

Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) Applications

Iceberg Tracking from Space

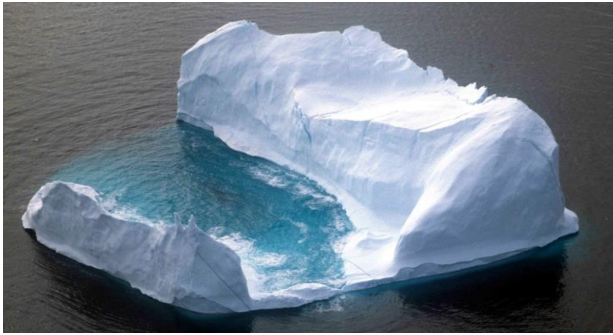


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Application Question: How can ICESat-2 contribute to identifying and tracking icebergs in shipping lanes?

Monitoring Iceberg Hazards to Ships

The sinking of the RMS TITANIC on April 15, 1912 following a collision with an iceberg is the most well-known disaster related to ice, but it won't be the last. Icebergs that calve off ice sheets in Antarctica, Greenland, or other land-bound ice sheets can be enormous and take years to melt completely. While less than one percent (487 annual average) of the 15,000 to 30,000 icebergs produced annually by the glaciers of Greenland ever make it to the transatlantic shipping lanes to be a significant shipping hazard, mapping and tracking icebergs are important to ship safety in the northern and southern oceans.

Icebergs are mostly submerged, adding to their threat to shipping. During the period from February 1 to August 31, the International Ice Patrol (IIP)—operated by the U.S. Coast Guard and funded by 17 countries—monitors the North Atlantic Ocean for the risk of iceberg collision by patrolling the major transatlantic shipping routes for icebergs 15m or longer using long-range fixed wing aircraft and by analyzing satellite images. The IIP also incorporates other iceberg reports into its daily warnings from different sources, including ships passing through the area and commercial aerial reconnaissance flights. Along with its partner, the Canadian Ice Service (CIS), IIP distributes daily iceberg warning products to the maritime community year-round. Together with the U.S. National Ice Center (USNIC), IIP and CIS are members of the North American Ice Service (NAIS) partnership, which strives to provide comprehensive ice information for North American mariners.

Iceberg observation data is fed into a computer model, which uses ocean current, wind, waves, and sea surface temperature data to predict the drift and deterioration of icebergs. Each day, the predicted iceberg locations are used to estimate the region where icebergs are likely to be found, and is incorporated into a daily NAIS Iceberg Warning product. Outside of the NAIS monitoring area, the Danish Meteorological Institute (DMI) tracks icebergs from Greenland. This region experiences less commercial ship traffic, but tour vessels are becoming more common.

Who Cares and Why?

With a warming climate, high-latitude Arctic shipping will become increasingly possible. The year 2016 tied 2007 for the second lowest minimum ice extent in the Arctic on record at 4.4 million square kilometers. Reduction of fast ice within the

calving areas promotes the release of icebergs into the Arctic Ocean. Increased shipping, fishing, energy and mineral production activities will affect national welfare and security for many nations in both the western and eastern hemisphere. This increased access to the Arctic means more and more ships and infrastructure are using the Arctic as a trade route. Indeed, Russia is investing billions of dollars in Arctic infrastructure to realize a "Suez of the north," which will further accelerate the need for accurate information about icebergs in the region.

Needed Measurements

Beyond aerial reconnaissance, remote detection of icebergs is based on active microwave, multi-polarized synthetic aperture radar (SAR) from various space-borne sensors. SAR sees the Earth's surface as a return signal (backscatter) that is proportional to the surface roughness. Differences in roughness and internal structure of the surface layer allow the different surface types to be identified. Icebergs in the Arctic are typically very rugged and rise above the level of the ocean and surrounding ice. Detecting and identifying icebergs within surrounding sea ice is particularly challenging for automated SAR algorithms. In order to produce an accurate forecast of where the icebergs will travel, changes in the mass and shape of each iceberg need to be forecasted as it is affected by ocean currents, waves, wind, and seawater of varying temperatures.

Laser altimetry provides an additional avenue to validate and tune results from automated detection algorithms currently in use at IIP and CIS. A laser altimeter offers a distinct advantage over SAR in determining an iceberg's height to allow modelers to infer important information about the iceberg's underwater size – a key parameter in predicting both drift and deterioration. The World Meteorological Organization "Global Cryosphere Watch" program and its developing system of CryoNet stations is one of the internationally accepted mechanisms to provide comprehensive, in-situ information on icebergs to validate SAR data.

The NASA Response

Launching no later than fall of 2018, the ICESat-2 mission will use a 6-beam lidar to measure surface elevation across the globe. The micro-pulse, multi-beam Advanced Topographic Laser Altimeter System (ATLAS) will enable global, seasonal and high-resolution observations and understanding of high latitude ice concentrations and behavior. The small footprints of ATLAS (~15m) combined with dense along-track spacing (~70 cm), precision elevation measurements (< 10cm over most surfaces) and geolocation knowledge (data located on earth's surface to < 6.5m) will allow ICESat-2 data to be used as a primary data source for iceberg locations where in situ observations are lacking. ICESat-2 data will be most useful when crossing icebergs that are at least 15m across, as they will provide several consecutive elevation measurements to define the iceberg height and edges with sufficient precision.

Comments? Thoughts?

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