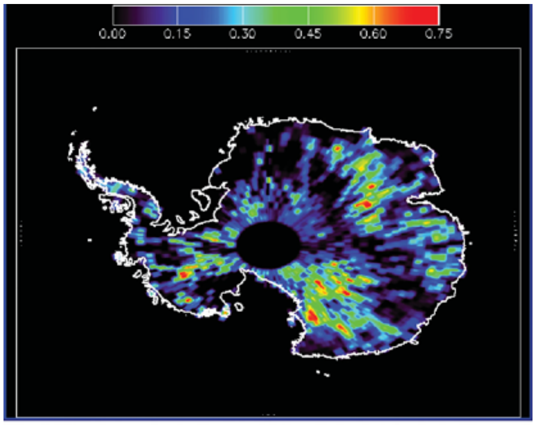
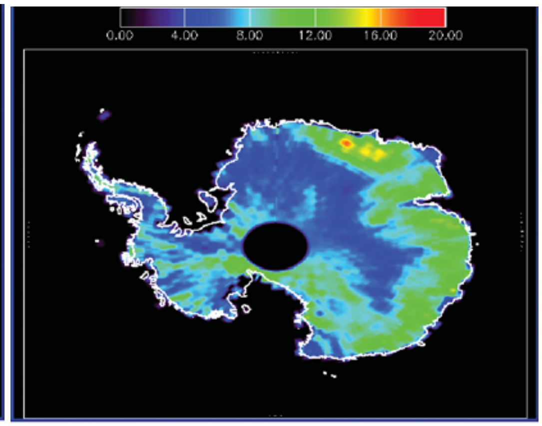
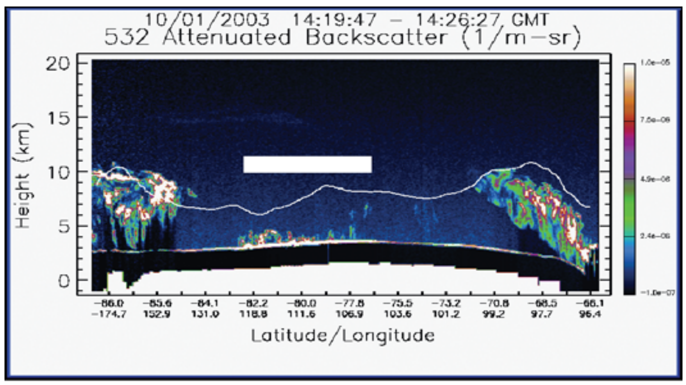


Blowing snow frequency of occurrence for Oct. 2003 from GLAS data analysis.



Surface wind speed from NSIDC model for Oct. 2003.



GLAS data track across Antarctica. The heavy white line is where blowing snow at the surface is detected. The thin white line shows the relative wind speed.

Figure 5.2. Relationship of wind speed to blowing snow across Antarctica.

5.4.4 Hurricane Research

The hurricane research carried out by the Laboratory helps address the central question of NASA's mission in this area: How can weather/hurricane forecasts be improved and made more reliable over longer periods of time using computer modeling? To address this question we have used the computational power of the Columbia supercomputer at AMES research center running the finite-volume General Circulation model (fvGCM) to study, for example, five-day track predictions and the intensity evolution of Hurricane Katrina in August 2005. The term 'fvGCM' has been historically used to refer to the model developed over 10 years at the NASA Goddard Space Flight Center and previously referred to as the NASA fvGCM. In addition to the finite-volume core it now includes the NCAR Community Climate Model 3 (CCM3) physics and the NCAR Community Land Model (CLM)

As of July 2006, three articles highlighting computations completed on Columbia since it came on-line in summer 2004 have been published. Two of them have been selected as American Geophysical Union Journal Highlights, and one has been cited as pioneering work (by Professor Roger Pielke, Sr. of Colorado State University). Recently, an article for the high-resolution simulations of Hurricane Katrina (2005) has been highlighted in Science magazine.

The 2005 Atlantic hurricane season was the most active in recorded history. There were 28 tropical storms and 15 hurricanes, four of which were rated Category 5. Hurricane forecasts pose challenges for General Circulation Models

(GCMs), the most important being the horizontal grid spacing. It is well known that GCMs' insufficient resolutions undermine intensity predictions. Thanks to the considerable computing power of Columbia, this limitation can now be overcome. The main goal of this research, supported by NASA's Weather Data Analysis and Assimilation Program, Earth Sciences Division, is to study the impacts of increasing resolution on numerical weather/hurricane forecasts, aimed at improving forecast accuracy. With the unprecedented computing resources provided by Columbia, it was possible to increase the horizontal resolution of the fvGCM to 1/4 degree in early 2004 and 1/8 degree in early 2005. Improvement stemming from higher resolution was illustrated by calculation of the intensity evolution of hurricane Katrina in which six 5-day forecasts with the 1/8-degree fvGCM obtained promising forecasts with small errors in center pressure of only ±12 hpa. It was also shown that the notable improvement in Katrina's intensity forecasts occurred when grid spacing decreased from 1/4 degree to 1/8 degree, which is sufficient to simulate the near-eye wind distribution and to resolve the radius of maximum winds. In addition to the computational issue, the validity of physics parameterizations poses a challenge to conducting ultra-high resolution simulations. Among these, convective parameterization (CP) is recognized as a crucial limiting factor affecting hurricane forecasts. The fvGCM was used with and without CP to simulate Katrina's track, intensity, and near-eye wind distribution.

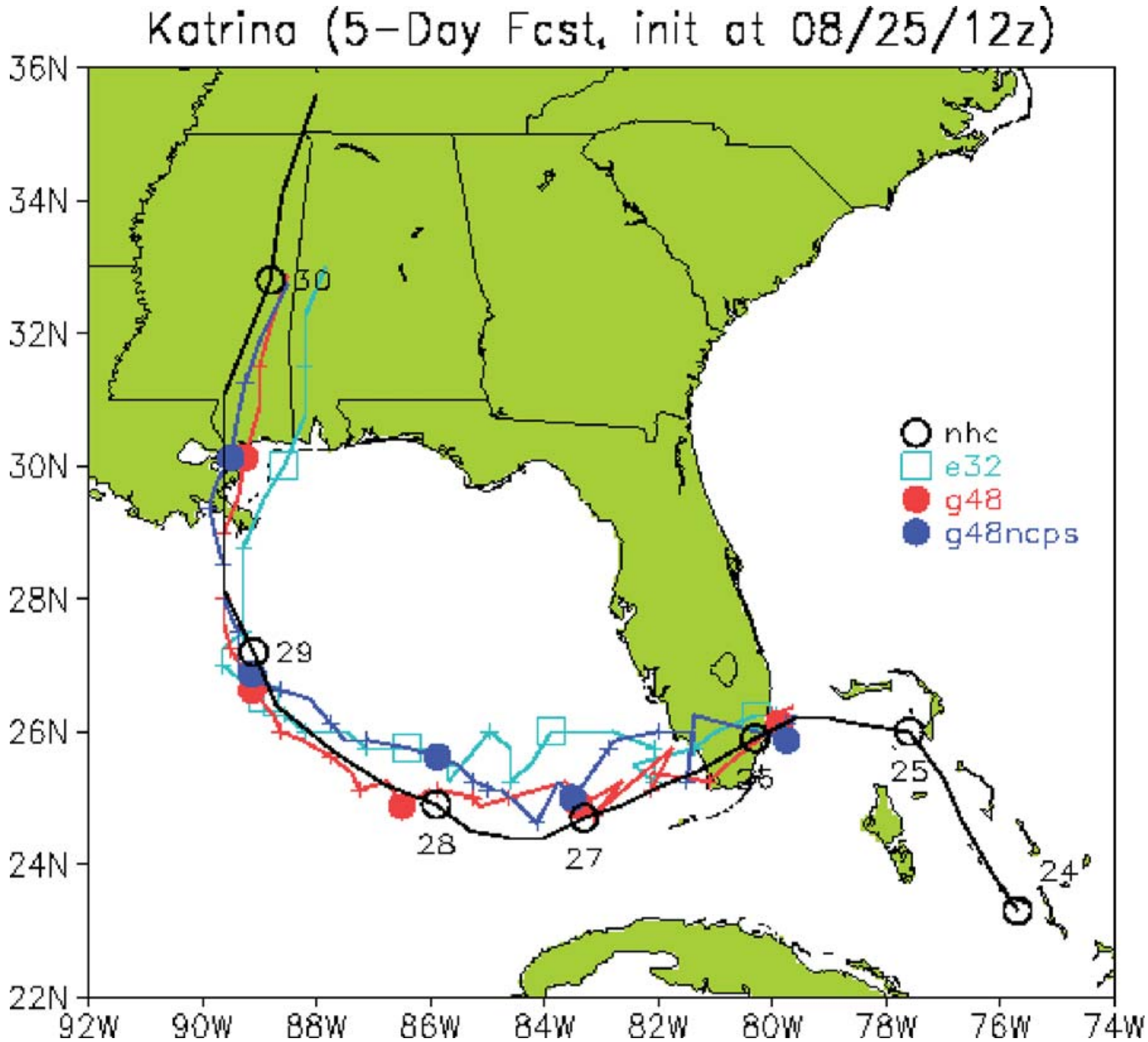


Figure 5.3. Five-day track predictions for hurricane Katrina initialized at 1200 UTC August 25, 2005. The light blue, red, and blue lines represent the tracks from 0.25°, 0.125° simulations, and 0.125° simulation with no CP. Each dot represents the center position at 3-hour time increments. The black line represents the advisory track with a 6-hour time increment from the National Hurricane Center.

Recently, the model's performance on intensity forecasts of major hurricanes was presented at the AGU 2006 Fall Meeting. In addition, the fvGCM at 1/12-degree resolution is being tested. The 1/12-degree fvGCM is the first global weather model with single digit resolution: 9 km at the equator and 6.5 km at mid-latitudes. For further information contact Bo-Wen Shen, Bo-Wen.Shen.1@gsfc.nasa.gov.

5.5 Instrument Development

The Instrument Systems Report, NASA/TP-2005-212783, described the status of instrument development in the Laboratory as of mid-2005. This section describes some of the developments since publication of that report.

5.5.1 High-Altitude Imaging Wind and Rain Airborne Profiler

A dual-wavelength (Ku and Ka band) High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) is under development for the NASA Instrument Incubator Program (IIP) for measuring tropospheric winds within precipitation regions and ocean surface winds in rain-free to light-rain regions. This instrument is being designed for operation on high-altitude manned aircraft and the Global Hawk UAV. Proposed lidar-based systems will provide measurements in cloud-free regions globally. Since many of the weather systems are in disturbed regions that contain precipitation and clouds, microwave-based techniques are more suitable in these regions. Airborne radars at NASA and elsewhere have shown the ability to measure winds in precipitation and clouds. These radars have not generally been suitable for deriving the full horizontal wind from above cloud systems (high-altitude or space) that would require conical scan. HIWRAP is a conical scan radar that uses new technologies that utilize solid state rather than tube-based transmitters. A prototype sensor will be completed and tested on the high-altitude WB-57F aircraft in late 2008 to demonstrate the system level performance of the instrument. For further information contact Gerry Heymsfield, Gerald.M.Heymsfield@nasa.gov.

5.5.2 Shared Aperture Diffractive Optical Element

ESTO funds the development of a Shared Aperture Diffractive Optical Element (ShADOE) telescope under their Advanced Component Technology program. The ShADOE telescope will eliminate most or all mechanical moving components by sequentially "addressing" several holograms multiplexed into a single optic in order to scan over the multiple fields of view. This last development should reduce the weight of large aperture scanning receivers by a factor of three. The objectives of the ShADOE project are as follows:

- Enable atmospheric Doppler (e.g. wind profiling) and surface-mapping lidar applications from space;
- Develop diffraction-limited holographic, or diffractive optical, elements for use with 2054 nm wavelength lasers and near-diffraction limited ShADOEs for use at 355 nm;
- Demonstrate an angle-multiplexed, multi-wavelength ShADOE telescope suitable for use with single and dual-wavelength lidars.

For more information on this technology, visit the Web site at http://estips.gsfc.nasa.gov/qc/images/1158.jpg or contact Bruce Gentry (Bruce.M.Gentry@nasa.gov).

5.5.3 Tropospheric Wind Lidar Technology Experiment

Global measurement of tropospheric winds is a key measurement for understanding atmospheric dynamics and improving numerical weather prediction. Global wind profiles remain a high priority for the operational weather community and also for a variety of research applications including studies of the global hydrologic cycle and transport studies of aerosols and trace species. In addition to space-based winds, a high-altitude airborne system flown on UAV or other advanced platforms would be of great interest for studying mesoscale dynamics and hurricanes. The TWiLiTE project is funded by ESTO as part of the IIP. TWiLiTE will leverage significant research and development investments in