

U.S. Geological Survey Role in Reducing Uncertainties and Refining Scenarios for Climate Modeling

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**The U.S. Geological Survey *does* have an interest
in projections, uncertainty, and scenarios:**

***We do modeling* of hydrology and land surface processes.**

However, for climate models:

**We think our best contributions are to provide measurements
and data to refine, constrain, and validate models.**



USGS Earth Surface Dynamics Program

Modeling and Forecasting:

- Coupled atmosphere-land and biosphere models**
- Visualization software, for land use and landscape change**
- Mandate: aid land management decision-makers**



Land surface modeling in Earth Surface Dynamics Program:

Hemispheric boundary layer

Shear stress imposed by the atmosphere on the ground:

- particle movement thresholds and estimates of surface roughness in areas of mixed cover by plants and rocks.**

On-site measurements of dust flux and wind strength.

Remote sensing for sites you can't visit but must model.

Purpose:

Erosion susceptibility

Magnitude of dust generation

Modeling re-creation of droughts of 1930's and 16th Century.



USGS Hydrologic models:

Downscaling of atmospheric models, to drive hydrologic models

Western U.S. basins (Rio Grande and Gunnison Rivers)

Collaboration with the five “stans” of Central Asia (former Soviet Union), for snowmelt runoff models and to fill gaps in recorded data from the past.



National Ice Core Lab (NICL)*

**Archives of model-constraining records:
Past atmospheric composition and deposition (trace gasses, dust,
salt, temperature, precipitation rates).**

**Hoping for wider collaboration with other institutions and agencies, centering on NICL (continued science inquiry through
Climate Change Research Initiative (CCRI)).**

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**Example of using measured and interpreted data
for validating models:**

**Borehole thermometry showed how much colder it really was in
Greenland during the Late Glacial Maximum (LGM).**

**(It was 21°C colder! Interpretations based on light stable iso-
topes said 8°C. The isotope measurement interpretation was in-
correct because present moisture source areas were ice-covered
during the LGM, and because the measurements reflected only
summer temperatures. Now, use of a “polar version” of MM5 by
Oregon State University (OSU) confirms the USGS’s 21°C value.)**

**This was a “model validation point” for climate at time of the
LGM.**



More on borehole thermometry:

Medieval Warm Period (MWP) and Little Ice Age (LIA) are departures from the overall cooling trend of the last 4,000 years (in the North Atlantic region).

***But* borehole thermometry shows a different story between west Antarctic and Greenland sites:**

Greenland temperatures confirm the MWP and LIA departures.

In west Antarctica, Medieval time was the coldest of the last 4,000 years, and the LIA was 2°-3°C warmer than the overall trend (there were opposite climatic features in the two polar regions).

This finding is a constraint on modeling the causes of the MWP and LIA (evaluation of the “free variation” of the system, “bi-polar see-saw”).

[From borehole thermometry, we know temperatures through this time interval to an accuracy of 0.5°C.]

**Further example of USGS work to constrain
past climate conditions:**

Measuring amounts of dust and salt, and chemical type of dust in polar ice sheets can serve as a set of firm constraints on:

- (1) Past wind strengths**
- (2) Extent of sea ice cover**
- (3) Changing continental source areas of dust**

Here's the "shorthand" climate parameter summary, from precise measurements of dust and salt in west Antarctic ice cores, from mid-Wisconsinan glaciation, into the Holocene:

Dust dominated the total mixture of dust and salt (70-80 percent dust) in full glacial times (strong winds from continents; ice covered ocean). This gave way to a steady decrease in the fraction of dust through the Holocene (to only 20-30 percent dust; more ice-free ocean to provide salt). But there was an apparent "relapse" to dominance of dust for a period of a few hundred years or more, at about 10 ka (brief return of sea ice). Dust had a strongly potassic character from the time of the glacial maximum or earlier (distinctive continental source). That changed to a more calcic composition between 6 and 10 ka (different source areas), but it never had much carbonate material, at any time. Total amounts of dust and salt deposited by the atmosphere onto the ice sheet at Taylor Dome were much greater in glacial times than during the Holocene, and greater at the glacial maximum than just before the termination (varying wind strengths).

See plots on next page.



