

ICESat-2 Mission Status, Outlook, and Contributions

¹Tom Neumann: Project Scientist

²Lori Magruder: Science Team Lead

¹Nathan Kurtz, Deputy Project Scientist

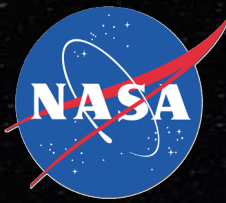
¹*NASA Goddard Space Flight Center*

²*University of Texas, Austin*

On behalf of the ICESat-2 Science Community



Current Status



1347 days on orbit since launch

ATLAS: transmitting laser light since 1 October 2018

1.1 Trillion laser pulses (compared with 2 billion from ICESat)

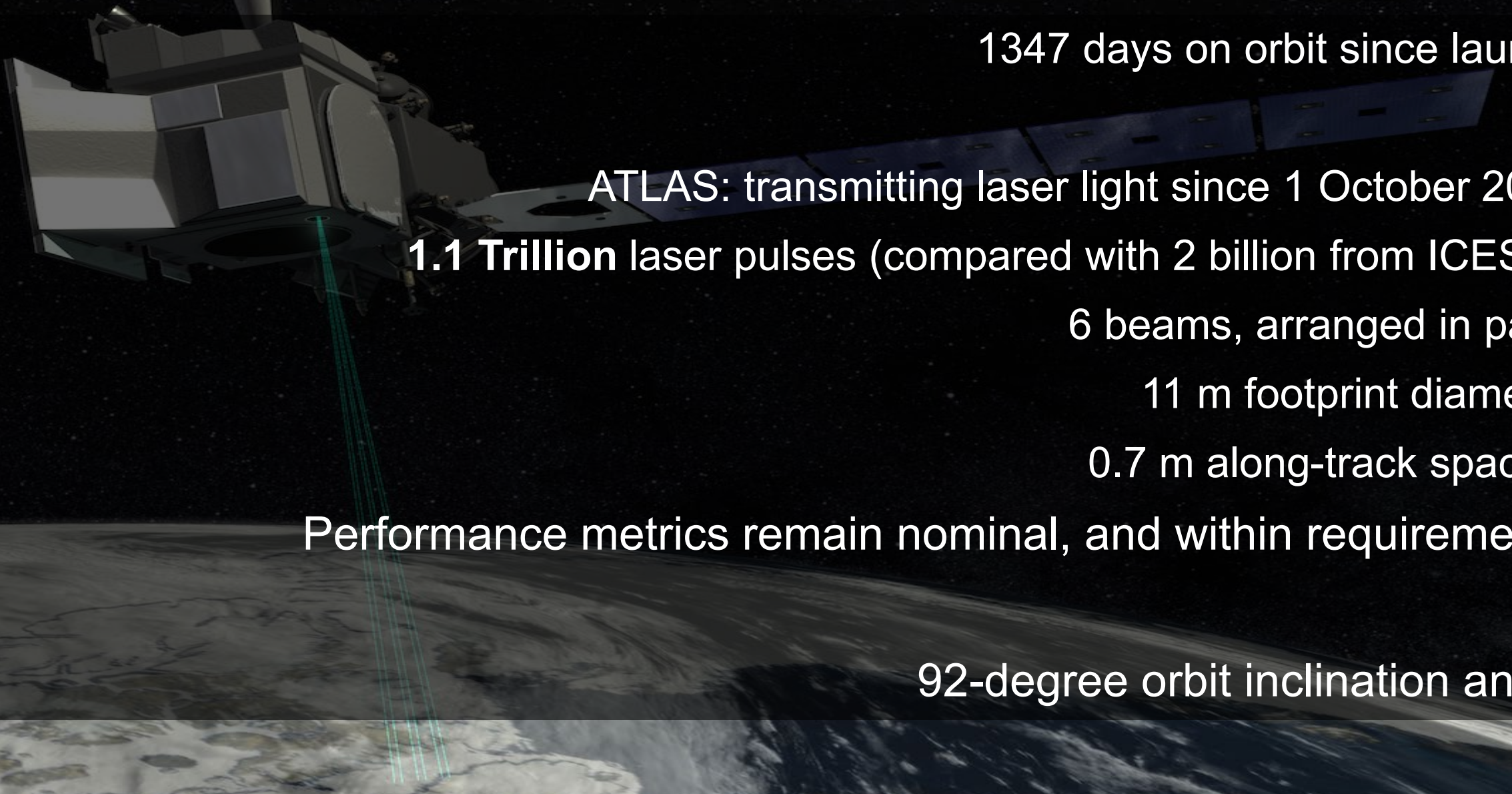
6 beams, arranged in pairs

11 m footprint diameter

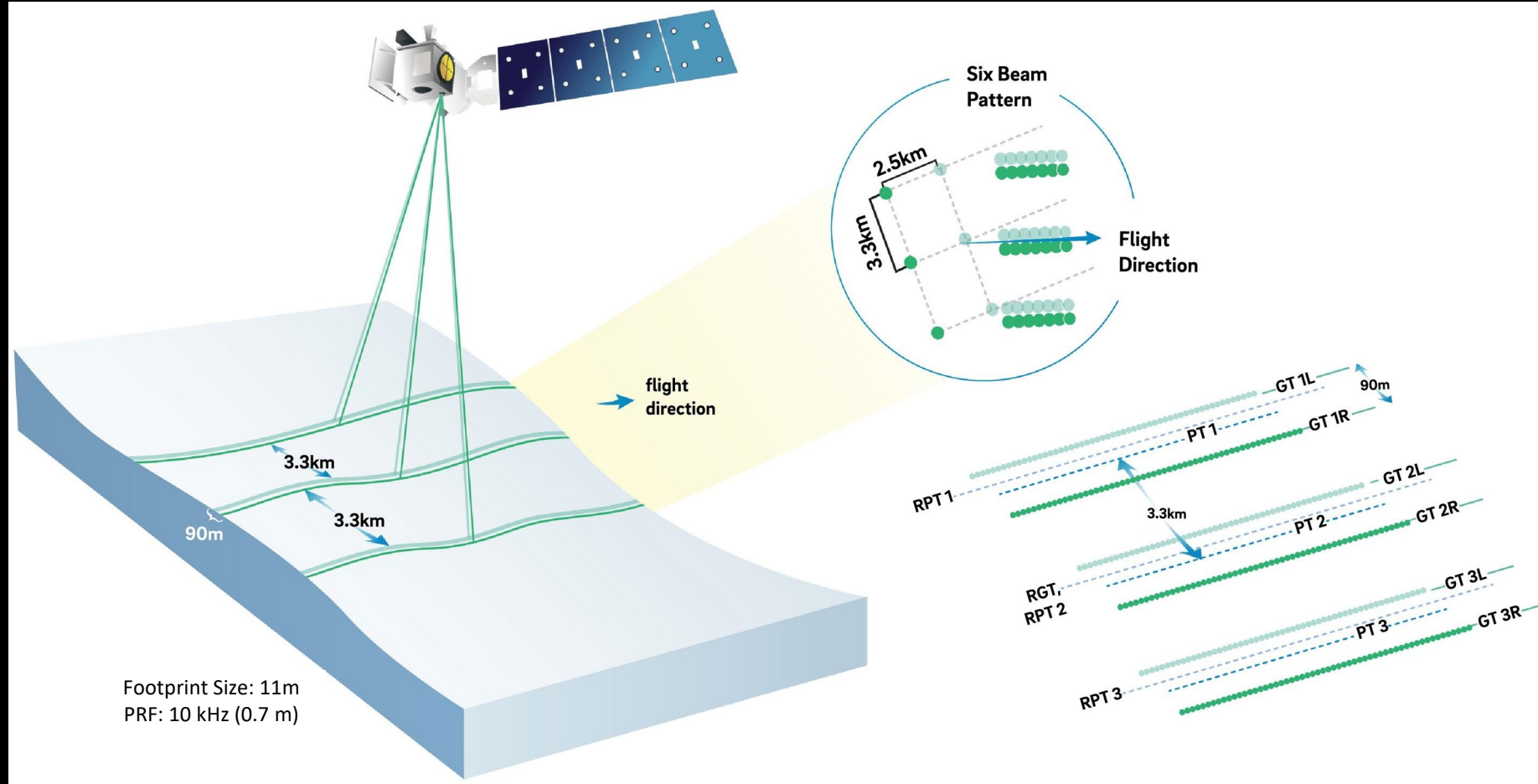
0.7 m along-track spacing

Performance metrics remain nominal, and within requirements

92-degree orbit inclination angle



Measurement Concept



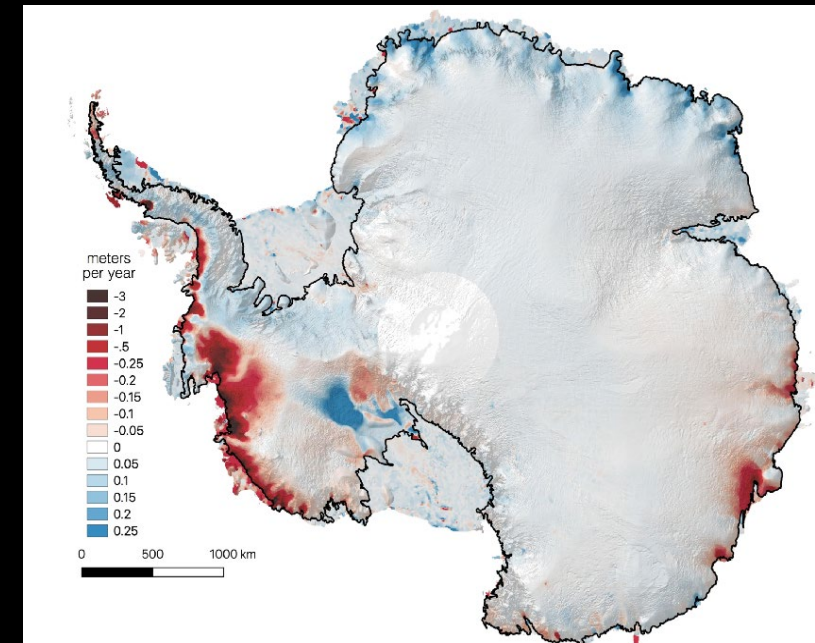
3.3 km spacing between pairs provides spatial coverage
90 m pair spacing for *slope determination*
high-energy beams for better performance over low-reflectivity targets.

End of Prime Mission Review (Jan - Feb 2022)

- Recap first 3 years of mission
- Assess performance against science requirements
 - Fully verified 8 of 9 requirements (freeboard to < 3 cm!)
 - Verification continues on 1 requirement (measure whole ice sheet elevation change to < 0.4 cm / yr).
- Assess outlook for continued operations

QuickLook (3-day latency) products now available

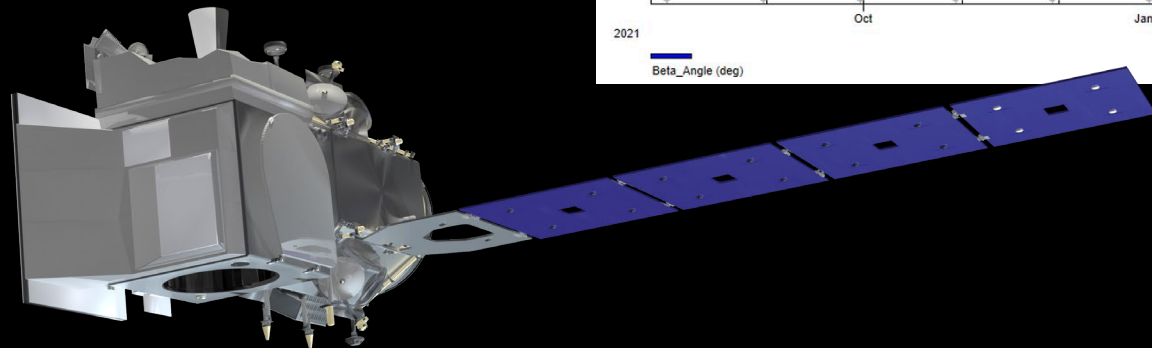
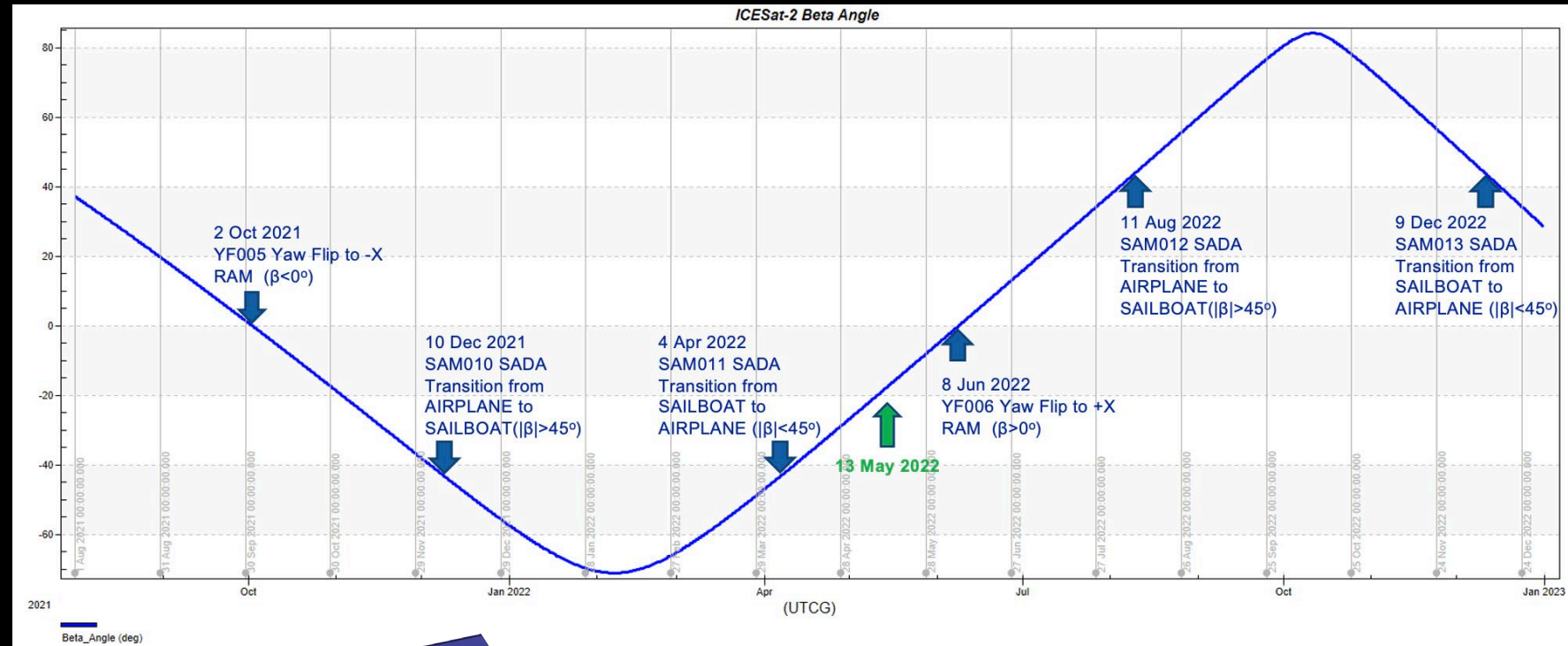
Smith et al., Science, 30 April 2020



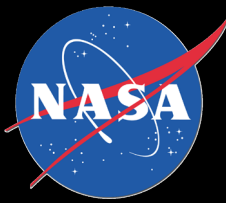
Safehold: 3 – 11 April 2022

Solar Array Orientation Changes

- Every ~120 days
- 11 such changes to date
- Timing dictated by sun-orbit geometry.
- Into SAILBOAT orientation:
12 Dec 2021
- Into AIRPLANE orientation:
3 April 2022

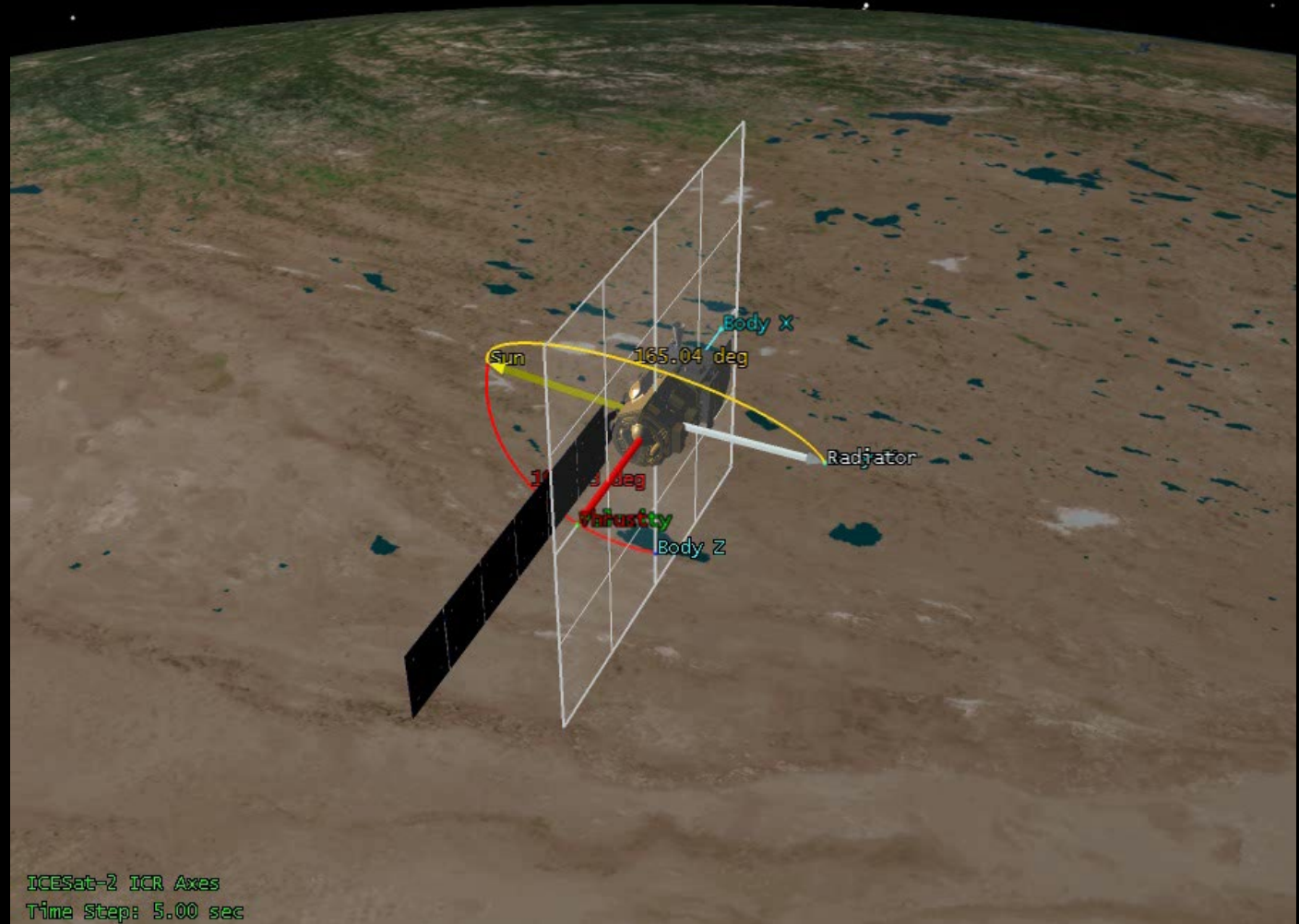


Recent Events



Solar Array position is actively managed for both seasonal events and during weekly maneuvers.

High Solar Beta Reorientation

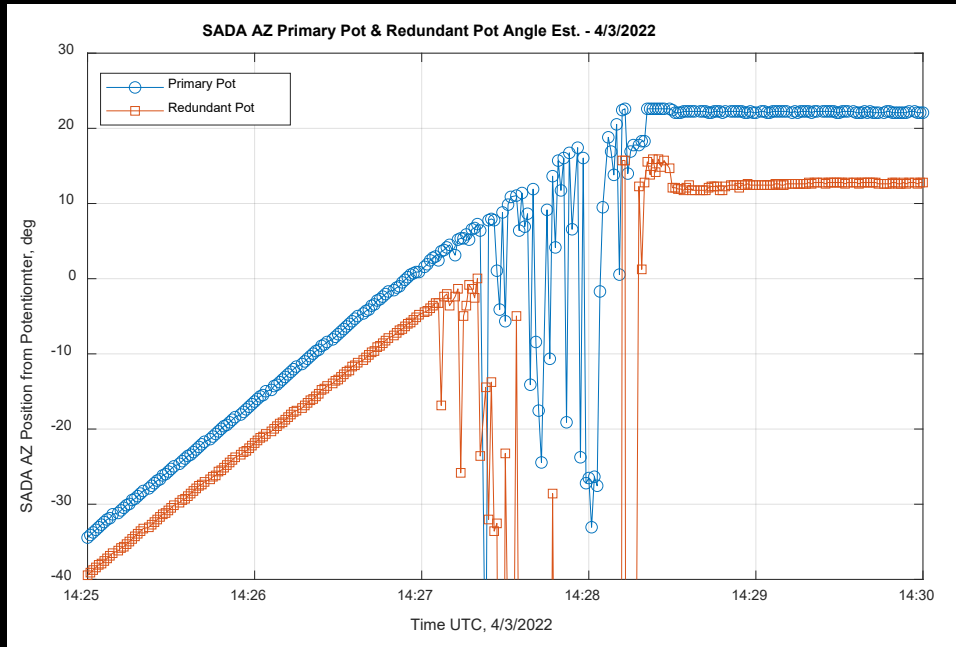


ICESat-2 ICR Axes
Time Step: 5.00 sec

Safehold: 3 – 11 April 2022

During 6th transition from SAILBOAT to AIRPLANE, observatory went into safe hold.

Root cause: microparticles on the potentiometer that measures the solar array position led to transient voltages

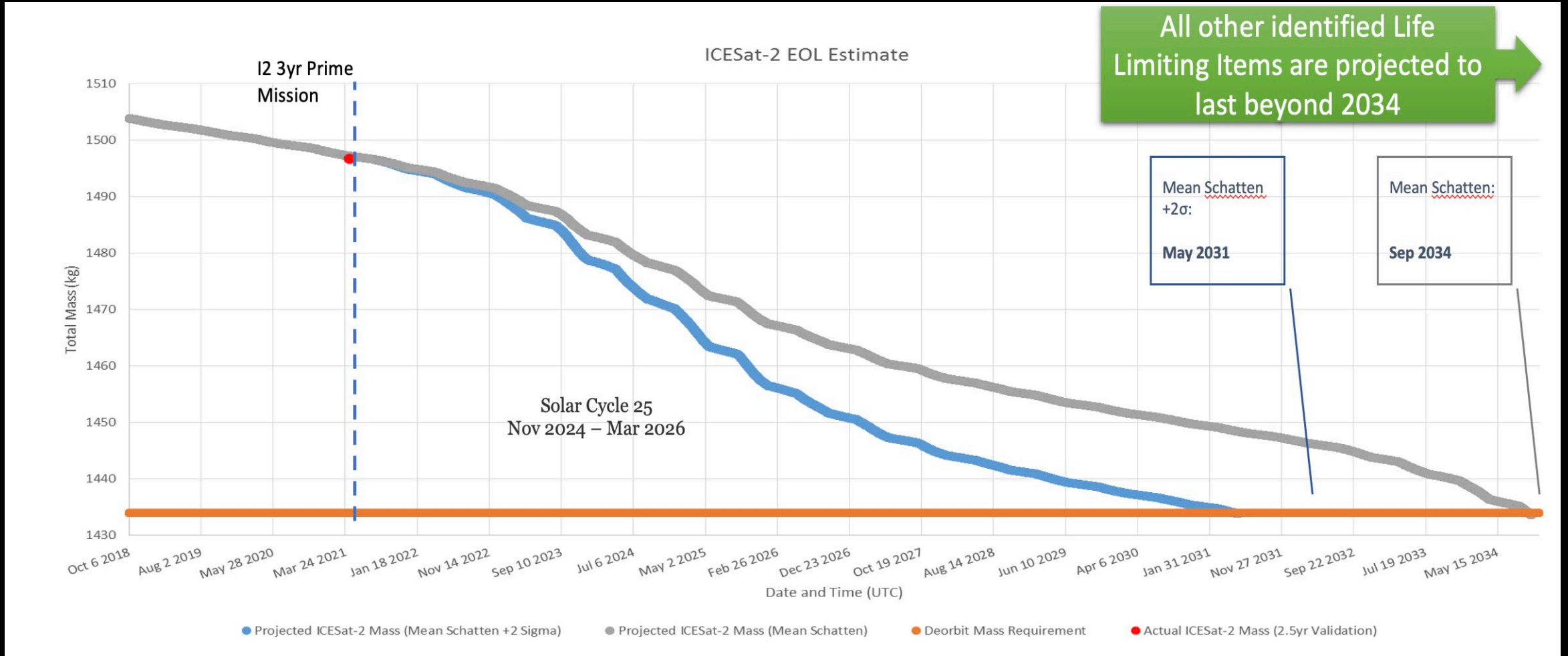


Spikes showed up on Redundant Pot (the “inner” Pot)

- Pot tracks are concentric in a plane normal to the output shaft
- Redundant Pot track is smaller diameter than Primary track
 - Variations in debris generation can be caused by manufacturing differences in wiper geometry



Propellant is likely life-limiting item





- Synced orbits between CryoSat-2 and ICESat-2 began 3 August 2020
- ~500 overlaps to date; overlaps occur every 1.3 days, currently optimized for the Arctic
- Overlaps will occur every 20th ICESat-2 RGT (RGT 605, 625, 645, etc.)
- <https://cryo2ice.org/>



Footprint overlaps with ICESat-2 's **CENTRAL** pair.

Spatial grid:

10 km x 10 km
in polar stereographic coordinates

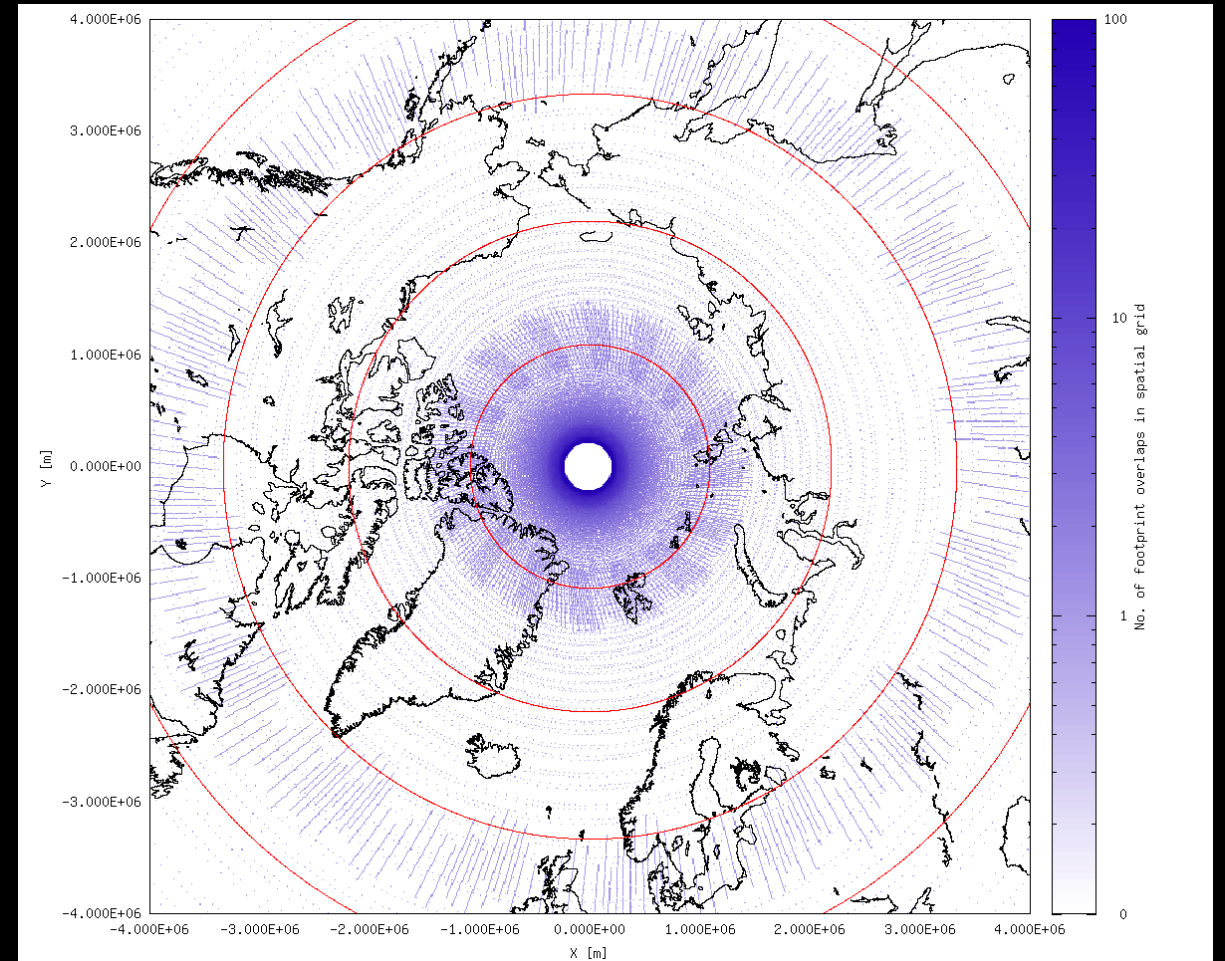
Analysis period:

1 year

Orbits:

CryoSat-2
19:20 resonance
Equatorial offset: +44 km

ICESat-2
Reconstructed reference



Search

Search parameters [Copy search url](#)

Search mode intersection-lat-long

Dataset A SIR_SAR_L2_E

Dataset B ATL07

Minimum latitude 70°

Maximum latitude 90°

Minimum longitude -180°

Maximum longitude 180°

Start time 2022-01-11 00:00

End time 2022-01-17 23:59

Minimum intersection duration 10 seconds

Maximum separation time 3 hours 0 minutes

Resolution 10km

Download data

No. of segments 159

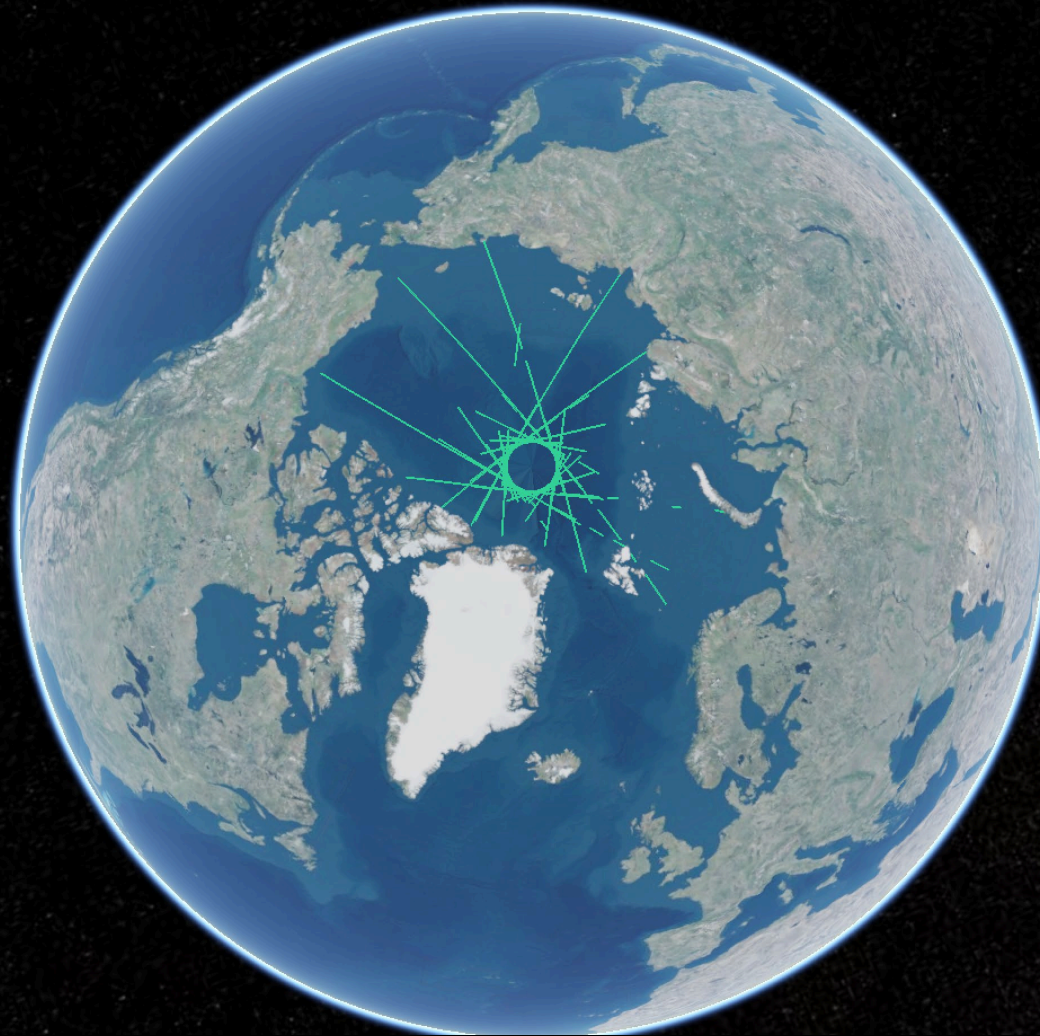
[Download intersections index \(.csv\)](#)

[Download segments \(.kml\)](#)

[Download CryoSat-2 SAR L2 POCA Baseline E data](#)

[Download ICESat-2 ATL07 Sea Ice Elevation Version 5 data](#)

[Download Custom Combined Product Data](#)



National Snow and Ice Data Center:

ATL03: Geolocated Photons

ATL06/11/14/15: Land Ice Elevation, along-track height timeseries, gridded height and height change

ATL07/10/20: Sea Ice Elevation and along-track/gridded freeboards

ATL09: Atmospheric Backscatter and weekly/monthly profiles

ATL12/19/21: Ocean Surface Height, gridded DOT, polar SSH

Quicklook (3-day latency): ATL07QL, 10QL, 08QL, and 13QL

4858 registered users
23.9 million files downloaded
Final products available for Oct 18, 2018 – Feb 10, 2022

NASA Distributed Active Archive Center (DAAC) at NSIDC

ICESat-2 Data

Ice, Cloud, and Land Elevation Satellite-2 Data



Overview

ICESat-2 Data Sets

Product Descriptions

- Level-1
- Level-2
- Level-3A
- Level-3B

Tools

Knowledge Base

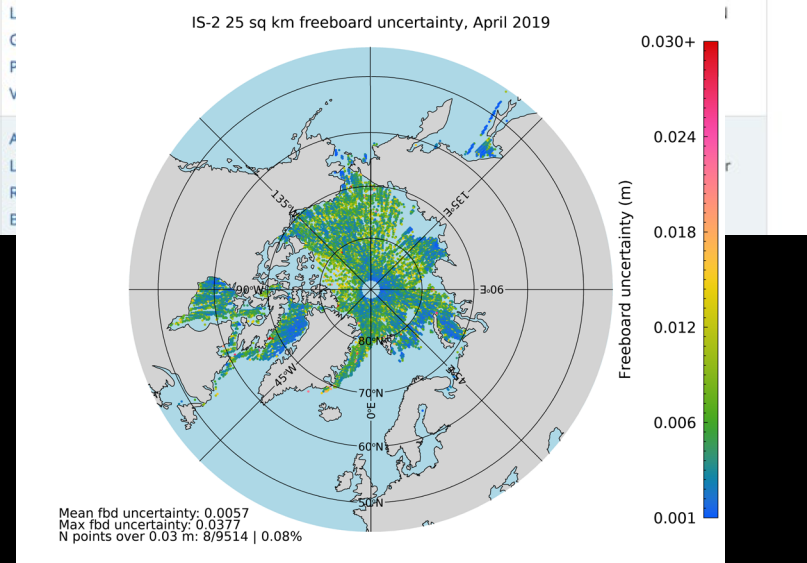
ICESat/GLAS Data

IceBridge Data

ICESat-2 Data Sets at NSIDC

The following table lists the ICESat-2 data sets that are currently available at the NASA NSIDC DAAC.

ID	Title	Spatial Coverage	Temporal Coverage	Spatial Resolution	Temporal Resolution	Parameter(s)
ATL02	ATLAS/ICESat-2 L1B Converted Telemetry Data, Version 1	GLOBAL	2018/10/13 to present	Not applicable	Not applicable	Engineering Telemetry Ancillary Data
ATL03	ICESat-2 Geolocated Photons	GLOBAL	2018/10/13 to present	30m	10m	Photons
ATL04	ICESat-2 Land Ice Elevation	GLOBAL	2018/10/13 to present	30m	10m	Elevation



Freeboard uncertainty, April 2019

National Snow and Ice Data Center (NSIDC DAAC):

Available tools (mostly in python) to facilitate access and use of data products.

Community continues to develop data tools:

Hackweek(s) – quick start tutorials

OpenAltimetry (<https://openaltimetry.org/>)

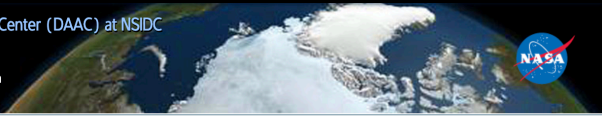
PhoREAL

icepyx

SlideRule (<http://voila.icesat2sliderule.org/>)

Photon Labeller

NASA Distributed Active Archive Center (DAAC) at NSIDC
ICESat-2 Data
 Ice, Cloud, and Land Elevation Satellite-2 Data

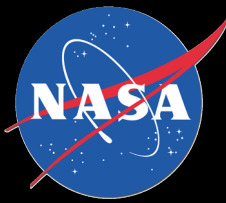


ICESat-2 Tools and Services

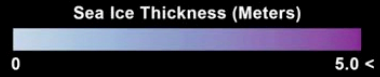
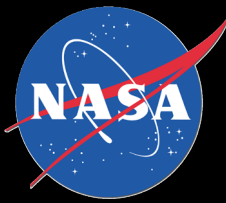
The following table lists the tools and services available for ICESat-2 data.

Name	Description	Access Type	Service Outputs	Source
OpenAltimetry	Discover, access, and visualize ICESat and ICESat-2 data. Key functions include on-the-fly plotting of segment elevations and photon clouds based on date and region of interest, ground track filtering and visualization, and data access in CSV or subsetted HDF5 format.	Web application	<ul style="list-style-type: none"> Downloadable elevation and photon plots Spatially subsetted HDF5 data CSV output of key parameters 	A NASA funded collaborative project between the Scripps Institution of Oceanography, San Diego Supercomputer Center, NSIDC DAAC, and UNAVCO.
NASA Earthdata Search	Search, visualize, and access data across thousands of Earth science data sets, including ICESat, IceBridge, and ICESat-2. Customization services are available for most ICESat-2 data sets, including subsetting and reformatting.	Web application	<ul style="list-style-type: none"> Data access via shell script and zip links Visit the page What subsetting and reformatting services are available for ICESat-2 data? for details on subsetting and reformatting services available for each ICESat-2 data set. 	NASA EOSDIS , supported by NSIDC DAAC.
Data Access and Service API	The NSIDC DAAC's Application Programming Interface, or API, provides spatial and temporal filtering as well as customization options as a single access command, without the need to script against our data directory structure.	API	Visit the page What subsetting and reformatting services are available for ICESat-2 data? for details on subsetting and reformatting services available for each ICESat-2 data set.	NSIDC DAAC
ICESat-2 Hackweek Jupyter Notebook Tutorials	A Github repository of Jupyter Notebook tutorials presented during the ICESat-2	Downloadable tool	Python-based guidance on access, reading, plotting, and exploration of ICESat-2	ICESat-2 Hackweek , hosted by the University of Washington with

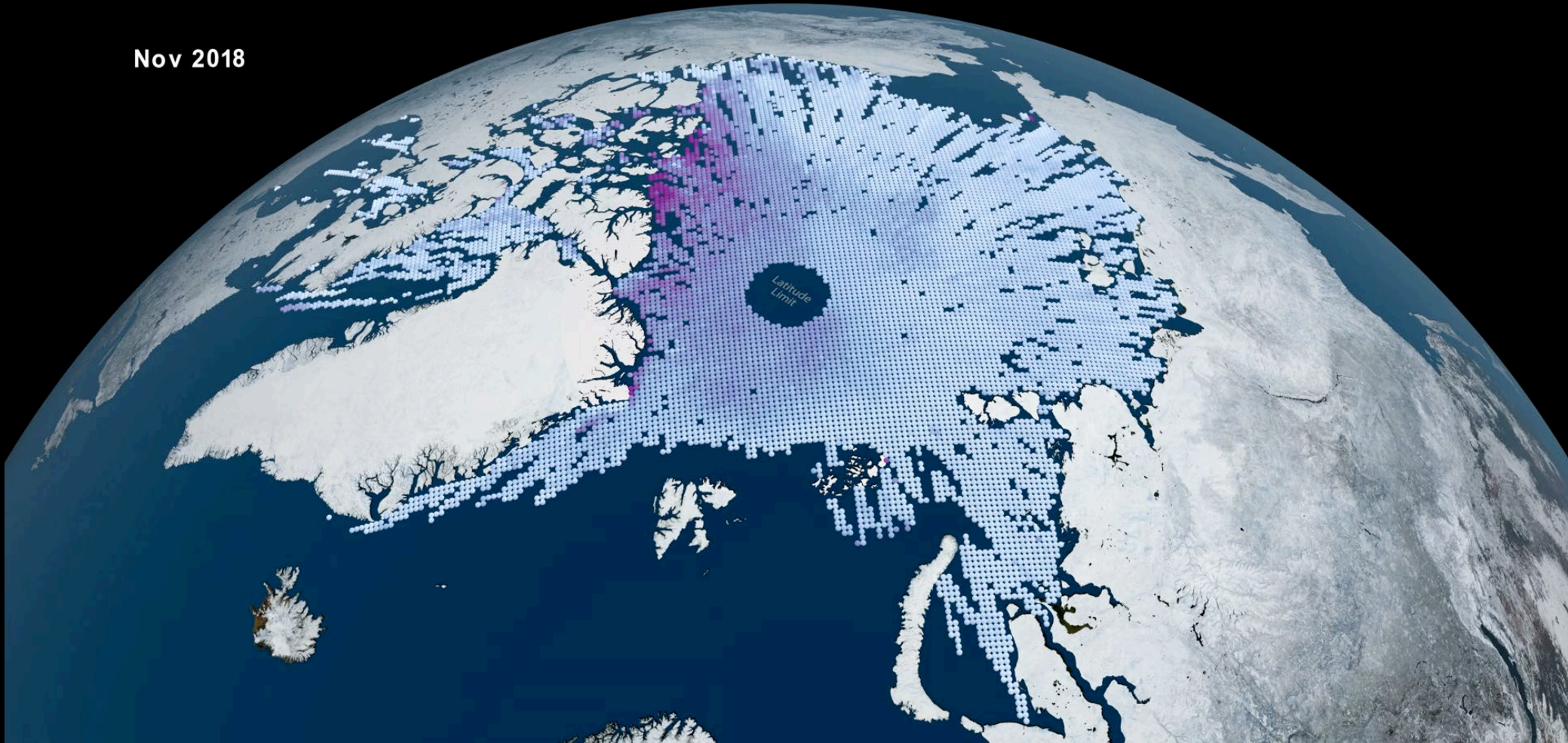
ATL14/15: Gridded elevation and change



Sea ice thickness change

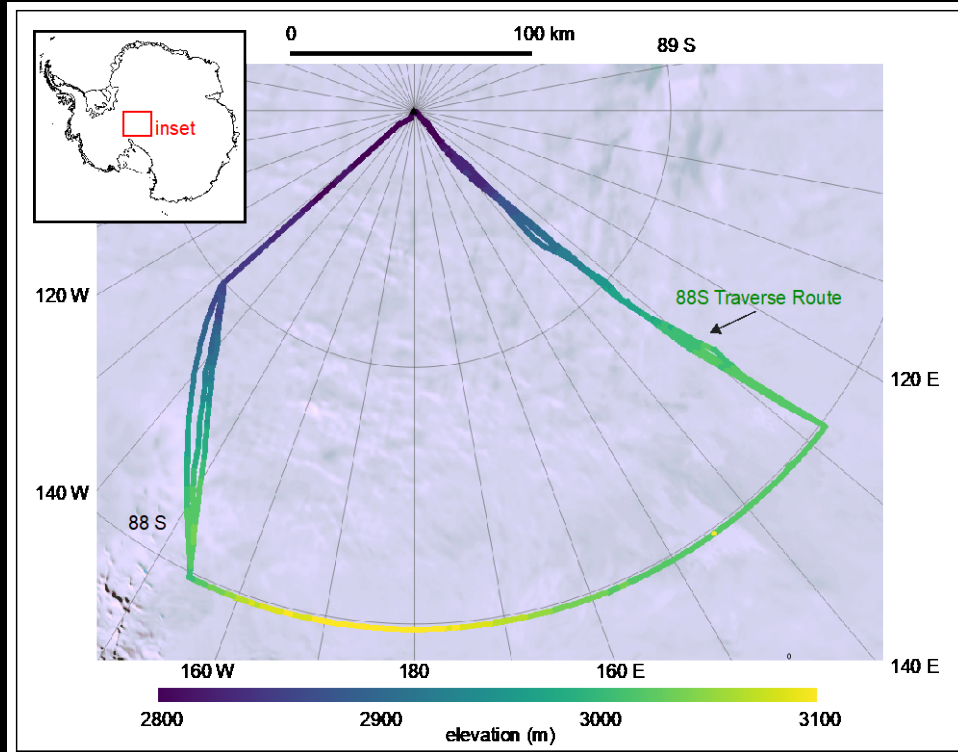


Nov 2018

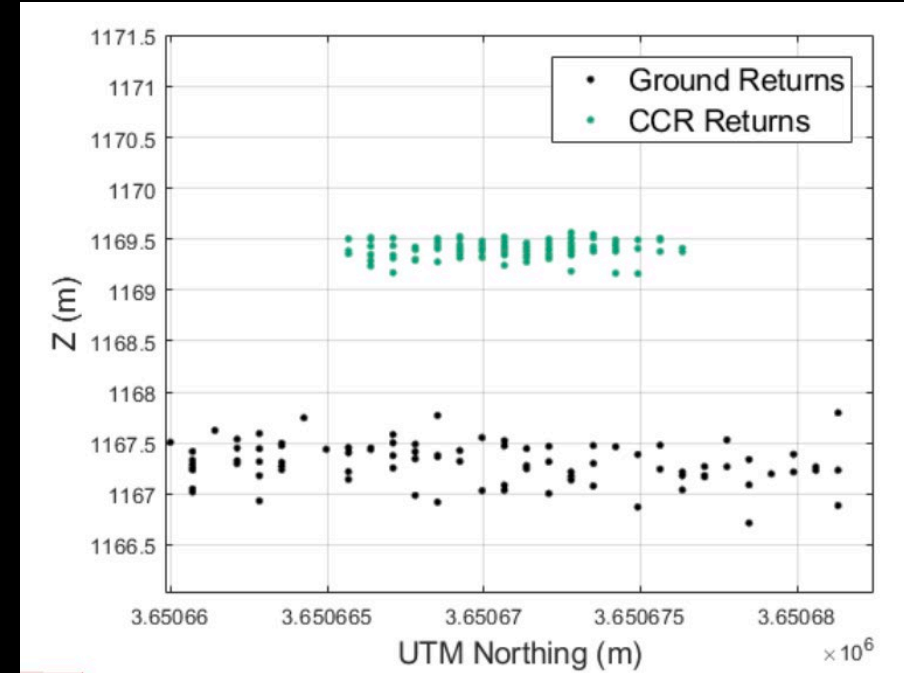


How good are the data?

88°S Antarctic Traverse (3 kinematic GPS surveys)



88°S Corner-cube retro-reflector arrays



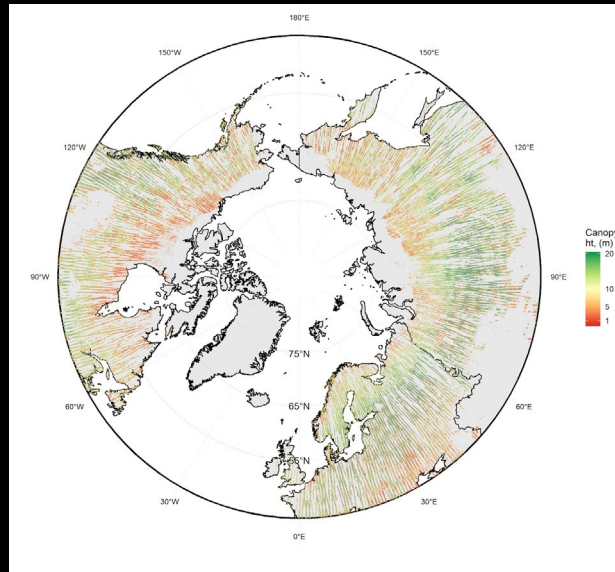
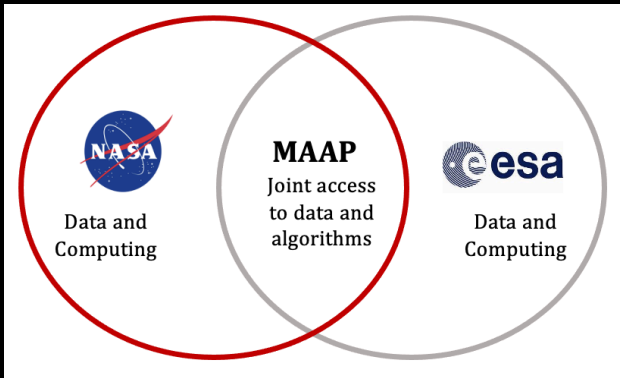
ATL03 (low slope): 5 cm vertical accuracy, 13 cm precision
 ATL06: 3 cm vertical accuracy, 9 cm precision
 Brunt et. al, (2019, 2021)

Average horizontal accuracy (geolocation) : $3.4 \text{ m} \pm 2.5 \text{ m}$
 Average footprint diameter: $11.3 \text{ m} \pm 0.8 \text{ m}$
 Magruder et. Al, (2021)

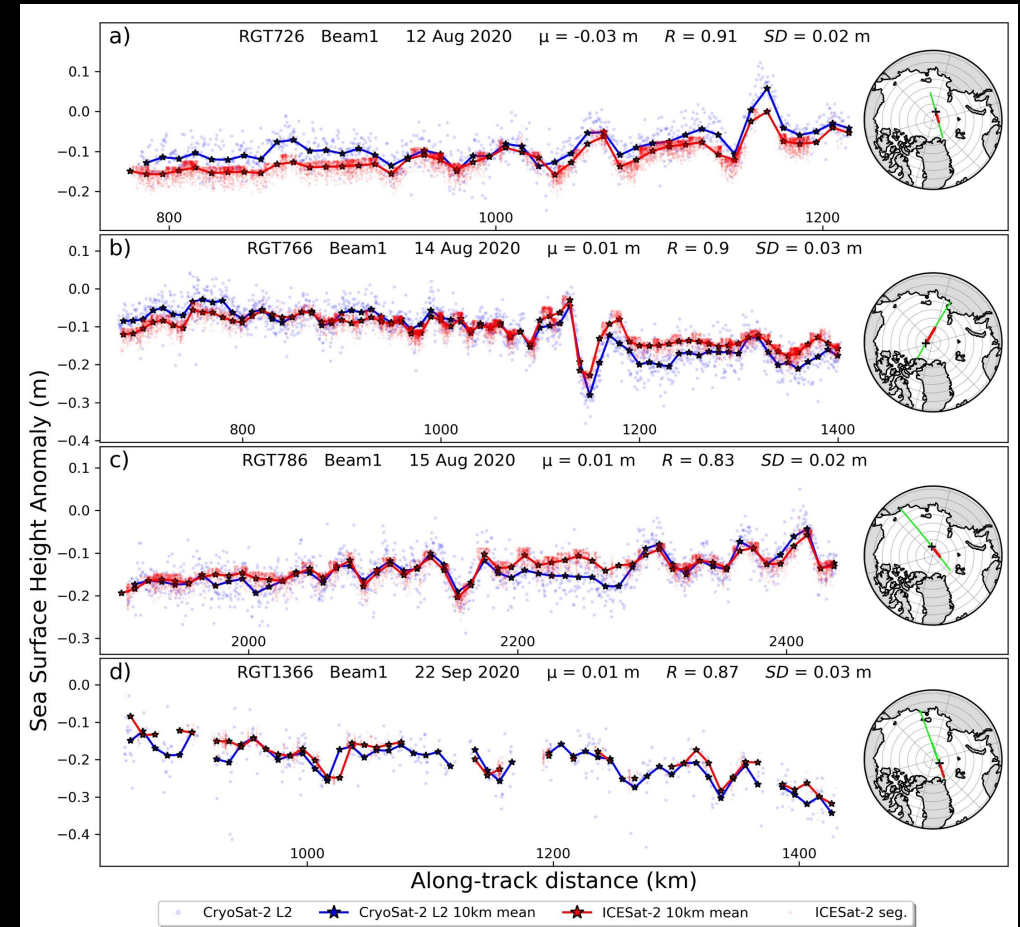
- Over 200 peer reviewed papers using on-orbit ICESat-2 data

icesat-2.gsfc.nasa.gov/publications

The Multi-Mission Algorithm and Analysis Platform (MAAP)



Duncanson et al. (2021)



Bagnardi et al. (2021)

The image shows the ICESAT-2 satellite in orbit above the Earth. The satellite is a complex, multi-faceted structure with a long, thin solar panel array extending from its side. It is emitting a green laser beam towards the Earth's surface. The Earth's surface is visible at the bottom, showing a mix of land and ice. The background is the dark, starry space of the universe.

Links!

<https://nsidc.org/data/icesat-2>

<https://github.com/ICESAT-2HackWeek>

Thank you

thomas.neumann@nasa.gov