Hurricane Forecasts with a Global Mesoscale Model on the NASA Columbia Supercomputer

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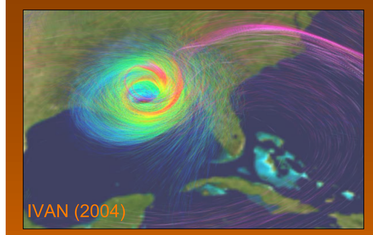
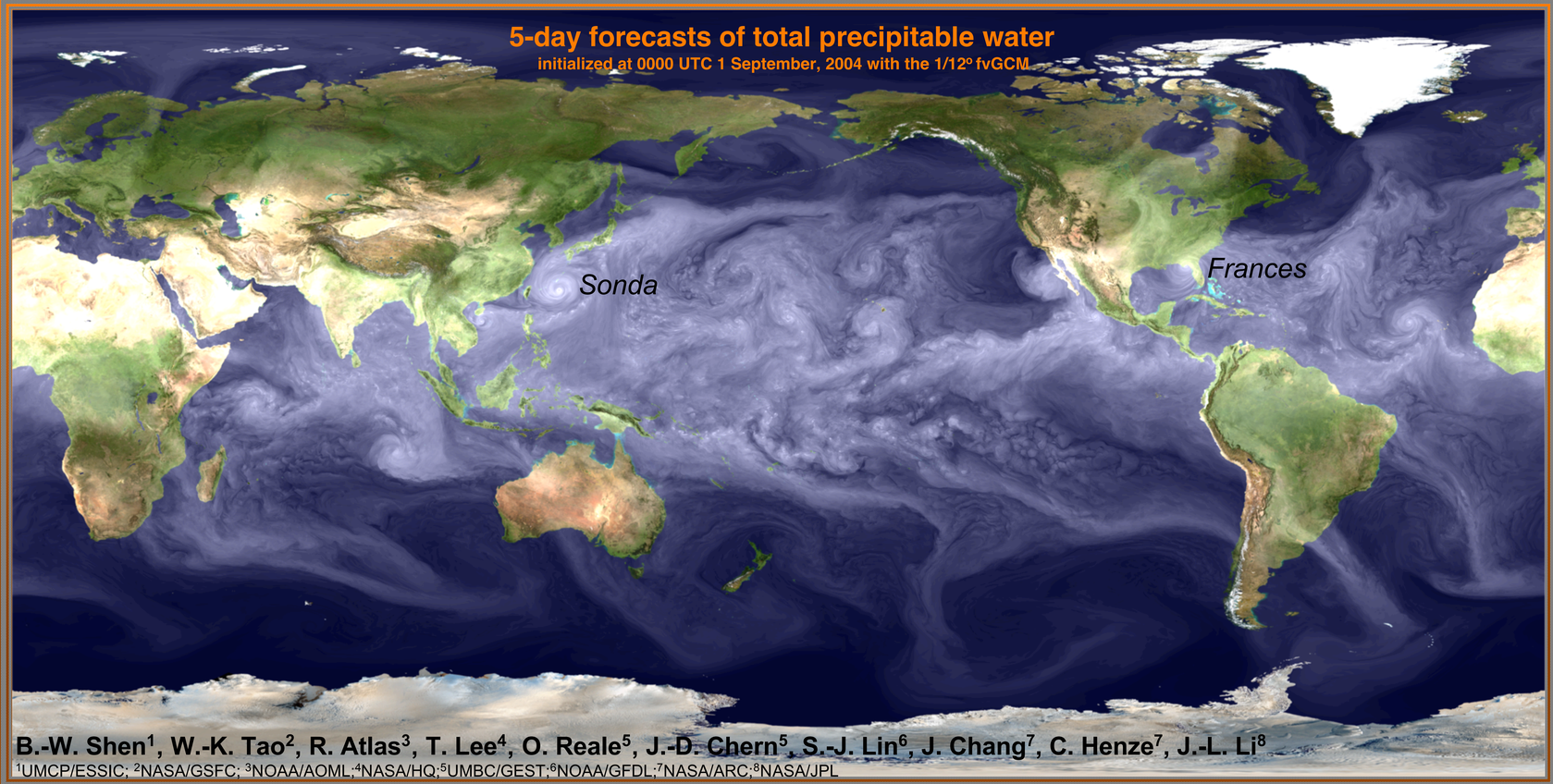
It is known that General Circulation Models (GCMs) have insufficient resolution to accurately simulate hurricane near-eye structure and intensity. The increasing capabilities of high-end computers have changed this. In 2004, the finite-volume General Circulation Model (fvGCM) at a 1/4 degree resolution, doubling the resolution used by most of operational NWP centers at that time, was implemented and run on the NASA Columbia Supercomputer to obtain promising landfall predictions for major hurricanes. In 2005, we successfully implemented the 1/8 degree version, and demonstrated its performance on intensity forecasts with hurricane Katrina (2005). It is found that the 1/8 degree model is capable of simulating the radius of maximum wind and near-eye wind structure, and thereby promising intensity forecasts. In this study, we will further evaluate the model's performance on intensity forecasts of hurricanes Ivan, Karl (2004), Dennis, Emily, Katrina, Rita (2005) and Daniel (2006).

The Finite-volume GCM (fvGCM) is a next generation modeling system based on a finite-volume dynamical core (Lin, 2004, *MWR, 2293-2307*), the community built physical parameterization schemes and land surface model at NCAR. Initial conditions are obtained from the state-of-the-art data assimilation system at NOAA/NCEP.



The Columbia Supercomputer
- 20 SGI® Altix™ superclusters, each with 512 CPUs.
- 10,240 Intel Itanium® II CPUs, current processor speed: 1.5 GHz current cache: 6 MBs
- 1 TB of memory per 512 CPUs, with 20 TB total memory



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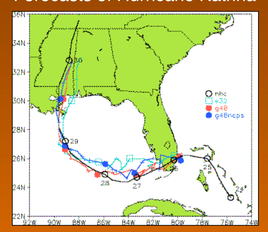
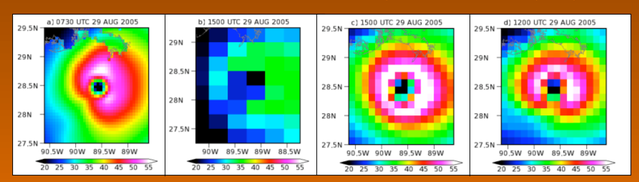
[1]UMCP/ESSIC; [2]NASA/GSFC; [3]NOAA/AOML;[4]NASA/HQ;[5]UMBC/GEST;[6]NOAA/GFDL;[7]NASA/ARC;[8]NASA/JPL

Model Validations
- Forecasts of hurricanes Gustav, Isidore (2002), Bonnie, Charley, Frances (2004), Emily and Katrina (2005) (Atlas et al., 2005, *GRL*, 32, L0307; Shen et al., 2006a,*GRL*, 33, L13813)
- Simulations of mesoscale eddies associated with surface forcing (e.g., the Catalina Eddy, the Hawaii Wake, Shen et al., 2006b, *GRL*, 33, L05801)
- Simulations of a Mei-Yu front accompanied by a drifting meso-cyclone (in preparation)

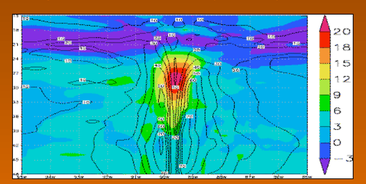
Forecasts of Hurricane Katrina



Near-eye Wind Distributions in a 2ºx2º box (a) AOML high-resolution surface wind analysis, (b) the 0.25º 99h simulations, (c) the 0.125º 99h simulations, (d) the 0.125º 96h simulations without convection parameterizations (CPs).

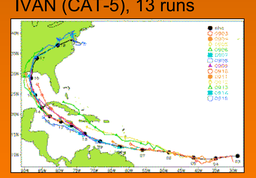


Vertical Structure of Katrina: 96h simulations of horizontal wind speeds (black) and temperature differences (shaded) with no CPs

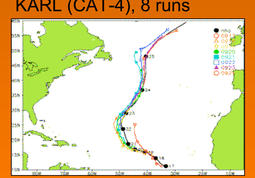


64 Track and Intensity Forecasts of Intense Hurricanes with no Cumulus Parameterizations

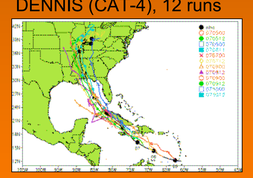
IVAN (CAT-5), 13 runs



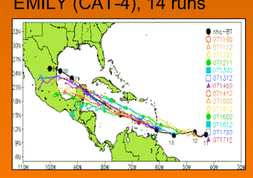
KARL (CAT-4), 8 runs



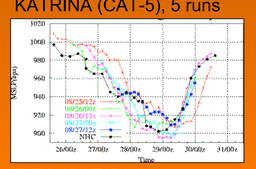
DENNIS (CAT-4), 12 runs



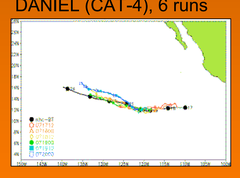
EMILY (CAT-4), 14 runs

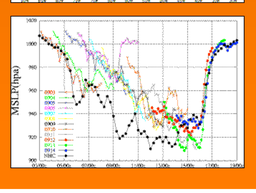


KATRINA (CAT-5), 5 runs

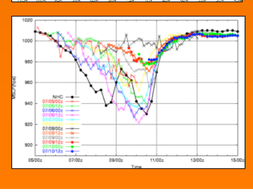


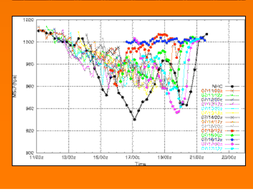
DANIEL (CAT-4), 6 runs



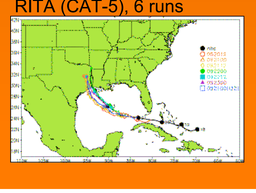


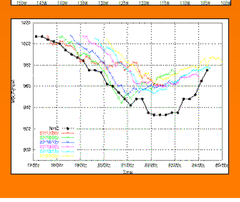
Res	x	y	# of cells
1/4º	1000	721	721 K
1/8º	2880	1441	~4 M
1/12º	4500	2251	~10 M





RITA (CAT-5), 6 runs





Concluding Remarks

The global mesoscale model has been implemented on the NASA Columbia supercomputer and produced promising forecasts for major hurricanes in 2004 and 2005. High-resolution simulations with and without cumulus parameterizations will be analyzed thoroughly to understand the dynamics of simulated storms. A high-resolution data assimilation system with better resolved vortices is expected to further improve predictive skill.