

Title: Tropical Cyclones, Hurricanes, and Climate: NASA's global cloud-scale simulations and new observations that characterize the lifecycle of hurricanes

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## Abstract

One of the primary interests of Global Change research is the impact of climate changes and climate variability on extreme weather events, such as intense tropical storms and hurricanes. Atmospheric climate models run at resolutions of global weather models have been used to study the impact of climate variability, as seen in sea surface temperatures, on the frequency and intensity of tropical cyclones. NASA's Goddard Earth Observing System Model, version 5 (GEOS-5) in ensembles run at 50 km resolution has been able to reproduce the interannual variations of tropical cyclone frequency seen in nature. This, and other global models, have found it much more difficult to reproduce the interannual changes in intensity, a result that reflects the inability of the models to simulate the intensities of the most extreme storms. Better representation of the structures of cyclones requires much higher resolution models. Such improved representation is also fundamental to making best use of satellite observations.

In collaboration with NOAA's Geophysical Fluid Dynamics Laboratory, GEOS-5 now has the capability of running at much higher resolution to better represent cloud-scale resolutions. Global simulations at cloud-permitting resolutions (10- to 3.5-km) allows for the development of realistic tropical cyclones from tropical storm (<119 km/hr winds) to category 5 (>249km/hr winds) intensities. GEOS-5 has produced realistic rain-band and eye-wall structures in tropical cyclones that can be directly analyzed against satellite observations. For the first time a global climate model is capable of representing realistic intensity and track variability on a seasonal scale across basins.

GEOS-5 is also used in assimilation mode to test the impact of NASA's observations on tropical cyclone forecasts. One such test, for tropical cyclone Nargis in the Indian Ocean in May 2008, showed that observations from Atmospheric Infrared Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU-A) on Aqua substantially

reduced forecast track errors. Tropical cyclones in the northern Indian Ocean pose serious challenges to operational weather forecasting systems, partly due to their shorter lifespan and more erratic track, compared to those in the Atlantic and the Pacific.

SA is also bringing several state of the art instruments in recent field campaigns to peer under the clouds and study the inner workings of the tropical storms. With the Genesis and Rapid Intensification Processes (GRIP) experiment, a NASA Earth science field experiment in 2010 that includes the Global Hawk Unmanned Airborne System (UAS) configured with a suite of *in situ* and remote sensing instruments that are observing and characterizing the lifecycle of hurricanes, we expect significant improvement in our understanding of the track and intensification processes with the assimilation of the satellite and field campaign observations of meteorological parameters in the numerical prediction models.