GEOS-5 Forecasts of Hurricane Sandy

Global Modeling and Assimilation Office, NASA GSFC

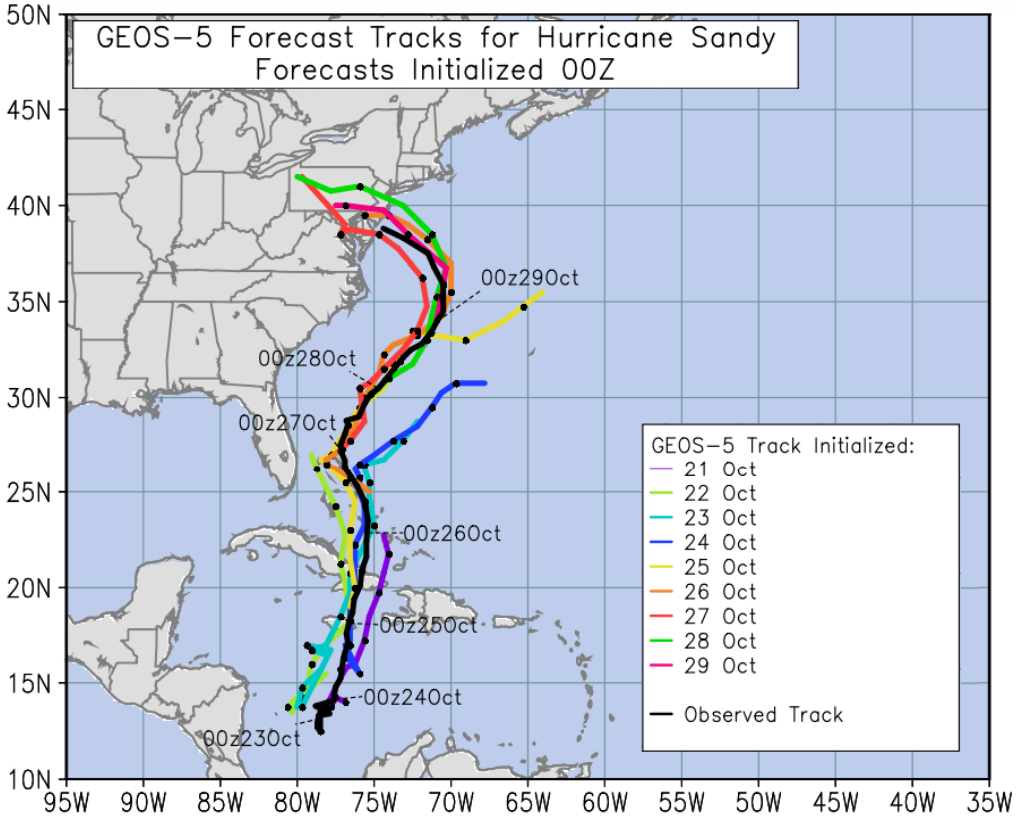

Figure 1: GEOS-5 forecasts for Sandy's track, initialized at 00Z (colored), and the observed track (black). Forecast storm locations are marked at 12 hour intervals.

Hurricane Sandy was an event unprecedented in both its impacts and its meteorology. When verifying the GEOS-5 forecasts for Hurricane Sandy, we found that GEOS-5:

- Forecast Sandy throughout its entire evolution from tropical depression to Category 1 hurricane.
- Successfully forecast Sandy's track and the general region of landfall.
- Successfully forecast Sandy's intensity (here, minimum central pressure) and key details of Sandy's storm structure.

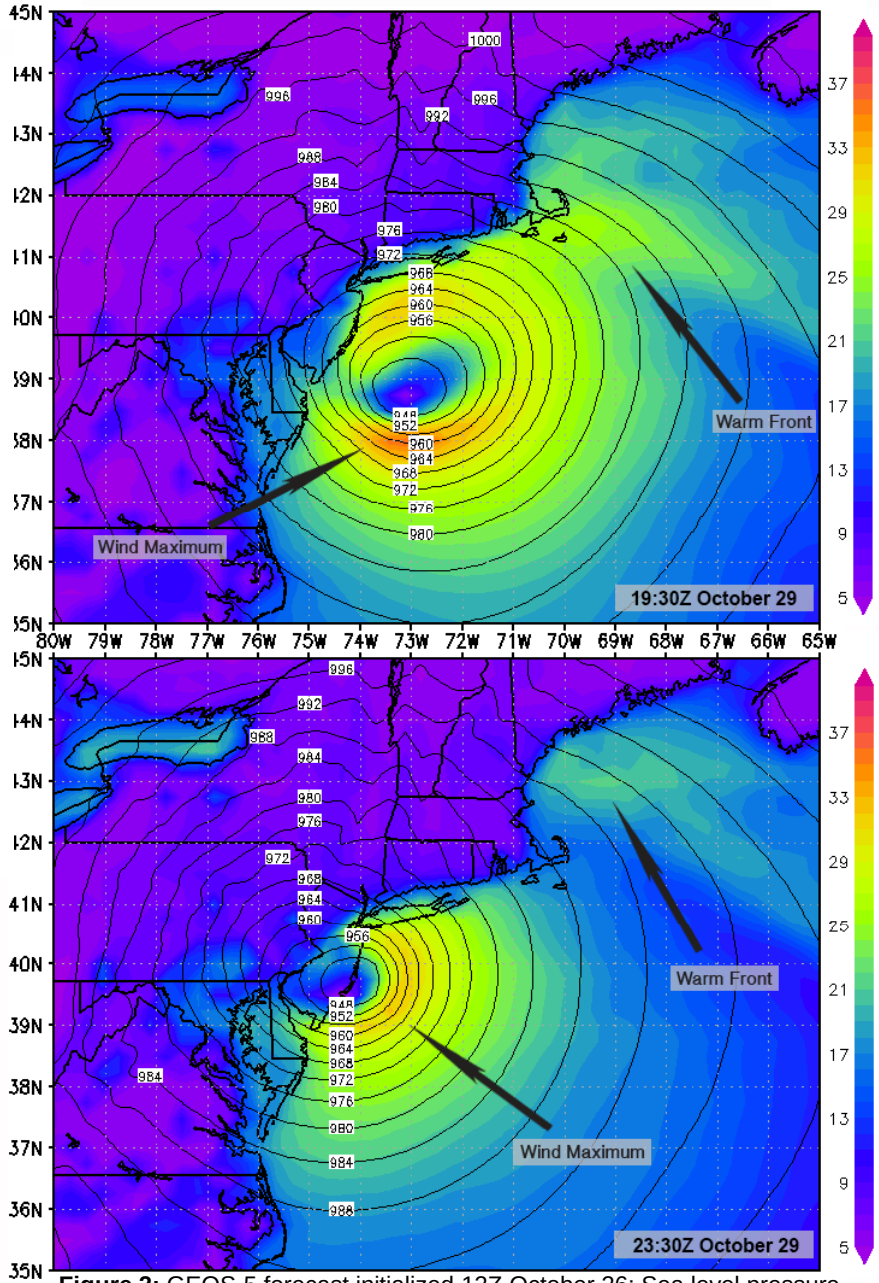

Figure 2: GEOS-5 forecast initialized 12Z October 26: Sea level pressure (hPa, contours) and 10m winds (m/s, color).

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Process:

GEOS-5 five-day forecasts are routinely produced twice daily. The model, which includes the affects of aerosols and trace gasses, is run at a 1/4 degree horizontal resolution with 72 vertical levels. Initial conditions are provided by real-time analyses of assimilated satellite and ground based observations.

The skill of GEOS-5 is continually monitored and compared with that of other NWP centers. For the 2012 Atlantic hurricane season, GEOS-5 performed well in a majority of cases. Due to the high impact nature of Hurricane Sandy, we've undertaken an in-depth investigation of the GEOS-5 forecasts of the storm.

Result:

Sandy was identified as a tropical storm on October 22, 2012, and later made land fall in New Jersey as a huge storm with Category 1 winds on October 30. GEOS-5 was able to forecast Sandy's track and intensity well throughout its lifespan, and was able to predict key aspects of its structure.

- GEOS-5 predicted that a trough in the jet stream would determine Sandy's motion. Initially, this trough was forecast to push Sandy away from the U.S. coast and out to sea, but beginning on October 25, GEOS-5 predicted that the trough would attain a negative (northwest-southeast) tilt and bring Sandy on shore in the Tri-State area. This forecast was verified when Sandy made landfall in southern New Jersey (see Figure 1).
- GEOS-5 predicted the general trends of Sandy's intensity, anticipating, for instance, that the storm would weaken several days before landfall and then re-intensify. GEOS-5 also correctly forecast that it would reach a minimum central pressure of near 940 hPa.
- GEOS-5 forecast the structure of Sandy's wind field very well. It predicted that, despite the immensity of the storm, the most intense winds near the storm center would remain compact, instead of being spread over a large area. GEOS-5 also anticipated that a wind maximum south of the storm's center would migrate to the eastern half of the storm upon landfall, sparing areas south of New Jersey from the worst of the wind. Additionally, GEOS-5 forecast an area of high winds to the north of Sandy, associated with a warm front (Figure 2). Had the wind field near Sandy's center been forecast to be diffuse, this second area of high winds would have been lost. All of these features were verified by observations.

Future:

Performance metrics associated with hurricane prediction help in the evaluation of the GEOS-5 modeling and assimilation system. Future work will look at a quantitative assessment of track and intensity error. The GMAO will continue to provide forecast support to Hurricane and Severe Storm Sentinel study (HS3) through 2014. Data collected during HS3 missions will in turn provide the GMAO with more information on how tropical storms form and intensify to help improve the GEOS-5 system.

Further Information:

GEOS-5 Forecasts of Hurricanes Isaac and Sandy - http://gmao.gsfc.nasa.gov/research/atmosphericassim/tracking_hurricanes

The GEOS-5 wiki - http://geos5.org/wiki/index.php?title=GEOS-5_Earth_System_Modeling_and_Data_Assimilation

GEOS-5 Forward Processing Product Details - http://gmao.gsfc.nasa.gov/products/GEOS-5_FP_details.php

GMAO HS3 Forecast Support - http://gmao.gsfc.nasa.gov/projects/HS3/