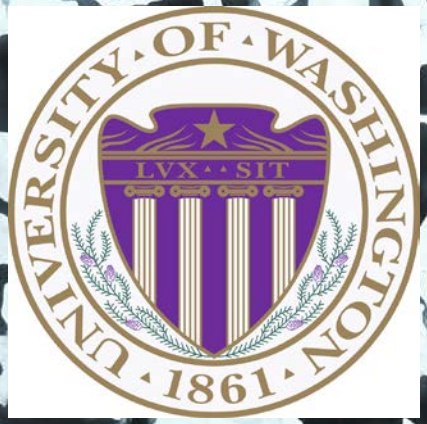
Sources of Seasonal Sea-Ice Predictability

by Cecilia Bitz



Complex Variability

When & where do leads form?

What is the distribution of snow?

When does melt start?

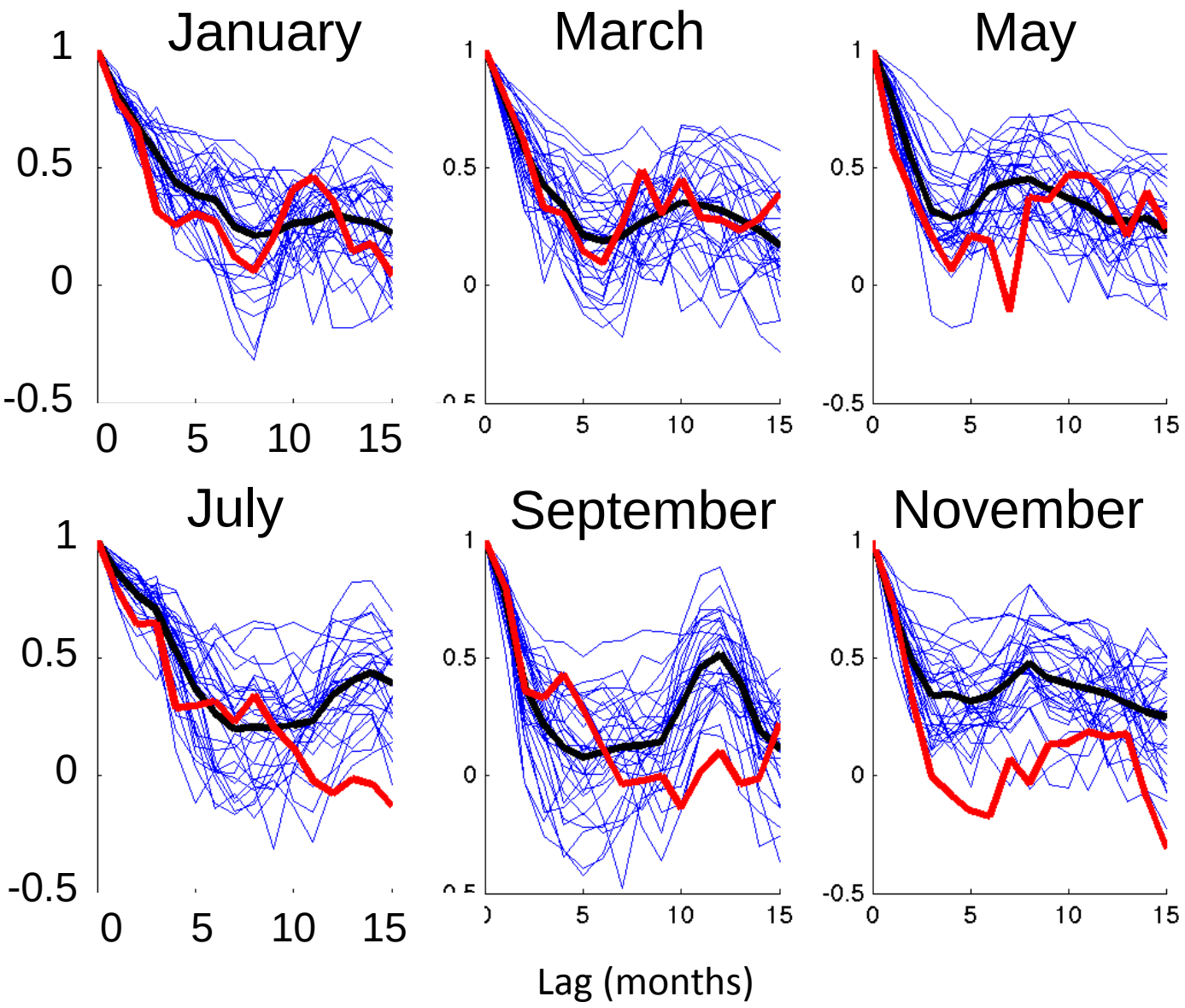
When do ponds form?

Seasonal prediction is inherently probabilistic

slide from D. Perovich

Variability Evolution from Initial Conditions

Lagged Correlation of pan-Arctic Sea Ice area



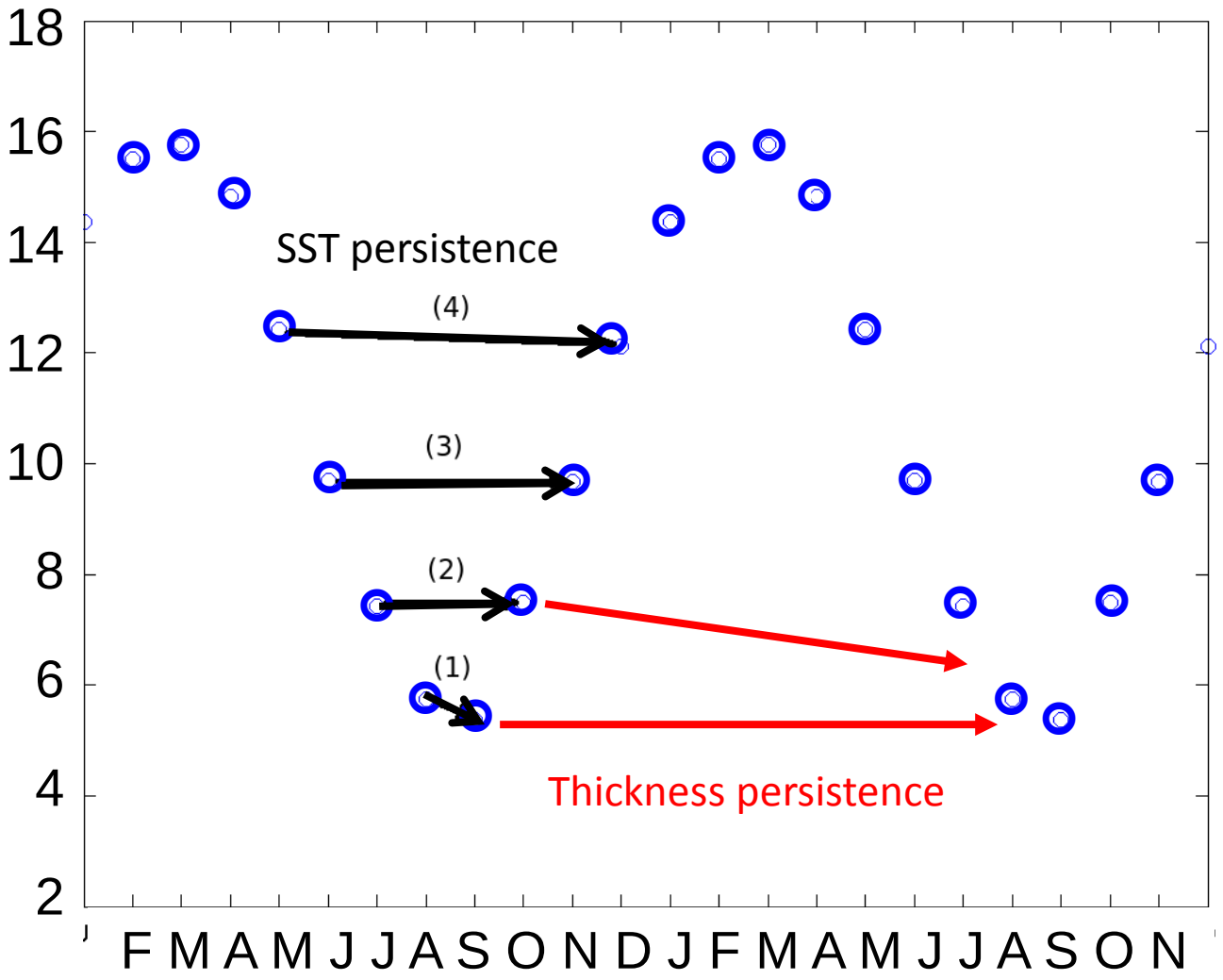
Model Mean

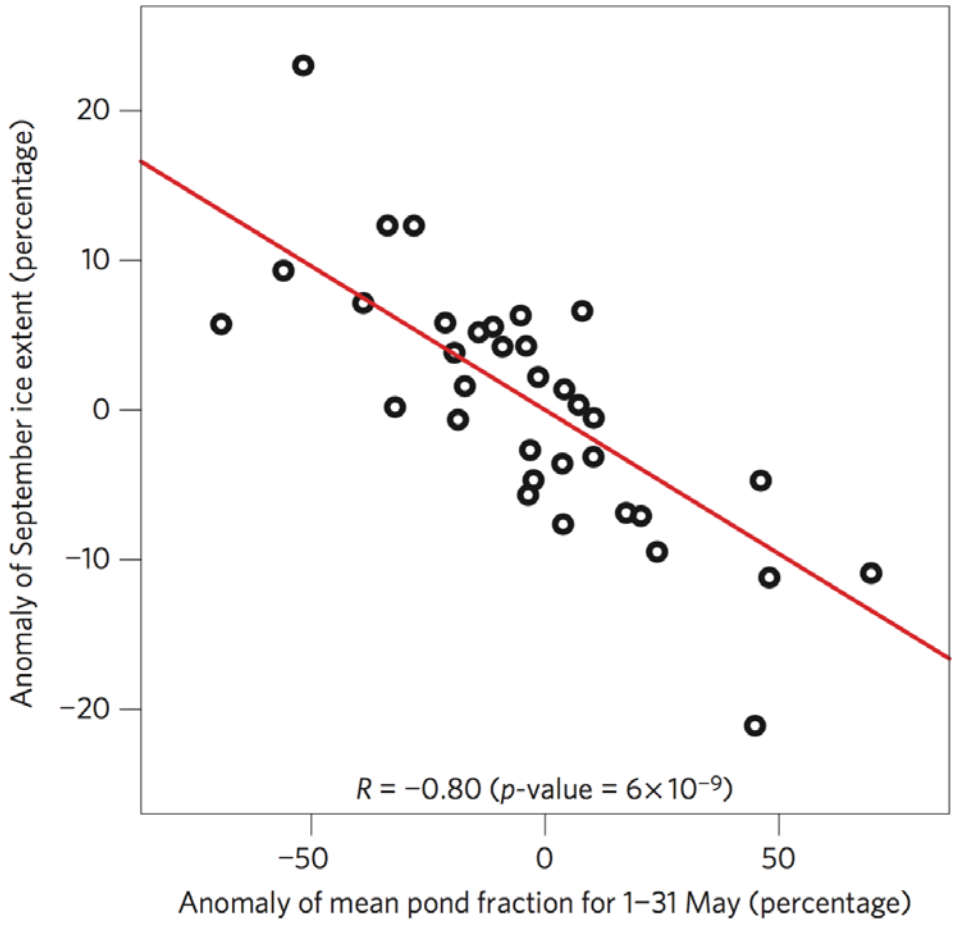
Observations

30-yr chunks from a model

Blanchard Wrigglesworth etal (2011)

Sea ice Area Seasonal Cycle in 10^6 km^2 cartoon





May Melt Ponds as a Predictor of Sea Ice Extent

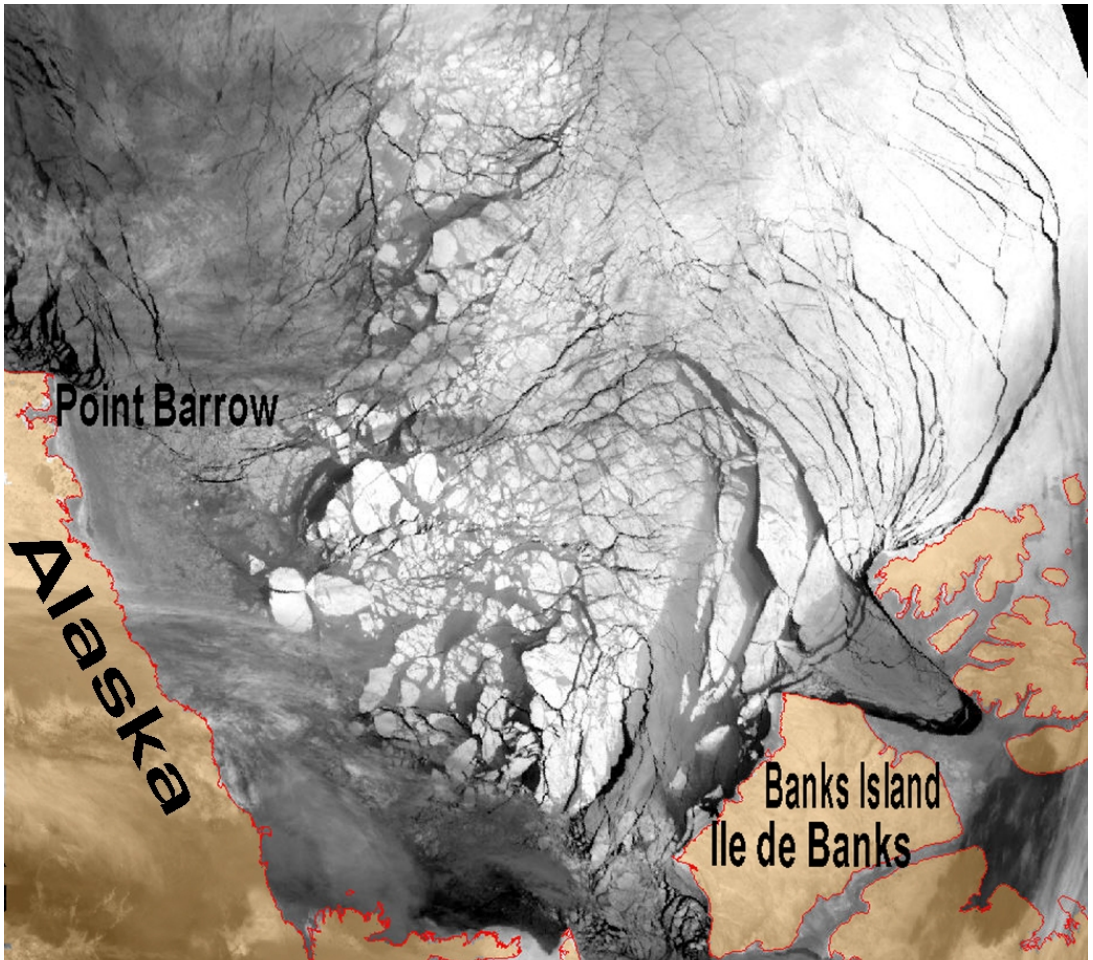
in a sea ice model

Schroeder et al (2014)

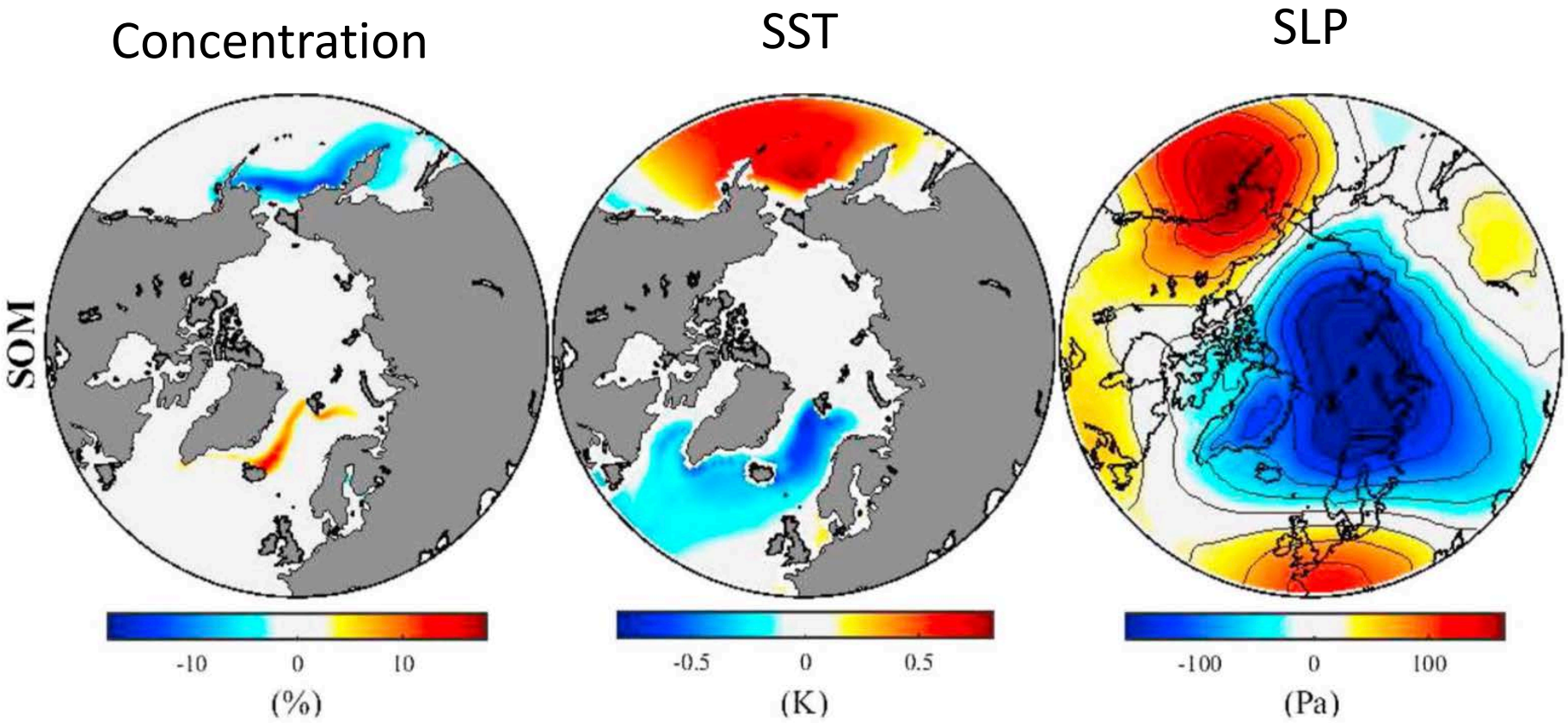
Not reproduced with satellite observations (Liu et al, 2015)
but these authors did find that the integrated May and June pond fraction is a good predictor of mid-summer sea ice extent

Keep in mind that far more information may be predictable at the local scale even when these pan-Arctic metrics are not.

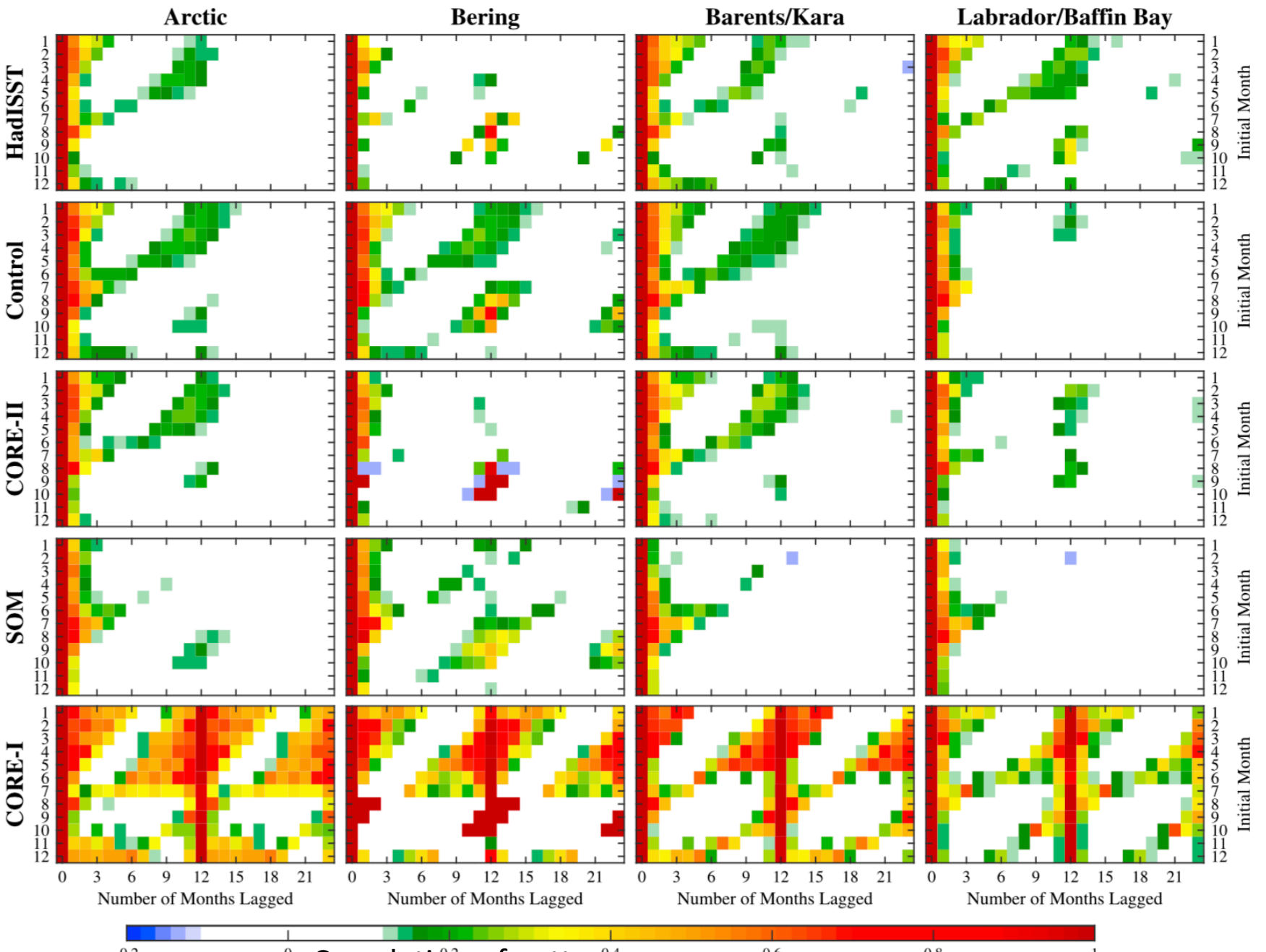
However, relatively little work has addressed the local scale.



Family of patterns

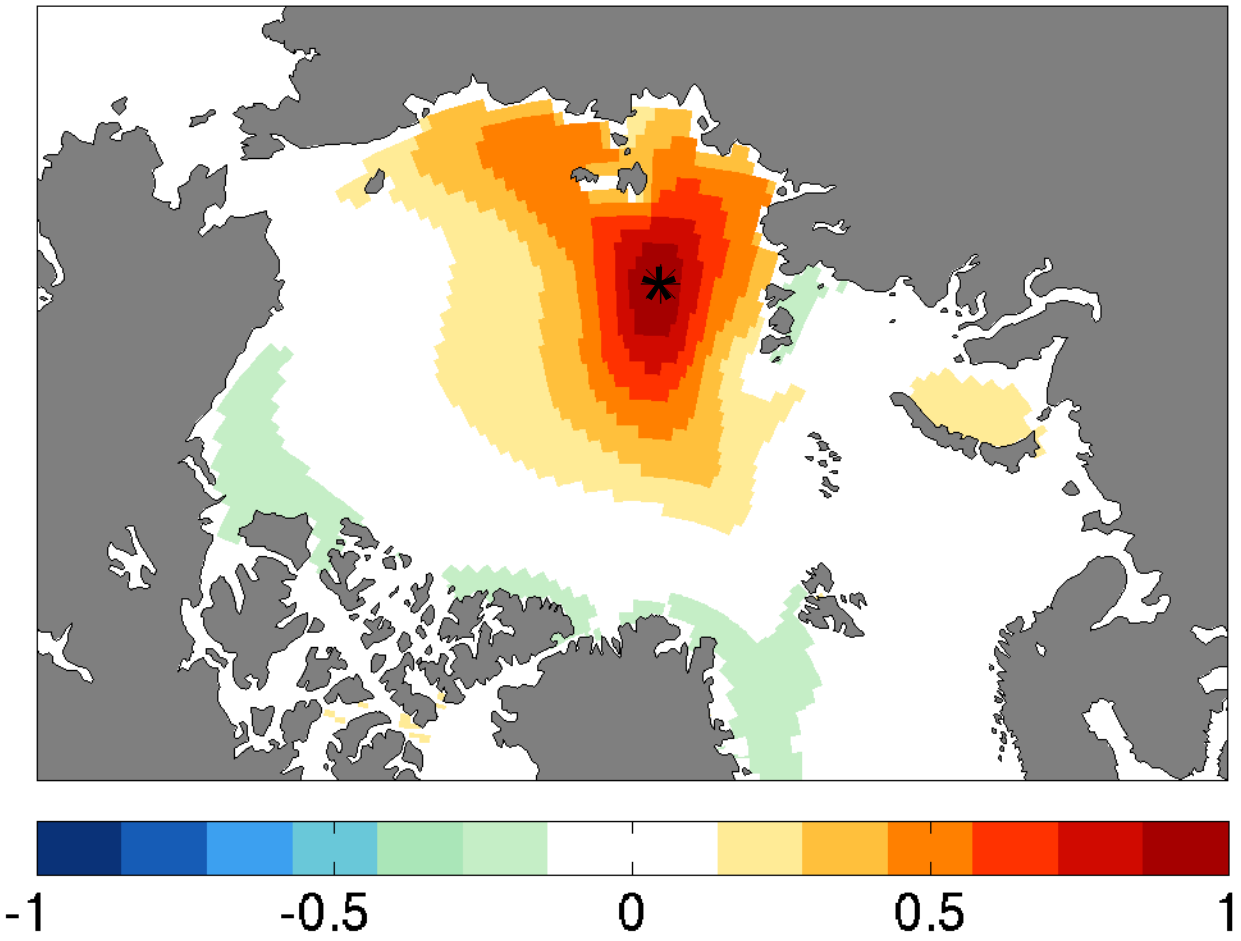


Bushuk et al (2015)



Bushuk et al (2015)

One-Point Correlation Map



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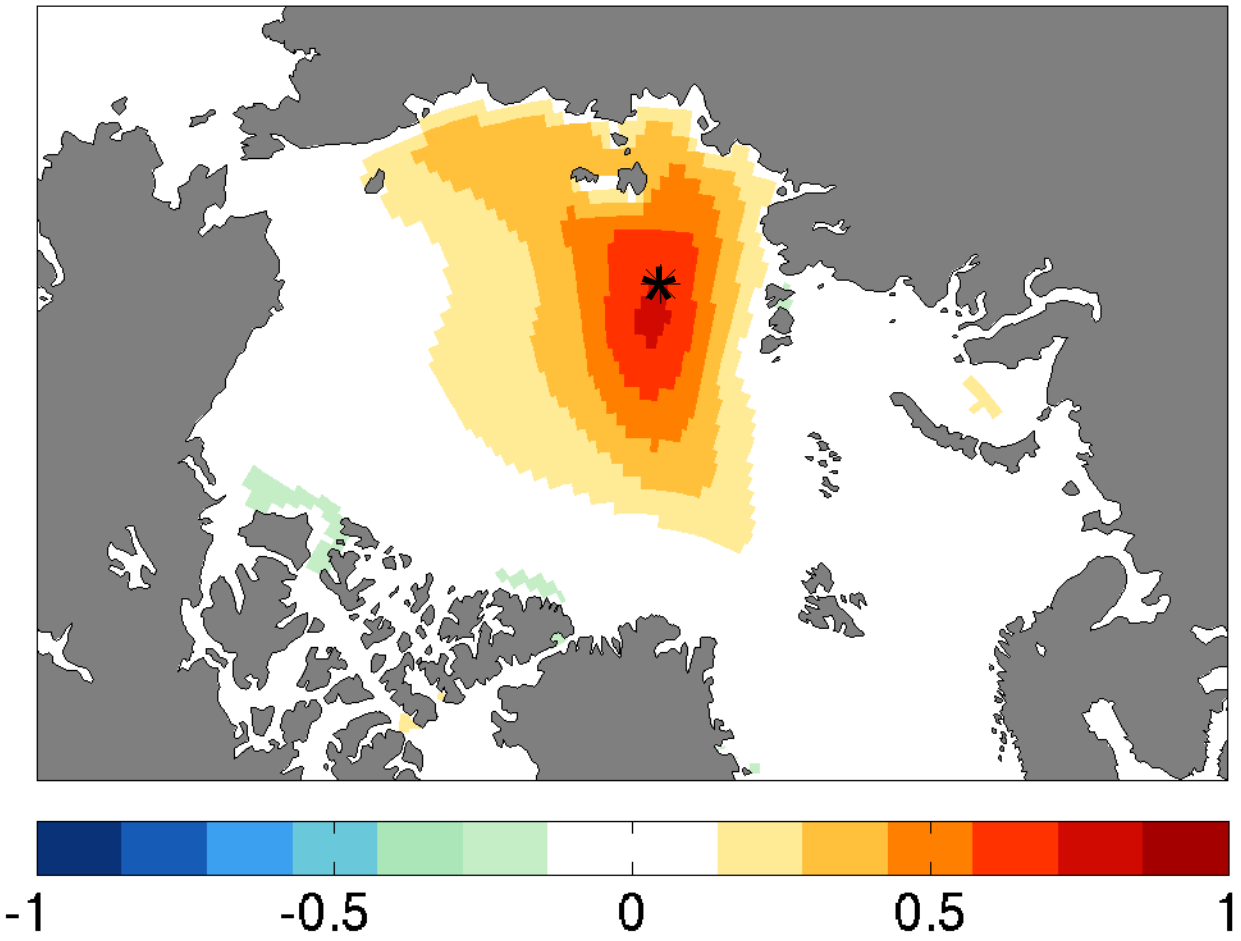
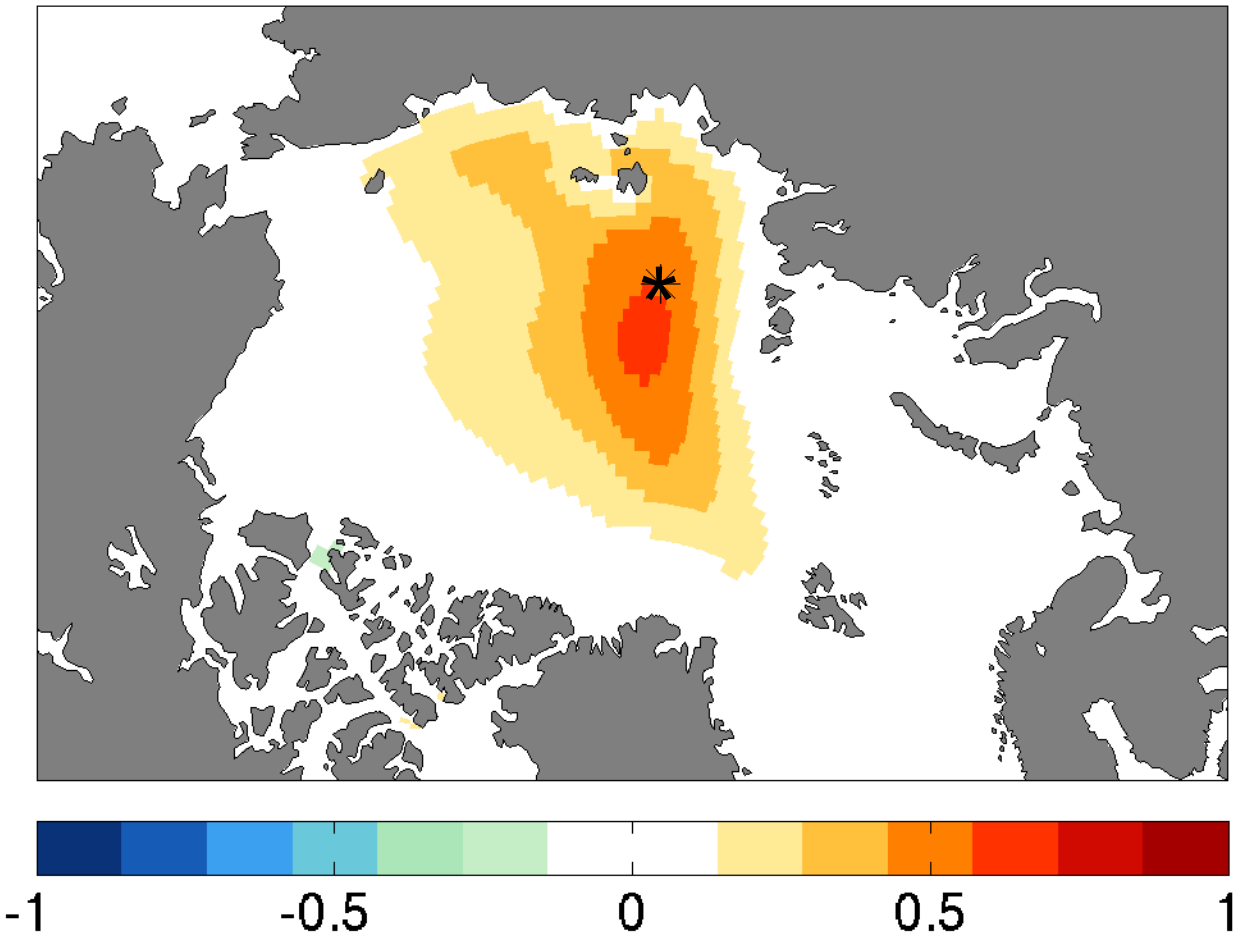


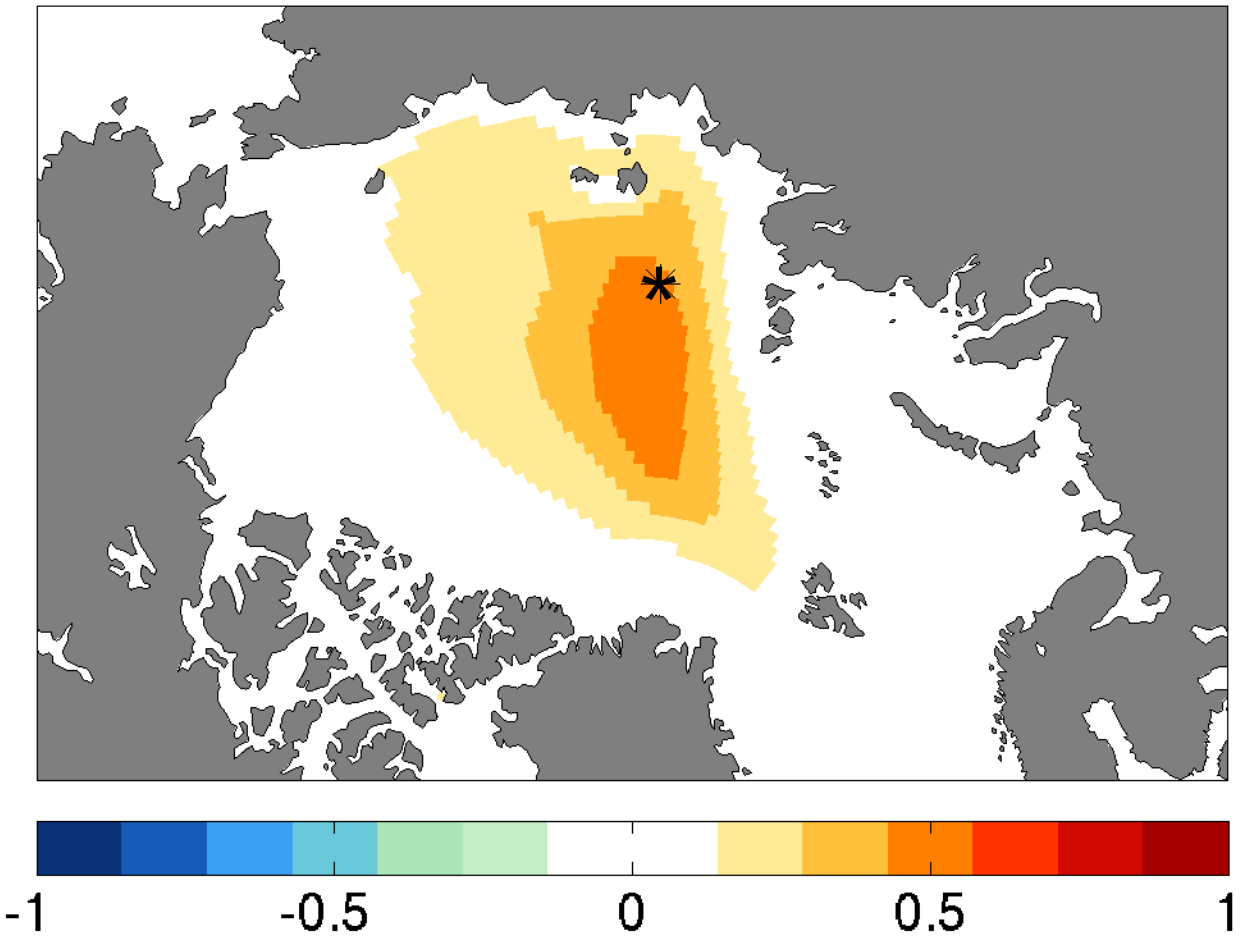
Correlation
3 month Lag

One-Point Correlation Map



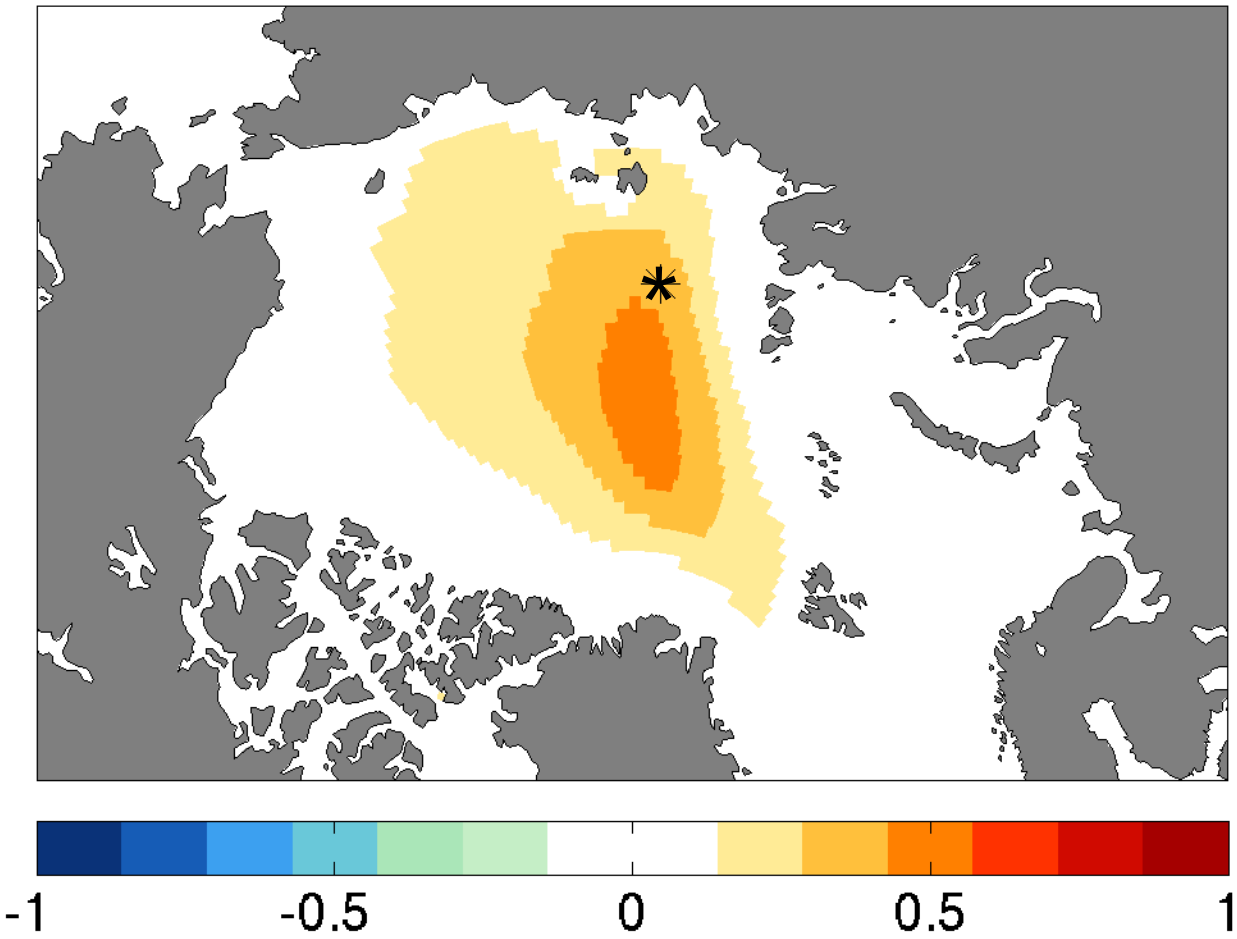
Correlation
6 month Lag

One-Point Correlation Map



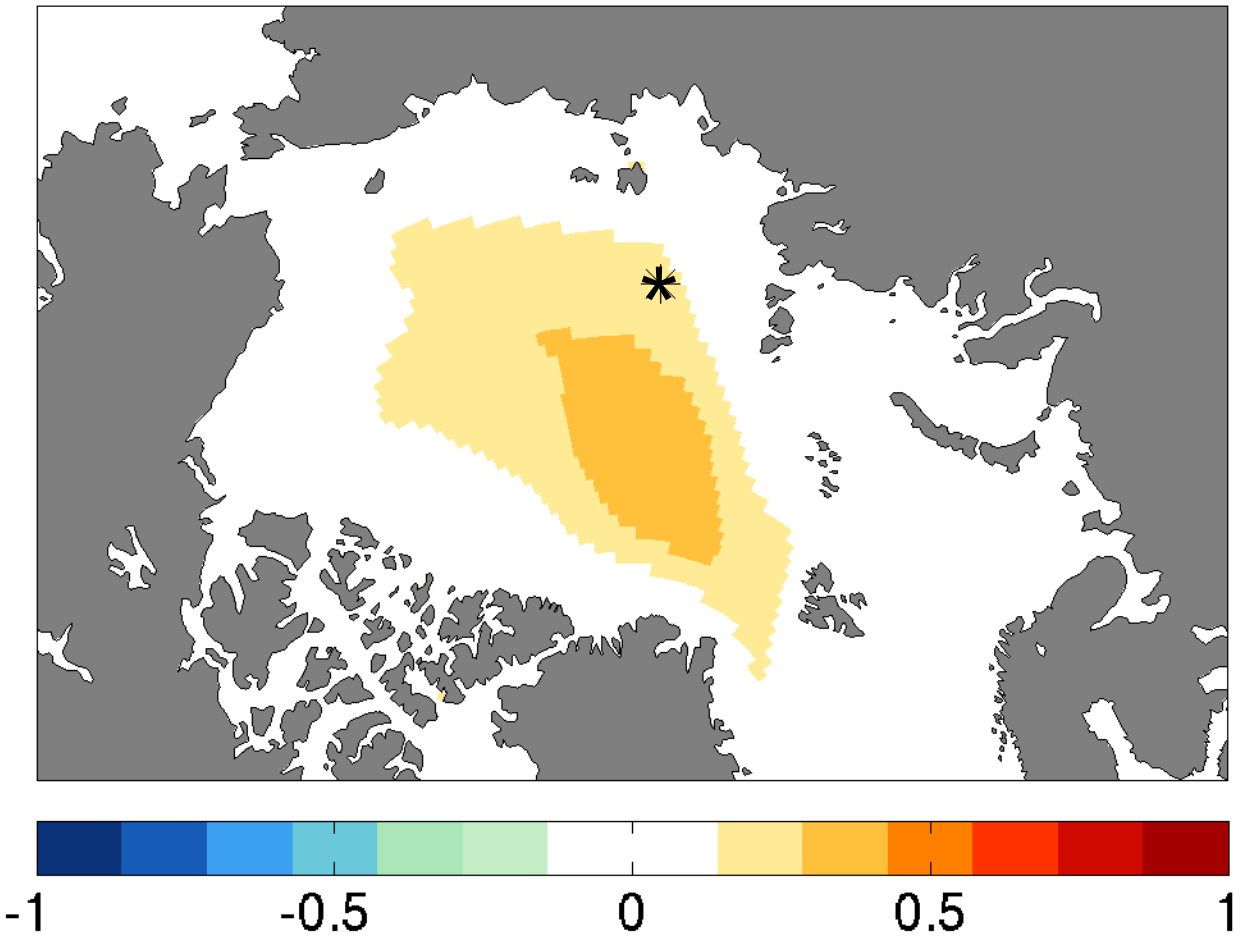
Correlation
9 month Lag

One-Point Correlation Map



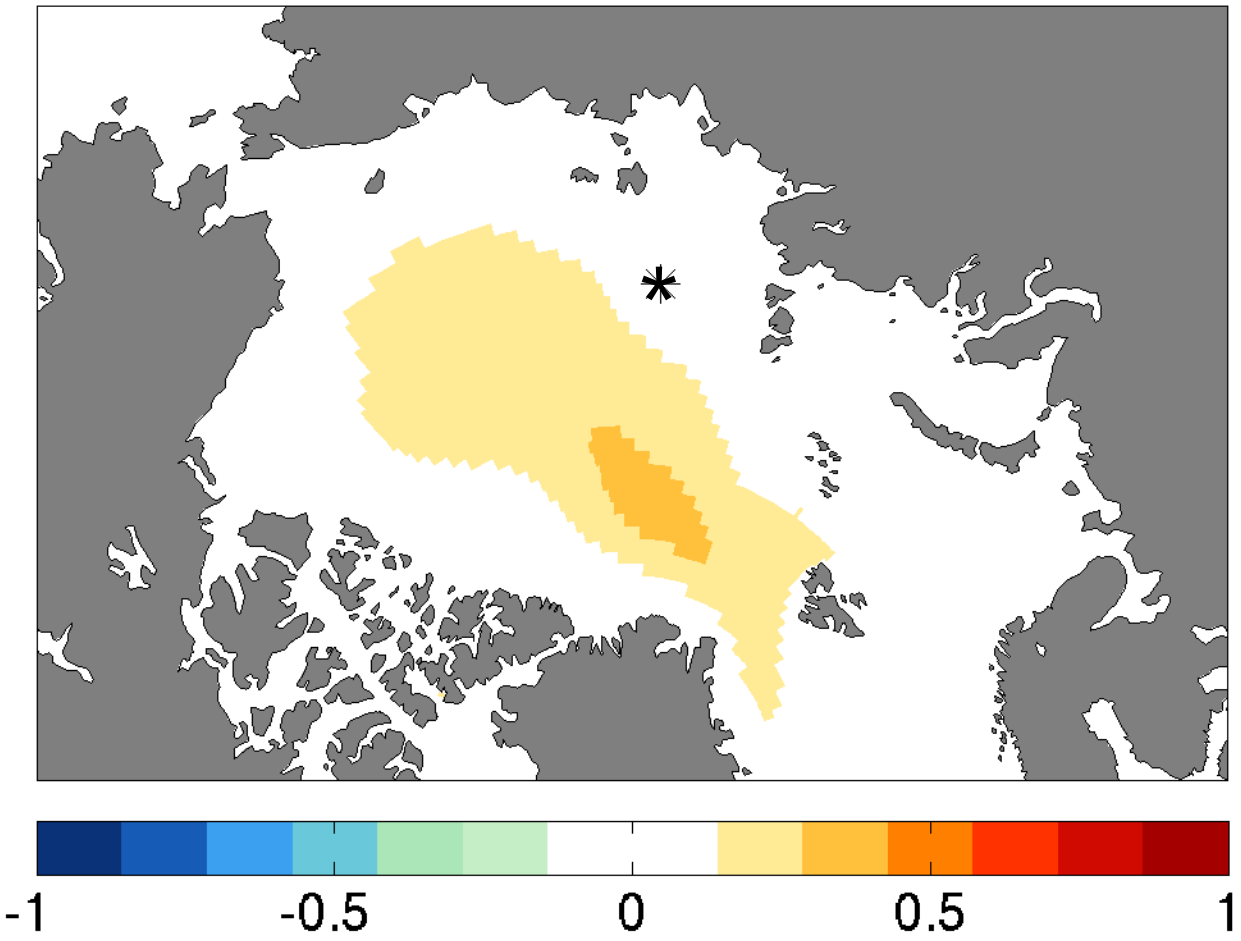
Correlation
12 month Lag

One-Point Correlation Map



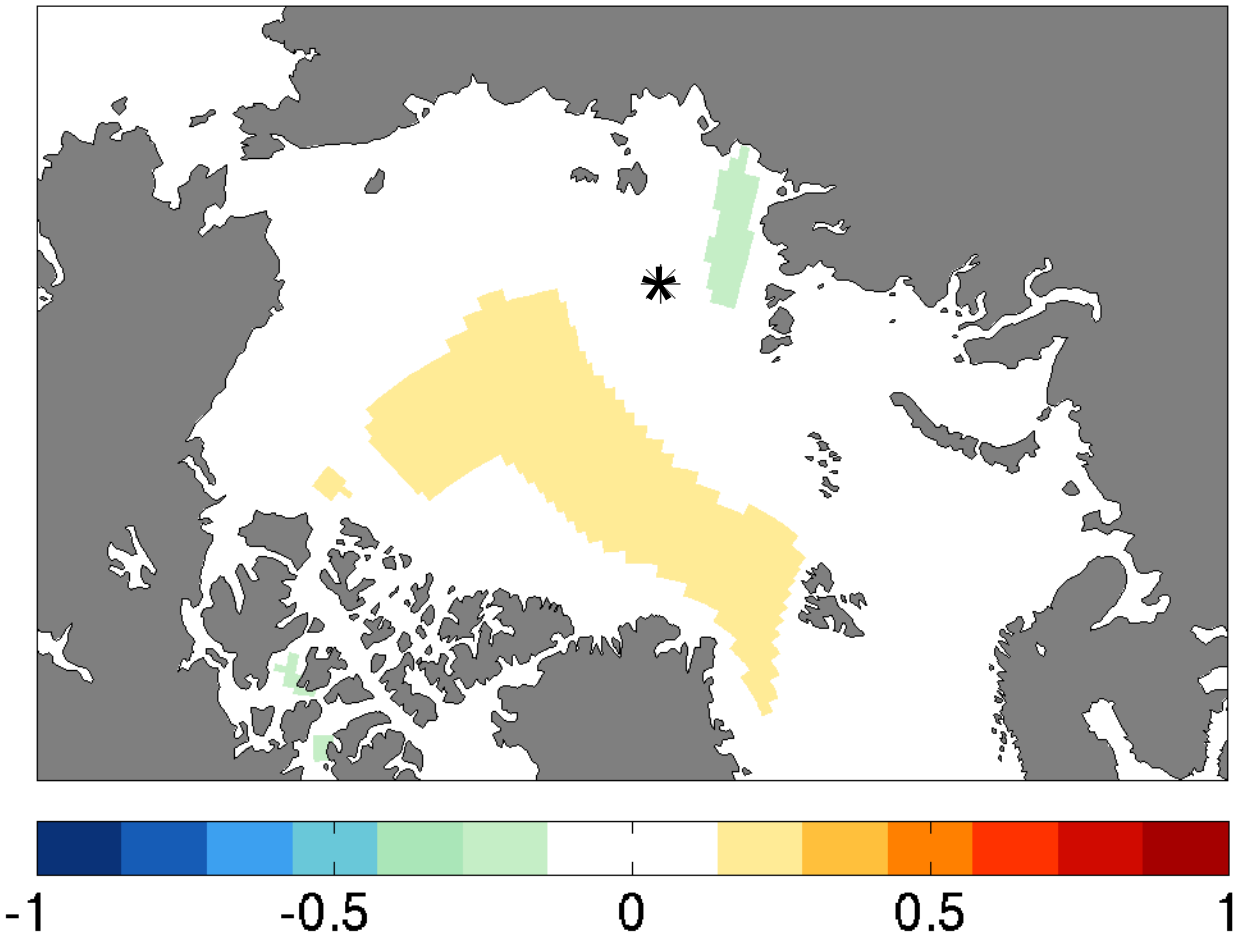
Correlation
18 month Lag

One-Point Correlation Map

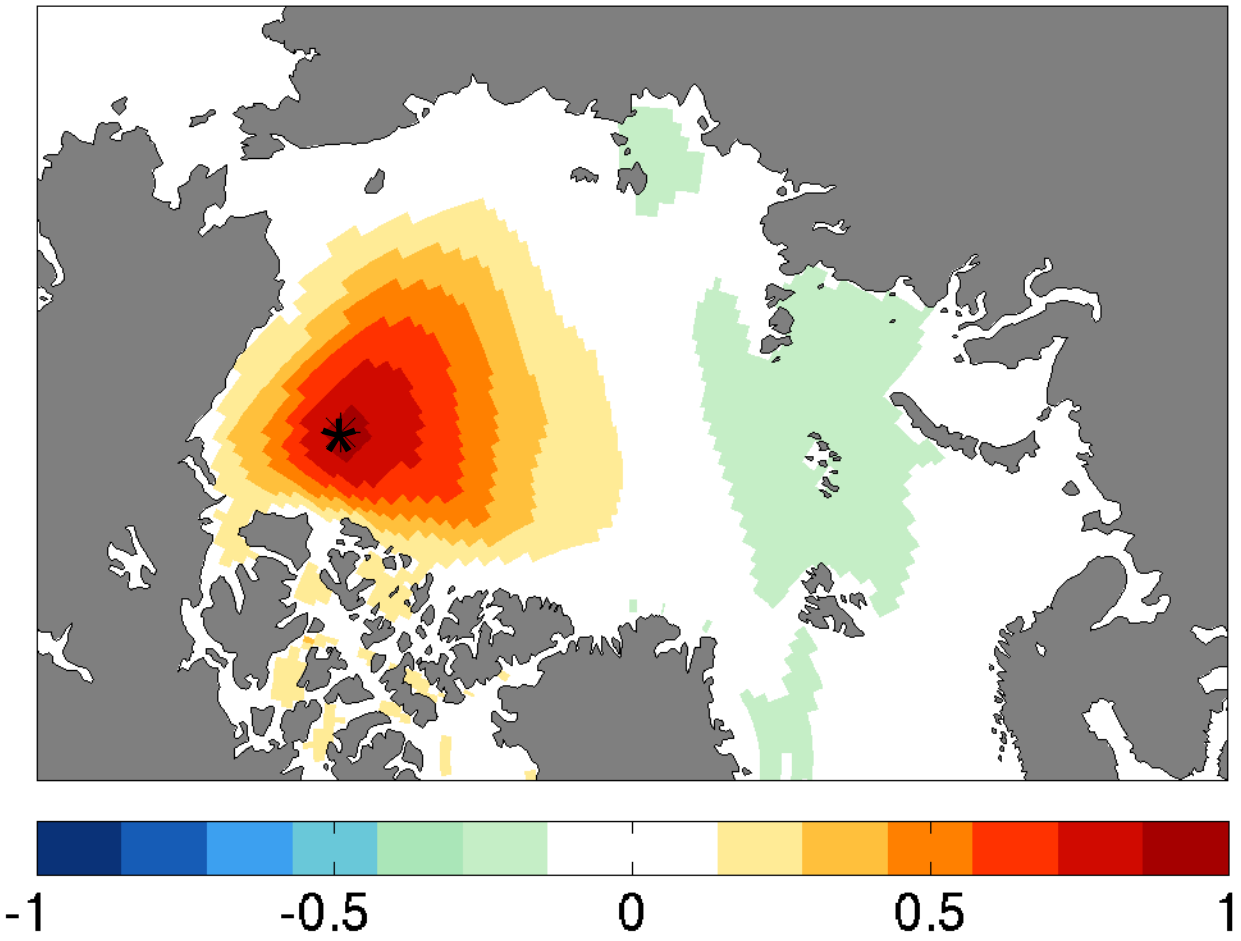


Correlation
24 month Lag

One-Point Correlation Map



One-Point Correlation Map



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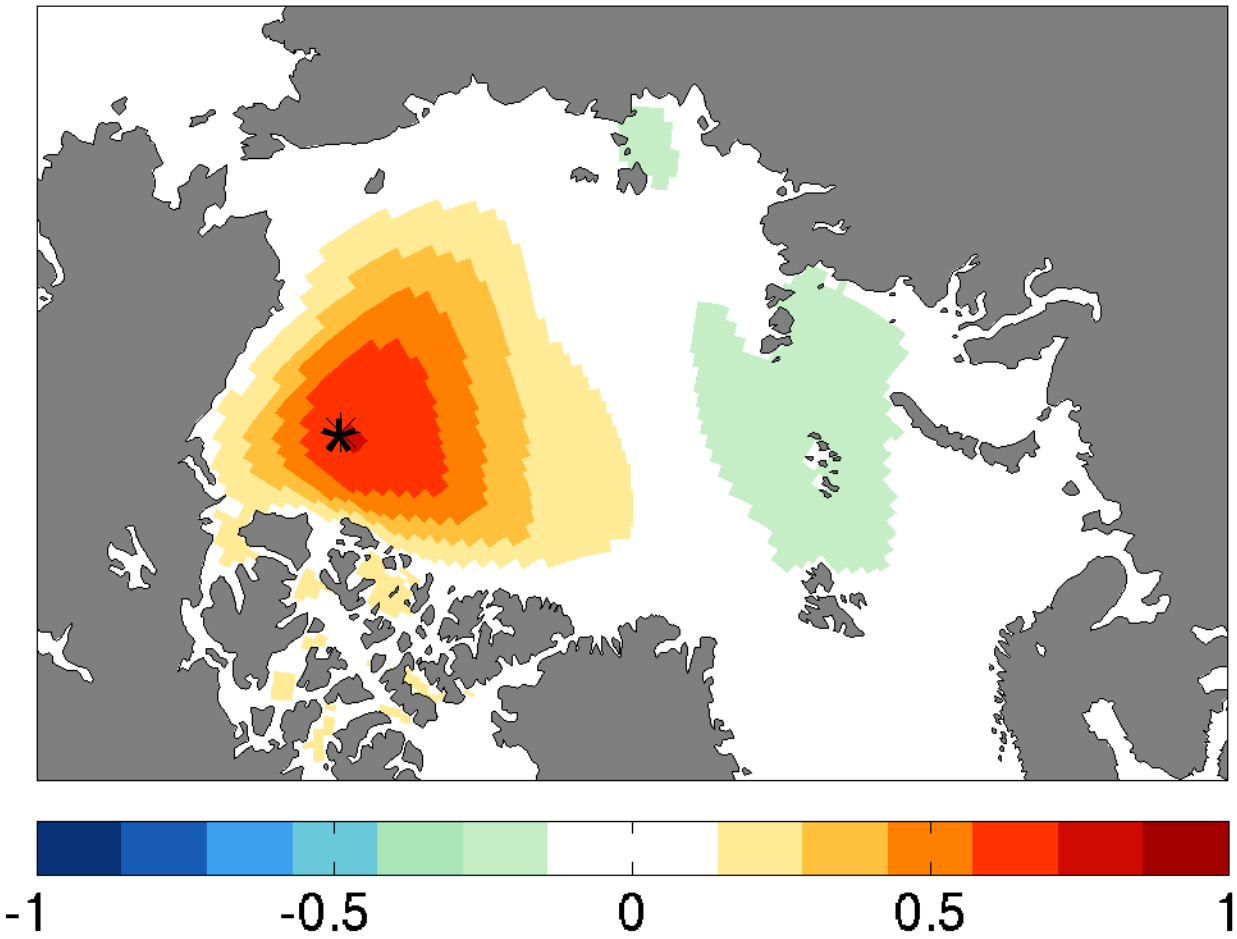
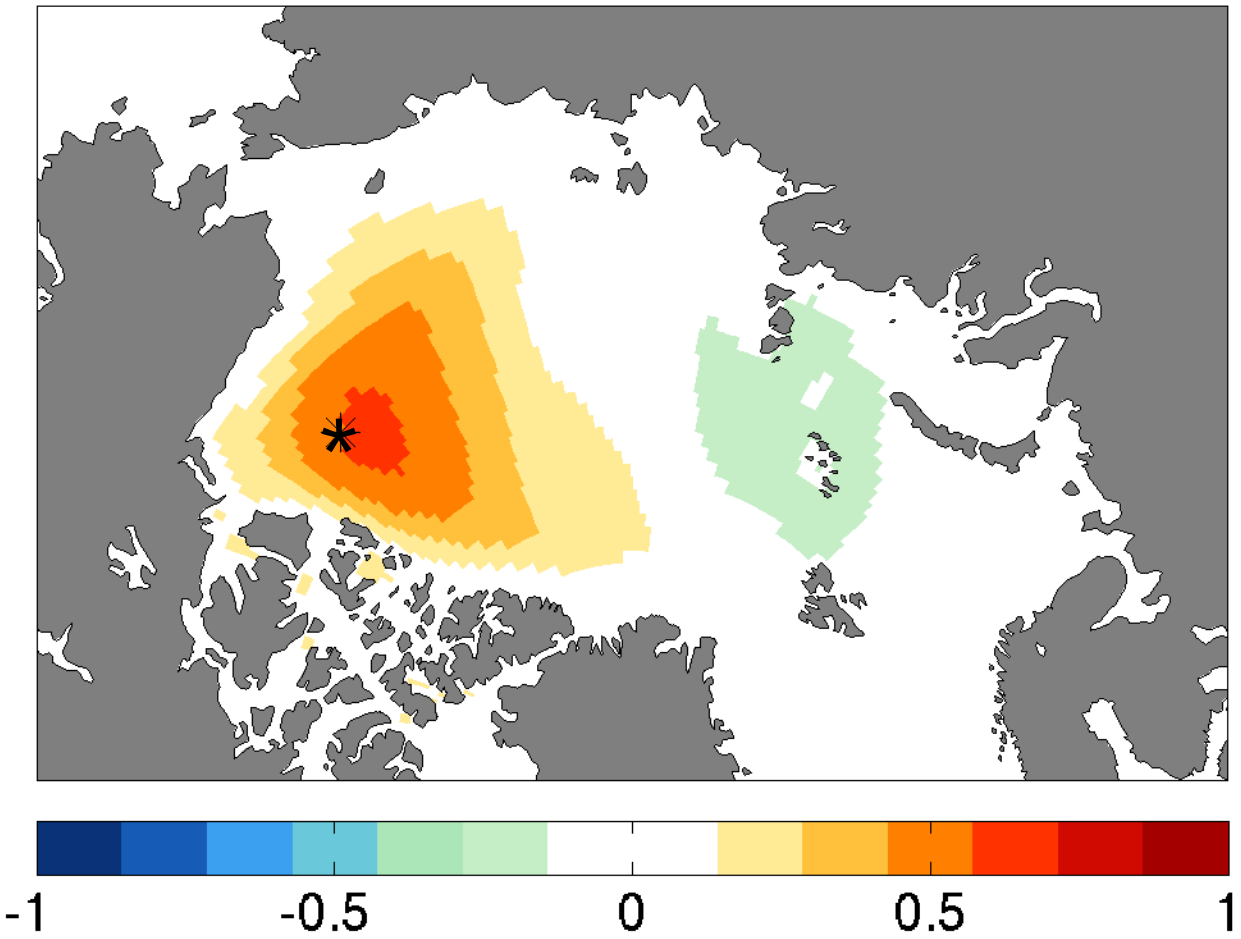


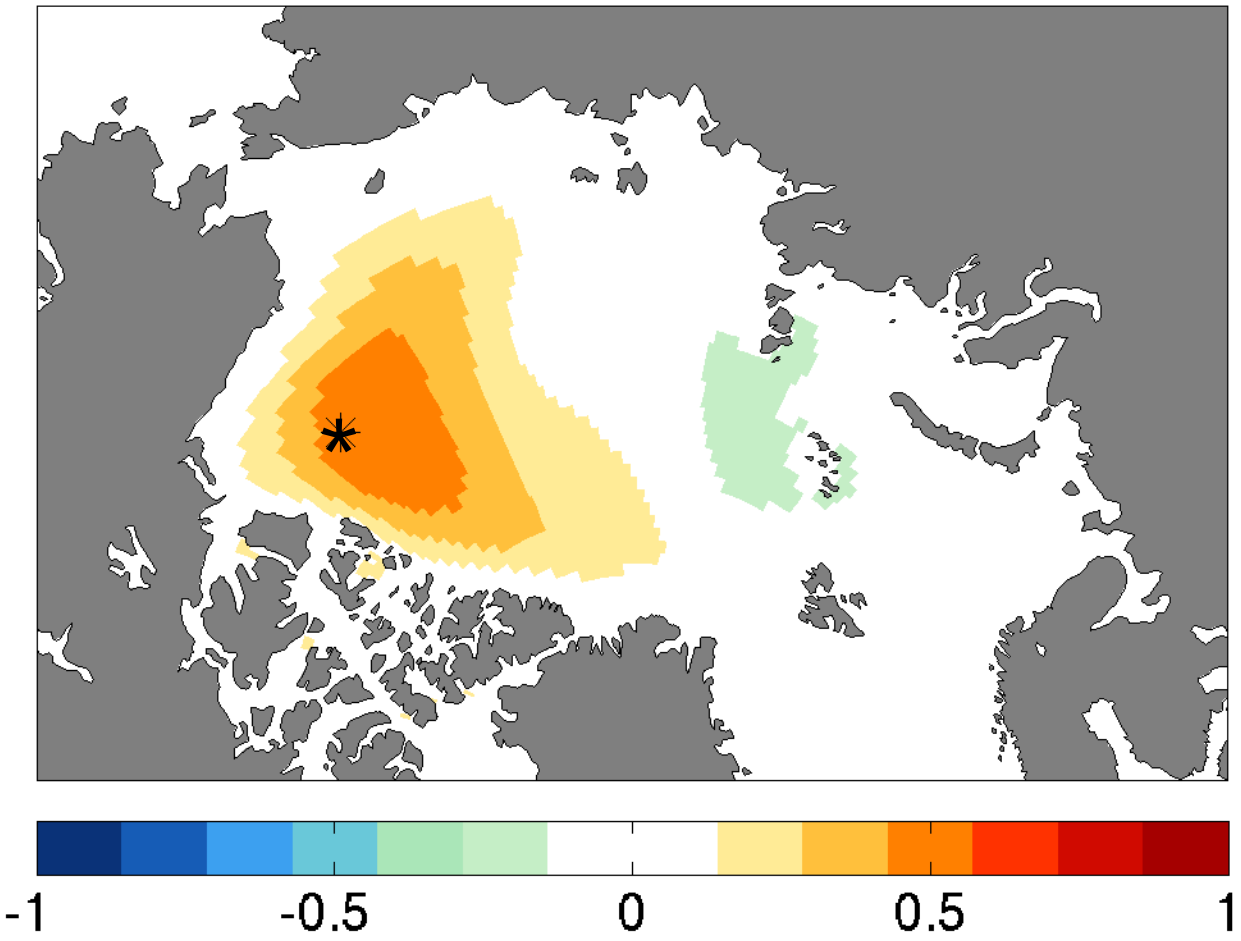
Correlation
3 month Lag

One-Point Correlation Map



Correlation
6 month Lag

One-Point Correlation Map



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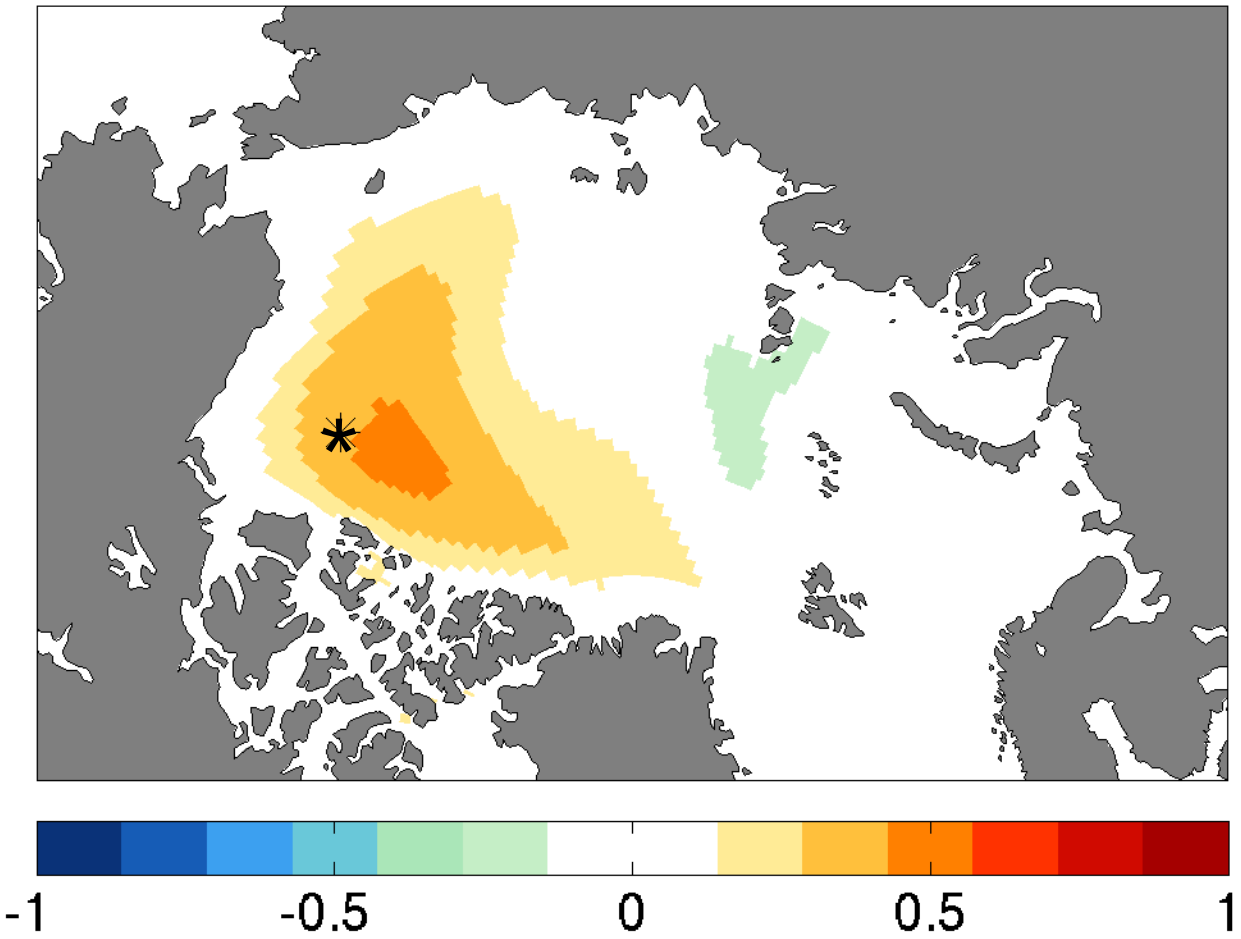

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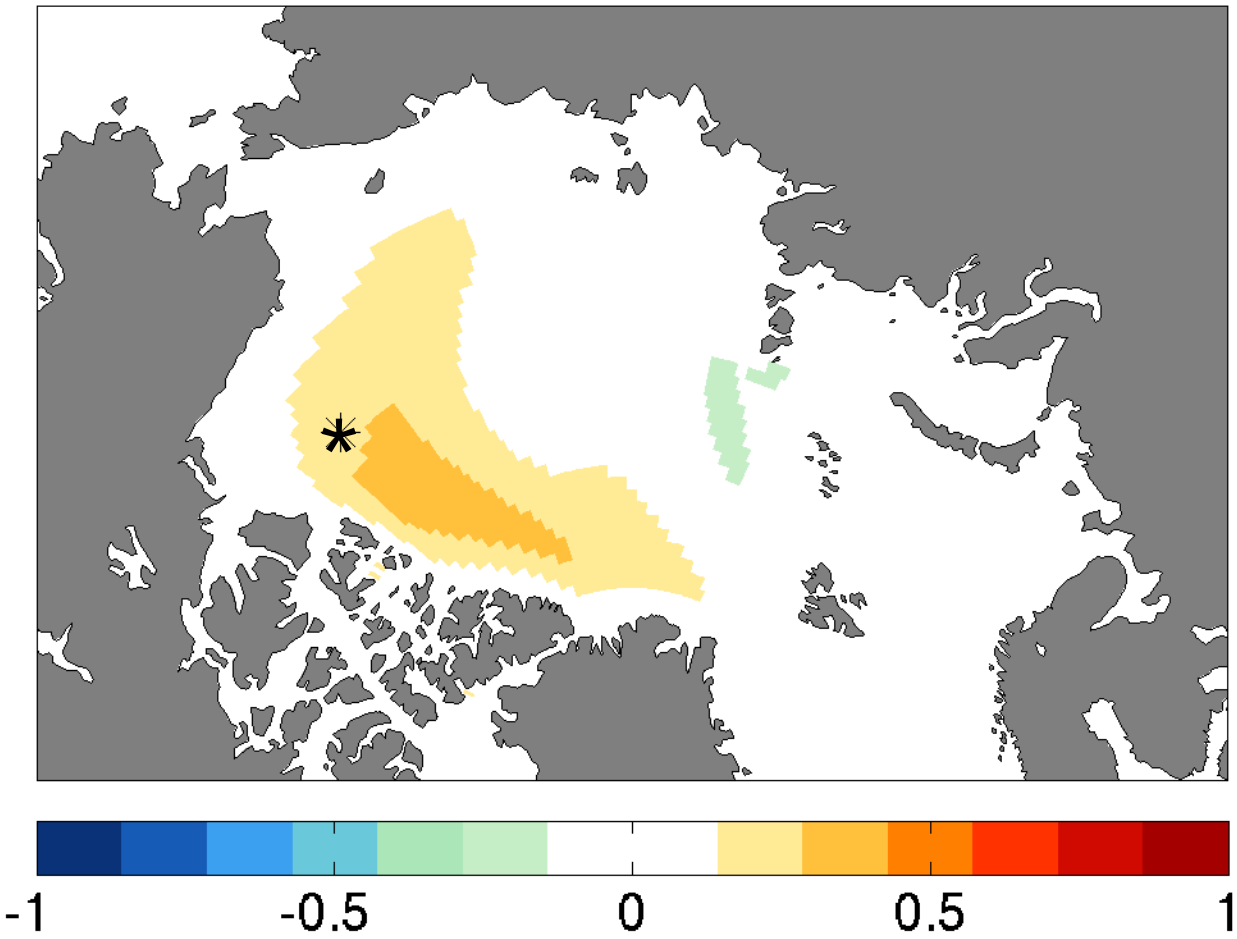

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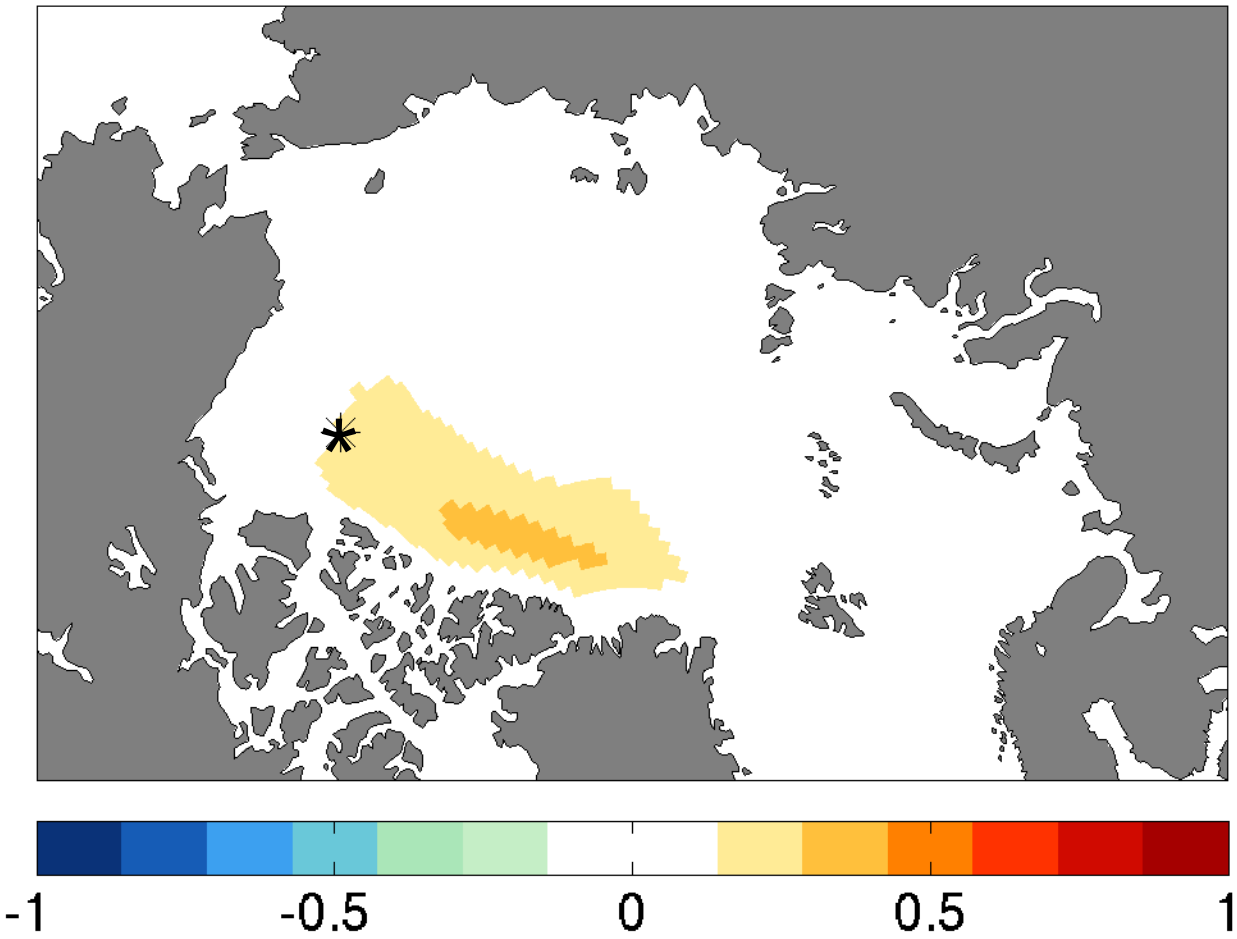
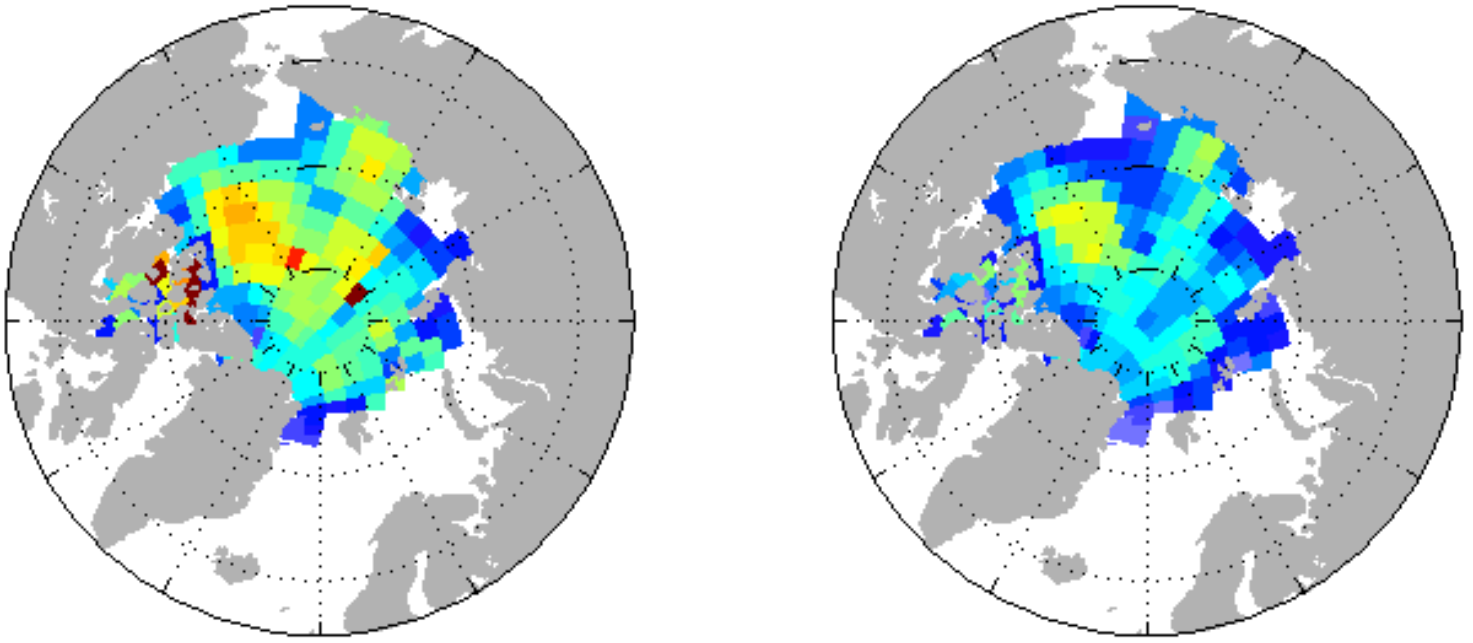
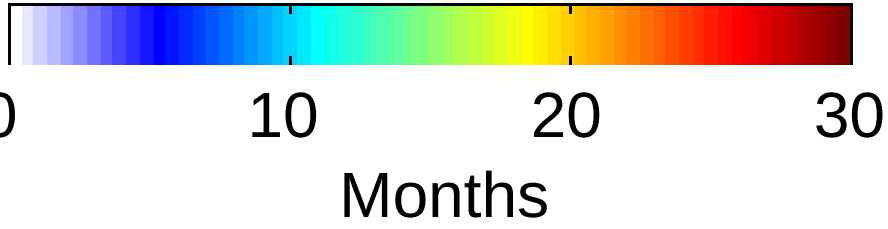


Lagrangian E-folding Times

Eulerian E-folding Times





Blanchard Wrigglesworth & Bitz (2014)

Accounting for transport in estimates of predictability (here as decorrelation time of perturbations) increases time by ~50%

“Known” sources of sea ice predictability

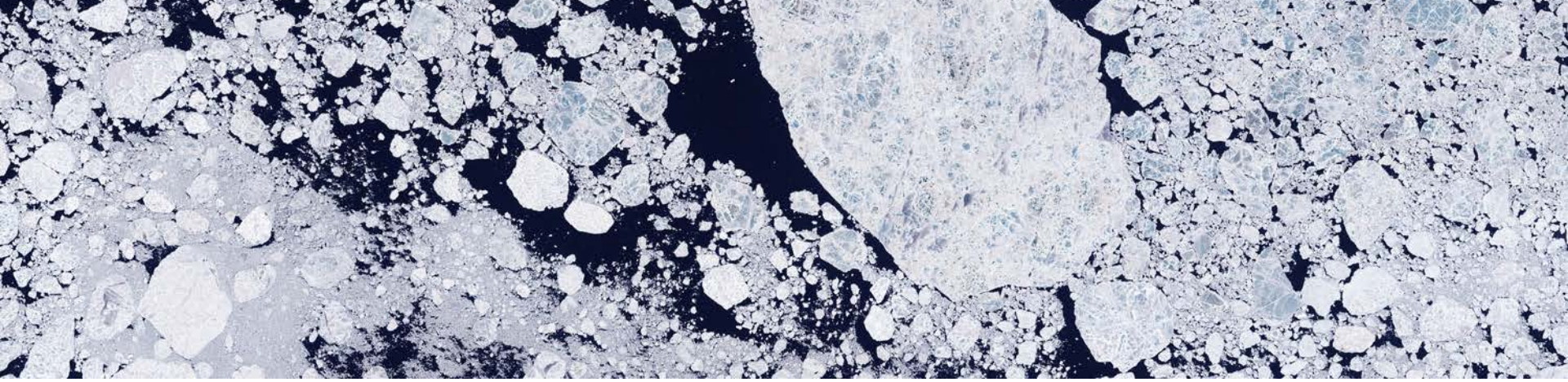
predictability of extent (pan-Arctic and regional) –

- extent
- thickness
- SST
- melt ponds
- transport

predictability of thickness –

- thickness & transport

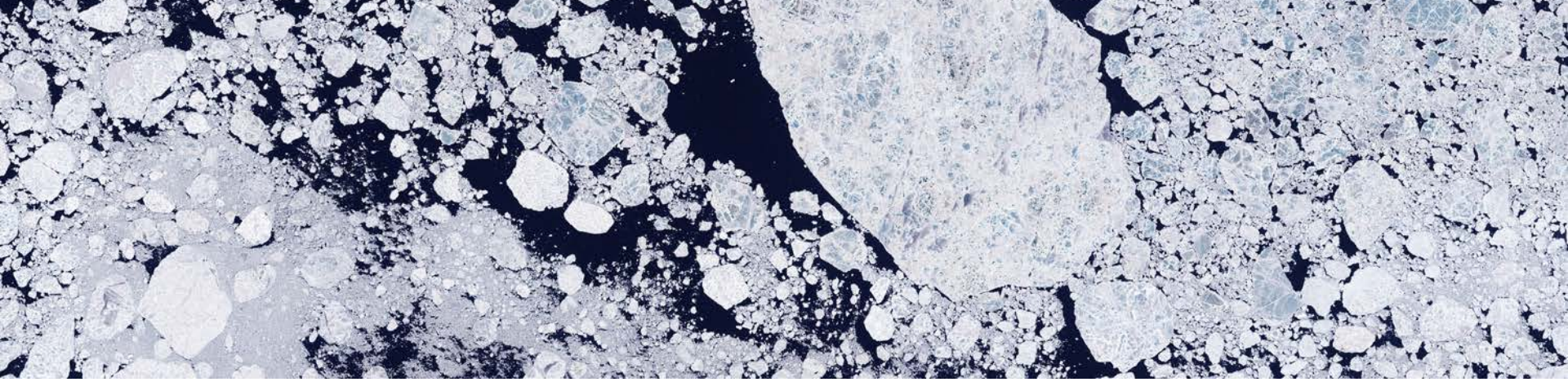
predictability of leads, snow depths, etc – not known



Sea ice models should simulate

- sea ice thickness distribution
- melt ponds
- floes size distribution
- anisotropy (orientation of leads)

Initialization for prediction: Under what conditions do properties that affect these items need to be initialized?

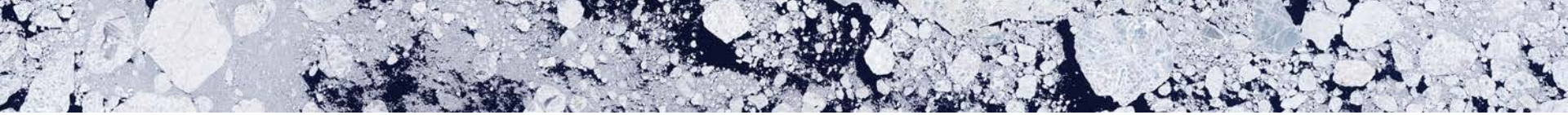


Sea ice – autocorrelation timescales

- sea ice thickness distribution – year or so
- melt ponds – a few months
- floes size distribution – a month? (my guess)
- anisotropy – a week

Subseasonal-seasonal forecast (3-50 weeks):

Initialized with the current thickness, concentration, and floe & melt pond size statistics. The key external initial condition is ocean temperature. Forecast is a coupled atmosphere-ocean-ice problem.



Current state of sea ice initialization in subseasonal to decadal prediction

Climatology of last X years

Sea ice “along for ride” = ocean state estimate - ocean DA and prescribed atm

Sea ice DA coupled with ocean DA (atm prescribed or ideally coupled)

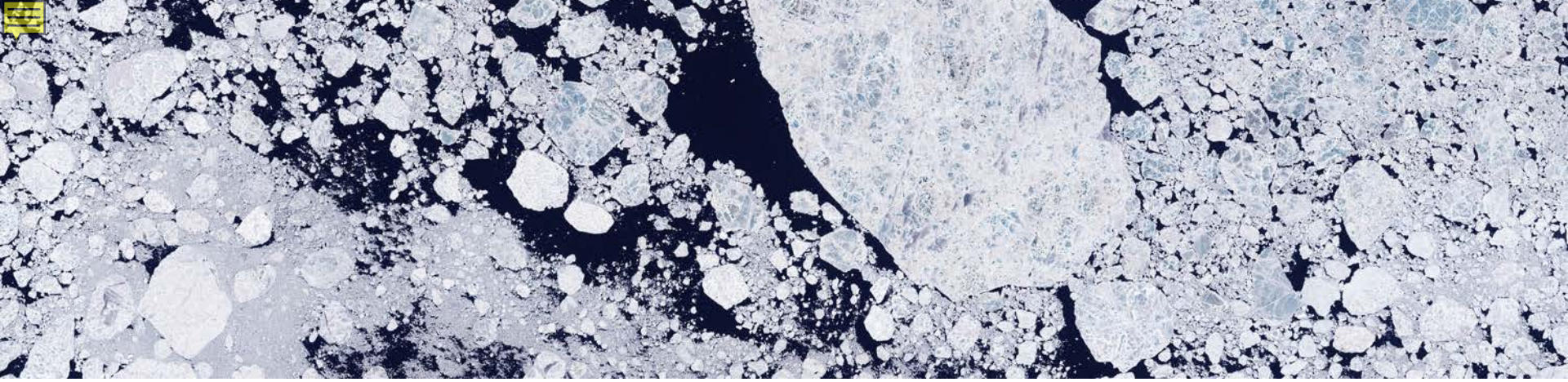
Sea ice DA is usually just sea ice concentration, though sea ice thickness/freeboard probably would have a bigger impact.

Resolution of available observations for ICs

AMSR products horizontal ~6 km (I think)

Ice thickness (long story)

Ice ponds and floe size – nothing available beyond a few surveys



Sea ice – autocorrelation timescales

- sea ice thickness distribution – year or so
- melt ponds – a few months
- floes size distribution – a month? (my guess)
- anisotropy (lead orientation) – a week

Subseasonal forecast (2-3 weeks):

Initialized with the current thickness, concentration, and floe & melt pond size statistics. The key external conditions that will determine the fast evolution is wind anomalies, and to a lesser extent SST anomalies. Forecast is primarily a coupled atmosphere-ice problem (with correct SST ICs).