Graph program to view the model output you generate. Run the Graph program on workstation. First, obtain a Graph tar file, and then follow the instruction given in Chapter 8, Section 8.7. Run Graph for both domain 1 and 2 model outputs.

Figure 12.1 MM5 model domain configuration for the Storm of the Centuray case (2 domains).



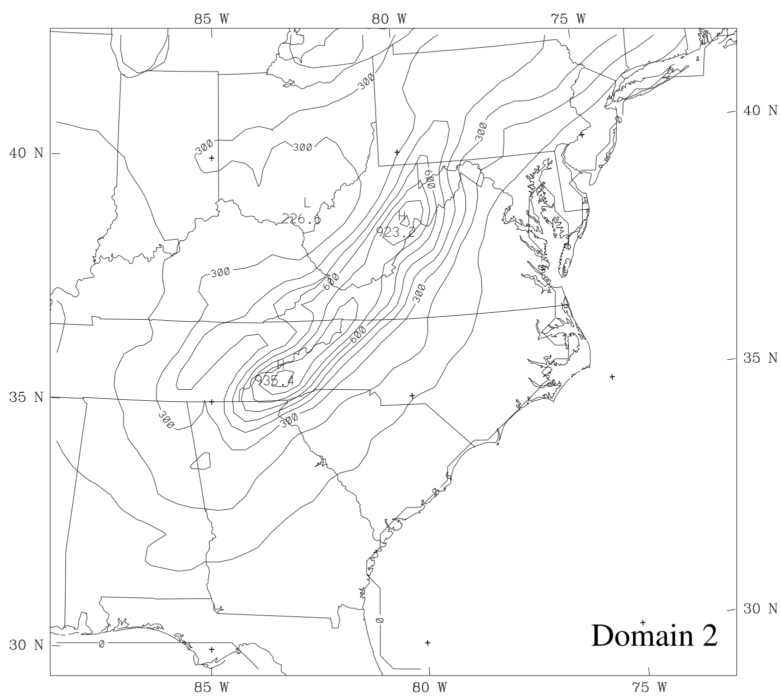
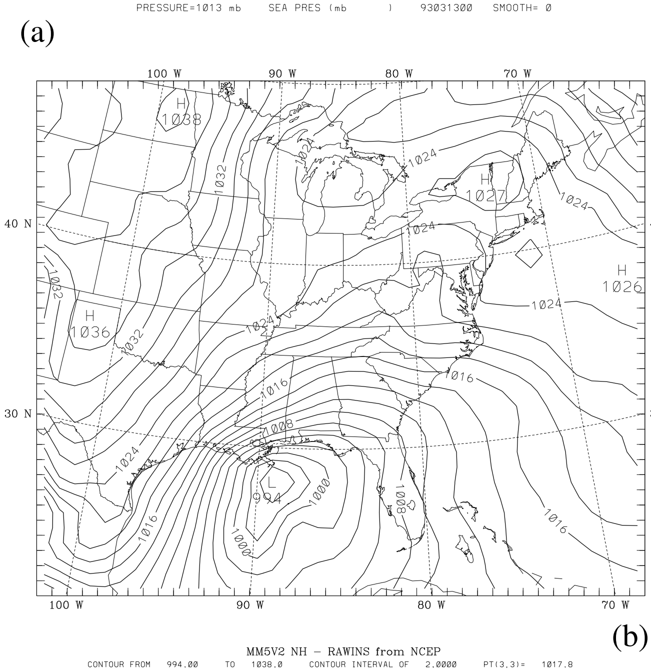
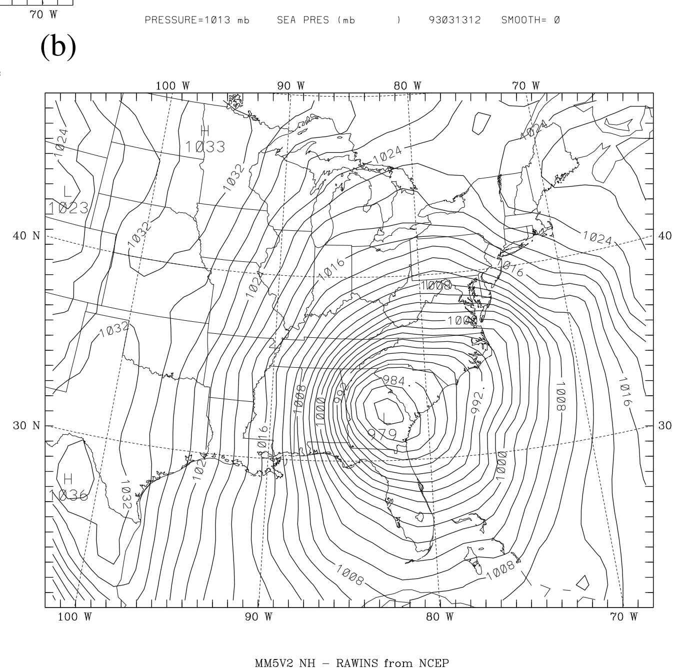


Fig. 12.2 The terrain maps of coarse and fine mesh. The contour interval is 100 m.

(a)



(b)



(c)

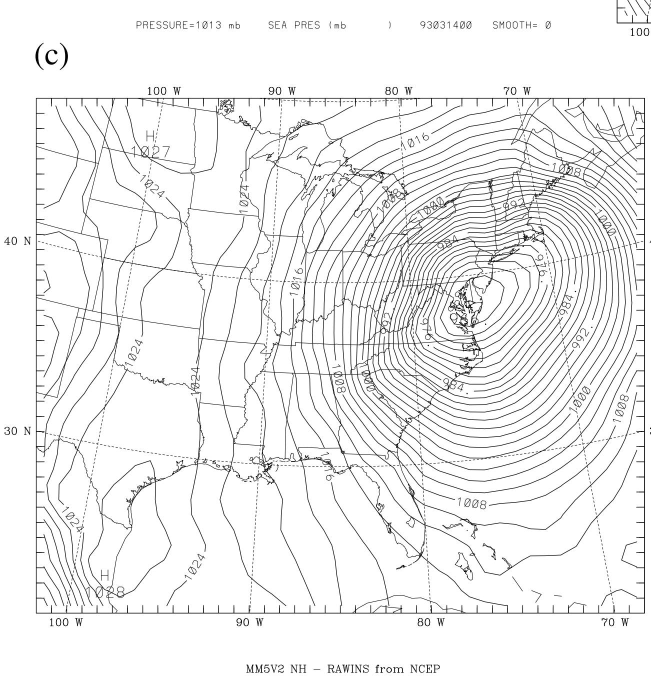


Figure 12.3 Objective analyses of sea-level pressure fields from RAWINS at (a) 0000 UTC, (b) 1200 UTC 13, and (c) 0000 UTC 14 March 1993.

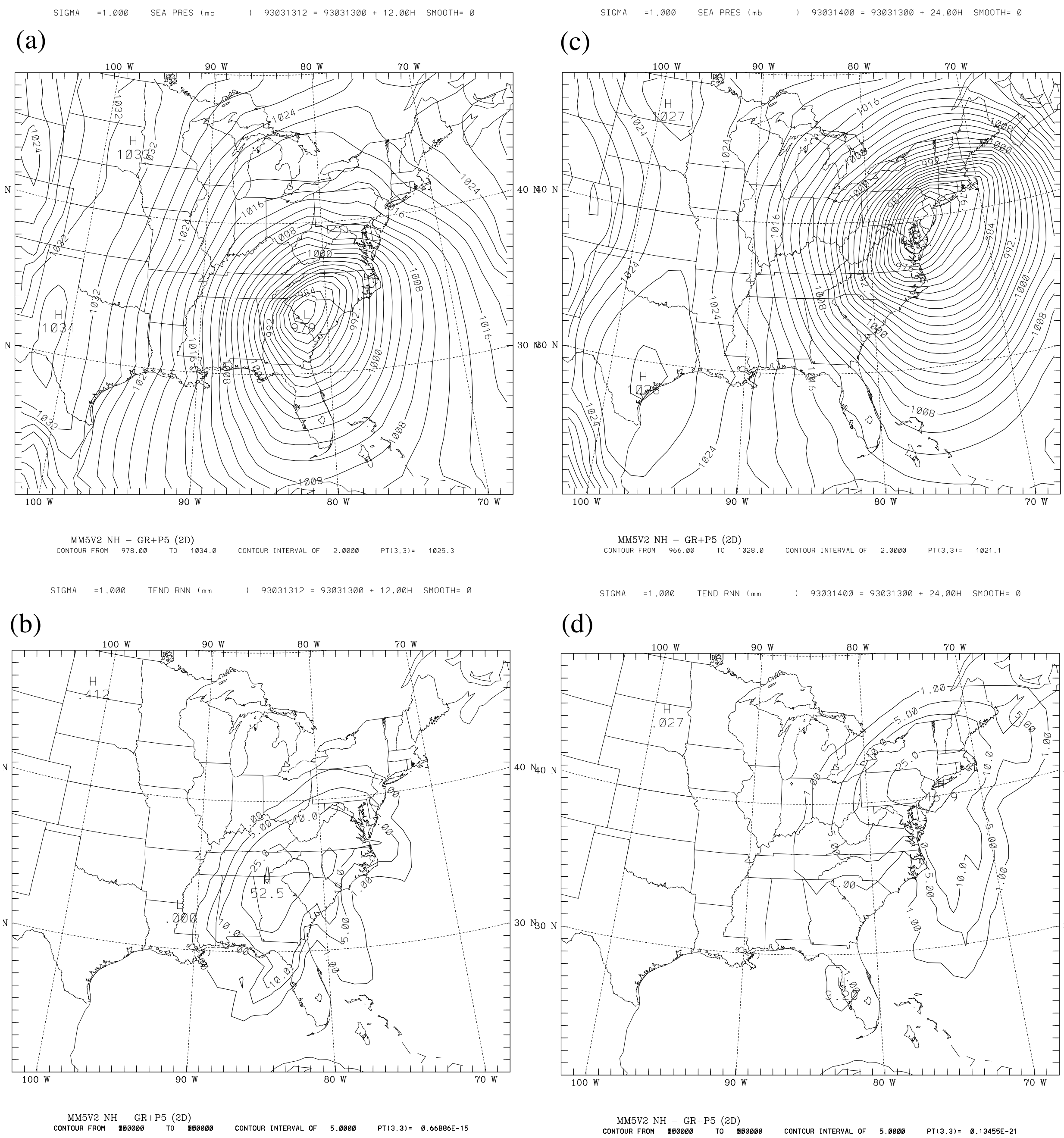


Figure 12.4 Simulated sea-level pressure valid at (a) 1200 UTC 13 March and (c) 0000 UTC 14 March, and 6 hour accumulated precipitation valid at (b) 1200 UTC 13 March, and (d) 0000 UTC 14 March.

The following is a reprint of an article from the Web page:

NATIONAL CLIMATIC DATA CENTER RESEARCH CUSTOMER SERVICE GROUP
TECHNICAL REPORT 93-01

THE BIG ONE!

A REVIEW OF THE MARCH 12-14, 1993 "STORM OF THE CENTURY"

NEAL LOTT, PHYSICAL SCIENTIST, MAY 14, 1993

****

On March 12-15, a storm now called "The Storm of the Century" struck the eastern seaboard. Following are the highlights of the information gathered about the storm thus far:

1) The preliminary death toll for the U.S. is approximately 270, and 48 people were reported as missing at sea (Gulf of Mexico and Atlantic, including Canadian waters). This is over 3 times the combined death toll of 79 attributed to hurricanes Hugo and Andrew. The death toll includes those caused by direct and indirect (e.g., shoveling snow) results of the storm. Due to the widespread nature of the storm, assessing its toll has been quite difficult for damage survey teams--hurricanes are easier to assess due to their more limited areal coverage. The following breakdown by state (not including lost at sea) is still preliminary (its summation does not reflect all deaths from the storm):

Florida 44;	New York 23;	South Carolina 1;	Alabama 16;	Georgia 15;
Tennessee 14,	North Carolina 19;	Kentucky 5;	Virginia 13;	Maryland 3;
West Virginia 4;	Maine 2;	Pennsylvania 49		

2) Thousands of people were isolated by record snowfalls, especially in the Georgia, North Carolina, and Virginia mountains. Over 200 hikers were rescued from the North Carolina and Tennessee mountains. Curfews were enforced in many counties and cities as 'states of emergency' were declared. The National Guard was deployed in many areas to protect lives and property. Generally, all interstate highways from Atlanta northward were closed.

3) For the first time, every major airport on the east coast was closed at one time or another by the storm. The Asheville, NC airport was closed for 3 days. Snowfall rates of 2-3 inches per hour were common during the height of the storm. Generally, New York's Catskill Mountains along with most of the central and southern Appalachians received at least 2 feet of snow. In areas to the east, wind-driven sleet occurred in some areas, with central New Jersey reporting 2.5 inches of sleet on top of 12 inches of snow--somewhat of an "ice-cream sandwich" affect.

4) Hundreds of roof collapses occurred due to the weight of the heavy wet snow. Over 3 million customers were without electrical power at one time due to fallen trees and high winds.

5) At least 18 homes fell into the sea on Long Island due to the pounding surf. About 200 homes along North Carolina's Outer Banks were damaged and may be uninhabitable. Over 160 people were rescued at sea by the Coast Guard in the Gulf of Mexico and Atlantic. At least 1 freighter sank in the Gulf of Mexico.

6) Florida was struck by an estimated 15 tornadoes, and 44 deaths in Florida were attributed either to the tornadoes or other severe weather. A 12-foot storm surge occurred in Taylor County, FL resulting in at least 7 deaths. Also, up to 6 inches of snow fell in the Florida panhandle.

7) 3 storm-related deaths were reported in Quebec and 1 in Ontario. About 110 miles south of Cape Sable Island, Nova Scotia, a 177-meter ship sank in heavy seas, with all 33 of its crew lost at sea. 65-foot waves were reported in the area. Also, a wind gust of 131 MPH occurred at Grand Etang, Nova Scotia. Some parts of northern New Brunswick experienced temperature drops of 45 degrees Fahrenheit in 18 hours. 3 deaths occurred in Cuba (Havana was blacked out), and a tornado left 5000 people homeless in Reynosa, Mexico (near Texas border).

8) Highest recorded wind gusts included:

144 MPH on Mount Washington, NH
109 MPH in the Dry Tortugas (west of Key West, FL)
101 MPH on Flattop Mountain, NC (by NCDC employee Grant Goodge--due to ice accumulation on anemometer, he estimated 105- 107 MPH)
98 MPH in South Timbalier, LA
92 MPH on South Marsh Island, LA
90 MPH in Myrtle Beach, SC
89 MPH in Fire Island, NY
83 MPH in Vero Beach, FL
81 MPH in Boston, MA
71 MPH at La Guardia Arpt, NY

9) Snowfall totals included:

56 inches on Mount LeConte, TN
50 inches on Mount Mitchell, NC (14-foot drifts)
44 inches in Snowshoe, WV
43 inches in Syracuse, NY
36 inches in Latrobe, PA (10-foot drifts)

35 inches in Lincoln, NH
30 inches in Beckley, WV
29 inches in Page County, VA
27 inches in Albany, NY
25 inches in Pittsburgh, PA
24 inches in Mountain City, GA
20 inches in Chattanooga, TN
19 inches in Portland, ME 19 inches in Asheville, NC
17 inches near Birmingham, AL (6-foot drifts) 16 inches in Roanoke, VA
13 inches in Washington, DC
9 inches in Boston, MA
4 inches in Atlanta, GA

10) Record low temperatures included (some records for March):
-12 degrees in Burlington, VT and Caribou, ME
-11 degrees in Syracuse, NY
-10 degrees on Mount LeConte, TN
-5 degrees in Elkins, WV
-4 degrees in Waynesville, NC and Rochester, NY
1 degree in Pittsburgh, PA
2 degrees in Asheville, NC and Birmingham, AL
6 degrees in Knoxville, TN
8 degrees in Greensboro, NC
1 degree in Beckley, WV
11 degrees in Chattanooga, TN and Philadelphia, PA
15 degrees in New York-JFK and Washington, DC
17 degrees in Montgomery, AL
18 degrees in Columbia, SC and Atlanta, GA
19 degrees in Augusta, GA 21 degrees in Mobile, AL
25 degrees in Savannah, GA and Pensacola, FL
31 degrees in Daytona Beach, FL

11) Record low sea-level pressures included:
28.38 inches in White Plains, NY
28.43 inches in Philadelphia, PA
28.43 inches at JFK Arpt, NY
28.45 inches in Dover, DE
28.51 inches in Boston, MA
28.53 inches in Augusta, ME
28.54 inches in Norfolk, VA
28.54 inches in Washington, DC
28.61 inches in Raleigh-Durham, NC
28.63 inches in Columbia, SC
28.73 inches in Augusta, GA
28.74 inches in Greenville-Spartanburg, SC
28.89 inches in Asheville, NC

12) The National Weather Service's Office of Hydrology estimated the volume of water that fell as snow as 44 million acre-feet. This is comparable to 40 days' flow on the Mississippi River at New Orleans. For example, the NWS office at the Asheville, NC airport reported a snow/water ratio of 4.2 to 1 from core samples of new snow. Numerous core samples taken in a nearby area by an NCDC employee showed similar results with a ratio of 5.3 to 1. This equated to 4-5 inches of liquid equivalent precipitation (or even higher in some areas) from the storm. Areas north of Asheville which reported up to 4 feet of snow probably received 'dryer' snow with similar liquid equivalent amounts. Due to the weight of the heavy snow, damage to trees and some buildings was extensive. Polk County, NC reported 99% of its electrical customers without power at one point during the storm. Some sleet also occurred during the storm, contributing to its 'heavy' nature. Many of the power outages occurred before the high winds arrived (due to snow-induced tree damage).

13) Overall damage figures are not yet complete, but the insured property damage estimates now exceed $1.6 billion. Therefore, this was the 4th costliest storm in U.S. history, and by far the most costly extra-tropical storm. Some estimates of total damages and costs from the storm now exceed $6 billion.