For more information, contact:
Chris Fairall
Chris.Fairall@noaa.gov
(303) 497-3253

Jian-Wen Bao
Jian-Wen.Bao@noaa.gov
(303) 497-5240

Improving Hurricane Forecasts

The prediction of a hurricane's track and its intensity relies heavily on numerical weather prediction (NWP) models. However, great uncertainties still remain in the formulation of a few key model physics components that are critical to the development of hurricanes. Over the past decade, research has been carried out at NOAA's Earth System Research Laboratory (ESRL) to combine atmospheric observations, laboratory experiments and computer modeling studies to develop, test and improve the measurements of air-sea momentum and heat fluxes under hurricane conditions.

Why Consider Sea Spray in Hurricane Forecasting?

- One uncertainty in NWP models is the formulation of the momentum and heat fluxes across the air-sea interface. All the forumulations currently used in operational NWP models were developed using observations taken under winds weaker than those associated with a typical hurricane. Under hurricane conditions, the air and sea are separated by a spray-filled transition layer. Momentum and heat exchanges across such a layer should take into account the effect of sea spray, but they currently do not.

How is this Being Addressed?

- Beginning with an older method from 1994, researchers at ESRL have developed a new, refined method that incorporates air-sea heat exchanges, observations from new field experiments, and updated theoretical understanding. A unique aspect of the new method is that it includes the sea-spray contribution to the air-sea heat fluxes for winds greater than 25 m/s.
- Testing and evaluation of this new method are being performed in the operational hurricane model (HWRF) and the community weather research and forecast model (WRF-ARW). Through ongoing research with both the operational and research models, ESRL scientists will be able to determine the sensitivity

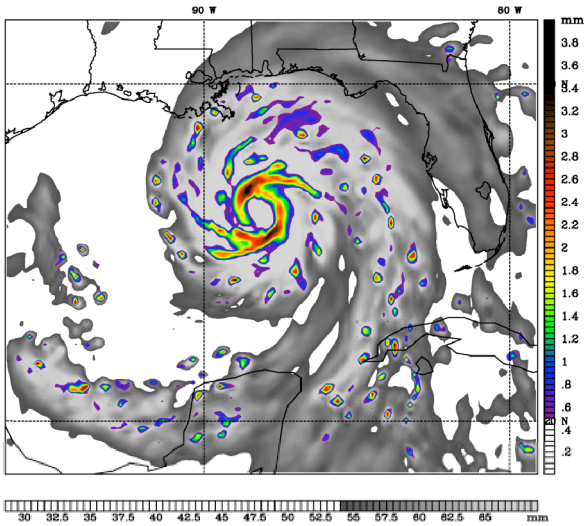
Ocean whitecaps during a hurricane.

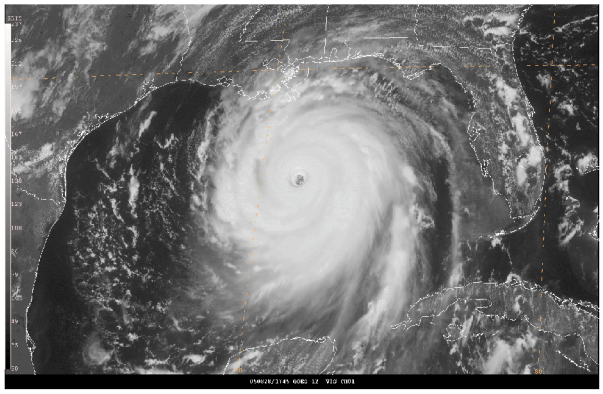
of the sea-spray calculation to the uncertainties in wave dynamics, and the motion and heat-producing feedbacks of sea spray. They will also be able to make the method more general by including both the spray evaporation feedback and stress reduction effects.

- Researchers from NOAA and universities are closely collaborating to evaluate the impact of the improved air-sea flux method on the dynamic marine boundary layer under hurricane conditions.

What are the Benefits?

- The inclusion of the impact of sea spray on the air-sea energy exchange in weather prediction models will increase the accuracy of hurricane track and intensity forecasts. The societal impact of this research is significant because it will improve the nation's coastal evacuation warning system and ultimately save lives.





Hurricane Katrina near peak intensity on August 28, 2005. *(Left) Simulation created by the WRF-ARW model for 18:00 UTC. Grayscale is vertically integrated water vapor, color scale shows water vapor and clouds. (Above) GOES-12 Satellite image at 17:45 UTC.*

Related Publications:

- Bao, J.-W., J. M. Wilczak, J.-K. Choi, and L. Kantha, 2000: Numerical simulations of air-sea interaction under high wind conditions using a coupled model: A study of hurricane development. *Mon. Wea. Rev.*, **128**, 2190-2210.
- Bao, J.-W., S. A. Michelson, J. M. Wilczak and C. W. Fairall, 2002: Storm simulations using a regional coupled atmosphere-ocean modeling system. Advances in Fluid Mechanics (Atmosphere-Ocean Interactions), Ed. W. Perrie, WPI Press, Boston, p. 115-153.
- Bao, J.-W., S. A. Michelson, and J. M. Wilczak: 2002: Sensitivity of numerical simulations to parameterizations of roughness for surface heat fluxes at high winds over the sea. *Mon. Wea. Rev.*, **130**, 1926-1932.
- Fairall, C.W., J.D. Kepert and G.J. Holland, 1994: The effect of sea spray on surface energy transports over the ocean. *The Global Atmosphere and Ocean System*, **2**,121-142.
- Kepert, J. D., C. W. Fairall, and J.-W. Bao, 1999: Modeling the interaction between the atmospheric boundary layer and evaporating sea spray droplets. Air-Sea Fluxes: Momentum, Heat, and Mass Exchange, G. L. Geemaert, Editor, Kluwer, Dordrecht, 363-409.

Research Partners for this Project:

- NOAA/NCEP EMC
- NOAA Atlantic Oceanographic & Meteorological Laboratory
- University of Miami
- University of Rhode Island
- Naval Research Laboratory

On the Web:

- http://www.esrl.noaa.gov/psd/psd3/hurricane/

NOAA Earth System Research Laboratory

Physical Sciences Division

325 Broadway

Boulder, CO 80305