National Aeronautics and Space Administration

NASA

ICESat-2

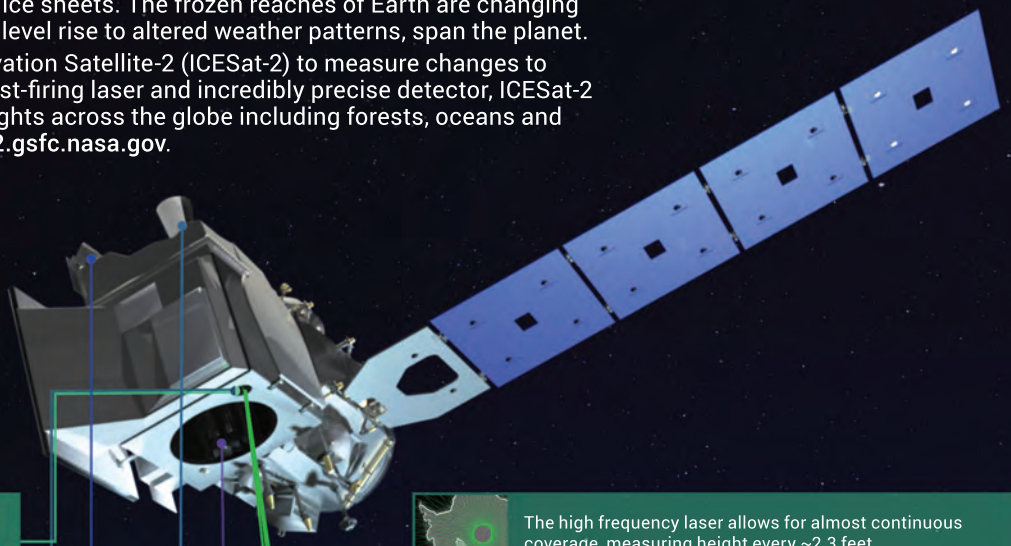
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

Retreating glaciers. Shrinking sea ice. Melting ice sheets. The frozen reaches of Earth are changing at dramatic rates — and the impacts, from sea level rise to altered weather patterns, span the planet.

NASA is launching the Ice, Cloud and land Elevation Satellite-2 (ICESat-2) to measure changes to Earth's ice seasonally and annually. With its fast-firing laser and incredibly precise detector, ICESat-2 will create the most detailed portrait yet of heights across the globe including forests, oceans and clouds. For more about ICESat-2, visit **ICESat-2.gsfc.nasa.gov**.

ANATOMY OF A SPACE LASER

ICESat-2 carries a single instrument, the **Advanced Topographic Laser Altimeter System (ATLAS).** ATLAS has three major tasks: send pulses of laser light to the ground, collect the returning photons in a telescope, and record the photon travel time. With the speed of light as a constant, the travel time can be converted to distance traveled. And with precise knowledge of the location of the satellite that comes from the GPS and star trackers, the distance traveled is converted to height.



Laser
Pulses 10,000 times a second, at a wavelength of 532 nanometers – a bright green on the visible spectrum.

Diffractive Optical Element
Splits the single laser beam into six before exiting ATLAS.

Telescope
Lightweight beryllium telescope receives about a dozen photons from each laser pulse as they return from Earth, and routes these photons to the detector.

Laser Reference System
Checks the aim of the laser to ensure the telescope is looking where the laser beams are pointing.

Star Trackers
Cameras that point to the stars; by comparing the image from the star tracker with a star map, we determine where ATLAS is pointing.

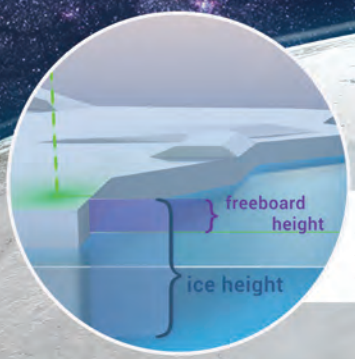
The high frequency laser allows for almost continuous coverage, measuring height every ~2.3 feet (70 cm) along the satellite's ground path.

The six beams are arranged in three pairs, designed to allow us to measure the slope of the terrain in one pass.

The detector times photons to within a billionth of a second. By combining photon data, ICESat-2 measures height to ~1 inch (3 cm).

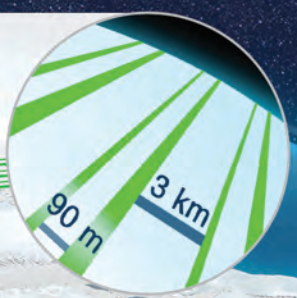
Aligning the laser with the telescope ensures ATLAS will detect returning photons.

Combining photon travel time with star tracker and GPS data allow us to precisely measure the height of the Earth's surface.



Sea ice thickness is estimated by measuring the **freeboard** – the difference between the top of ice and the ocean. Roughly 1/10th of the sea ice is above the ocean surface.

ICESat-2 will fly each of its 1,387 unique orbits once every 91 days, to monitor ice surfaces once a season.



Land Ice including glaciers and ice sheets, form as snowfall accumulates over centuries and millenia. Land ice melting into the ocean causes global sea level rise. ICESat-2 will measure the annual rise or fall of ice sheets to within a fraction of an inch.

Sea Ice forms when ocean water freezes. In the polar oceans, it forms a white and reflective cap that helps regulate Earth's temperature.
The ICESat-2 mission will calculate the freeboard of sea ice to within 1.2 inches (3 cm), from which sea ice thickness is calculated.