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TAKING THE PULSE OF OUR PLANET FROM SPACE

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Simulating snow depth on Antarctic sea ice using remote sensing data and atmospheric reanalyses

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Simulating snow depth on Antarctic sea ice: Motivation

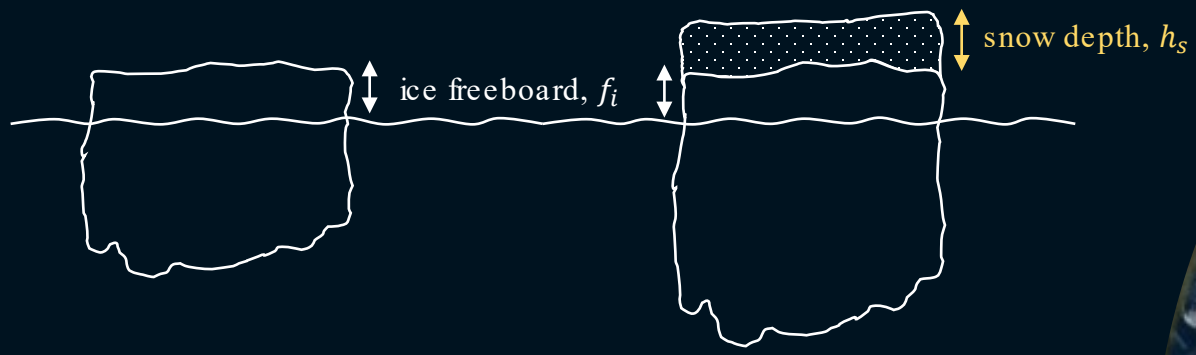
Why do we care about snow depth?

- Important for local energy and freshwater budget.

Simulating snow depth on Antarctic sea ice: Motivation

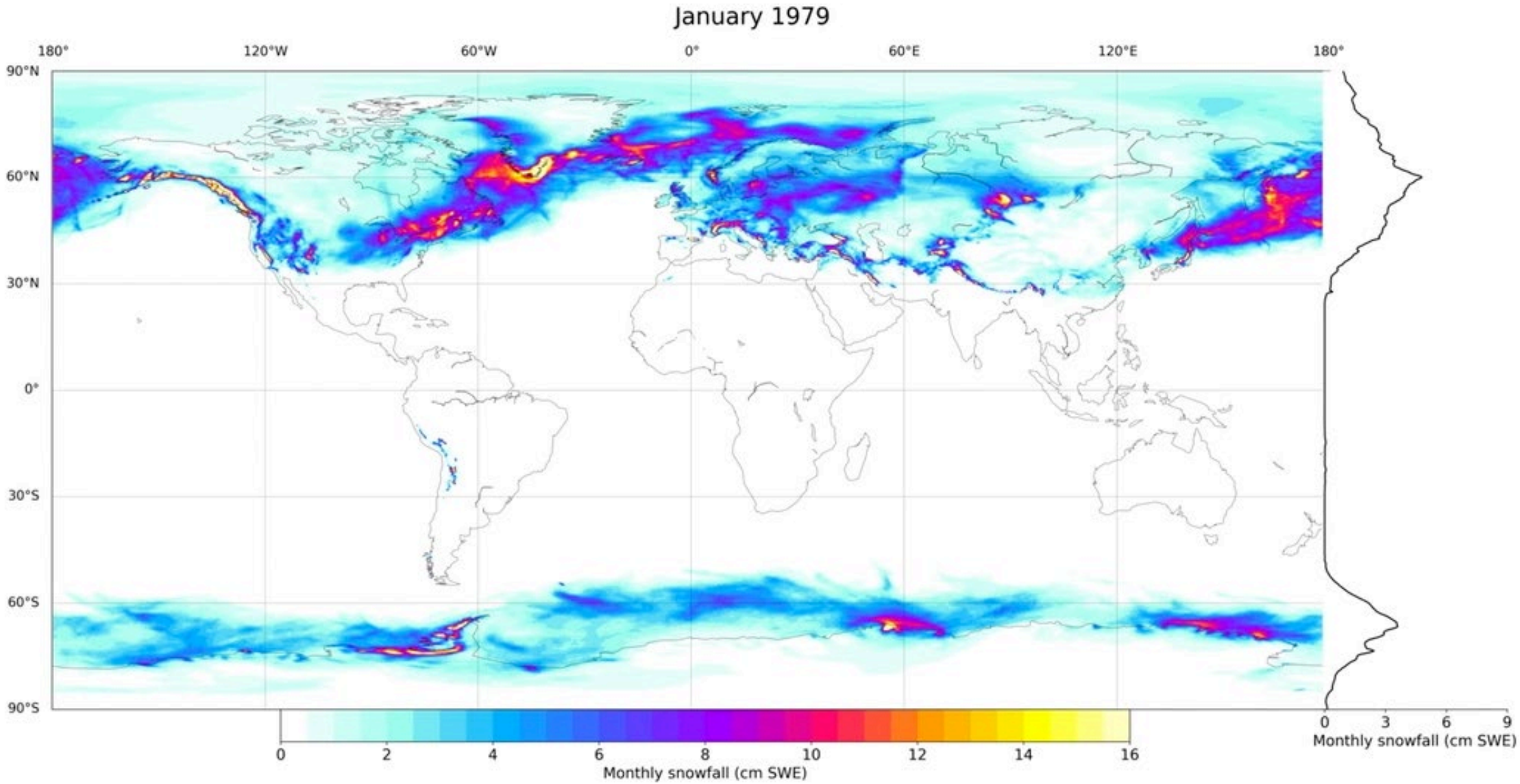
Why do we care about snow depth?

- Important for local energy and freshwater budget.
- Essential parameter for retrieving sea ice thickness from altimetry:



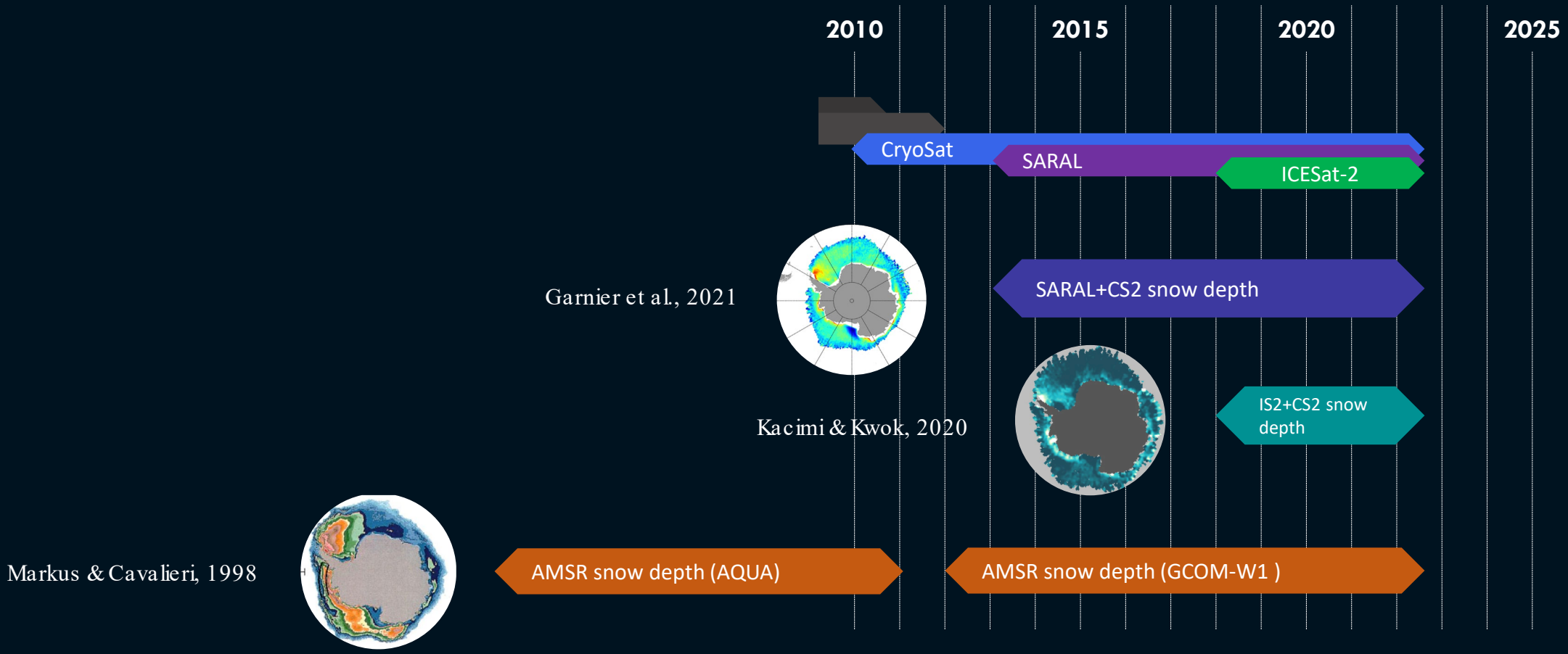
$$\text{Sea ice thickness} = \frac{f_i\,\rho_w}{\rho_w - \rho_i} + \frac{h_s\,\rho_s}{\rho_w - \rho_i}$$

Simulating snow depth on Antarctic sea ice: Motivation

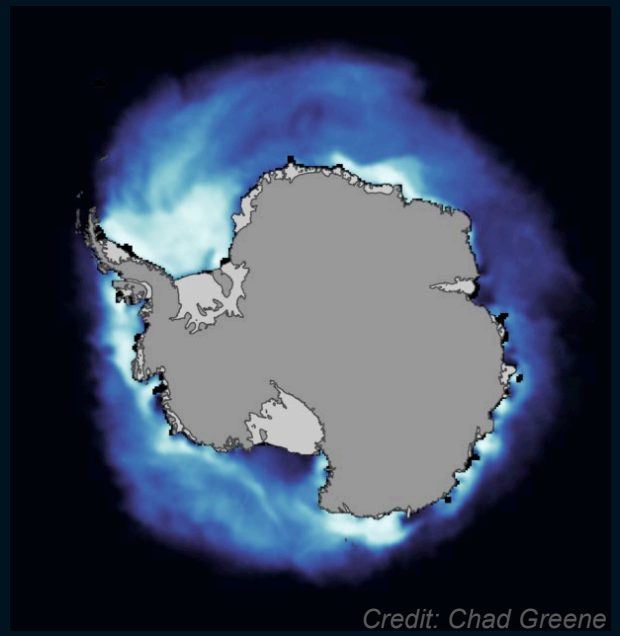


Simulating snow depth on Antarctic sea ice: Motivation

Can’t we remotely sense snow depth?



Simulating snow depth on Antarctic sea ice: Basic concept



Sea ice concentration

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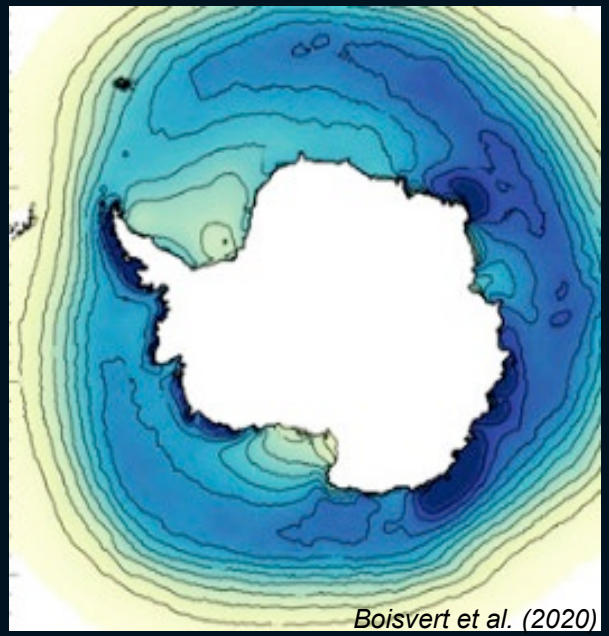

Snowfall

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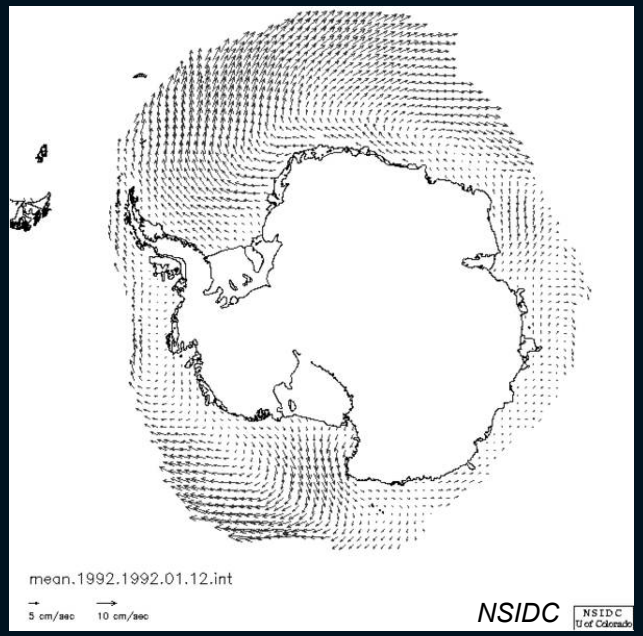
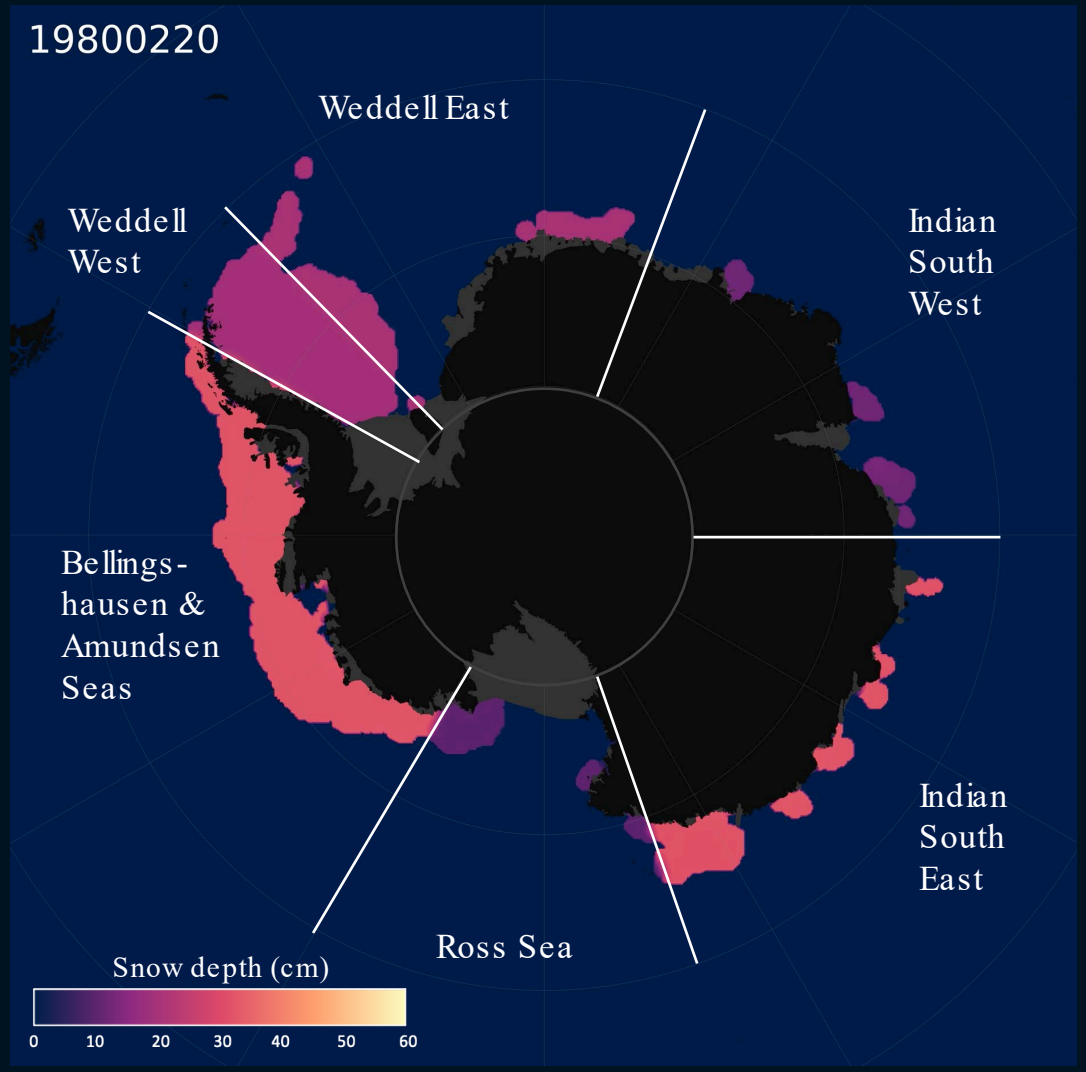


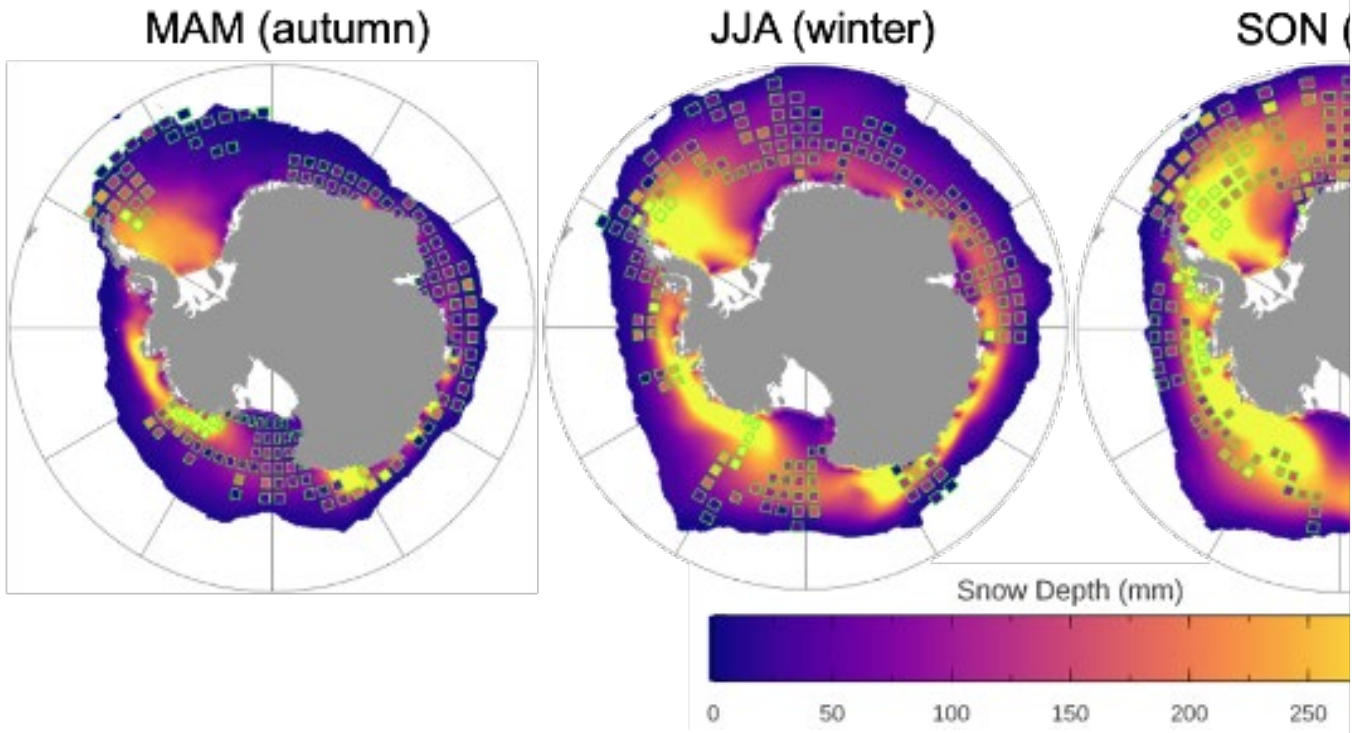
Sea ice drift

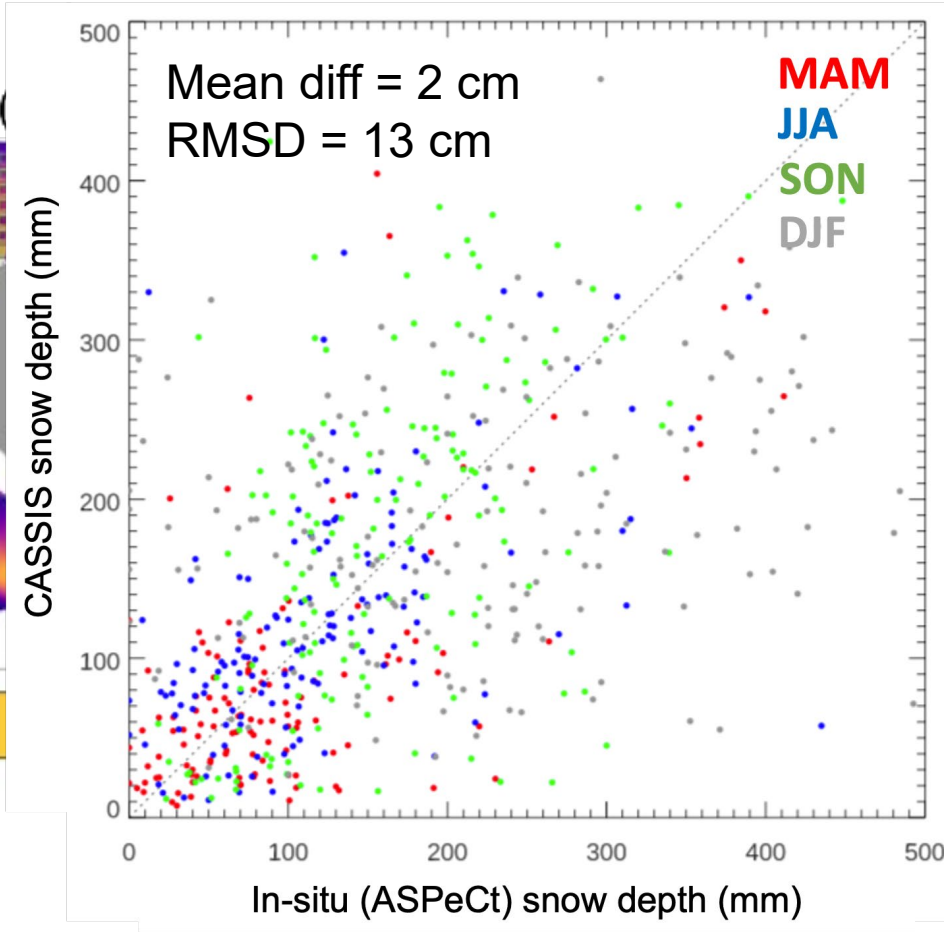
Simulating snow depth on Antarctic sea ice: CASSIS

1. On the 20th Feb each year, Lagrangian grid points are created every 10km.
2. Points within the sea ice extent mask are initialised with a snow depth from in-situ observations.
3. At daily frequency, ice parcels are shifted according to sea ice motion vectors.
4. Where ice parcels diverge or the sea ice extent boundary increases, new ice is created.
5. If parcels drift beyond sea ice extent mask, snow is removed.
6. Points accumulate snow from the atmosphere and the ice sheet, and lose snow to leads and snow-ice formation.

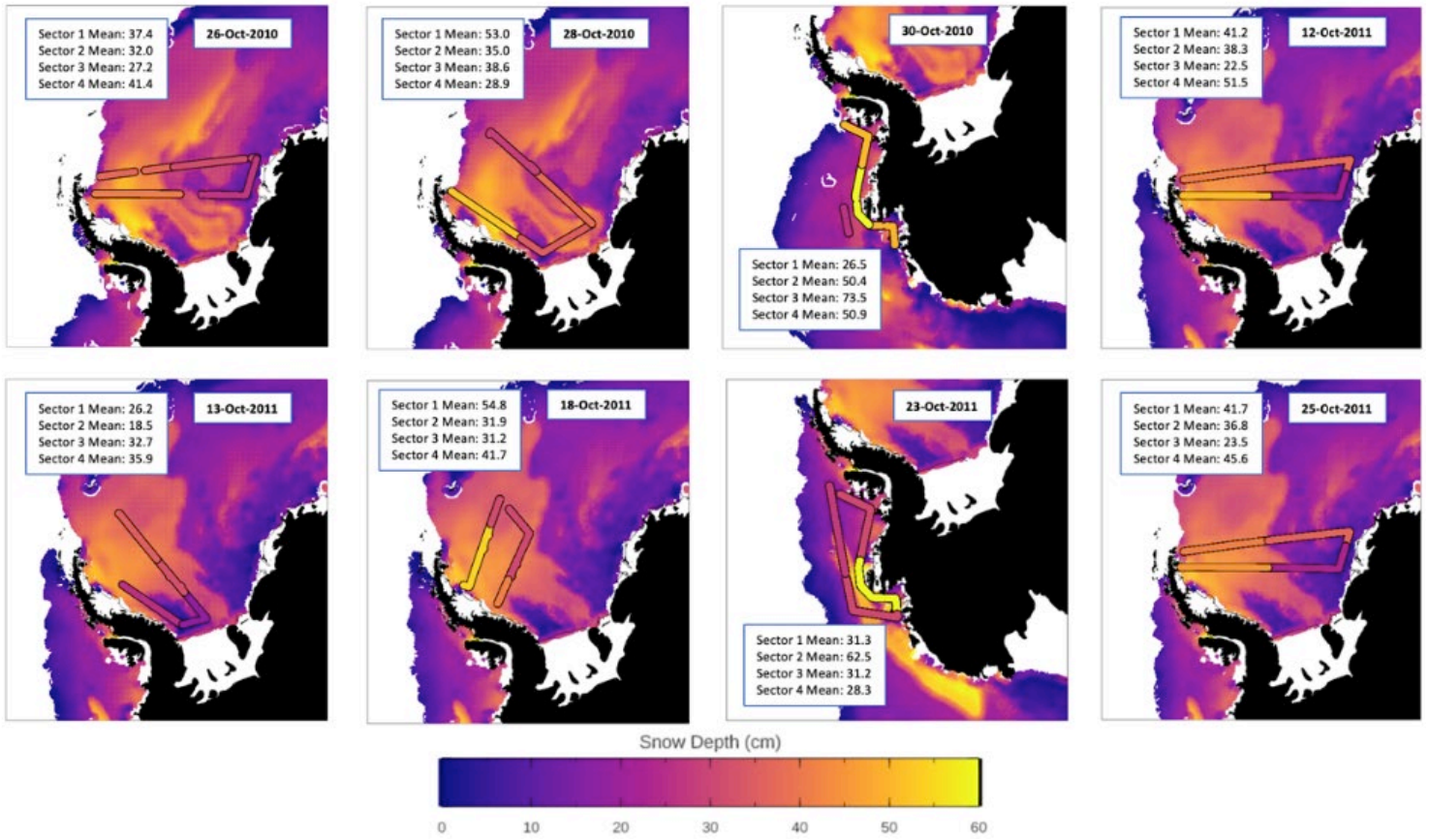


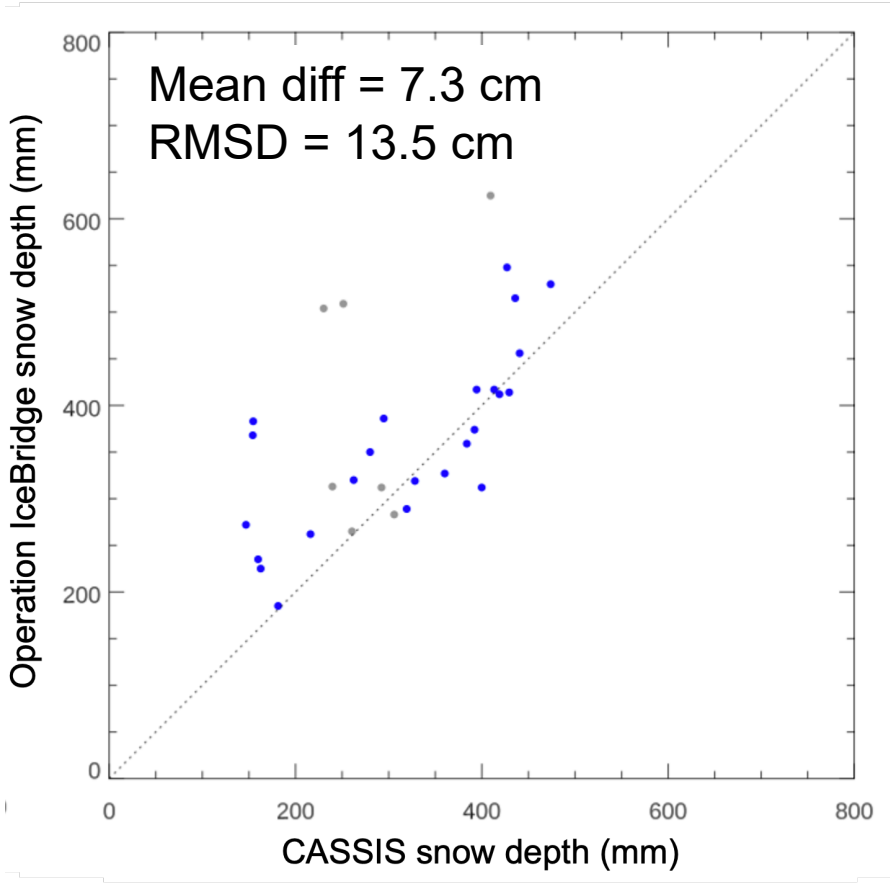
Simulating snow depth on Antarctic sea ice: Climatology



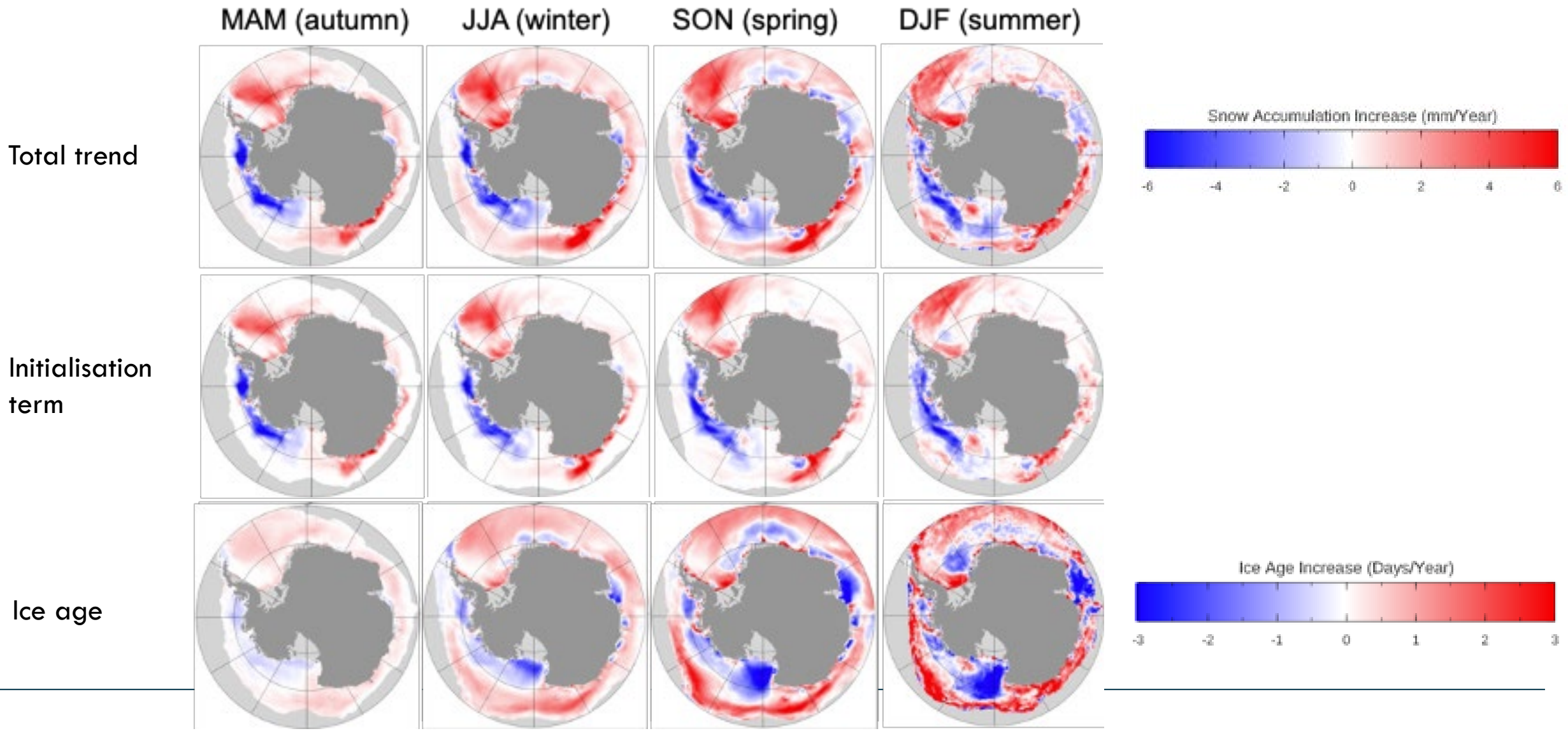


Simulating snow depth on Antarctic sea ice: Validation





Simulating snow depth on Antarctic sea ice: Trends

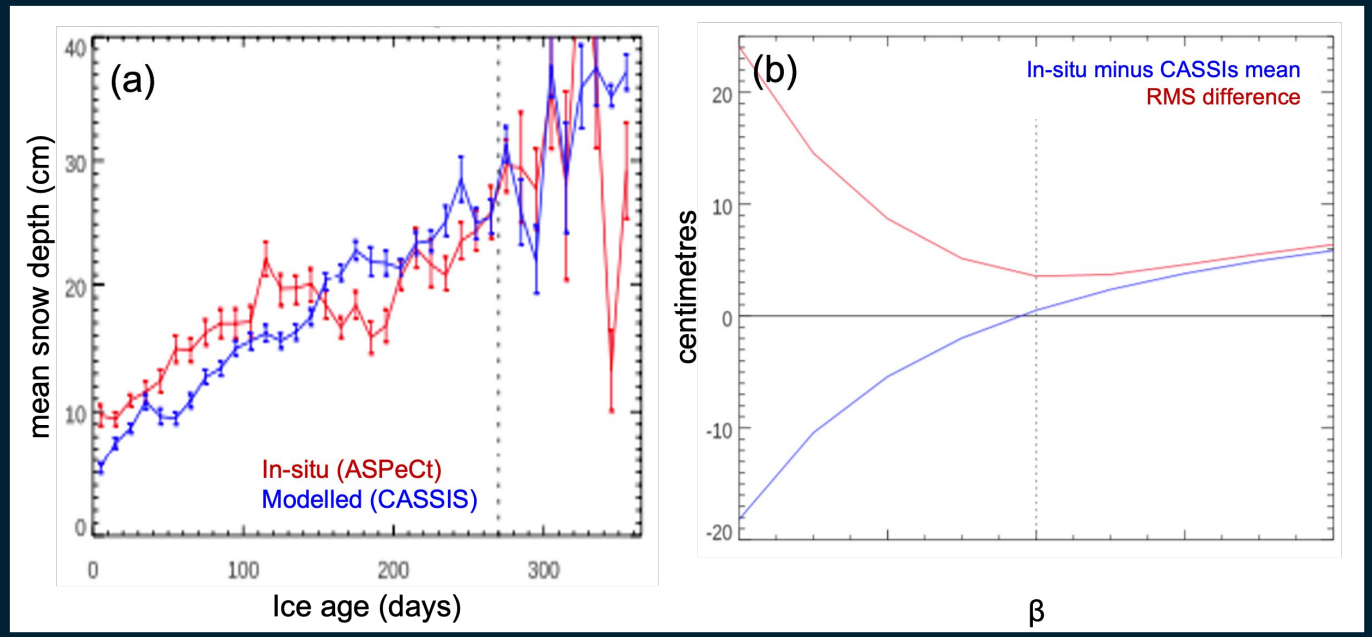


Simulating snow depth on Antarctic sea ice: Summary

- Our model, CASSIS, simulates the snow depth of Southern Ocean sea ice at daily resolution between 1981 and 2018.
- CASSIS is forced with sea ice concentration and motion data derived from satellites, and meteorological data from atmospheric reanalyses.
- We account for snow accumulation from the atmosphere, blown off the ice sheet, and loss of snow to leads and snow-ice formation.
- We find a RMSD of 13 cm between modelled snow depths and in-situ data collected from ships. We also find a RMSD of 13.5 cm compared to airborne data from NASA Operation IceBridge.
- Trends in simulated snow depth are driven by trends in summer sea ice concentration and ice age.

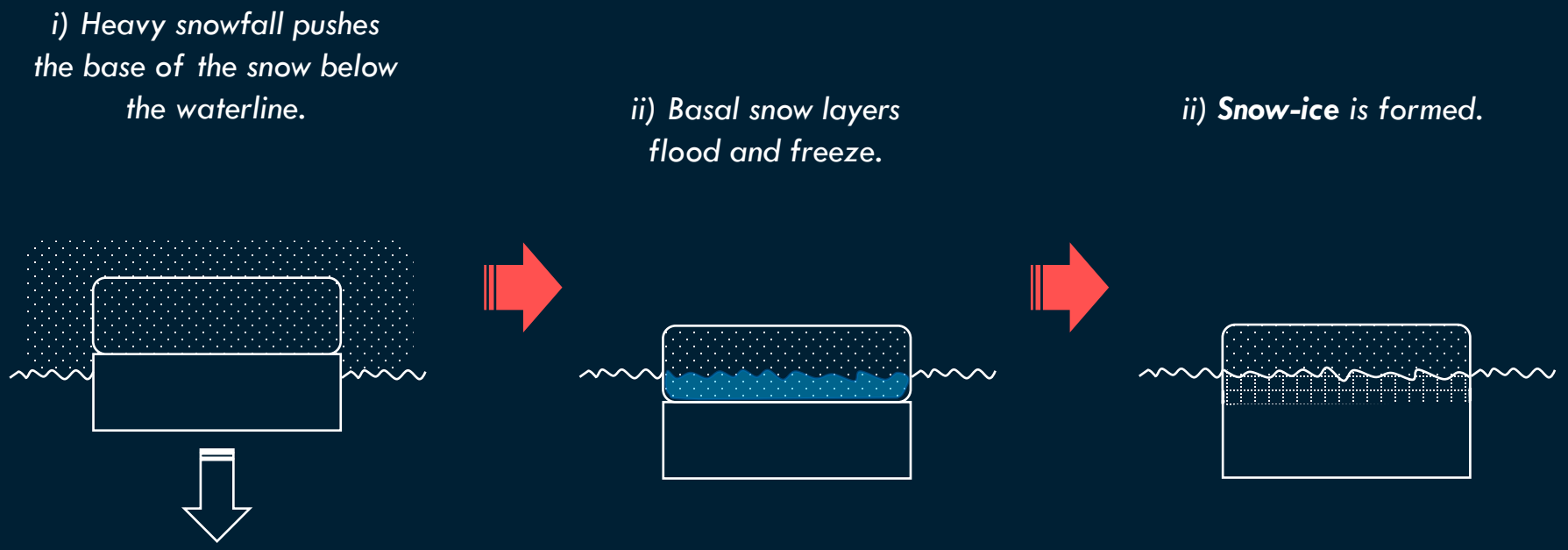
Modelling snow depth on Antarctic sea ice: Snow blown into leads

- Snow is lost to the ocean by being blown into leads
- We use a simple formula to account for snow lost to leads as a function of sea ice concentration and windspeed.

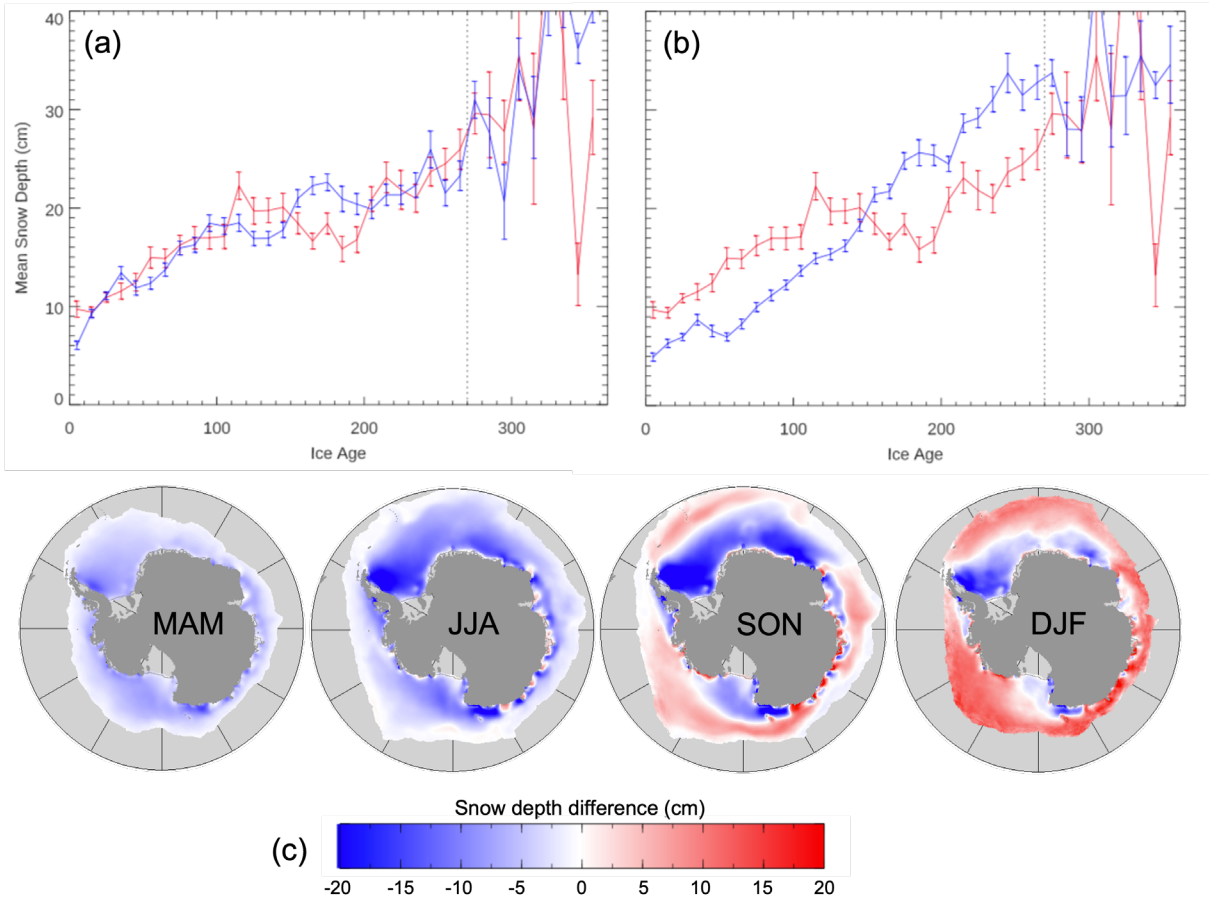


Modelling snow depth on Antarctic sea ice: Snow-ice formation

- Snow-ice formation is a prevalent process in Antarctica.



Modelling snow depth on Antarctic sea ice: Snow-ice sensitivity



From Lawrence et al., submitted