

Bloomin' algae: microbes and ice sheets

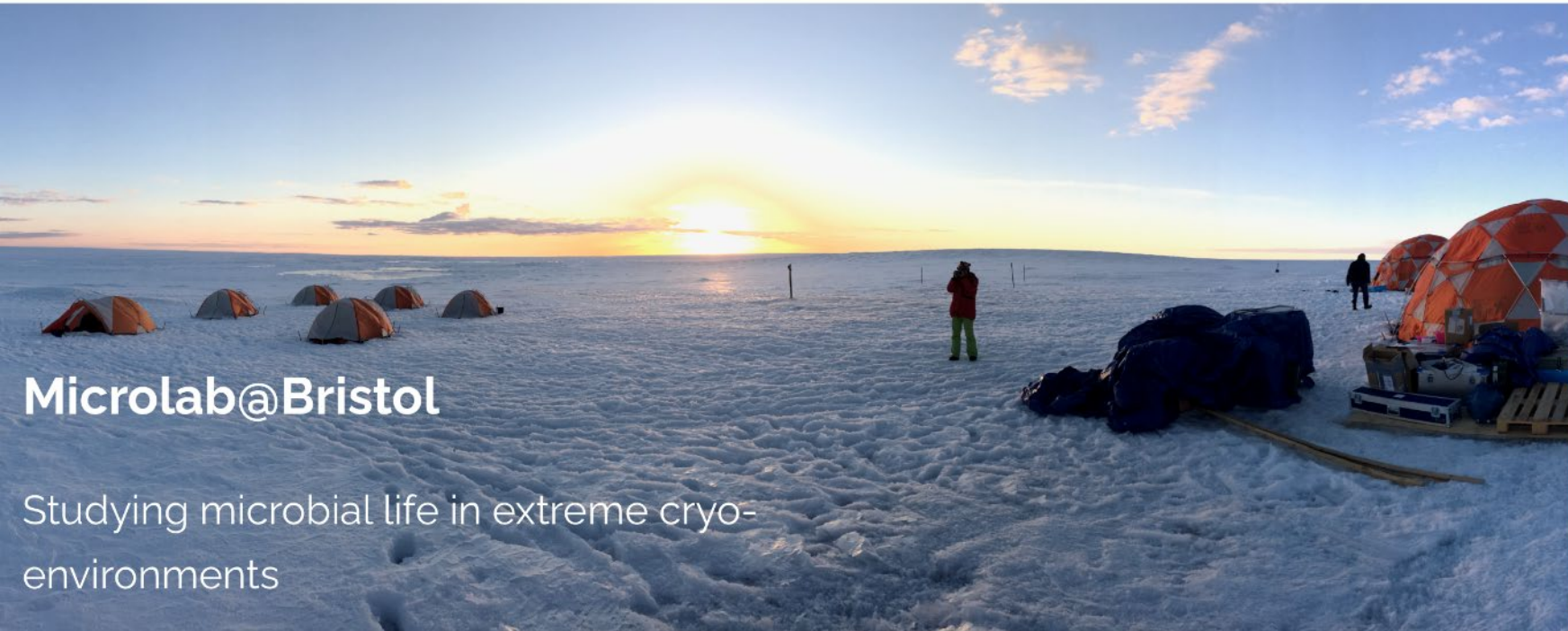
School of Geographical Sciences

Dr Chris Williamson

March 2021

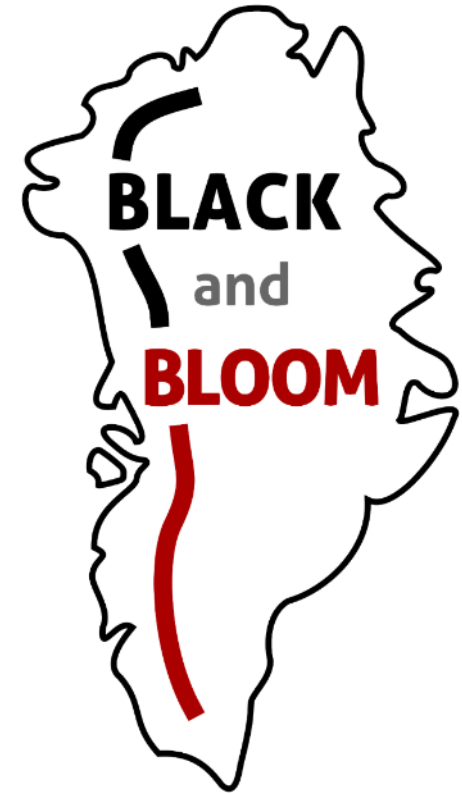
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Studying microbial life in extreme cryo-
environments



iDAPT: examining the role of the cryosphere in driving one of the biggest transitions in Earth's history – the evolution of land plants.



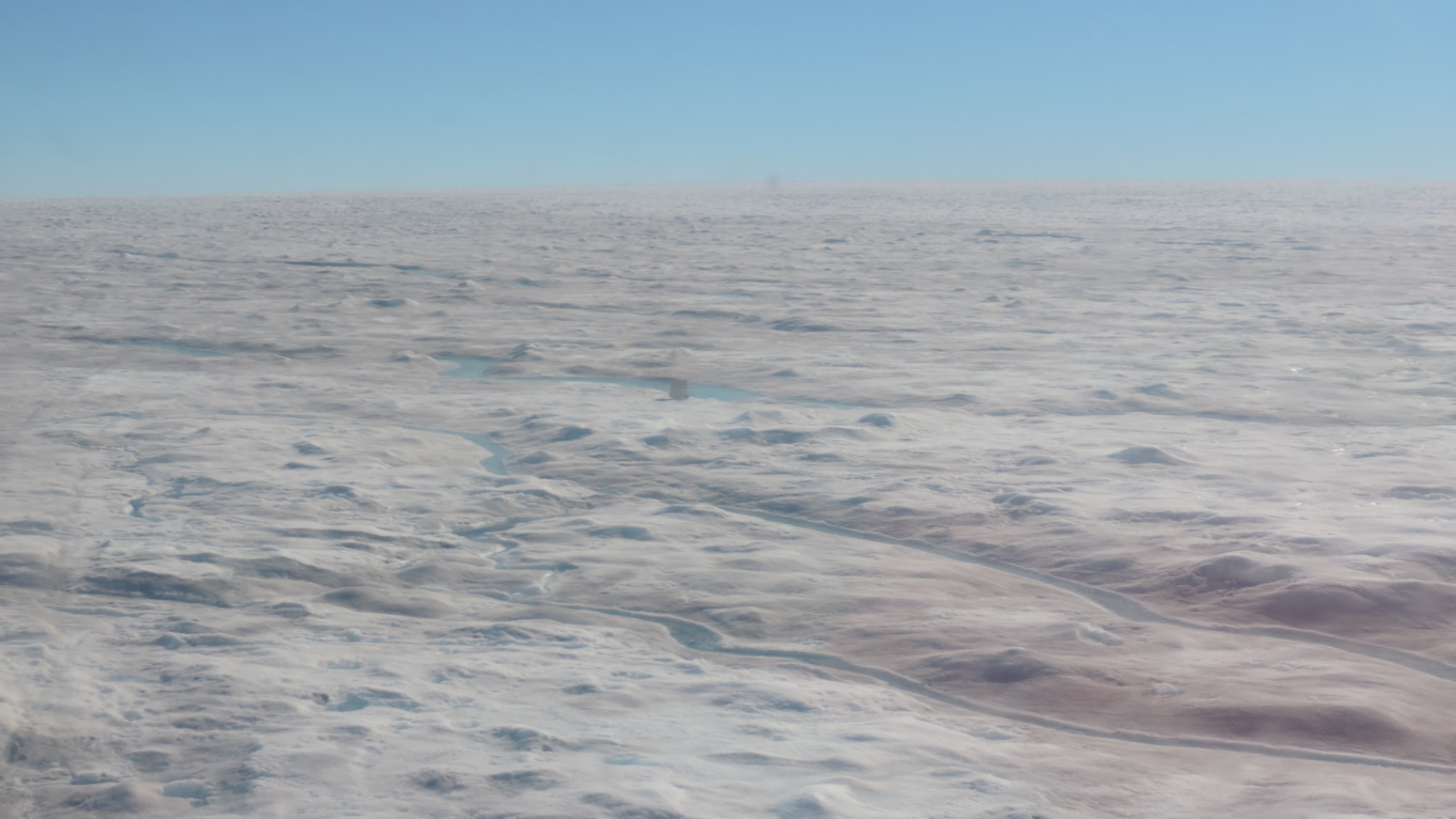
Supraglacial carbon cycling: using field data to model Greenland Ice Sheet glacier algal blooms and their contribution to global carbon cycling.

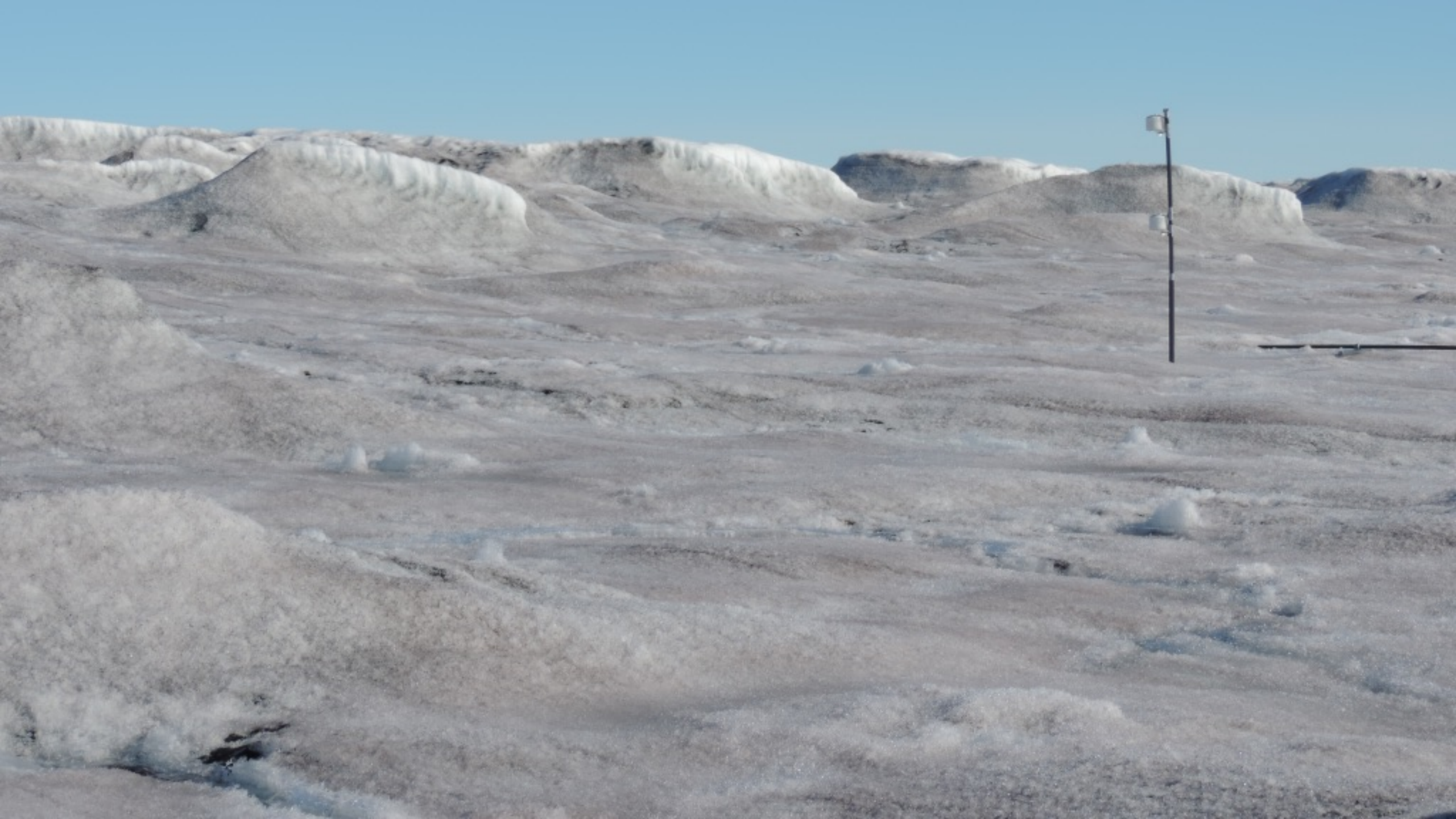


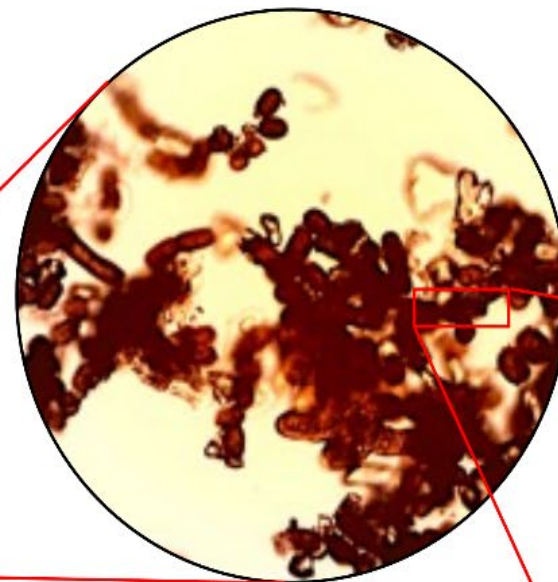
Smart Catchment Management: using machine learning to model Cyanobacterial blooms in freshwater reservoirs.



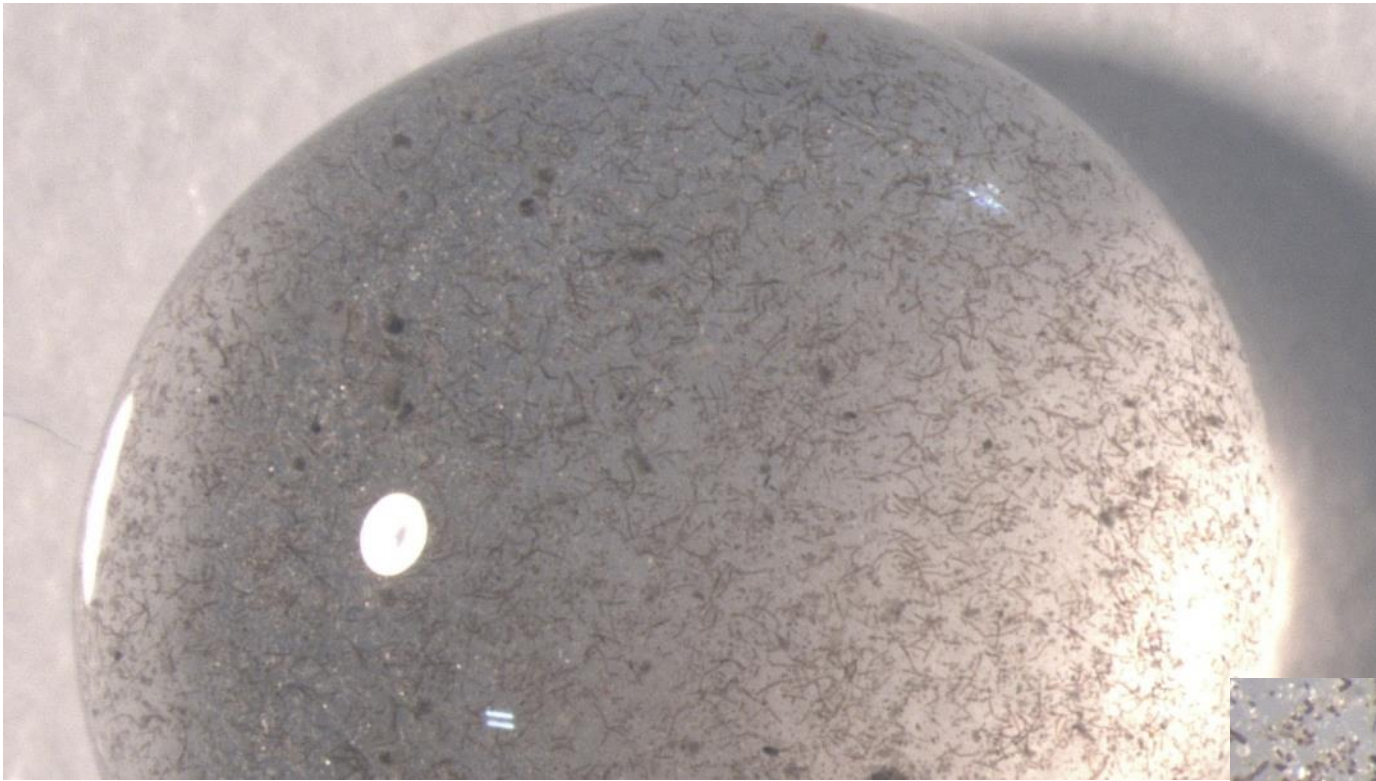






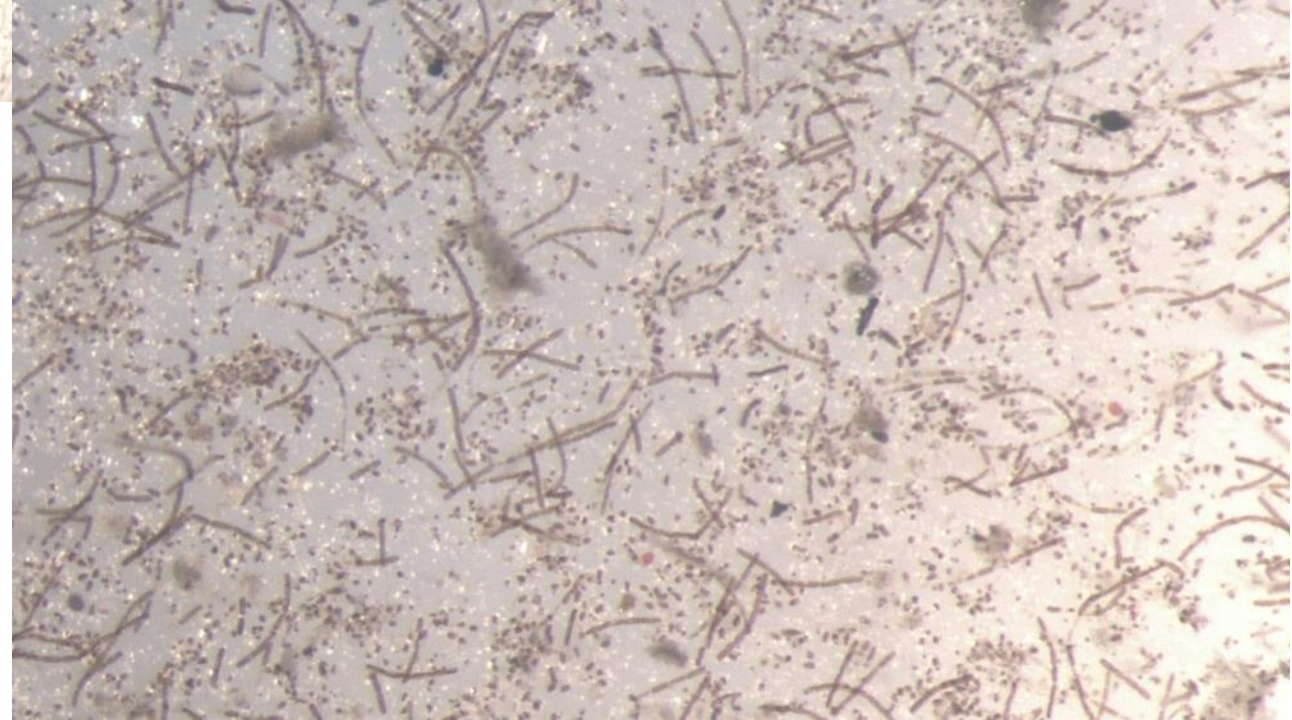


Dark surface ice dominated by blooms of
“glacier algae”



Per ml of melt water;
 10^6 micro-algal cells (1,000,000)
 10^7 bacterial cells (10,000,000)
? Fungi, viruses, other microbes

Streptophyte “glacier algae”



Why do we care about life in glacial systems?

- Understanding the limits of life
- Earth's evolutionary history
- Analogies for astrobiology
- Global biodiversity
- Ecosystem functioning
- Impacts to the physiochemical characteristics of the cryosphere
- Influences outside of the cryosphere?



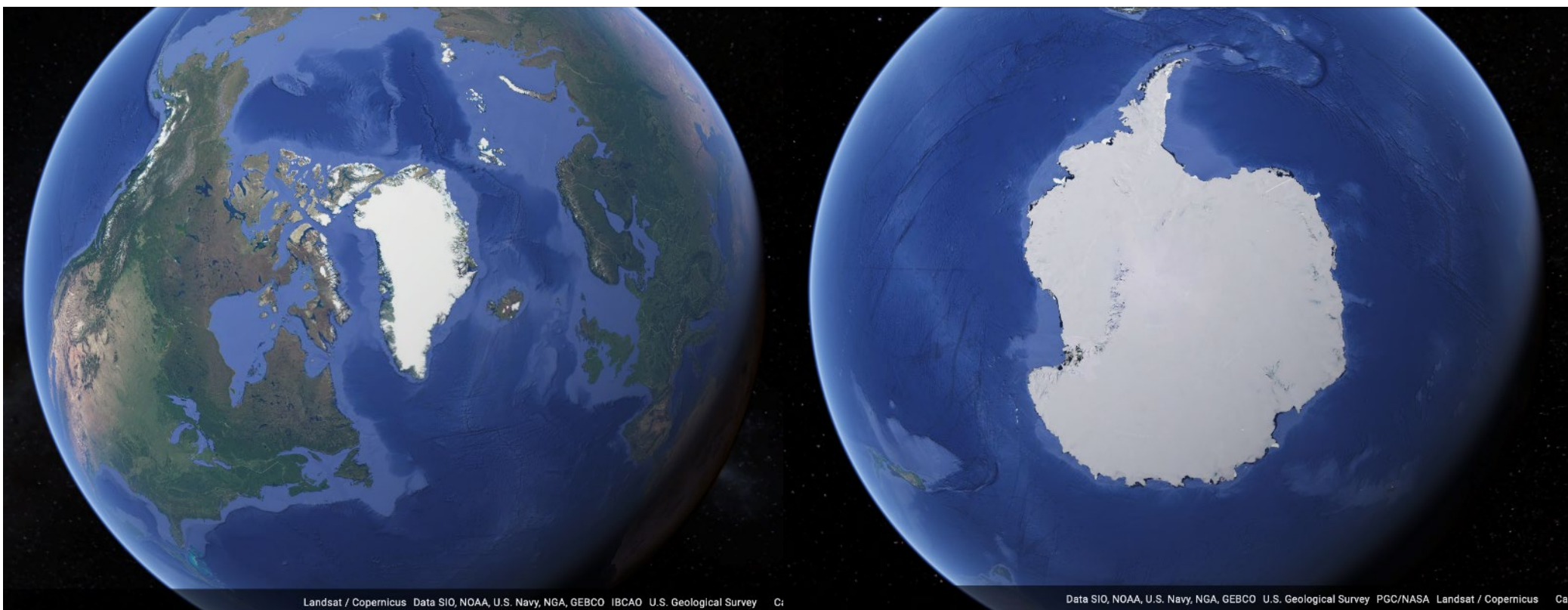
Ice sheets and glaciers worldwide have lost significant mass

Between 2006 – 2015:

- $278 \pm 11 \text{ Gt yr}^{-1}$ lost from Greenland Ice Sheet
- $155 \pm 19 \text{ Gt yr}^{-1}$ lost from Antarctic Ice Sheet
- $220 \pm 30 \text{ Gt yr}^{-1}$ lost from glaciers worldwide outside of Greenland/Antarctica

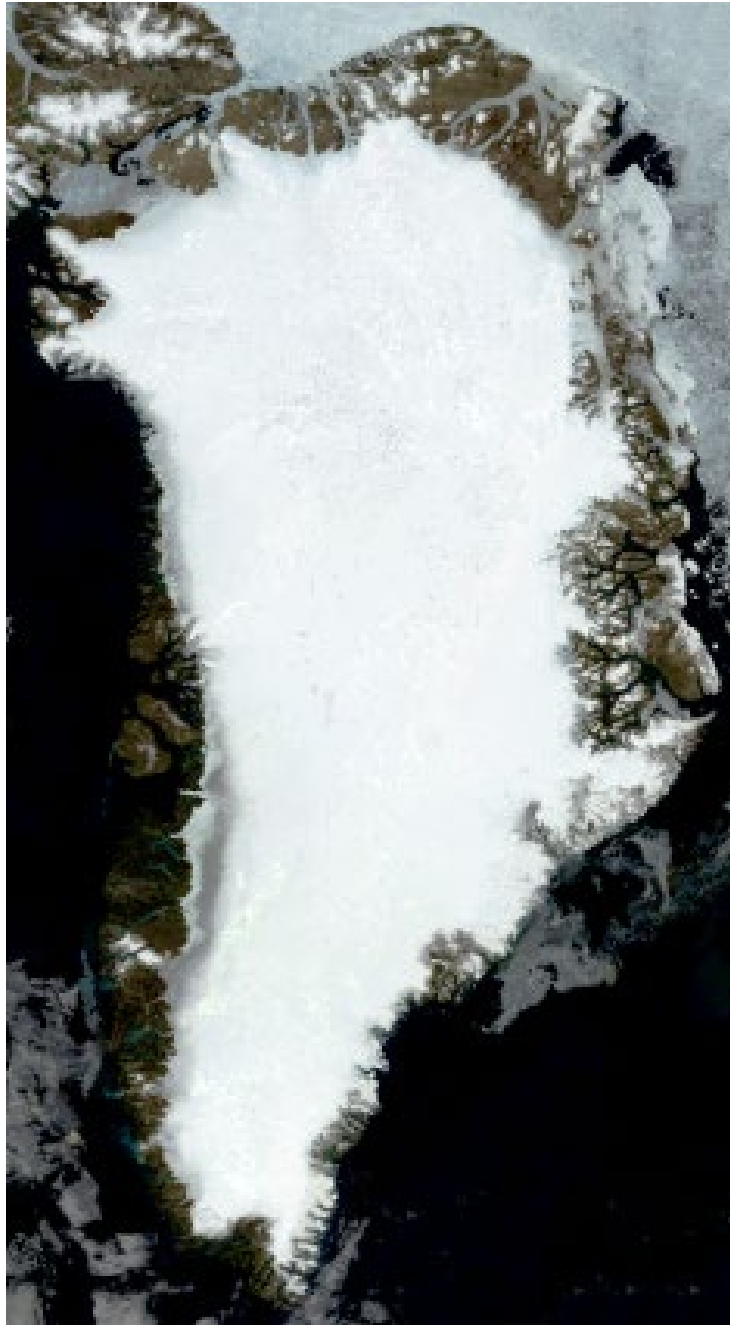
100,000,000 Olympic sized pools each year

1 gigatonne of water = 400,000 Olympic-sized swimming pools

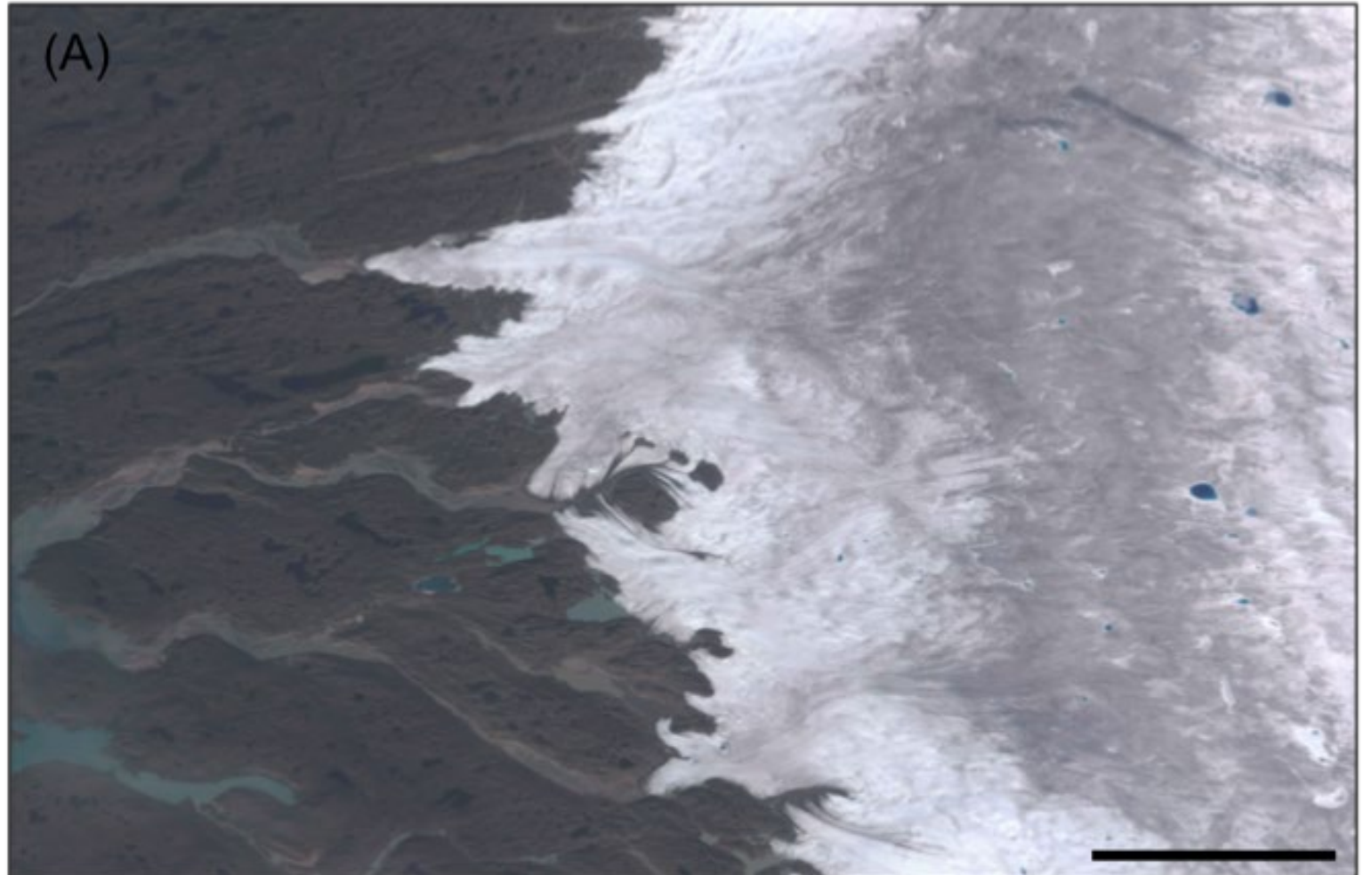


Cryosphere Component	Ice Area (10 ⁶ km ²)	Ice Volume (10 ⁶ km ³)	Potential Sea-level rise (m)
Snow on land	1.9-45.2	0.0005-0.005	0.001-0.01
Sea Ice	19-27	0.019-0.025	0
Glaciers and ice caps	0.51-0.54	0.05-0.13	0.15-0.37
Ice shelves	1.5	0.7	0
Ice Sheets	14	27.6	63.9
Greenland	1.7	2.9	7.3
Antarctica	12.3	24.7	56.6
Permafrost	22.8	0.011-0.037	0.03-0.10

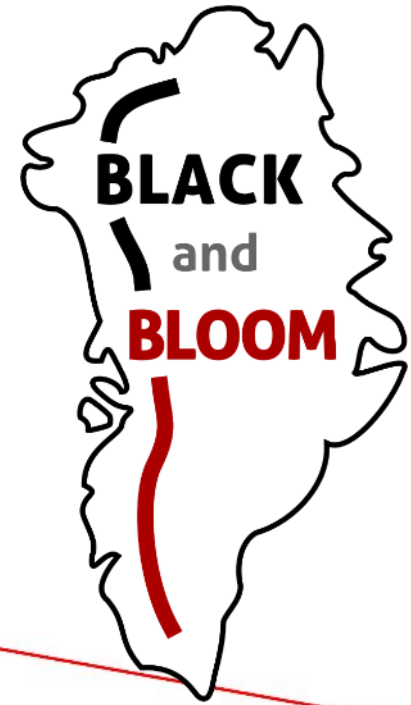
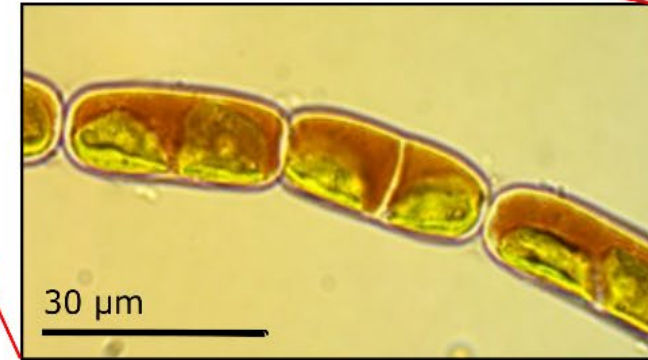
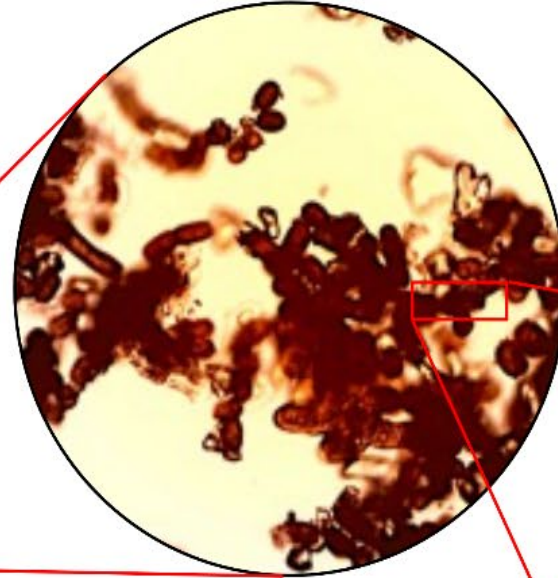
- Sea level rose by ~ 15 cm during the 20th century
- Land ice loss has contributed ~ 60% of total SLR since 1972
- Globally > 250 million people live within 5 m of current sea level



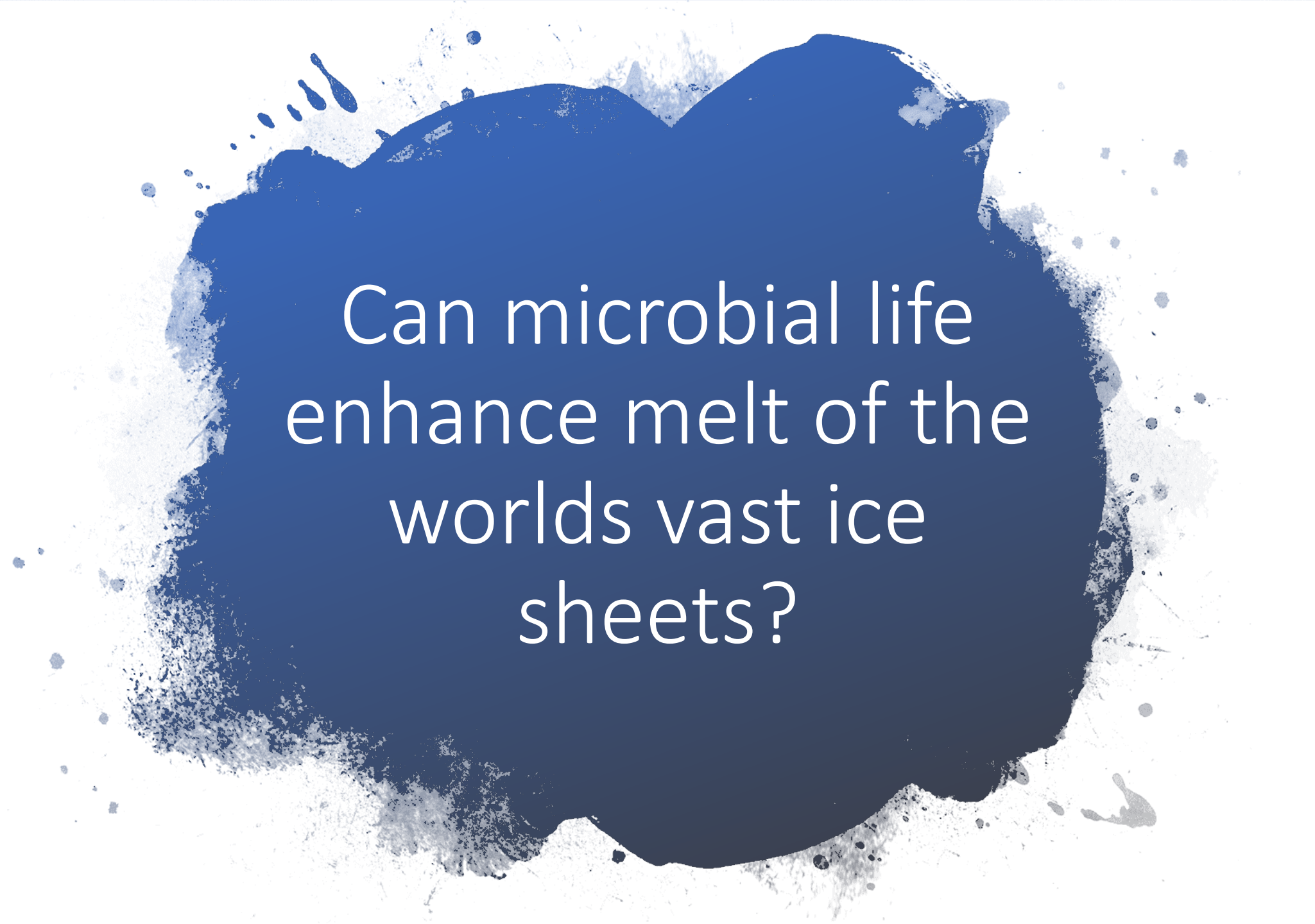
Increasing melt of the Greenland Ice Sheet and the 'dark zone'



What is making the ice darken and melt faster?



Could it be blooms of microalgae in the ice surface?



Can microbial life
enhance melt of the
worlds vast ice
sheets?

How to study life on the GrIS?

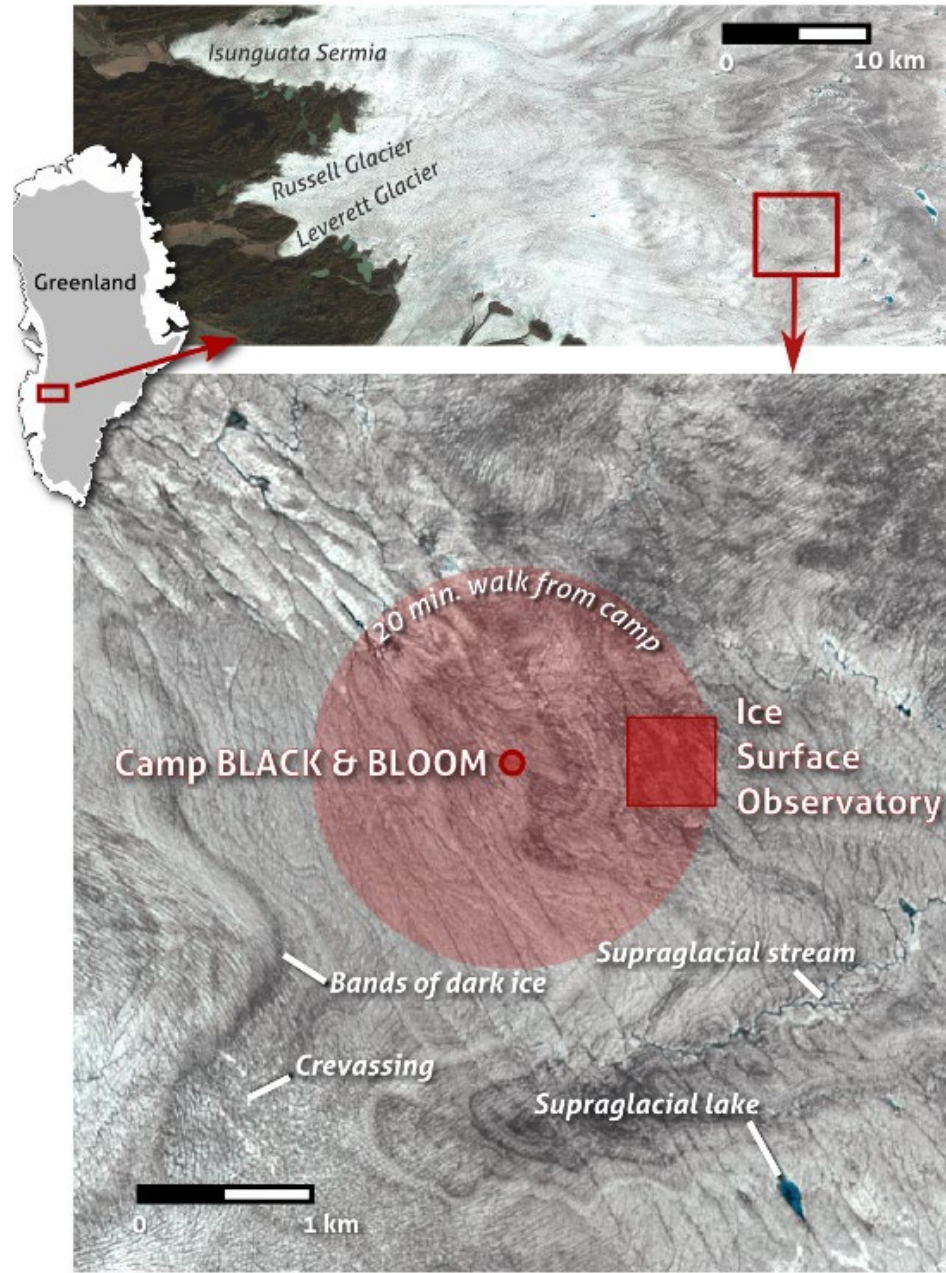
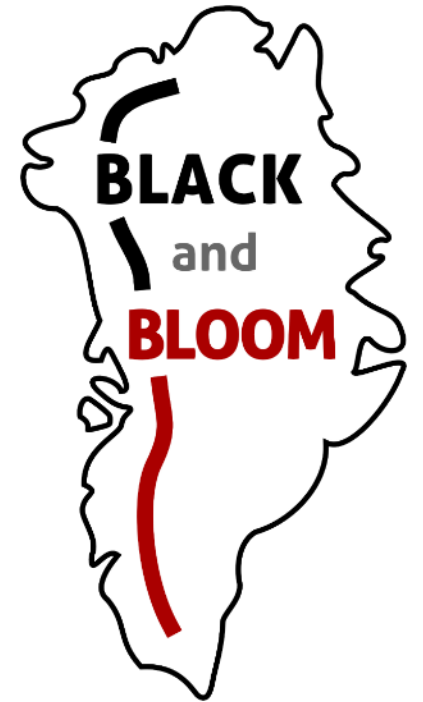


Image: Sentinel 2-A true-colour composite at 10 m resolution, acquired 11 July 2016

A. Tedstone, 13 July 2016





The stages of a field expedition

1. Organise your gear.



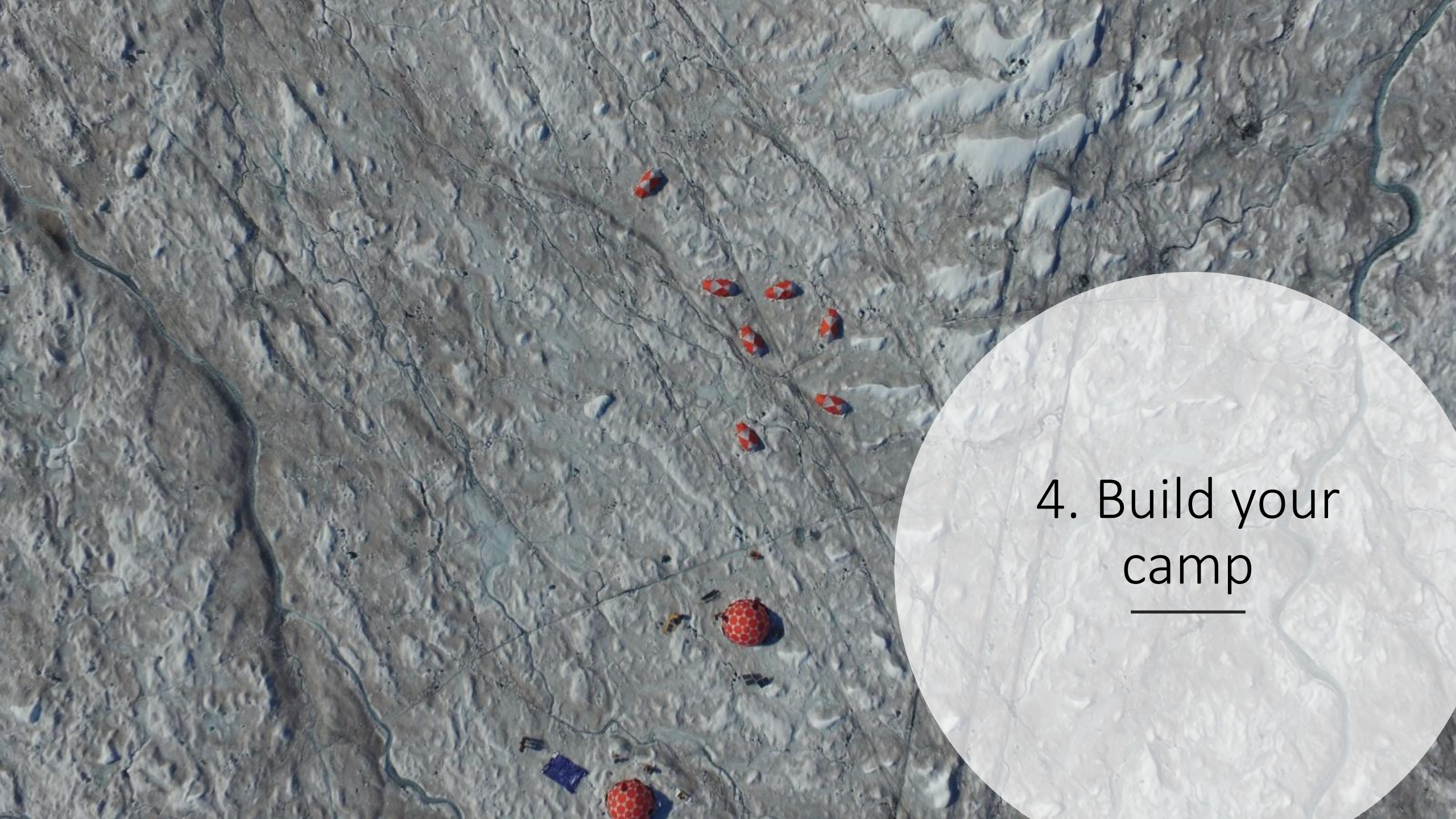
2. Fly to staging location
and prepare

3. Hitch a ride and deploy









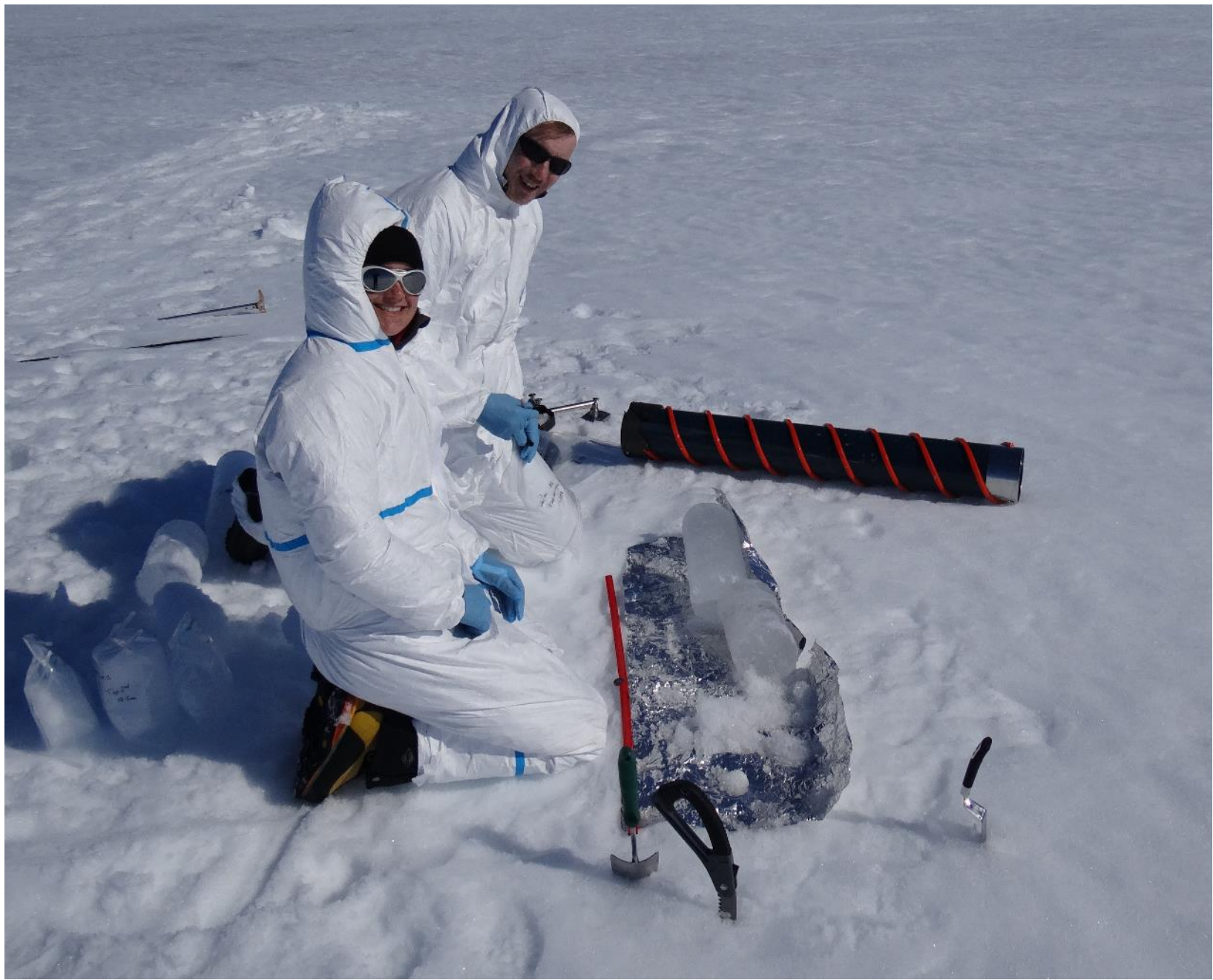
4. Build your
camp







Sample everything!
















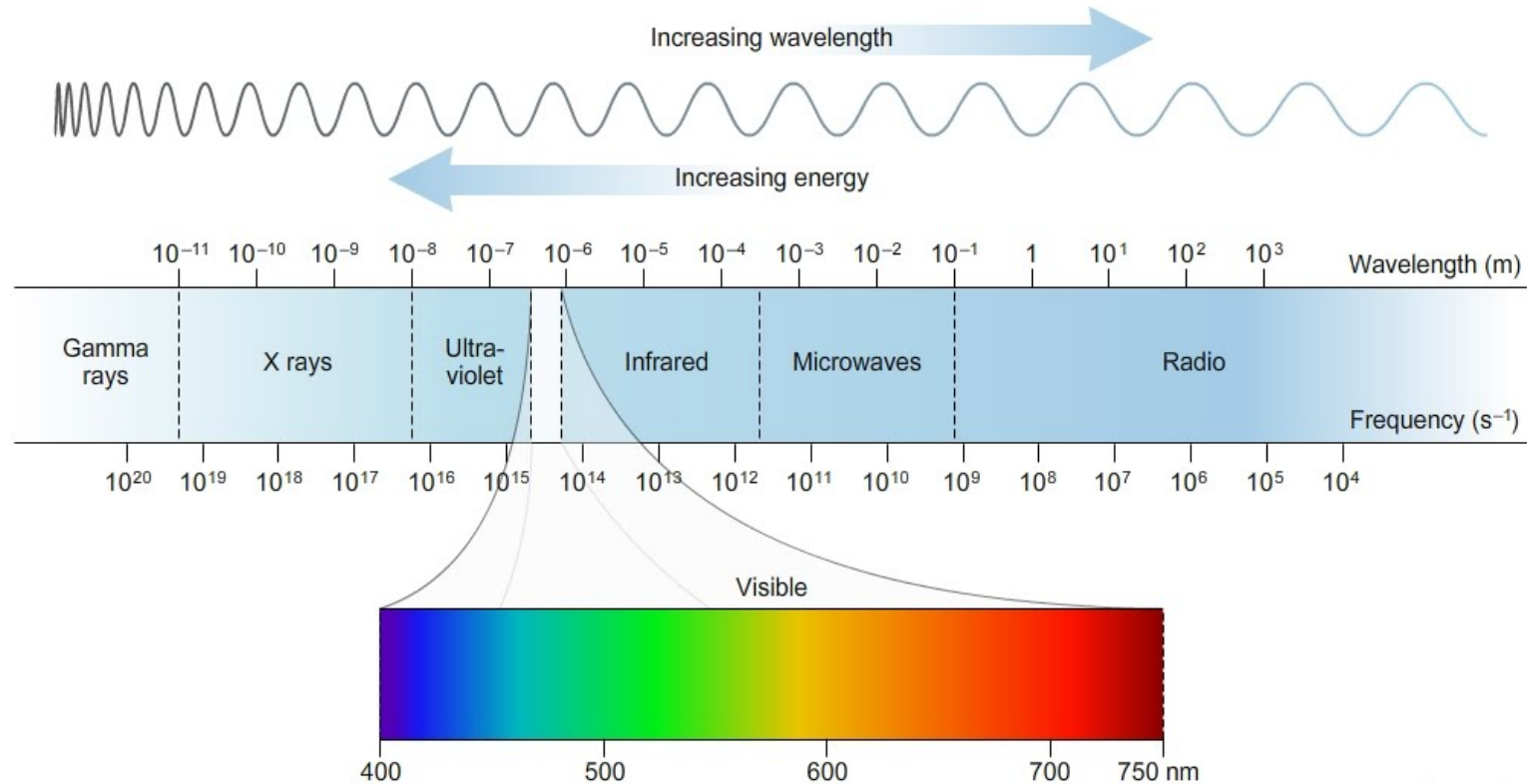


Can microbial life
enhance melt of the
world's vast ice
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Glacier algae and their specialist pigments



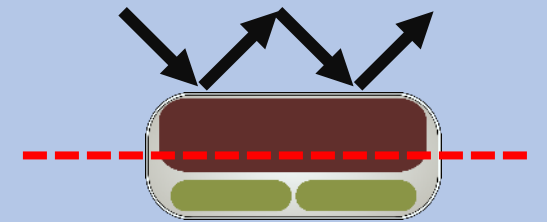
Different pigment absorb different wavelengths of light



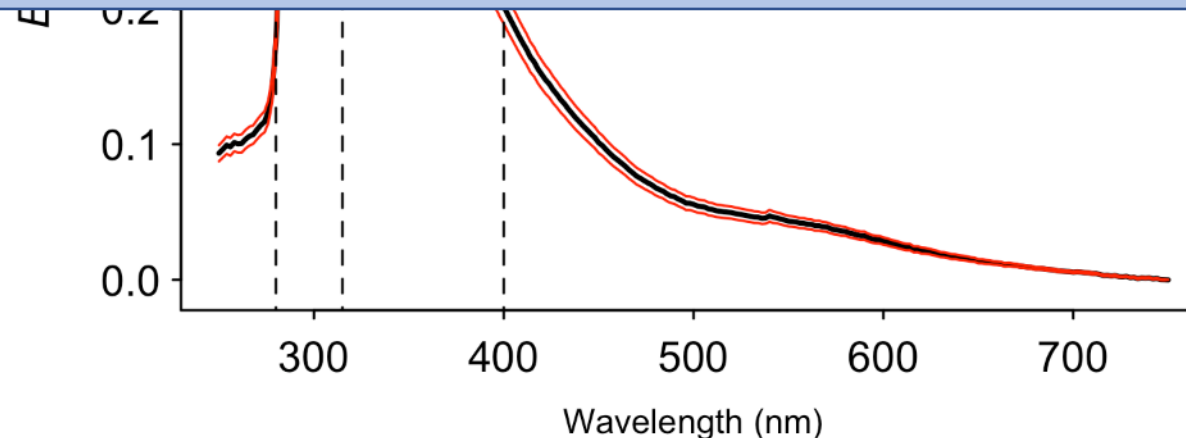
Glacier algae are highly specialised for glaciers

- Between 48 – 65% of sunlight absorbed by glacier algal unique pigmentation (and available for melt generation!)
- ~30% not absorbed by the cells
- Only ~ 1 – 2.4 % of sunlight used for photosynthesis
- Glacier algae are optimized to absorb light

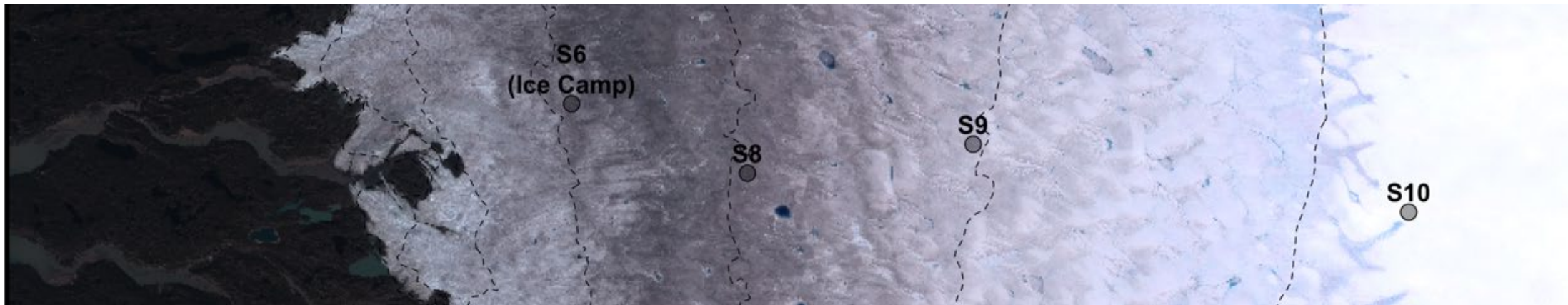
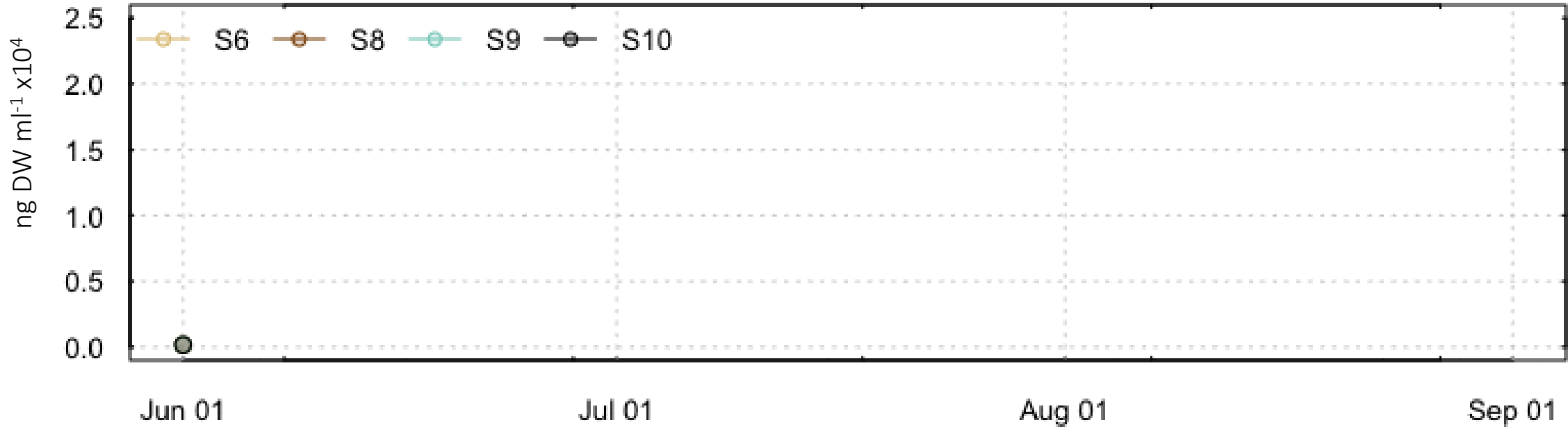
Allow some visible light to reach chloroplasts for photosynthesis

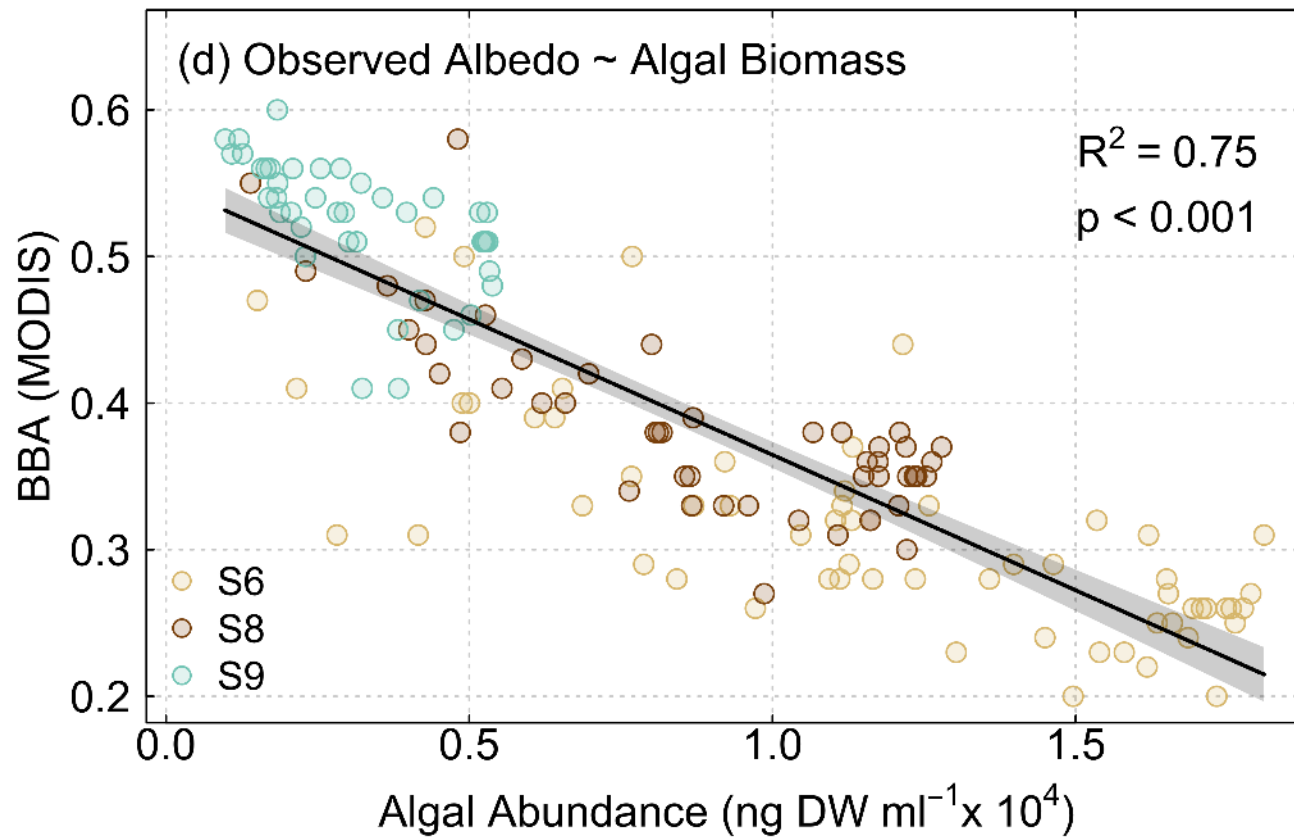


around the cell
→ liquid water

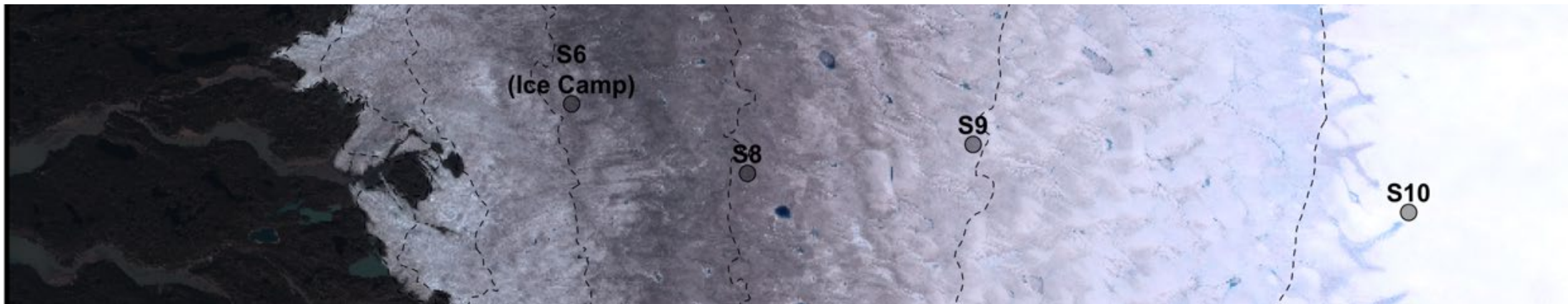


What about at the regional scale?



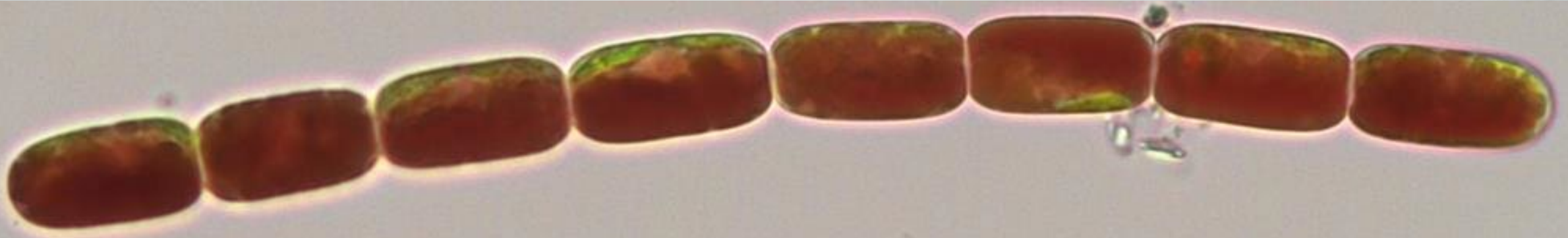


- Up to ~75% of the darkening along the southwestern GrIS may be due to glacier algal growth within surface ice
- Converted to melt potential, glacier algae can cause $\sim 1.8 \text{ cm melt d}^{-1}$
- $\sim 10 - 13\%$ of the total melt generated or $\sim 8 - 12 \text{ Gt}$ of ice
- 3,200,000 – 4,800,000 Olympic sized swimming pools worth of melt in SW Greenland alone!



To summarize

- Microbial life abounds in polar environments, with the surface of glaciers and ice sheets home to abundant algal, bacterial, fungal and viral communities
- Streptophyte “glacier algae” form widespread blooms during summer melt seasons e.g. along the western margin of the GrIS
- These blooms hold significant potential to enhance the melt of surface ice given the specialist pigmentation and abundances achieved by glacier algae during blooms
- Microbial communities are thus able to exacerbate wastage of our world’s vast ice sheets, which are already under serious threat from global climate change, with consequences for us all.



What can I do from my backyard?



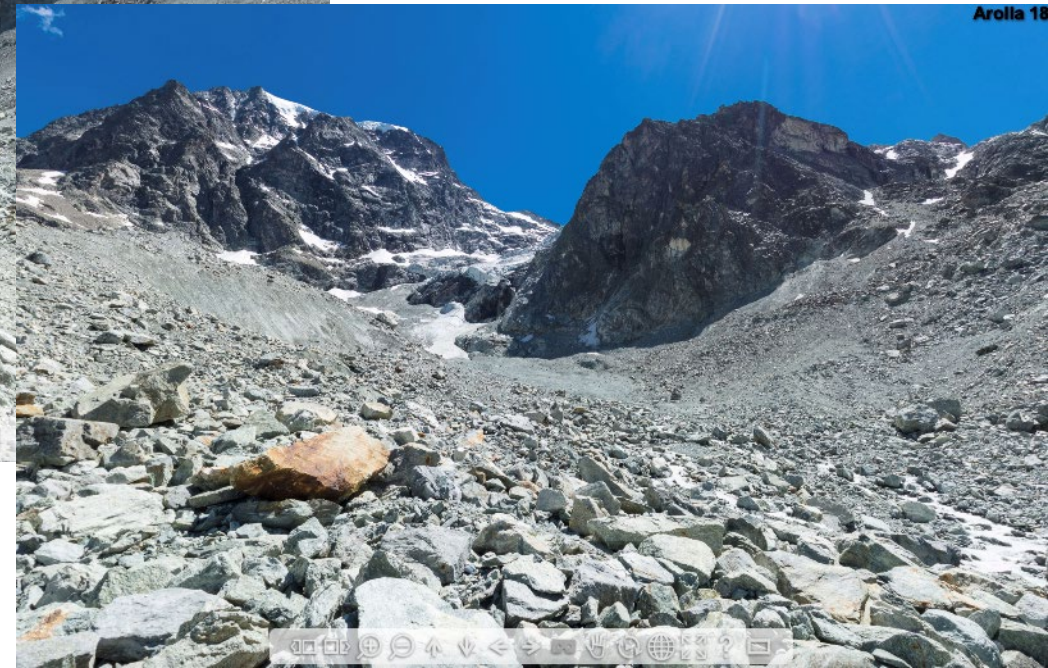
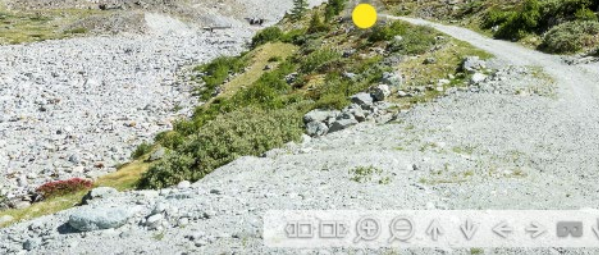
VR Glaciers & Glaciated Landscapes

Supporting, not replacing, 'real' fieldwork

Virtual fieldwork has a role to play in supporting class- and lab-based learning, teaching and assessment. It can be used in many ways, including the support of 'real' fieldwork – for which there is no substitute.

Find out more.



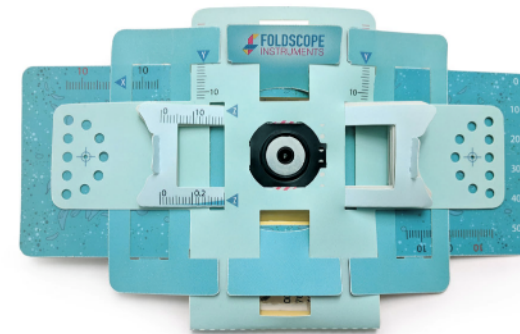


Arolla valley in the Swiss Alps





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The Paper Microscope

Foldscope was created with a vision to solve an accessibility problem in science... What began as a simple idea has grown into a company that provides low-cost tools to communities around the world!

Foldscope is the ultra-affordable paper microscope. It was designed to be portable and durable, while performing on par with conventional research microscopes (**140X magnification** and **2 micron resolution**).

As a company, *Foldscope Instruments Inc's* mission is to break down the price barrier between people & the curiosity and excitement of scientific exploration!

Through the purchase of our products, you directly support our mission and enable us to bring tools to communities around the world.



Bloom

12:36



Bloomin' Algae

Warning

Blue-Green algae (also known as Cyanobacteria) can be harmful to the health of people and animals. Do NOT touch or ingest anything you suspect to be a bloom and do not allow pets or children to come into contact with, or swallow, the water

I understand

12:36



Send



Bloomin' Algae



Algal guide



Location

ST519758



Date

Today



Bloom size



Activities



Comment



No photo has been added

12:36



Identify



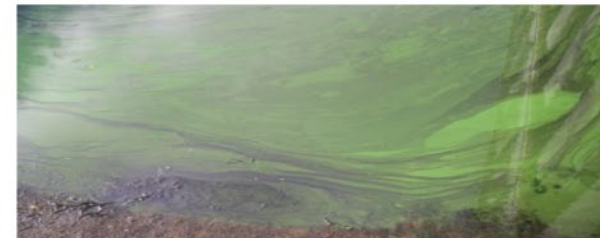
If you are still not sure after looking at this guide please submit the record anyway

Blue-Green Algal Blooms

Usually green or blue-green in colour

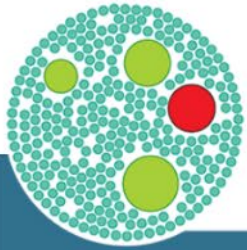


Form paint-like surface scums often along shorelines



Tiny irregular-shaped clumps (<3 mm) suspended in water.
May be small and round or tiny grass like flakes





**British
Phycological
Society**
Understanding and using algae

Welcome to the British Phycological Society's Website. The Society, a charity devoted to the study of algae founded in 1952, was one of the first to be established in the world, and is the largest in Europe.

Membership of the British Phycological Society is open to everybody.

JOIN TODAY

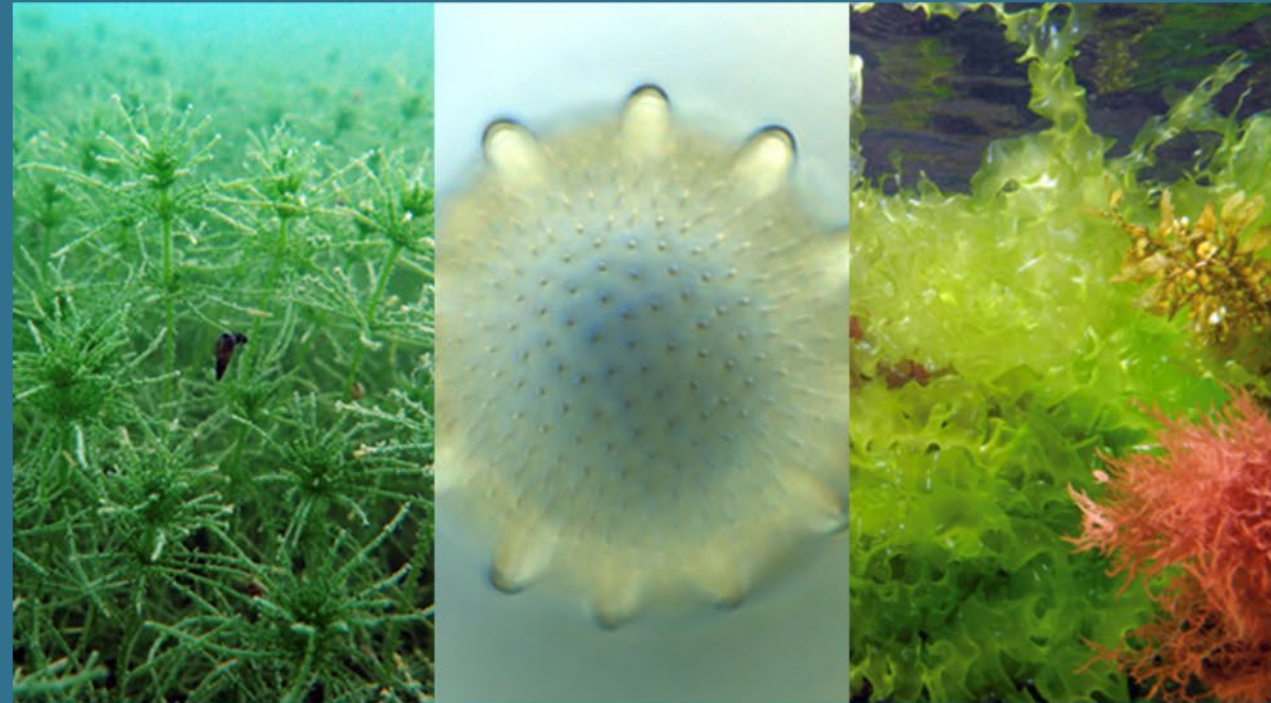
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Thanks.

