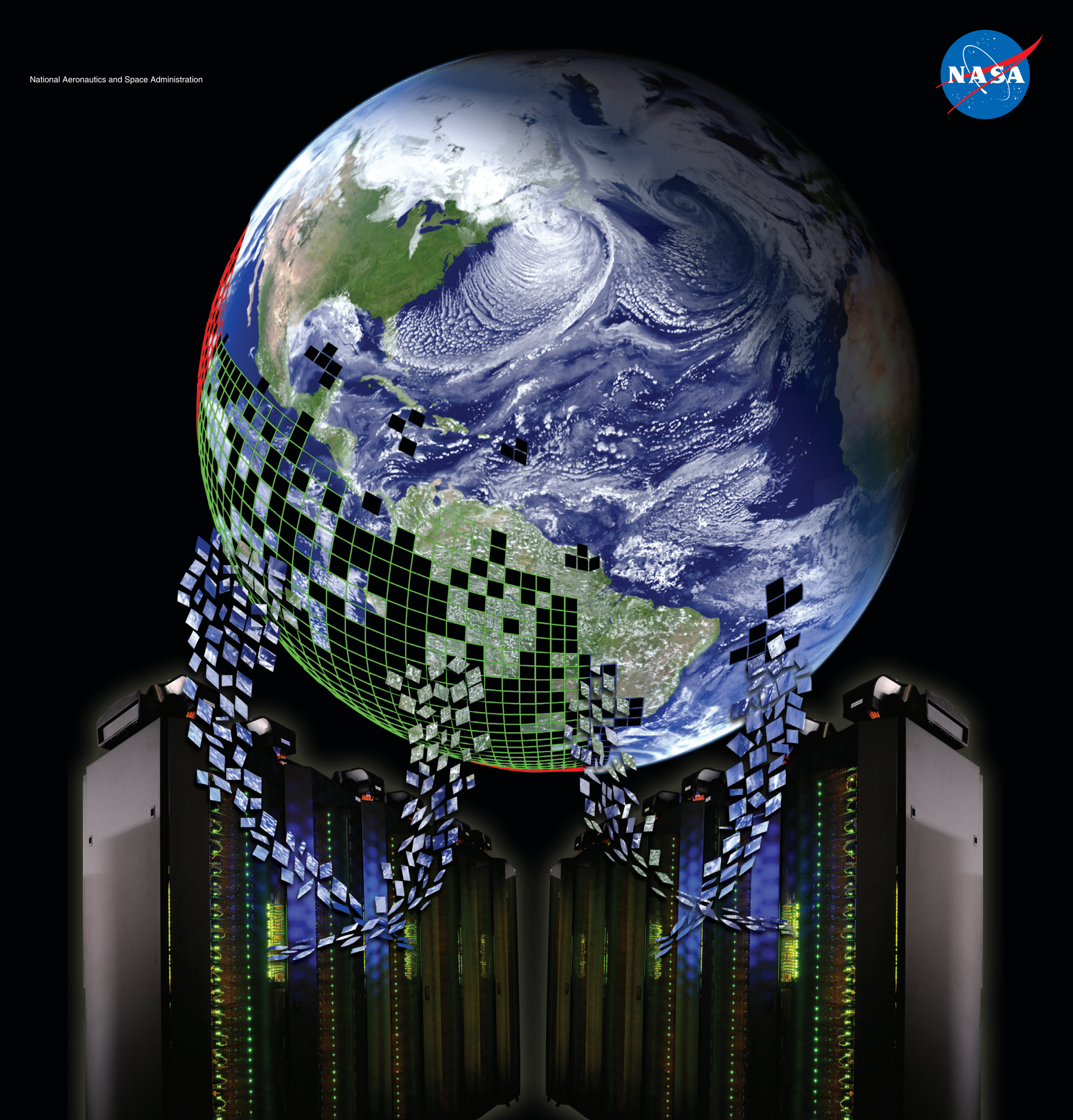
National Aeronautics and Space Administration



# NCCS

## NASA Center for Climate Simulation

www.nasa.gov

Debuting in Spring 2010, the **NASA Center for Climate Simulation (NCCS)** is the new name for a Goddard Space Flight Center organization that has provided supercomputing resources to NASA scientists and engineers for over 25 years.

NCCS offers an integrated set of supercomputing, visualization, and data interaction technologies to enhance agency capabilities in weather and climate prediction. It serves hundreds of users at Goddard, other NASA centers, laboratories, and universities across the U.S.

The NCCS centerpiece is the Discover supercomputer, which links thousands of Intel Xeon processors to perform trillions of operations per second. Discover-hosted simulations span time scales from days (weather prediction) to seasons and years (short-term climate prediction) to decades and centuries (climate change projection). Highlights include:

- 3.5-kilometer global simulations producing cloud and hurricane features at groundbreaking fidelity for a global model
- A comprehensive reanalysis of the last 30 years of weather and climate—one of the largest assimilation datasets available today
- Climate change projections for the Intergovernmental Panel on Climate Change going back a full millennium and forward to 2100

In addition to a powerful supercomputer, NCCS supports users with a massive data archive, a new data management system, expanded data analysis and visualization capabilities featuring a 17- by 6-foot multi-screen visualization wall, and services for distributing simulation data to users and the broader climate research community.

Visit us at **http://www.nccs.nasa.gov**

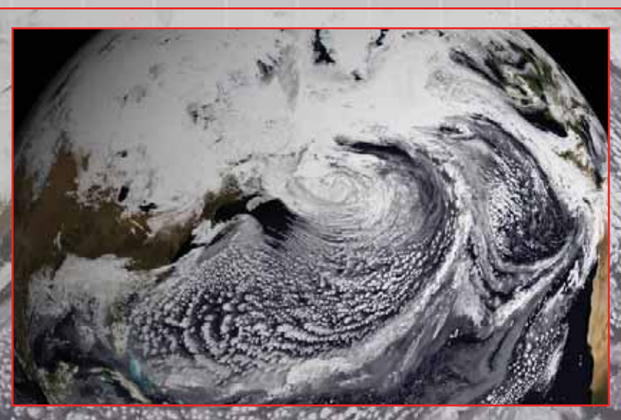
# NCCS Climate Simulation Results

## Weather Prediction

Time Scale: Days

### GEOS-5 Modeled Clouds at 3.5-Kilometer Global Resolution

Model: Goddard Earth Observing System Model, Version 5 (GEOS-5) – Global Modeling and Assimilation Office (GMAO)/Goddard Space Flight Center

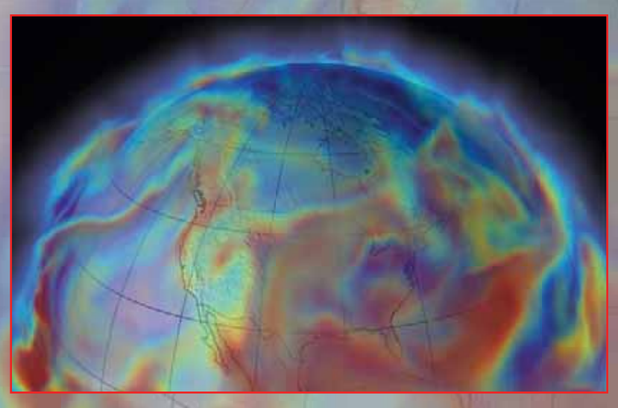


This visualization shows clouds from a simulation using a cubed-sphere version of GEOS-5. The global atmospheric simulation ran at 3.5 kilometers per grid cell—equaling the highest resolution to date for a global climate model—and covered a single day: January 2, 2009.

*Research: W. Putman, NASA/GSFC; Visualization: G. Shirah, NASA/GSFC*

### Modern Era Retrospective-analysis for Research and Applications (MERRA)

Model: Model: GEOS-5 Data Assimilation System – GMAO



MERRA is producing a comprehensive record of Earth's weather and climate from 1979, the beginning of the operational Earth-observing satellite era, up to the present. This visualization depicts specific atmospheric humidity on June 17, 1993, during the Great Flood that hit the Midwestern United States.

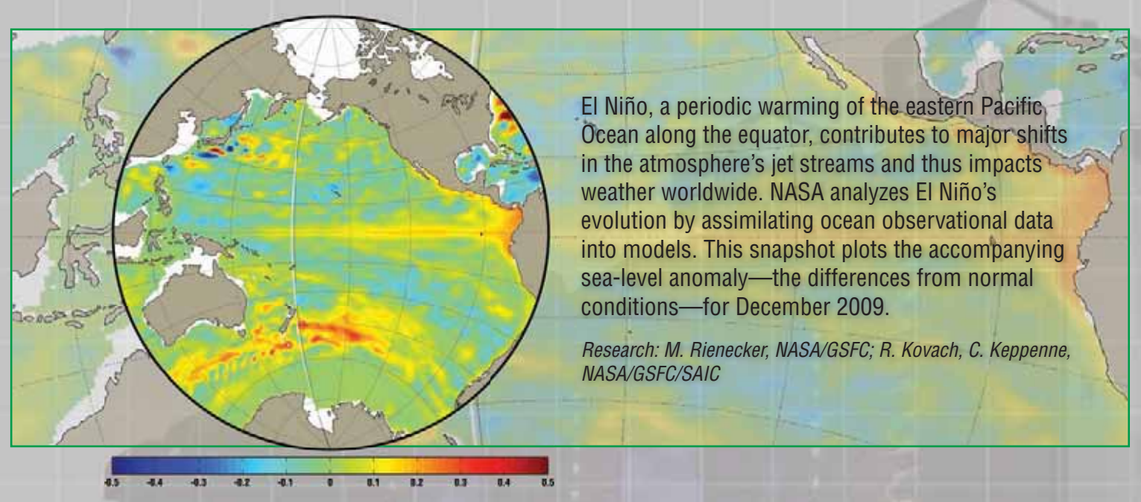
*Research: M. Rienecker, M. Suarez, R. Gelaro, J. Bacmeister, R. Todling, L. Takacs, E. Liu, S. Pawson, M. Bosilovich, S. Schubert, G. Kim, NASA/GSFC; Visualization: T. Schindler, NASA/GSFC/UMBC*

## Short-Term Climate Prediction

Time Scale: Seasons to Years

### El Niño Sea-Level Anomaly Analysis

Model: Poseidon V4 Ocean Model – GMAO and George Mason Univ.; Ensemble Kalman Filter (EnKF) Assimilation – GMAO



El Niño, a periodic warming of the eastern Pacific Ocean along the equator, contributes to major shifts in the atmosphere's jet streams and thus impacts weather worldwide. NASA analyzes El Niño's evolution by assimilating ocean observational data into models. This snapshot plots the accompanying sea-level anomaly—the differences from normal conditions—for December 2009.

*Research: M. Rienecker, NASA/GSFC; R. Kovach, C. Keppenne, NASA/GSFC/SAIC*

### The Role of Black Carbon in Himalayan Warming

Models: Goddard Chemistry Aerosol Radiation and Transport (GOCART) Model – Laboratory for Atmospheres/ Goddard Space Flight Center; GEOS-5 – GMAO

Black carbon, or soot, is formed from the burning of fossil fuels and biomass and lingers in the atmosphere for days or weeks before being deposited on the land or ocean. A simulation following black carbon production and movement for over 3 months confirmed that soot and dust contribute as much (or more) to atmospheric warming in the Himalayas as greenhouse gases.

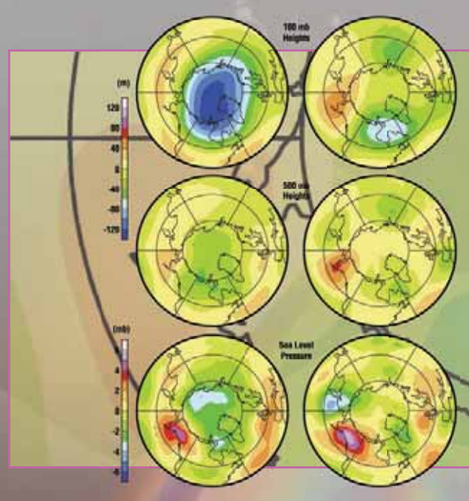
*W. Lau, P. Colarco, A. da Silva, M. Chin, NASA/GSFC; Visualization: H. Mitchell, NASA/GSFC*

## Near-Term Climate Change Projection

Time Scale: Decades

### The Ozone Hole and Global Warming Patterns: A New Interpretation

Model: Global Climate Middle Atmosphere Model 3 – Goddard Institute for Space Studies (GISS)

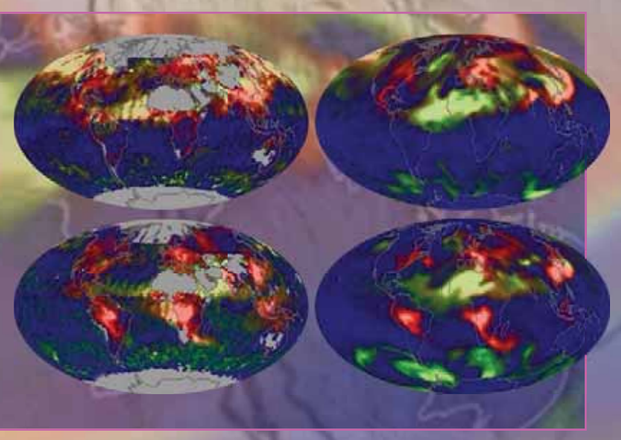


The left column shows the modeled Northern Hemisphere (NH) height/pressure pattern anomalies associated with the Southern Hemisphere (SH) ozone hole. The right column shows the same diagnostics for a model experiment that adds an NH ozone hole. Results are for the lower stratosphere (100 mb), the mid-troposphere (500 mb), and the surface (sea level pressure). The SH ozone hole produces a very different stratospheric circulation and height/pressure response pattern, which influences the geographical pattern of warming in the NH.

*Research: D. Rind, NASA/GISS; J. Jonas, P. Lonergan, Columbia Univ.; S. Stammerjohn, NASA/GISS and Univ. of California, Santa Barbara*

### Global Modeling of Aerosols and their Impacts on Climate and Air Quality

Model: GOCART Model – Laboratory for Atmospheres



The visualizations depict aerosol optical depth observed by the Moderate Resolution Imaging Spectroradiometer (MODIS) (left) and simulated by the GOCART model (right) for April 13, 2001 (top) and August 22, 2001 (bottom). April 13 sees transport of heavy dust (green) and pollution (red) from Asia to the Pacific, and dust (green) transport from Africa to the Atlantic. August 22 sees large smoke plumes (red) over South America and Southern Africa.

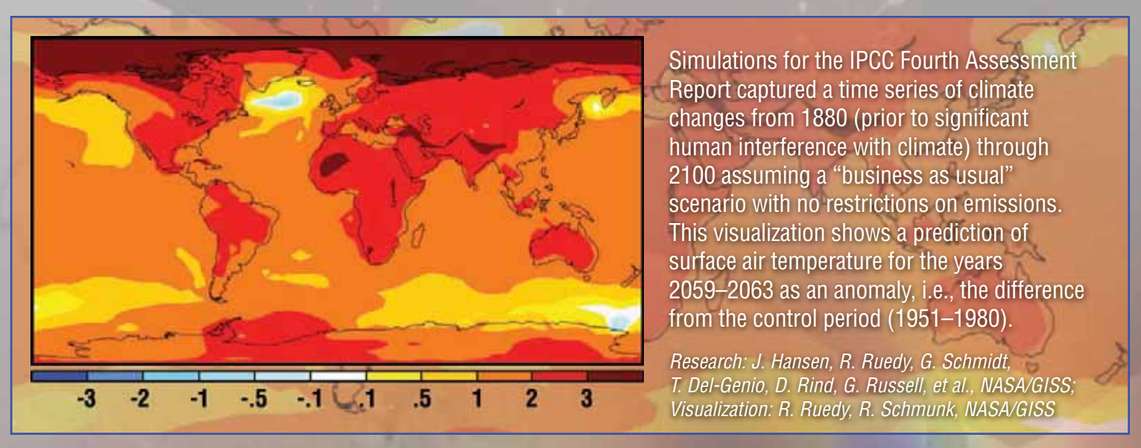
*Research: M Chin, NASA/GSFC; T. Diehl, H. Bian, H. Yu, Q. Tan, T. Kucsera, NASA/GSFC/UMBC*

## Long-Term Climate Change Projection

Time Scale: Centuries

### Simulations of 1880–2100 for the Intergovernmental Panel on Climate Change (IPCC)

Model: ModelE – GISS

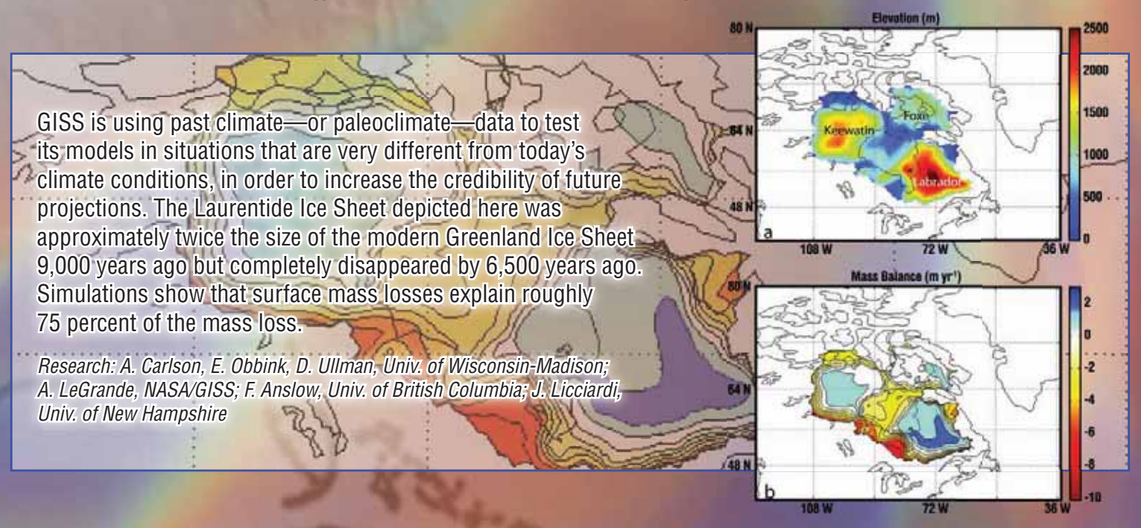


Simulations for the IPCC Fourth Assessment Report captured a time series of climate changes from 1880 (prior to significant human interference with climate) through 2100 assuming a "business as usual" scenario with no restrictions on emissions. This visualization shows a prediction of surface air temperature for the years 2059–2063 as an anomaly, i.e., the difference from the control period (1951–1980).

*Research: J. Hansen, R. Ruedy, G. Schmidt, T. Del-Genio, D. Rind, G. Russell, et al., NASA/GISS; Visualization: R. Ruedy, R. Schmunk, NASA/GISS*

### Past and Future: Applications for Paleoclimate Research

Models: ModelE-R – GISS; Energy-Moisture Mass Balance Model – Oregon State Univ.




GISS is using past climate—or paleoclimate—data to test its models in situations that are very different from today's climate conditions, in order to increase the credibility of future projections. The Laurentide Ice Sheet depicted here was approximately twice the size of the modern Greenland Ice Sheet 9,000 years ago but completely disappeared by 6,500 years ago. Simulations show that surface mass losses explain roughly 75 percent of the mass loss.

*Research: A. Carlson, E. Obbink, D. Ullman, Univ. of Wisconsin-Madison; A. LeGrande, NASA/GISS; F. Anslow, Univ. of British Columbia; J. Licciardi, Univ. of New Hampshire*

EW-2010-4-034-GSFC