



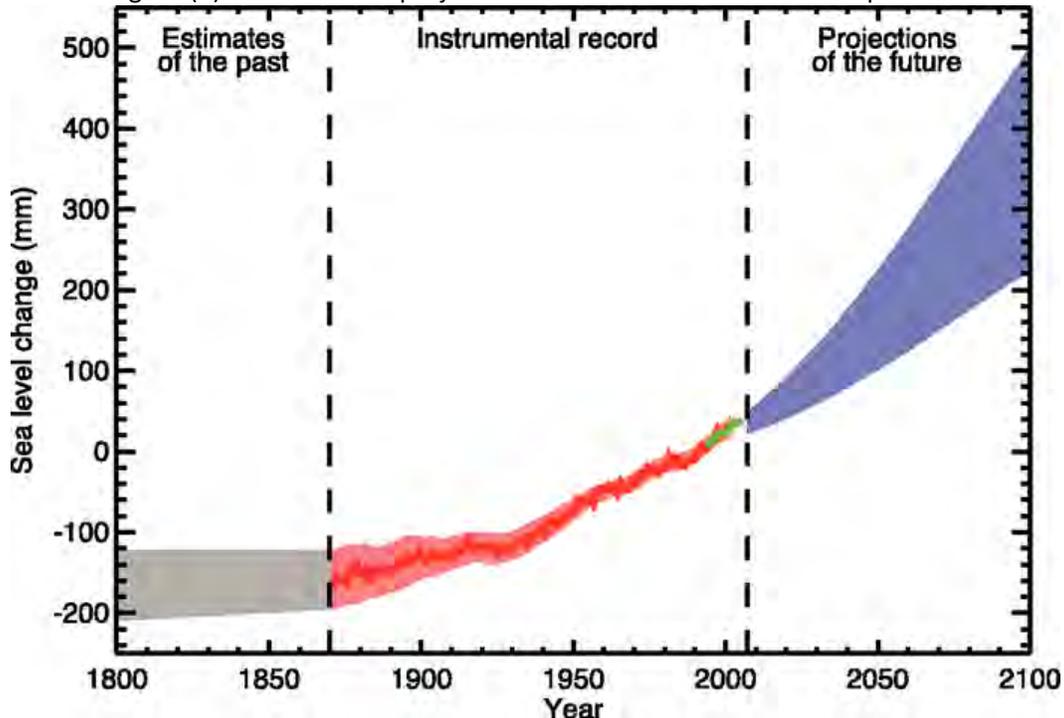
Bits and Bytes – Introduction to IcePod Science

Scientists agree - the world's major ice sheets are changing. They are thinning on the edges, shrinking in overall mass, and increasing in movement. Now researchers need to focus on answering why and how these changes are occurring. Detailed imaging is required to more accurately model and understand the structures and movements of glaciers.

Why should we care about the changes in these stockpiles of ice located on some of the world's most distant and remote locations? While we may think of the Polar Regions as isolated, they are actually connected to every location on Earth through the water or hydrologic cycle. When the Earth's climate cools, ice sheets grow. As water moves from the oceans to the ice, sea level around the world will fall. When the climate warms, the process reverses and water in the ice sheets melts back into the oceans causing sea levels to rise. At this time, the ice found in these isolated Polar Regions accounts for over 75% of the world's freshwater¹.

The rate of polar ice loss will ultimately determine the rate and extent of sea level rise across the globe. Humans do not like surprises, especially when the unknown is how much the sea level will change in the next 100 years. Figure 1 considers different rates of sea level rise. The more accurate our imaging of the entire glacier, the more confident scientists can be with their modeling predictions.

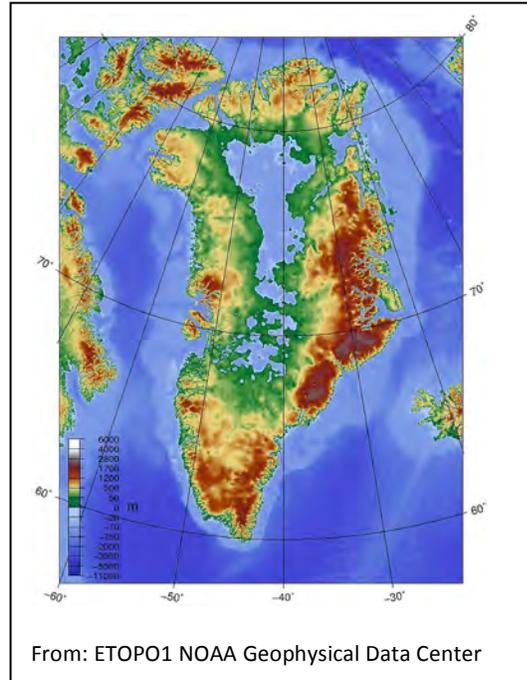
Figure (1) Sea Level Rise projections until 2100 from the IPCC Report 5.²



¹ http://earthobservatory.nasa.gov/Features/PolarIce/polar_ice2.php

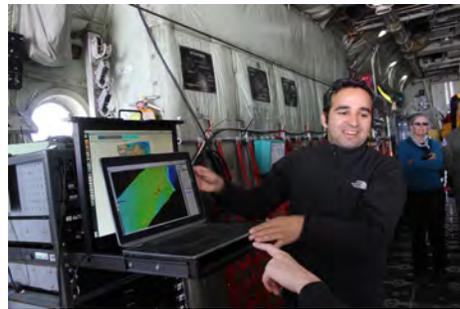
² https://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-5-1-figure-1.html

Things are not always what they seem. Which of these is the TRUE image of Greenland?



We are used to seeing Greenland as a country predominantly covered with a thick ice sheet. The land surface of Greenland only becomes apparent through images created using data from instruments like radar and techniques like gravity and seismic explosions. These methods help us 'see' through the ice. Removing the ice, in the image on the right, you can see how the thick overlying ice sheet has pushed down the center of Greenland. The blue coloring in the middle of Greenland, represents land currently below sea level. But how do the land and the ice interact? This is what the IcePod project is studying.

Description of Research:

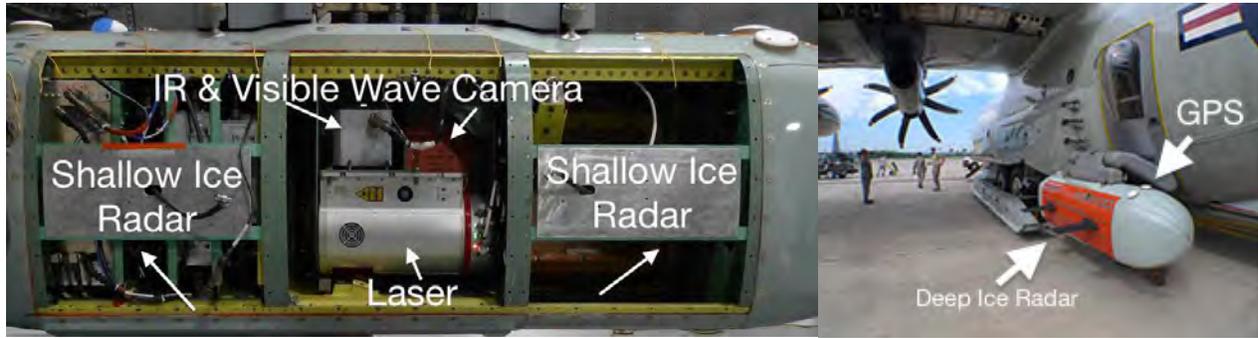


IcePod includes a critical computer set up inside the LC-130 to monitor data collection and communicate with the instruments during flight (Photo Credit: Lynn Reed)

IcePod promises to improve the efficiency in producing highly detailed and accurate images of ice sheets in both the Arctic and Antarctic. IcePod is a modular part of the aircraft attaching to the side of LC-130 Hercules military plane. It is lowered during flight and can be easily installed or removed as needed. The beauty of IcePod is it will collect valuable scientific data at the same time that these planes are fulfilling their regularly

scheduled missions throughout both the Arctic and Antarctic. This 'two for one' approach allows for more frequent and affordable data collection of the ice sheet. This is only possible because the IcePod repackages multiple (previously bulky)

devices into one, sleek, relatively small container that easily attaches to the LC-130. The IcePod itself is 8.5 feet long and 2 feet wide. It could hold approximately 30 regulation size basketballs. The combination of five instruments operating in tandem, allows for more detailed and continuous imaging from the ground below the ice up to the surface of the ice sheet. This is not been possible using satellite and transect derived data.



(L) IcePod instruments packed inside the pod; (R) Deep Ice Radar 'blades' attach to the outside

LiDAR (abbreviated combination of light and radar) uses lasers to scan a 1 kilometer swath (strip) of surface area (both of the land and the glacier) in order to create a three dimensional model of glacier features with a resolution of 10-20cm.

Infrared Camera detects variation in temperature on the glacier. This helps with identifying areas of melt and ice in surface channels and areas of heat loss and gain.

Visible Wavelength Camera is able to calculate measurements of real world structures from photographs to create a type of 3D landscaped image. In combination with the infrared camera incredibly detailed and accurate images of the ice sheet can be produced.

Deep Ice Radar (or Ice-Penetrating Radar) uses microwave frequency signals to penetrate ice up to 4 km thick. It can help determine ice thickness, bedrock topography, internal ice movement, and as it cannot penetrate water it detects the presence or absence of water within the ice and at its base.

Shallow Ice Radar focuses on the top 100 meters of glacial features. It is able to distinguish between annual snow accumulations for understanding variability in snowfall.

Who does this stuff?



IcePod and team at Camp Raven on top of the Greenland ice sheet (2000 meters elevation). Team Leads: far left Robin Bell, lead scientist; beside her Nick Frearson, lead engineer; Second from right Chris Zappa, science team; third from right Kirsty Tinto, science team.

Robin E. Bell, is lead scientist for IcePod and a senior research scientist from the Lamont-Doherty Earth Observatory of Columbia University in New York City. She studied geology as an undergraduate student at Middlebury College and then received her Ph.D. from Columbia University. When she is not flying over the world's most massive ice sheets, Robin enjoys sailing (she has sailed across the Atlantic with her family including her dog!), beekeeping, and exploring the great outdoors.

Set of Links:

- <https://www.youtube.com/watch?v=g0v1rUqSaW8> I know that this is a YouTube video, but it is a nice summary and introduction to what Ice Pods is.
- http://www.theguardian.com/environment/2013/aug/27/icepod-greenland-melting-sheet-radar?CMP=tw_t_gu This article goes into a bit more detail on how the IcePod works. It also has a link to the video from YouTube.
- <http://www.usatoday.com/videos/news/nation/2013/08/25/2697675/> This is another video that focuses more on the reason for using the LC-130 Hercules planes.
- <http://www.ldeo.columbia.edu/res/pi/icepod/> This is the IcePod Project page that has several layers of information written for the general user.
- <http://www.ldeo.columbia.edu/research/marine-geology-geophysics/icepod-development-ice-imaging-system-monitoring-changing-ice-she>. This is a scientist written summary of the IcePod project and focus.
- http://www.usclivar.org/sites/default/files/meetings/Bell_GRISO2013_Talk.pdf A PowerPoint that would probably not be super useful to a k-12 teacher is its current format, but it has many good images. I will plan to edit this ppt and narrow it to just a few images and annotations. I will link it to the project webpage and give you a new link.
- <https://polarexplorer.ccnmtl.columbia.edu/water/> - Interactive that connects sea level impacts from the total Greenland ice amounts on a U.S. coastal city
- <https://polarexplorer.ccnmtl.columbia.edu/glacier/> - Interactive that explores how changes at the leading edge of a glacier can cause an acceleration of sea level rise.

More IcePod and polar science activities: <http://www.ldeo.columbia.edu/edu/polareducation/>
