ICESat-2 in the mid-latitudes and some lessons learned

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Greenland ice sheet elevation, 2019
Mission Overview

Successor to ICESat (2003-2009)
Designated as a top priority in the 2007 Earth Science Decadal Survey
ATLAS: Advanced Topographic Laser Altimeter System
Launched successfully 15 September 2018
Measurement Concept

Single laser pulse at 532nm, split into 6 beams. Single-photon sensitive detection.

Footprint size: 17 m
PRF: 10 kHz (0.7 m)

3 km spacing between pairs provides spatial coverage
90 m pair spacing for slope determination
high-energy beams for better performance over low-reflectivity targets.
Current Status

367 days on orbit since launch

ATLAS: transmitting laser light since 1 October 2018

292 billion laser pulses (compared with 2 billion from ICESat)

6 beams, arranged in pairs

17 m footprint diameter

0.7 m along-track spacing

Performance metrics remain nominal, and within requirements
ATL03: Geolocated Photons

Height WRT WGS-84

Along track time or distance

3 October 2018!
ATL03: Geolocated Photons

Classify Photons

Reduce data volume higher-level products have to deal with

Histogram-based approach

Parameters are surface specific

Likely signal photons w/ high, medium or low confidence
ATL03: Geolocated Photons

Along Track Distance (km)

Eastern
British
Columbia
ATL08: Vegetation and Canopy

Uses 100m segments to further reject noise, and classify photons.
ICESat-2 Data are Publicly Available

National Snow and Ice Data Center (NSIDC DAAC)

Data Products:

- Geolocated Photons
- Land Ice Elevation
- Sea Ice Elevation and Freeboard
- Land Elevation
- Atmospheric Backscatter
- Ocean Surface Height
- Inland Water Elevation

1342 data users to date
777,410 files served from May 28 – Sep 8
ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

Orbit and Coverage

500 km altitude

88S to 88N

15 revs/day

1387 tracks

91-day revisit

Ground tracks at icesat-2.gsfc.nasa.gov
Off Pointing in Mid-Latitudes

Notional Off-Track Pointing for vegetation data collection

Note: Actual time order of tracks will be determined by the Science and Operations Teams.
Grand Mesa, CO

via NSIDC spatial search tool
Grand Mesa, CO

Reference Ground Tracks repeat every 91 days

Currently in Cycle 4 (off pointing by ~7 km)

5 RGTs intersect Grand Mesa every 91 days:

211
714
737
1156
1179

Each RGT has 3 strong and 3 weak beams associated with it.

RGT locations (green lines) account for off-pointing plan.
Grand Mesa, CO

Reference Ground Tracks repeat every 91 days

Cycle 6 begins late December

5 RGTs intersect Grand Mesa every 91 days:

211  
714  
737  
1156  
1179  

Some are ascending passes, some descending

Yellow is right pair  
Green is center pair  
Blue is left pair
Major ICESat-2 Trades

What were some of the major trades in the development of ICESat-2? What did we learn?
Major ICESat-2 Trades

The Lidar Equation relationship between transmitted power, received power, and range to target (among many other things)

- laser energy per pulse
- telescope (FOV) size
- orbit altitude
- surface reflectivity
- receiver sensitivity / received energy per pulse
- total optical power
- atmospheric scattering / attenuation
- divergence
- laser pulse repetition frequency

A robust link model of the instrument is critical for evaluating these trades
**Major ICESat-2 Trades**

**Orbit:** feeds into link model, determines data coverage at any latitude and revisit interval.
- altitude
- inclination
- physics

Compromise between coverage at high latitude, coverage at sea ice edges, and coverage at equator.
- 92º inclination, 500 km altitude
  - 1387 revs every 91 days
  - coverage to 88N and 88S
ICESat-2 Measures

ICESat-2 well on its way to meeting science requirements:
  ice sheet elevation, sea ice freeboard, vegetation canopy height

Initial science papers in review

Initial data quality: < 10 cm vertical, < 10m horizontal

Data Release 002 coming in October
Correlation = 0.982

Correlation = 0.969

ICESat-2 Calibration / Validation

Ron Kwok, JPL

April 8, 2019  Operation IceBridge underflights of ICESat-2 tracks (Arctic Ocean sea ice)
Depending on water clarity, ICESat-2 measures both the water surface elevation, and bathymetry (up to ~30m).

We do not have a bathymetry product currently – lots of interest from science community, USCG, USGS, NGA, etc.

ATL03, Grand Bahama Bank, 26 October 2018