Data Products from the Ice, Cloud, and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) at the National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC)

Heidi Schumacher, Siri Jodha Singh Khalsa, Melinda Marquis, John Maurer and Matt Savoie
National Snow and Ice Data Center, University of Colorado http://nsidc.org nsidc@nsidc.org

The Geoscience Laser Altimeter System (GLAS) is the sole instrument developed to fly on the Ice, Cloud, and land Elevation Satellite (ICESat). The ICESat mission is an integral part of the NASA Earth Science Enterprise (ESE). ICESat launched on January 13, 2003. The National Snow and Ice Data Center (NSIDC) archives Level 0, Level 1A, Level 1B and Level 2 products from the GLAS instrument. NSIDC currently has an 8 day sample data set (GLA01 to GLA15) from Laser 1 available to users.

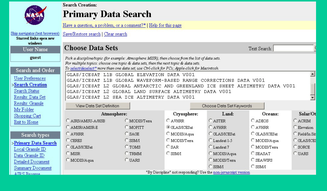
ICESat/GLAS (Laser Data) vs. Radar Data

One of the most substantial problems with radar data is the large footprint, which is typically in the range of 1-10 km. Significant radar altimetry errors are introduced over sloping and undulating surfaces, which are prominent over 10-15% of the Greenland and Antarctic ice sheets. Also, some of the energy radiated by a radar altimeter actually penetrates into the ice surface, which introduces elevation errors as well. An advantage to employing radar, however, is that it can penetrate clouds.

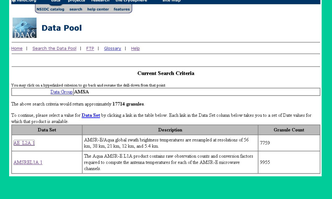
A satellite laser altimeter operates with a very narrow beam so it illuminates a relatively small footprint on the ice sheet surface (GLAS = 60 m at nadir), which significantly reduces errors introduced by sloping surfaces. Further, laser altimeters operate at wavelengths which do not significantly penetrate the ice surface so that a true surface elevation is measured. A limitation to employing a laser altimeter for measuring surface elevations is that it cannot penetrate clouds. However, this allows a laser altimeter to measure the vertical distribution of clouds and aerosols in the atmosphere.

Access to ICESat/GLAS data at NSIDC

ICESat data are available via the Earth Observing System (EOS) Data Gateway (EDG), a web-based search-and-order tool that provides a way for users to search for Earth Science data from multiple participating archives.
http://nsidc.org/~imswww/pub/imswelcome



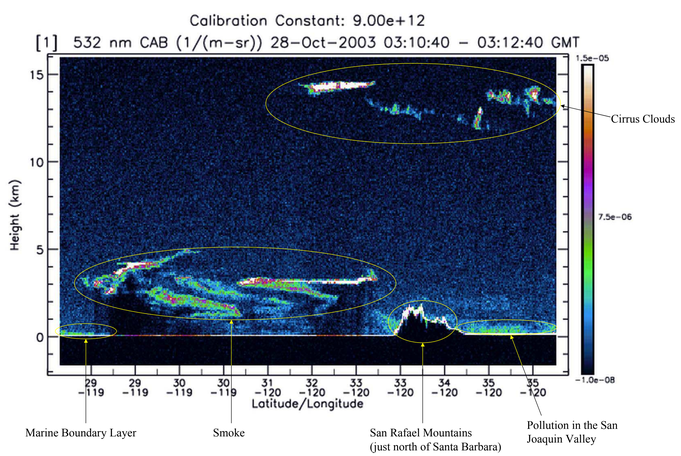
ICESat data are also available via the Data Pool, a short-term data cache that provides direct FTP access to several NSIDC products. A simple web search interface helps you to quickly locate data of interest.
http://nsidc.org/data/data_pool



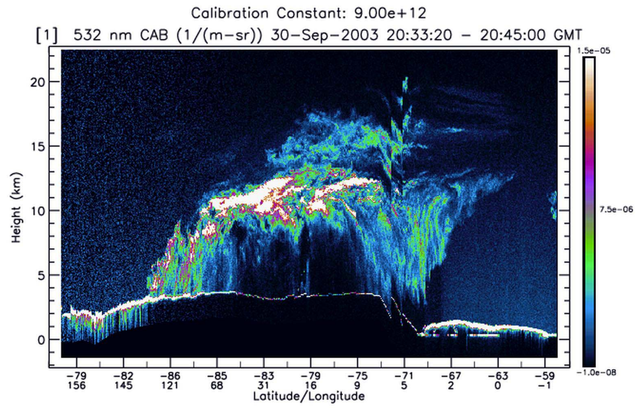
NSIDC User Services Staff is responsible for providing responses to user inquiries related to ICESat data. Send e-mail to "nsidc@nsidc.org" or call +1-303-492-6199.

Further information regarding ICESat data can be found at
http://nsidc.org/daac/icesat.

Sample Images from GLAS

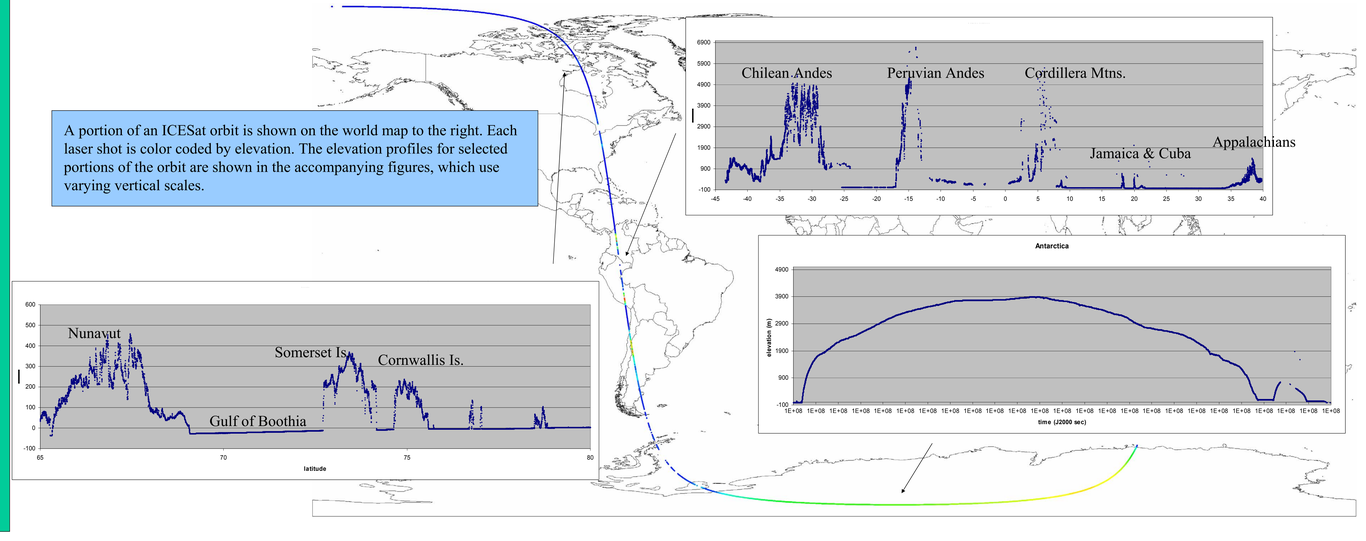


This image shows smoke from the wildfire near Santa Barbara, CA, on October 28, 2003, in addition to other interesting features. This image illustrates the calibrated attenuated backscatter data from the GLAS instrument, which is found in the Level 1B data product (GLA01): GLAS/ICESat L1B Global Backscatter Data.



This image shows clouds ranging from the surface to the tropopause over Antarctica. The temperature structure near and above the tropopause (~12 km) on this day supports the existence of Polar Stratospheric Clouds (PSCs). Like the California wildfire image, this image also illustrates the calibrated attenuated backscatter data from the GLAS instrument, which are found in the GLA07 data product.

A portion of an ICESat orbit is shown on the world map to the right. Each laser shot is color coded by elevation. The elevation profiles for selected portions of the orbit are shown in the accompanying figures, which use varying vertical scales.



Applications

The ICESat mission has two sets of objectives.

The primary objectives relate to the cryosphere and rely on altimetry:
- To provide accurate, high resolution elevation measurements of the Greenland and Antarctic ice sheets.
- Determine the present-day mass balance of the ice sheets and estimate present and future contributions of the ice sheets to global sea level rise.
- These data will also increase our understanding of the way that changes in the ice sheets affect changes in polar climate, such as precipitation, temperature, and cloudiness.

The secondary objectives relate to the atmosphere (measurements of which rely on Light Detection and Ranging [LIDAR]), as well as to land and oceans (measurements of which rely on altimetry):
- To measure cloud heights and the vertical structure of clouds and aerosols in the atmosphere;
- To measure land topography and vegetation canopy heights;
- To measure sea ice roughness and thickness;
- To measure ocean surface elevations; and
- To measure surface reflectivity.

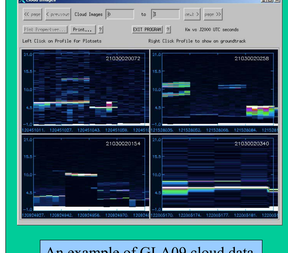
Tools

Sample source code, written in Fortran 90, that will read ICESat/GLAS data and dump it to ASCII format is available. Currently this code will compile only on Hewlett-Packard and some Sun Unix platforms. Thie code is provided so users can modify the code or create different programs to suit their needs.

Interactive Data Language (IDL) and Fortran 90 multi-platform code will be available in the future. Additionally, IDL-based visualization software for ICESat/GLAS data will be available in the future.

All products are in a flat binary format, except for GLA16, which will be in Hierarchical Data Format - Earth Observing System (HDF-EOS). GLA16 (GLAS/ICESat Global L3 Elevation and Atmosphere HDF-EOS Data) is a global product containing elevation, elevation distribution, average reflectivity, optical depths, cloud layer, aerosol and Planetary Boundary Layer heights. The data rates are 40, 5, 1, .25, and .05 Hz. Granules contain 14 orbits of data.

The images below are examples of the output of the visualization software that NSIDC will be able to provide users in the future.



An example of GLA09 cloud data, displayed by the visualization software

An example of GLA14 elevation data, displayed by the visualization software