



ICESat-2: A next generation laser altimeter for space-borne determination of surface elevation

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Ice, Cloud, and land Elevation Satellite 2 (ICESat-2)

ICESat (2003 – 2009)

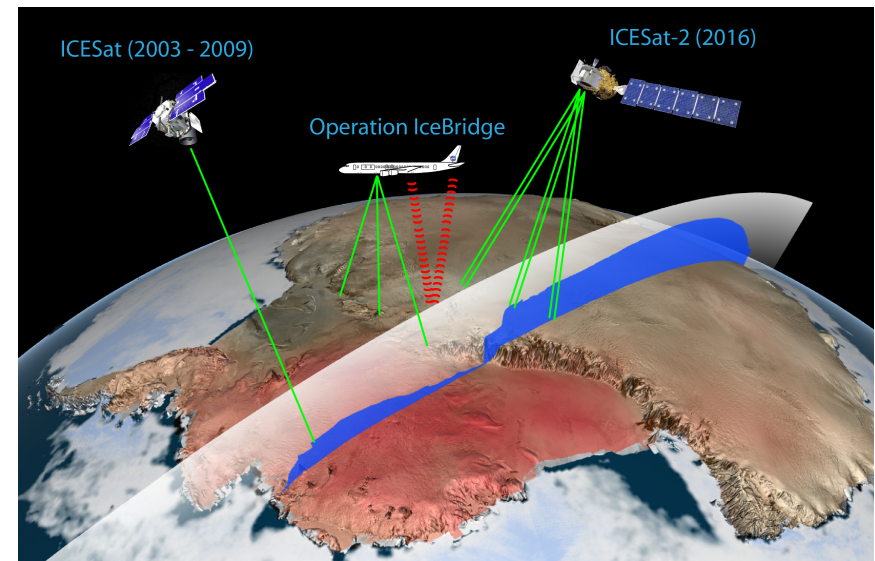
1064 nm, 40 Hz
70 m footprint, 172 m along-track spacing
1 beam
+/- 86° latitude
91 day orbit with ~monthly subcycle
energy waveform approach

Operation IceBridge (2009 – 2017)

ICESat-2 (Launch: 2016)

532 nm, 10 kHz
10 m footprint, 0.7 m along-track spacing
6 beams (+/- 3 km swath); 3 sets of strong/weak pairs (0.9 km offset)
+/- 88° latitude
91 day orbit with ~monthly subcycle
photon counting approach

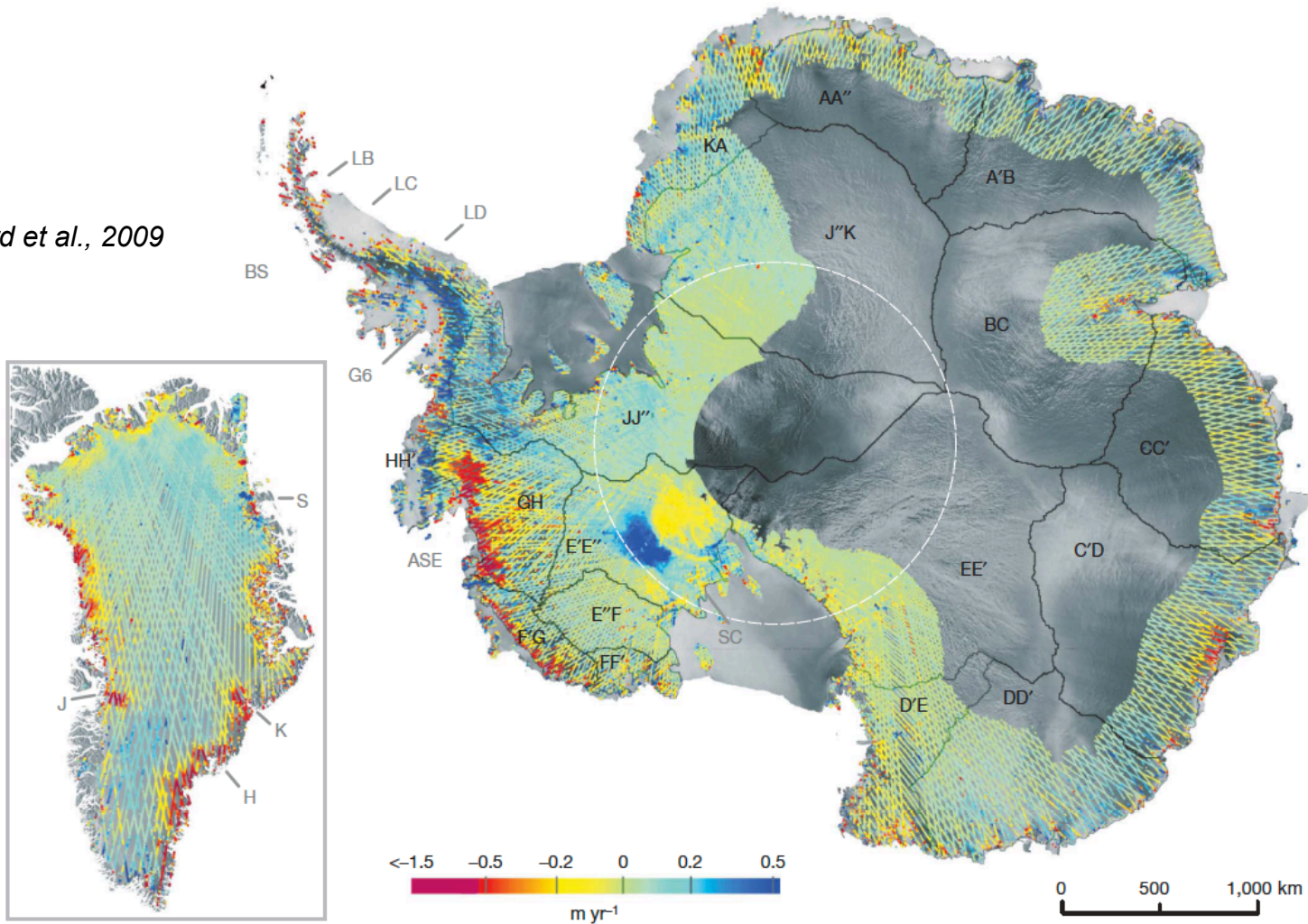
icesat.gsfc.nasa.gov





ICESat Ice-Sheet Thickness Change (2003 to 2009)

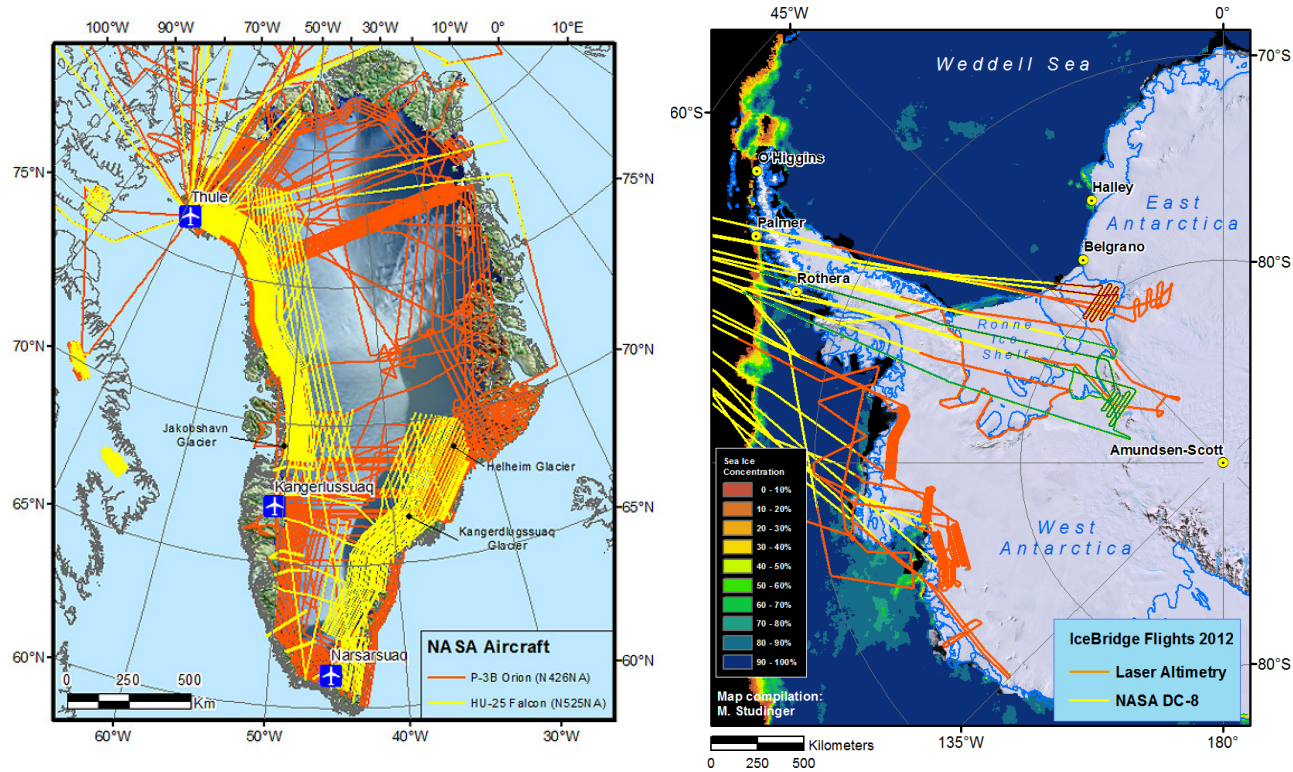
Pritchard et al., 2009



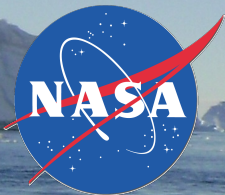


Operation IceBridge

Airborne mission to bridge the gap between ICESat and ICESat-2



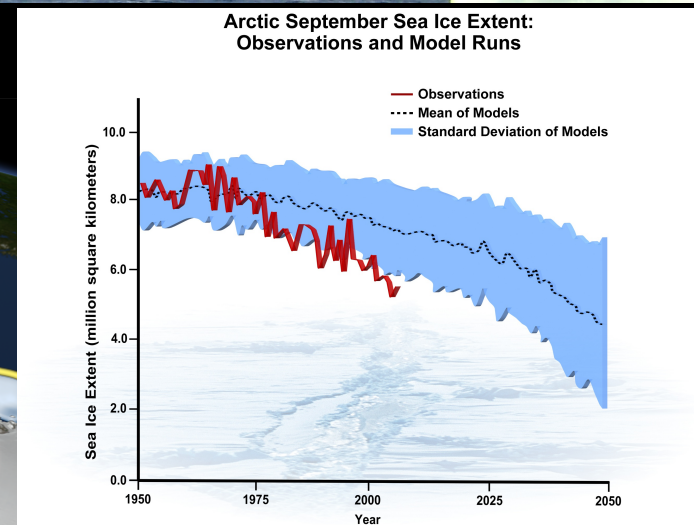
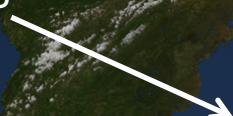
www.nasa.gov/icebridge



Sea Ice

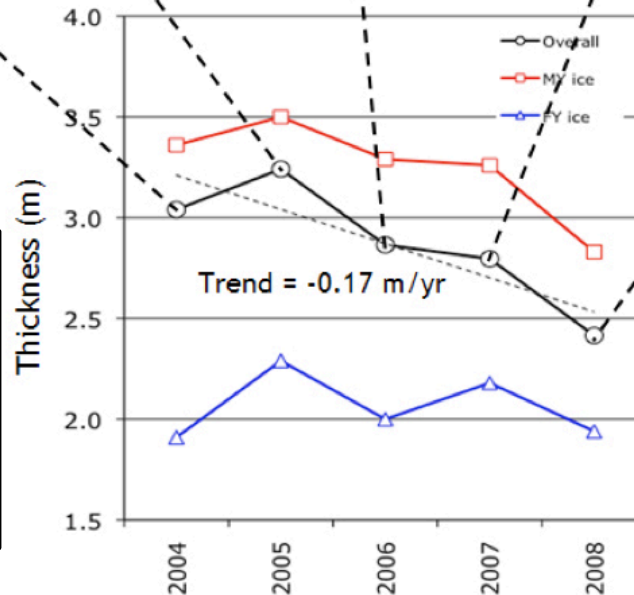
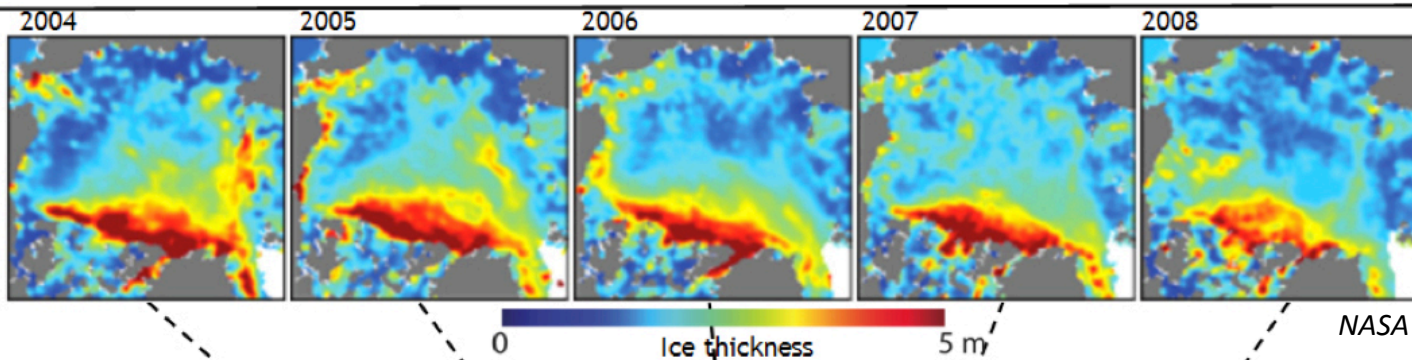
16 Sept 2012

30 yr average minimum





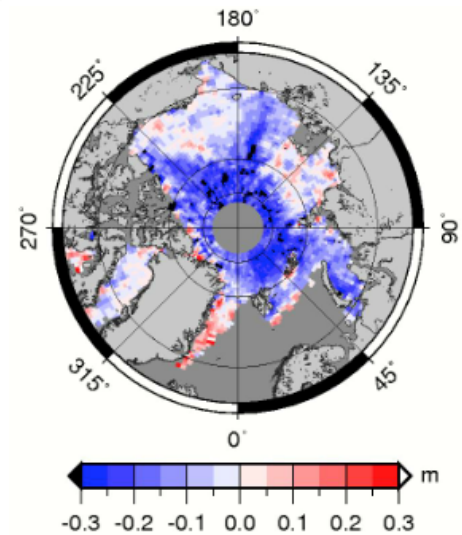
ICESat Sea Ice Thinning



Overall, sea ice thickness has decreased by about **0.7 m**

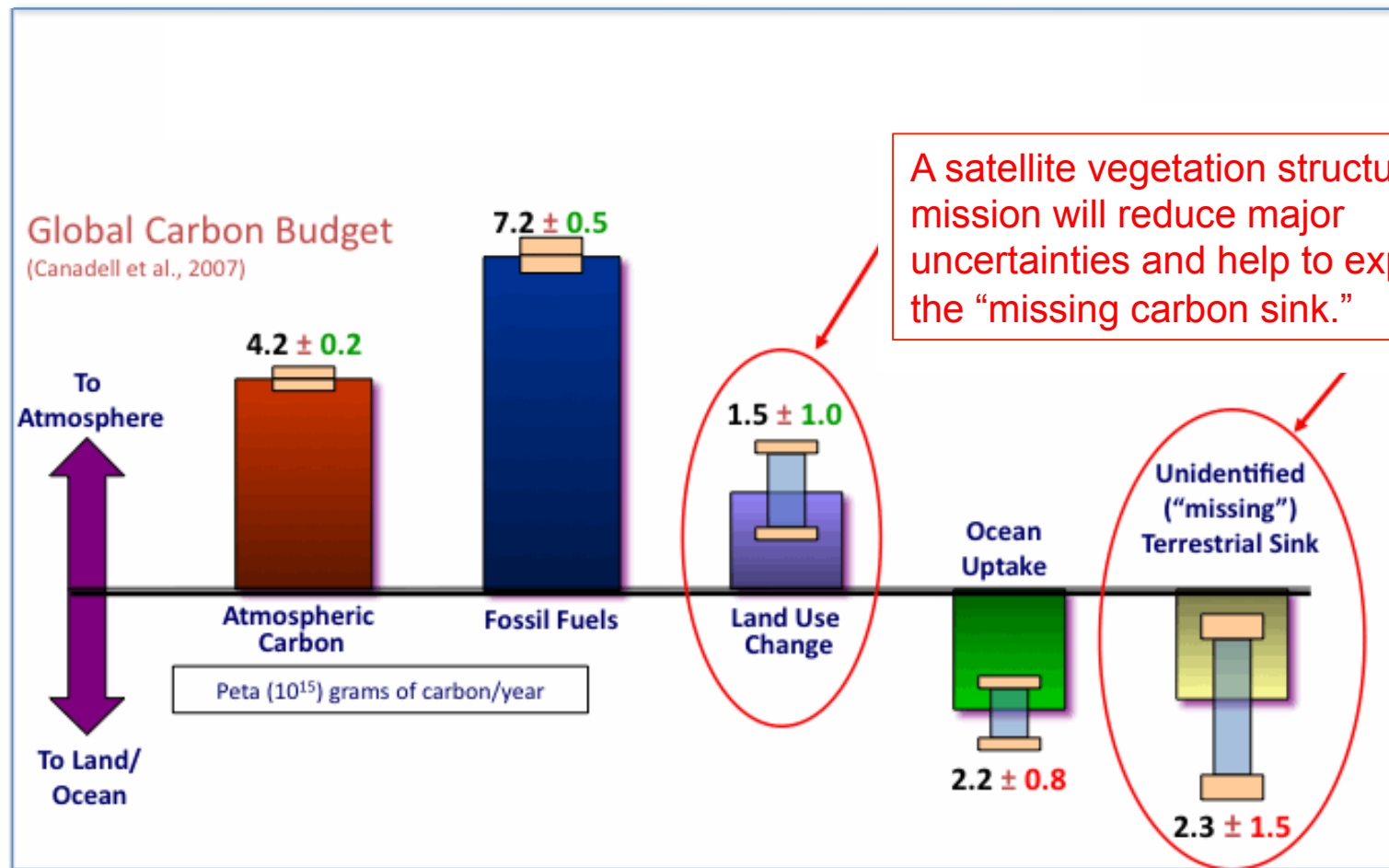
Area of thick, multiyear ice has decreased by **42%**

ICESat change in freeboard
Mar 2008 – Mar 2003





Carbon Budget Uncertainties: Terrestrial Components





ICESat-2 Science Objectives

ICE SHEETS

- a) Quantify polar **ice-sheet contributions** to current and recent sea-level change and the linkages to climate conditions;
- b) Quantify regional signatures of **ice-sheet changes** to assess mechanisms driving those changes and improve predictive ice sheet models; this includes quantifying the regional evolution of ice sheet change, such as how changes at outlet glacier termini propagate inward;

SEA ICE

- c) Estimate **sea-ice thickness** to examine ice/ocean/atmosphere exchanges of energy, mass and moisture;

VEGETATION

- d) Measure **vegetation canopy height** as a basis for estimating large-scale biomass and biomass change.



ICESat-2 Primary Data Products

- **ICE SHEETS:** Seasonal maps of ice sheet elevation for Greenland and Antarctica
- **SEA ICE:** Monthly maps of sea ice thickness for the Arctic and Southern Ocean
- **VEGETATION:** High-precision (cm) elevation measurements over land with a track density of 2 km along the equator after 2 years through off-nadir pointing



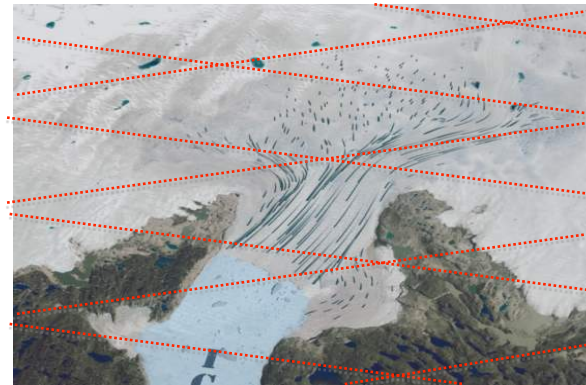
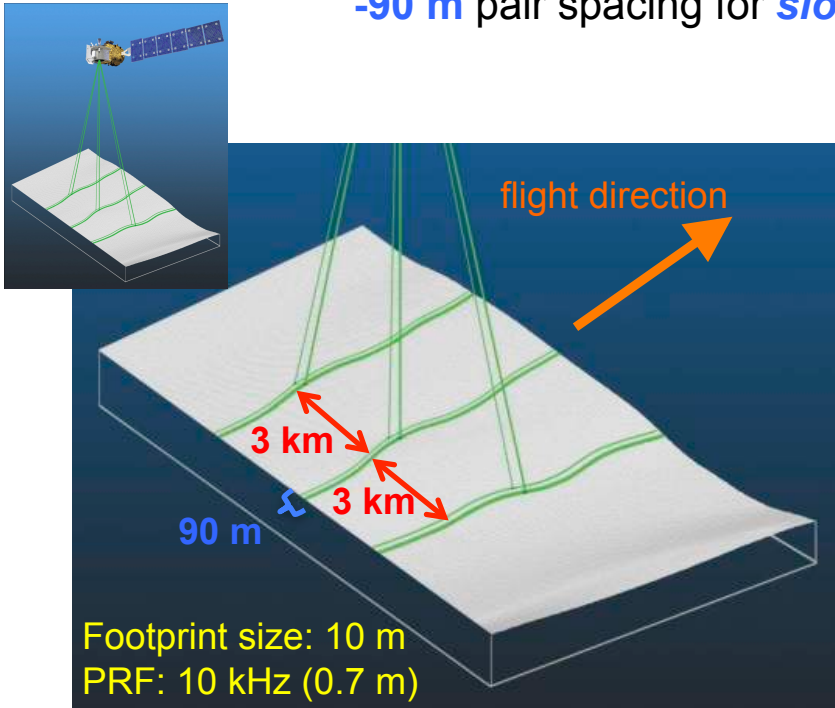
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- **VEGETATION:** High-precision (cm) elevation measurements over land with a track density of 2 km along the equator after 2 years through off-nadir pointing
- **Atmosphere:** Cloud and other significant atmosphere layer heights, blowing snow, integrated backscatter, optical depth
- **Ocean:** Elevation of the mean sea surface
- **Inland water and snow:** Lake elevations and snow depth



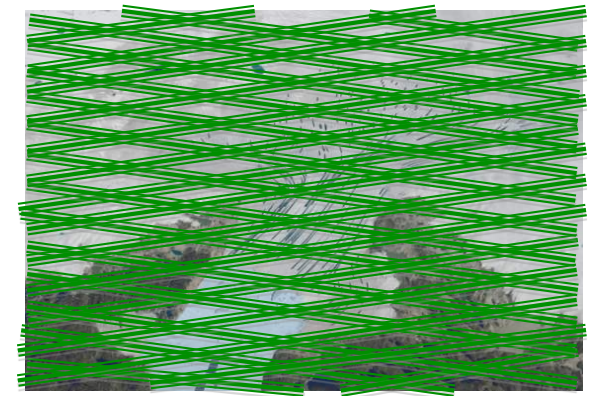
ICESat-2 Measurement Concept

-3 km spacing between pairs provides spatial coverage
 -90 m pair spacing for *slope determination* (2 degrees of yaw)



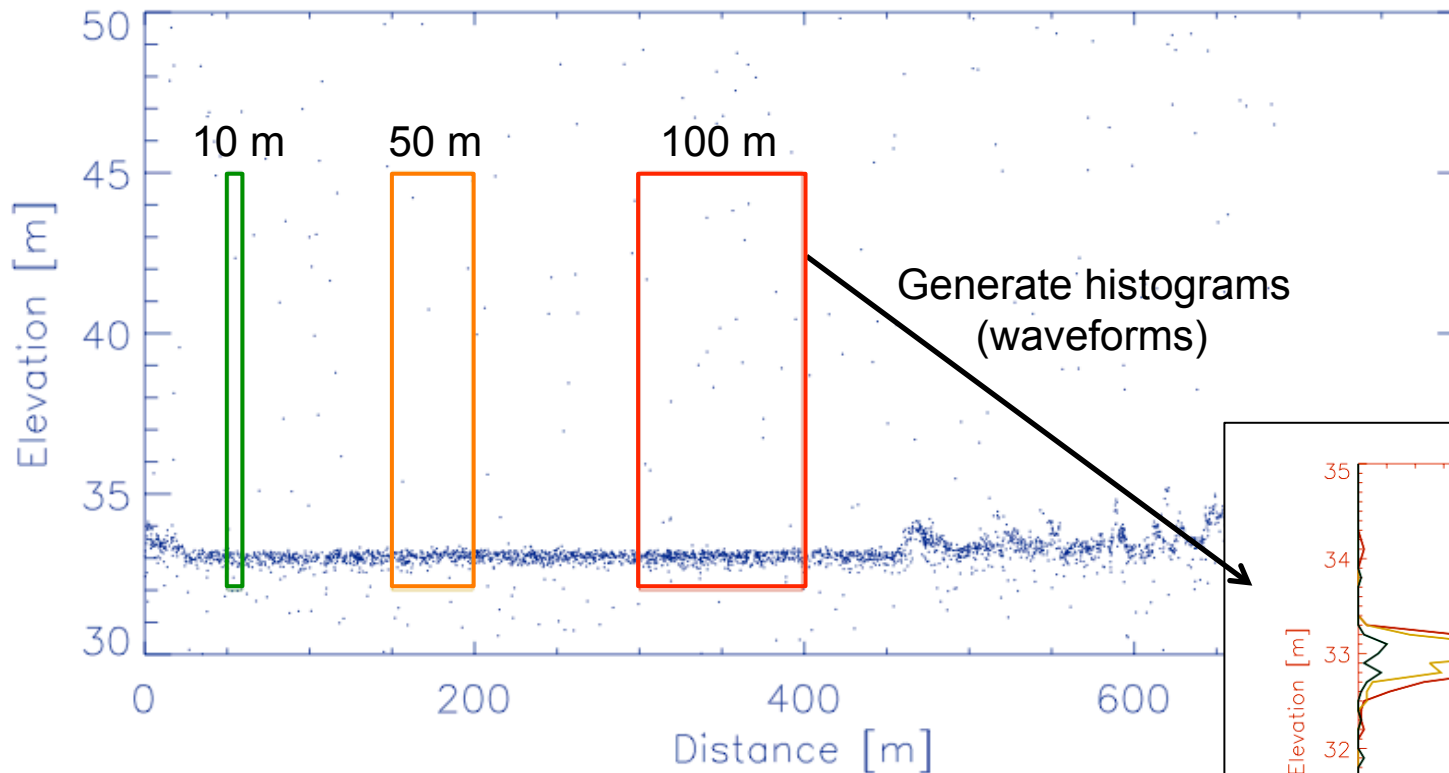
ICESat-1 spacing
 Jakobshavn Isbrae

ICESat-2
 planned spacing



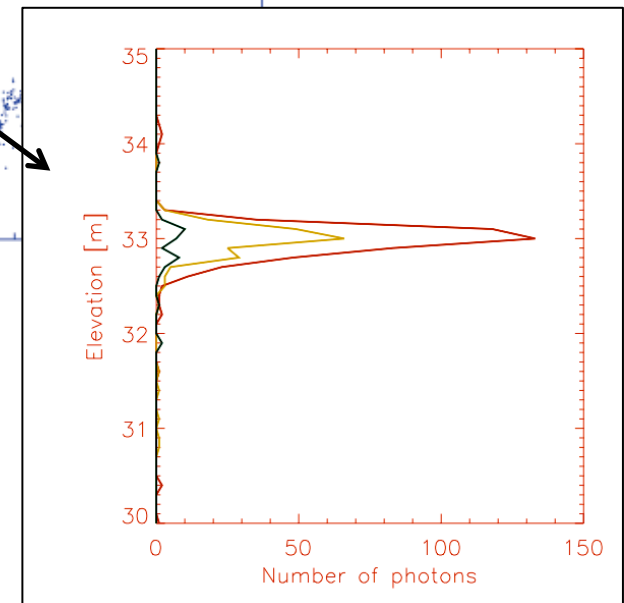


ICESat-2 Measurement Concept



Data from
ICESat-2
airborne
simulator:
MABEL

Generate histograms
(waveforms)



- No gaps between shots
- Flexibility in generating histogram (waveform)
- Varies as a function of surface roughness as well as lead width



ICESat-2 Applications

Applications are defined as innovative uses of mission data products in **decision-making activities for societal benefit.**

Applications research will provide fundamental knowledge of how mission data products can be scaled and integrated into users' policy, business, and management activities to improve decision-making efforts.

User Community includes

- individuals or groups
- public or private sectors
- national or international organizations
- local to global scales of decision making

Examples relevant to the AMS community may include

- NOAA (NWS)
- Navy
- National Ice Center (NIC)
- USGS
- Please suggest your group/sector!



ICESat-2 Applications

Key aspects of ICESat-2 Applications Program

- Define communities of potential users in the scientific, operational, and policy domains
- Engage user communities to solicit information on potential uses of mission data
- Sponsor research programs to ensure rapid and effective uptake of mission data after launch

Engagement with communities at a number of levels

- Engagement with mission, participate in cal/val, and product evaluation
- Participate on the Applications Working Group
- Become an **Early Adopter**



ICESat-2 Applications

Implementation Strategy

- ICESat-2 Applications Research, possibly funded by NASA ROSES call
- Coordination with ICESat-2 Cal/Val and MABEL (ICESat-2 simulator) acquisitions
- Coordination with other NASA Missions
- ***Early Adopter Program***

Early Adopters, pre-launch pioneers for mission applications

A subset of users who have a direct or clearly defined need for new mission data and who are planning to apply their own resources (funding, personnel, facilities, etc.) to demonstrate the utility of mission data for their particular system or model.

Vanessa Escobar's poster, Wednesday 14:30

A Professional Review of NASA's SMAP Mission Pre-Launch Application Effort

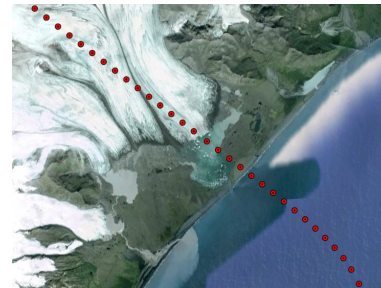
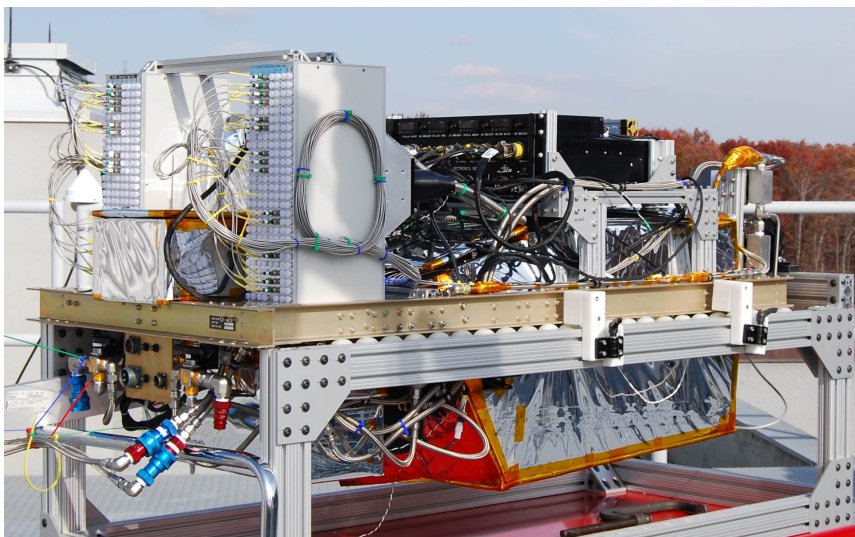


MABEL: ICESat-2 Airborne Simulator



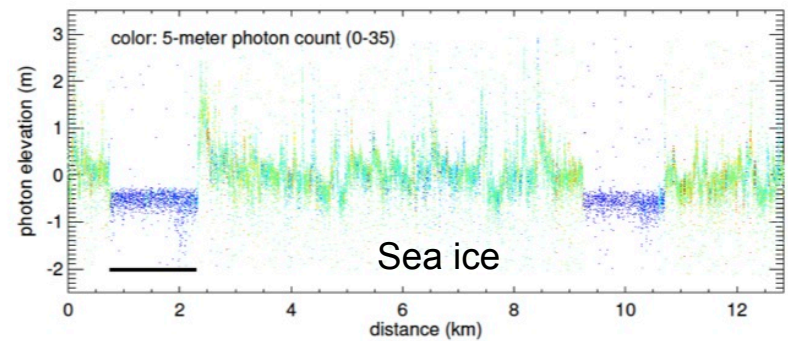
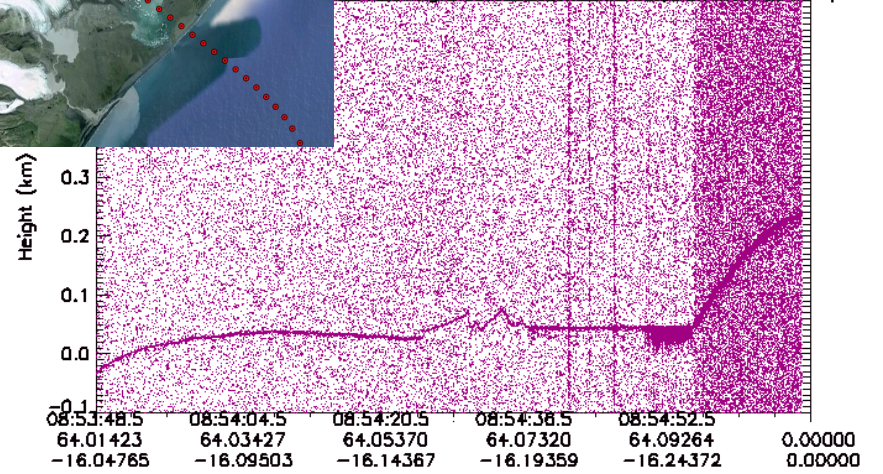
NASA ER-2

MABEL



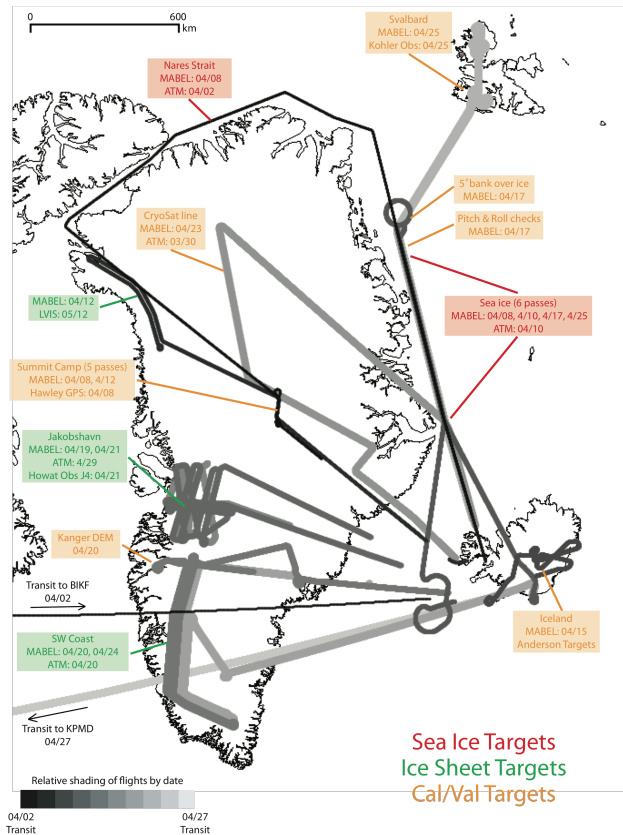
Iceland, change in background

20415flight_Glacier\PNG\T1-Apr15.085348-Apr1

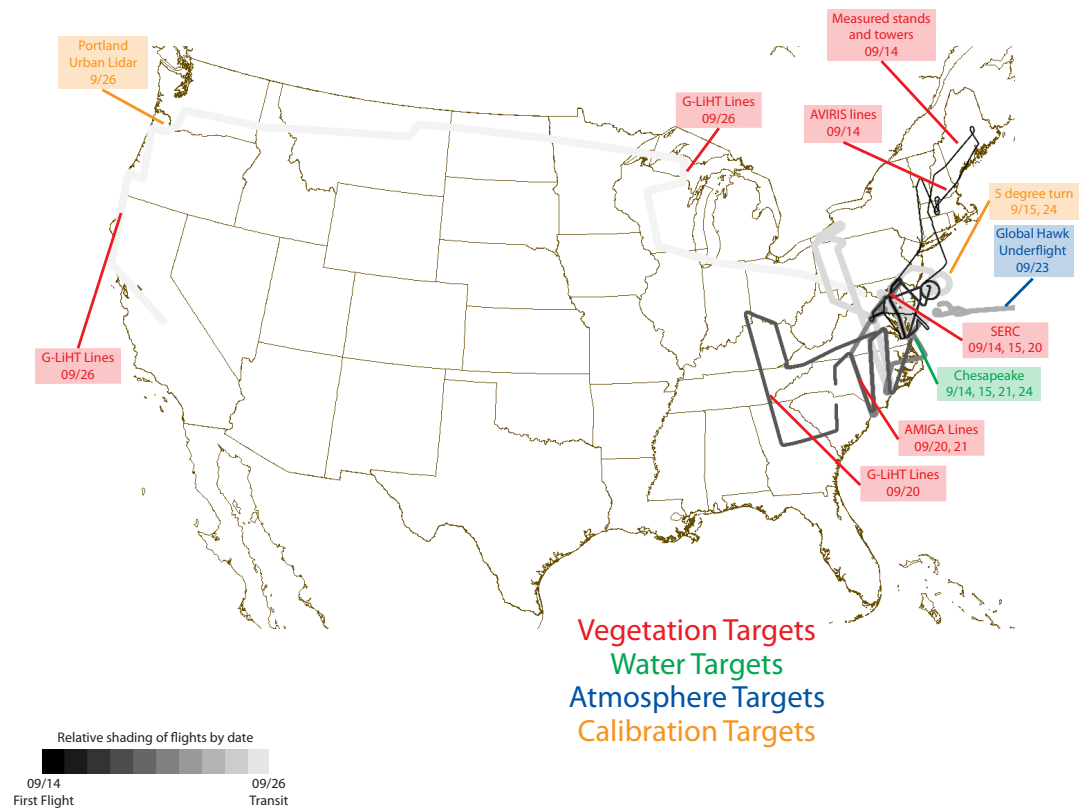




MABEL: ICESat-2 Airborne Simulator



Greenland, April 2012



East Coast, Sept 2012

http://icesat.gsfc.nasa.gov/icesat2/data/mabel/mabel_docs.php



SUMMARY

- ICESat (2003-2009)
- Operation IceBridge (2009-2017)
- ICESat-2 launch in 2016

- ICESat-2: next-generation satellite laser altimeter
 - Micro-pulse photon counting approach
 - Pairs of beams to resolve surface slope on an orbit basis
 - High repetition rate (**10 kHz**) for dense along-track sampling (**~70 cm**)
 - Small footprint (**10 m**)

- Science data products:
 - Ice sheets
 - Sea ice
 - Vegetation
 - Atmosphere
 - Oceans
 - Inland water and snow

- Applications Program and Early Adopters

- MABEL: ICESat-2 airborne simulator

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