# A New Snow on Sea Ice Budget Model and Snow Depth Dataset over the Polar Oceans

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*Petty, A. A., M. Webster, L. N. Boisvert, T. Markus (2018), The NASA Eulerian Snow on Sea Ice Model (NESOSIM): Initial model development and analysis, Geosci. Model Dev. Discuss., doi: 10.5194/gmd-2018-84, in review.*

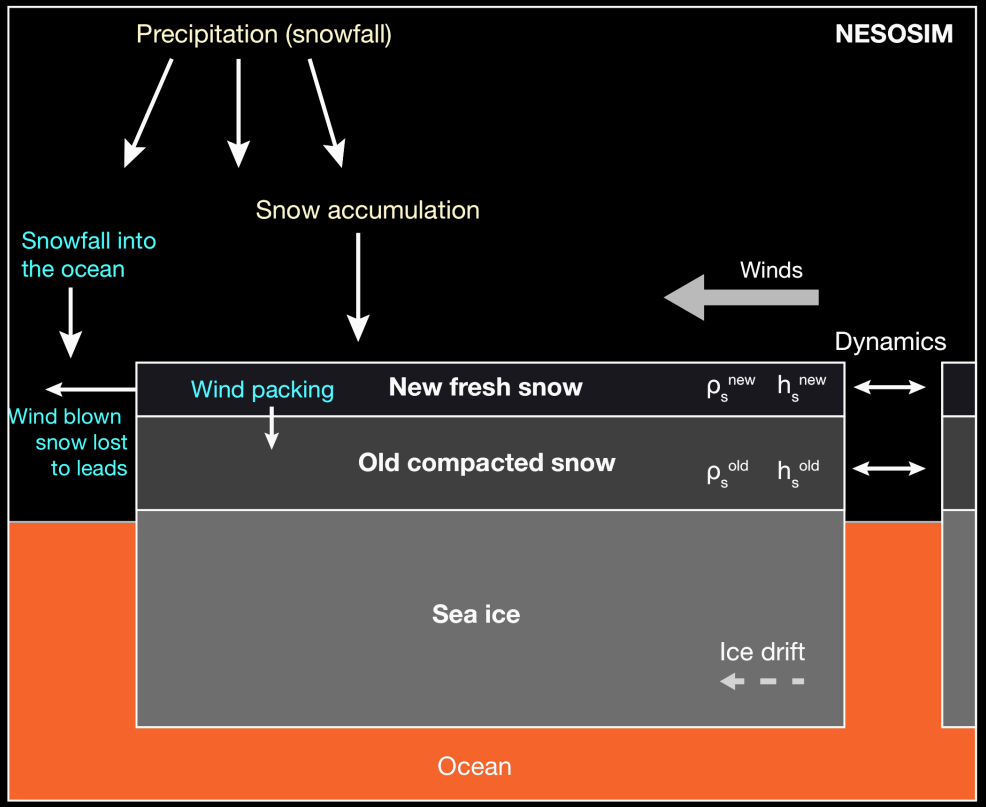
github.com/akpetty/NESOSIM

# Motivation & Philosophy

- Need daily basin-scale snow depth estimates for satellite altimetry (mainly ICESat-2) sea ice thickness.
- Build on earlier work (e.g. Kwok and others) of accumulation-derived snow depths from reanalyses.
- Assume forcing uncertainty is large, increment model sophistication as needed.

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

- Two layer Eulerian model.
- 100 km grid (adaptable).
- Arctic Ocean domain (adaptable).
- Quick to run (~3 minutes for a 30 year run).
- Snowfall/ice conc/ice drift/ winds as forcings.
- Daily (August to May) gridded data output.
- Open source Python code.

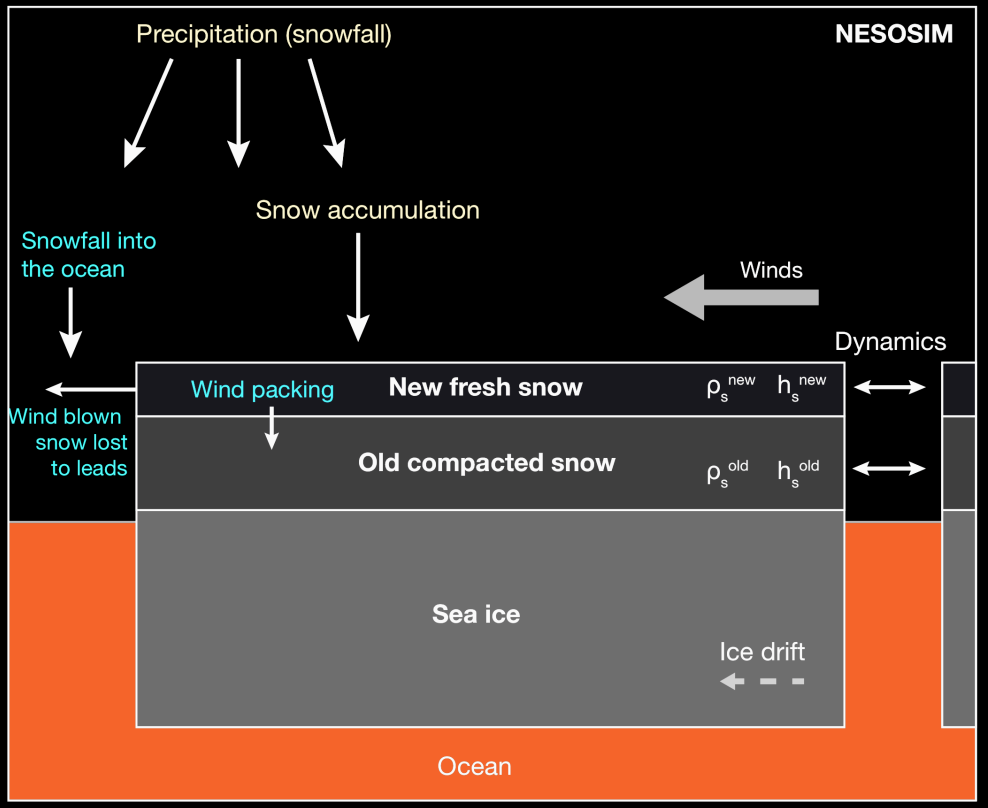


# The NASA Eulerian Snow on Sea Ice Model (NESOSIM v1.0)

Included processes

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

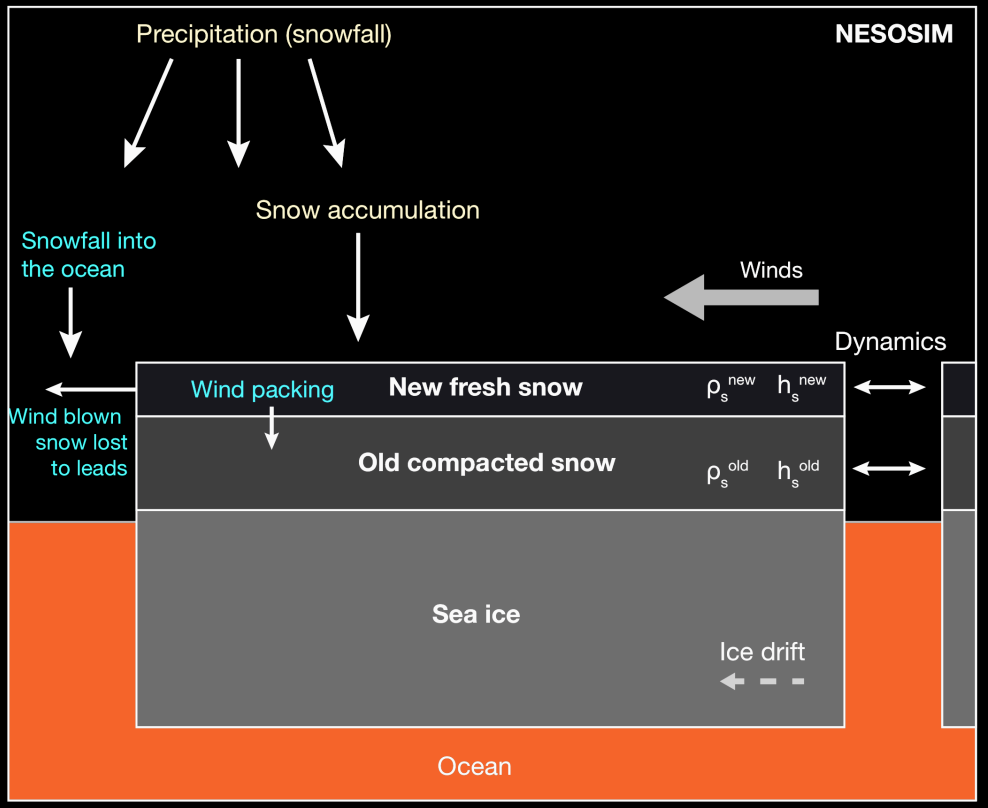
Prognostic snow depth & density



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

NOT Included processes (yet..)

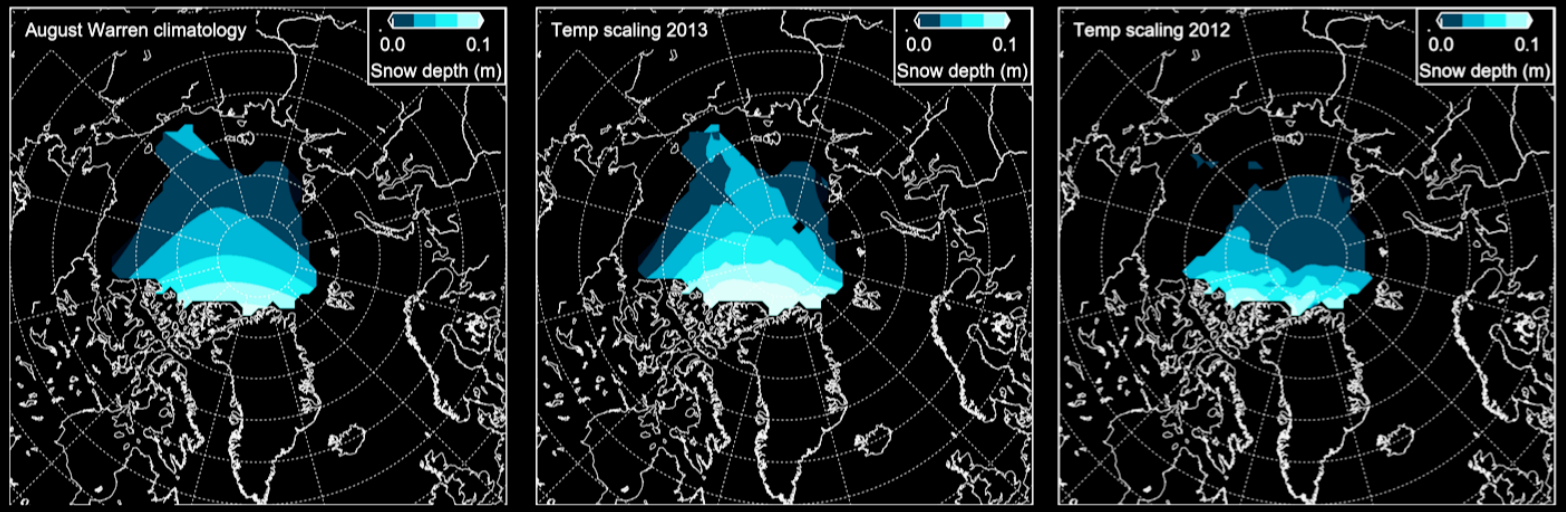
- Snow melt (extending the model through the melt season)
- Blowing snow to adjacent grid-cells
- Snow-ice conversion
- ?



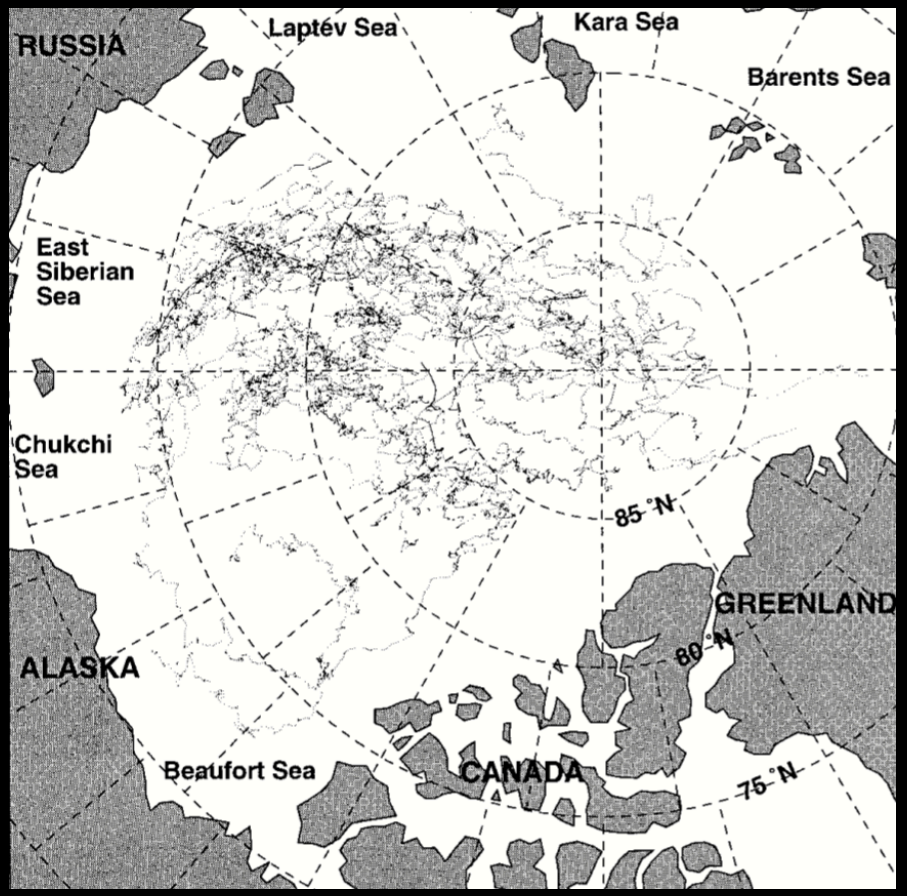
# The NASA Eulerian Snow on Sea Ice Model (NESOSIM v1.0)

## *Initial conditions*

*Temperature scaled August Warren snow depths*



# Calibrations with Soviet Station data



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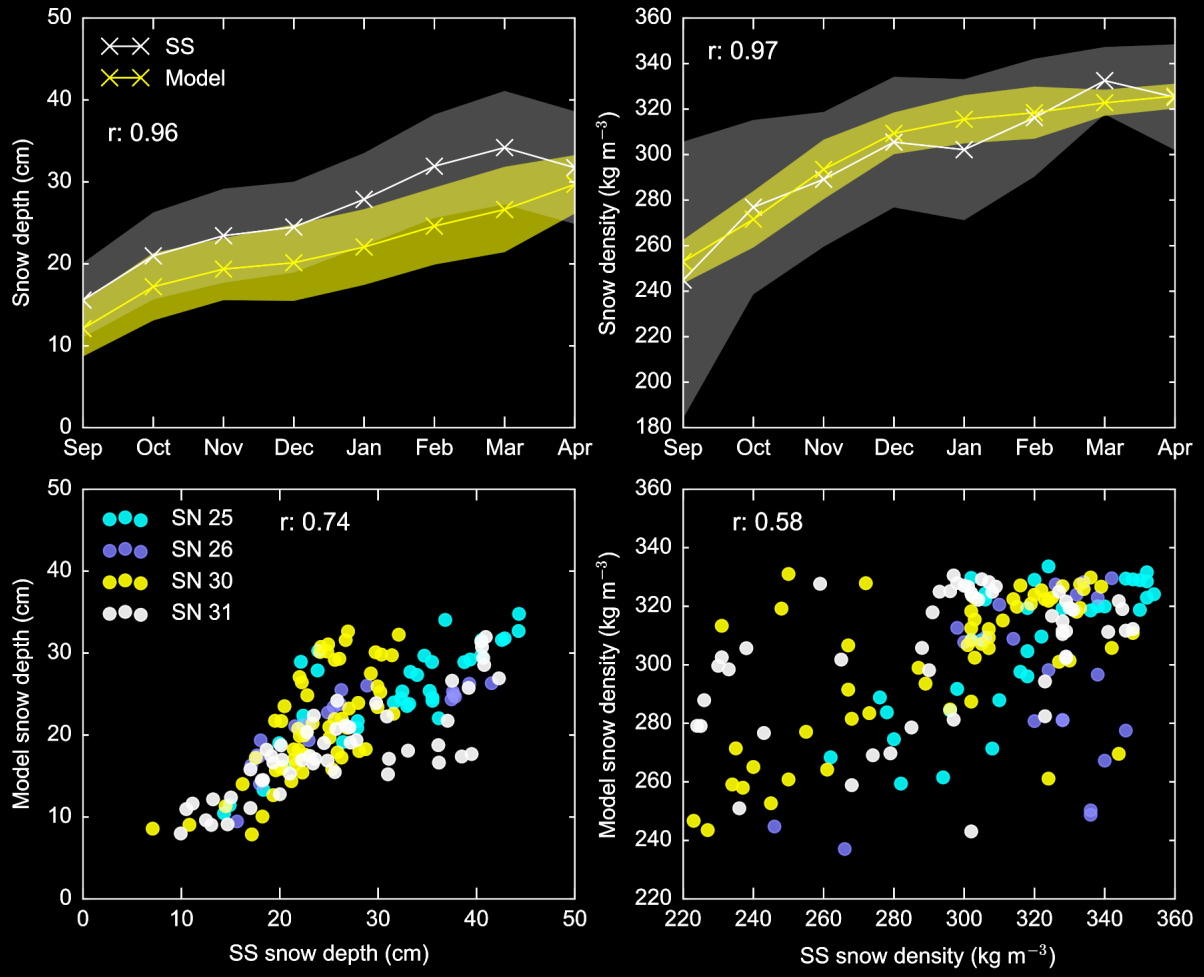
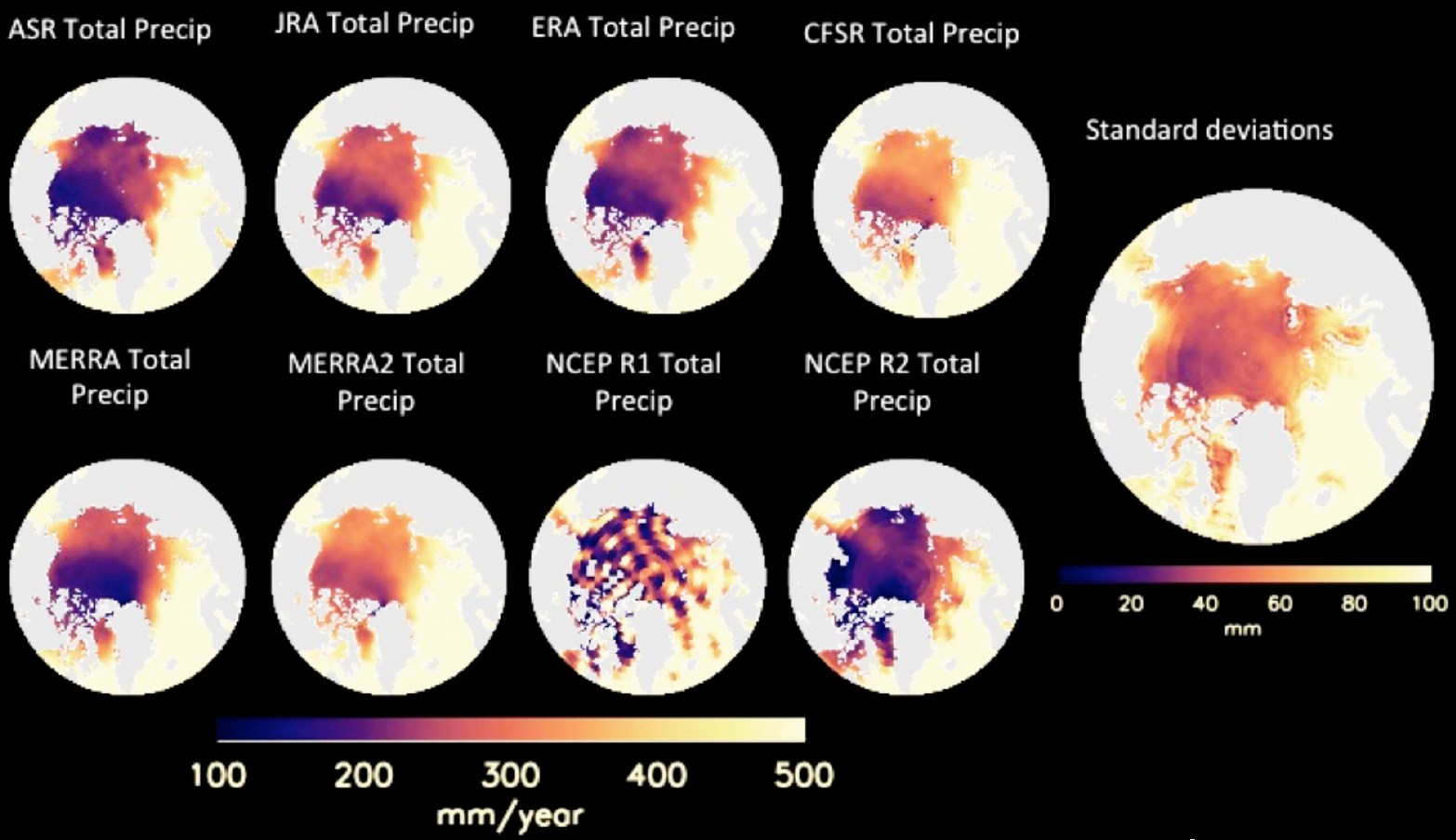


# Total Arctic precip across 8 reanalyses



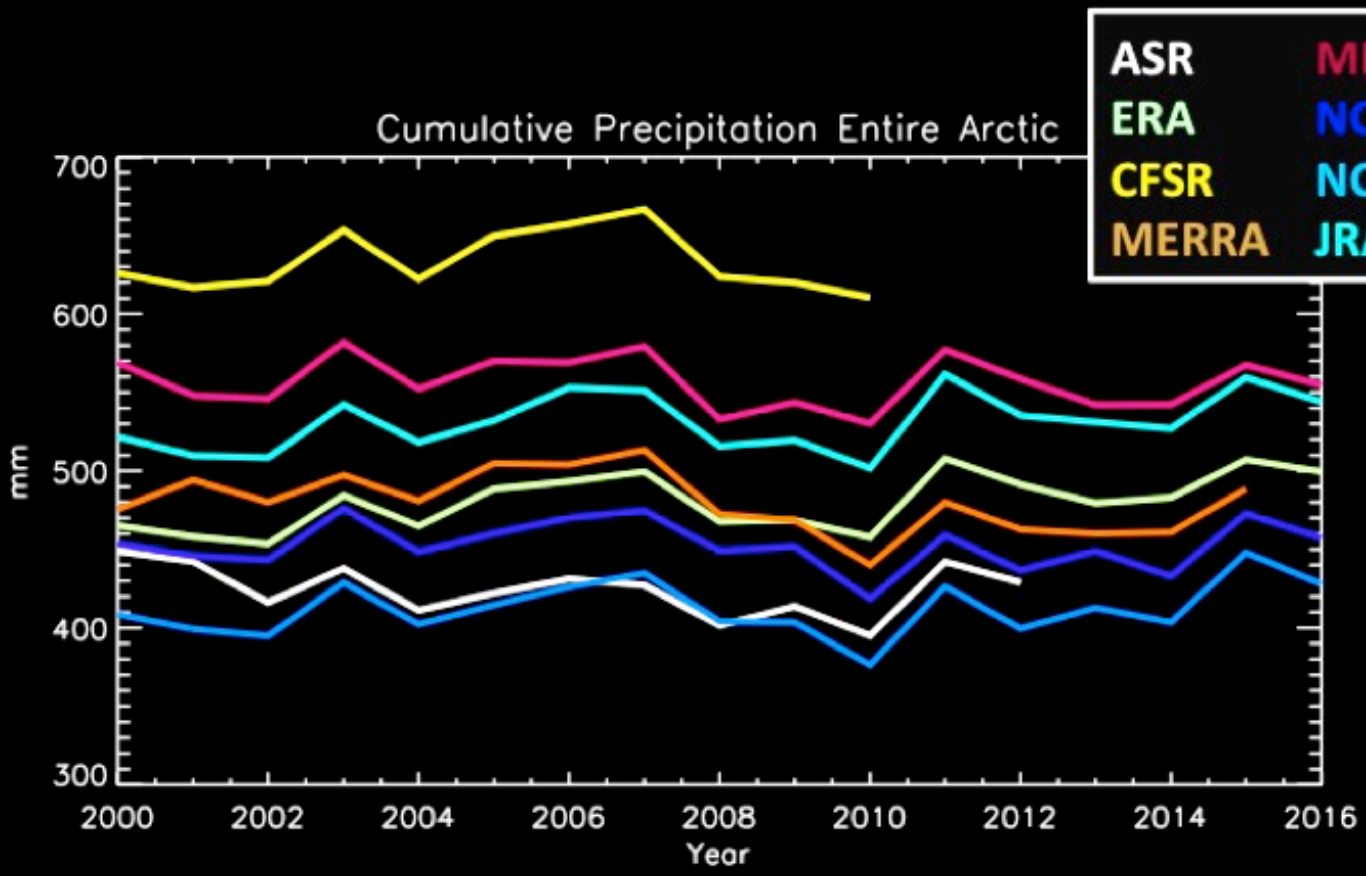

From [Boisvert et al., 2018 , *in review*]

# Annual Arctic precip across 8 reanalyses

5760 km$^3$

4800 km$^3$

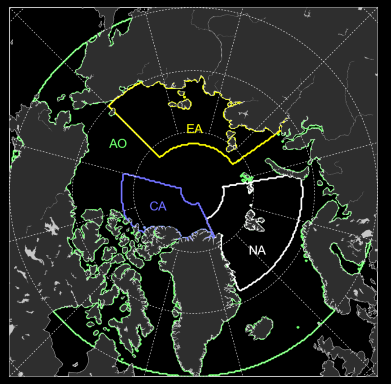
3840 km$^3$

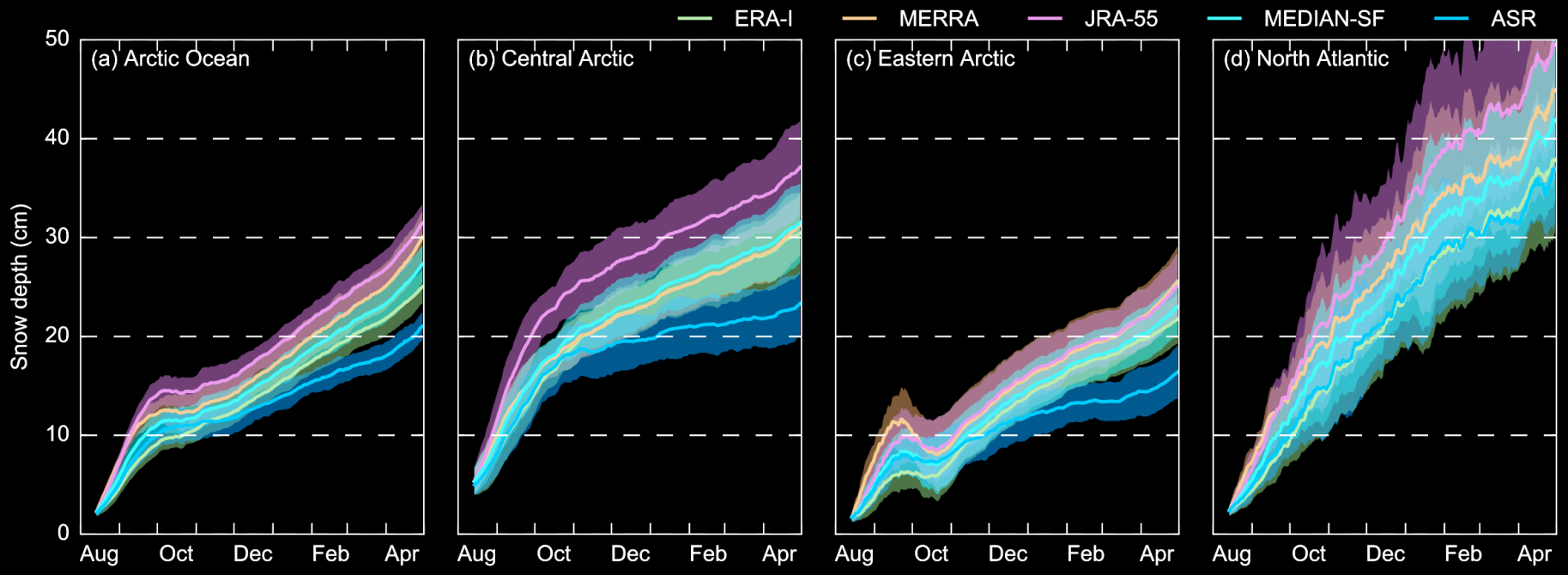



From [Boisvert et al., 2018 , *in review*]

# NESOSIM forced by different reanalyses

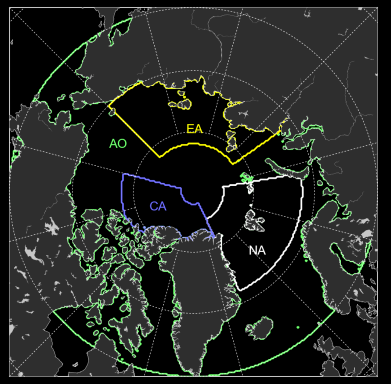
## 2000-2015 season cycle

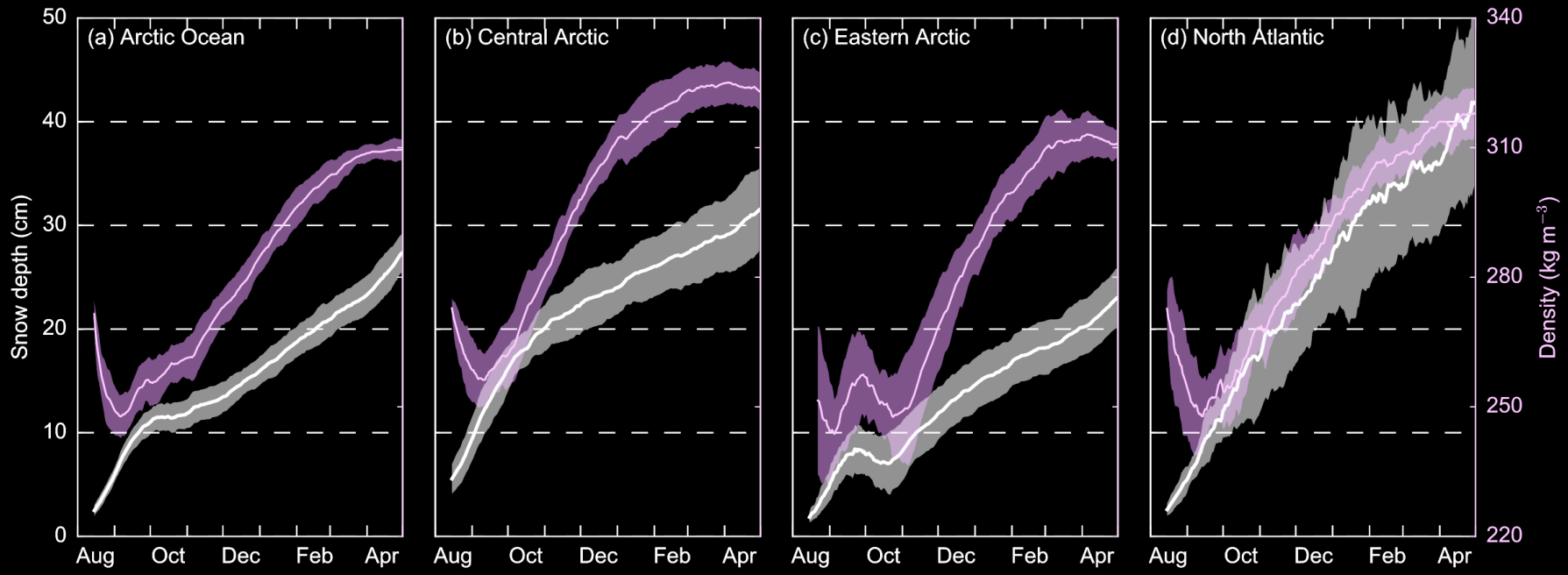


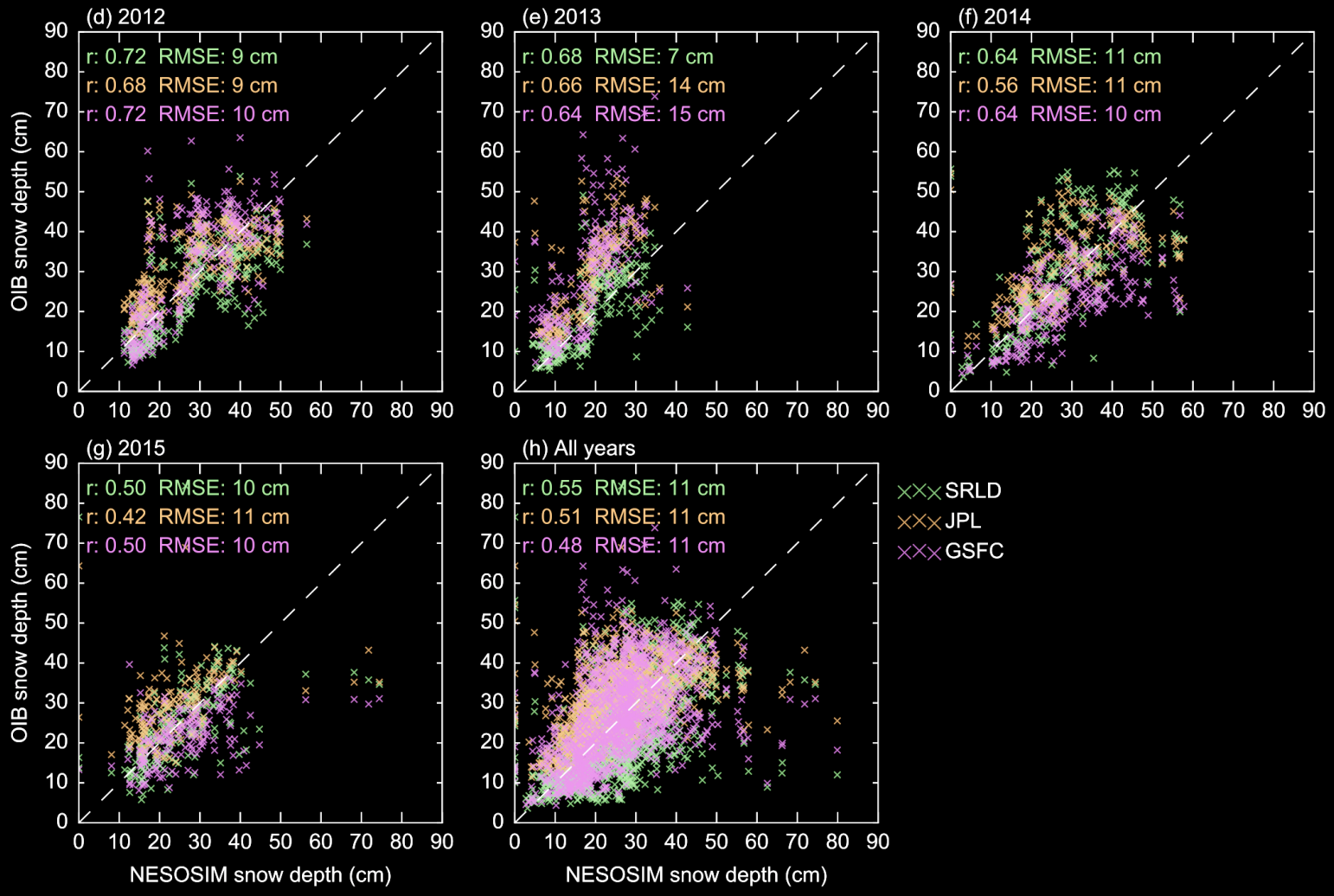
# NESOSIM (Median-sf)

## 2000-2015 depth/density seasonal cycle

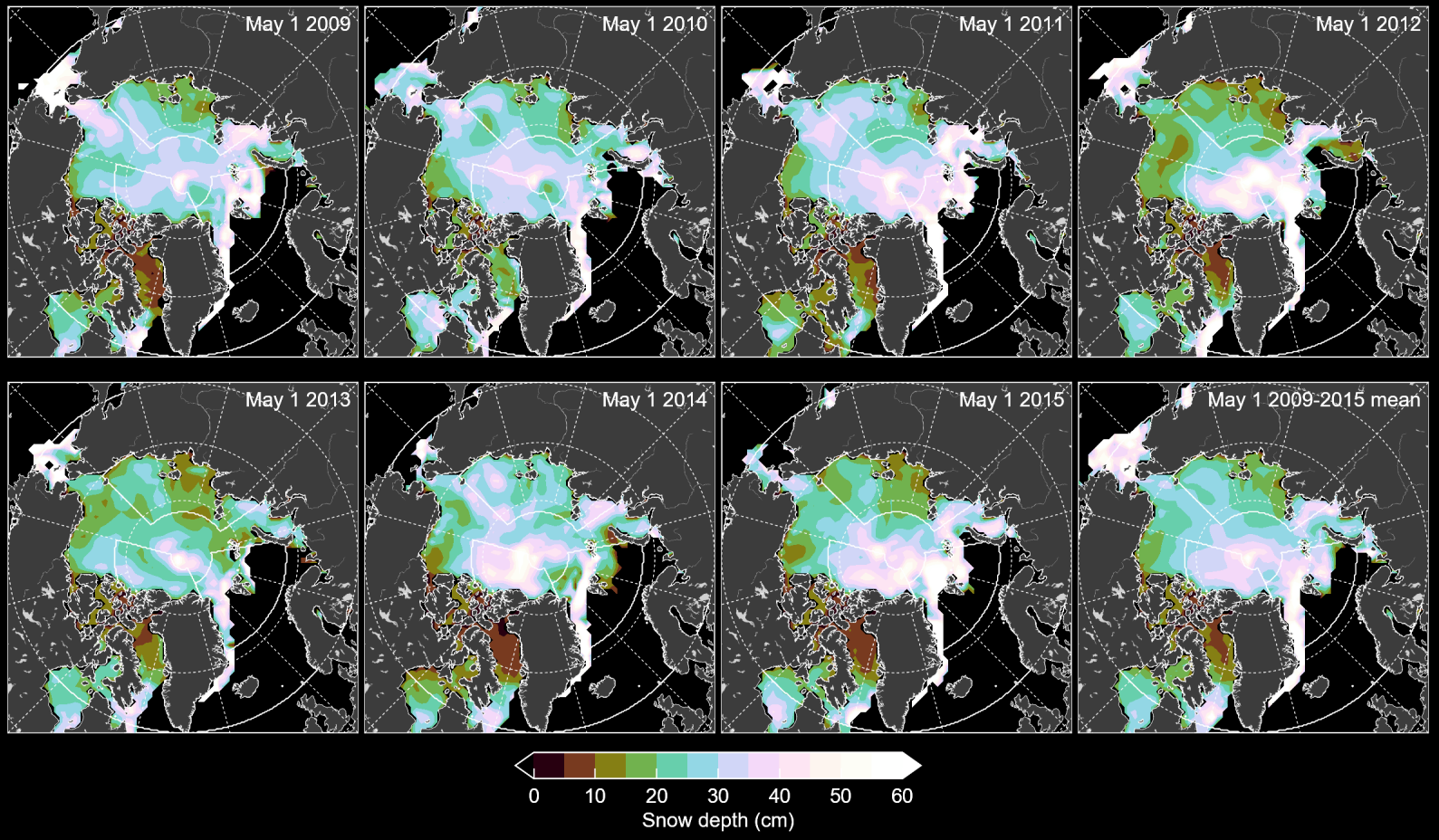


# Validate with NASA's Operation IceBridge



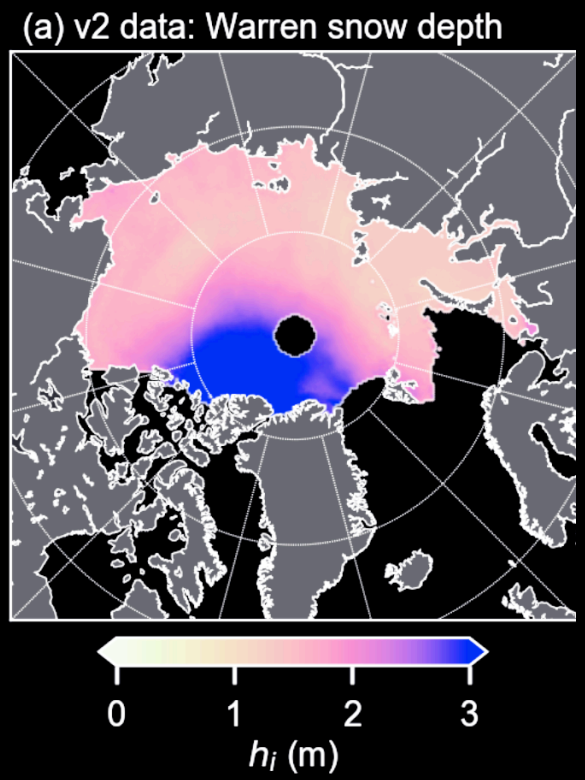
# May 1st results (2009-2015)




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

# What next?

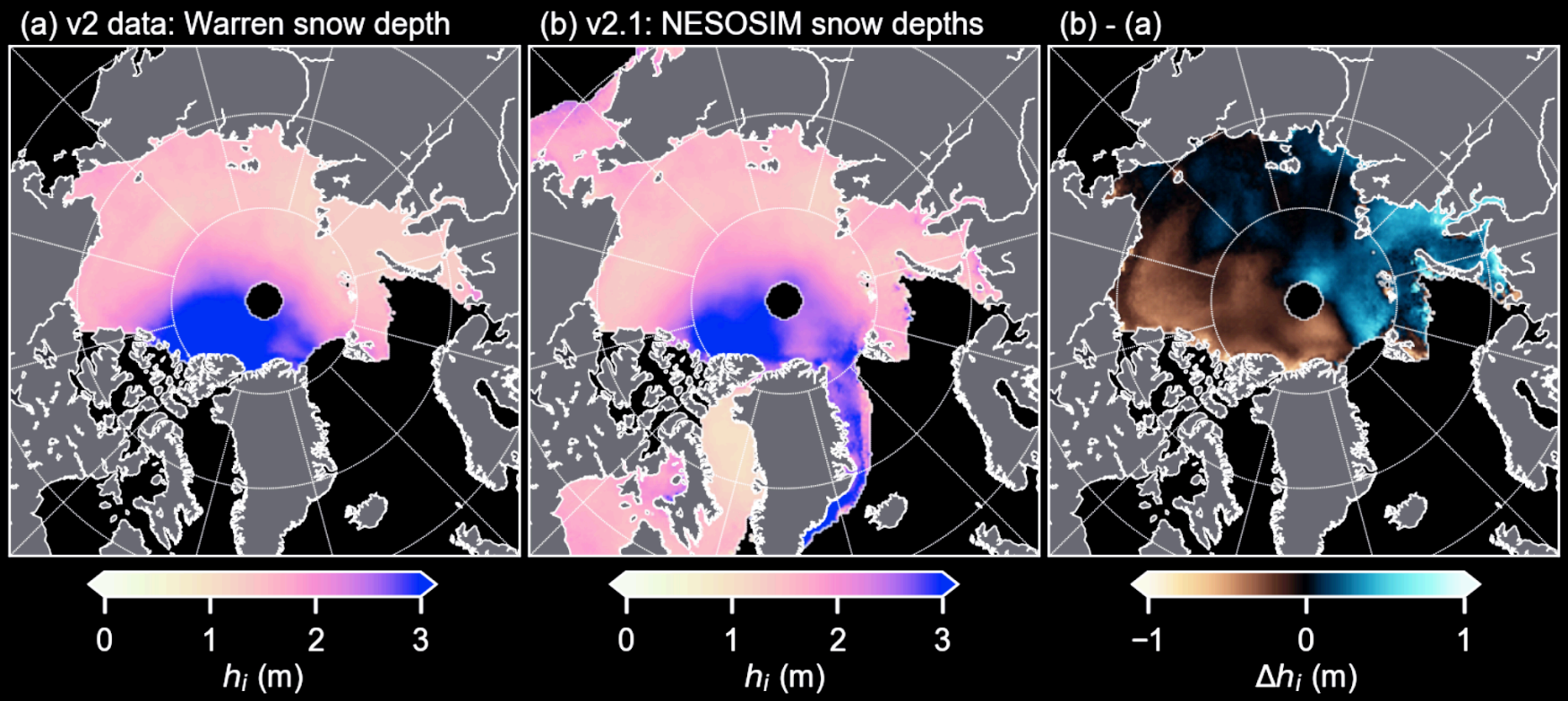
# Improving CryoSat-2 thickness estimates




Winter mean (2010-2016)

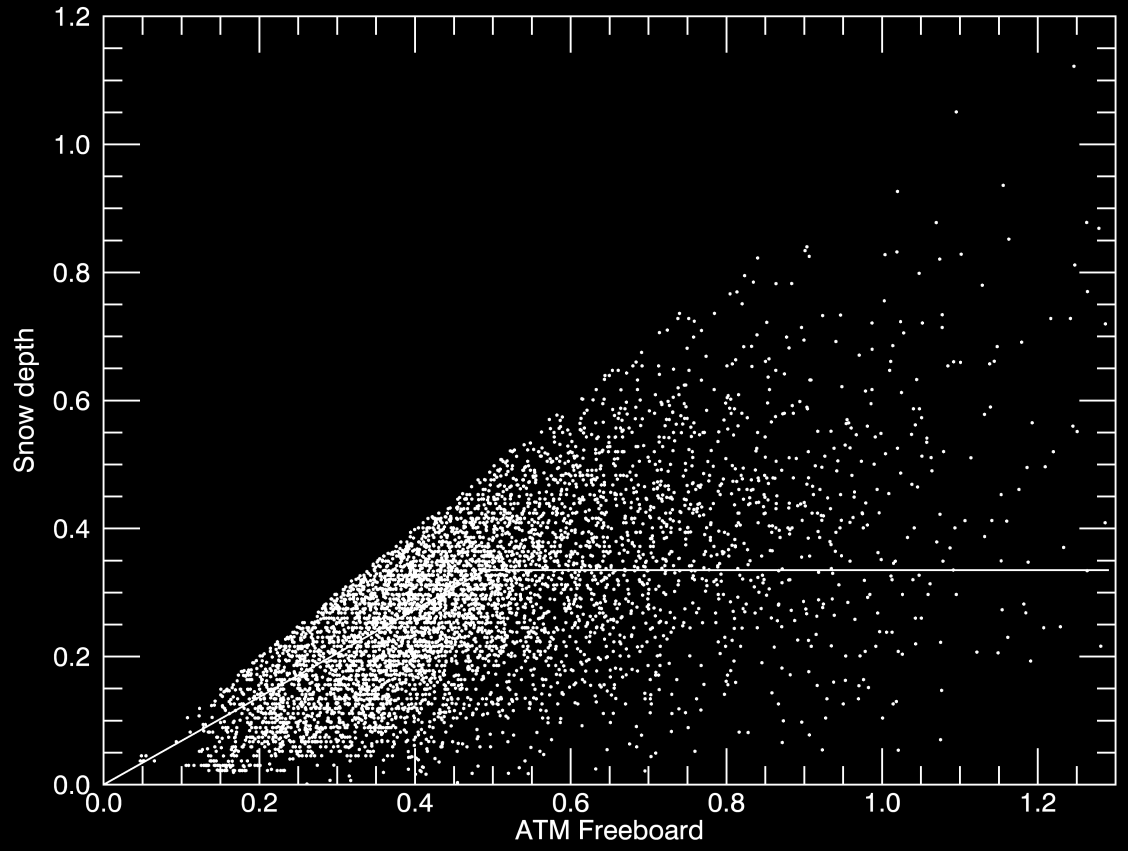
CryoSat-2 sea ice thickness using Warren snow depth climatology

# Already improving CryoSat-2 thickness estimates



# Distribute the snow?

Use NASA's Operation IceBridge data to assess high resolution relationships between snow depth and freeboard



# Future work and summary

- Produce updated CryoSat-2 & ICESat thickness estimates
- Distribute the snow over higher resolutions.
- Improve model physics
- Run NESOSIM in the Southern Ocean
- Get ready for ICESat-2!

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