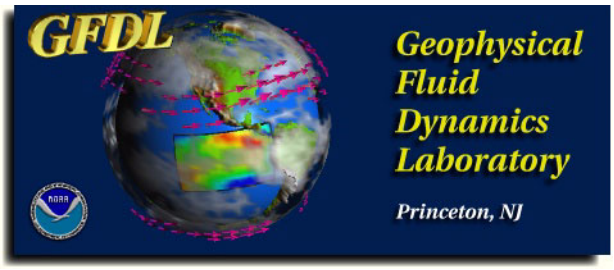
Global Warming and Hurricanes: Computer Model Simulations



The strongest hurricanes in the present climate may be upstaged by even more intense hurricanes in the future, as the climate warms in response to increasing levels of atmospheric greenhouse gases (GHGs).

Computer model simulations conducted at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) suggest that the potential exists for significant increases in wind speeds and rainfall rates for the strongest tropical cyclones (hurricanes and typhoons) if tropical sea surface temperatures (SSTs) warm substantially by the late-21st century.

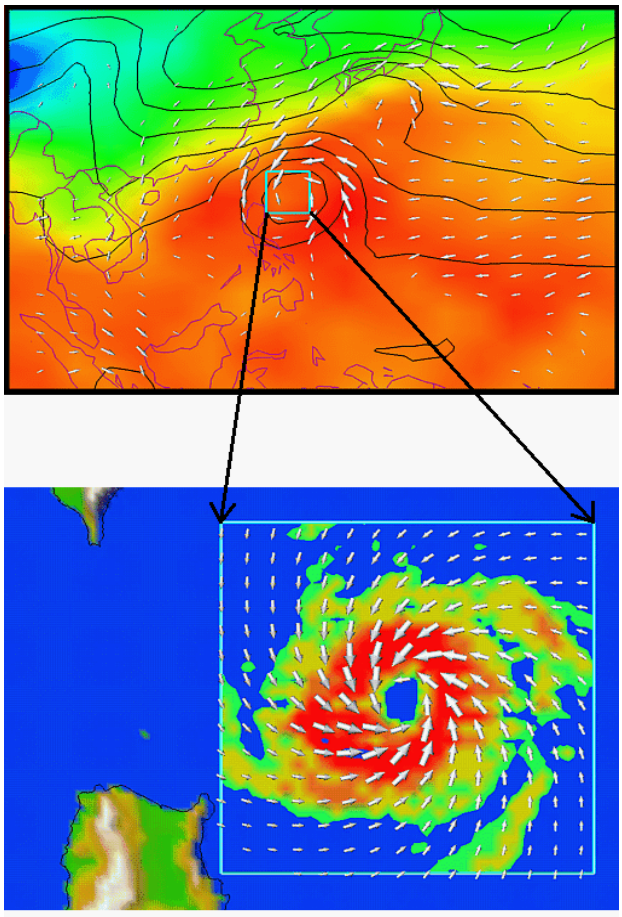
A series of idealized tropical cyclone simulations were performed with GFDL's hurricane prediction model, using large-scale environmental conditions from a GFDL global climate model. Maximum surface wind intensities of the tropical cyclones rose by 3 to 10% as simulated tropical SSTs warmed 4.0 to 4.9^{o}F (2.2 to 2.7^{o}C) in response to an idealized scenario of future GHG levels. Hurricane-related rainfall amounts also were simulated to rise under high GHG conditions. In the warmer climate, maximum precipitation rates for the storms increased by about 30% and the average rainfall within 62 miles (100km) of the storm centers increased by about 20%. The responses were broadly similar for idealized tropical cyclones in the Atlantic, Pacific, and Indian Oceans.

Similar results were obtained when samples of northwest Pacific typhoons from both the present-day climate and from a GHG-warmed climate were taken from the global climate model and used for case studies with the hurricane prediction model (see figures). This hurricane prediction model is the operational computer model that has been used successfully by NOAA's National Centers for Environmental Prediction to predict tropical storm tracks for the last several hurricane seasons.

These research results are documented in a series of three scientific research papers (listed below), the most recent of which was authored by Tom Knutson and Bob Tuleya of GFDL and Weixing Shen and Isaac Ginis of the University of Rhode Island.

TAKE HOME POINTS

- ☛ **Hurricane intensities increase when model-simulated tropical sea surface temperatures warm 4 to 5^{o}F in response to increased greenhouse gas levels**
- ☛ **Simulated rainfall amounts within 60 miles of the hurricane centers are about 20% larger for the warmer climate than for the present**
- ☛ **Modeled wind speeds increase 3 to 10% for the strongest hurricanes in the warmer climate**



REFERENCES:

Knutson, T.R., R.E. Tuleya, and Y. Kurihara, 1998: Simulated increase of hurricane intensities in a CO2-warmed climate. *Science*, 279(5353), 1018-1020.

Knutson, T.R., and R.E. Tuleya, 1999: Increased hurricane intensities with CO2-induced global warming as simulated using the GFDL hurricane prediction system. *Climate Dynamics*, 15, 503-519.

Knutson, T.R., R.E. Tuleya, W. Shen, and I. Ginis: 2001. Impact of CO2-induced warming on hurricane intensities as simulated in a hurricane model with ocean coupling. *Journal of Climate*, 14(11), 2458-2468.

Figure Captions:
Top: A tropical storm in the Pacific as simulated in GFDL's global climate model. Color shading sho ws temperature, contours show atmospheric pressure, and arrows show wind directions and speeds.
Bottom: The same storm simulated with the hurricane prediction model, with surface winds (arrows) and precipitation (shading) shown. The more densely packed arrows in the bottom panel illustrate the finer spatial resolution (distance between grid points) of the nested hurricane model (11 miles or 18 km) compared to the global climate model in the top panel (about 300 miles or 480 km). Arrows in the bottom panel are plotted at every other model grid point (every 22 miles or 36 km).

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