Changing Snow on Sea Ice

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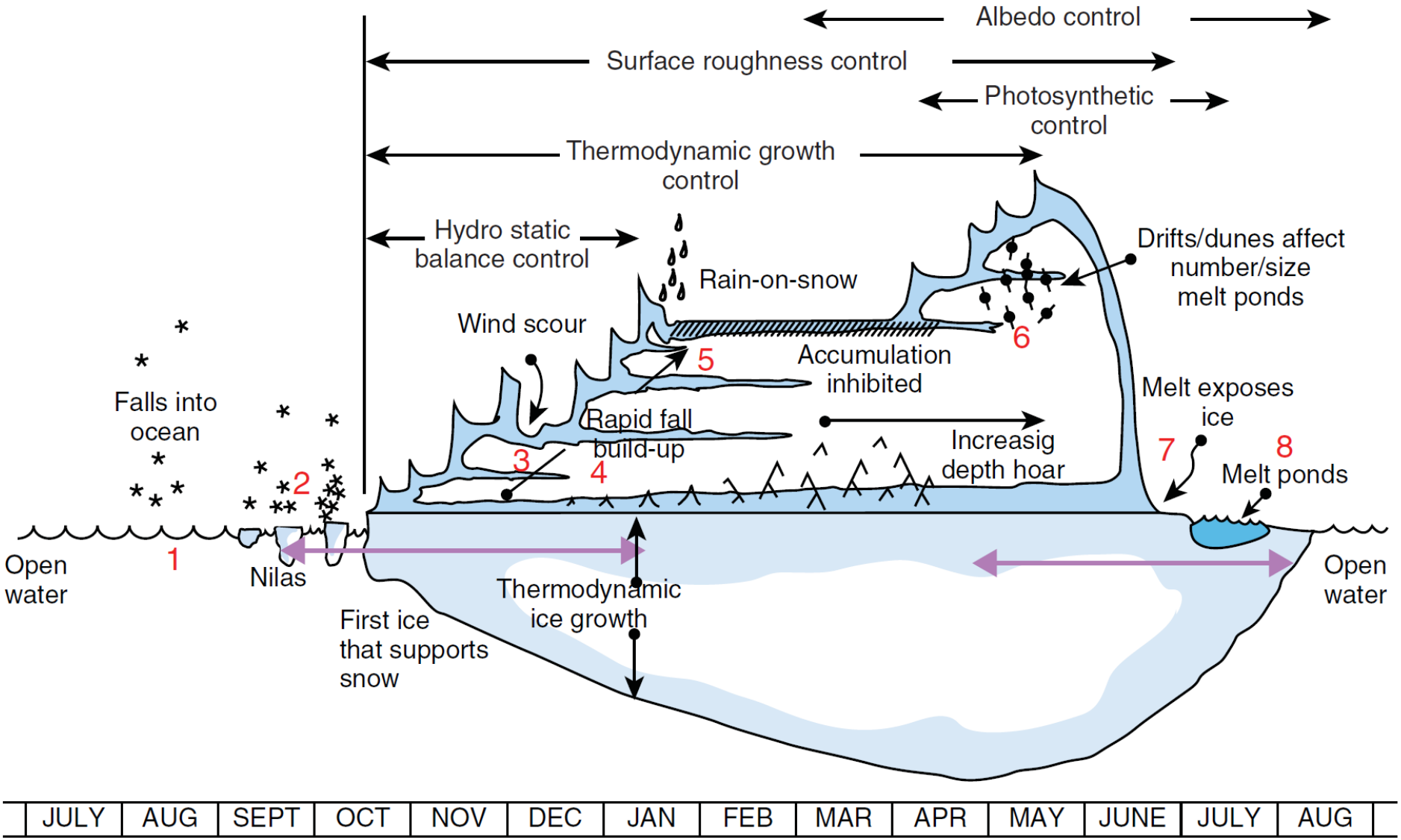
Snow on sea ice:

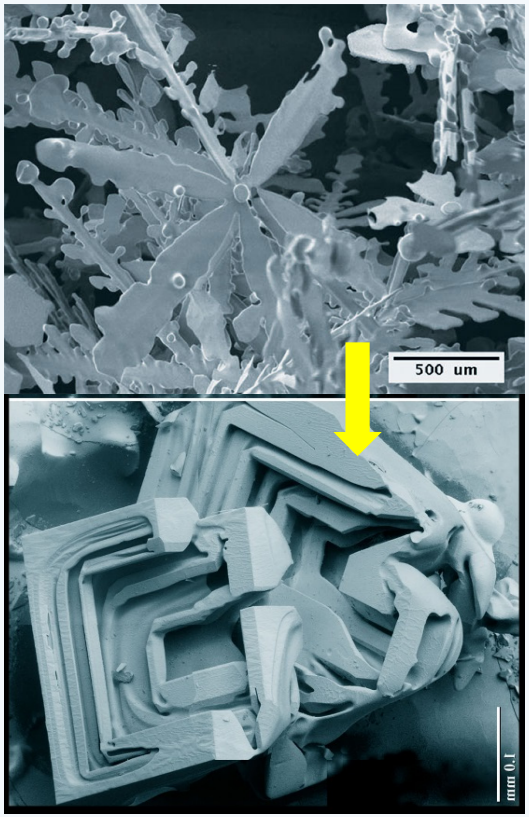
- Why is it important?
- Where is it distributed?
- What's changed?
- Which key processes are driving these changes?
- What can we anticipate in the future?

Why is snow on sea ice important?

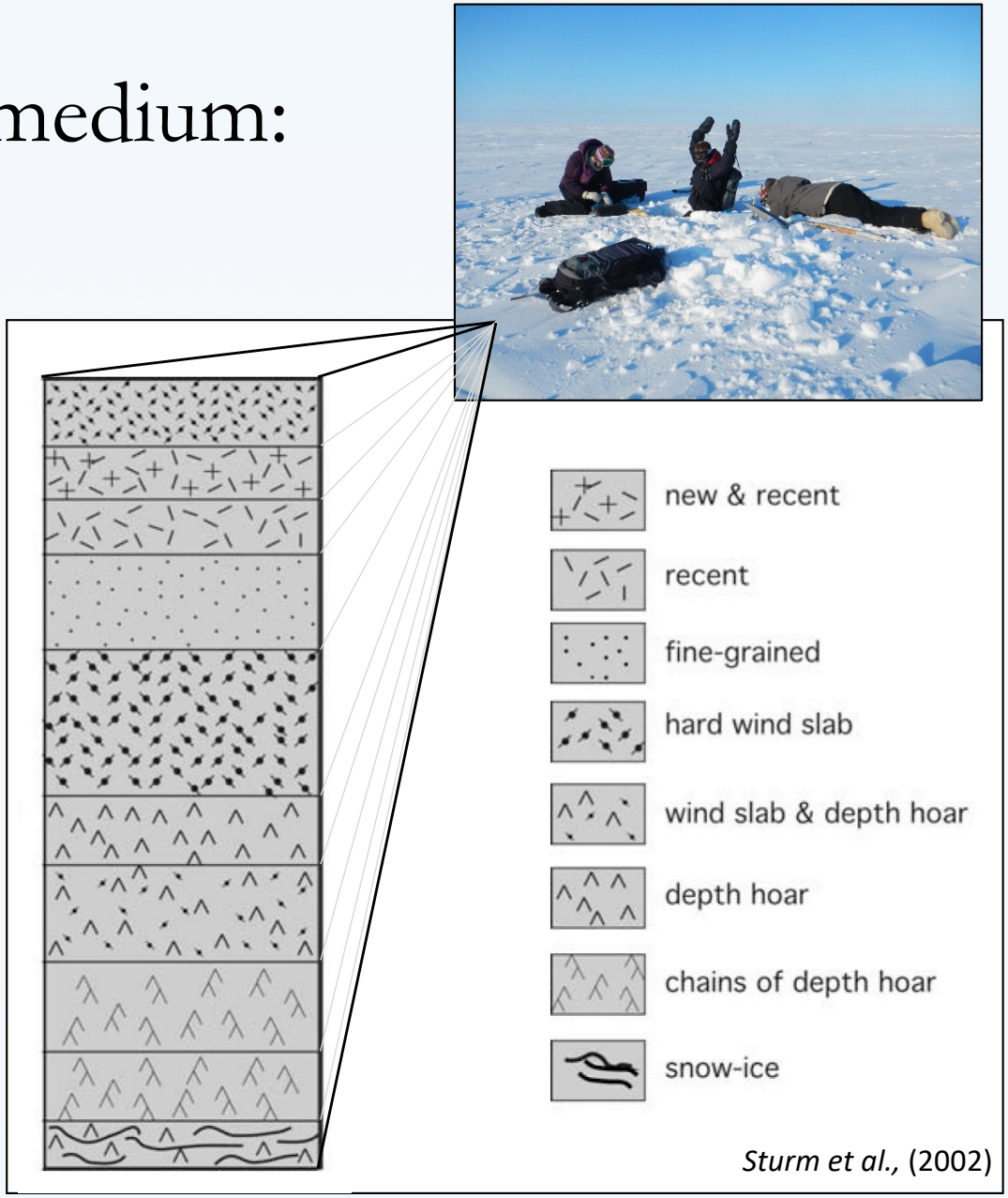


Sturm and Massom (2017)

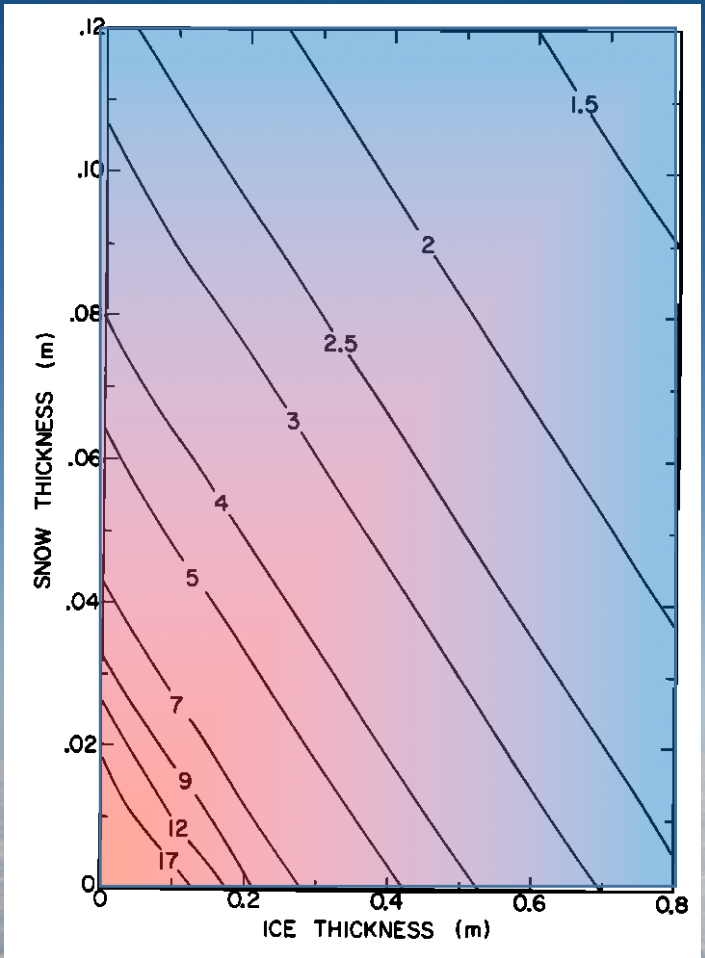
Snow's a complex medium:



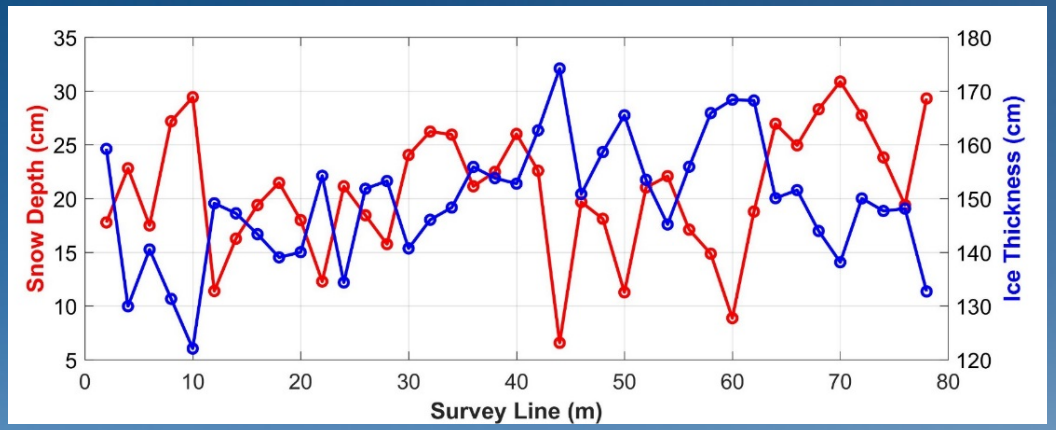
Left: ©Si Chen. Right: ©Beltsville Agricultural Research Center Electron and Confocal Microscopy Unit



It's an excellent insulator:

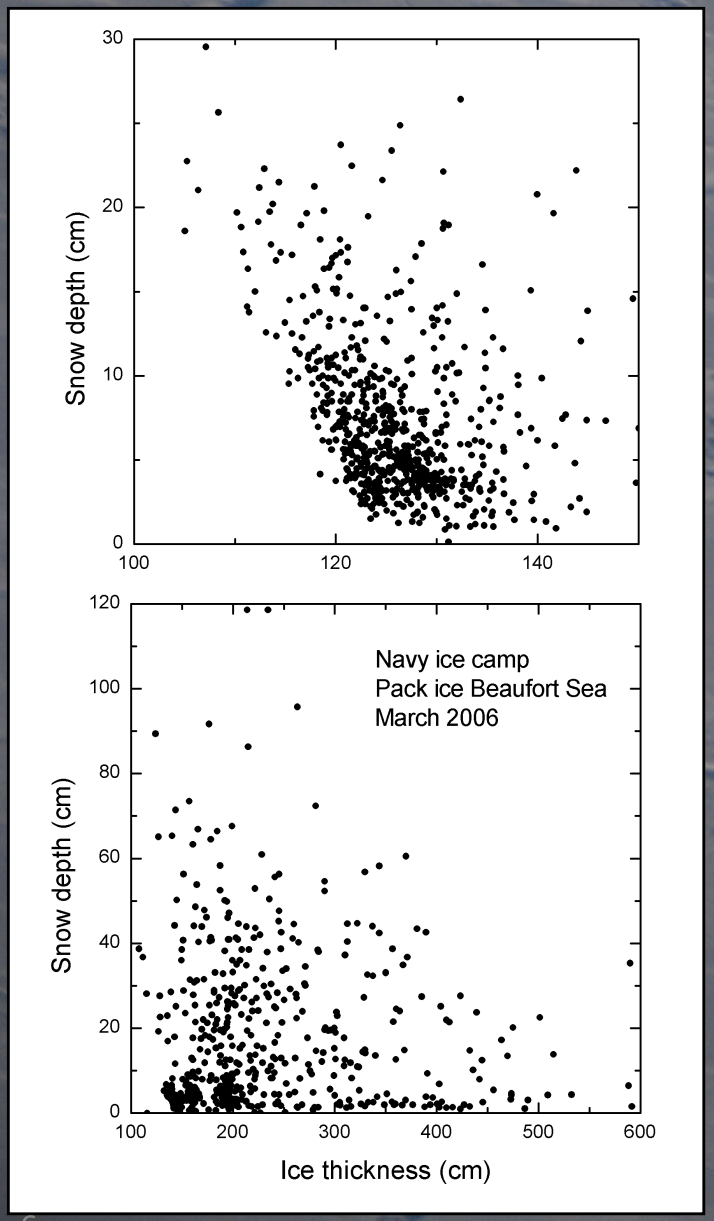


Maykut (1978)



Webster et al., (2012)

Snow & sea ice affect one another:

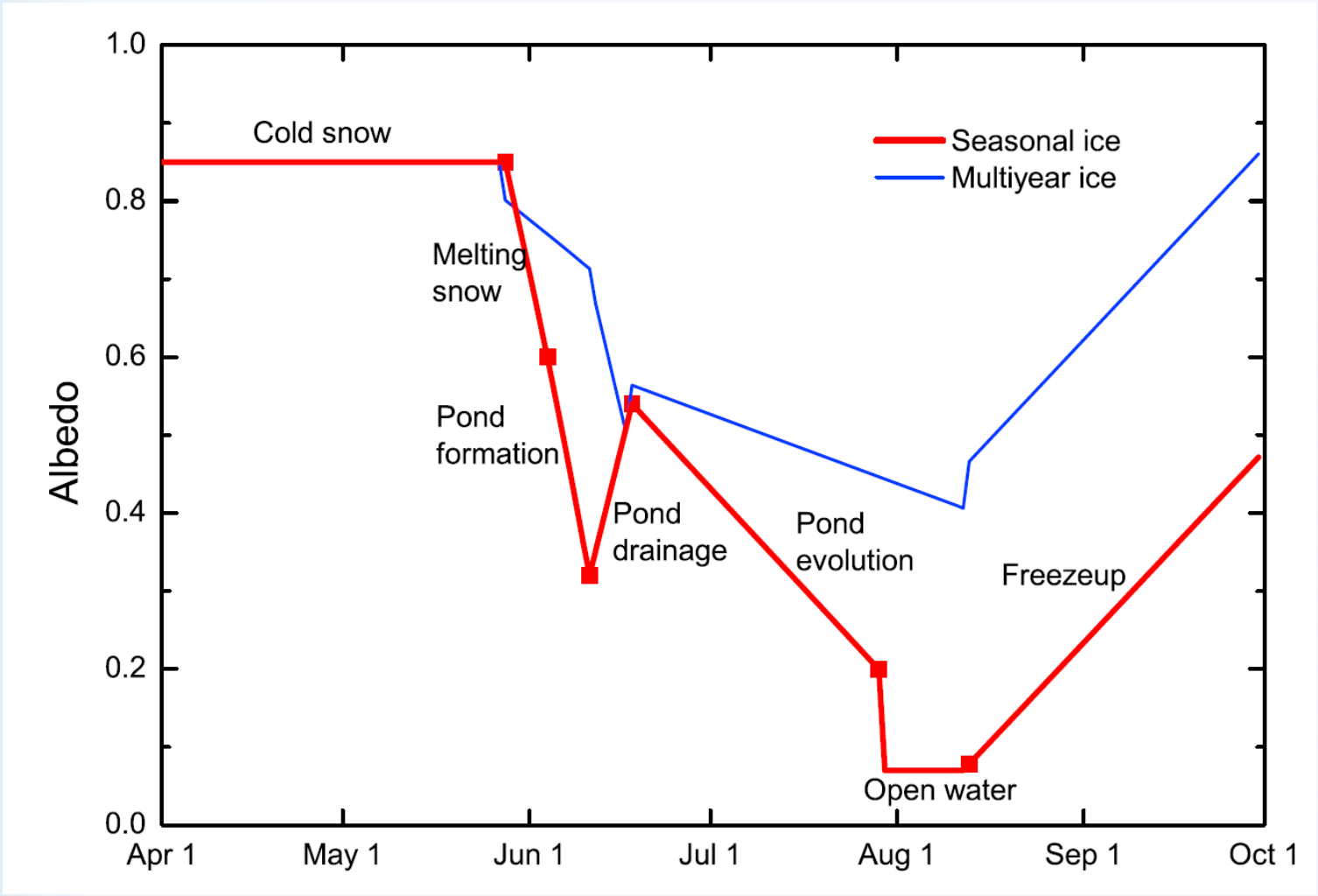


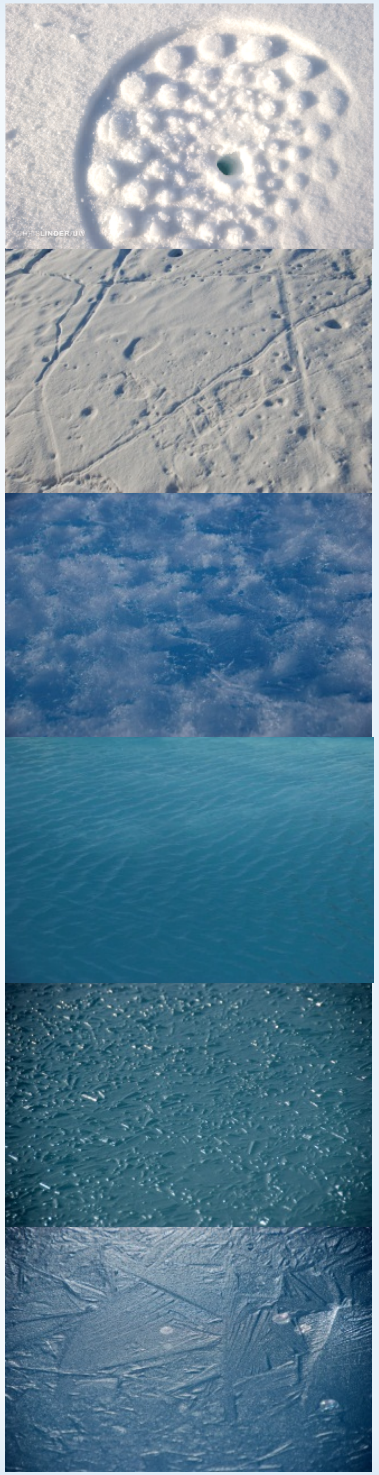
← Snow influencing sea ice thickness.

↗

← Sea ice influencing snow thickness.

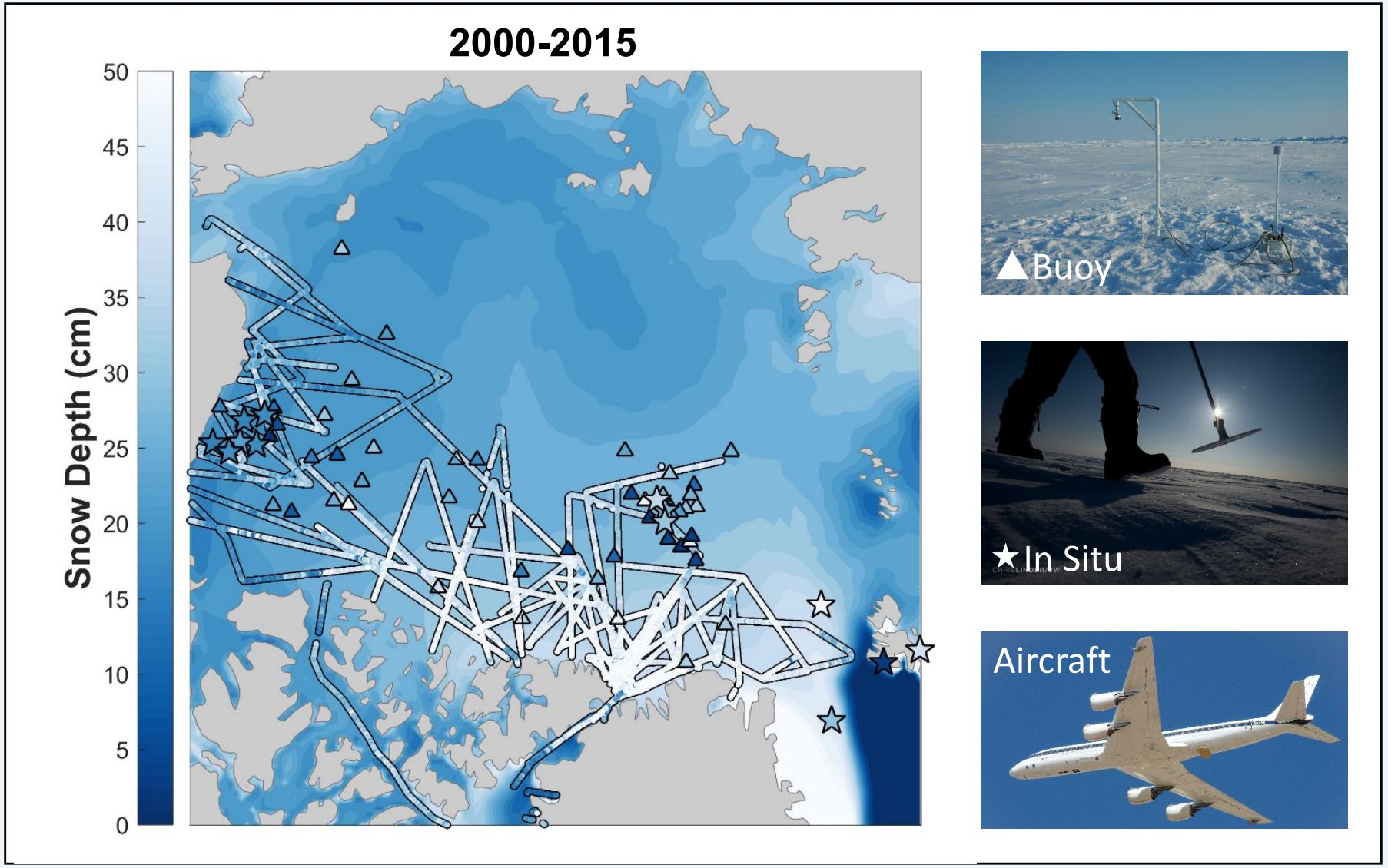
Incredibly reflective!





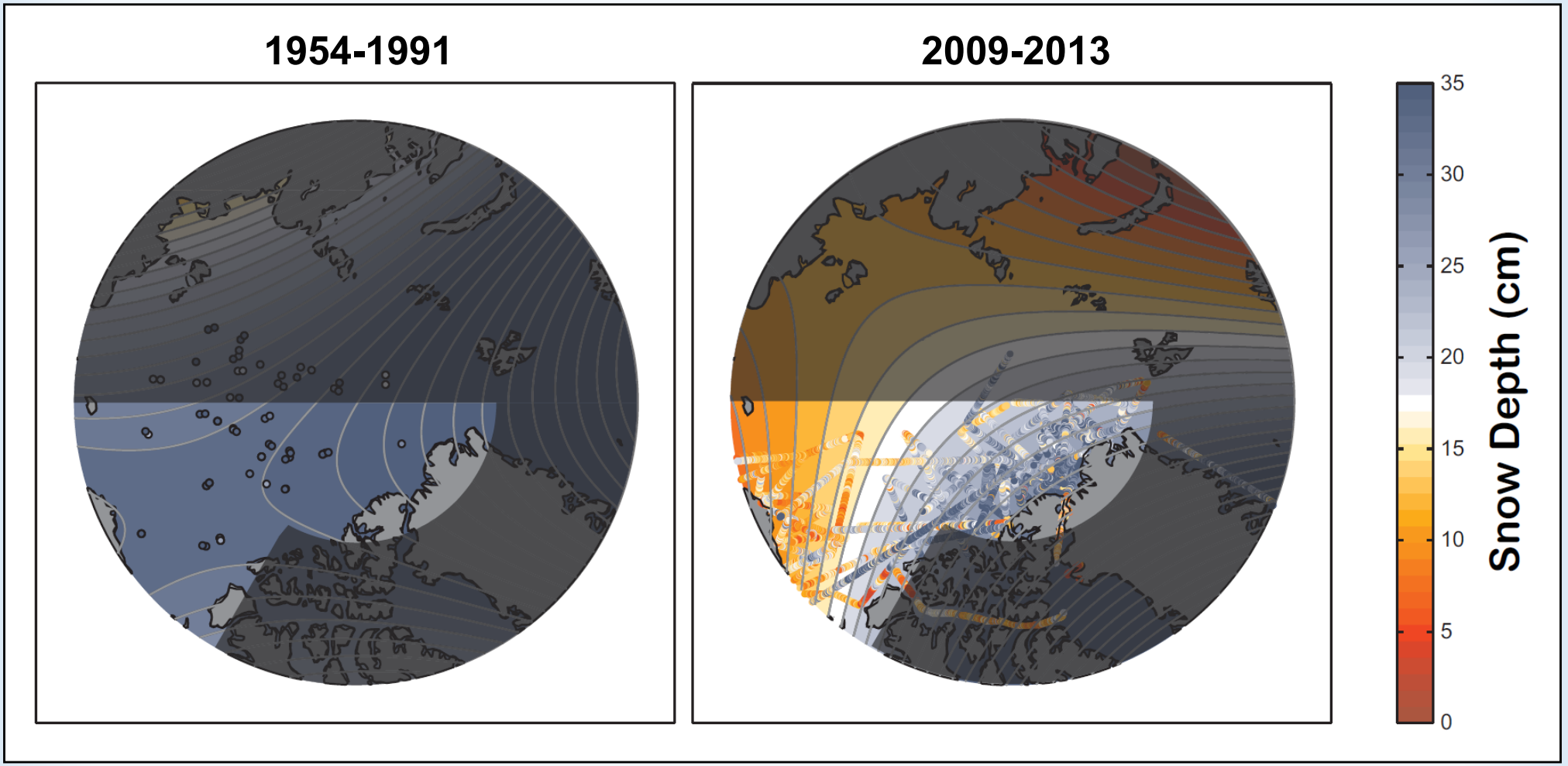
Perovich and Polashenski (2012)

Where is all the snow?



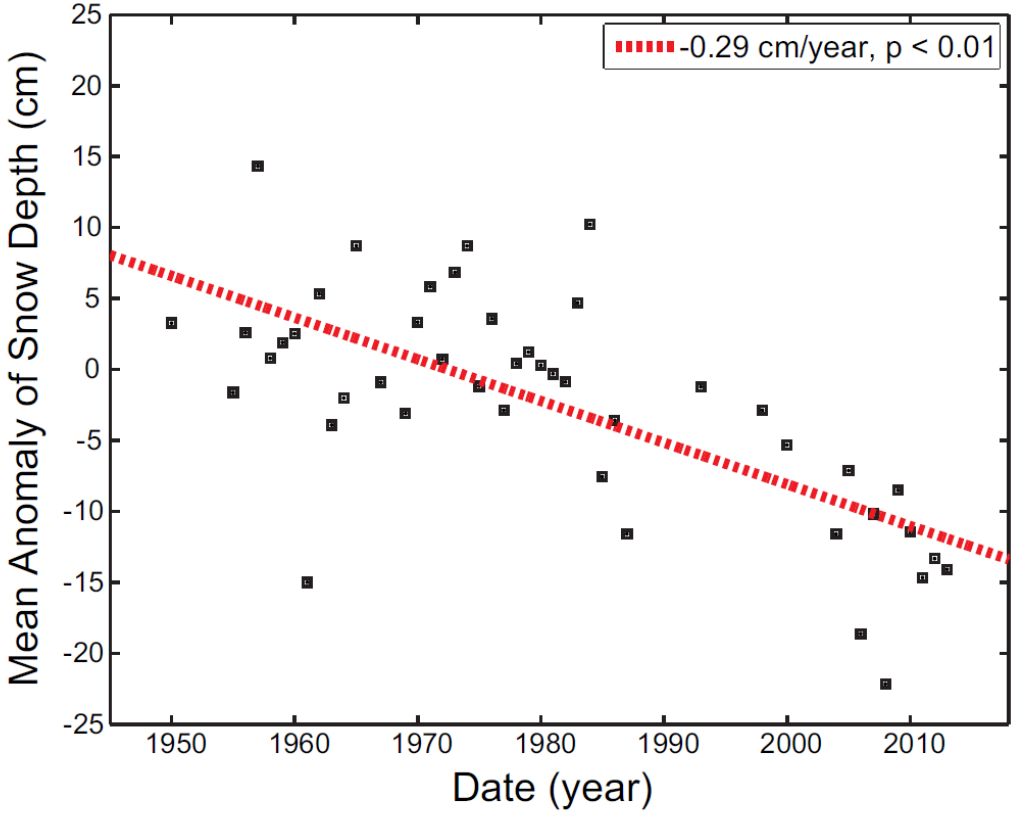
Webster et al., (in prep)

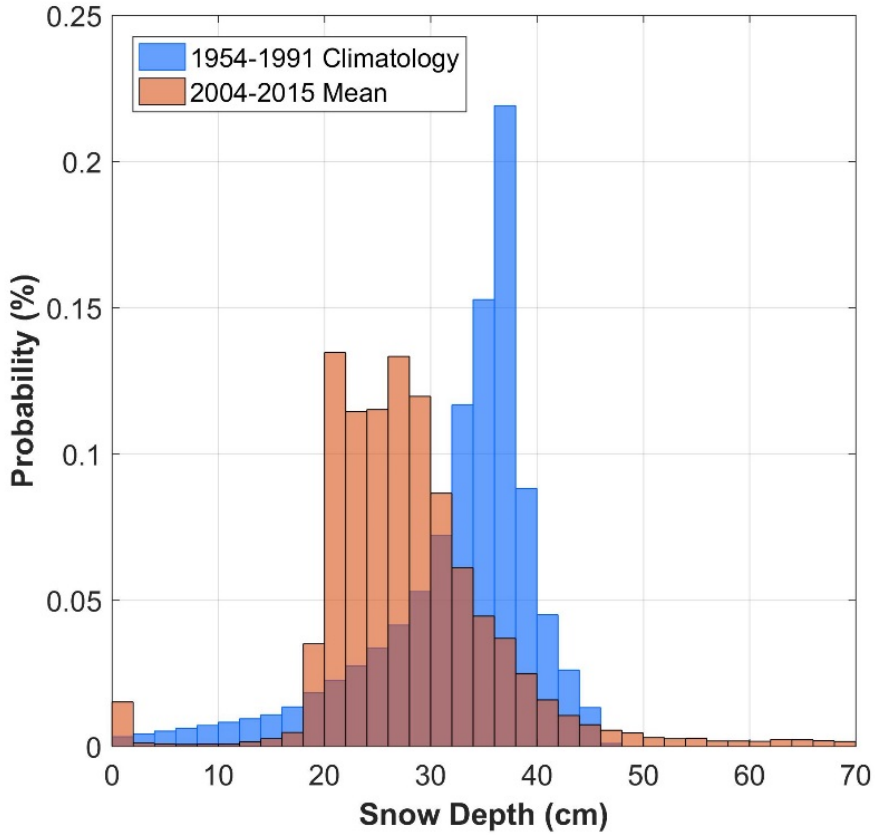
Snow depth distributions have changed:



Webster et al., (2014)

Observations & models agree:

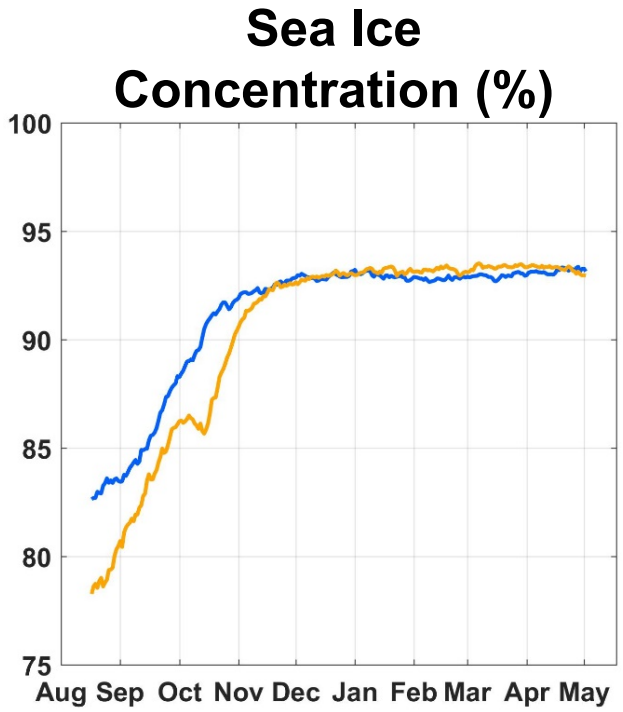


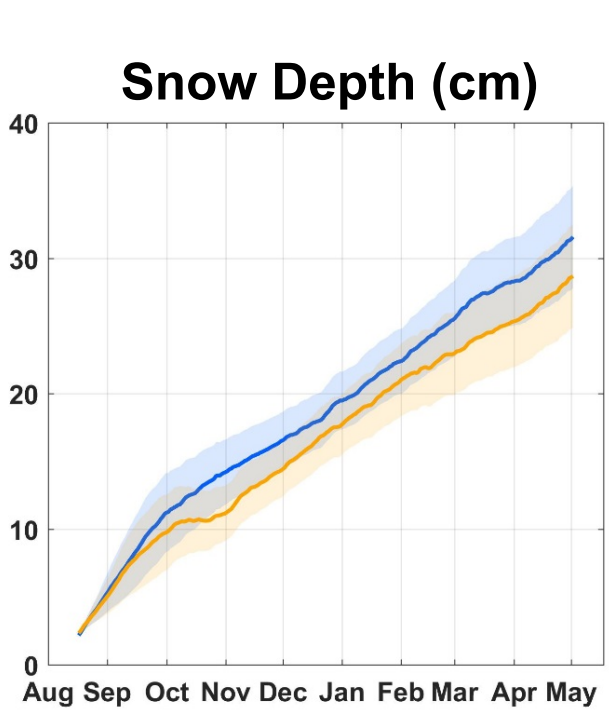


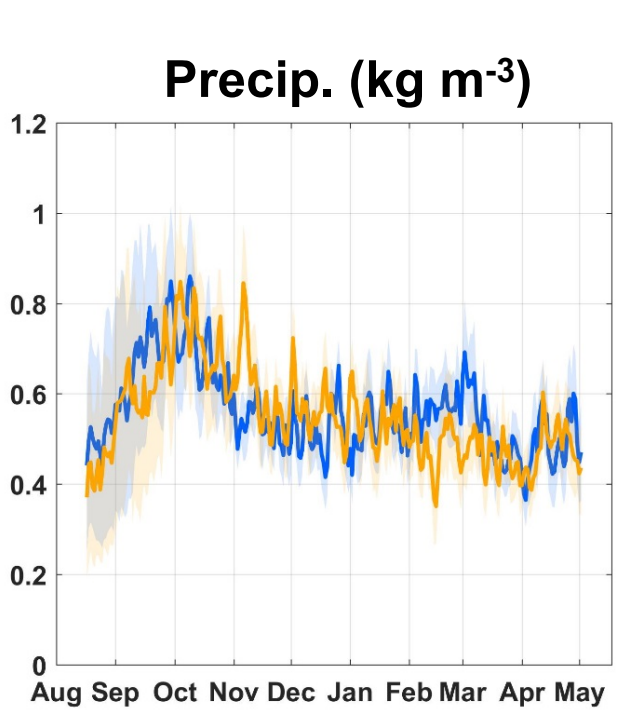
Which processes might be driving this trend?

Webster et al., (2014; in prep)

Models can reveal insight into processes:



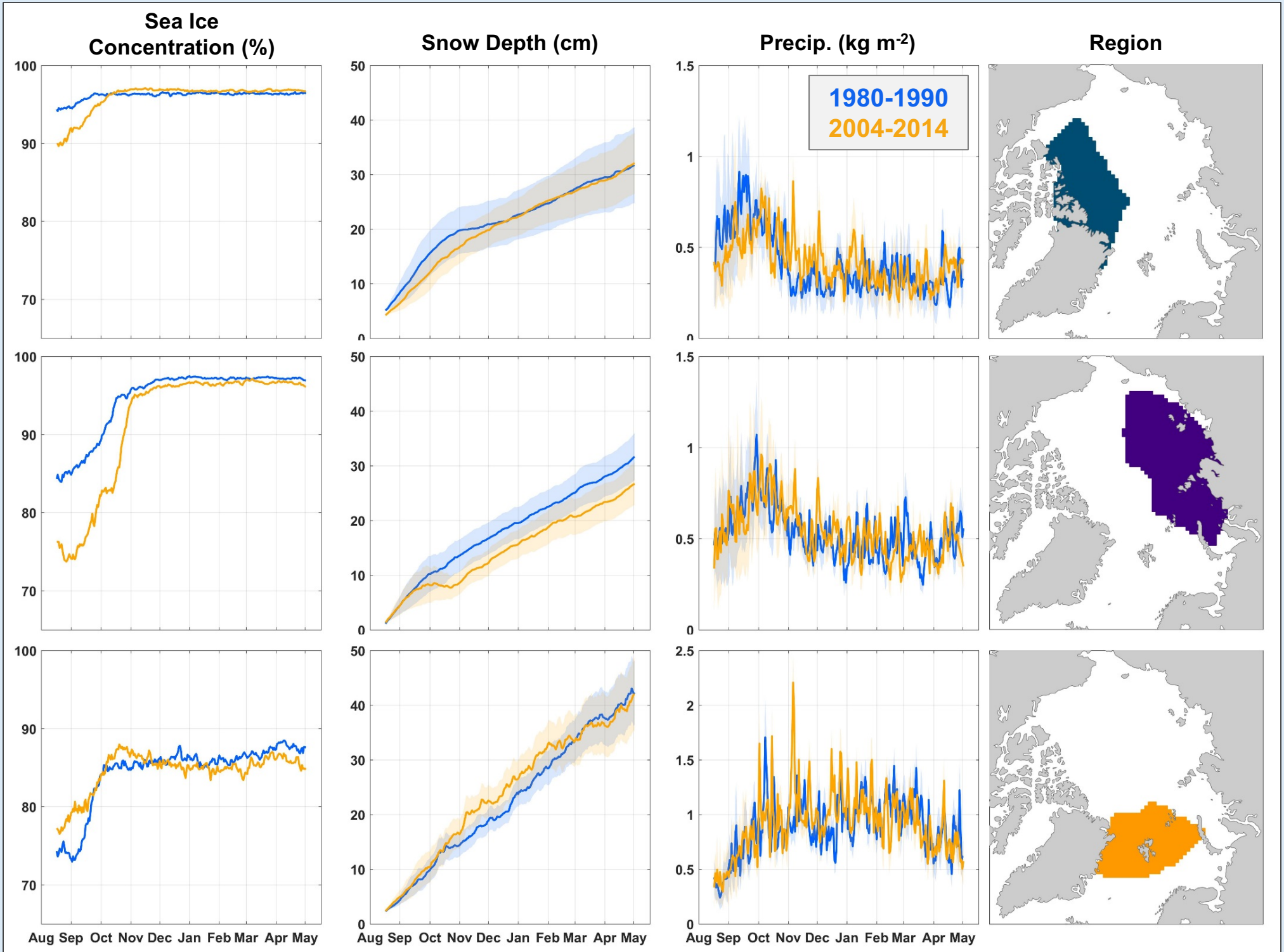




3+ week freeze-up difference N. of 70°N

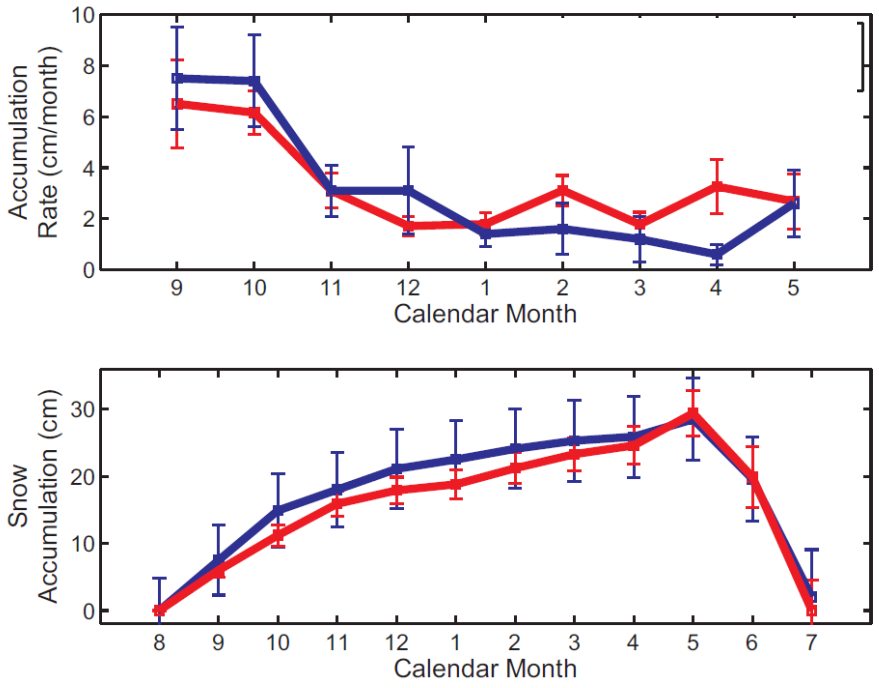
1980-1991
2003-2014

Petty et al., (in review)*; Webster et al.,* (in prep)

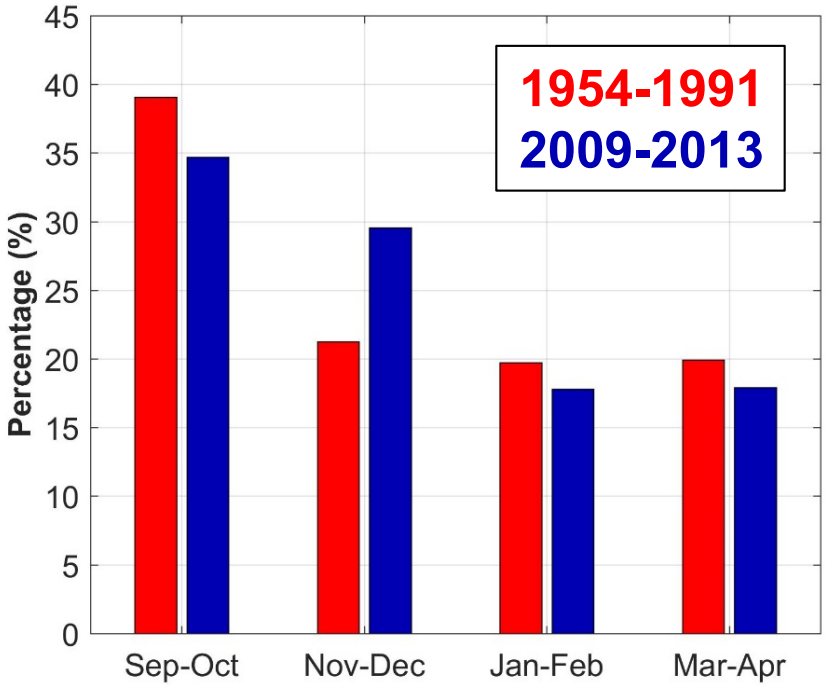

Sea Ice Concentration (%)
Snow Depth (cm)
Precip. (kg m-2)
Region
1980-1990
2004-2014
100
90
80
70
50
40
30
20
10
0
1.5
1
0.5
2.5
2
Aug Sep Oct Nov Dec Jan Feb Mar Apr May

The seasonal cycle is shifting:

Observations



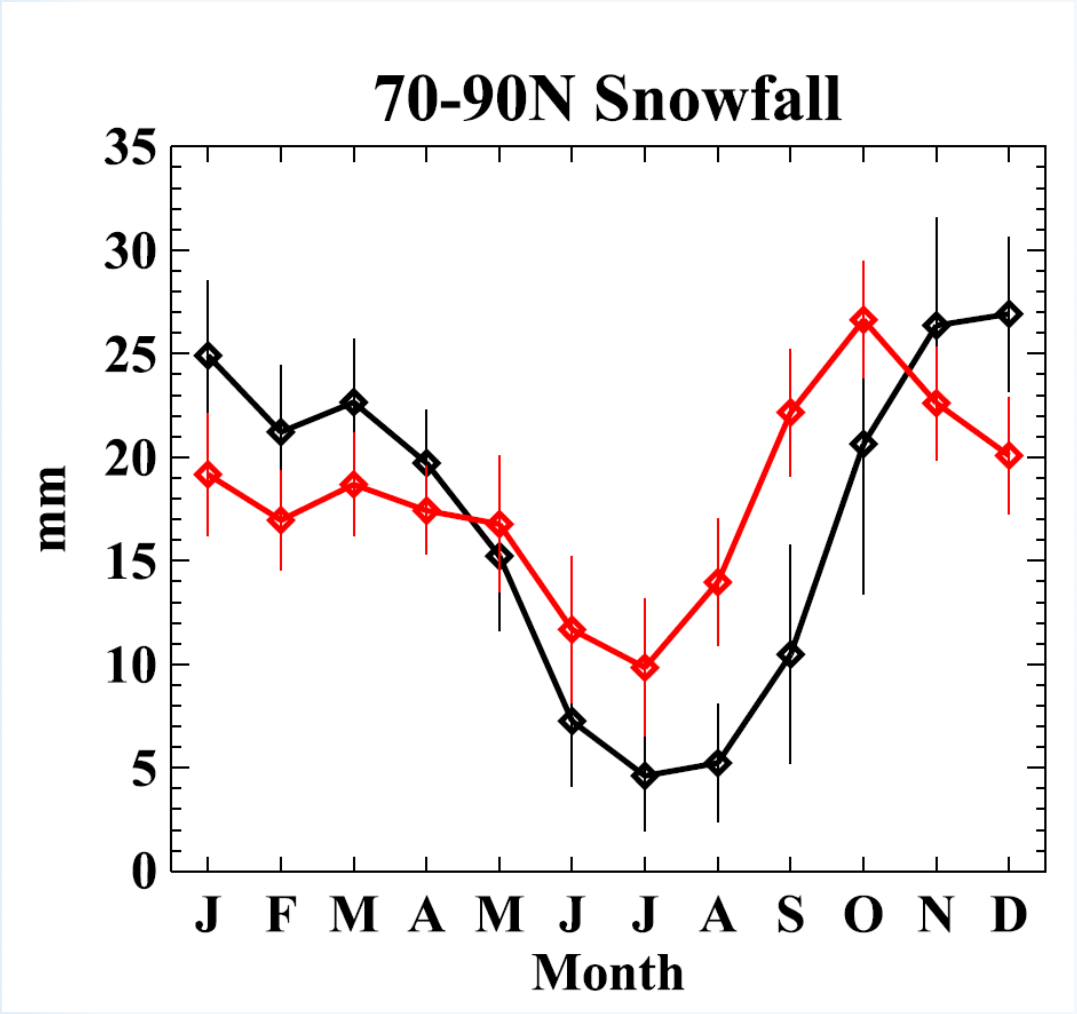
Model

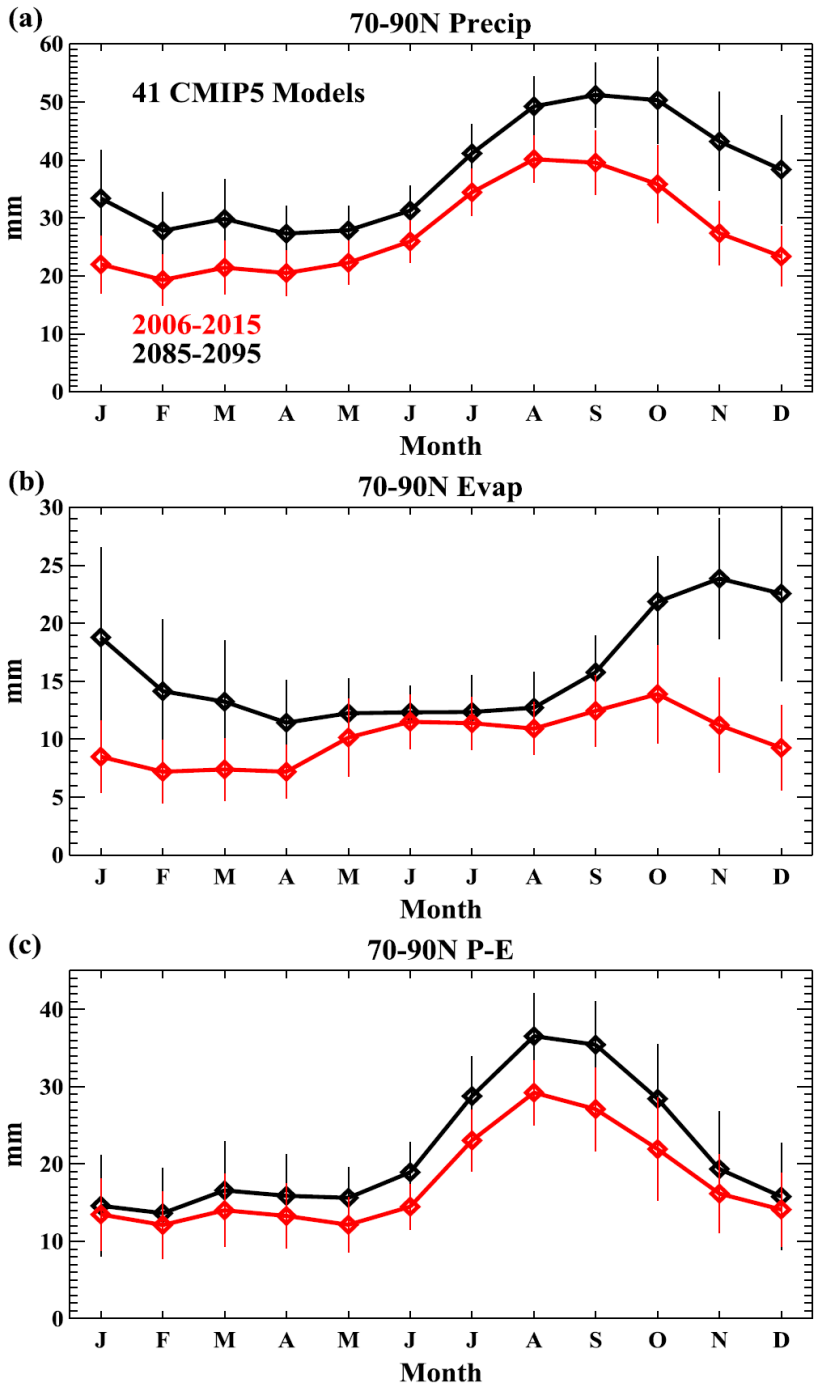


Webster et al. (2014; in prep)


What can we anticipate as future scenarios?

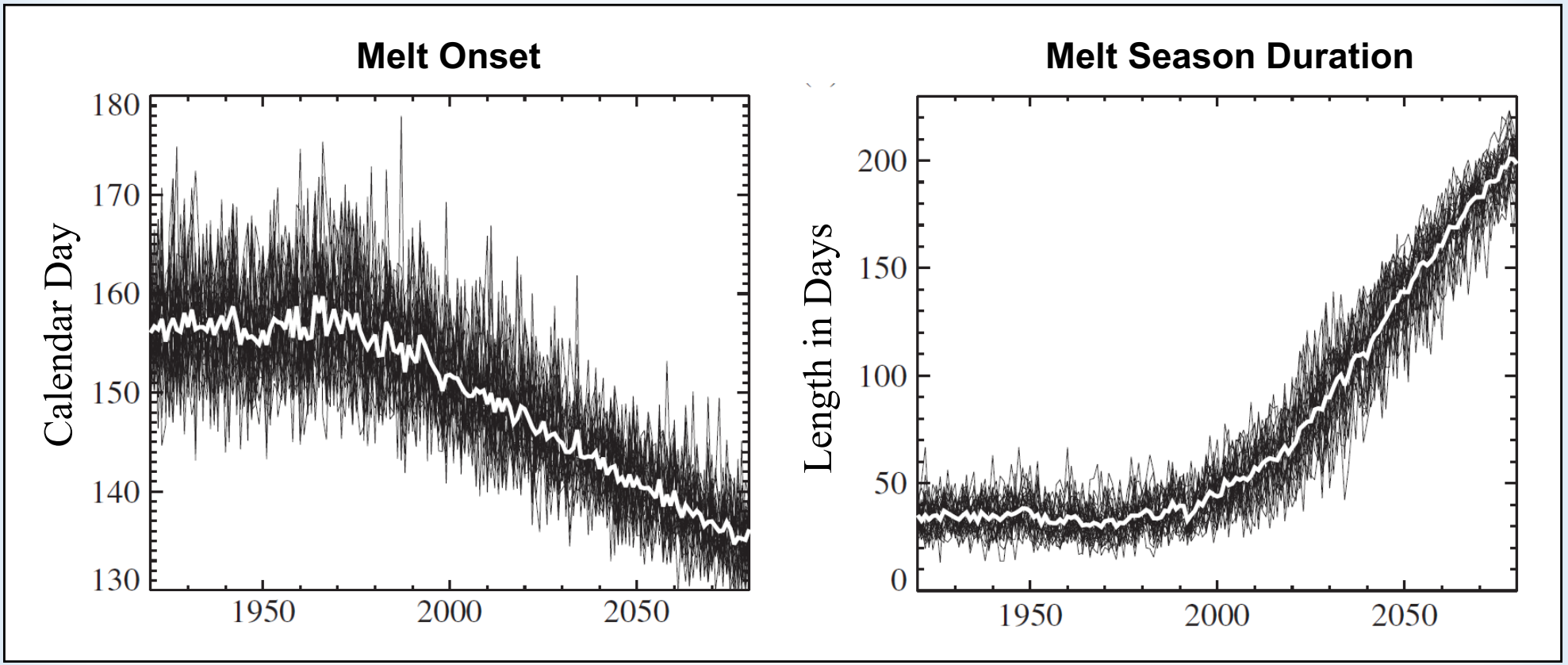
More precipitation…

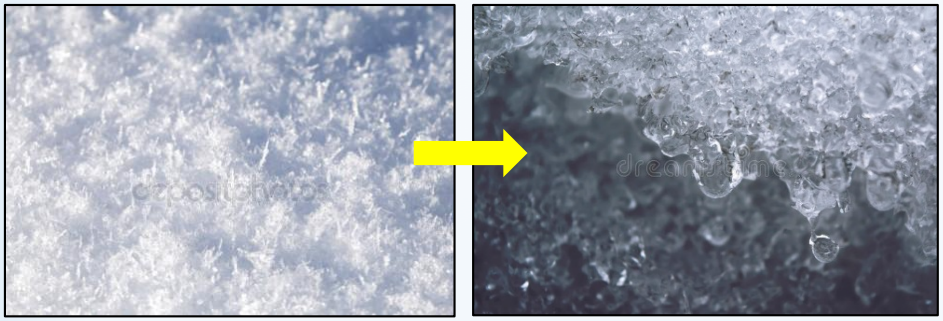




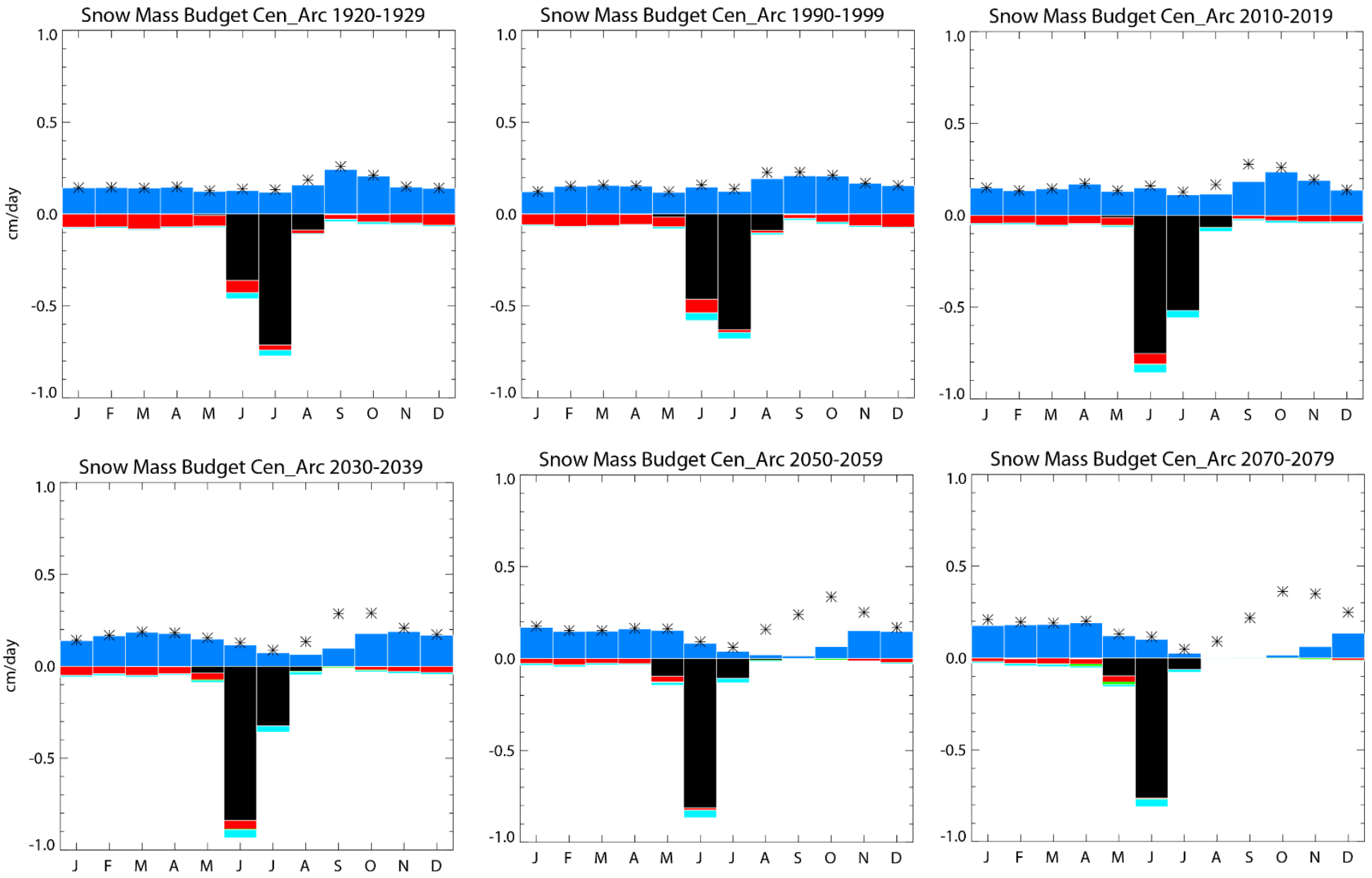
Lique et al. (2016)

An earlier and longer melt season…



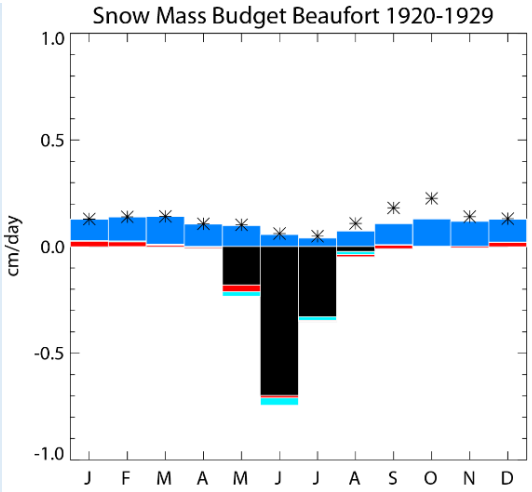


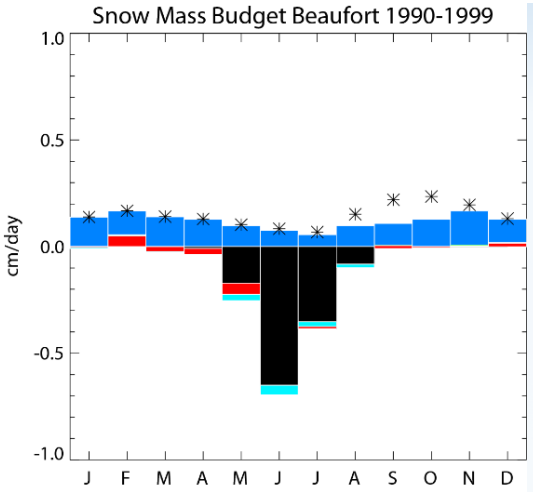
Holland and Landrum (2015)

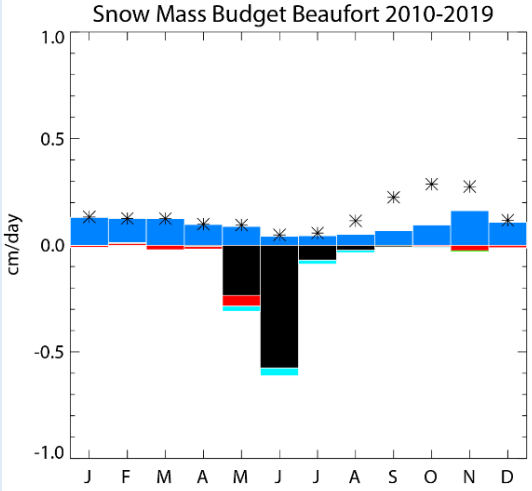


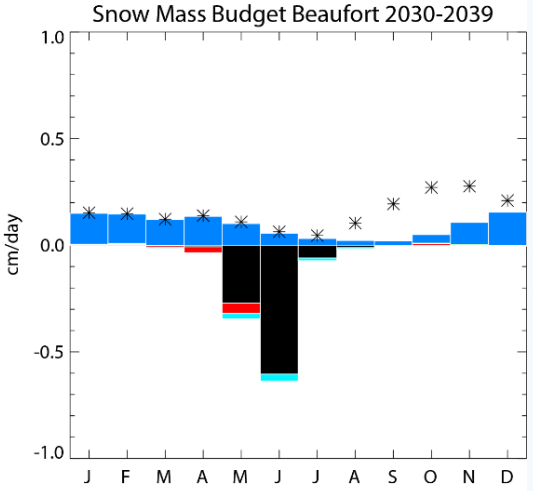
Snow accumulation, **Melt**, **Ridging/Advection**, **Evaporation**, **Snow-ice formation**, *Snowfall

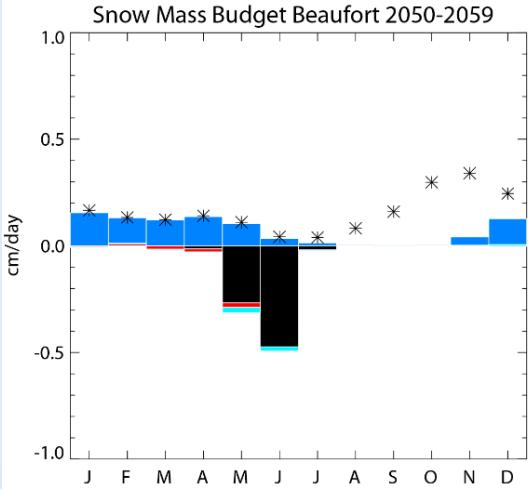
Webster et al., (in prep)

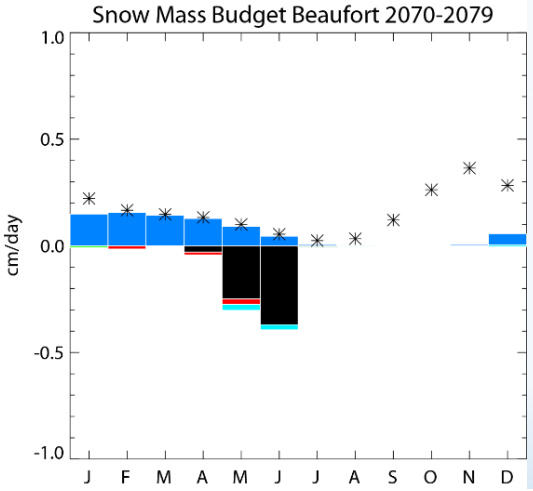


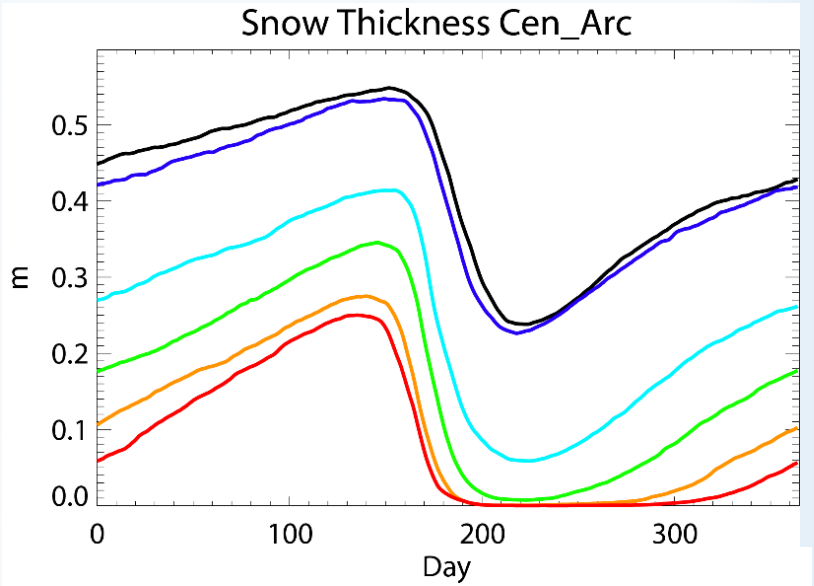


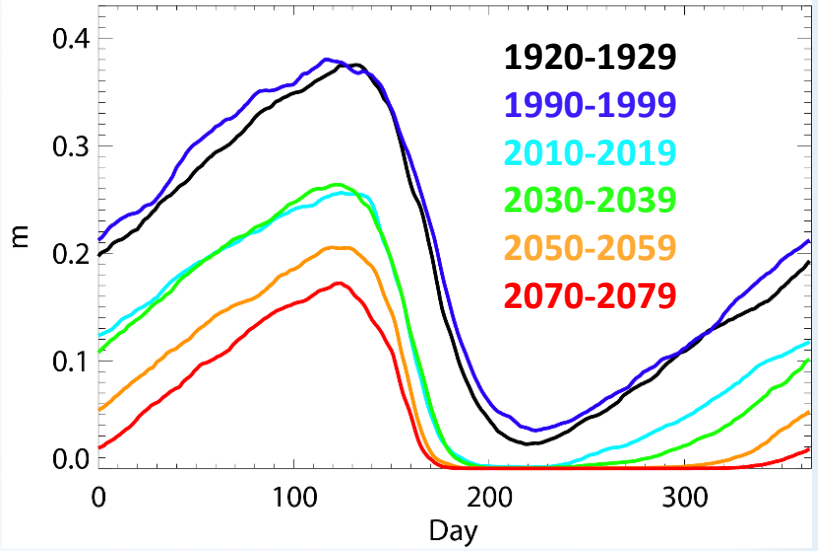










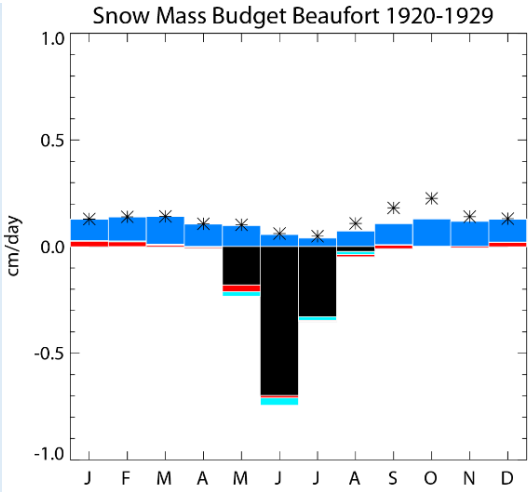


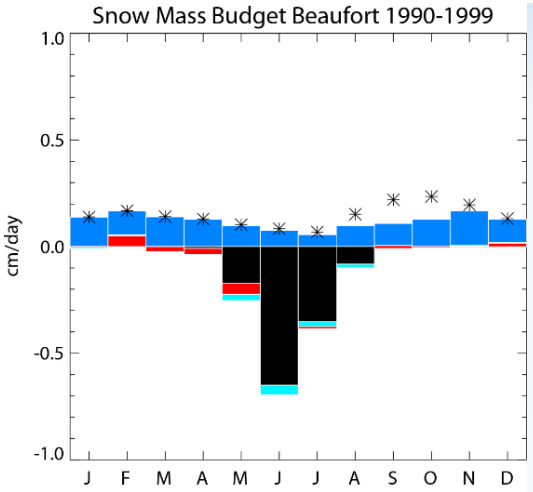
Webster et al., (in prep)

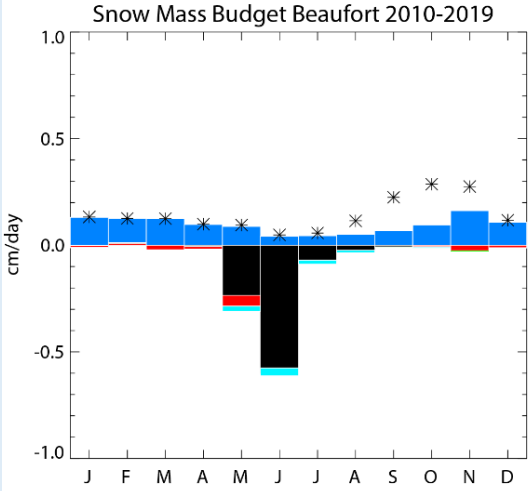
Summary:

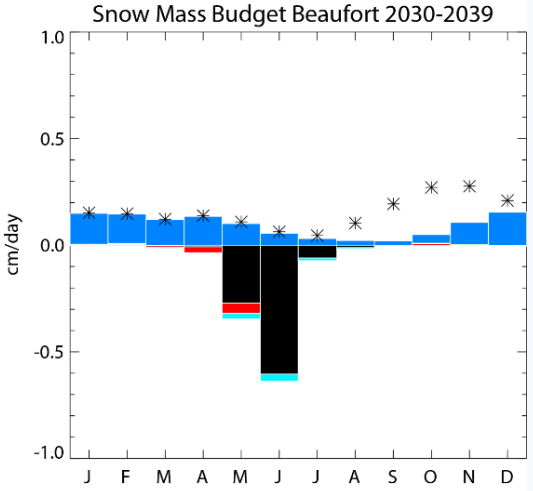
- Snow is a complex medium, excellent insulator & reflector.
- The deepest snow is on multiyear ice; thinner snow is on younger ice.
- Less multiyear ice → less snow.
- We can anticipate shift in seasonal snow accumulation & less total snow.
  - →Snow-albedo feedback?
  - →Better ice growth conditions?

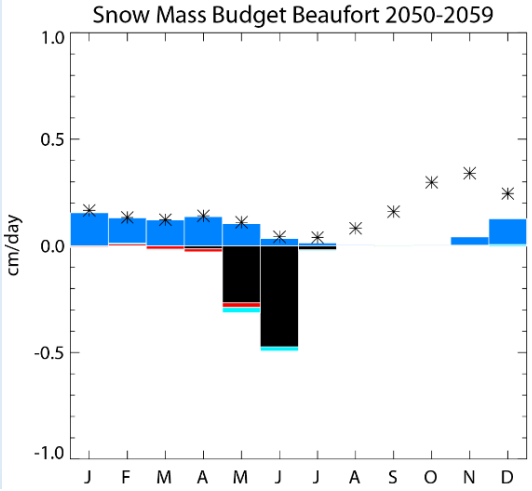
Extra:

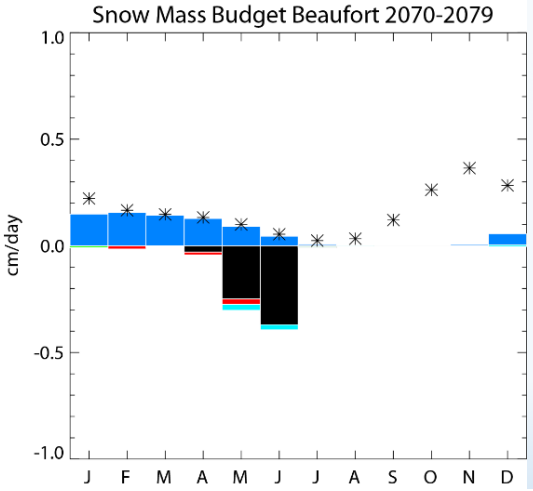


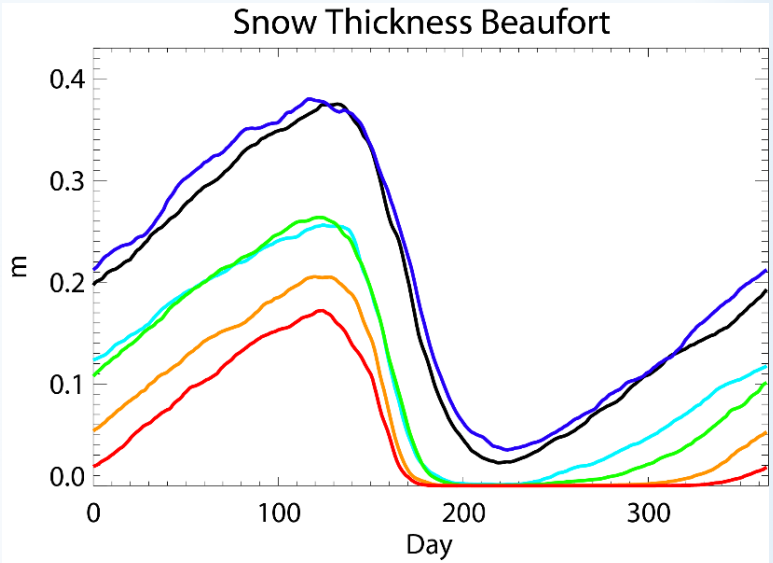


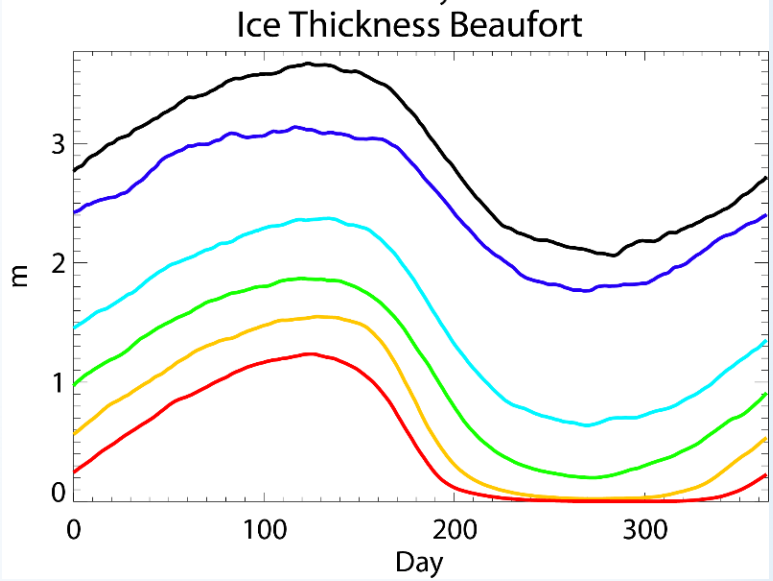












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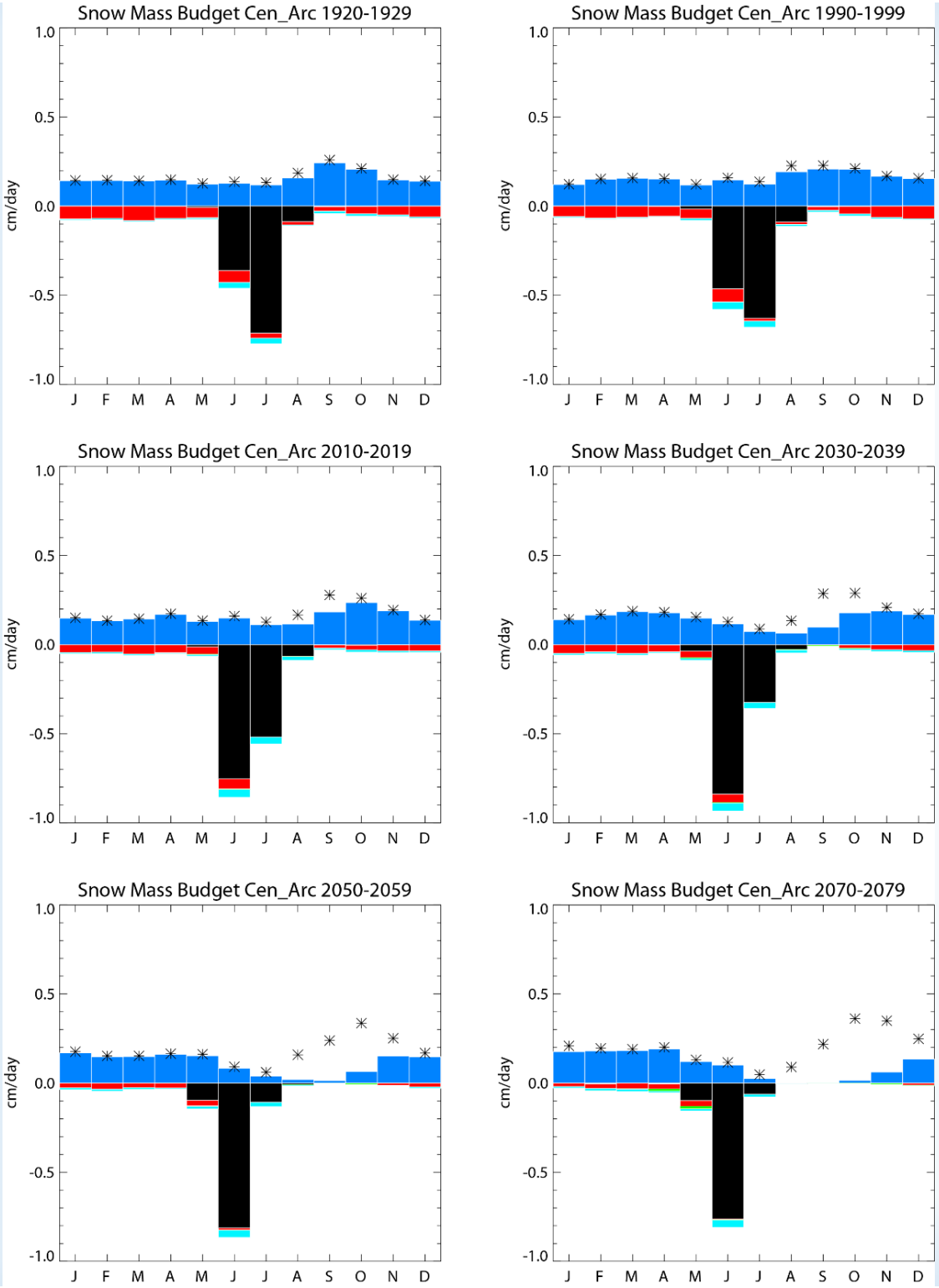
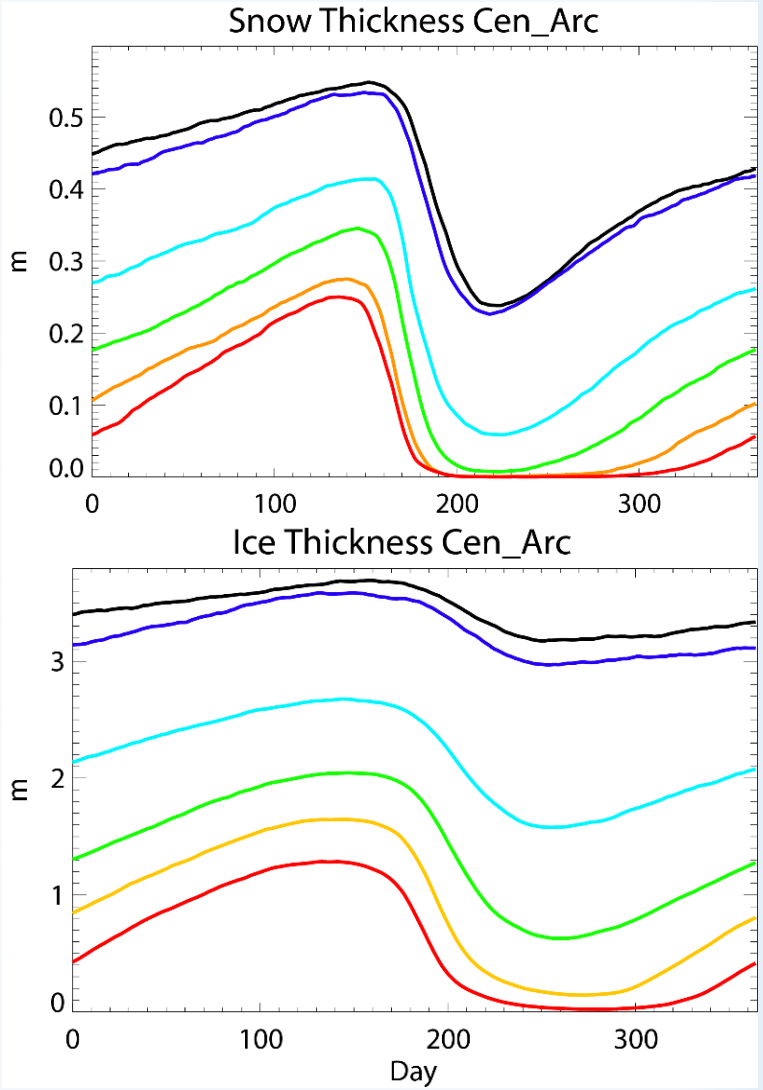
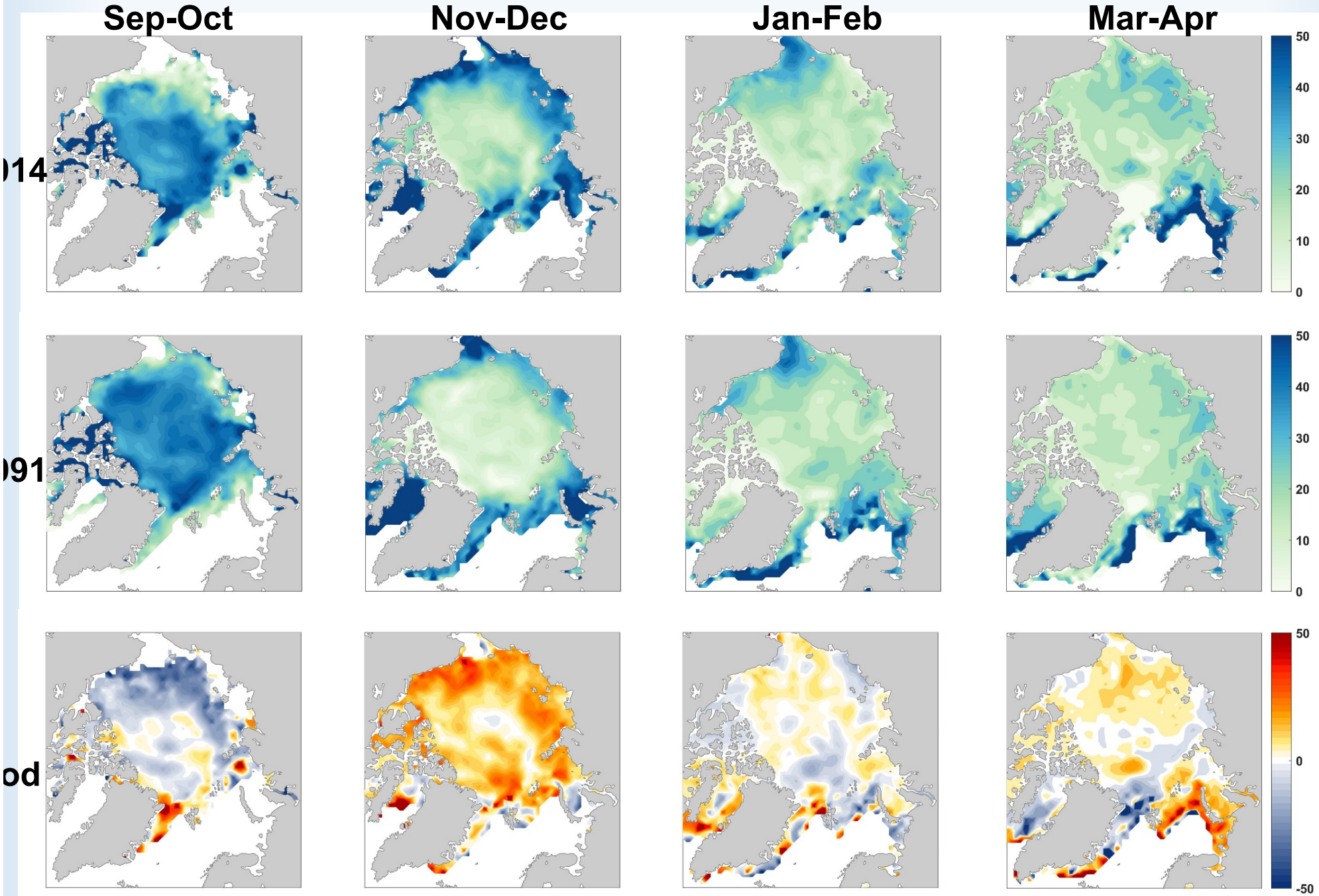


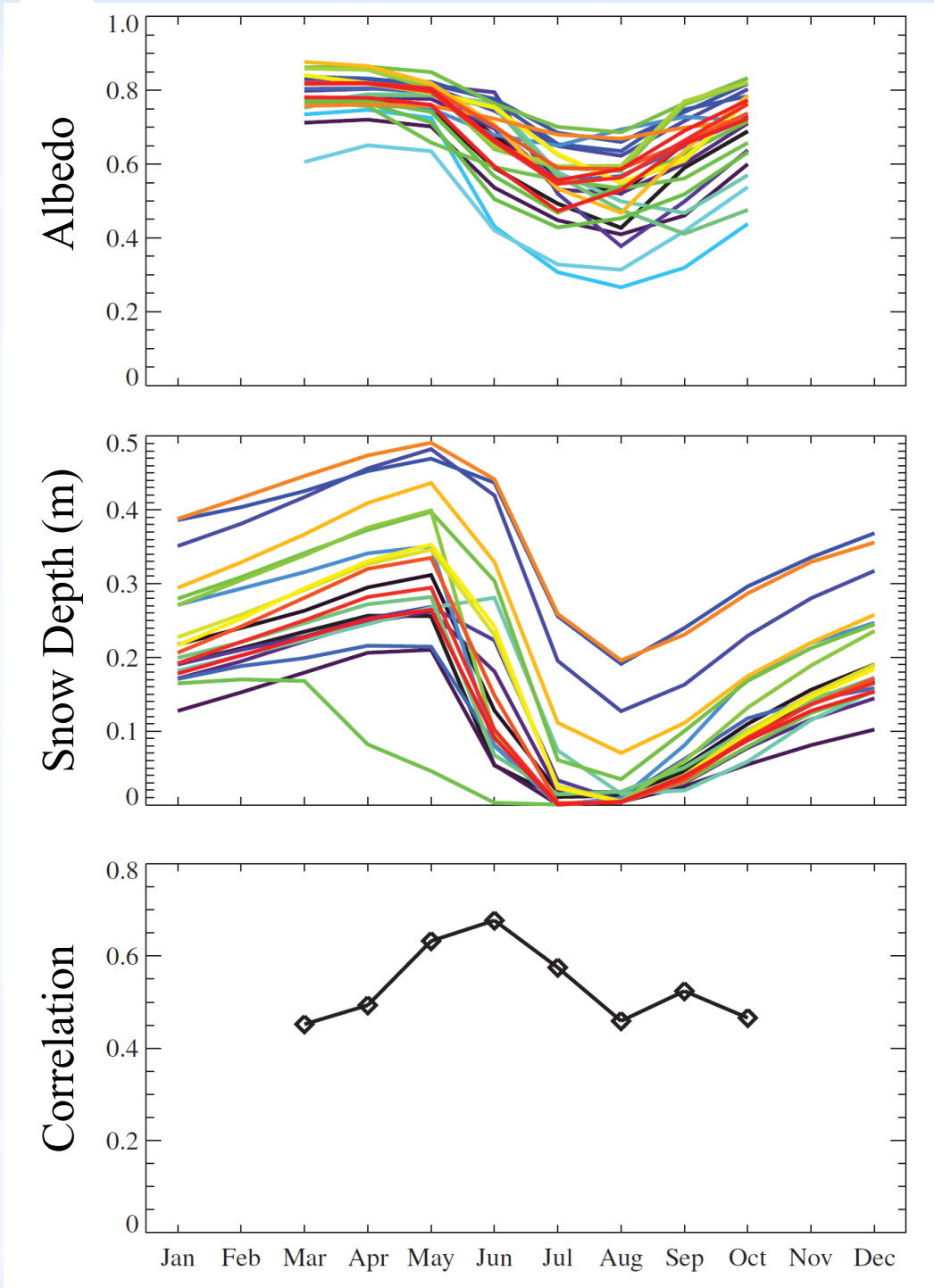


Webster et al., (in prep)

Seasonal Contributions (%) to total depth



…more solar absorption…



Holland and Landrum (2015)