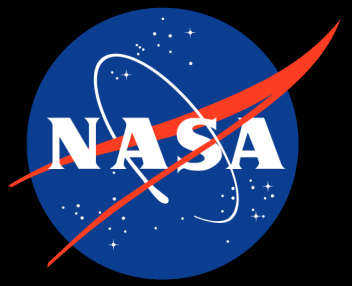
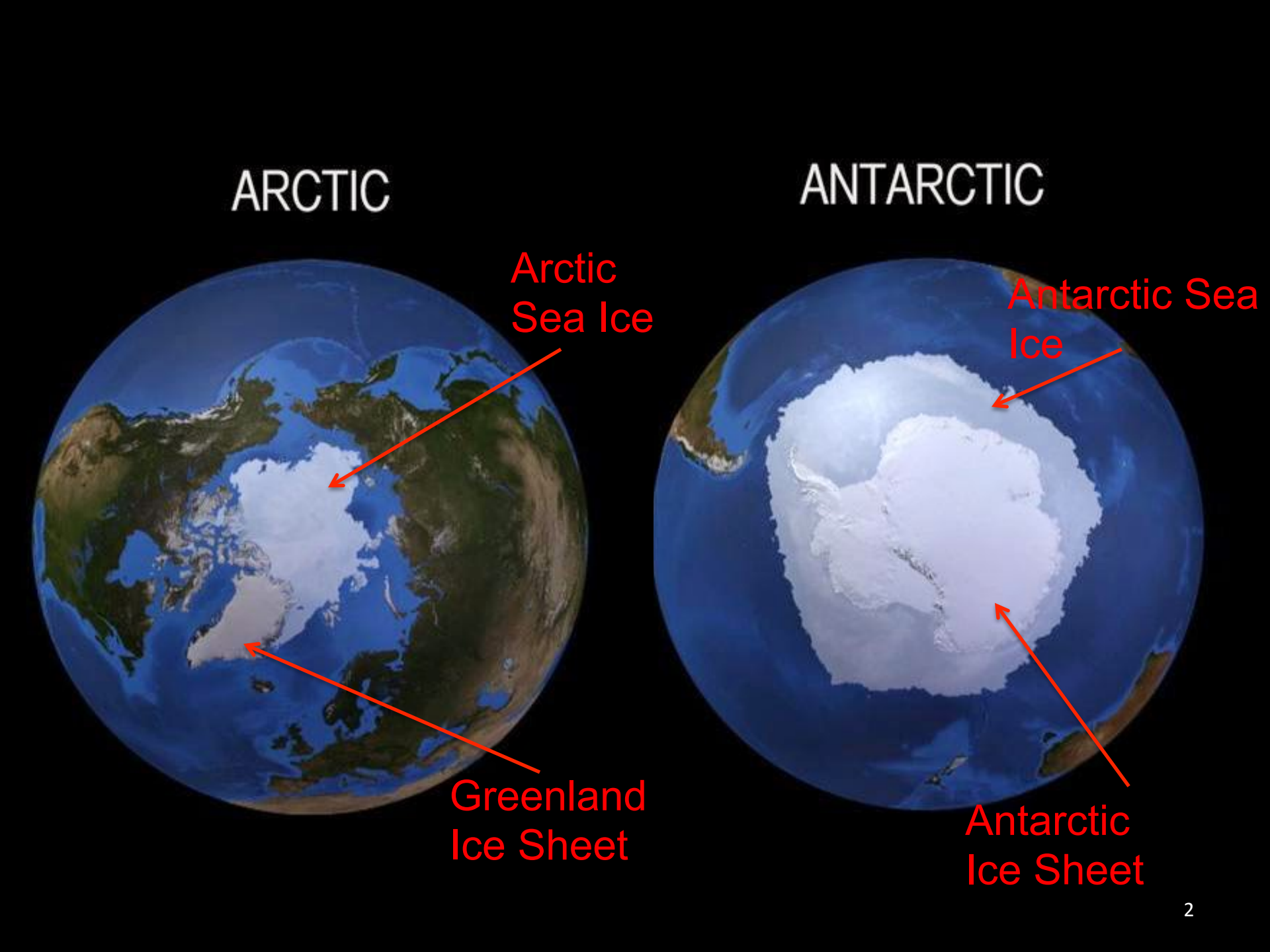
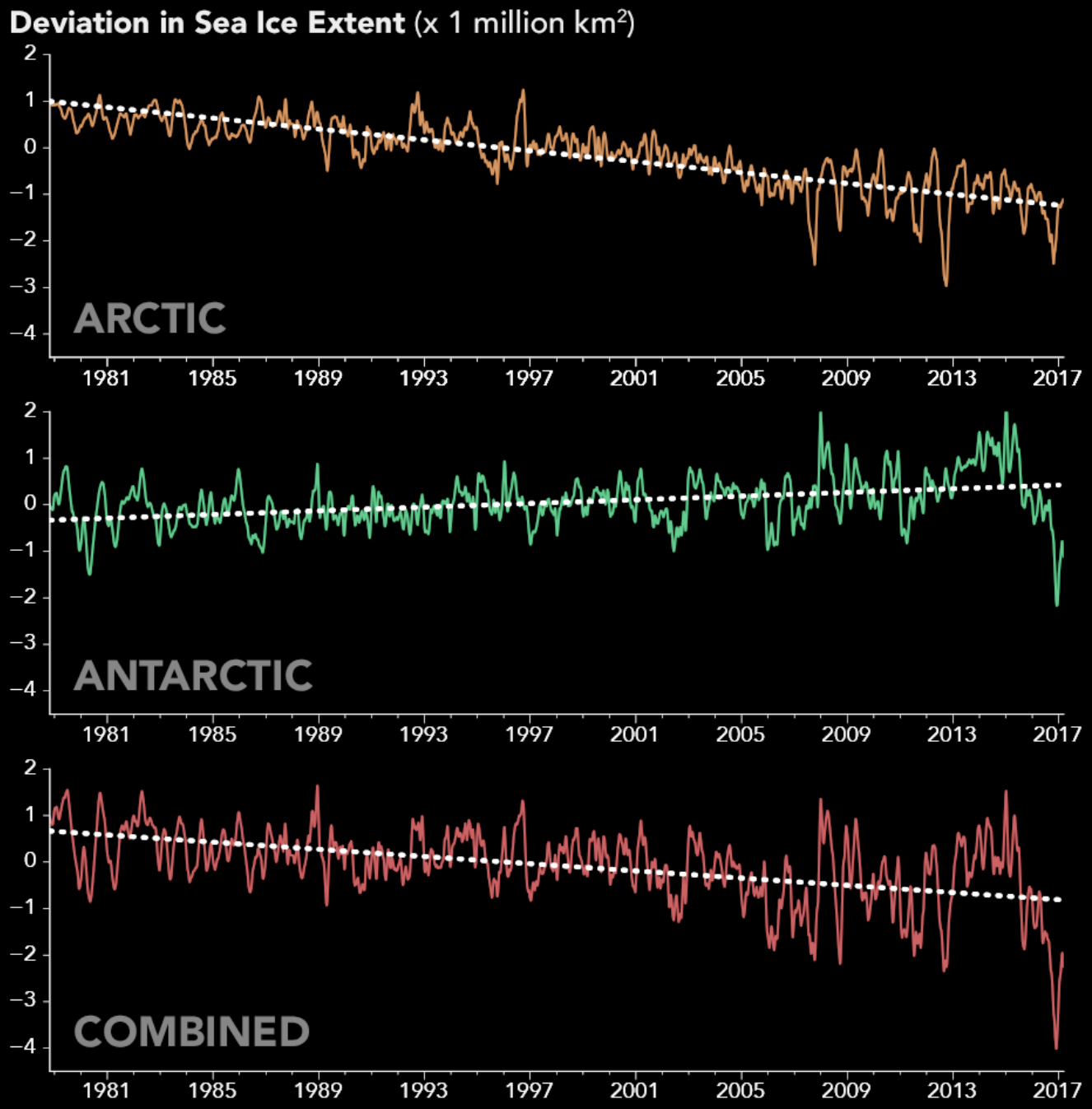
Deriving Sea Ice Thickness from ICESat-2: From Freeboard to Thickness via Snowfall

Alek Petty ***Code 615 (Cryospheric Sciences Lab)***



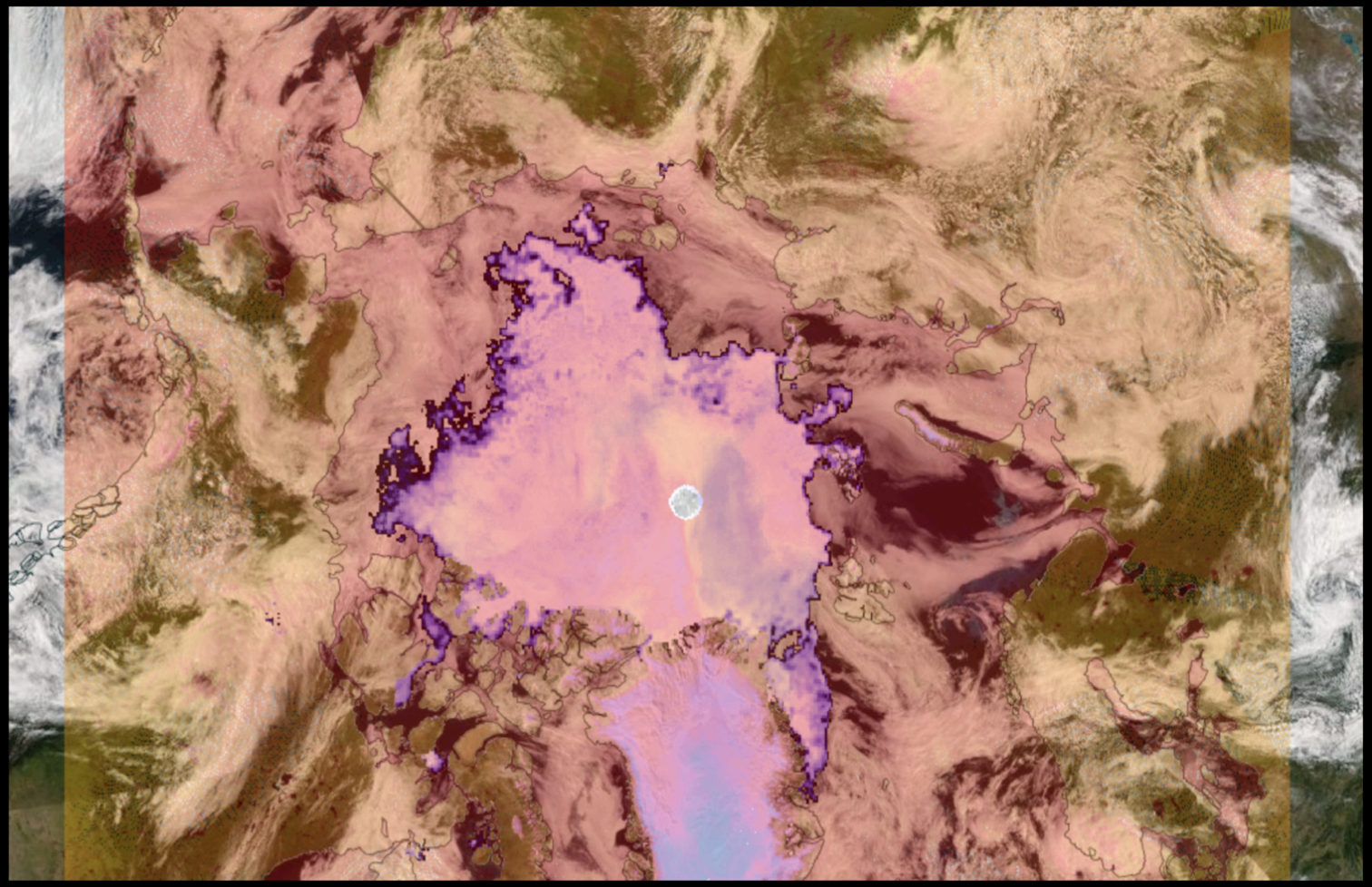
www.alekpetty.com / @alekpetty / alek.a.petty@nasa.gov


ARCTIC
Arctic
Sea Ice
Greenland
Ice Sheet
ANTARCTIC
Antarctic Sea
Ice
Antarctic
Ice Sheet



Produced by NASA's SVS

Passive microwave sensing sea ice cover



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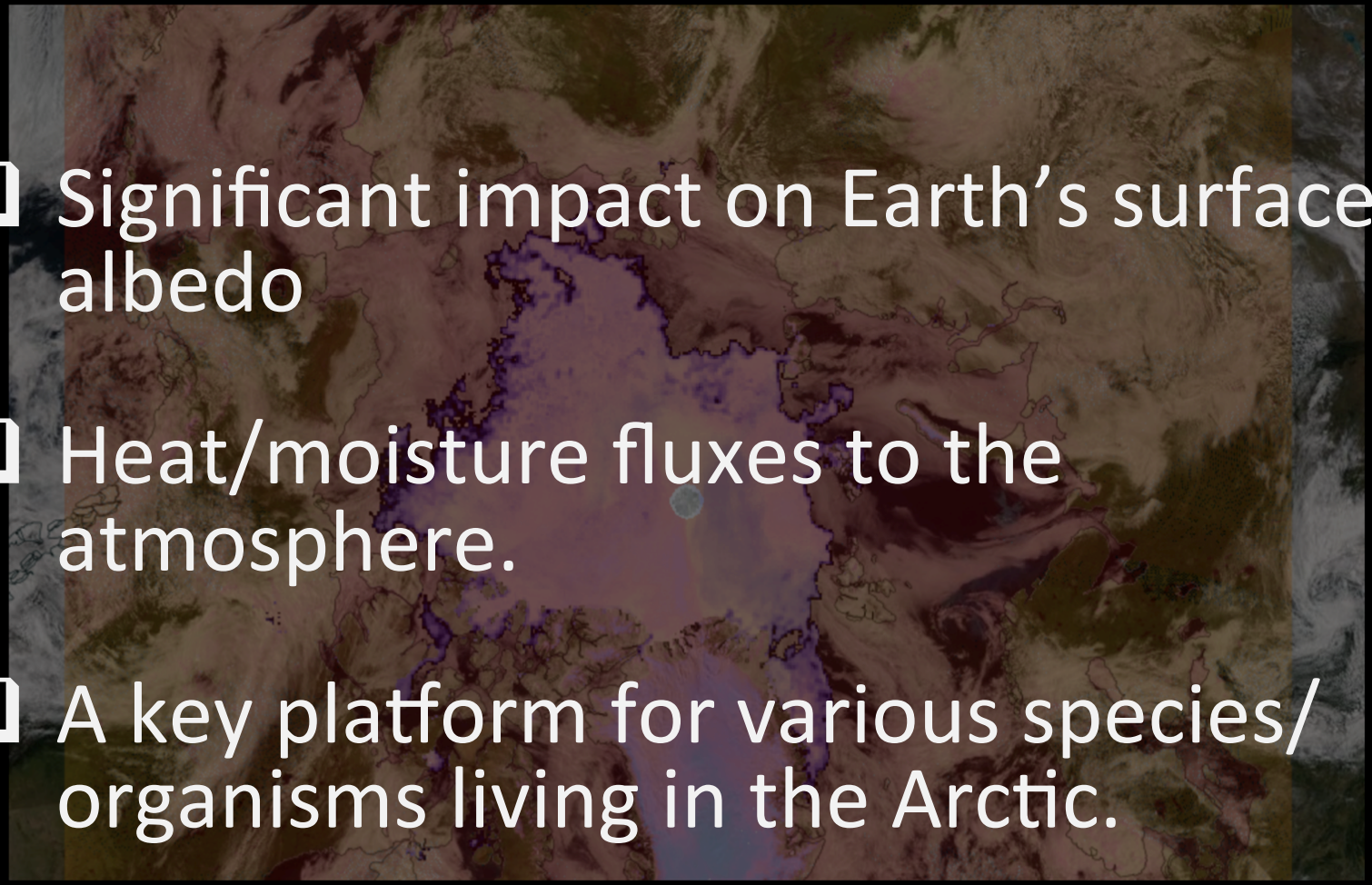
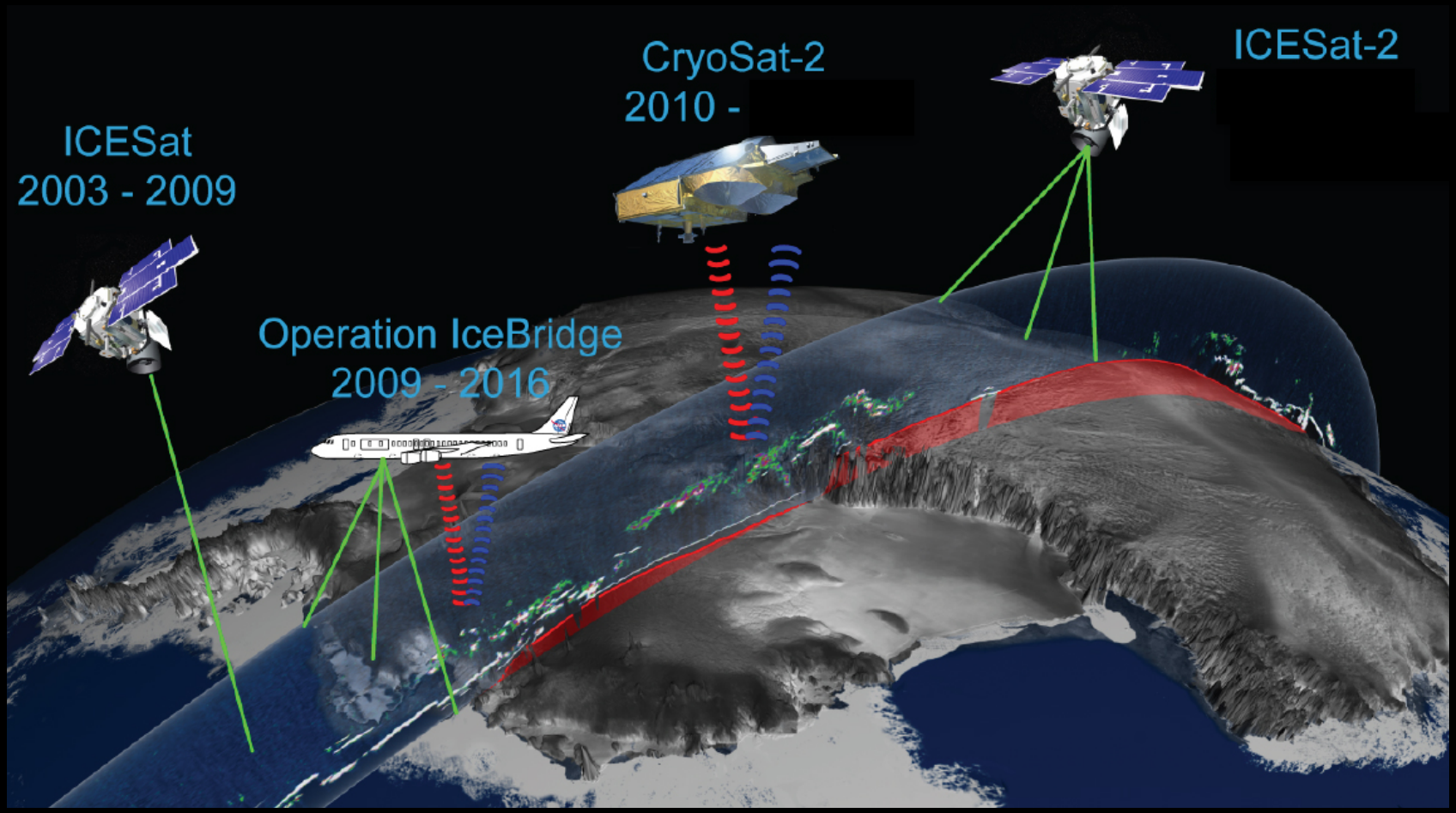
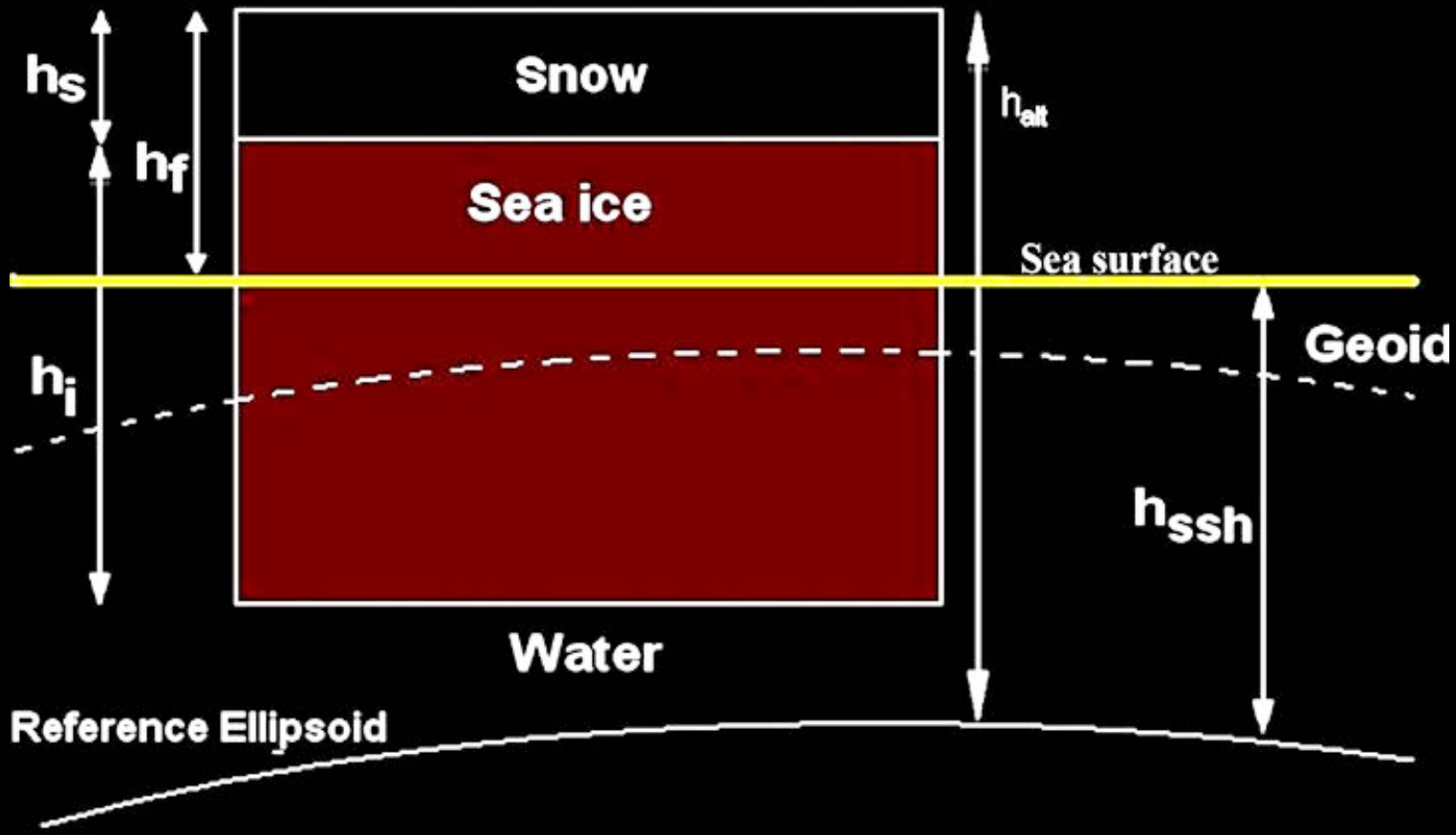


- Significant impact on Earth's surface albedo
- Heat/moisture fluxes to the atmosphere.
- A key platform for various species/ organisms living in the Arctic.

New crop of active satellites provide the crucial third dimension



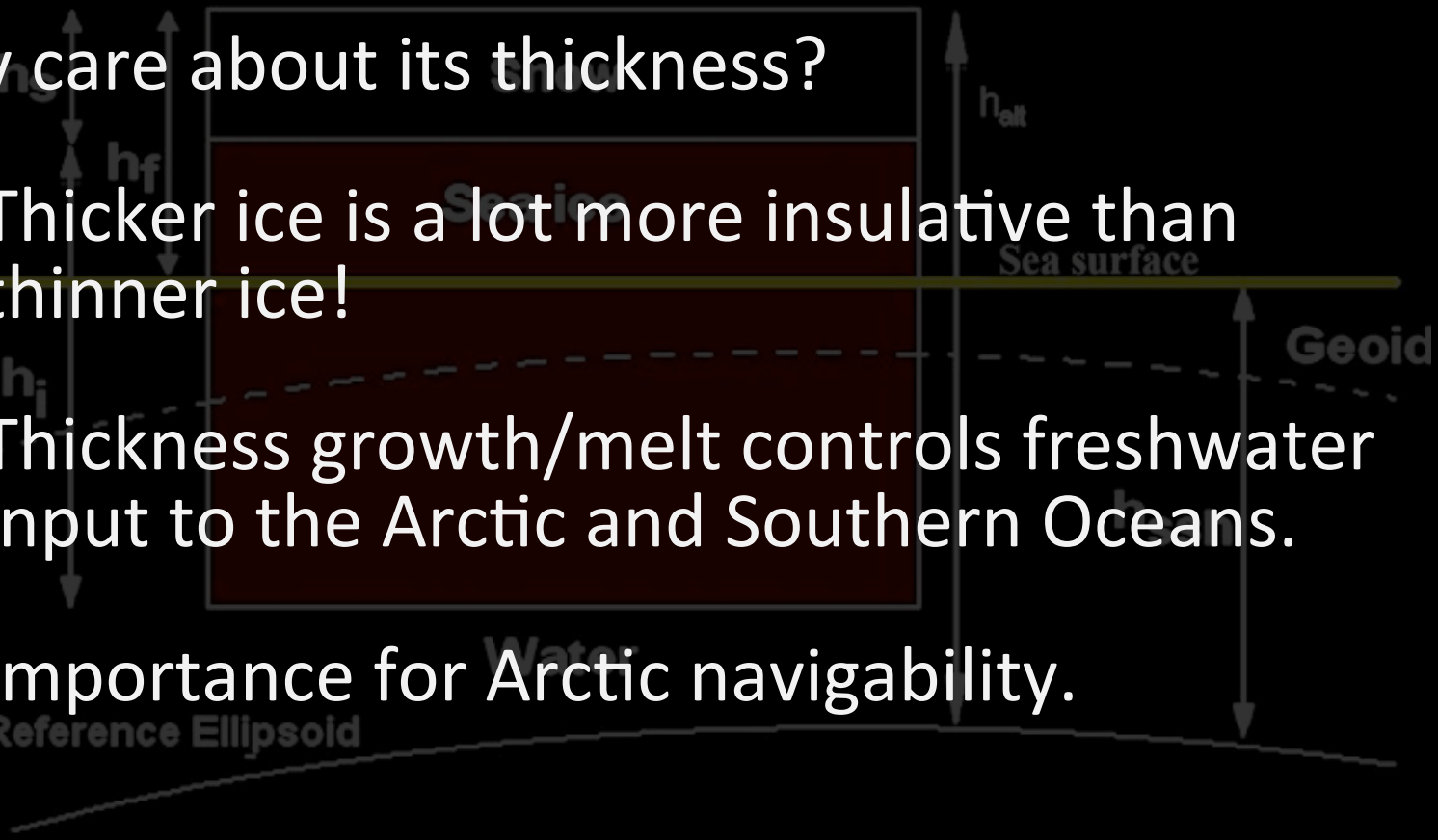
Inferring sea ice thickness remotely



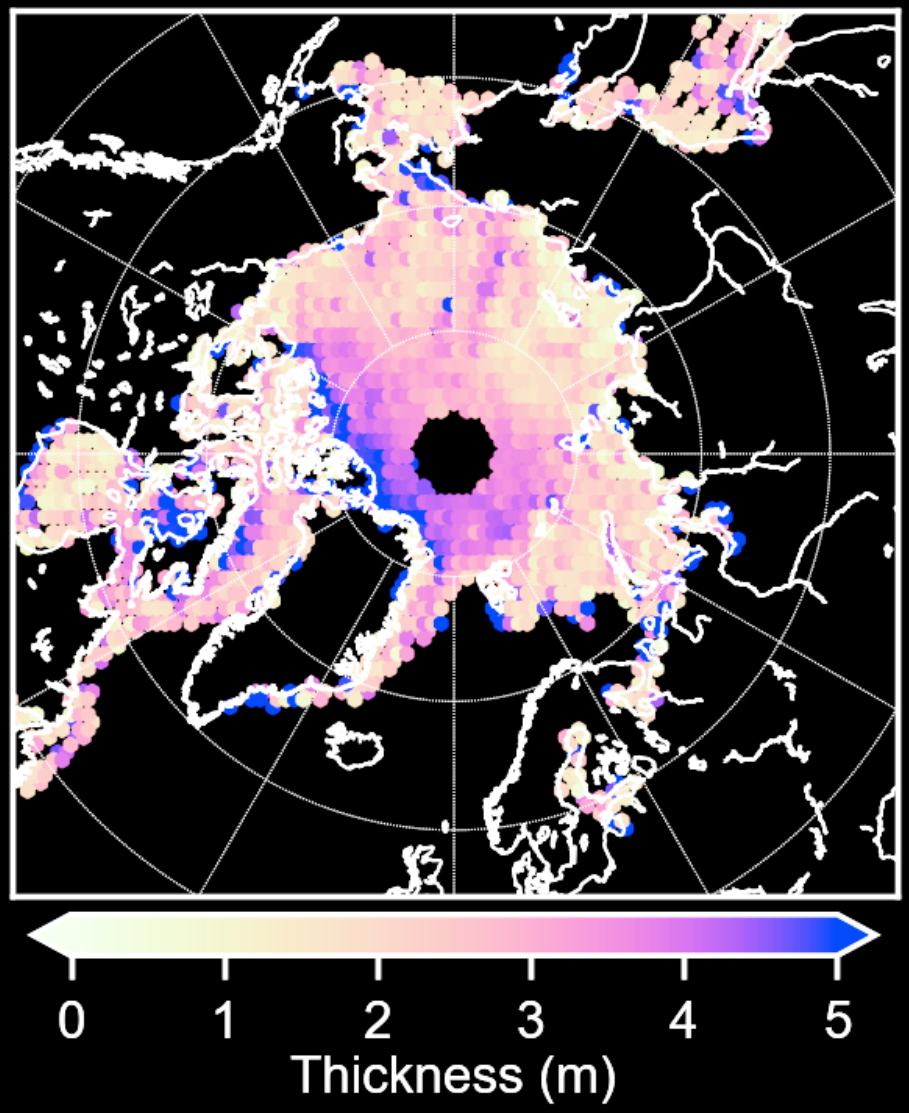
Inferring sea ice thickness remotely

Why care about its thickness?

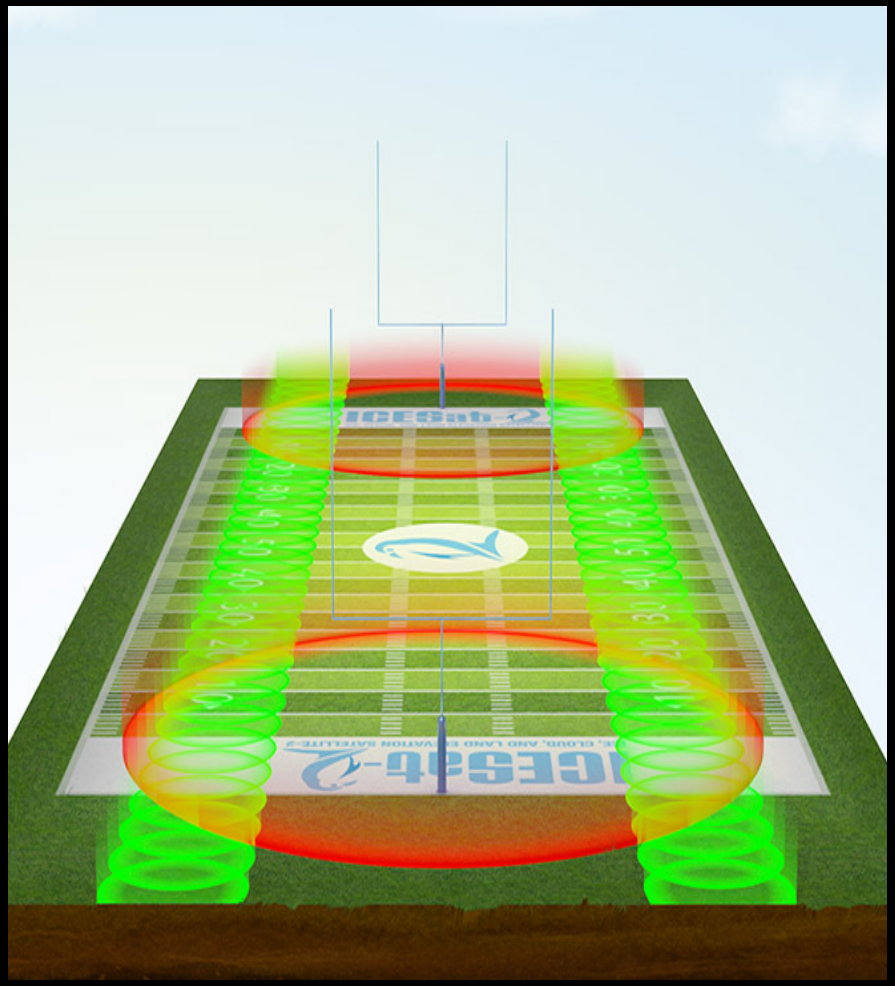
- Thicker ice is a lot more insulative than thinner ice!
- Thickness growth/melt controls freshwater input to the Arctic and Southern Oceans.
- Importance for Arctic navigability.



e.g. ICESat-1 thickness (spring 2003)



NASA's ICESat-2 mission!



- Laser altimeter, photon counting.
- Three pairs of beams, footprint of ~15 m.

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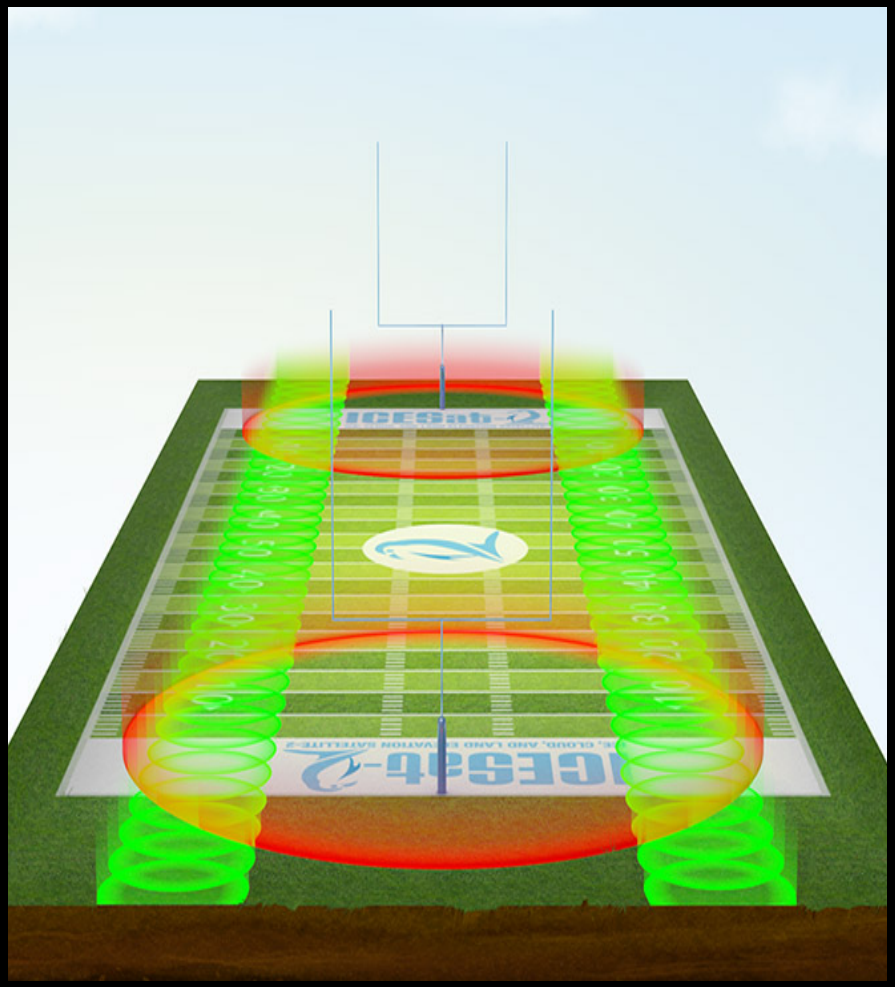

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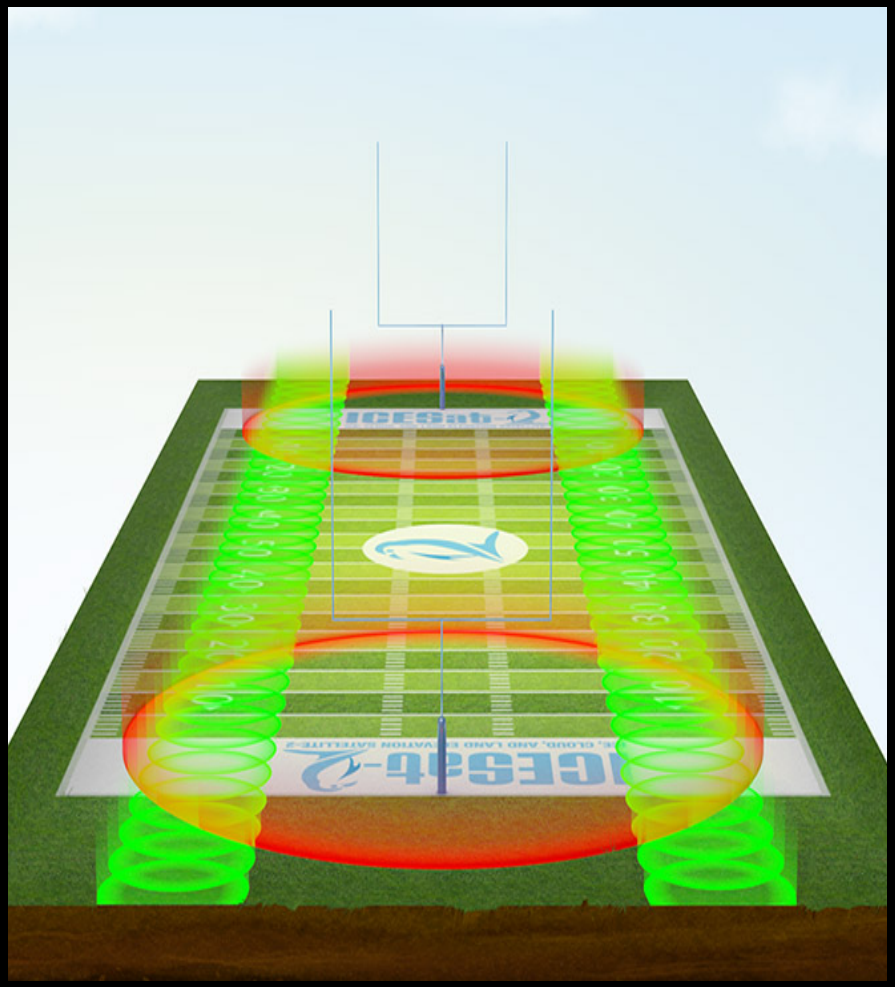

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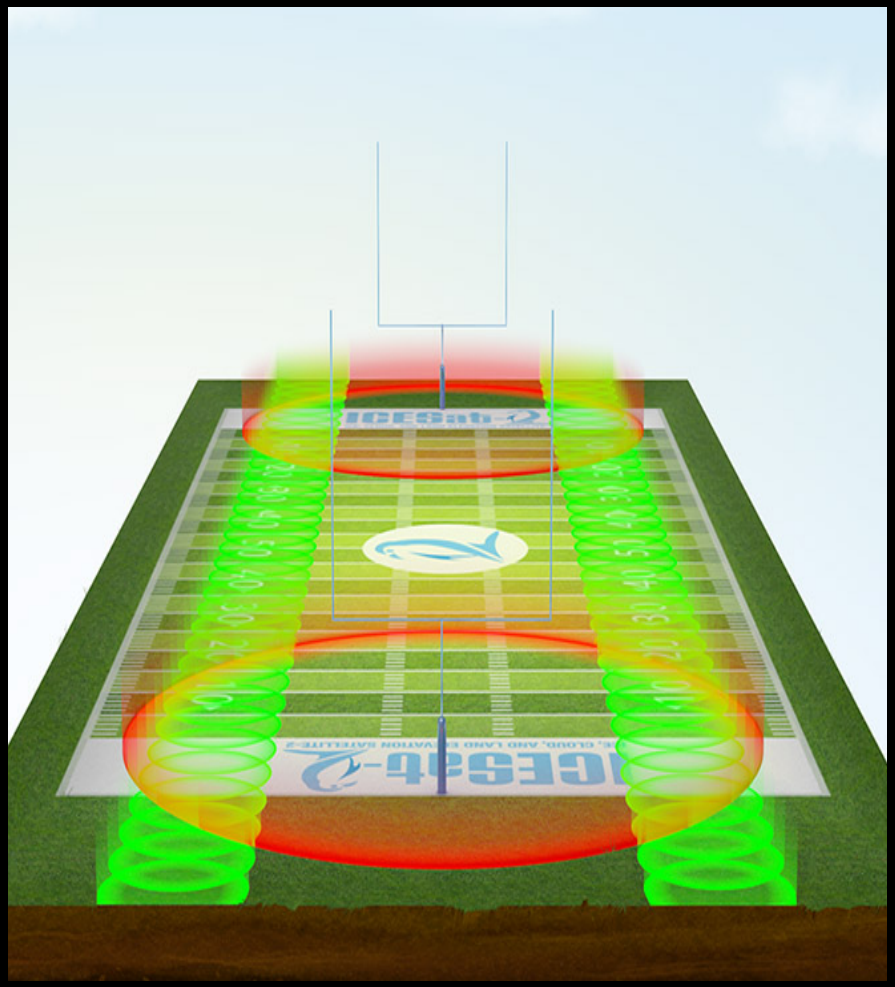

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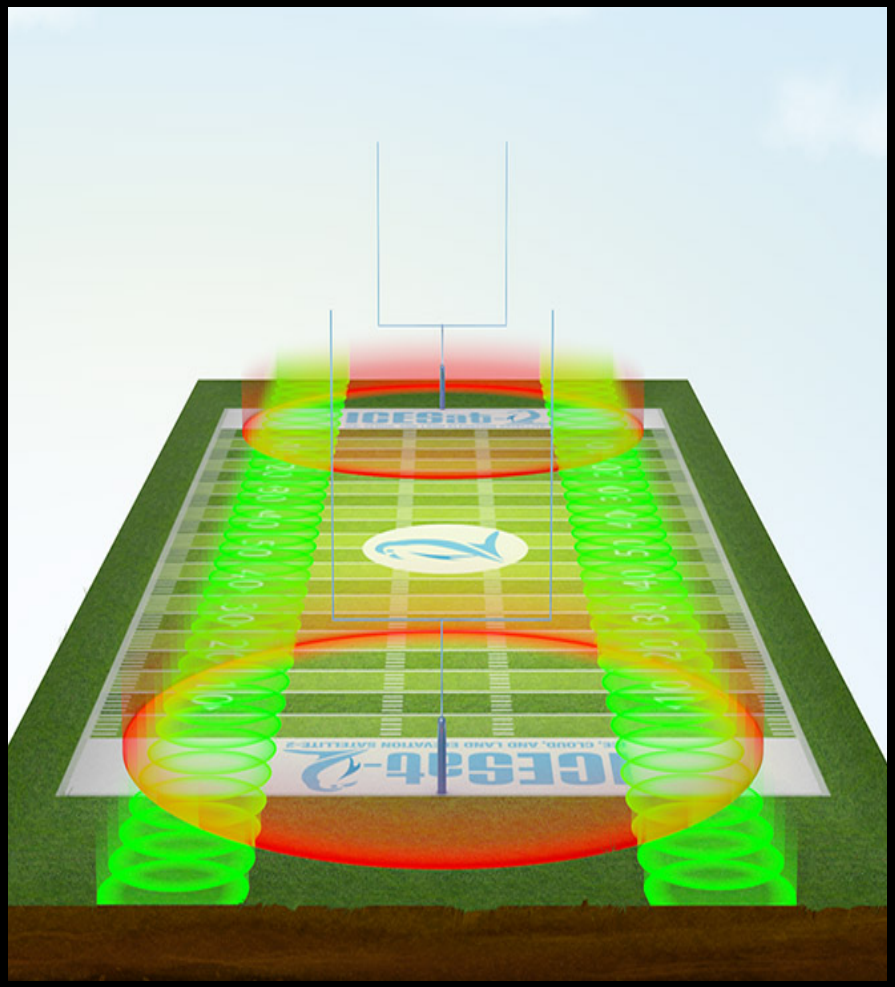

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- Three pairs of beams, footprint of ~15 m.
- Official products will be made available after launch: e.g. elevation and freeboard.
- Semi-official sea ice thickness product.
- Need ancillary data, e.g. snow depth and density.
- How else can we use the data for sea ice research?

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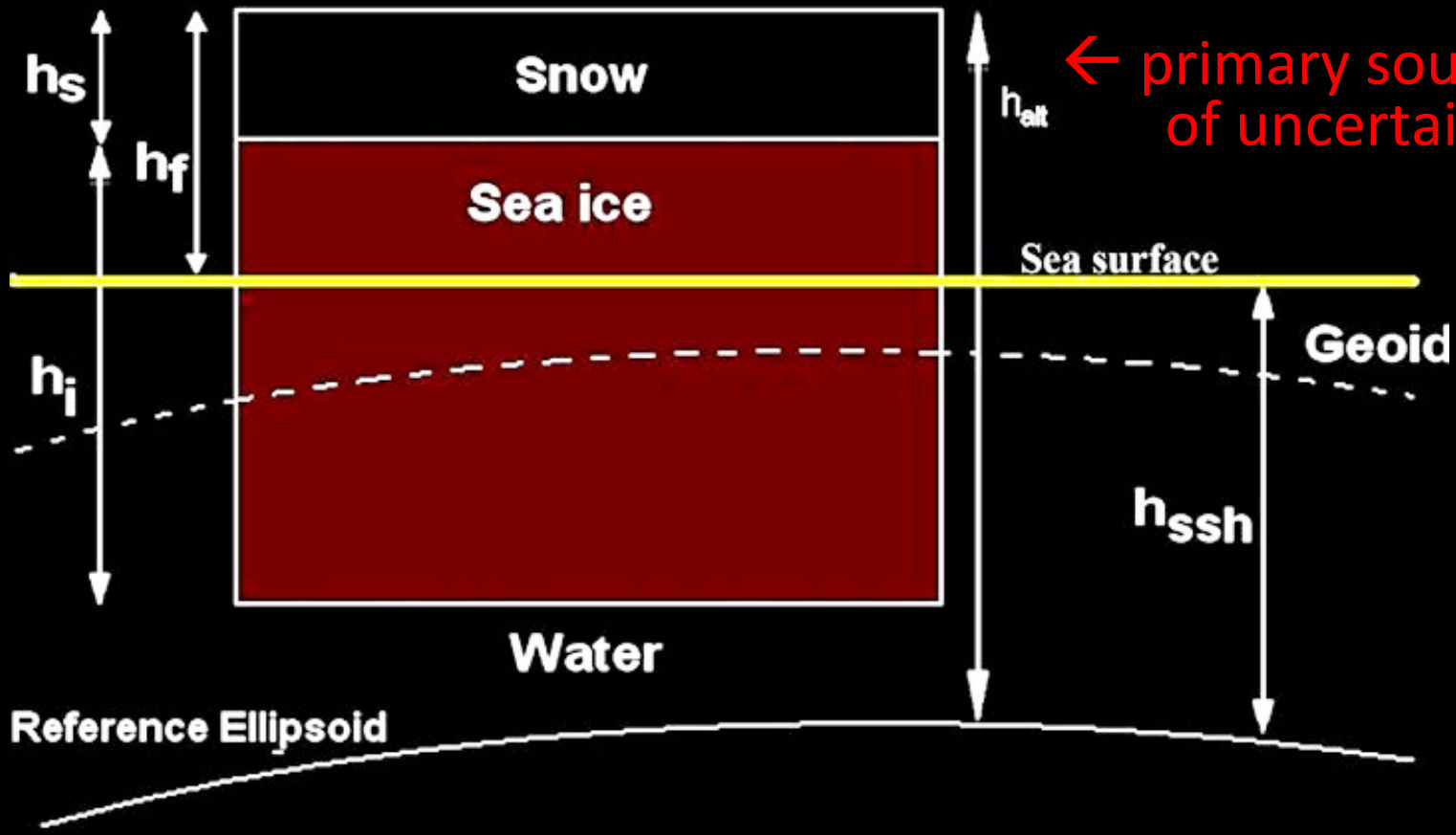
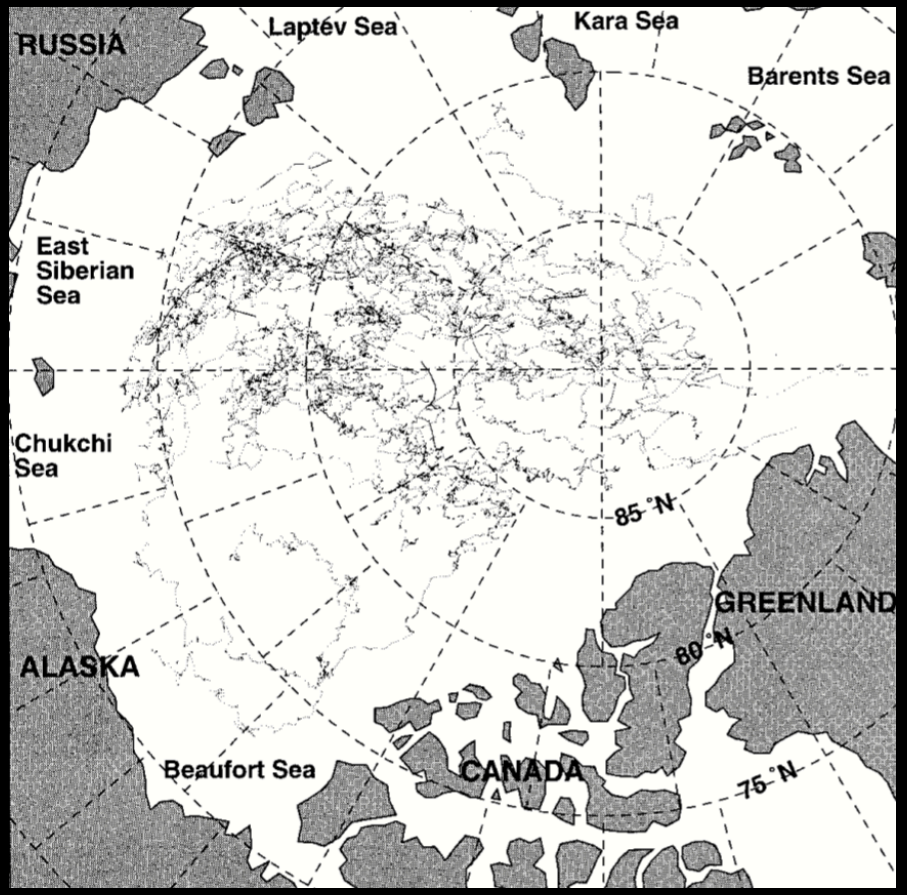


← primary source of uncertainty

Soviet Station Arctic snow climatology



Soviet Station Arctic snow climatology

However, the Arctic climate has changed rapidly.

This does not apply in the Southern Ocean.

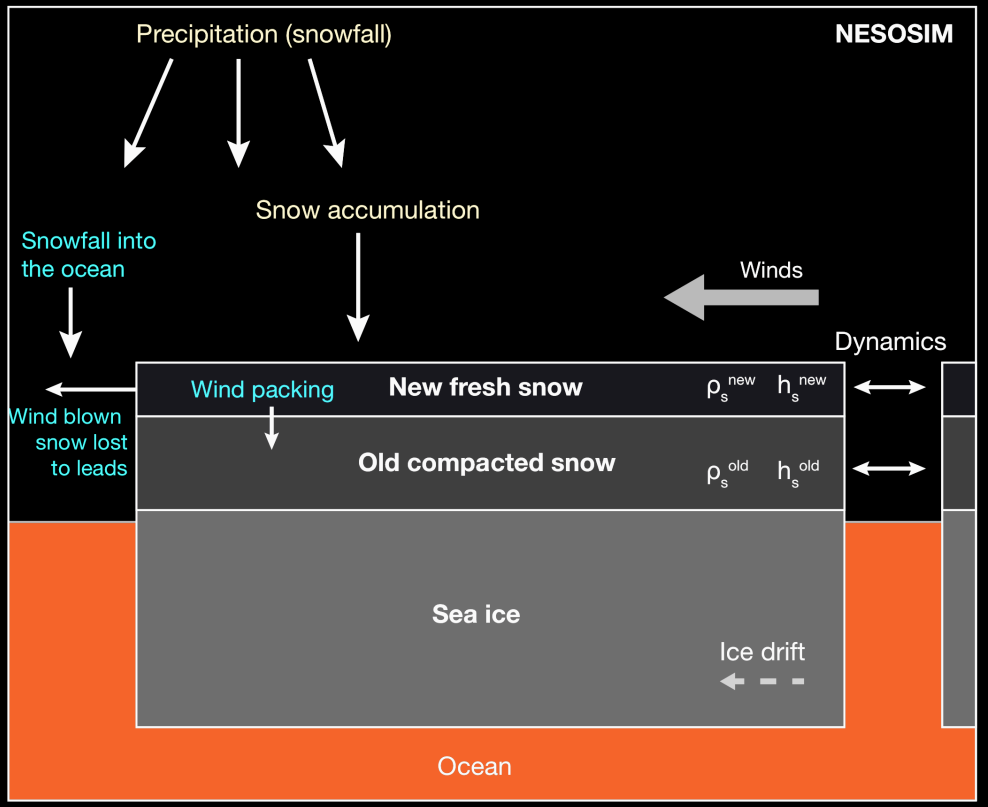
We need updated snow depths!

The NASA Eulerian Snow on Sea Ice Model (NESOSIM v1.0)

Included processes

- Snow accumulation
- Wind packing
- Ice/snow dynamics
- Blowing snow lost to leads

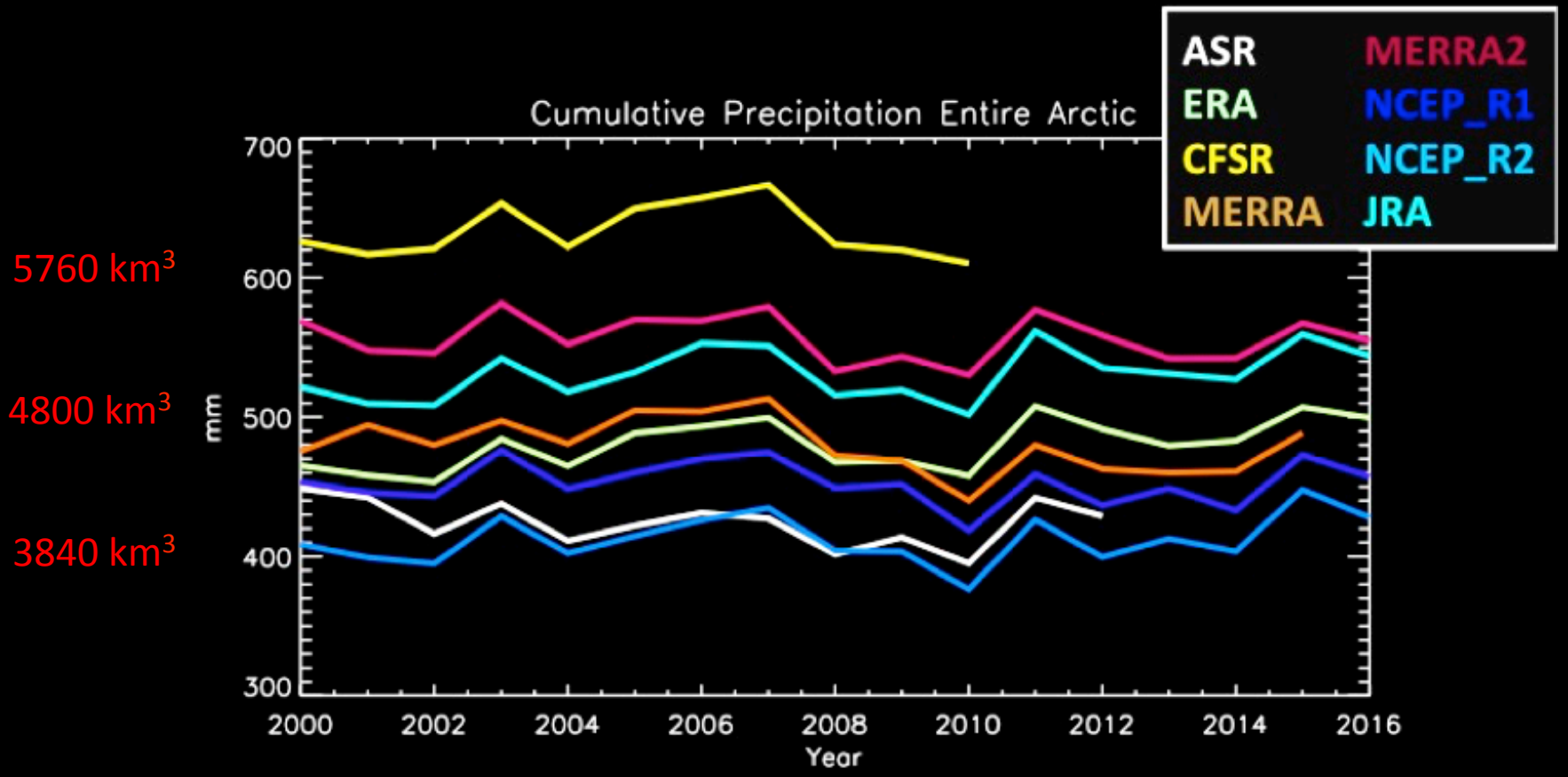
Prognostic snow depth & density



NESOSIM model code & data: github.com/akpetty/NESOSIM

From Petty et al., [2018 , *in review*]

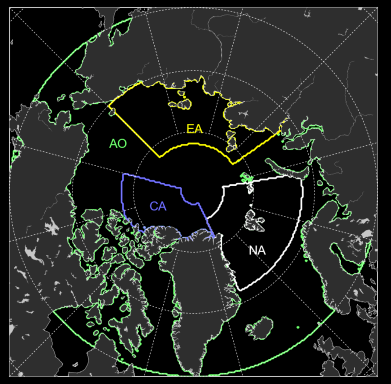
Annual Arctic precip estimates from reanalyses show high spread

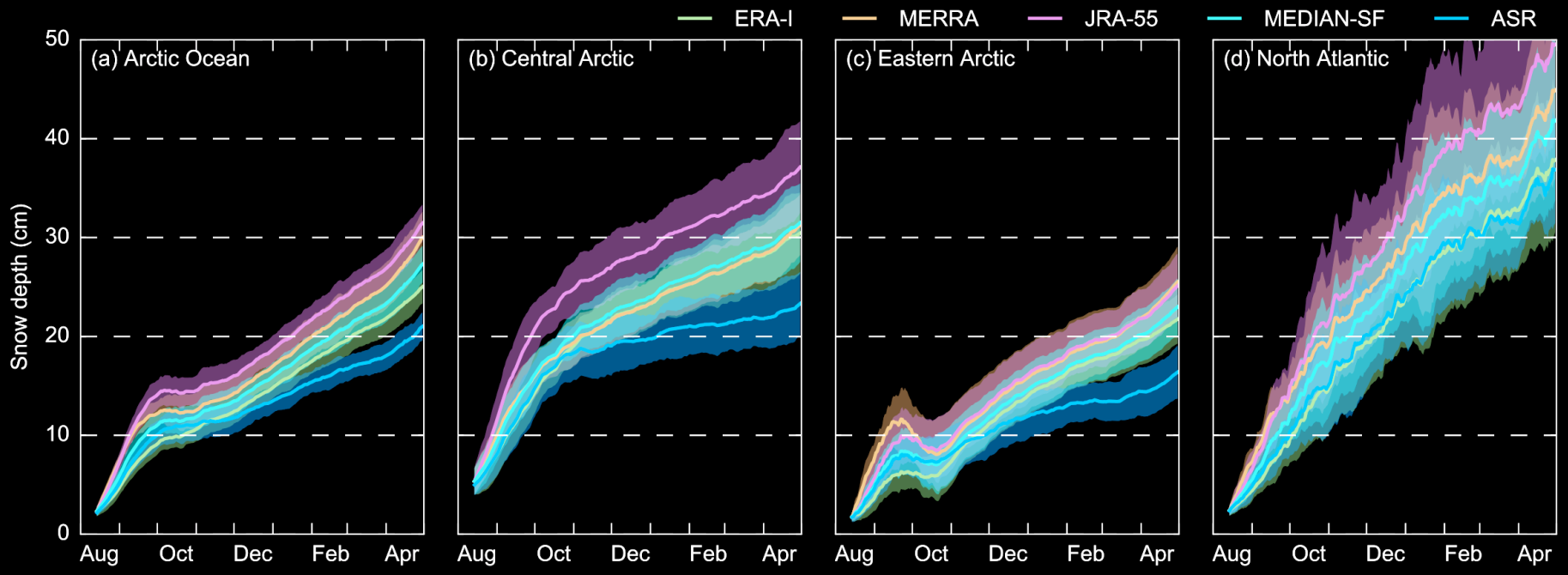


From Boisvert et al., [2018 , *J Climate*]

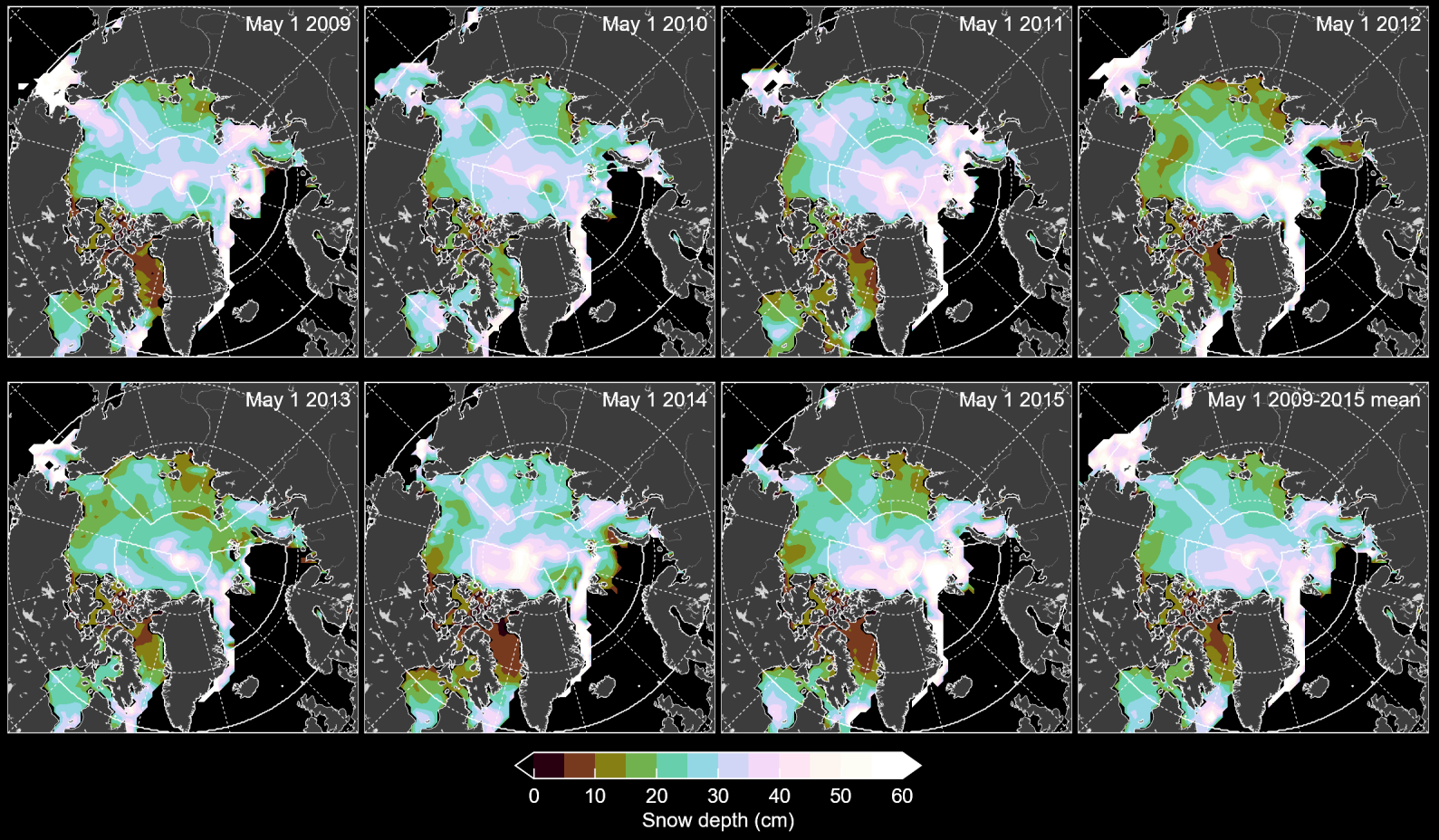
NESOSIM forced by different reanalyses

2000-2015 season cycle





May 1st results (2009-2015)



Forced by MEDIAN snowfall, ERA-I winds, Bootstrap SIC, NSIDCv3 ice drift.

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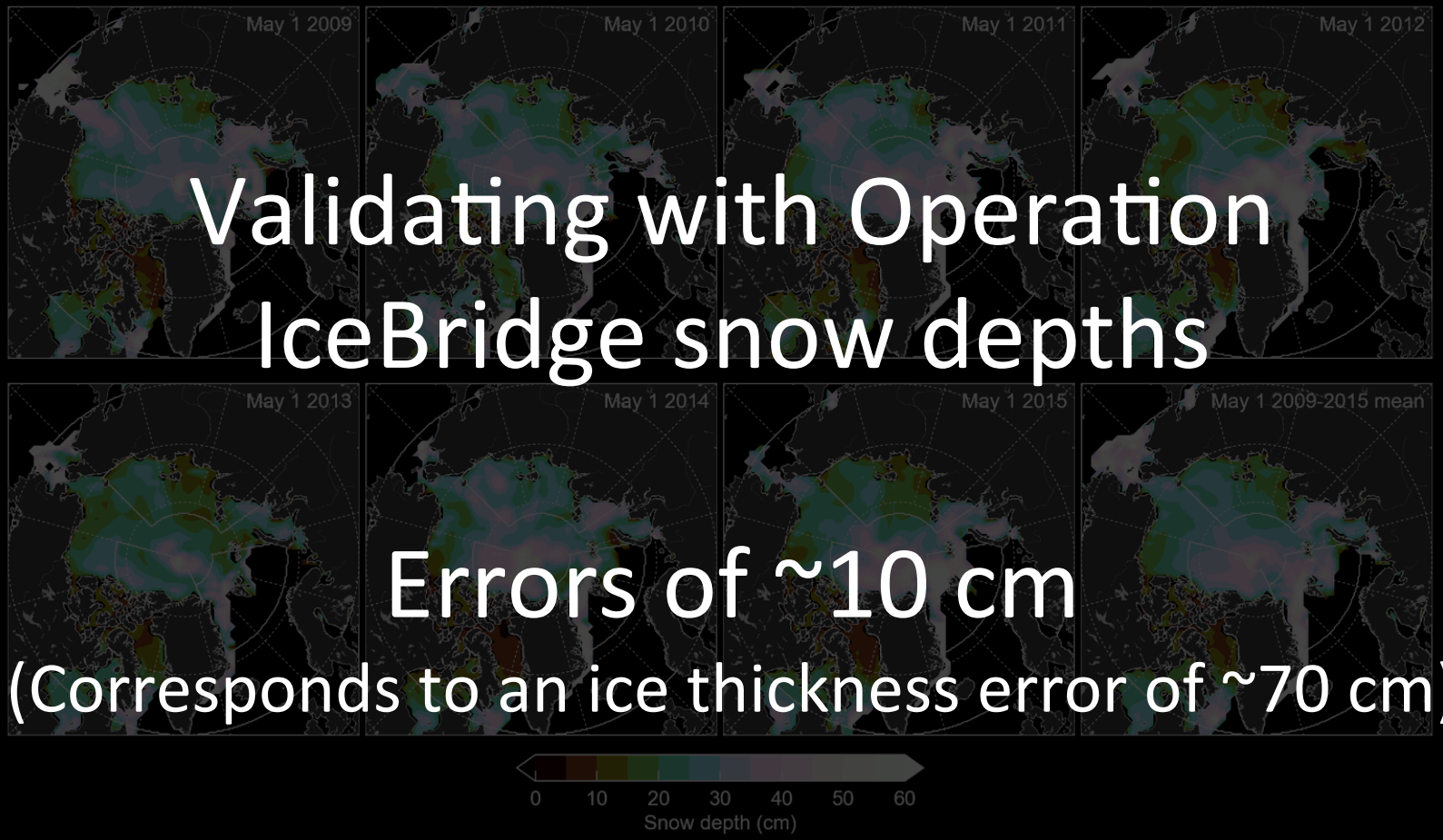


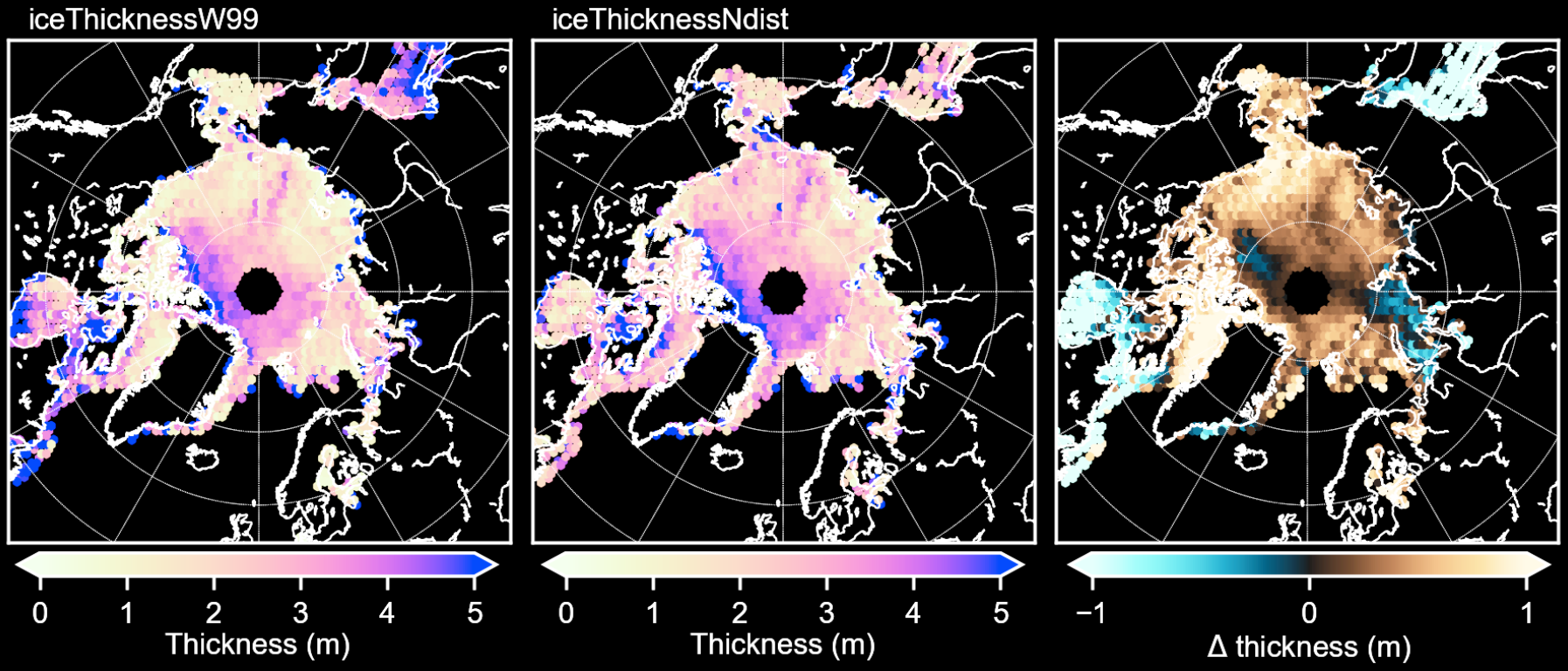
Validating with Operation IceBridge snow depths

Errors of ~10 cm

(Corresponds to an ice thickness error of ~70 cm)

Forced by MEDIAN snowfall, ERA-I winds, Bootstrap SIC, NSIDCv3 ice drift.

Improving original ICESat thickness estimates



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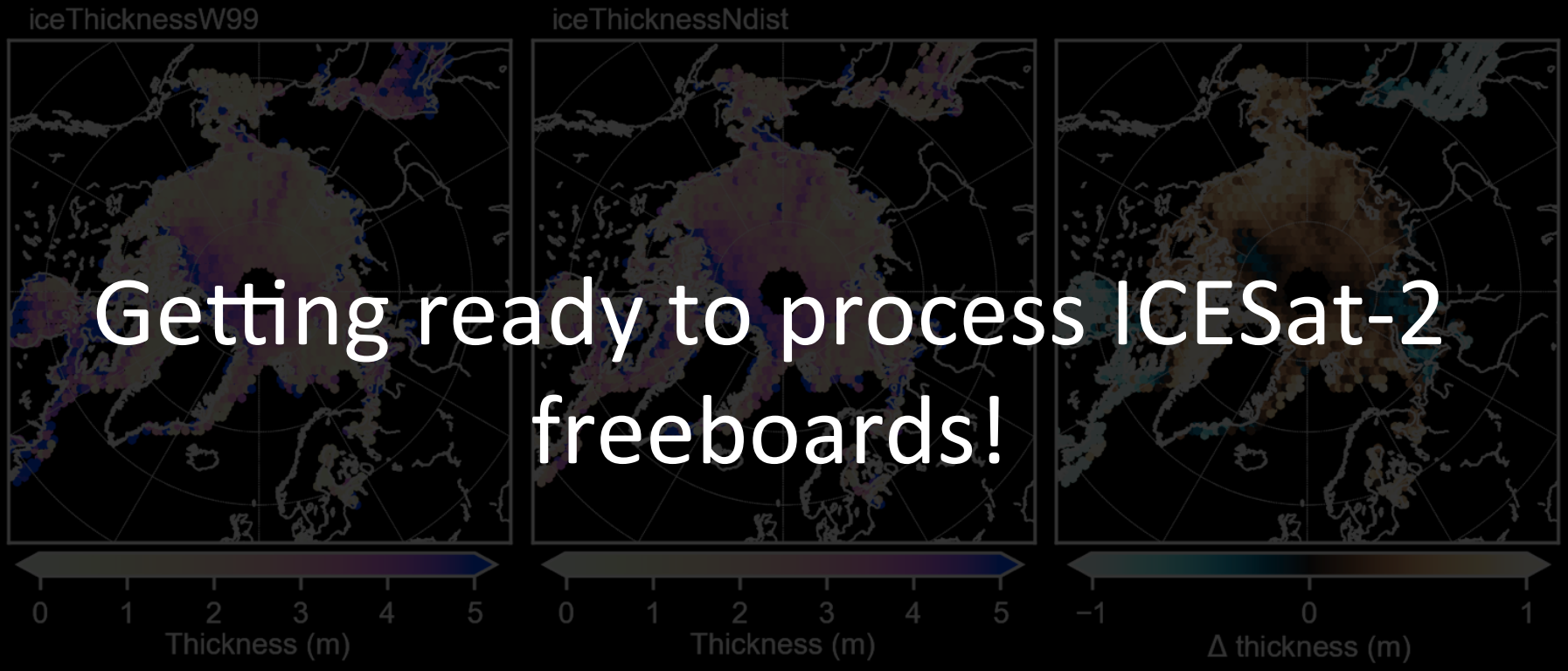
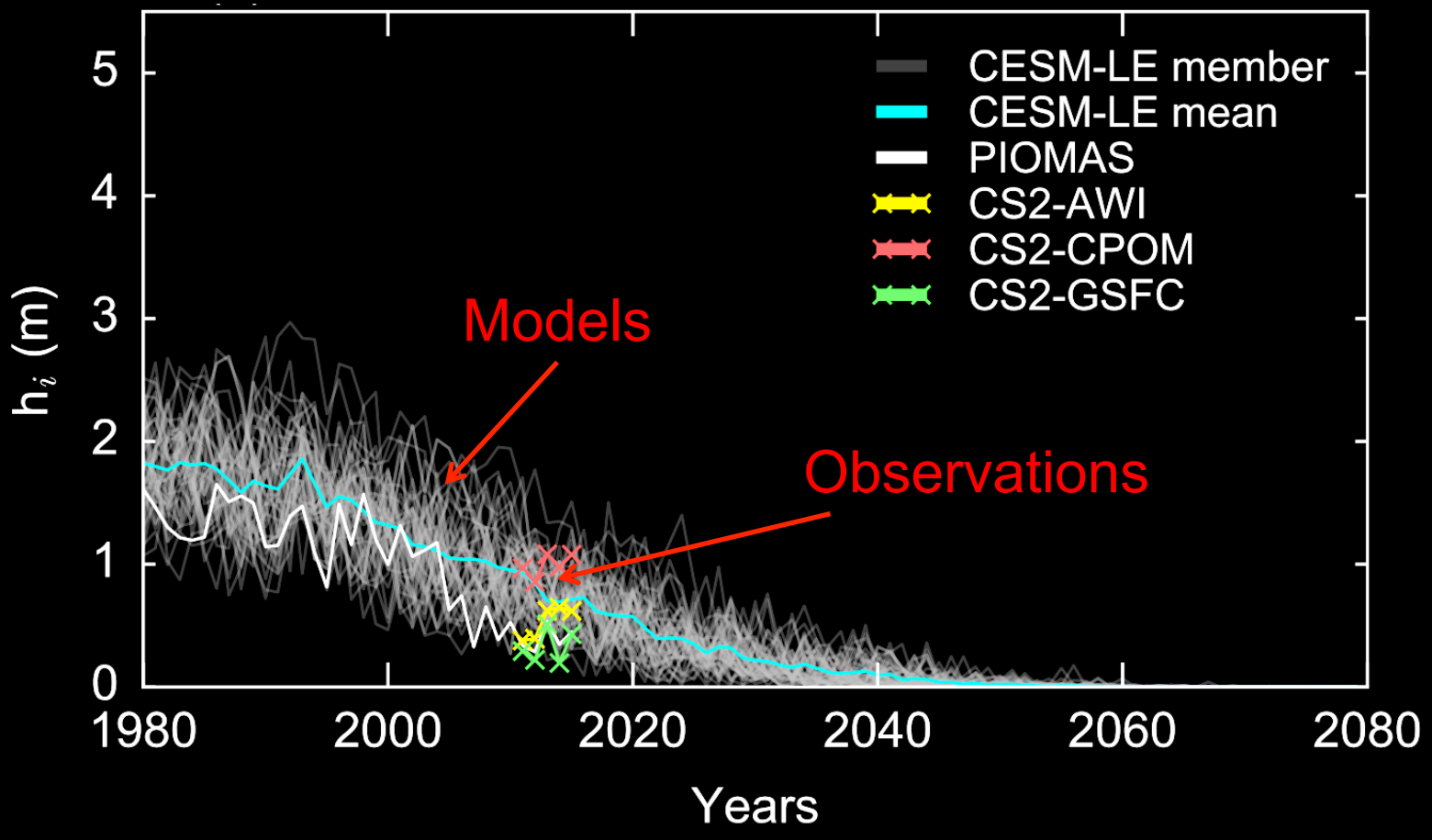


Getting ready to process ICESat-2 freeboards!

Working with climate modelling groups to provide longer term context



To summarize:

ICESat-2 will provide new insights into the Arctic and Antarctic sea ice thickness distribution.

We're ready for launch and excited to find out what those photons look like.

Questions?

Alek Petty **Code 615 (Cryospheric Sciences Lab)**

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