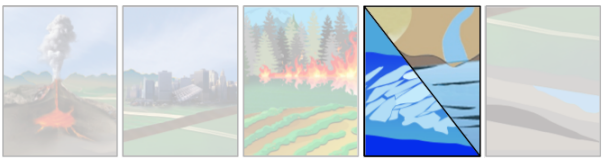
National Aeronautics and Space Administration

NISAR: The NASA-ISRO SAR Mission



Glaciers, Ice Sheets, and the Oceans

Observations of the flow of Earth's ice sheets and glaciers are critical to understanding current and future rates of sea level rise. Synthetic aperture radar can serve as a 'radar speed gun' to provide global maps of ice flow in support of sea level rise impact assessments

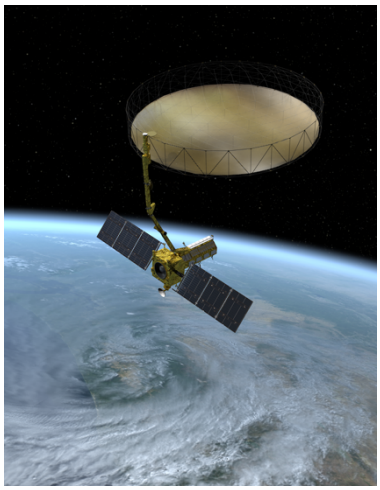
Rising Sea Level from Glaciers and Ice Sheets

Perhaps you imagine the polar ice sheets as icy white blankets at the ends of the Earth, static and majestic, but far removed from your daily life. In reality, these areas are among the most dynamic and rapidly changing places on Earth, where the forces of gravity disgorge huge icebergs to the ocean. These distant changes have very real local consequences in terms of rising sea level. As the City Manager of Galveston noted, "Whether it's man-made or cyclical, the oceans and our Gulf are rising," [Houston Chronicle, 1/1/2013]. Miami Beach has already committed nearly half a billion dollars to adapt its infrastructure to cope with rising sea levels [Miami Herald, 10/23/2015]. NISAR will measure the discharge of ice to the ocean to help improve projections of both near- and long-term sea level rise. Such information is vital for community planners trying to appropriately size infrastructure investments.

Credit: I. Joughin, U. Washington

Ice Sheets and Sea Level

A big contributor to changes sea level is the net change in the amount of ice that flows from Earth's ice sheets into the oceans. Determining either a best estimate or an upper bound for sea level rise is difficult because of a basic lack of understanding of ice-flow related processes. This difficulty directly stems from our limited knowledge about the stability of the ice sheets that enshroud most of Greenland and Antarctica with ice more than a mile thick.



The NISAR Mission – Reliable, Consistent Observations

The NASA–ISRO Synthetic Aperture Radar (NISAR) mission, a collaboration between the National Aeronautics and Space Administration (NASA) and the Indian Space Research Organization (ISRO), will provide all-weather, day/night imaging of nearly the entire land and ice masses of the Earth repeated 4-6 times per month. NISAR's orbiting radars will image at resolutions of 5-10 meters to identify and track subtle movement of the Earth's land and its sea ice, and even provide information about what is happening below the surface. Its repeated set of high resolution images can inform resource management and be used to detect small-scale changes before they are visible to the eye. Products are expected to be available 1-2 days after observation, and within hours in response to disasters, providing actionable, timely data for many applications.

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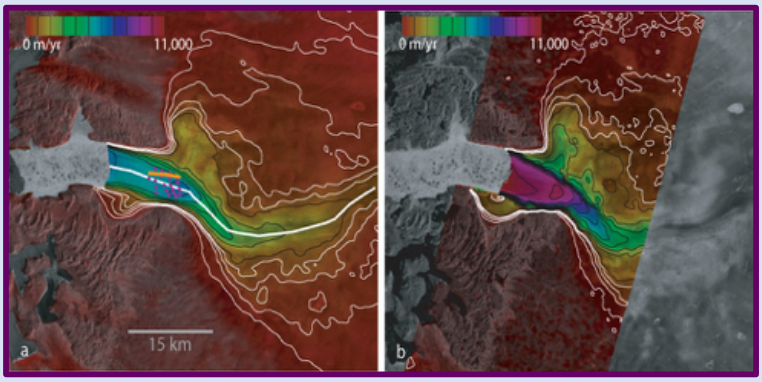
Ice sheets deform under their own immense weight, slowly moving downhill towards the coast, carrying the snowfall that has transformed to ice within their vast interiors. At the coast, large outlet glaciers and rivers of ice known as ice streams discharge ice to the ocean, just as rivers of water drain the other continents. Unlike the other continents, however, ice sheets have locked up a vast reservoir of water over the millennia that is sufficient to raise sea level by many tens of meters were it all to melt. Even a loss of 1% of the volume of water in the ice sheets would raise sea level by more than 2 feet, with severe economic consequences for low-lying coastal communities worldwide.

Today, measurements show that ice is being lost from ice sheets and glaciers, but much of it is not caused by direct melting due to warmer air temperatures. Instead, it occurs because outlet glaciers and ice streams have accelerated dramatically in their march to the coast, disgorging increased volumes of ice into the ocean. For example, Greenland's largest glacier, Jakobshavn Isbrae, has sped up nearly threefold since the 1990s. Many of Greenland's other glaciers have sped up in the 21st Century (more than 30% on average). Similarly, large glaciers in unstable regions of West Antarctica have produced substantial increases in sea level.

Disintegrating ice sheets and retreating glaciers raise sea level, yet predicting future sea level changes is difficult at present. Rising sea level will displace millions of people and adaptation will be costly. Recent observations provide only isolated snapshots of ice sheet velocity and changes, and current satellite missions miss many of the most important fast-moving glaciers. NISAR will provide systematic measurements that reveal both short-term variations and long-term trends. NISAR also will provide a time history of ice sheet and glacier behavior. In addition, NISAR will precisely measure the changing location near the coast at which glaciers begin to float, known as the grounding line. Understanding ice sheet and glacier behavior and changes will improve projections of their impacts on sea level rise. Accurate sea-level projection will improve planning of sea walls, dikes, and other mitigation strategies.

The Radar Revolution for Ice Sheets and Glaciers

Scientists only learned that glaciers could speed up dramatically in the late 1990s when spaceborne radar instruments began acquiring data over ice sheets. The international constellation of radar satellites was critical to observing glacier accelerations and to revealing the large gaps in our understanding of how these massive bodies of ice behave. This constellation is limited, however, in that the observational strategy is sporadic, causing many major events to be missed. Furthermore, most foreign sensors were not optimized for measurements of ice sheets' deformation, so areas such as the catchment of the rapidly changing Pine Island Glacier, are difficult to measure. This lack of a consistent set of observations has been one of the major limitations to improving our knowledge of the cause of current and future sea level change. NISAR will revolutionize ice sheet science by routinely imaging to determine how fast glaciers and ice streams are discharging ice to the world's oceans.



Measurements from the Canadian RADARSAT mission show the rapid acceleration of Jakobshavn Isbrae in Greenland from 1992 to 2000. With additional increases in speed since 2000, this glacier alone increased sea level by nearly 1 mm over the last decade [*Joughin et al., 2004*].