

ICESat-2 Science Team Main Goals

1) Provide internal coordination within ST, PSO & HQ

- Status updates
- Complacency check

2) Stimulate collaboration within ST & across disciplines

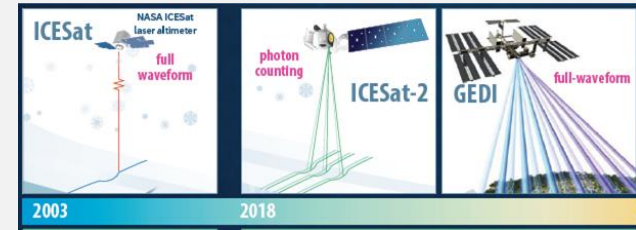
- Science talks / posters / social events at meetings
- Cross-cutting themes

3) Ensure we maintain visibility of ICESat-2 mission

- Publishing/reviews/press releases/Op Eds/White papers
- Open Science
- Synergies/links with other missions

4) Looking forward: next 5 years of ICESat-2 & beyond

- Funding for Earth Science missions
- ESAS Decadal Survey 2026-7



ICESat-2 Science Team working groups



SCIENCE TEAM

The Science Team is a group of competitively selected scientists who help define and implement ICESat-2's science goals. They provide guidance and advice to the ICESat-2 project to ensure the mission meets its science requirements.

ANDERSON, ERIC

Hydrology
[Colorado School of Mines](#)

CHRISTIAN, KENNETH

Clouds & Aerosols
[University of Maryland, College Park](#)

FERREIRA, CELSO

Hydrology
[George Mason University](#)

HAMLINGTON, BENJAMIN

Oceanography
[NASA Jet Propulsion Lab](#)

KACIMI, SAHRA

Sea ice
[NASA Jet Propulsion Lab](#)

BIRKETT, CHARON

Hydrology
[NASA GSFC](#)

EIDAM, EMILY

Oceanography
[Oregon State University](#)

FRICKER, HELEN AMANDA

Ice sheets, Science Team Lead
[University of California, San Diego](#)

HELL, MOMME

Sea ice
[Brown University](#)

KAIRMZADEH, MORTEZA

Sea ice
[University of Colorado Boulder](#)

KING, MICHAELA

Ice sheets
[University of Washington](#)

MORISON, JAMES

Arctic oceanography
[University of Washington](#)

NAVARI, MAHDI

Ice sheets
[University of Maryland, College Park](#)

PADMAN, LAURIE

Antarctic oceanography
[Earth & Space Research](#)

PONTE, RUI

Sea ice
[Atmospheric and Environmental Research, Inc.](#)

RYAN, JONATHAN

Hydrology
[University of Oregon](#)

SILVA, CARLOS ALBERTO

Forestry
[University of Florida](#)

TILLING, RACHEL

Sea ice
[University of Maryland, College Park](#)

MAKSYM, TED

Sea ice
[Woods Hole Oceanographic Institution](#)

MORLIGHEM, MATHIEU

Ice Sheets
[Dartmouth College](#)

NEUENSCHWANDER, AMY

Vegetation
[University of Texas at Austin](#)

PETTY, ALEK

Sea ice
[University of Maryland, College Park](#)

POPESCU, SORIN

Vegetation
[Texas A&M University](#)

SIEGFRIED, MATTHEW

Land ice
[Colorado School of Mines](#)

SOMMERS, ALEAH

Ice sheets
[Dartmouth College](#)

ZHAO, MENGAN

Sea ice
[Atmospheric and Environmental Research, Inc.](#)

<https://icesat-2.gsfc.nasa.gov/>



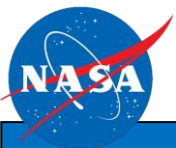
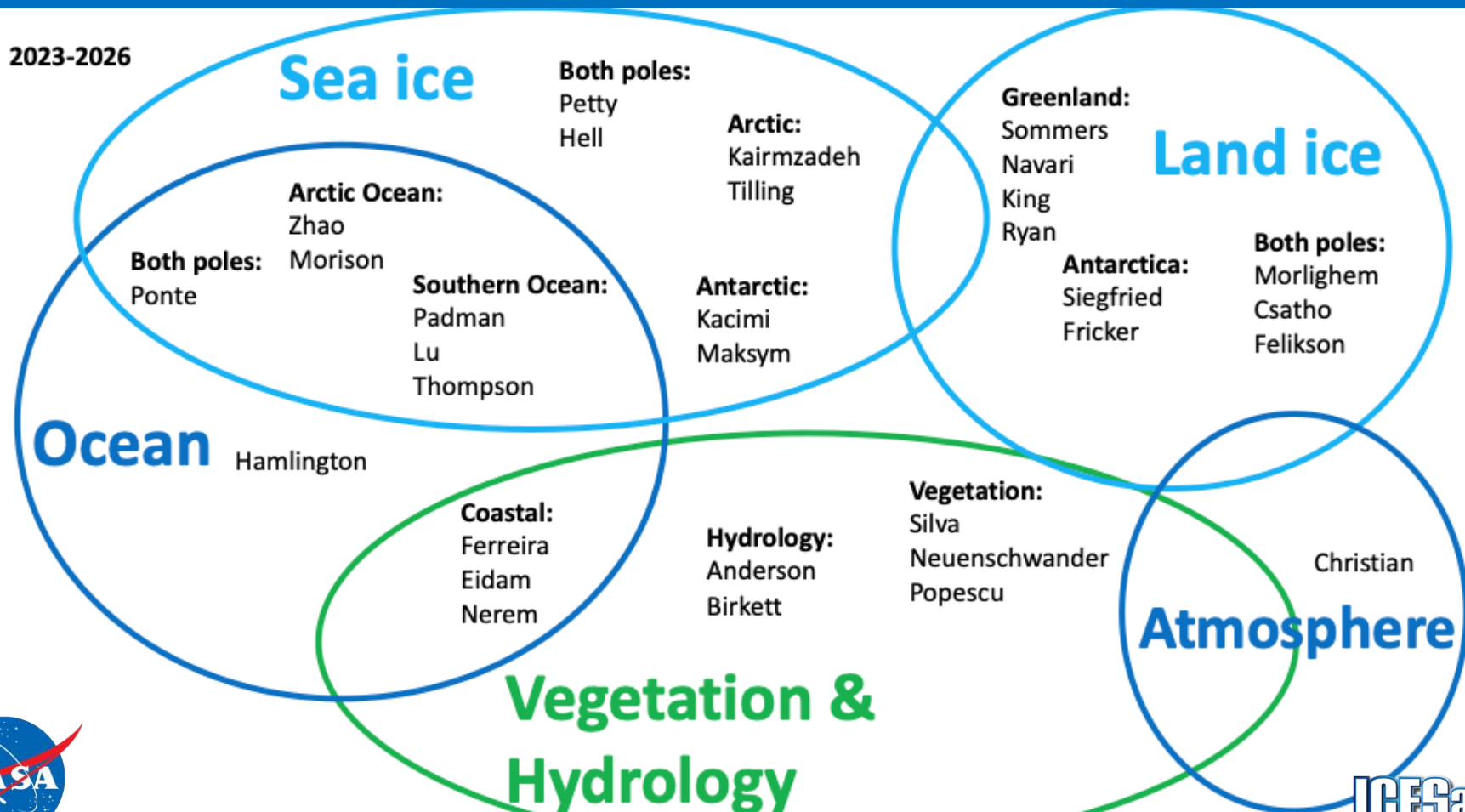
NASA Official: Tom Neumann
Webmasters: [610 WebDev](#)
Curator(s): Valerie Casasanto,
Kate Ramsayer, Brian Campbell
Website Design &

Privacy
[Contact Us](#)
Accessibility



ICESat-2 Science Team 2023-2026

2023-2026



Amy Neuenschwander, University of Texas at Austin



Forest Structure Metrics to Improve Boreal Biomass Estimation from ICESat-2

PI Amy Neuenschwander
University of Texas at Austin

Co-I Laura Duncanson
University of Maryland





ICESat-4D

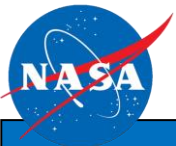
Monitoring Forest Resistance and Post-Hurricane Recovery Dynamics in Southern Forests by the Synergism of ICESat-2, SAR, and Optical Data and an Ecosystem Demography Model



Carlos Alberto Silva
c.silva@ufl.edu

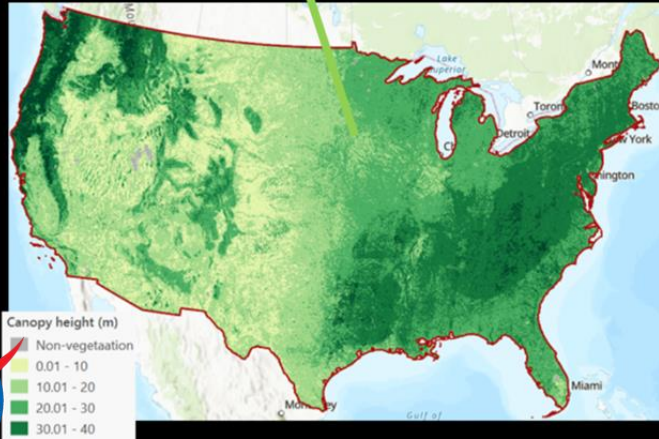
Assistant Professor of Forest Biometrics and Remote Sensing
Forest Biometrics and Remote Sensing Lab (Silva Lab)
School of Forest, Fisheries, and Geomatics Sciences (SFFGS)
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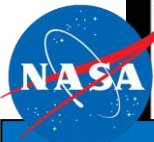
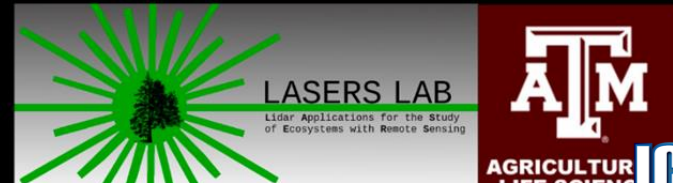




Contiguous US 30-m Canopy Height Map



Sorin Popescu and Lonesome Malambo
Texas A&M University





Assessing and predicting Arctic Coastal Erosion Hazards with ICESat-2

Celso Ferreira, PhD, PE

Associate Professor

Department of Civil, Environmental and Infrastructure Engineering



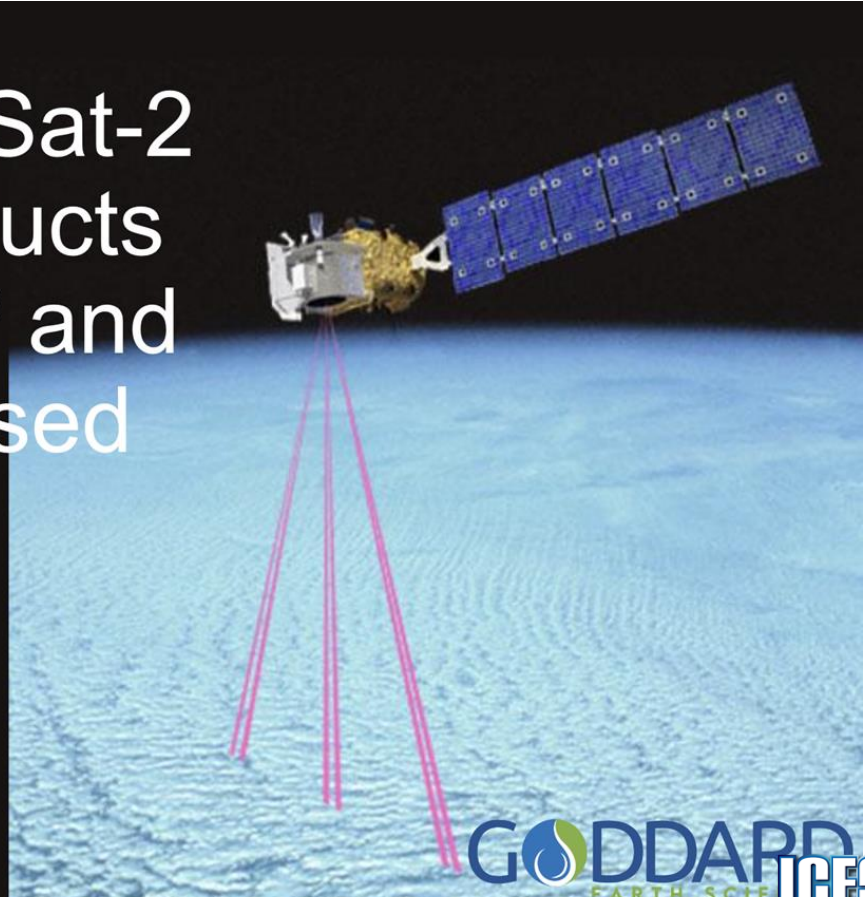
Credit: Ferreira, GMU



Evaluation of ICESat-2 Atmospheric Products using the CALIOP and CATS Spaced-Based Lidars

Kenneth Christian

Steve Palm, John Yorks, Edward
Nowottnick



Improving Greenland Ice Sheet surface mass balance estimates by assimilation of ICESat-2 products

Mahdi Navari (mahdi.navari@nasa.gov)

Christopher Stevens,

Collaborators

Denis Felikson, Brooke Medley



La Jolla 2023



Coupled subglacial hydrology and ice dynamics constrained by surface elevation evolution



Aleah Sommers¹, Lauren Andrews², Aaron Stubblefield¹, Colin Meyer¹

¹Thayer School of Engineering, Dartmouth College

²NASA Goddard Space Flight Center

ICESat-2 Science Team meeting

October 3, 2023

ICESat-2 Applications Workshop 3rd June 2024



Interactions between sea ice, ice shelves, icebergs and the ocean around Antarctica



Laurie Padman & Susan L. Howard

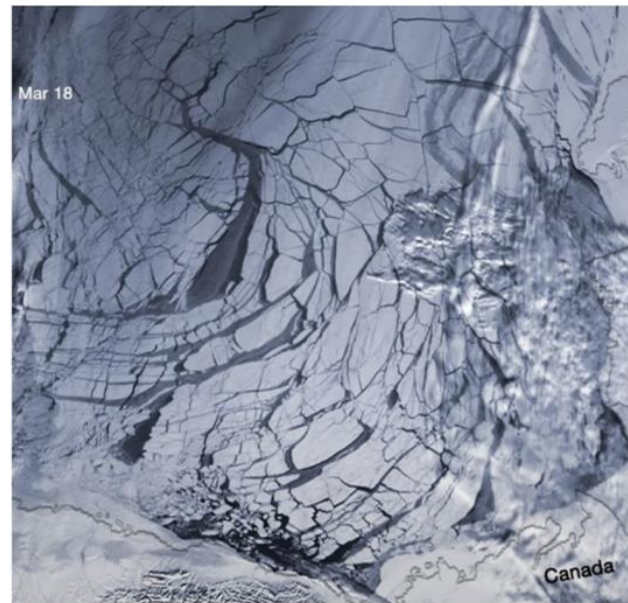




Arctic Sea Ice Leads and their Influence on Upper Ocean Dynamics

Mengnan Zhao
Christopher Little

10/03/2023



Ted Maksym, Woods Hole Oceanographic Institution

Antarctic sea ice dynamics and drivers of seasonal variability with ICESat-2

Ted Maksym



WOODS HOLE
OCEANOGRAPHIC
INSTITUTION

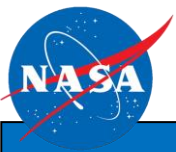
ICESat-2 Applications Workshop 3rd June 2024

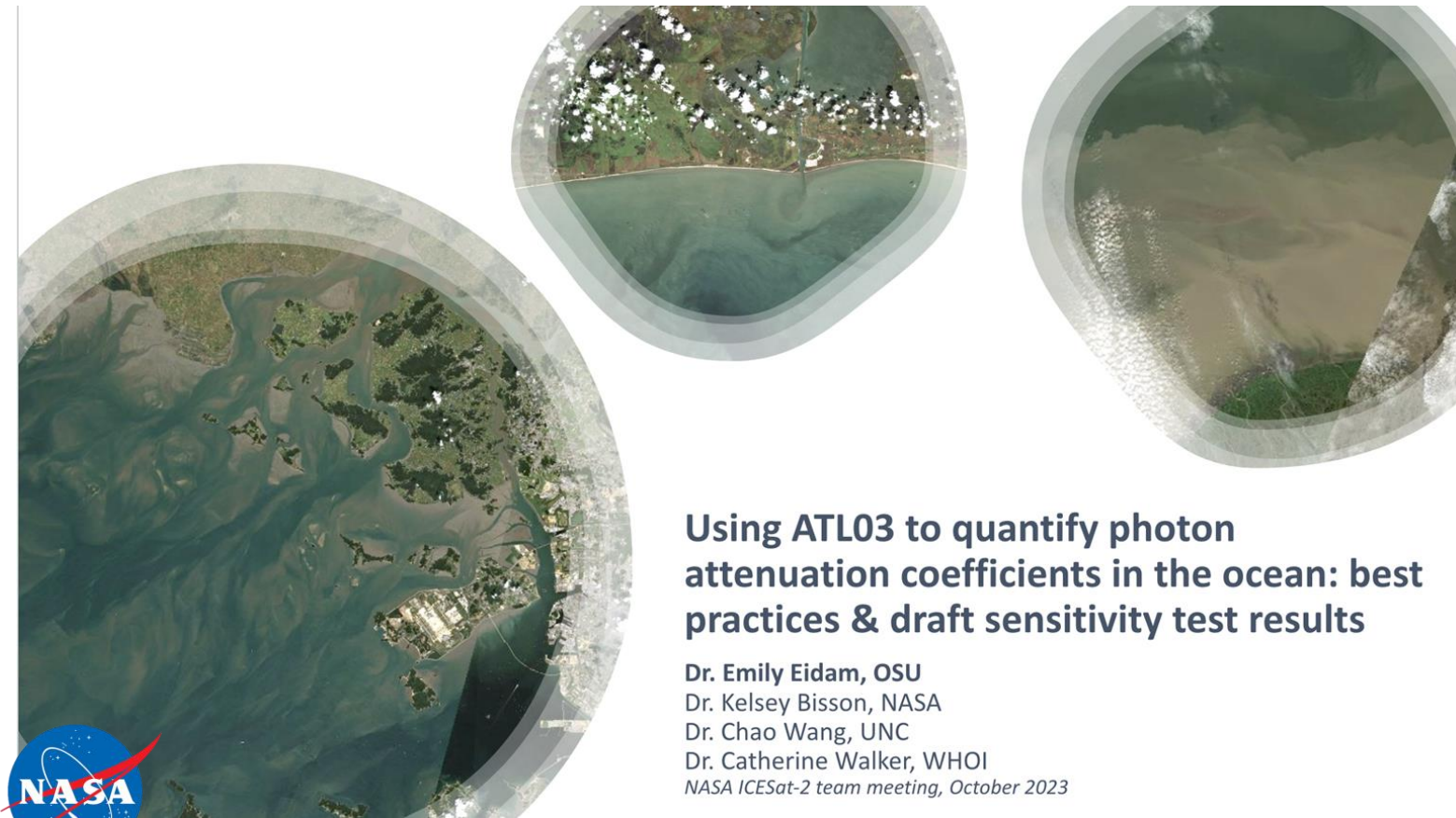


Charon Birkett, GSFC

High Latitude Lake and River Dynamics: Capturing Hydraulic Measurements using ICESat-2

Charon Birkett, Mike Jasinski, Martina Ricko, Hunter Yang, Kristine Barbieri (GSFC)
David Bjerklie (USGS, AKDOT), Benjamin Johnson (NOAA/NWS), Michael Winfree (FWS),
Daniel Shugar (Univ. Calgary), and Krista Bartz/Peter Kirchner (NPS)





Using ATL03 to quantify photon attenuation coefficients in the ocean: best practices & draft sensitivity test results

Dr. Emily Eidam, OSU
Dr. Kelsey Bisson, NASA
Dr. Chao Wang, UNC
Dr. Catherine Walker, WHOI
NASA ICESat-2 team meeting, October 2023





Atmospheric and
Environmental Research

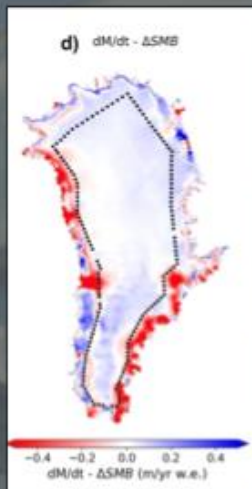
An Investigation of Sea Ice-Ocean Interactions Using ICESat-2 Data

Rui M Ponte

October 4, 2023



Improving Greenland ice velocities and components of mass change with ICESat-2 elevation products



Michalea King,
Ben Smith,
Ian Joughin



80NSSC23K0937-ICESAT2



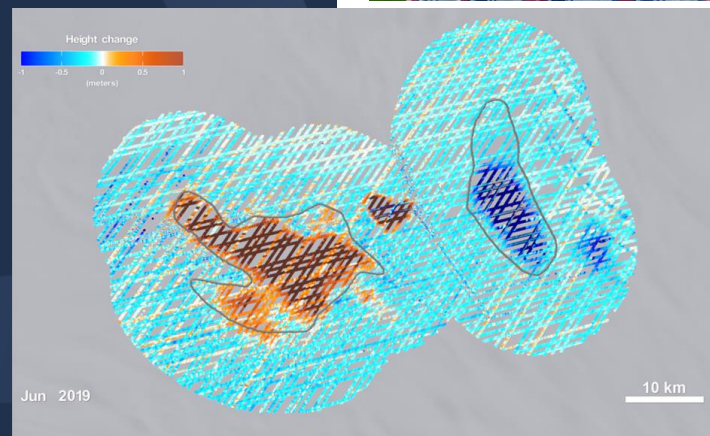
Leveraging ICESat-2 altimetry for Antarctic subglacial lake
identification, evolution, and basal properties

+

Tracing Antarctic freshwater: Coupling ICESat-2 observations of
subglacial lake fluxes with ice-shelf cavity models to quantify
impacts on ice-ocean processes

Matthew Siegfried
(and a host of collaborators)
ICESat-2 Science Team Meeting
2 October 2023

siegfried@mines.edu
@MinesGlaciology

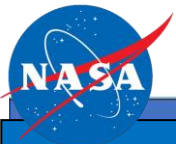
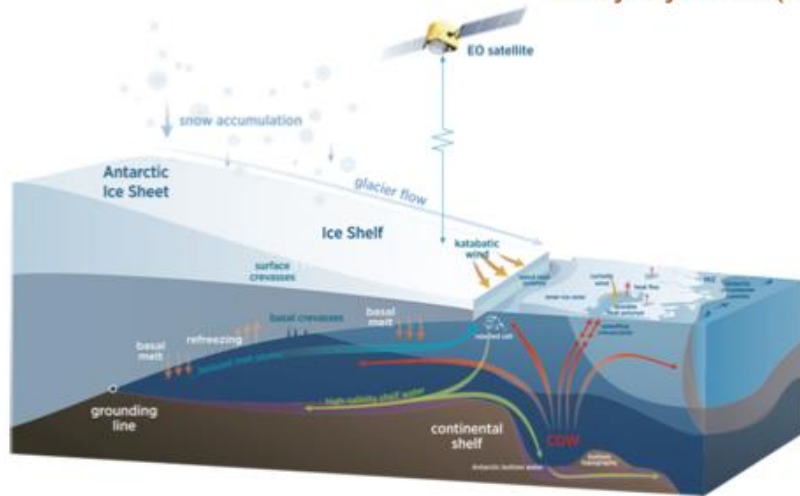


Helen Amanda Fricker, Scripps Inst of Oceanography, UC San Diego

Quantifying processes affecting buttressing capacity of East Antarctica's ice shelves with **ICESat-2**, CryoSat-2 & optical satellite imagery

Helen Amanda Fricker (PI)

Susheel Adusumilli (SIO postdoc), Chancellor Roberts (SIO student), Philipp Arndt (SIO student) & Bryony Freer (BAS/Leeds student)



Review article



Monitoring Earth's climate variables with satellite laser altimetry

Lori A. Magruder^{1,2}, Sinead L. Farrell^{3,4}, Amy Neuenschwander⁵, Laura Duncanson⁶, Beata Csatho⁷, Sahra Kacimi⁸ & Helen A. Fricker¹

Abstract

Satellite laser altimetry measures accurate elevations of the Earth's surface and precise changes with time, monitoring key climate variables. These observations have transformed understanding of the Earth System, revealing changes and dynamics across spheres. In this Review, we highlight the Earth and climate science contributions from three NASA satellite laser altimeter missions: Ice, Cloud and land Elevation Satellite (ICESat; 2003–2009), ICESat-2 (2018 to present) and Global Ecosystem Dynamics Investigation (GEDI; 2018 to present). Over two decades of observations, satellite altimetry revealed cryosphere decline, including a loss of 320 Gt yr⁻¹ in global land ice from Greenland and Antarctica, and a 30% decrease in volume of winter sea ice in the Arctic between 2003 and 2021. Observations have also been key to understanding ecosystems on land, providing data on the hydrosphere (showing that 57% of the Earth's seasonal terrestrial water storage variability comes from human-managed reservoirs) and biosphere (showing that forest carbon stocks have globally increased owing to growth, despite a loss of the equivalent of -8 Gt CO₂ from land use). In the atmosphere, the data have enabled assessment of the global vertical cloud distribution, aerosol fraction, and dust and smoke transport. There is currently no planned satellite laser altimeter mission to continue from ICESat-2 and GEDI, jeopardizing critical data collection that supports decision-making and environmental management.

Sections

- Introduction
- Background
- Cryosphere
- Biosphere
- Hydrosphere
- Atmosphere
- Summary and future perspectives



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Review article



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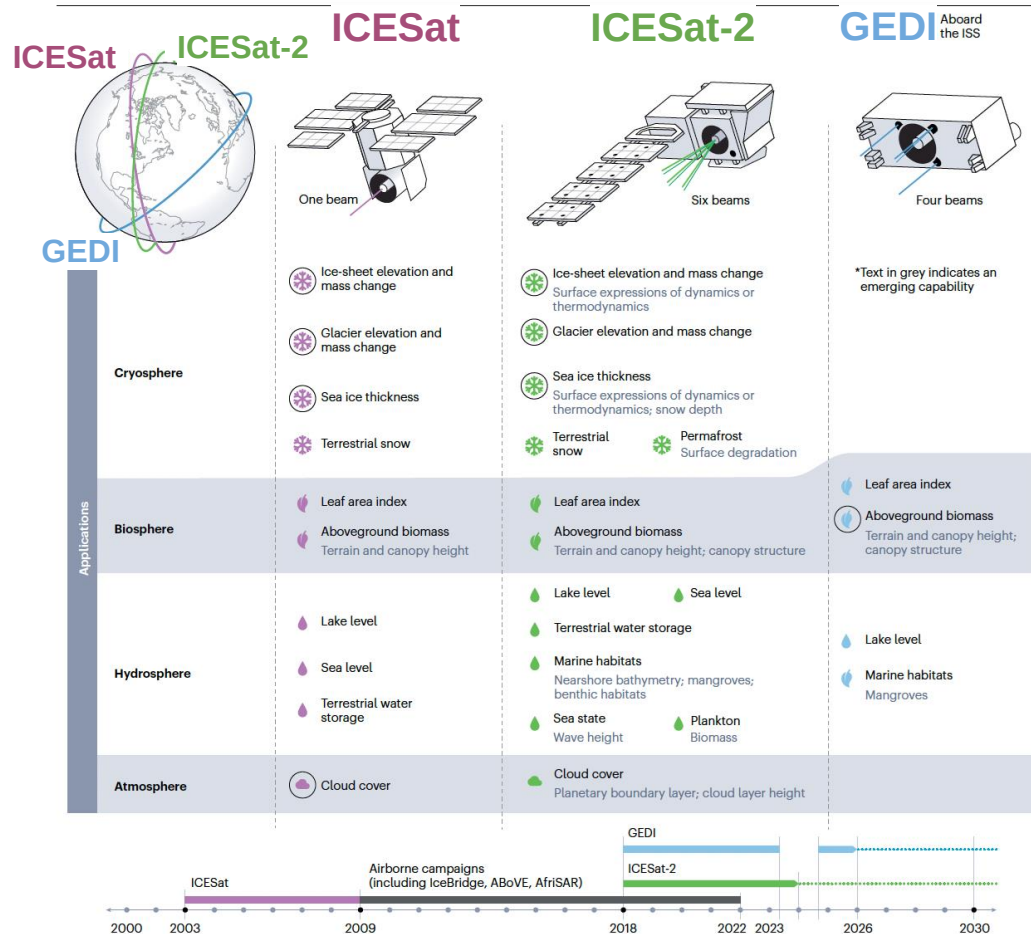


Fig. 1 | Key climate variables monitored by satellite laser altimetry.

Observations from the Ice, Cloud and land Elevation Satellite (ICESat), ICESat-2 and Global Ecosystem Dynamics Investigation (GEDI) across the cryosphere, biosphere, hydrosphere and atmosphere aid measurements of a wide variety of essential climate variables including ice-sheet and glacier elevation and mass

change, sea ice and terrestrial snow thickness, permafrost, leaf area index, aboveground biomass, lake and sea level, terrestrial water storage, sea state, marine habitat properties, plankton and cloud cover. Climate variables that map to a specific mission science requirement are circled. ISS, International Space Station.

¹Department of Aerospace Engineering and Engineering Mechanics, University of Texas at Austin, Austin, TX, USA. ²Center for Space Research, University of Texas at Austin, Austin, TX, USA. ³Department of Geographical Sciences, University of Maryland, College Park, MD, USA. ⁴Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD, USA. ⁵Department of Geological Sciences, University at Buffalo, Buffalo, NY, USA. ⁶Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA. ⁷Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA. ⁸e-mail: lori.magruder@austin.utexas.edu

Box 1

Basic principles of satellite laser altimetry

Full-waveform

Full-waveform laser altimetry, used in ICESat/GLAS and GEDI, records all of the reflected energy from each transmitted laser pulse to create a returned energy profile along the laser line of sight¹⁰. This received energy profile creates a waveform whose shape and size depends on the vertical structure of the illuminated surfaces, the surface reflectivity and the topography. An advantage of full-waveform systems is that the data processing required for elevation and geolocation determination is well understood¹⁰. The waveform has a single peak for simple, unvegetated surfaces with low slopes, most ice sheets and the ocean; the average range to the surface is from the centroid of the transmit pulse to the centroid of a Gaussian fit to the waveform⁹ (see the figure, panel **b**). However, more complex surfaces and vegetation lead to multiple peaks in the waveform, due to the laser illuminating multiple surfaces at different elevations⁹ (see the figure, panel **b**). A range offset for each individual surface can be derived from the timing of each peak relative to the time-tag of the waveform leading edge. Full-waveform signal detection relies on thresholds of thousands of photons returning to the receiver, which requires a large amount of transmitted energy¹⁰. This requirement on

laser power for signal detection constrains the possible repetition rates of the laser, which affects the along-track resolution. GPS, Global Positioning System; POD, precise orbit determination.

Photon-counting

Photon-counting laser altimetry, used in ICESat-2/ATLAS, removes the dependence on signal thresholds, as its detection sensitivity is at the single-photon level¹⁷. Each individual photon is assigned a time-tag to calculate the range based on the laser energy time of flight, and standard methods are used to provide a geodetic position and elevation²²⁰. Single-photon systems eliminate the need for substantial laser power, allowing the laser to operate at higher repetition rates and the energy from a single laser to be distributed across multiple beams (see the figure, panel **c**). These operational aspects of photon-counting systems provide expanded coverage and improve the resolution of the along-track measurement. One challenge of photon-counting laser altimetry is that the detector records all incoming photons but does not distinguish between true signal and ambient solar noise, so that complex algorithmic approaches are required for signal finding when processing the data¹⁴.

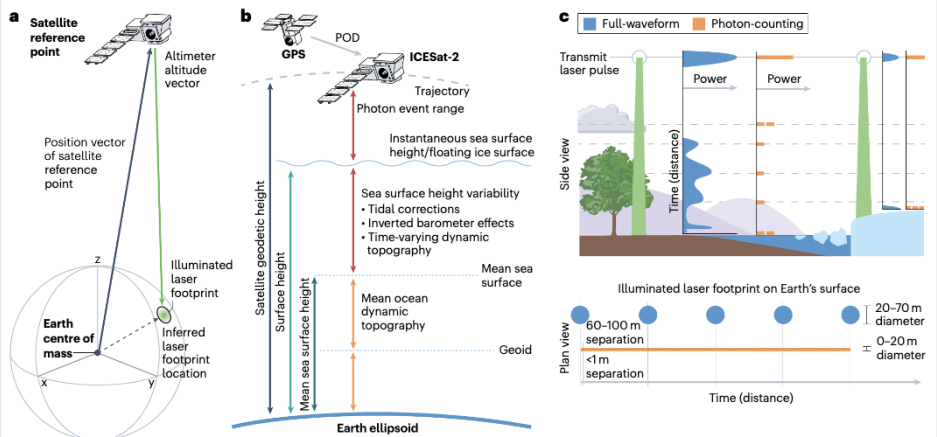
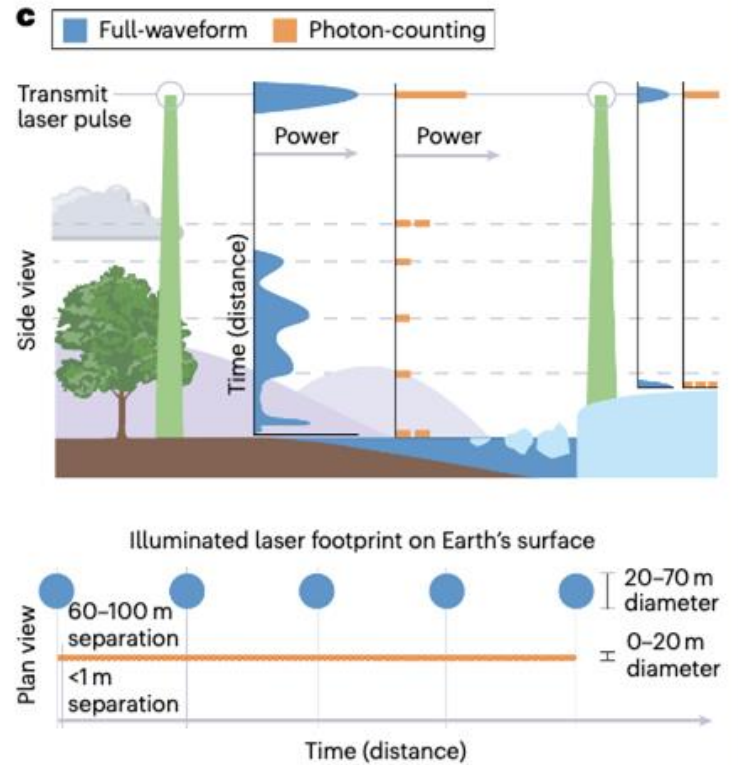
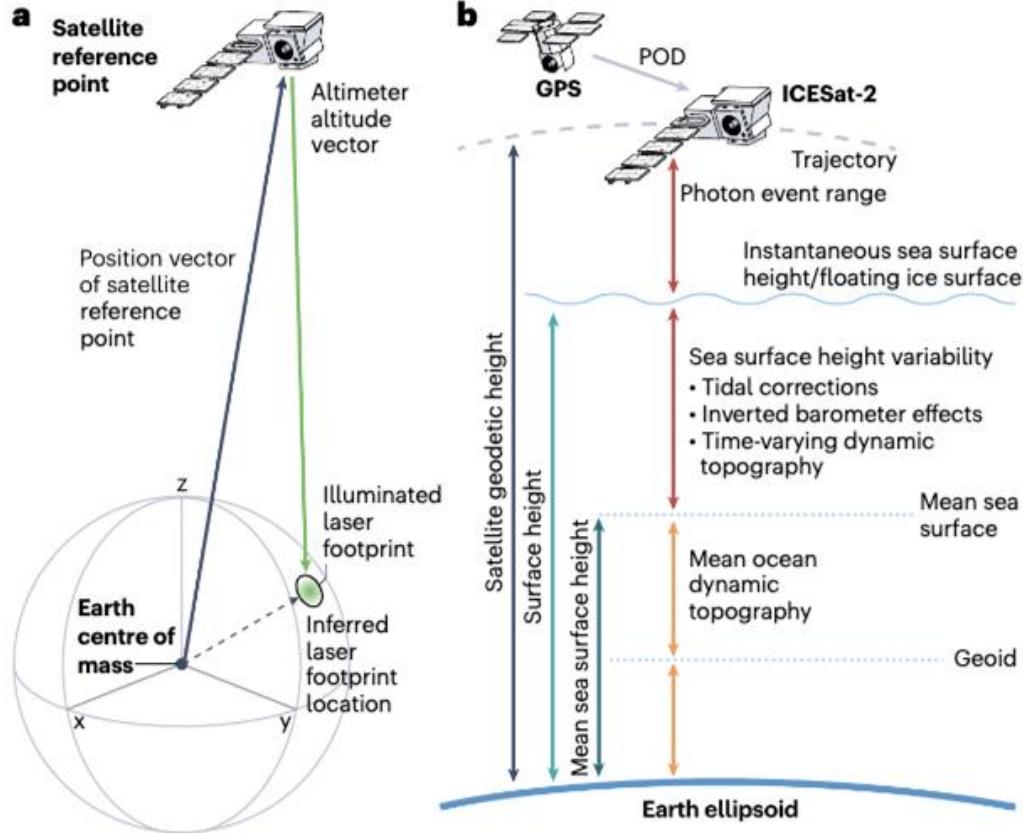


Table 1 | Operational and instrumental parameters of NASA's space-based laser altimeter systems

Parameters	ICESat	ICESat-2	GEDI
Altitude (mean value)	596 km	500 km	420 km
Coverage	±86°	±88°	±51.6°
Number of beams	1	6	4
Laser wavelength	532 nm/1,064 nm	532 nm	1,064 nm
Lidar technology	Full-waveform	Photon-counting	Full-waveform
Laser repetition rate	40 Hz	10 kHz	242 Hz
Along-track sampling	172 m	0.7 m	60 m
Laser footprint diameter	35–70 m ^a	11 m	25 m
Laser energy per pulse	70 mJ	0.03 mJ/0.12 mJ ^b	5 mJ/10 mJ ^b
Laser pulse width	4 ns	1 ns	14 ns
Orbit inclination	94°	92°	51.6°
Track separation at Equator	15 km	<2 km after 3 years	Variable
Ground track repeat cycle	91 days	91 days	N/A
Mission geolocation accuracy requirement	4.5 m	6.5 m	10 m

^aICESat had variable laser footprint diameters for each of the operational lasers. ^bICESat-2 and GEDI provide two energy levels across the multiple beams.



Monitoring Earth's climate variables with satellite laser altimetry

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Key Points

- NASA's three satellite laser altimeter missions (ICESat, GEDI and ICESat-2) have provided surface elevation data for monitoring essential climate variables across the Earth system, at high spatial and temporal resolution.
- In the **cryosphere**, ICESat and ICESat-2 observations revealed a decline in sea ice thickness in the Arctic and a loss of land ice from glaciers, the Greenland Ice Sheet and the Antarctic Ice Sheet, and provided insights into the drivers of loss.
- In the **biosphere**, ICESat, ICESat-2 and GEDI measured vegetation structure and ground heights across all ecosystems to better quantify changes to the biosphere in response to climatic and anthropogenic forces.
- In the **hydrosphere**, ICESat, ICESat-2 and GEDI inventoried and monitored global water reservoirs and sea level changes including in the Arctic Ocean. ICESat-2 provides nearshore bathymetry for benthic mapping and coastal geomorphology.
- In the **atmosphere**, ICESat and ICESat-2 have provided vertical structure of global clouds and aerosol layers critical to modelling radiative fluxes. They have also revealed substantial climate events associated with dust storms and fire disturbances.

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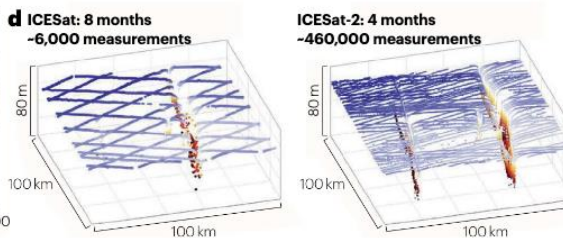
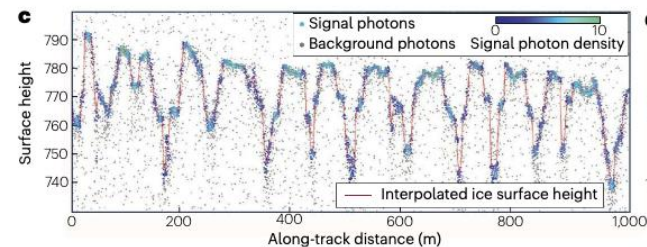
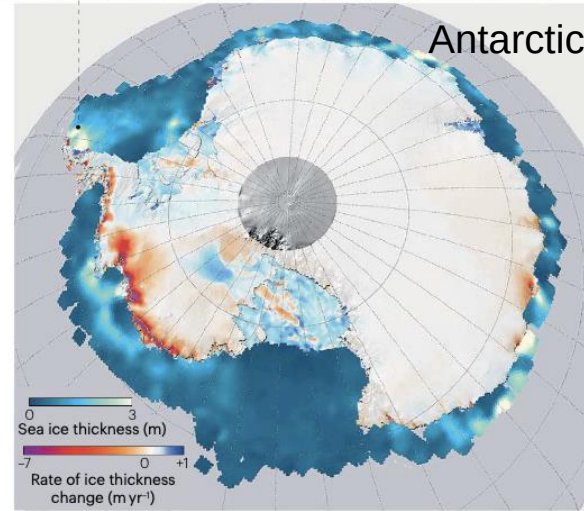
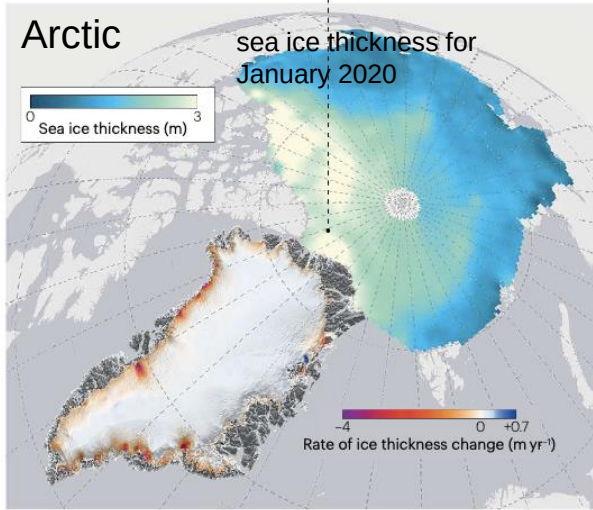
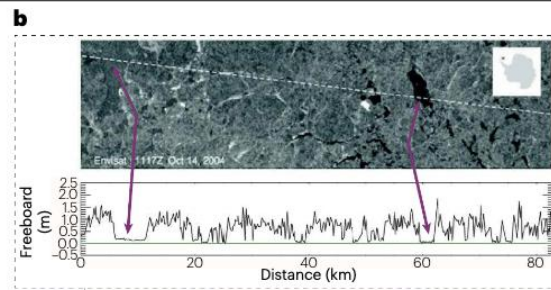
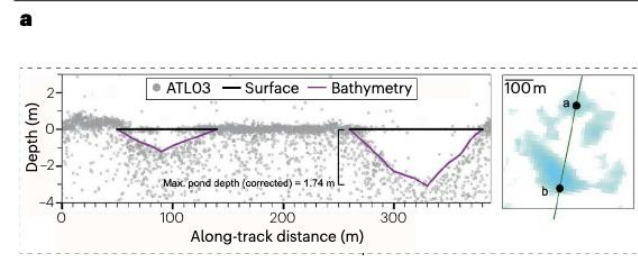
⁶Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA. ⁷Institute of Geophysics and

Planetary Physics, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA.

✉ e-mail: lori.magruder@utexas.edu

Cryosphere

ICESat & ICESat-2 revealed a decline in sea ice thickness in the Arctic and a loss of land ice from glaciers, the Greenland Ice Sheet and the Antarctic Ice Sheet, and provided insights into the drivers of loss.



Biosphere

ICESat, ICESat-2 and GEDI measured vegetation structure and ground heights across all ecosystems to better quantify changes to the biosphere in response to climatic and anthropogenic forces.

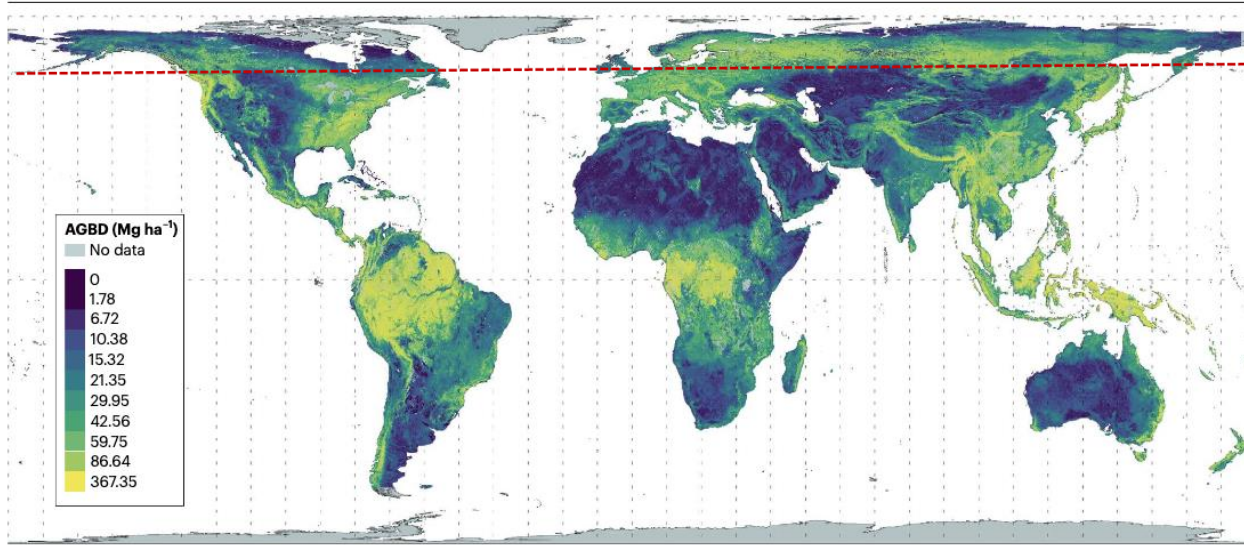
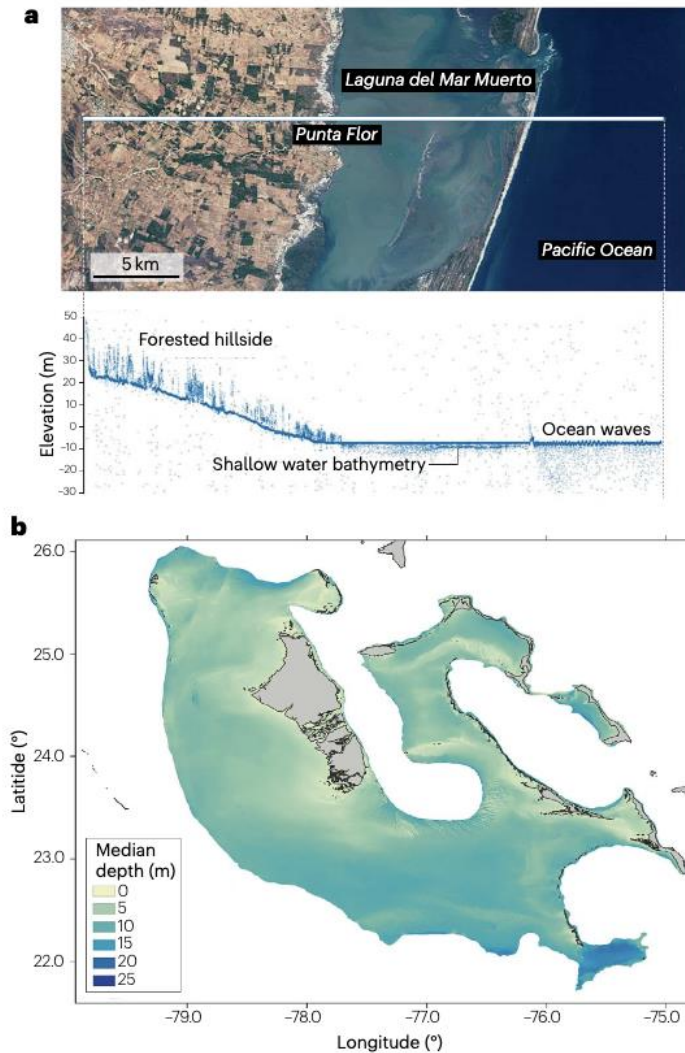


Fig. 3 | Global woody aboveground biomass density (AGBD) from GEDI and ICESat-2. Estimates up to 52° N are from the 1-km gridded GEDI product, whereas northern ecosystems have wall-to-wall 30-m maps from a fusion of ICESat-2,

Harmonized Landsat/Sentinel-2 and the Copernicus digital elevation model. Both products are available through the NASA Oak Ridge National Laboratory DAAC (<https://daac.ornl.gov/>).



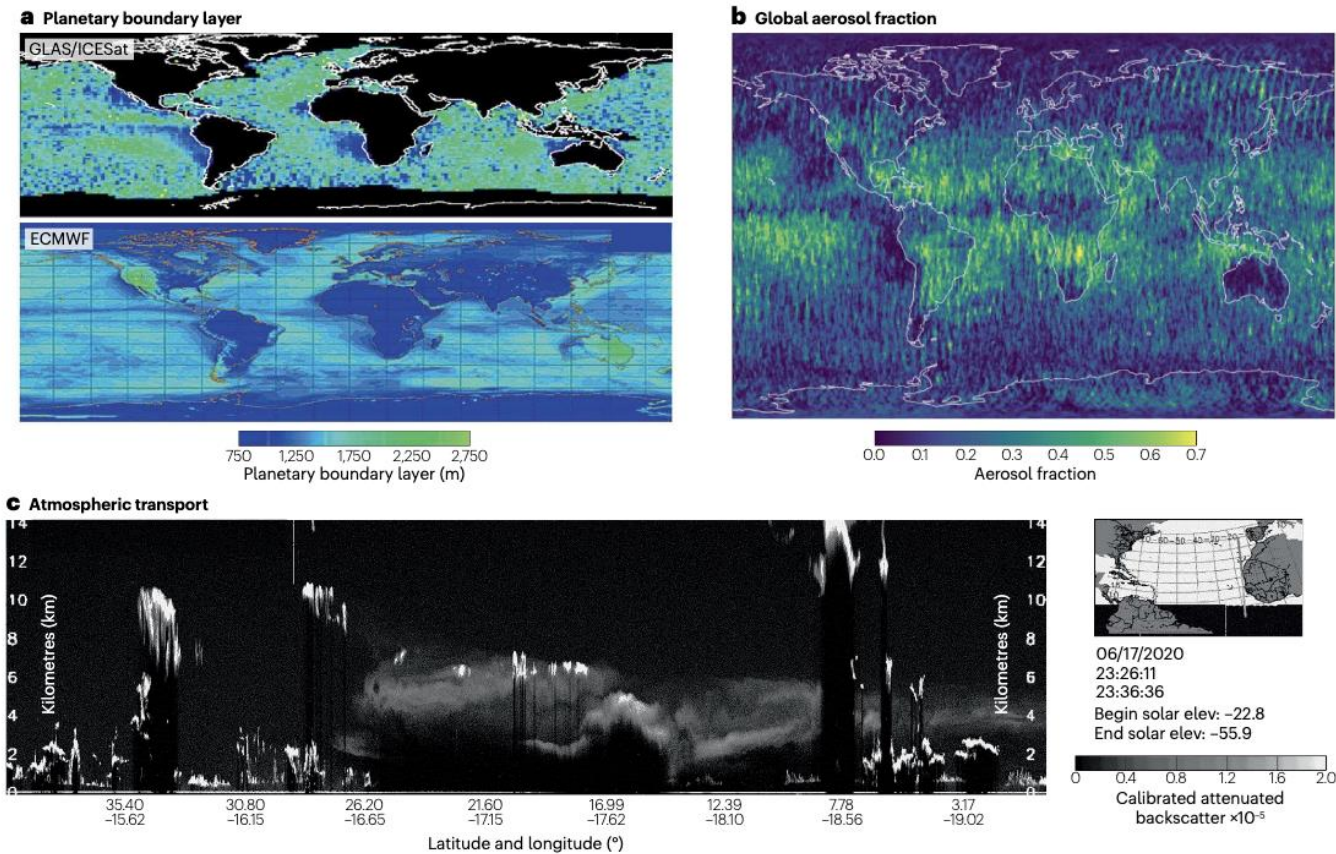


Hydrosphere

ICESat, ICESat-2 and GEDI inventoried and monitored global water reservoirs and sea level changes including in the Arctic Ocean. ICESat-2 provides nearshore bathymetry for benthic mapping and coastal geomorphology.



Fig. 4 | Nearshore shallow water bathymetry mapping with ICESat-2. **a**, An ICESat-2 transect of measurements across the coast of Mexico as the satellite moves from the left to the right. The corresponding photon elevations (bottom graph) reveal vegetation, water surface, shallow water bathymetry and ocean waves. **b**, Satellite-derived bathymetry model of depths over the Great Bahama bank using a single Landsat image and ICESat-2 bathymetry²¹⁷. Part **a** is adapted from ref. 217, CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0/>).



Atmosphere

ICESat and ICESat-2 have provided vertical structure of global clouds and aerosol layers critical to modelling radiative fluxes. They have also revealed substantial climate events associated with dust storms and fire disturbances.



Fig. 5 | The vertical structure of the atmospheric layer from laser altimetry.
a, ICESat/GLAS backscatter showing the transport of Saharan dust over the subtropical Atlantic to the Caribbean and biomass burning smoke from South Africa to the east coast of South America just south of the Equator. **b**, July 2021 global aerosol fraction from ICESat-2 atmospheric backscatter measurements¹⁹⁸.

c, Average height of marine planetary boundary layer (PBL) for October 2003, using the ICESat/GLAS 532-nm backscatter measurements to validate, and the European Centre for Medium-Range Weather Forecasts (ECMWF) PBL height analysis for the same period²¹⁸. Part **a** adapted with permission from ref. ²¹⁸, Wiley. Part **c** adapted with permission from ref. ¹⁹⁷, Wiley.

Summary

- NASA's three laser altimeter missions have provided a comprehensive record of elevation change and structure across the Earth system, monitoring essential climate variables
- Challenges in spatial coverage, particularly over ice sheets, glaciers, sea ice, and vegetation, due to sparse track spacing, sensor resolution, and geolocation mean that key processes remain poorly observed
- To enhance predictive capability future missions must provide at least seasonal sampling for land ice to capture dynamic processes; sea ice requires daily-to-weekly sampling
- Continuous acquisition of high-resolution laser altimetry data is essential for advancing understanding in land ice, sea ice, and vegetation trends and variability
- Most serious threat to observational capability is lack of planned satellite laser altimeter missions beyond ICESat-2 and GEDI

