

The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

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Nathan Kurtz, Jeremy Harbeck*

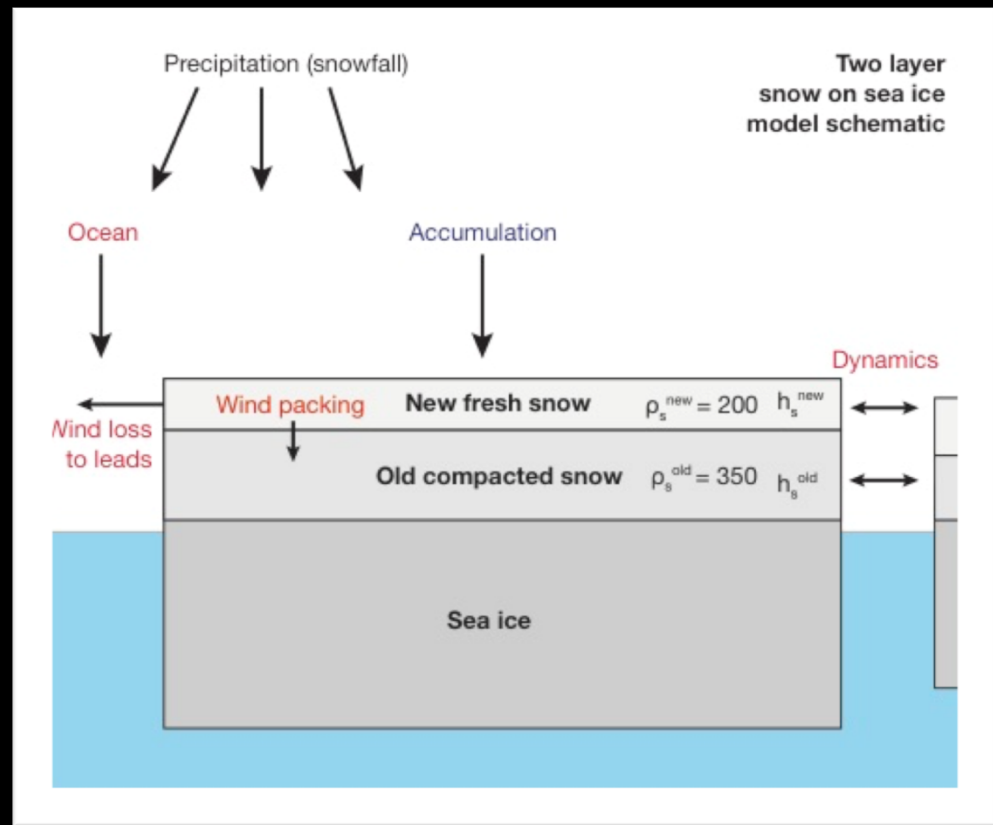


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The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

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

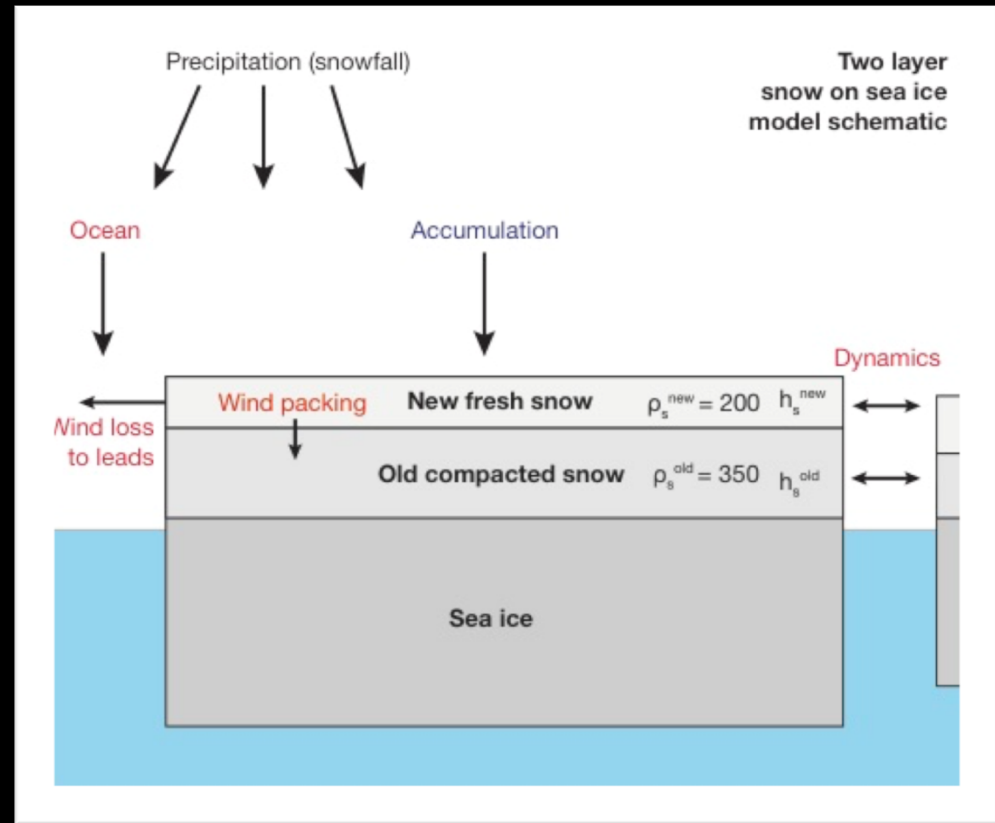


[Petty et al., in prep]

The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

Included processes

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

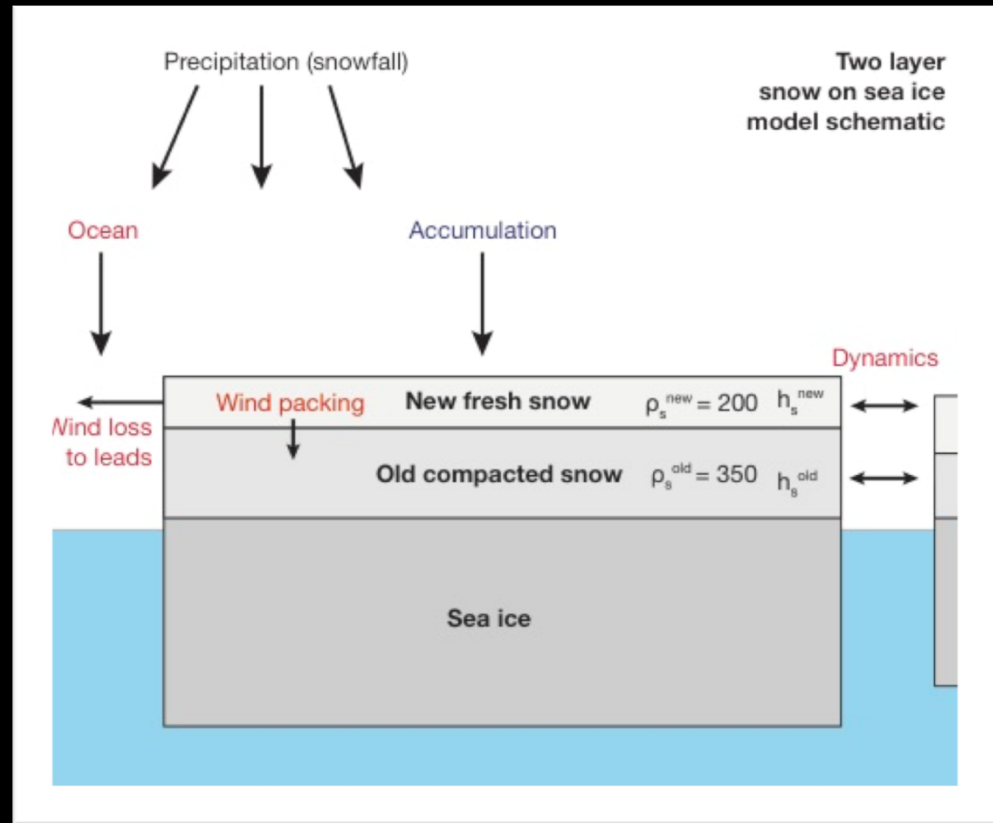


[Petty et al., in prep]

The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

NOT Included processes (yet..)

- Snow melt
- Blowing snow to adjacent grid-cells
- Snow-ice conversion
- ?



[Petty et al., in prep]

The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

Accumulation

$$\Delta h_s^{acc}(x, y) = (S_f(x, y) / \rho_s^n) A(x, y)$$

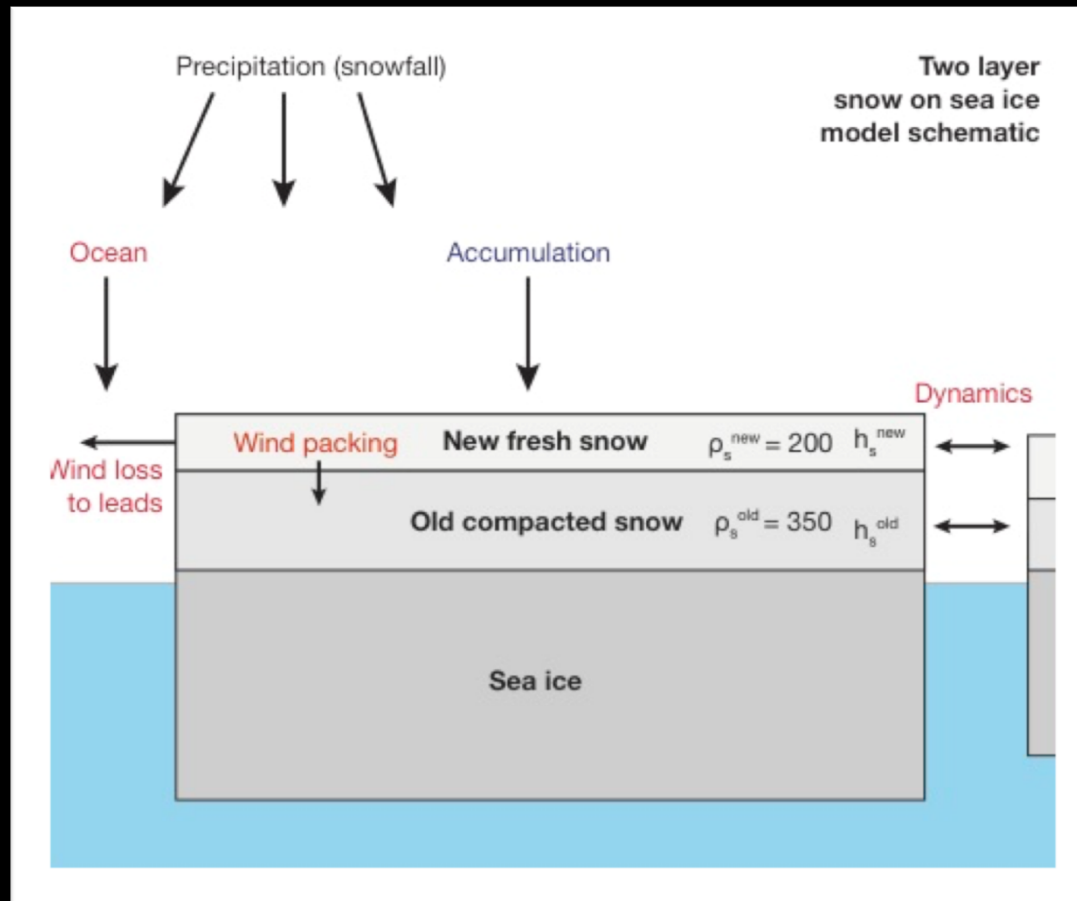
The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

Accumulation

$$\Delta h_s^{acc}(x, y) = (S_f(x, y)/\rho_s^n) A(x, y)$$

**Tracking snow volume*

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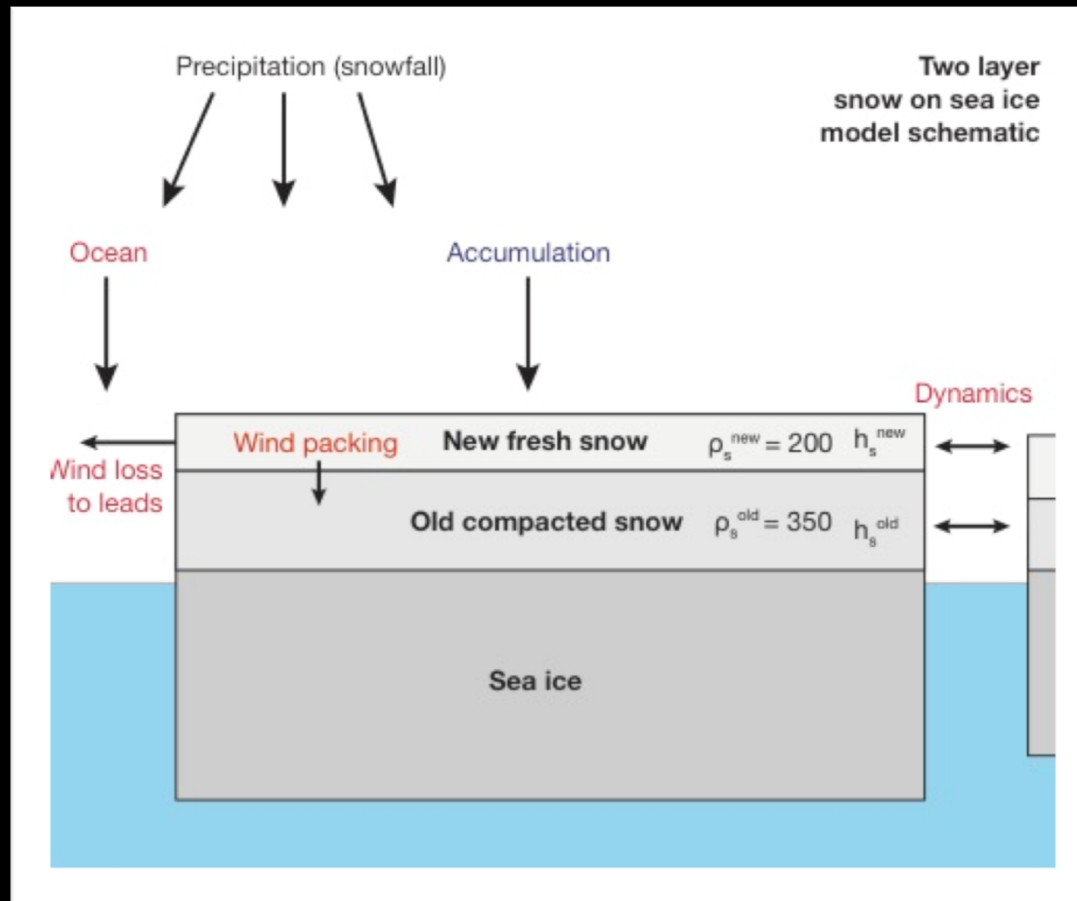


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Dynamics

$$\Delta h_s^{dyn}(x, y) = \nabla(h_s(x, y) \cdot u_i(x, y))$$

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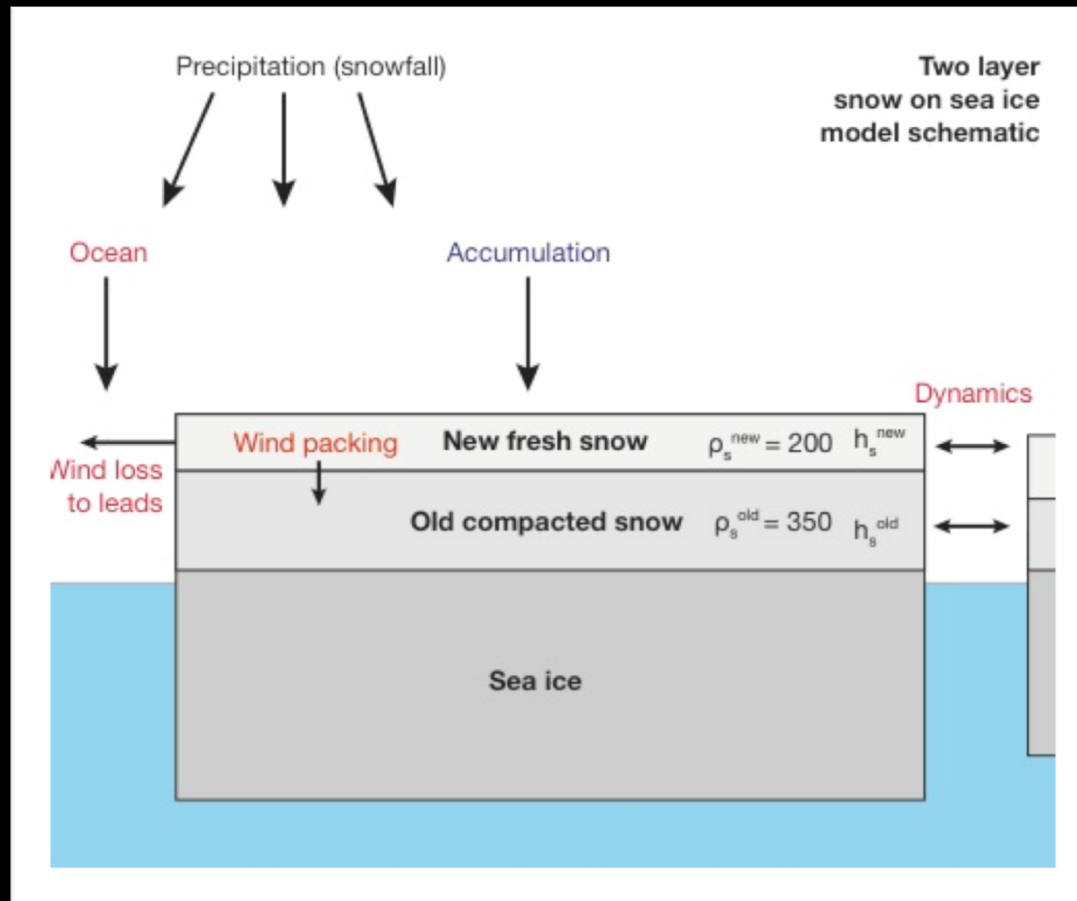
Wind packing

$$\Delta h_s^{wp}(0, x, y) = -\alpha h_s(0, x, y) \text{ for } U > 5$$

$$\Delta h_s^{wp}(1, x, y) = (\rho_s^n / \rho_s^o) \alpha h_s(0, x, y) \text{ for } U > 5$$

[Petty et al., in prep]

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[Petty et al., in prep]

The NASA Eulerian Snow on Sea Ice Model (NESOSIM)

Blowing snow lost to leads

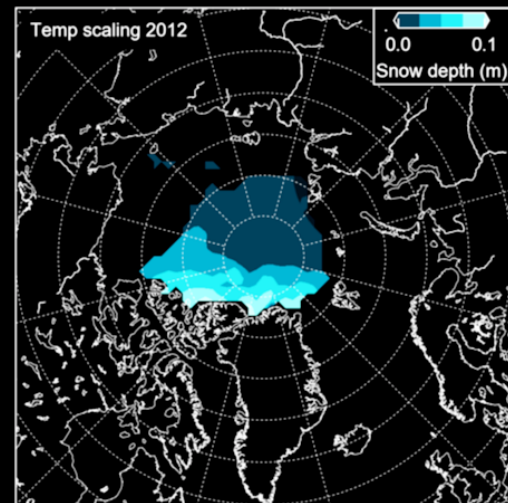
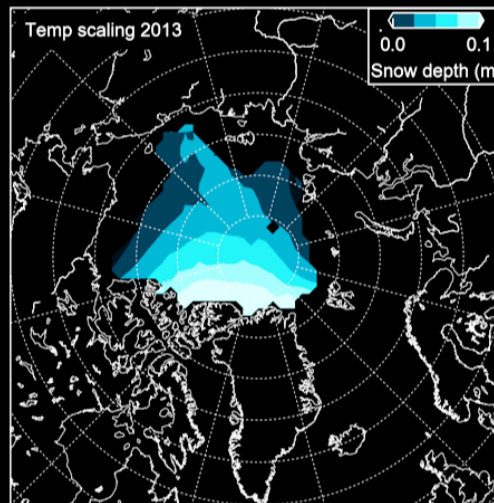
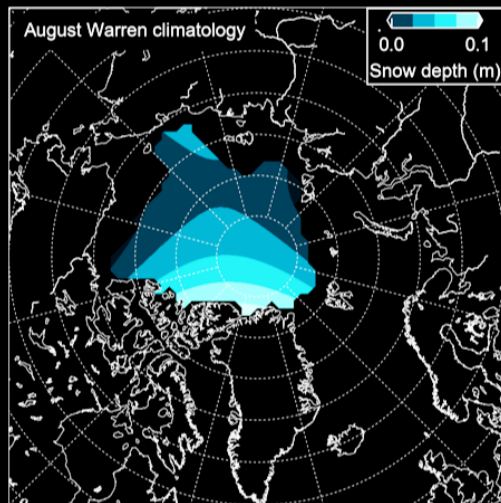
$$\Delta h_s^{bs}(x, y) = \beta U(x, y) h_s(0, x, y)(1 - A(x, y))$$

for $U(x, y) > 5$

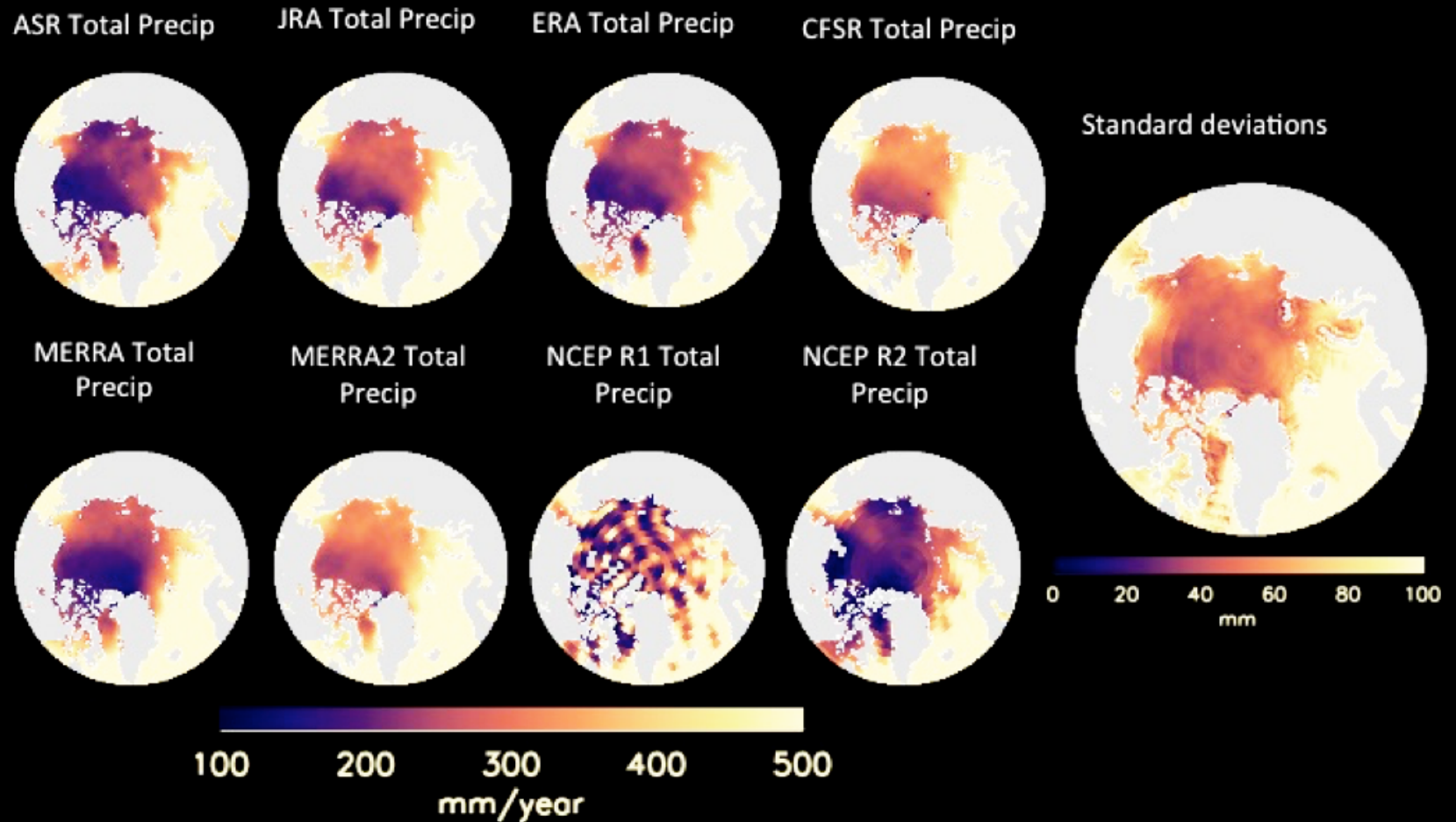
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Initial conditions

Temperature scaled August Warren snow depths

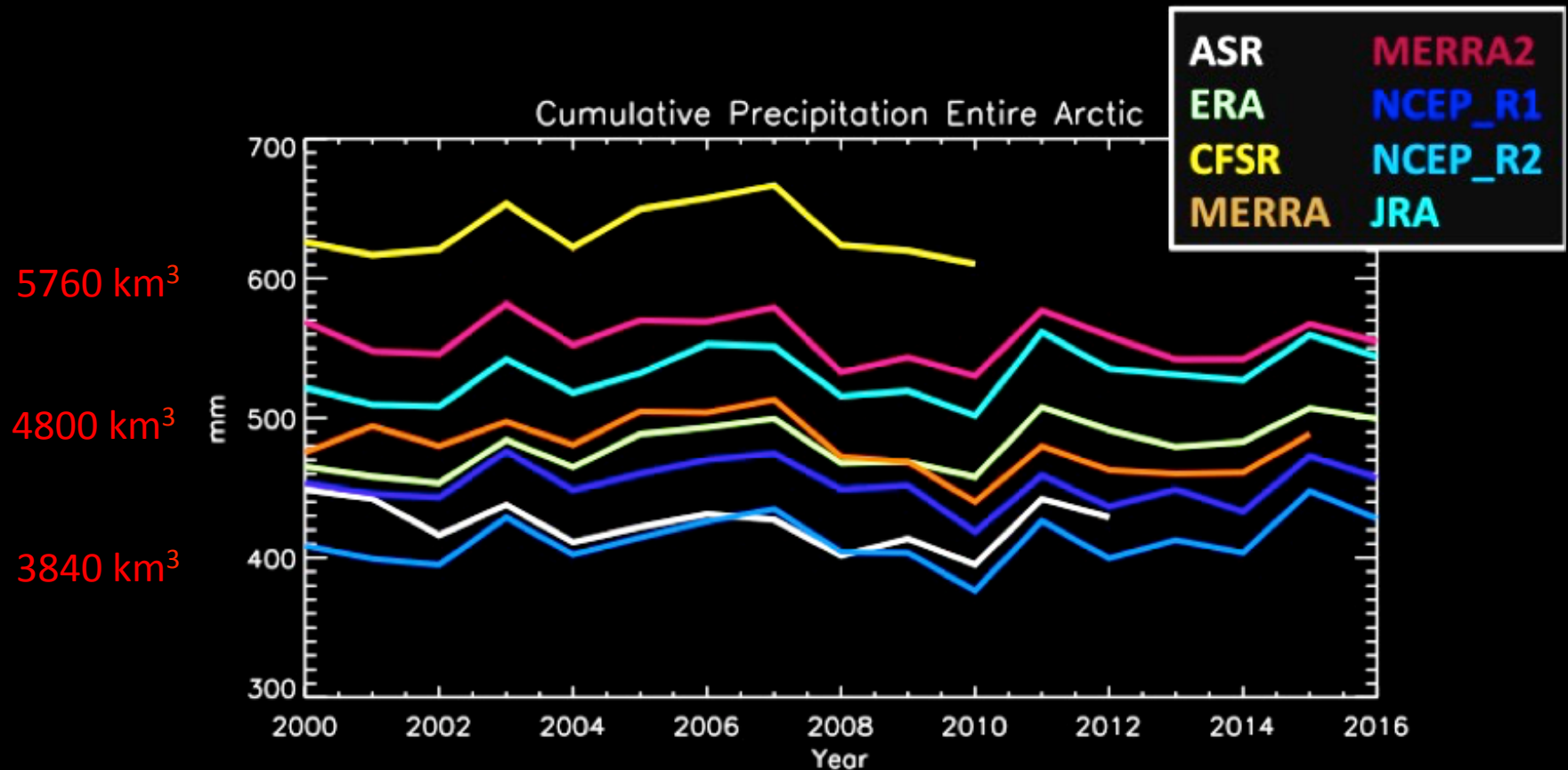


Total Arctic precip across 8 reanalyses



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

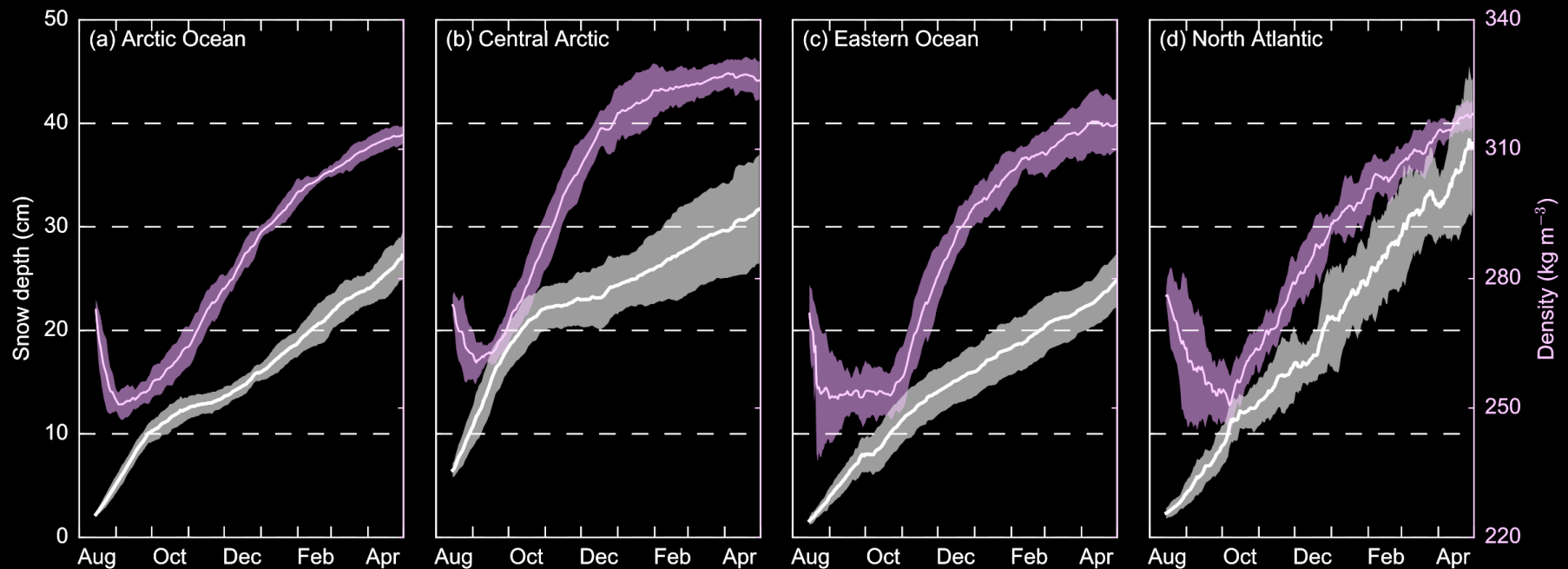
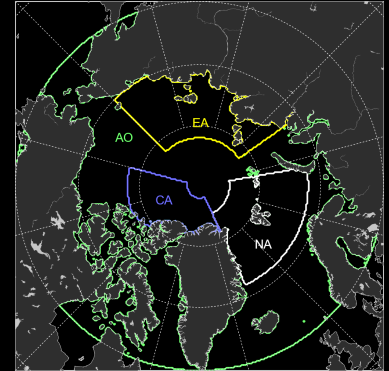
Annual Arctic precipitation across 8 reanalyses



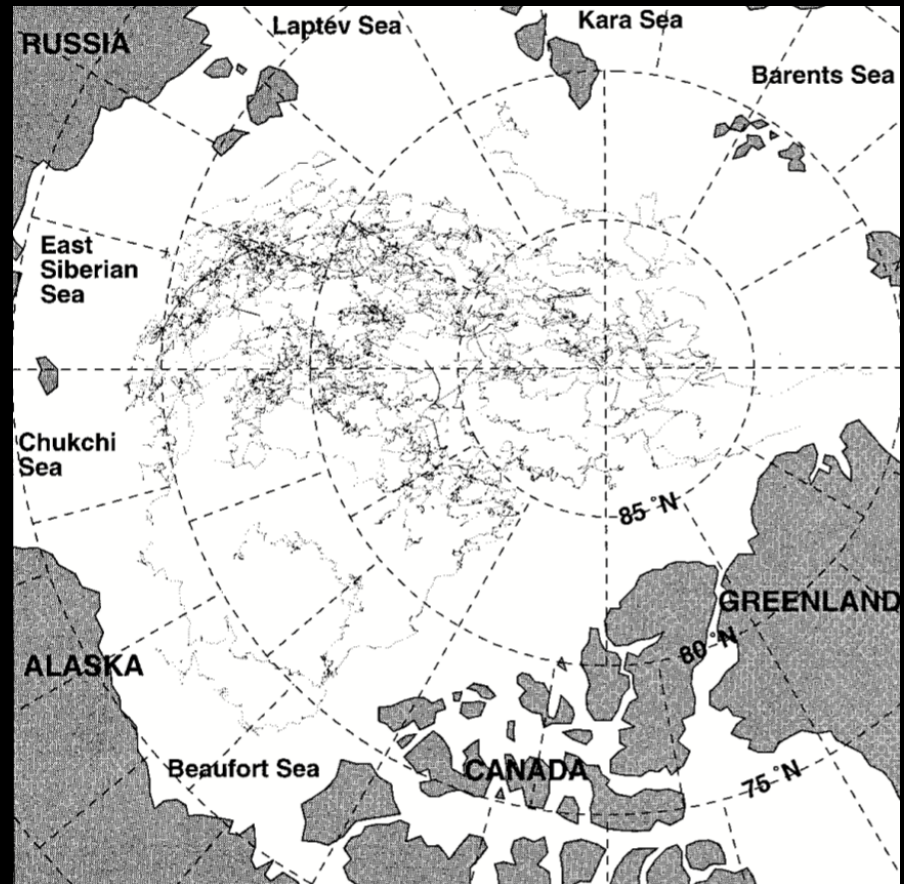
From [Boisvert et al., 2018 , *in prep*]

NESOSIM forced by ERA-I

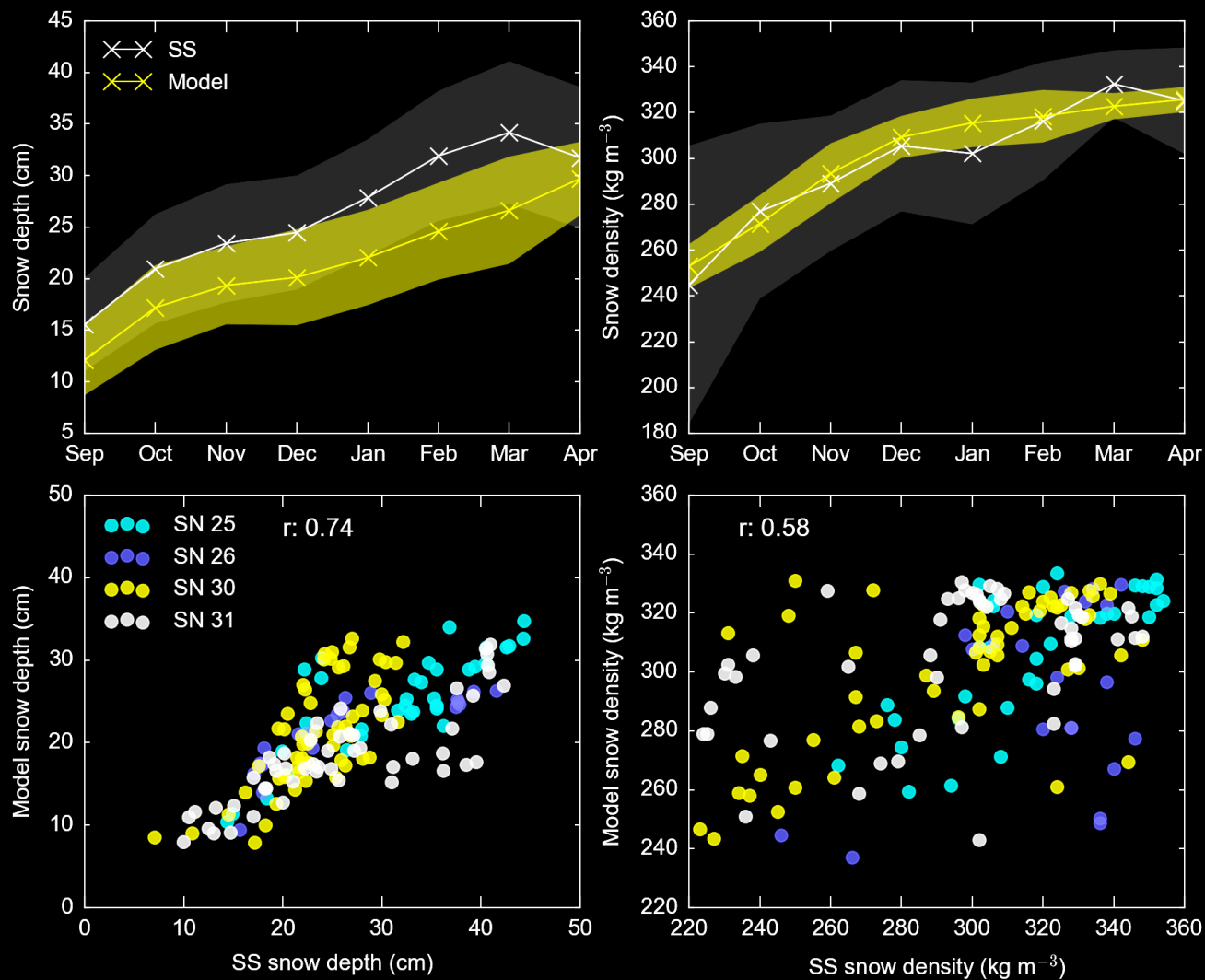
1980-1991



Calibrations with Soviet Station data

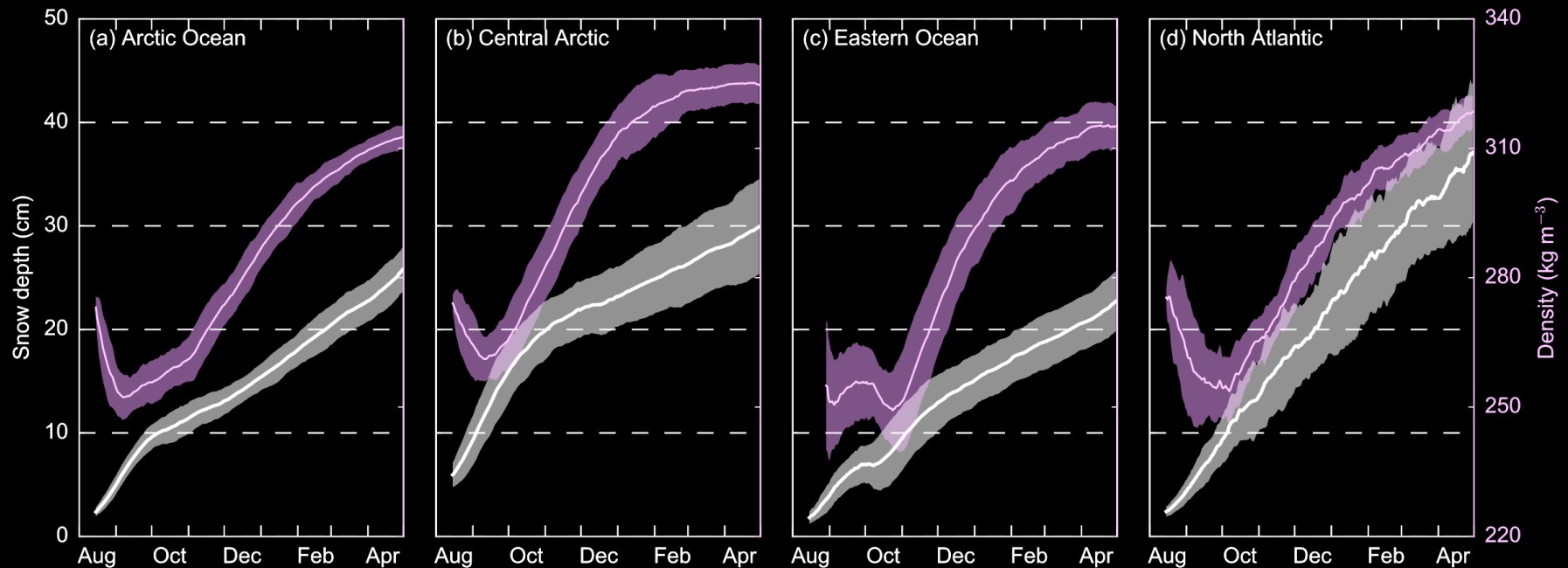
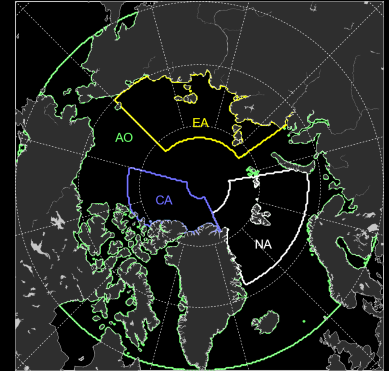


Calibrations with Soviet Station data

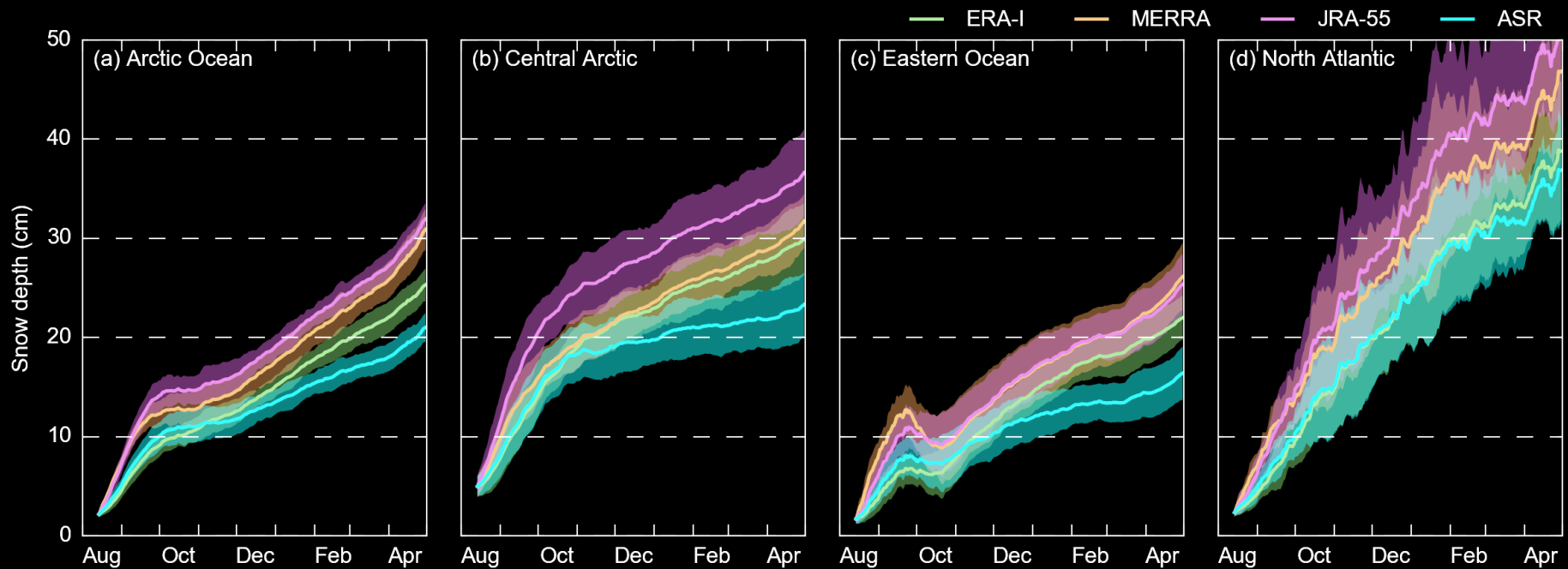
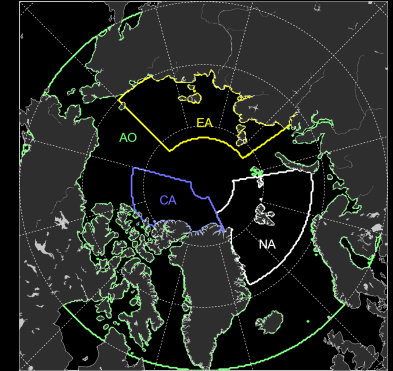


NESOSIM forced by ERA-I

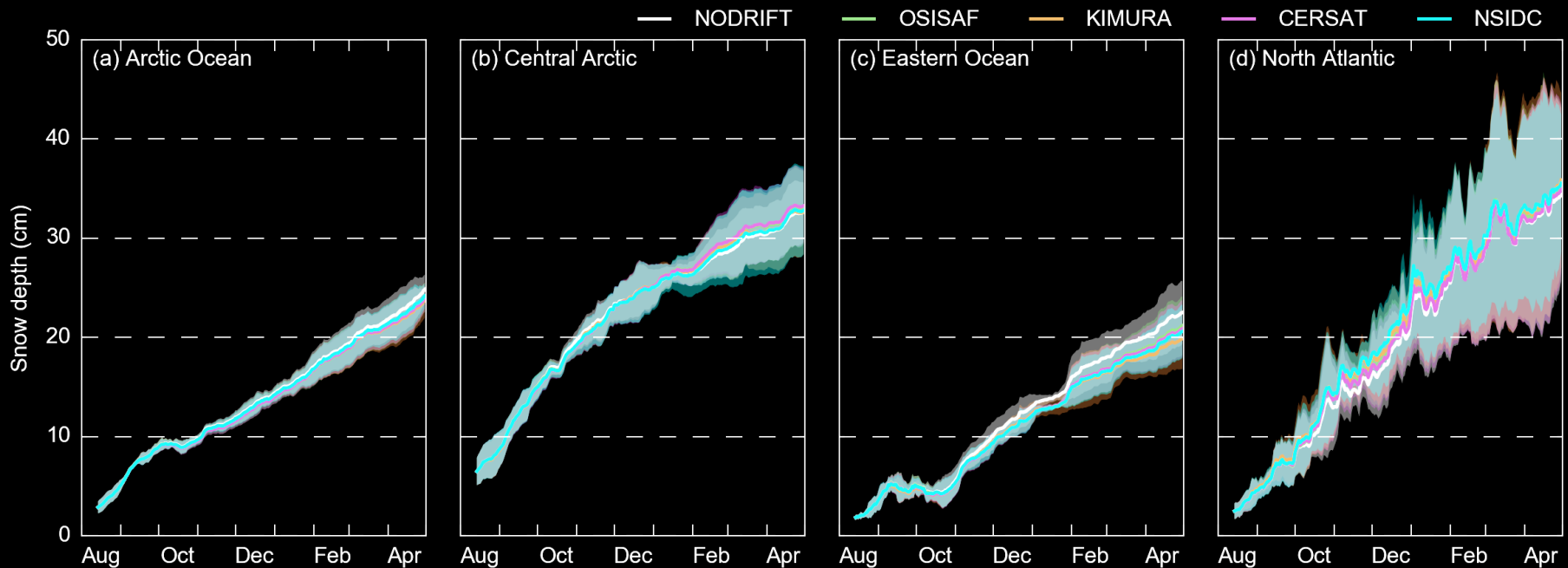
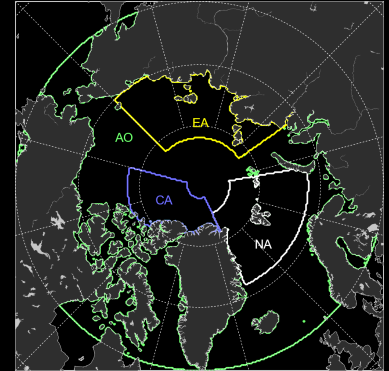
1980-2016 climatology



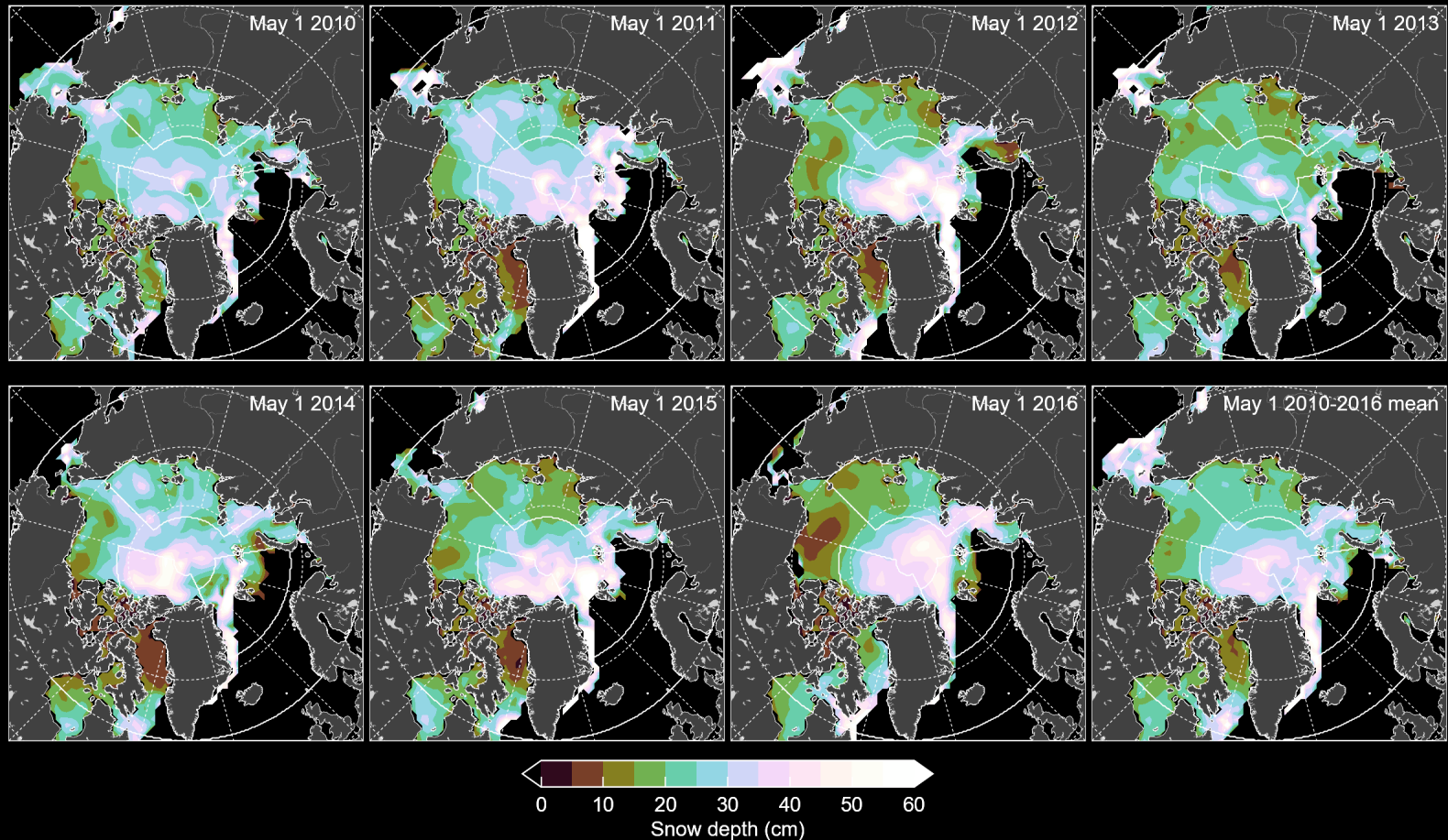
NESOSIM forced by different reanalyses



NESOSIM forced by different ice drifts

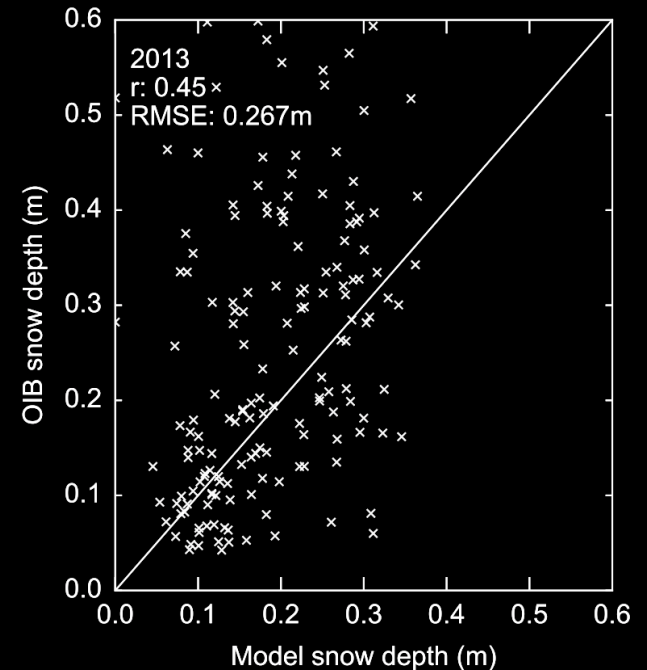
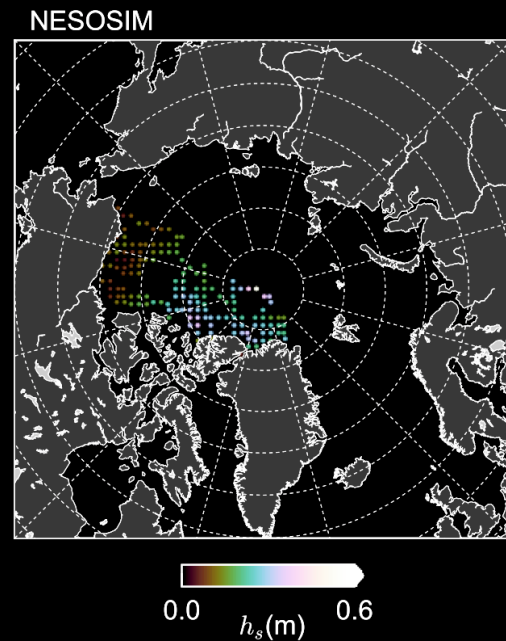
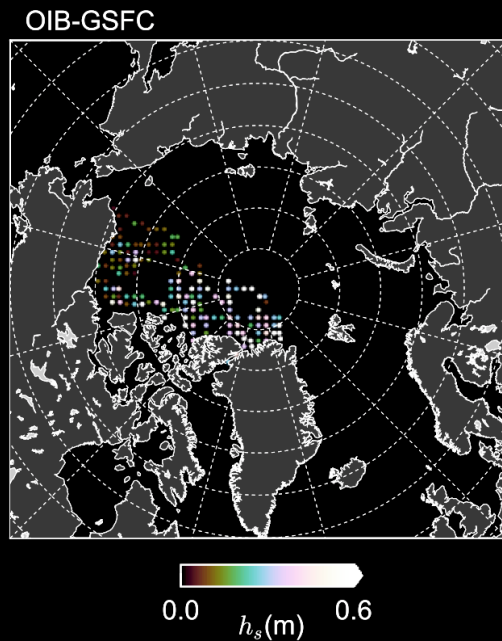


NESOSIM results

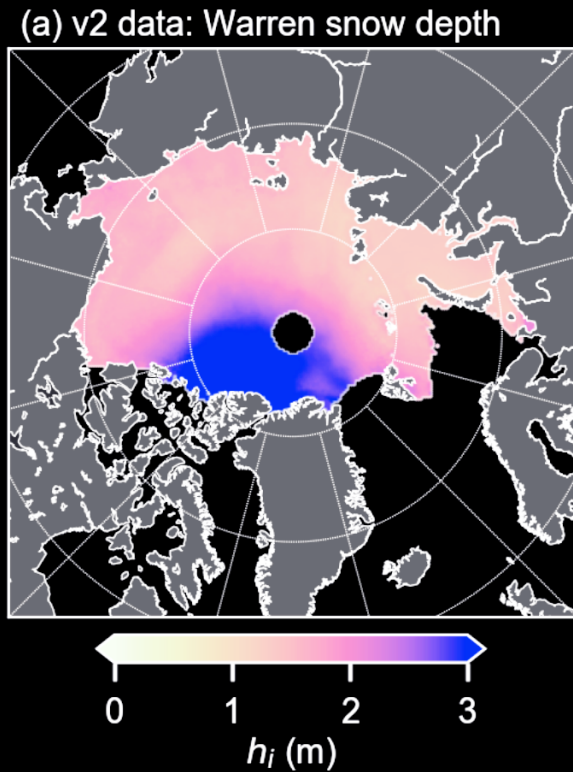


Forced by ERA-Interim snowfall/winds, Bootstrap ice concentration, NSIDCv3 drift.

Validate with NASA's Operation IceBridge



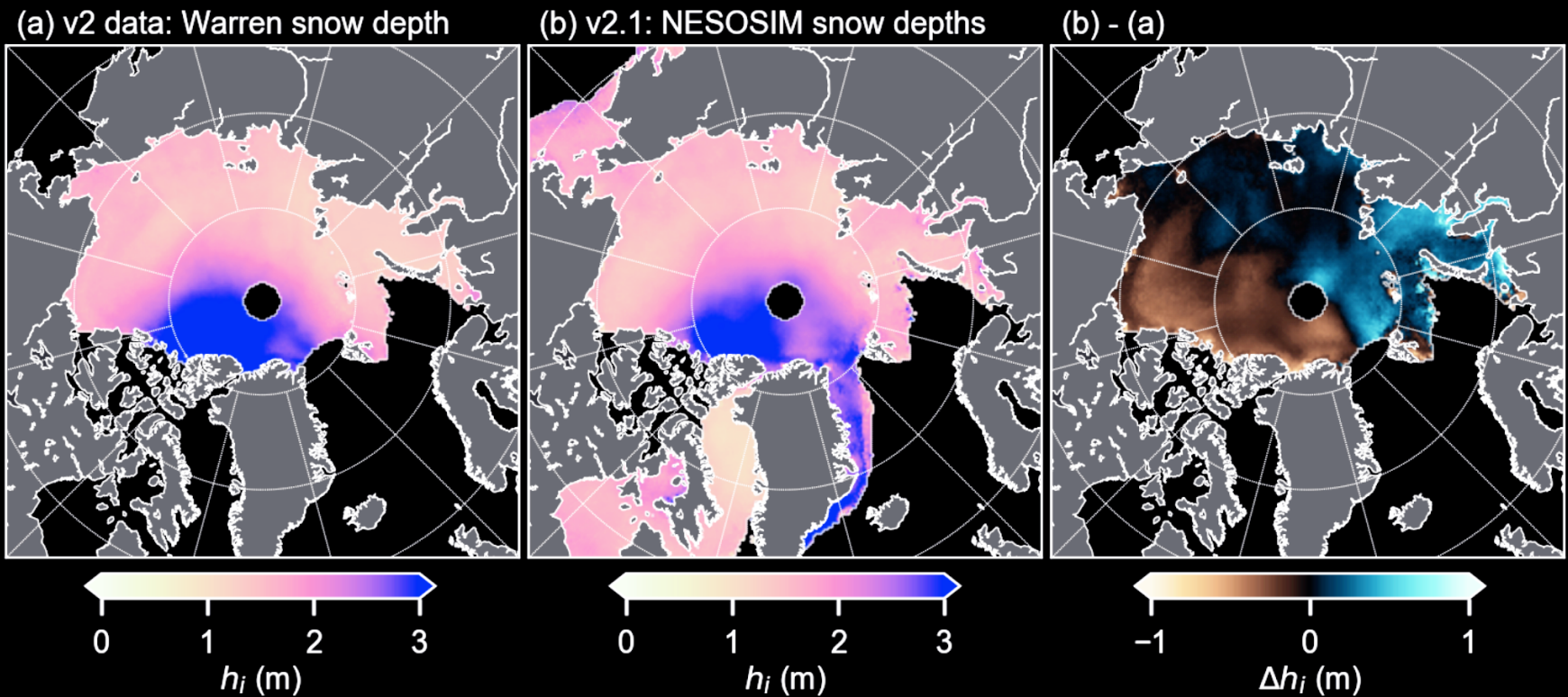
Already improving CryoSat-2 thickness estimates



Winter mean
(2010-2016)

CryoSat-2 sea ice
thickness using Warren
snow depth climatology

Already improving CryoSat-2 thickness estimates



Future work and summary

- Produce updated CryoSat-2/ICESat thickness estimates
- Improve model physics
- Run NESOSIM in the Southern Ocean
- Get ready for ICESat-2