

IcePicks: a collaborative database of Greenland outlet glacier termini

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and the IcePicks Team



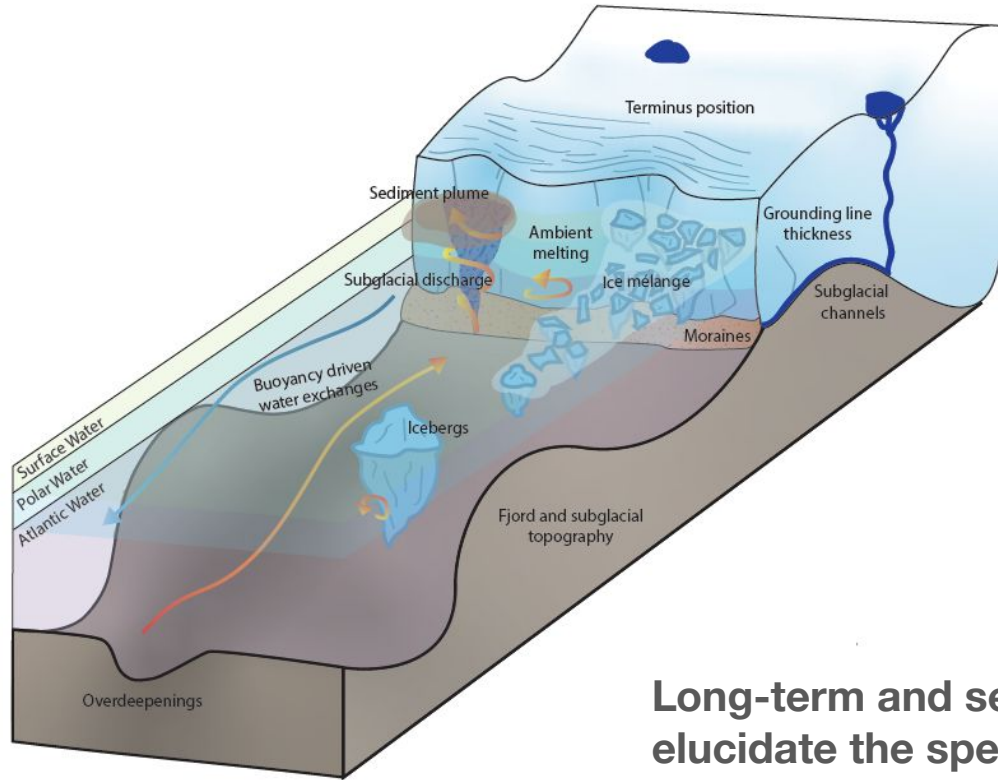
EGU Sharing Geoscience 2020



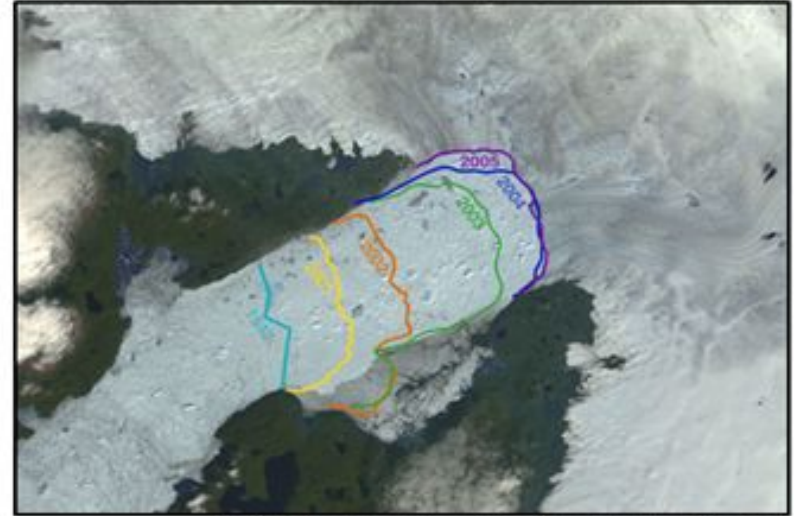
BOISE STATE UNIVERSITY



Marine-terminating outlet glacier terminus change is controlled by ice-ocean-bed-atmosphere interactions



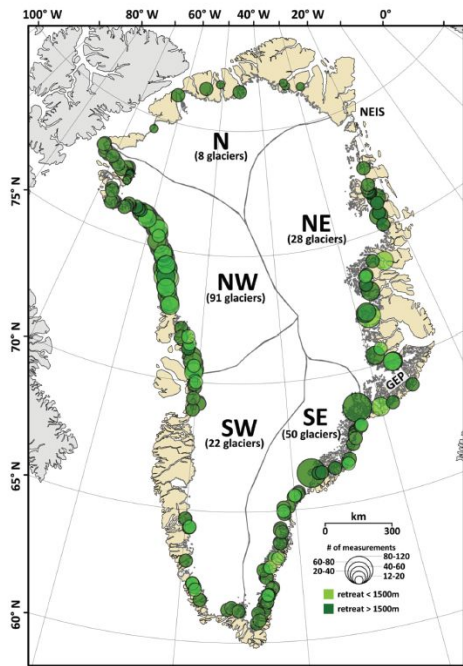
Jakobshavn Isbrae terminus positions (1942, 2001-2005)



NASA/Goddard Scientific Visualization Studio

Long-term and seasonal terminus records can help to elucidate the specific controls on individual glaciers

Terminus change mapped from satellite and aerial imagery is used extensively to understand how Greenland outlet glaciers adjust to climatic changes over a range of time scales

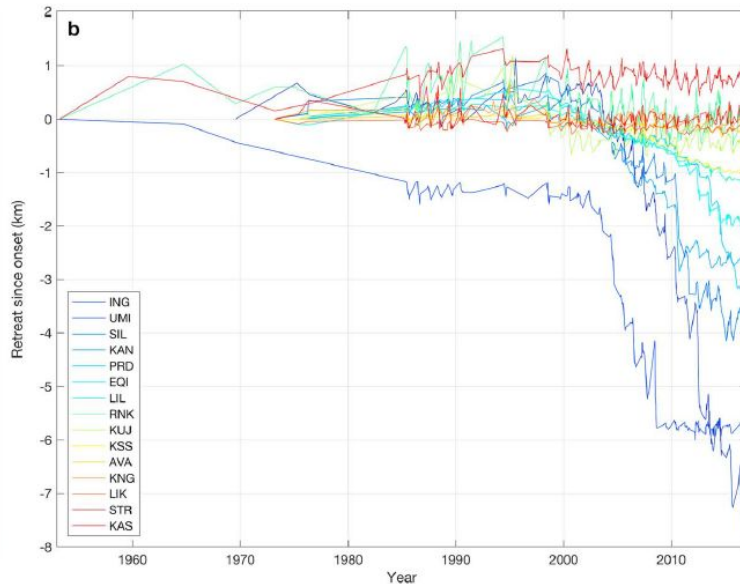
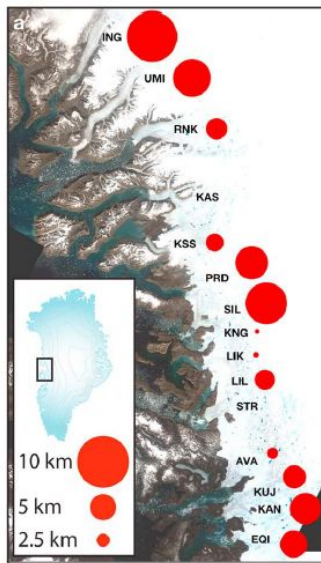


Murray *et al.* (2010)

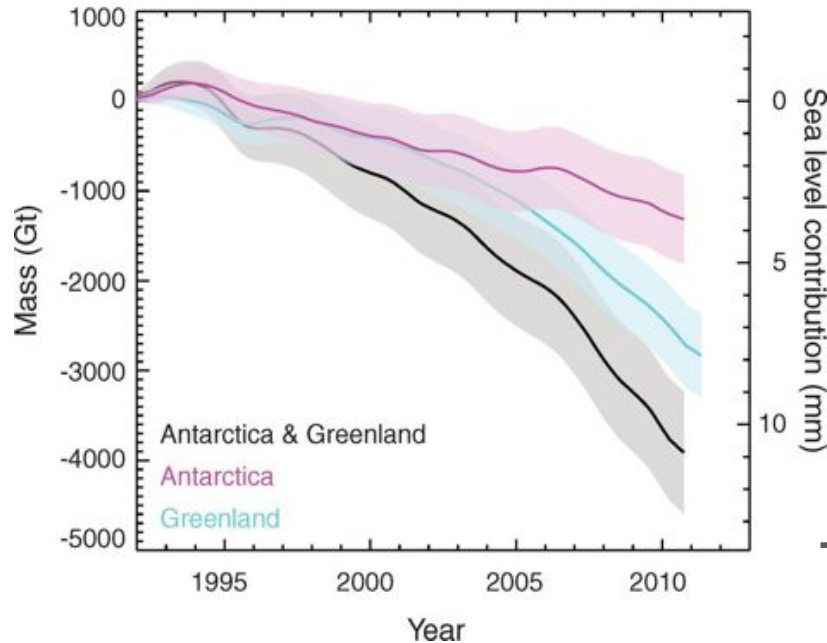
Picked sub-annual time series of glacier termini 2000-2010

Catania *et al.* (2018)

Picked all available landsat images for West Greenland glaciers



The lack of a centralized collection of spatially and temporally detailed observations of terminus change means the impact of glacier geometry and climate on mass loss is highly uncertain

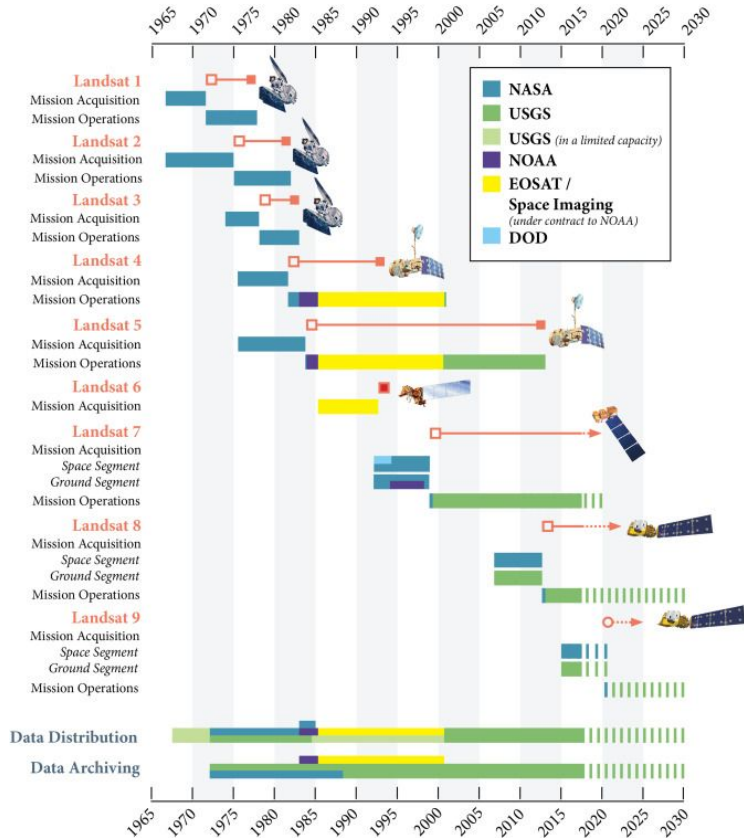


Shepherd et al., (2012)

Published Source	Spatial Coverage	Temporal Range	Temporal Resolution
Bunce et al. (2018)	276 glaciers	2000-2015	annual
Catania et al. (2018)	15 glaciers	1953-2016	all available
Lea et al. (2014)	1 glacier	1921-2019	all available
Carr et al. (2017)	169 glaciers	1992-2010	decadal
Murray et al. (2015)	199 glaciers	2000-2010	seasonal
Joughin et al.	238 glaciers	2000-2017	~annual
Seale et al. (2011)	32 glaciers	2000-2009	sub-annual
Andersen et al. (2019)	40 glaciers	1999-2019	annual
Cowton et al. (2018)	10 glaciers	1990-2015	annual
Black and Joughin (2019)	92 glaciers	1972-2019	annual
Bjørk et al. (2012)	132 glaciers	1933-2010	sporadic
Schild and Hamilton (2013)	5 glaciers	2001-2010	weekly
Howat and Eddy (2011)	210 glaciers	1972-2010	decadal
Howat et al. (2008)	32 glaciers	2000-2006	annual
Howat et al. (2010)	6 glaciers	1999-2009	seasonal
Sakakibara et al., (2018)	19 glaciers	1987-2014	annual

These efforts are also disparate, covering different areas and times, with different file types and metadata, making it difficult for intercomparison

And there are massive amounts of data to pick from!



Landsat missions, 1972-present (Wulder *et al.*, 2019)

Satellite and aerial imagery coverage over Greenland outlet glaciers

	Sensor	Coverage	Resolution	Repeat	Time Range	Access	DAAC
Optical	Landsat 1-5	global	30 m	18 d	1972-2013	Public	LP
	Landsat 7-8	global	15 m	16 d	1999-present	Public	LP
	ASTER	global	15-90m	16 d	1999-present	Public	LP
	Corona	regional	2-3 m	irregular	1960-1972	Public (cost)	LP
	Hexagon	regional	7-10 m	irregular	1971-1984	Public (cost)	LP
	Aerial Photos	coastal	25 m	irregular	1940-1980	Public	NOAA
	Sentinel-2	global	10 m	10 d	2015-present	Public	LP
	DigitalGlobe	global	30cm	1.7 d	2009-present	Public	PGC
	Planet Labs	global	3.7 m	1 d	2009-present	Private	N/A
SAR	Sentinel-1A	global	10 m	6-12 d	2014-present	Public	ASF
	TerraSAR-X	global	3.5 m	11 d	2007-present	Public (cost)	N/A
	ALOS PALSAR	regional	10-20 m	14 d	2006-2011	Public	ASF
	NISAR	global	100 m	6-12 d	planned 2021	Public	ASF

The dramatic increase in satellite coverage in the 21st century presents both an opportunity and a challenge for tracking terminus changes in detail

Collecting manually digitized terminus picks into a single database

- Data will be cleaned, associated with appropriate images, and compiled so they can be easily accessed by scientists
- Data are organized in shapefiles per glacier, identified using Joughin *et al.* (2017) glacier numbering scheme
- Metadata include image type, date, and quality flags so they can be easily queried programmatically and in GIS
- Ultimately, these data will be used to create training data for further automatic picking efforts

GlacierID	Center_X	Center_Y	SequenceN	QualFlag	Satellite	Date	Year	Month	Day	ImageID	irnIndc	OfficialName	AltName	RefName	Author
153	491846.3...	-2293390.1...	71	0	LC08	2018-05-16	2018	5	16	LC08_L1TP_229012_20180516_20180604_01_T1		Kange...	Kang...	Kangerlussuaq Gletsjer	Cheng_D
153	491811.9...	-2291747.8...	72	0	LC08	2018-07-26	2018	7	26	LC08_L1TP_230012_20180726_20180731_01_T1		Kange...	Kang...	Kangerlussuaq Gletsjer	Cheng_D
153	497384.9...	-2295716.9...	73	10	LM01	1972-09-06	1972	9	6	LM01_L1TP_250011_19720906_20180429_01_T2		Kange...	Kang...	Kangerlussuaq Gletsjer	Cheng_D
153	497584.9...	-2295483.3...	74	10	LT05	1985-04-19	1985	4	19	LT05_L1TP_229012_19850419_20170219_01_T2		Kange...	Kang...	Kangerlussuaq Gletsjer	Cheng_D

Example of metadata from CALFIN

Machine learning techniques for automated picking can reduce time-intensive hand-picking of termini for future and missing data

CALFIN (*Calving Front Machine*)

Uses neural networks to automate detection of glacier termini

Led by:

Daniel Cheng & Wayne Hayes (UC Irvine)

Performance example:

Manual terminus positions in **green**

CALFIN identified positions in **red**

Overlap between methods in **yellow**

Adverse Conditions Calving Front Performance

— Match/Correct
— ML Prediction
— Ground Truth

a) Shadows

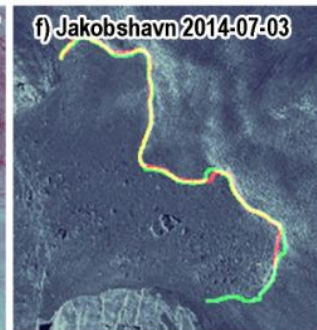
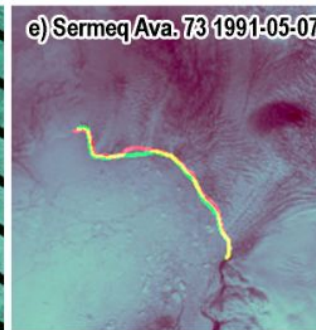
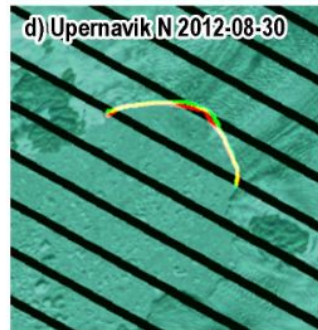
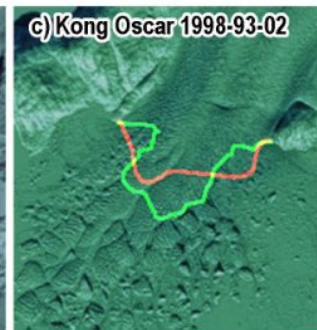
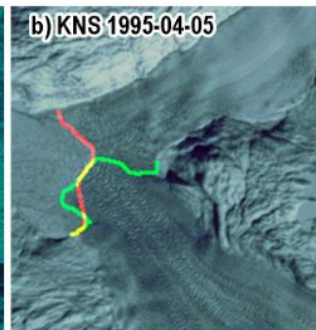
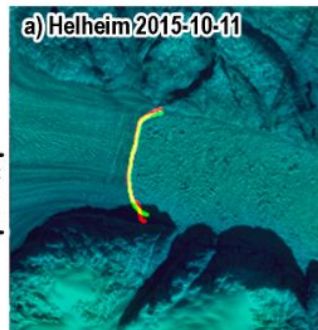
b) Unclear Termini

c) Ice Tongues

d) Landsat 7 SCE

e) Clouds

f) SAR/Multi Sensor Handling



**See Daniel's work
in this session!**

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[Calving Front Machine \(CALFIN\): Automated Calving Front Dataset and Deep Learning Methodology for East/West Greenland, 1972-2019](#)

Daniel Cheng, Yara Mohajerani, Michael Wood, Eric Larour, Wayne Hayes, Isabella Velicogna, and Eric Rignot

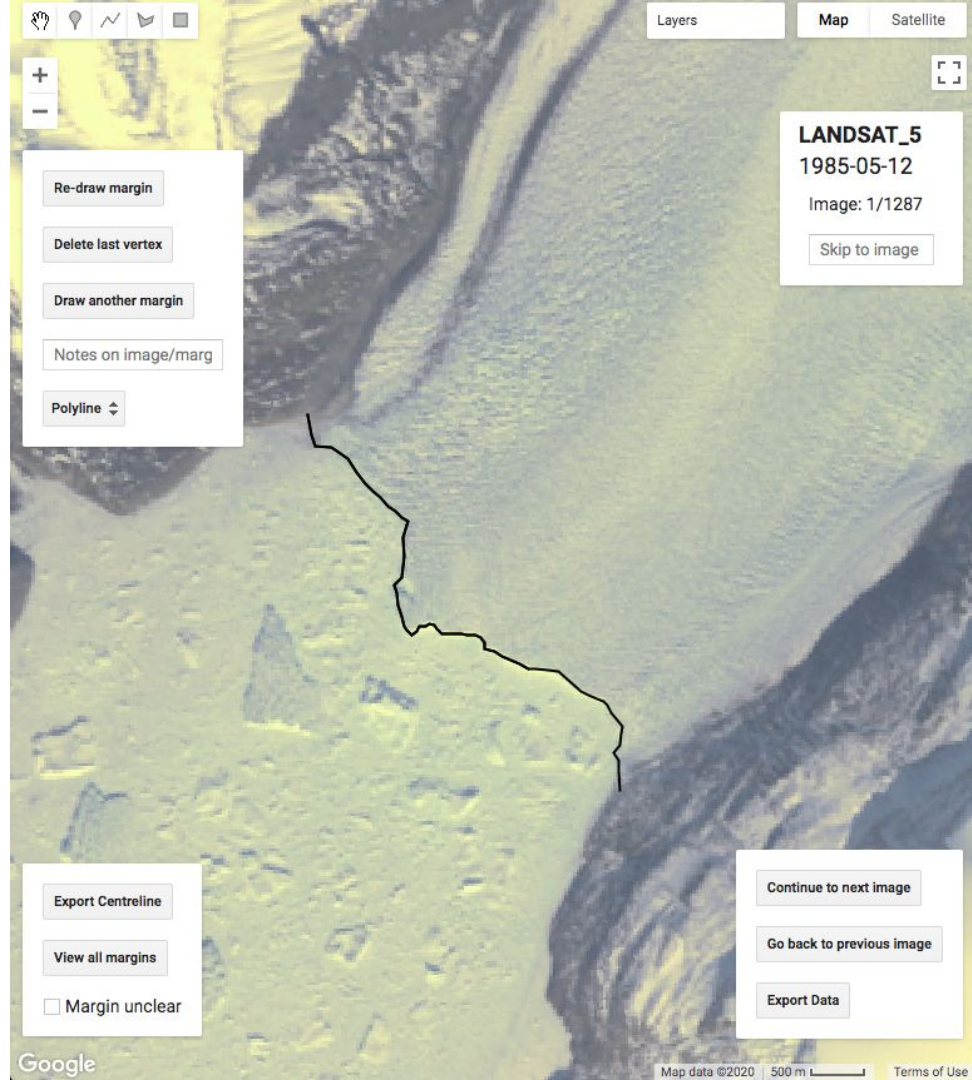
Conditions such as shadows or heavy melange may require hand-picking and additional training data

GEEDiT (*Google Earth Engine Digitisation Tool*)

Used to hand-pick termini on images where the ML technique is not able to fully pick the glacier front

Developed by **James Lea** (*U Liverpool, IcePicks team member, and session chair!*)

GEEDiT interface



**Do you have data you want to share?
Ideas for training data? Want updates on
the product?**

Email Sophie Goliber, sgoliber@utexas.edu

*Data will be submitted to Earth System Science Data (ESSD) with proper
authorship for those involved in the project and data shared*