

## **Hurricane Sandy - October 28<sup>th</sup>-31<sup>st</sup>, 2012**

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### **Meteorological Overview:**

At the end of October, 2012, one of the most memorable storms in recent U.S. history made landfall along the New Jersey coast. A negative NAO, or strong blocking pattern in the North Atlantic, set the stage for this historical event (Fig. 1). Sandy originated as a tropical depression in the southwestern Caribbean Sea on Monday, October 22. The storm quickly increased in size and intensity while tracking north through the Caribbean, and by 1500 UTC October 24<sup>th</sup>, Sandy had strengthened to a category one hurricane near Jamaica. Hurricane Sandy continued its northward track into the Atlantic, and then on October 27<sup>th</sup>, the storm turned briefly northeastward away from the United States. However, the strong ridge over the North Atlantic prevented Sandy from going out to sea, and instead, the storm eventually began to interact with a mid-latitude trough digging into the Ohio/Tennessee Valleys and re-curved northwestward toward the US coast. This unique interaction between a tropical and mid-latitude low-pressure system accelerated and strengthened Sandy as it approached the U.S. coast on Monday, October 29<sup>th</sup>.

The large wind field, combined with a long easterly fetch over the Atlantic, enhanced storm surge along the Eastern Seaboard from the Chesapeake Bay to Cape Cod as the storm approached the U.S. coast, and the full phase of the moon on Monday aided in creating extreme high tides and storm surges. Similar to most tropical events, winds increased with the approaching storm, and anomalous moisture streaming inland allowed for heavy rains from Virginia to New Jersey. The most significant rains fell over the Delmarva Peninsula, with a maximum of 12.83 inches of rain reported in Bellevue, MD (Fig. 2a). According to the final report issued by the National Hurricane Center, Sandy officially became the largest hurricane to develop in the Atlantic since 1988, expanding nearly 1000 miles in diameter. On the afternoon of October 29<sup>th</sup>, the storm was still offshore, but the minimum central pressure lowered to 940 hPa. Also according to the Sandy report issued by the National Hurricane Center, at 2224 UTC, a 945.5 hPa pressure was recorded at Atlantic City, NJ, which set a record for the minimum sea-level pressure ever recorded north of North Carolina in the United States. Sandy made landfall just south of Atlantic City, New Jersey at around 0000 UTC Tuesday, October 30<sup>th</sup>, shortly after the National Hurricane Center declared it had transitioned from a hurricane to a post-tropical storm (Fig. 3).

The storm gradually weakened after making landfall, but the combination of strong dynamic cooling from the deep-layered cyclone backing westward into the Mid-Atlantic States and cold air advection from the west-northwest lowered temperatures enough to change rain over to snow along the higher elevations of the central and southern Appalachians. An expansive area of strong low-level winds surrounded the storm, and the northwesterly flow over the Appalachians enhanced snowfall rates on the northwestern slopes of the terrain. Measurable snow was reported from the Smoky Mountains into southwestern Pennsylvania (Fig. 2b). The most significant totals were over the higher elevations of West Virginia as well as North Carolina, where three feet of snow were observed.

After tracking through southern New Jersey and westward across southern Pennsylvania, Sandy took a turn to the north Tuesday evening, October 30<sup>th</sup>. The storm caused gusty winds, lakeshore flooding, and some snow showers across portions of the Great Lakes as it moved north through western Pennsylvania, and finally, Sandy crossed Lake Erie and exited the states by Wednesday morning, October 31<sup>st</sup>.

**Impacts:**

Sandy impacted 24 U.S. states and caused over 50 billion dollars in damage. The hardest-hit areas were along the New Jersey coastline and into Long Island, where rising ocean waters washed out protective beaches and damaged hundreds of thousands of homes and businesses. In New York City, storm surge and tropical storm strength winds closed subway stations and the New York Stock Exchange. Also, the impacts from Sandy shut down multiple airports and train stations across the Northeast, and residents of New York and northern New Jersey were faced with a major gas shortage after the storm. Heavy rains and flash flooding were the main hazard in the Chesapeake Bay area, where the storm closed several schools, business, and major highways across the northern Mid-Atlantic States. Farther inland, record-breaking early-season snow fell in the Appalachians from the Smoky Mountains to Western Maryland. The rain, snow, and winds from Sandy left over 8 million people without power from the Atlantic coast to the Great Lakes, and some homes in New York and New Jersey were without power for weeks after the storm. Hurricane Sandy also directly claimed the lives of 147 people, with over 70 deaths reported in the United States.

Sandy also created a stir in the meteorological community. The unique hybrid storm left room for debate on what exactly to call the storm, which was given labels such as “Frankenstorm” and “Superstorm Sandy”. The NWS referred to the storm as “Post-tropical storm Sandy”. Even within the NWS, the uncertainty on the exact time Sandy would transition from tropical to post-tropical led to some confusion as to which agency should be issuing statements on the storm and what types of watches and warnings should be posted across the Mid-Atlantic and New England States. Despite the debates and uncertainty, Sandy was a very well-forecasted storm. NWS forecasters highlighted the event six days in advance, which provided government responders and the public time to prepare for the event (Fig. 4).

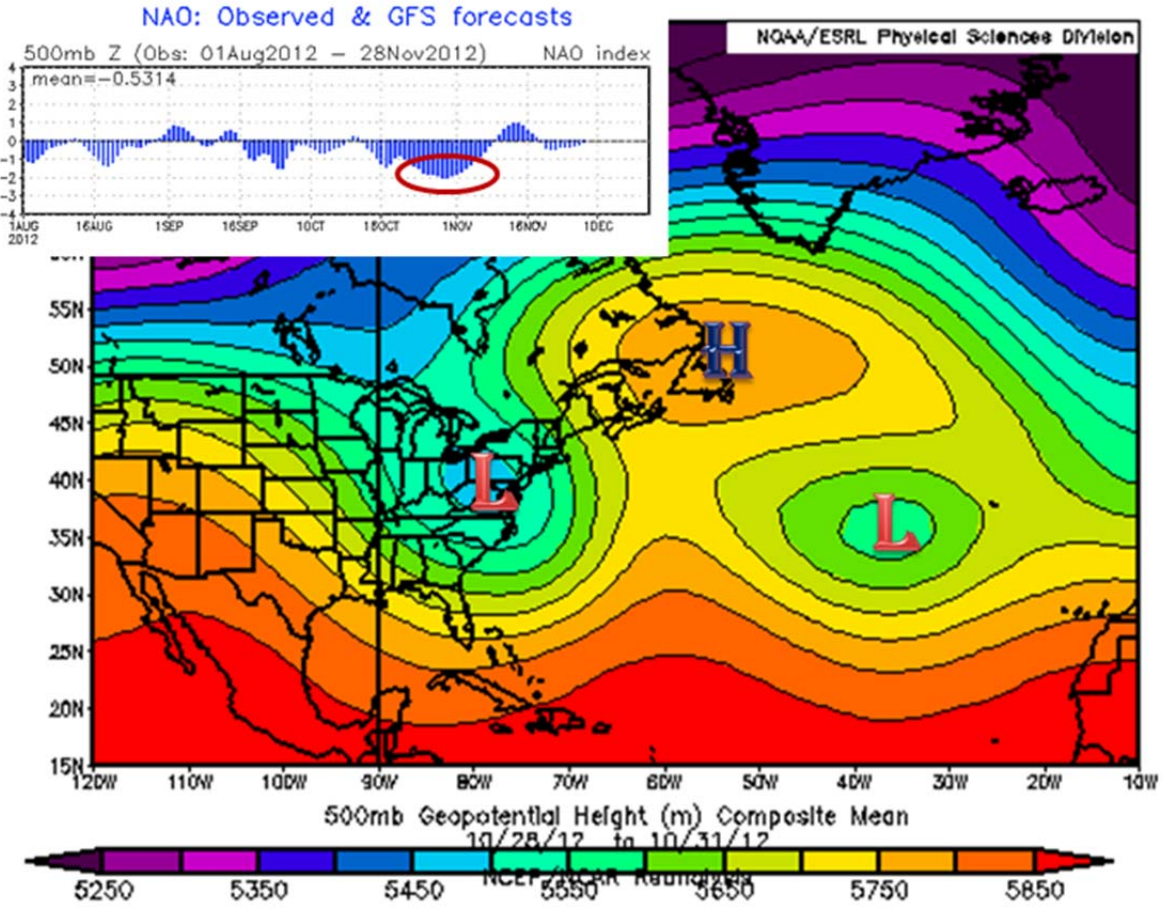


Figure 1: Composite mean of 500mb geopotential heights from October 28<sup>th</sup>–31<sup>st</sup> overlaid with observed NAO index from August 1<sup>st</sup> 2012 – November 28<sup>th</sup> 2012 (Images provided by NOAA/ESRL Physical Science Division and the Climate Prediction Center).

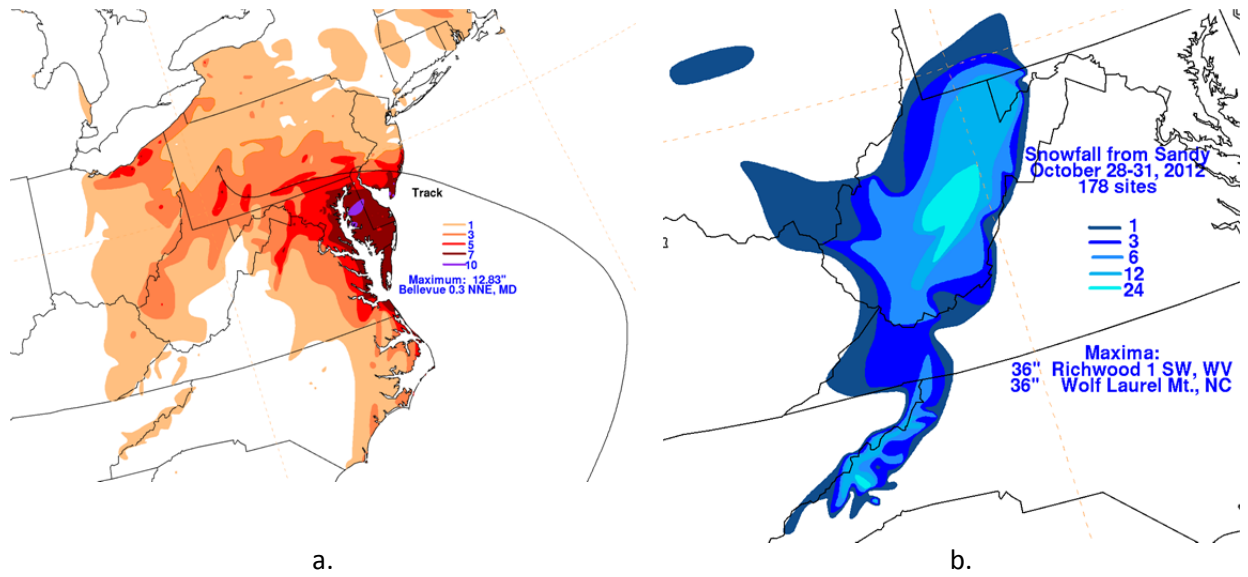
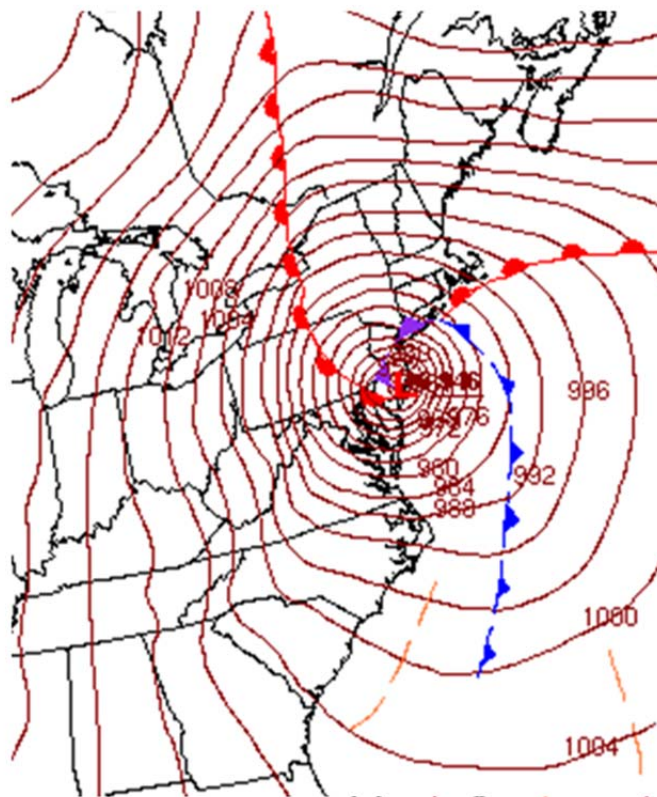


Figure 2: Observed rainfall (a) and snowfall (b) from Hurricane Sandy (Images provided by HPC).



0000Z SURFACE ANALYSIS  
 DATE: TUE OCT 30 2012  
 ISSUED: 0129Z TUE OCT 30 2012  
 BY HPC ANALYST MONARSKI  
 COLLABORATING CENTERS: HPC, NHC, OPC

Figure 3: Analyzed surface pressures (isobars every 4 mb) and fronts at 00 UTC on October 30<sup>th</sup>, 2012 (Image provided by HPC).

EXTENDED FORECAST DISCUSSION  
 NWS HYDROMETEOROLOGICAL PREDICTION CENTER COLLEGE PARK MD  
 329 PM EDT TUE OCT 23 2012

VALID 12Z FRI OCT 26 2012 - 12Z TUE OCT 30 2012

...POTENTIAL FOR MAJOR STORM OVER THE MID ATLANTIC & NORTHEAST  
 EARLY NEXT WEEK...

Figure 4: Excerpt from the extended forecast discussion issued by the National Weather Service on Tuesday, October 23<sup>rd</sup> 2012 (Image provided by HPC).