Our Blue Planet: EARTH

March 23, 2022

The webinar will begin at 1:00 p.m. (MT) and will be recorded.

While you're waiting

1) Find the toolbar – it will either be on the bottom or top of your Zoom window
2) Introduce yourself in the chat box (please select **"Share with Everyone"** *not* **"Share with Hosts and Panelists"**)
3) Click audio "Join by Computer" – you won't have microphone access

Tip for viewing: You can resize and move the location of the video and slide screens by clicking and dragging them

Facilitator Introduction

- Claire Ratcliffe Adams (Space Science Institute)
- Dr. Paul Schenk (Lunar and Planetary Institute)
- Dr. Michael Wood (NASA Jet Propulsion Laboratory)

Today's Agenda

- Welcome/Intro
- Icebreaker
- Video: Other Ocean Worlds
- Oceans activities
- Sea Level and Ice: Greenland's Glaciers
- Q&A

Icebreaker Poll Question

How much water on Earth is fresh water?

a. 50%
b. 25%
c. 10%
d. 3%


ARE THERE
OCEANS
ON OTHER
WORLDS ?

Hands-On Activity

How do scientists study other objects in space?

Investigating the Insides

Patrons explore how we study planets, using balloons as models

Investigating the Insides

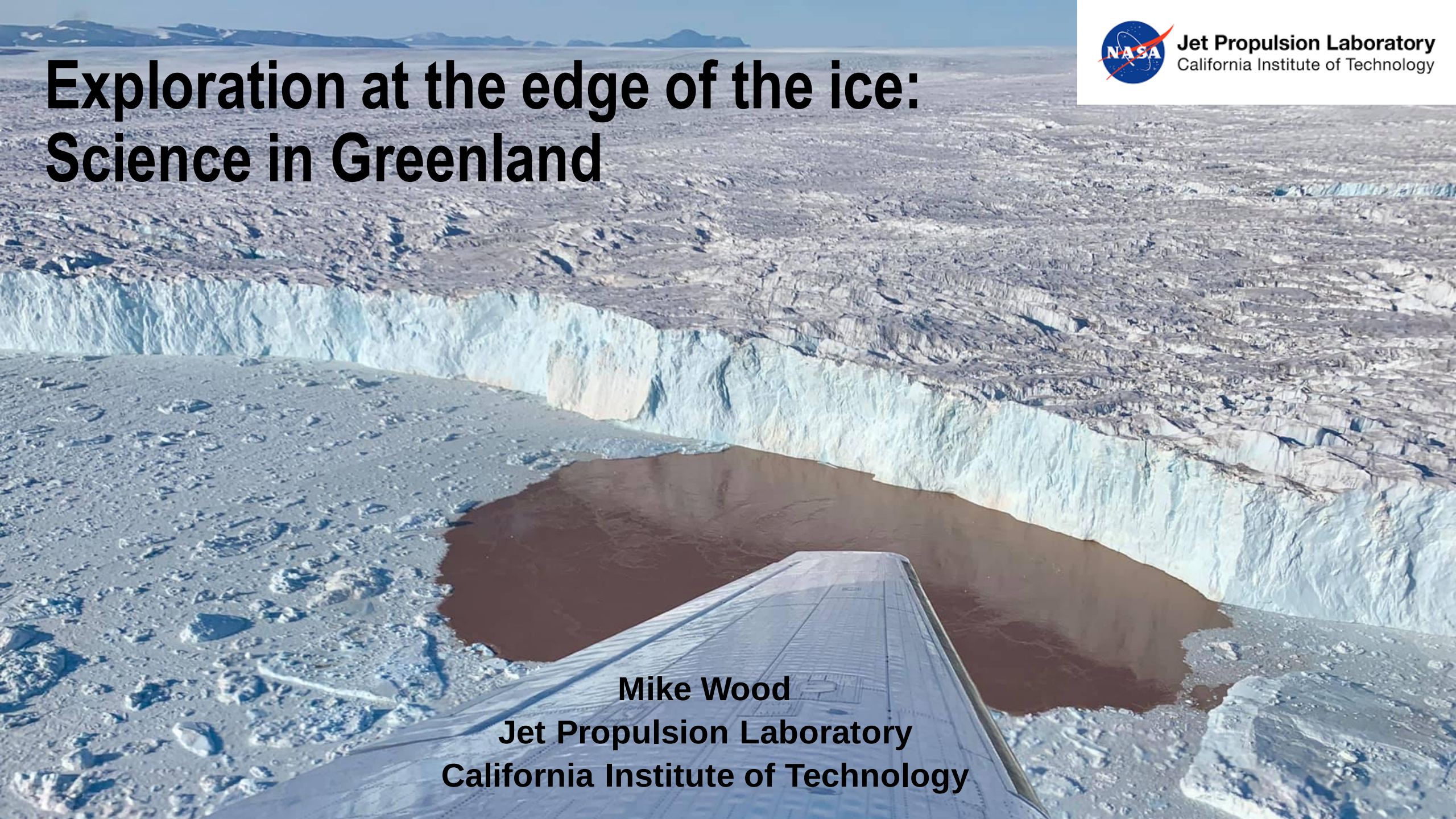
- The interior of a planet cannot be studied directly
- Different instruments provide different forms of indirect evidence.
- Scientists use their observations (evidence) to build on what they already know about the universe.
- Models offer a useful way to explore properties of the natural world.

Investigating the Insides

Materials:

- Balloons (or clear ornament balls)
- Magnets (one strong, several moderate)
- Paperclips
- Beads
- Marbles
- Magnifying glasses
- (optional): laser pointers, scales, thermometers

Exploration at the edge of the ice: Science in Greenland

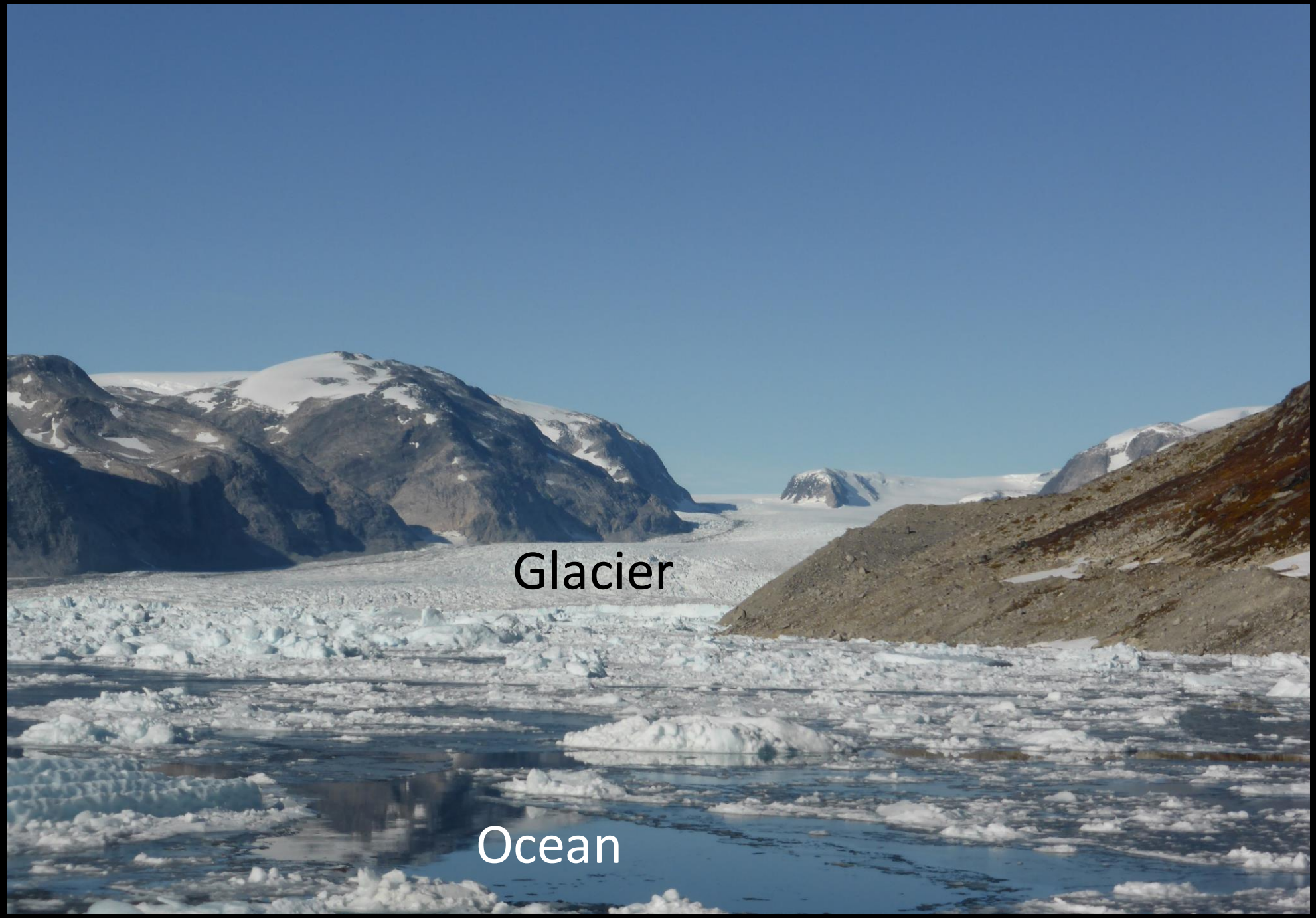


Jet Propulsion Laboratory
California Institute of Technology

Mike Wood
Jet Propulsion Laboratory
California Institute of Technology


North Pole
Greenland
U.S.A.
30 million km³ of ice
=
25 feet of sea level rise
Google Earth

All photos are my own
unless otherwise indicated



Lots of Icebergs!

Who am I?

- My Position:
  - Postdoctoral researcher
- I study:
  - Why glaciers are melting
  - How the oceans are changing
  - How the oceans and ice interact
- I use:
  - Satellite observations
  - Ocean models
  - Field measurements

SY Ivilia, Upernavik, Greenland 2017

Greenland Field Work


Photo credit: Chris Kemp

MV Cape Race,
Melvillle Bay
2015

Torsukataq Fjord,
Greenland 2018

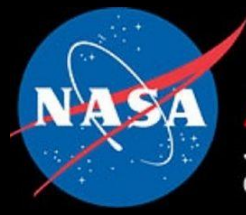

Photo credit: Josh Willis (pictured)

Kangerlussuaq, Greenland 2020

In today's talk

Overarching questions:

1. Why am I doing research in Greenland?
2. What was NASA doing in Greenland?
3. What have we learned from our work in Greenland?



JPL
Jet Propulsion Laboratory
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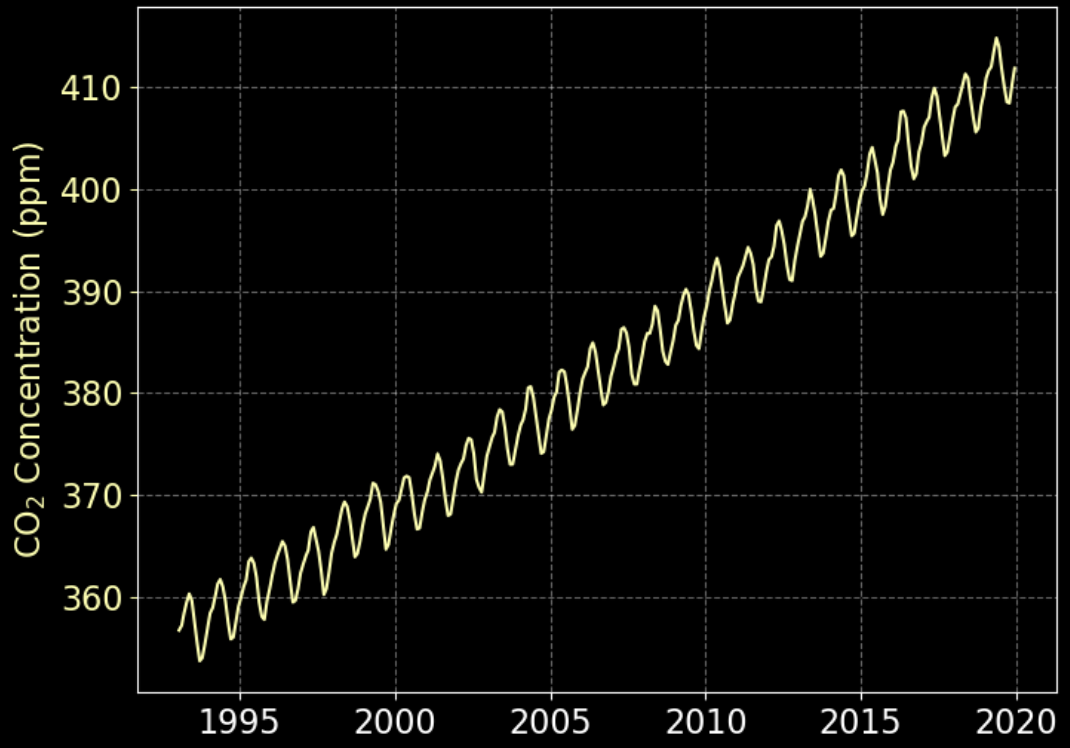
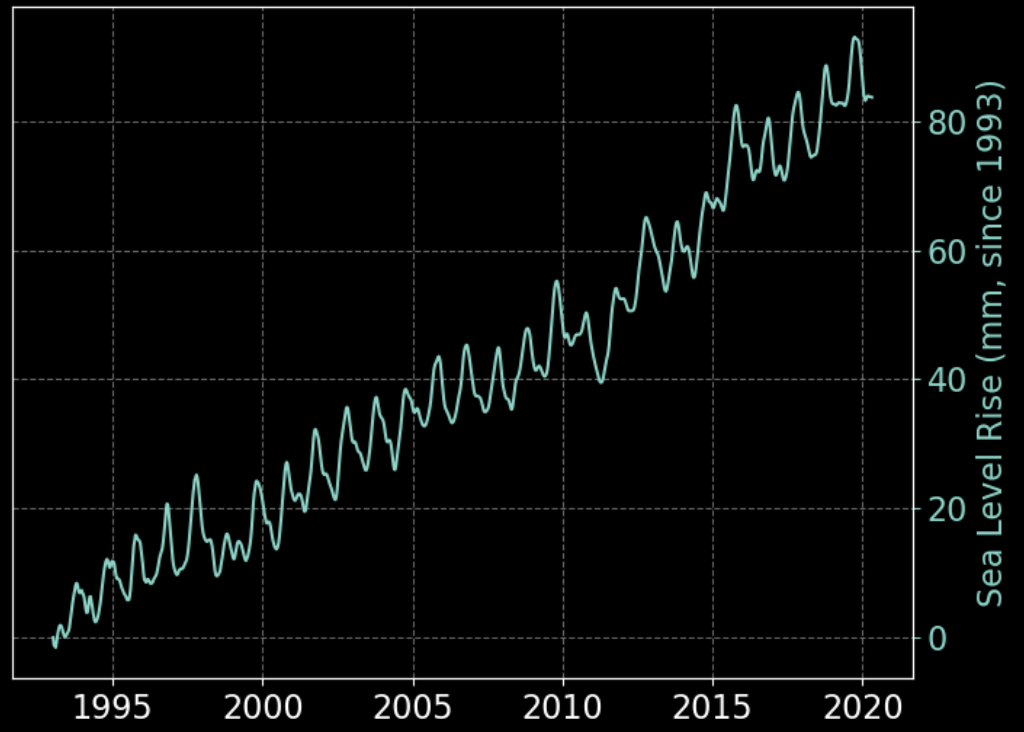
Why am I doing research in Greenland?

Sea Level Rise in California

Climate Change and Sea Level Rise

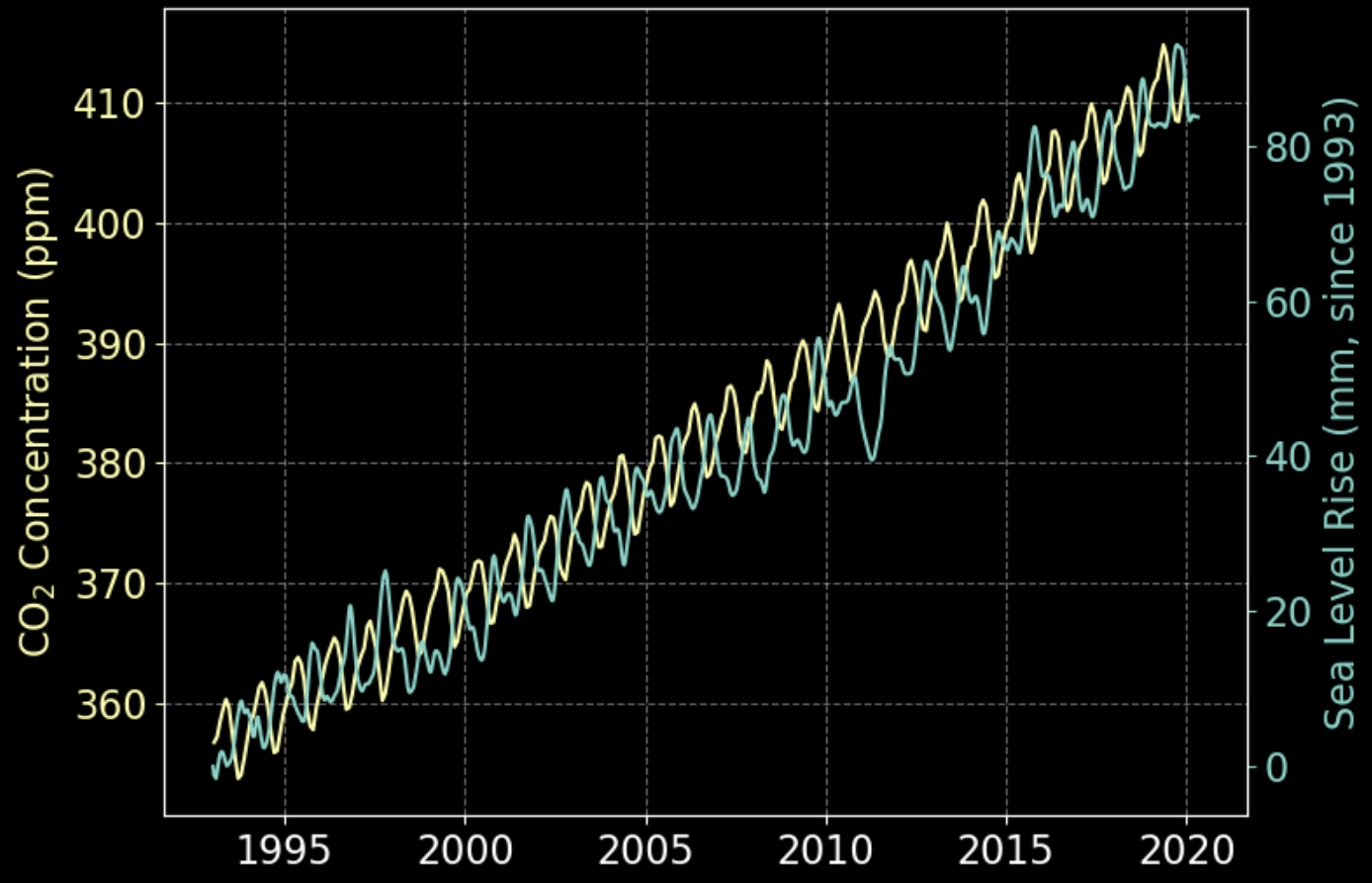


CO_2 measured by Keeling and others in Manoa, Hawaii



Global sea level rise measured by NASA's Jason satellites

Climate Change and Sea Level Rise

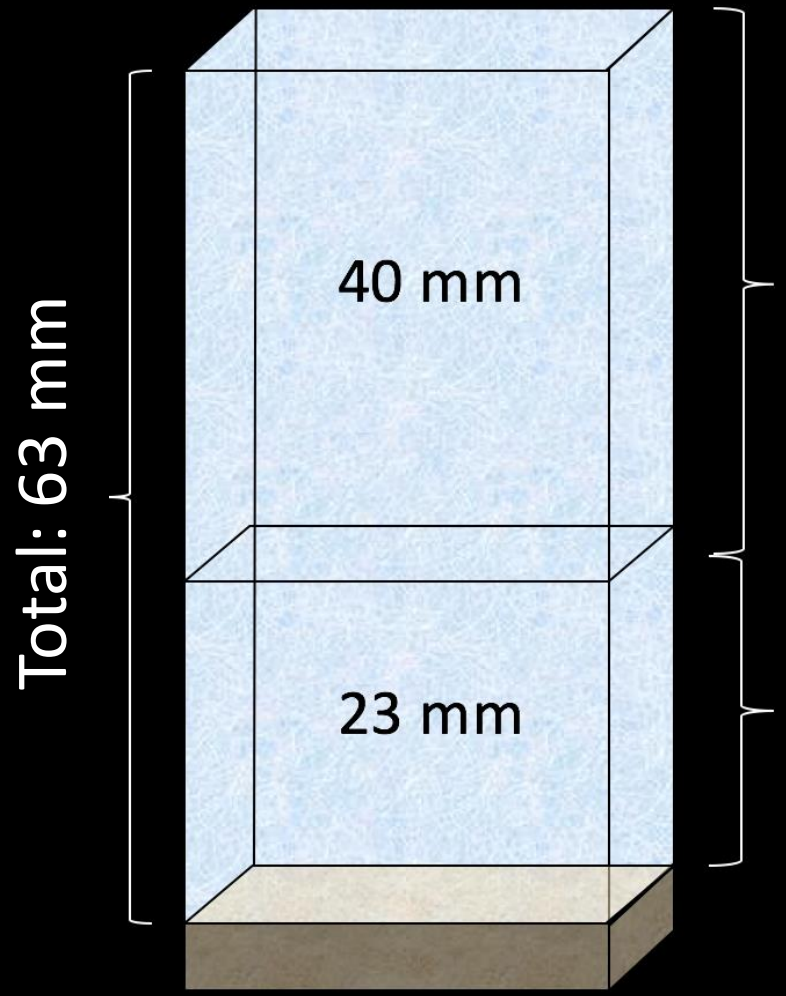


CO_2 and sea level rise are correlated on inter-annual timescales

What are the possible causes behind this relationship?

What causes sea level to rise?

Sea Level Rise Since 2000



<u>"Barystatic" Sea Level Rise</u>

Changes in the amount of water in the ocean

- Example: Melting Ice ⇒ More water

<u>"Steric" Sea Level Rise</u>

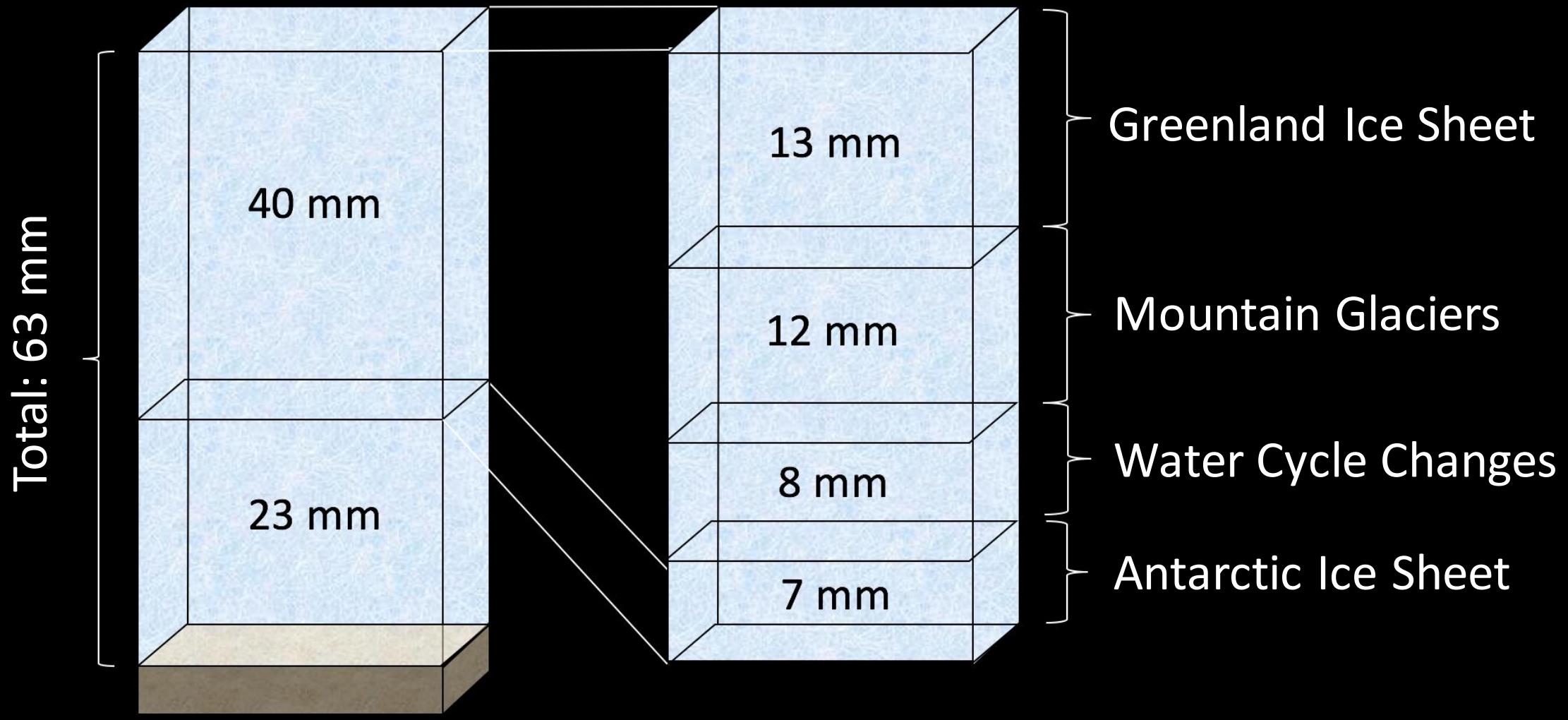
Changes in the salt/heat that change volume

- Example: More heat ⇒ Expansion

Data from Frederikse et al 2020

What causes sea level to rise?

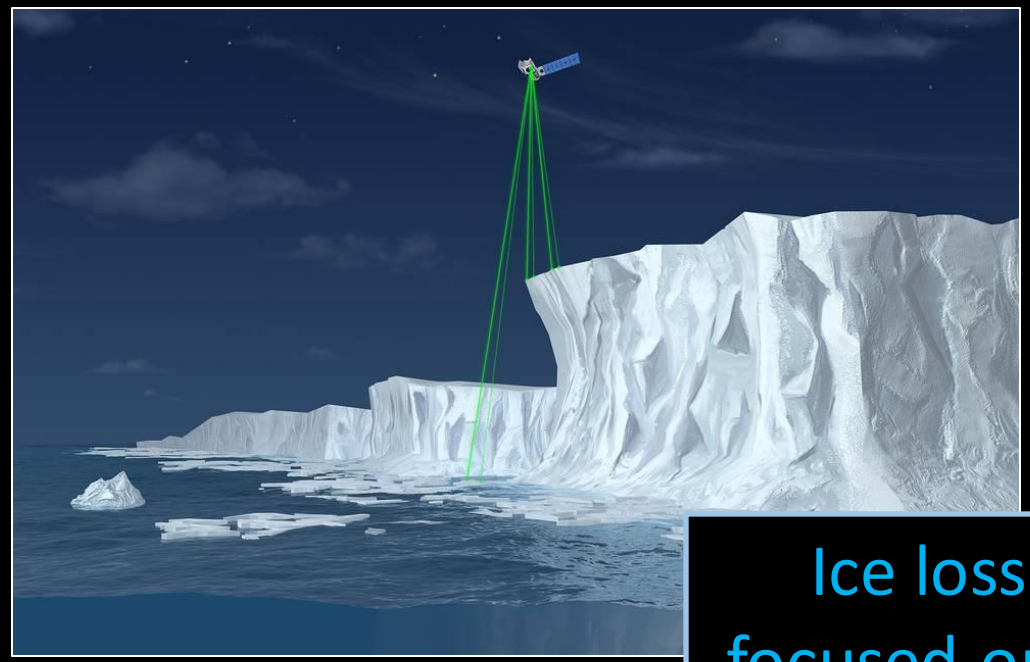
Sea Level Rise Since 2000



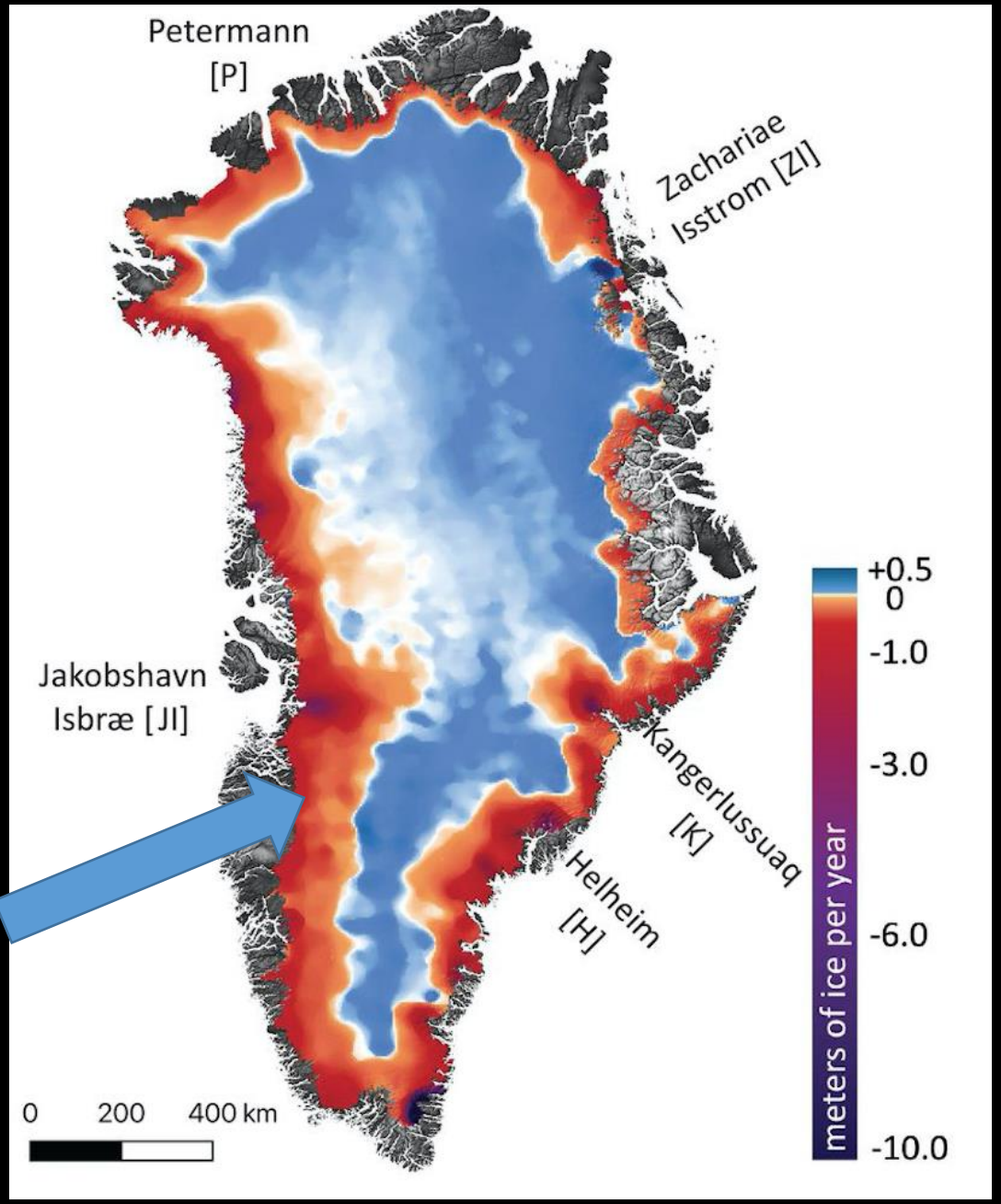
Data from Frederikse et al 2020

Recent Ice Loss

ICESat and ICESat-2 satellites measure changes in ice height



Ice loss is focused on the coast



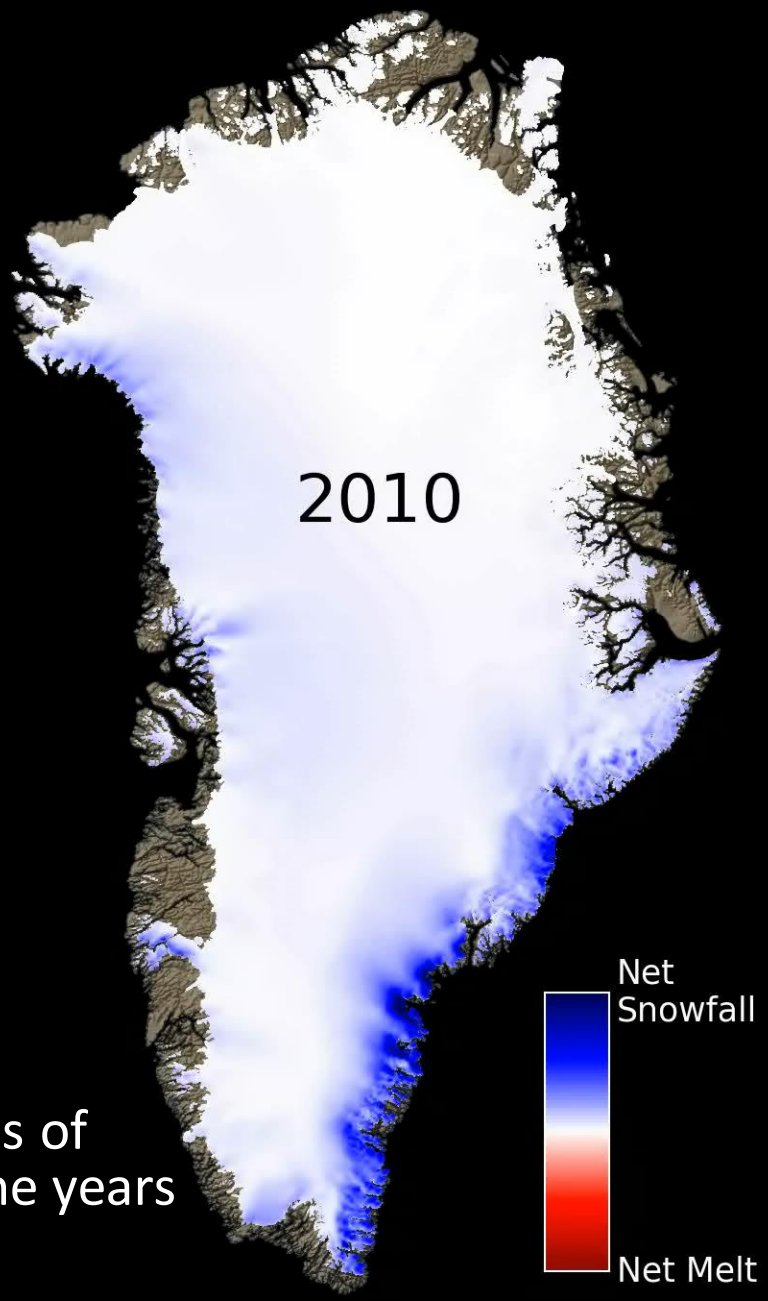
Smith et al 2020

How does Greenland's ice melt?

Method 1: On the surface

Just like an ice cube on a hot day

Warmer air ⇒ More melt



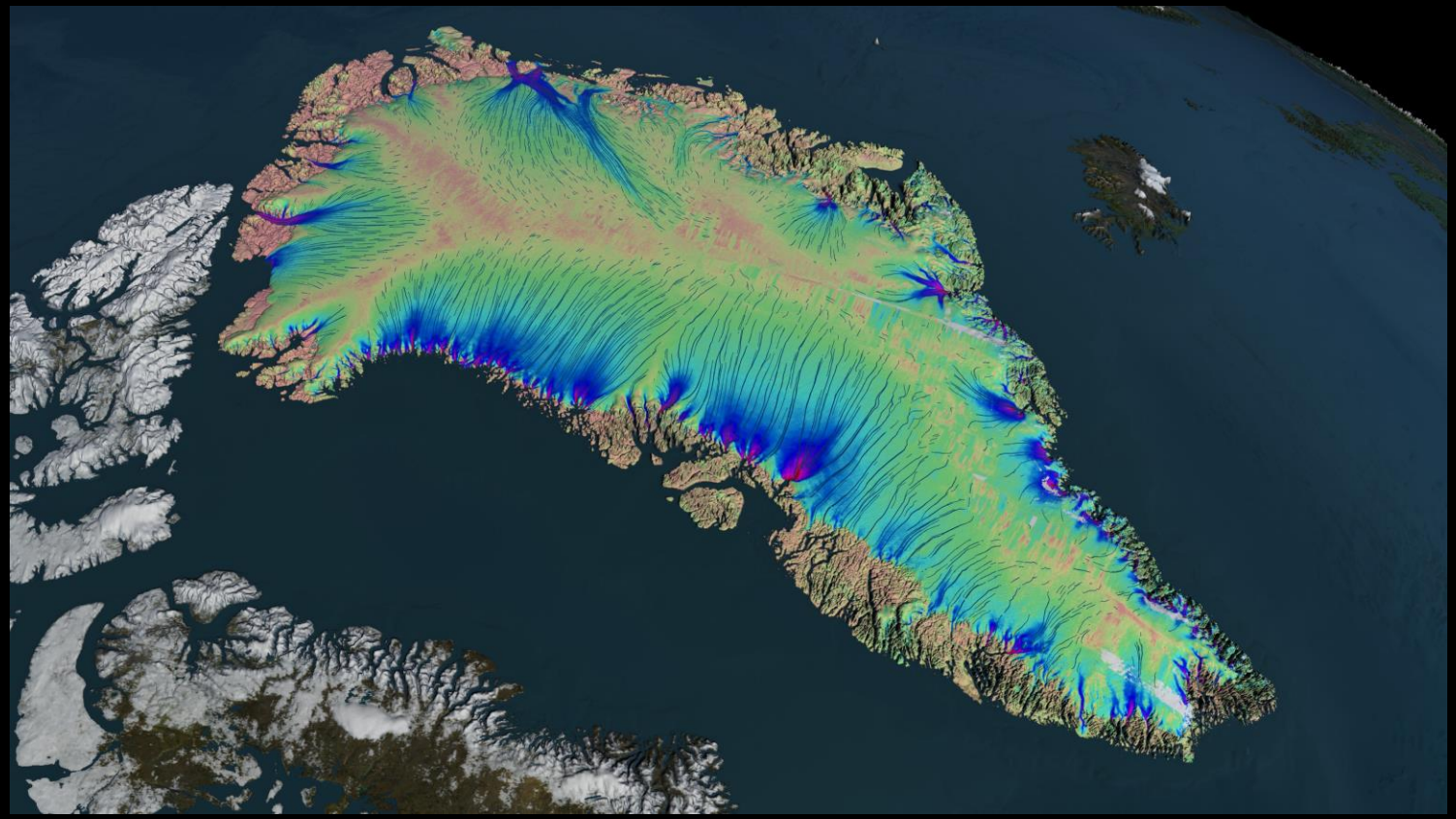
Models reconstruct estimates of snowfall and melt through the years

Data from RACMO2.3p2, Noël et al 2019


NASA
Scientific Visualization Studio

How does Greenland's ice melt?

Method 2: Glaciers Speeding Up



As glaciers flow faster, they contribute more ice into the ocean

Scientific Visualization Studio

What was NASA doing in Greenland?

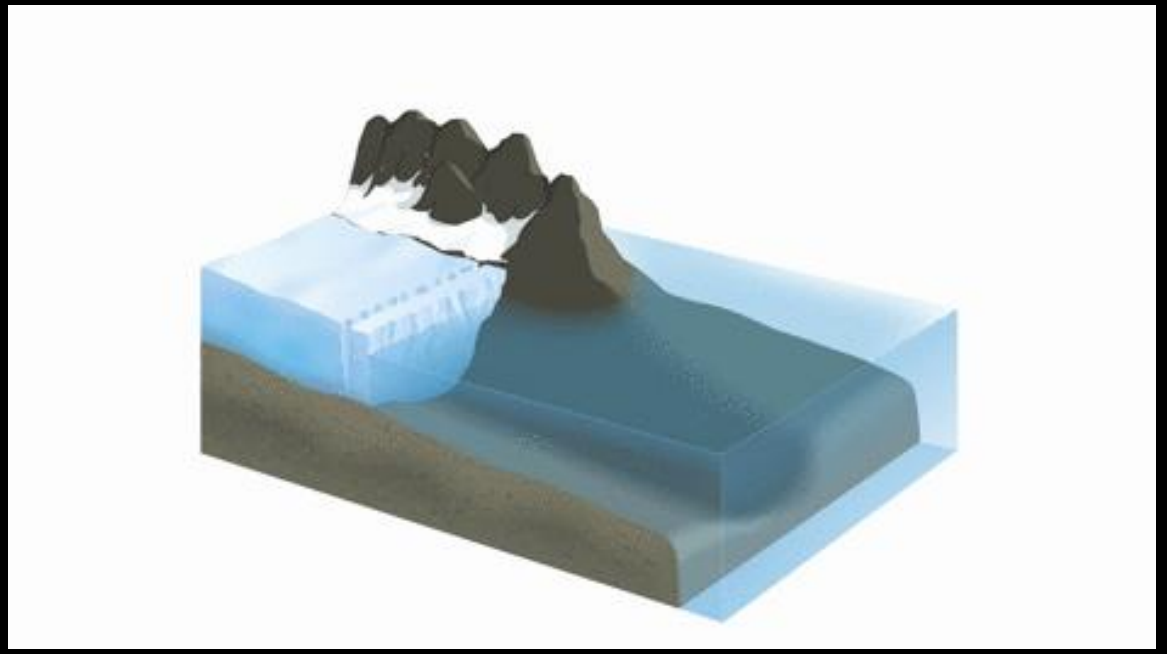
Why are glaciers speeding up?

- Our Hypothesis: Warmer ocean waters are melting the glaciers
- Big Problems:
  - What does the ocean floor look like?
  - How does temperature vary?
  - Can’t see these parameters from space!
- Mission: Oceans Melting Greenland

Oceans Melting Greenland

Objective 1: Measure the ice and ocean

1. How is the ice changing?
2. How is the temperature of the water changing?



GIF from OMG Image Archive

Greenland Field Work

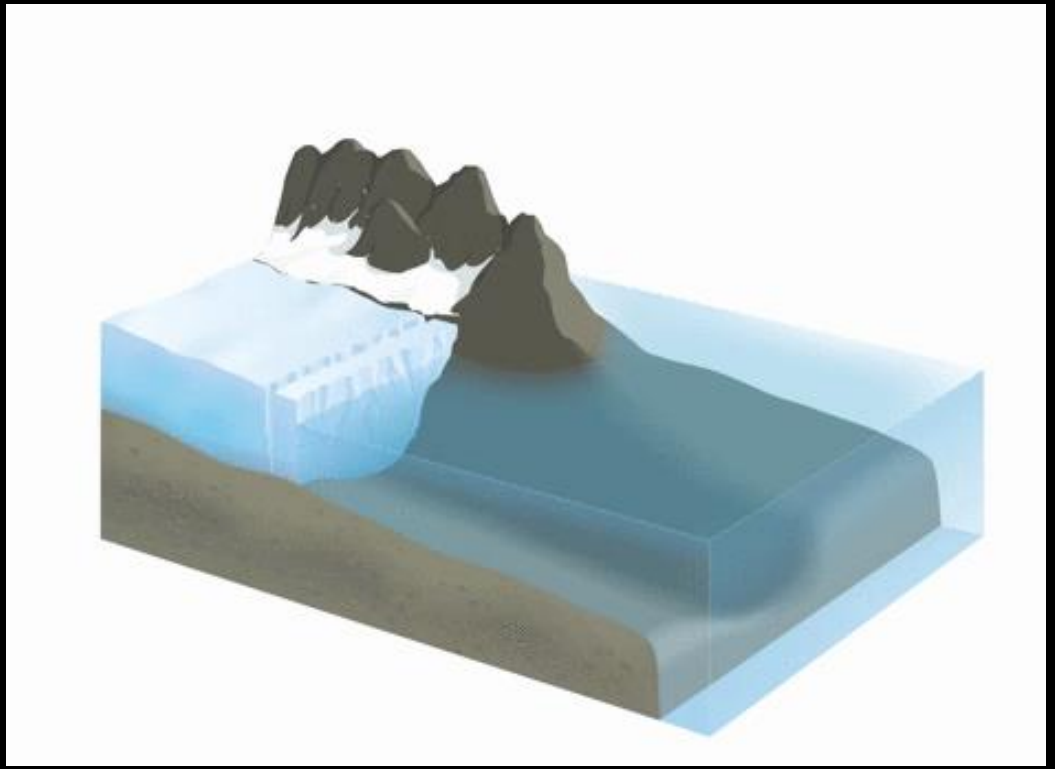
Kangerlussuaq, Greenland 2020

Survey Flights, 2020

Oceans Melting Greenland

Objective 2: Map the ocean floor

How deep is the water
next to the glaciers?



GIF from OMG Image Archive

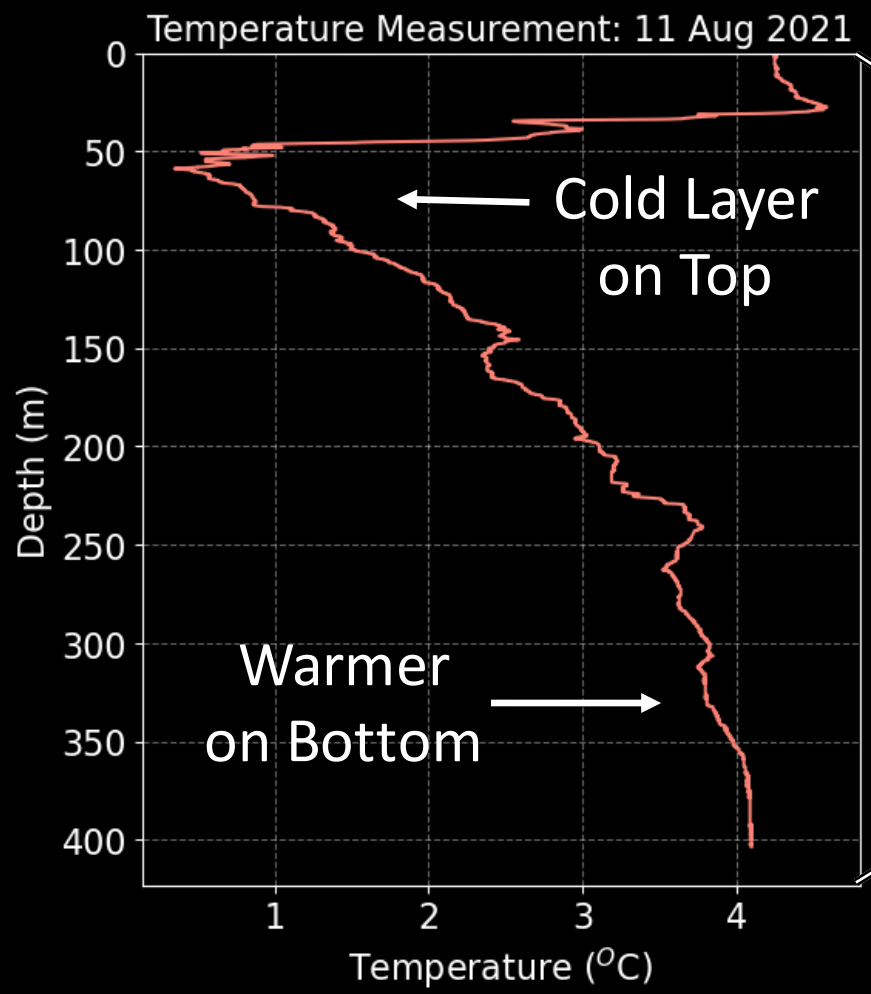
Greenland Field Work

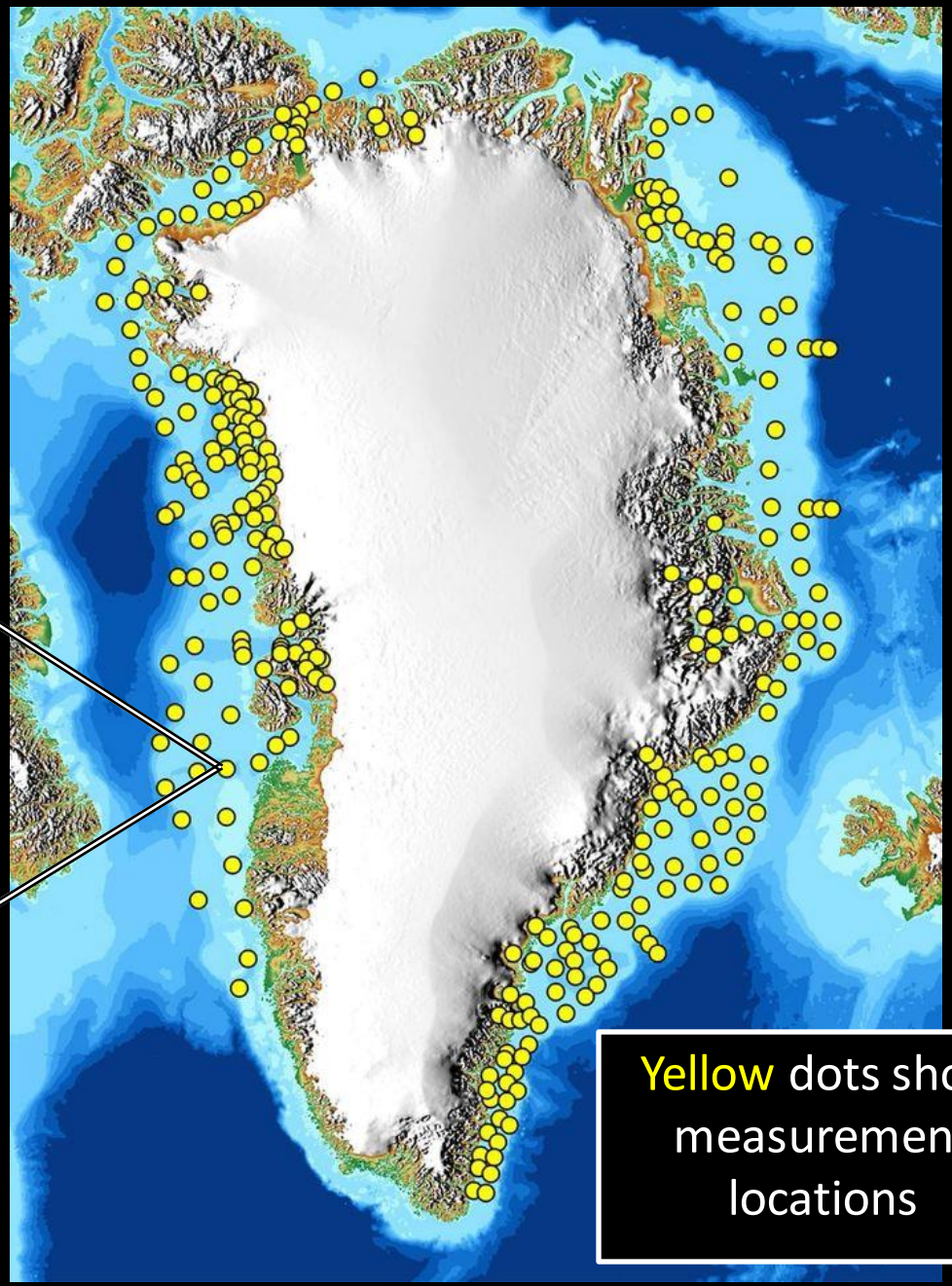
Upernavik, Greenland 2017

MV Cape Race, Northwest Greenland 2015

What have we learned from our work in Greenland?

How does the ocean temperature vary?

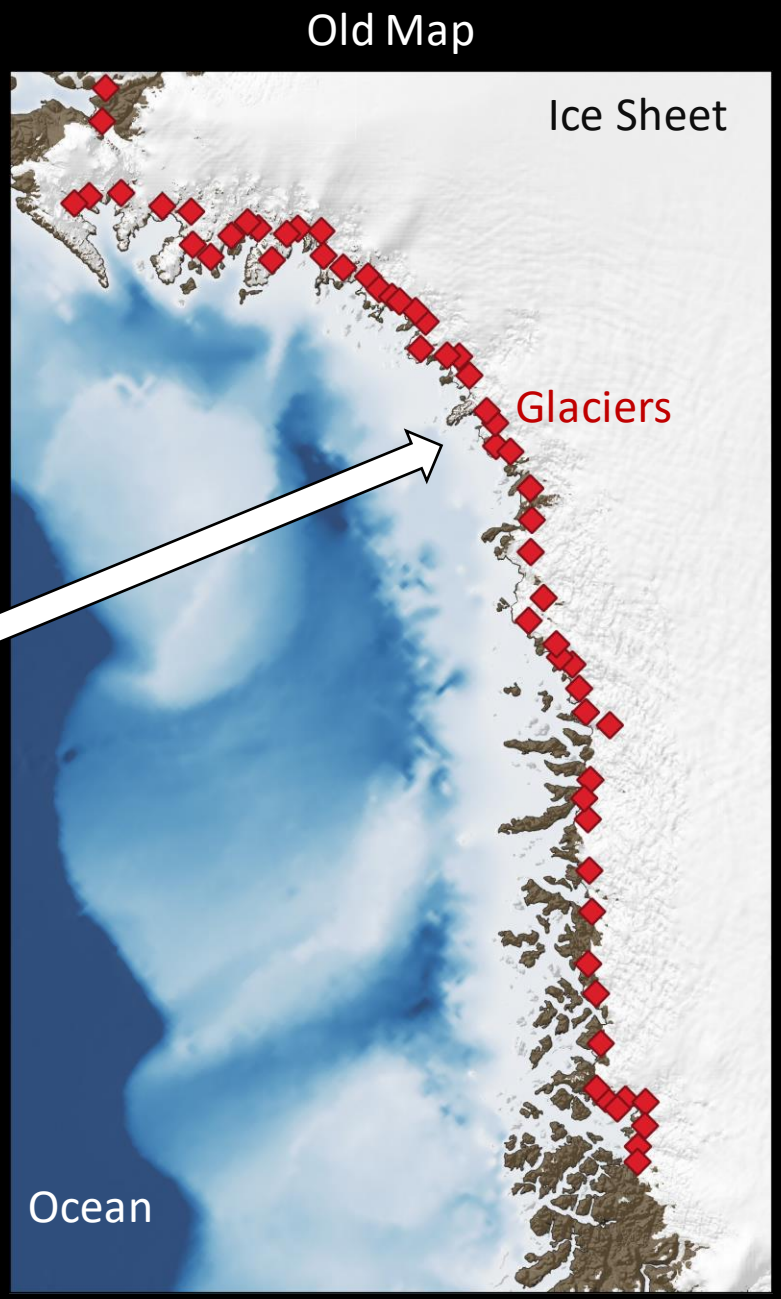


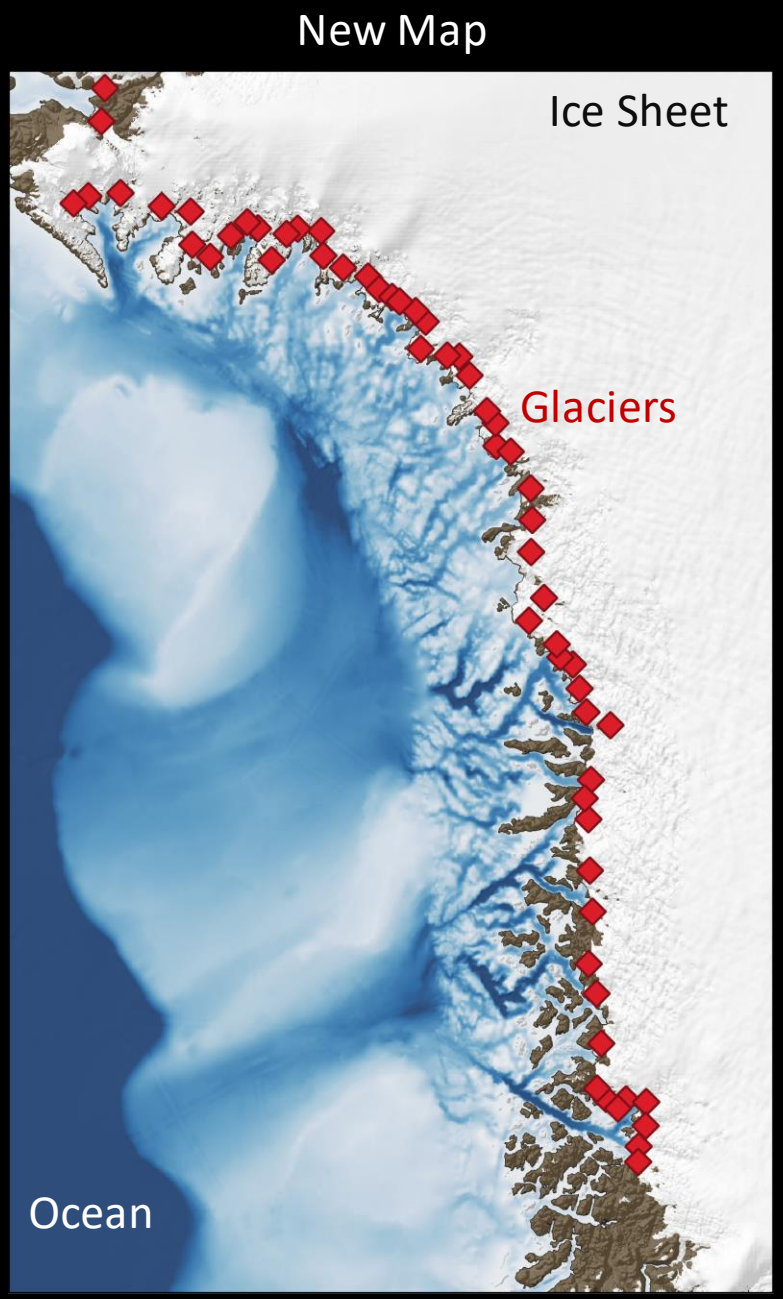


Map from Josh Willis

How deep is the ocean near the glaciers?

Shallow water on the coast in old map!



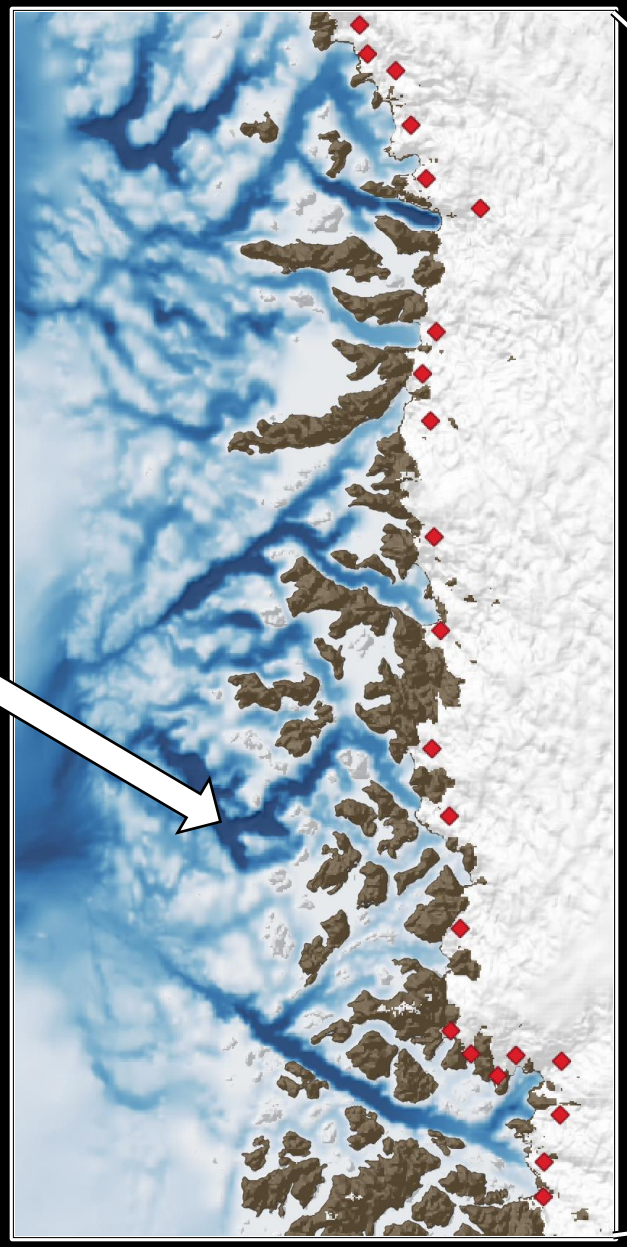


How deep is the ocean near the glaciers?

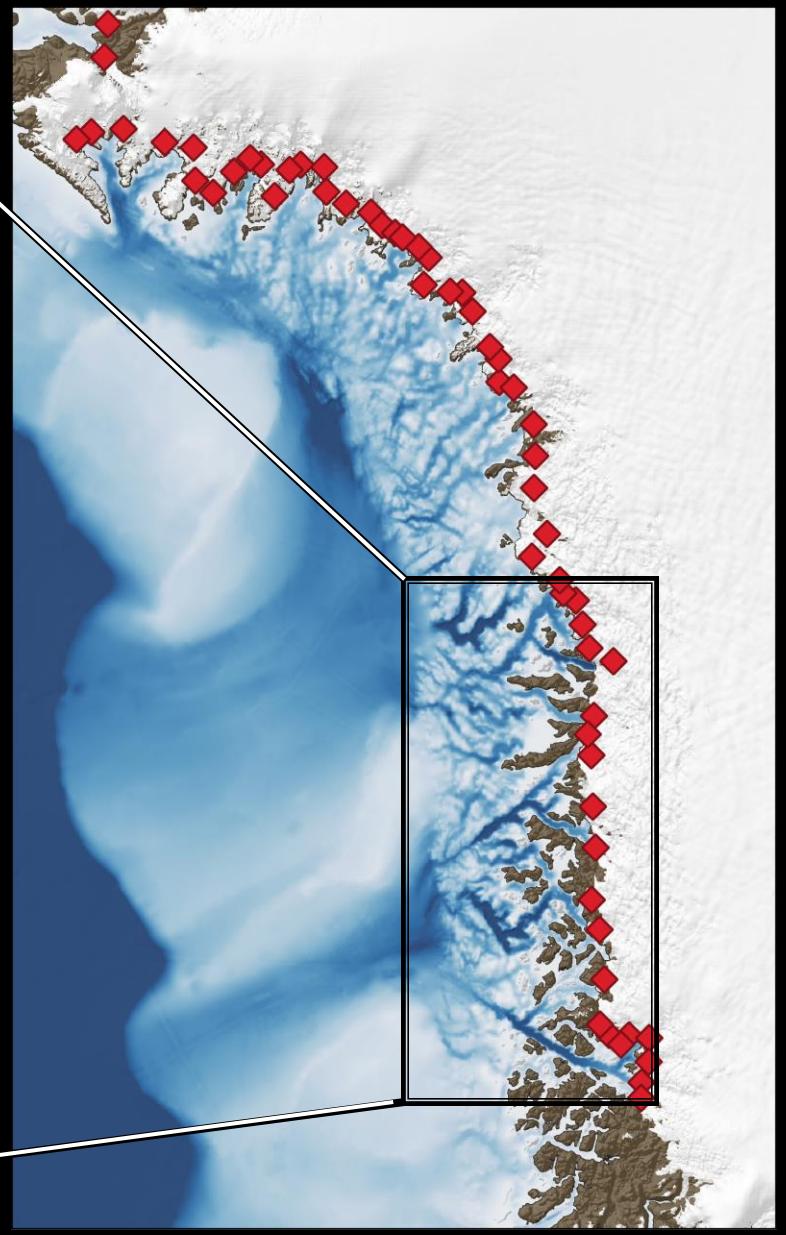
Deep channels connect ocean to glaciers

Shallow

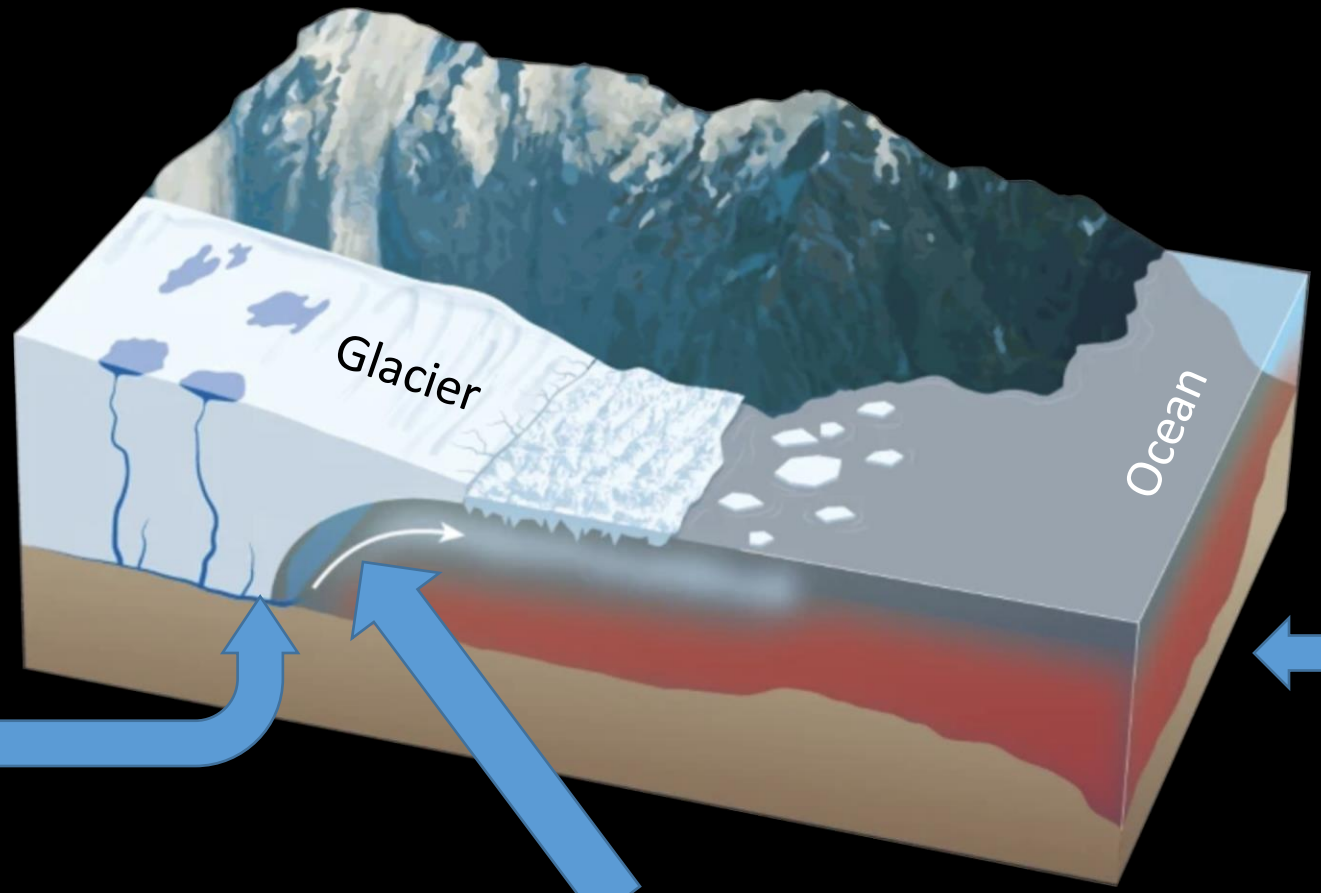
Deep



New Map



Understanding Glacier Melting



Glaciers are deep 100's of meters!

Warm water is at the bottom of the ocean

Melt occurs deep in the ocean

Image from Straneo and Heimbach 2013

Understanding Sea Level Rise

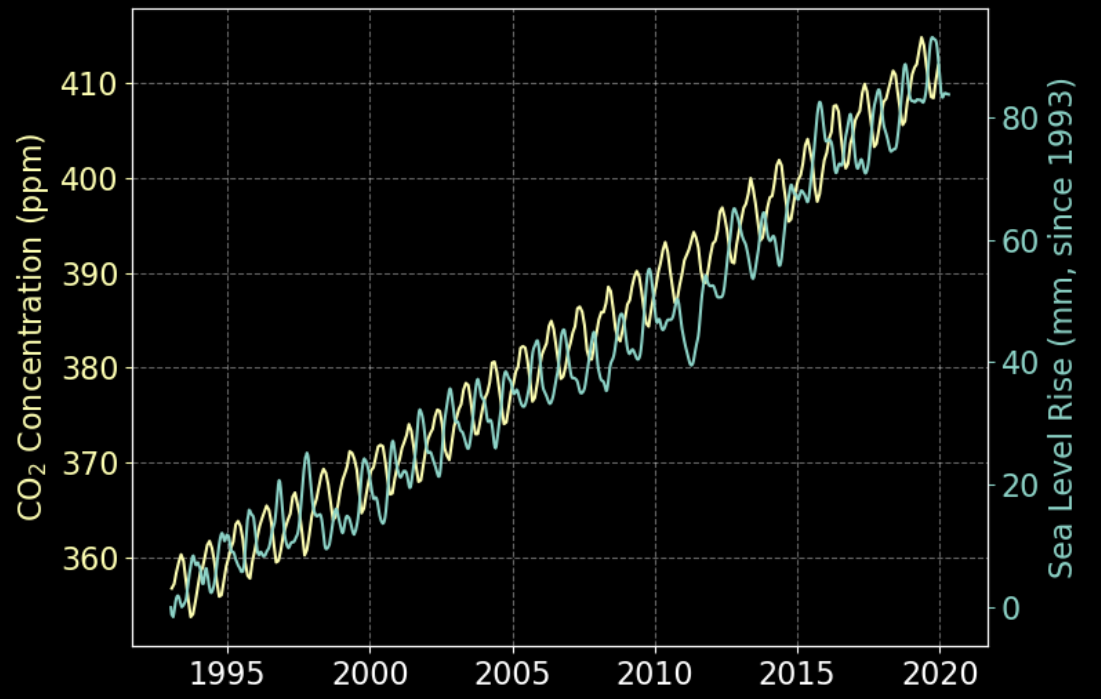
CO_2 Emitted

Ocean Temperature Increase

Glacier Melt

Glacier Speed Up

Sea Level Rise



Our Next Big Question: Future Sea Level Rise?

vs

2 feet? or 6 feet?

Take-away Messages

- More CO_2 in atmosphere ⇒ More melt from Glaciers
  - Glacier speed-up is influenced by warmer ocean waters melting Greenland from below

- Next: Future sea level rise?
  - Better preparations for the future

Questions?

mike.wood@jpl.nasa.gov

Links

- JPL Earth Science: https://science.jpl.nasa.gov/division/earth-science/
- OMG Mission: https://science.jpl.nasa.gov/projects/omg/
- NOAA Sea level rise viewer: https://coast.noaa.gov/slr
- NASA Scientific Visualization Studio Greenland Ice Flow: https://svs.gsfc.nasa.gov/3962
- Science Journal for Kids: https://www.sciencejournalforkids.org/articles/how-is-the-ice-in-greenland-melting/

Extra Slides

My Personal Pathway

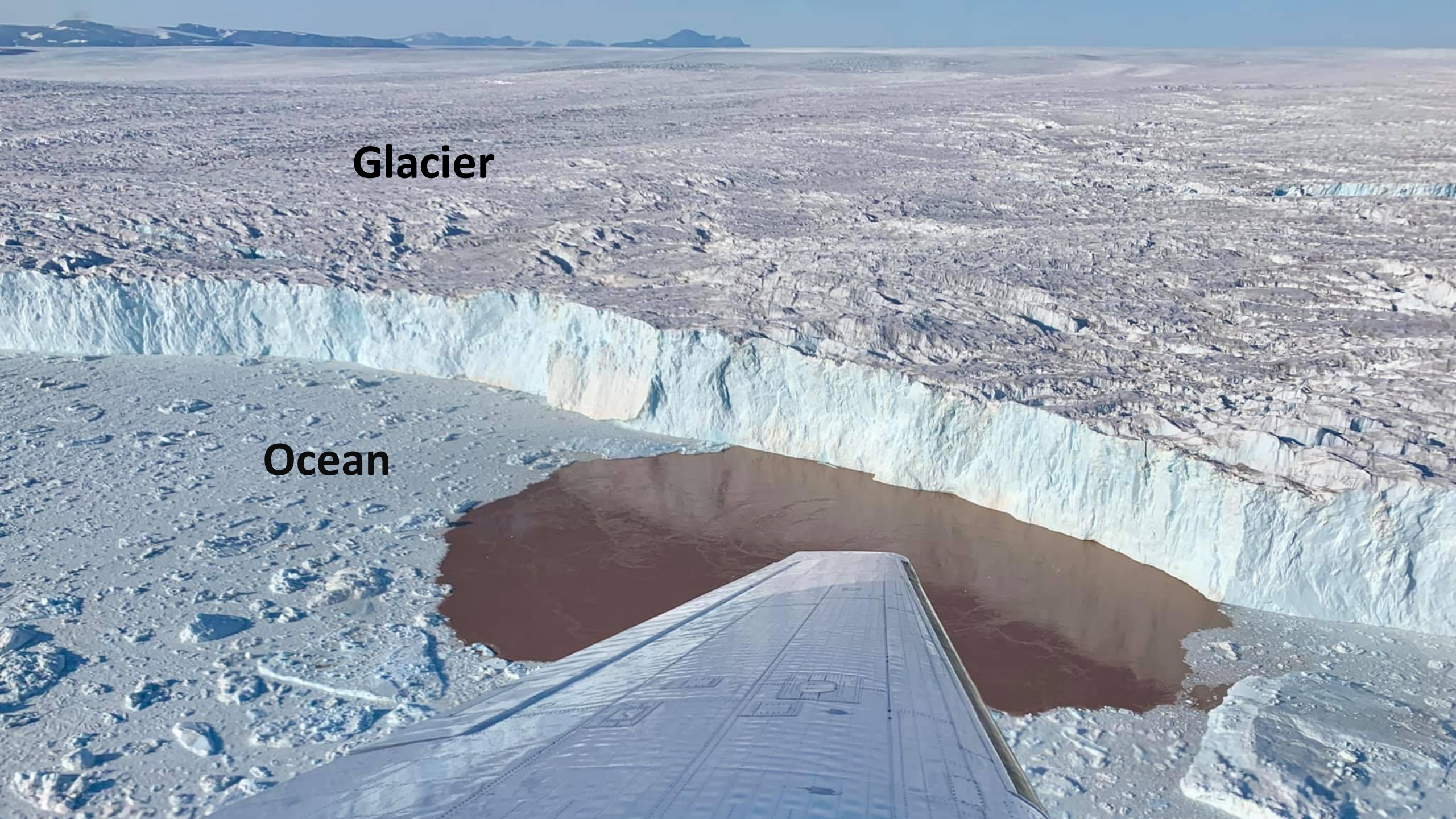
B.S. Mathematical Sciences (4 years)

Ph.D. Earth System Science (5 years)

Interested in Climate Science?

Climate change involves all of us

- Scientists
  - Chemistry, Math, Physics, Biology, and more
- Policy Makers
  - Political Science, History, Law
- Communicators
  - Public Speaking, Writing, Literature, Film
- And more!


Glacier
Ocean