The start date dependence of idealised predictions of Pan-Arctic and regional sea ice cover

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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Outline

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1. Description of "Perfect model" experiments.

2. Lagged correlation properties of Arctic sea ice extent. Are all start dates equal?

3. Compare lagged correlation with initialised skill.

4. Regional predictability and its start date dependence.

Experiment design

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Model: HadGEM1.2

"Perfect model" runs:

- Ensembles initialised from present day control run (fixed 1990 forcing).
- Initialised from Jan, May, July.
- 8 start years.
- 16 members.
- 3 years.

- Similar method to Koenigk & Mikolajewicz 2009; Blanchard-Wrigglesworth et al. 2011; Holland et al. 2011.

Example ensemble

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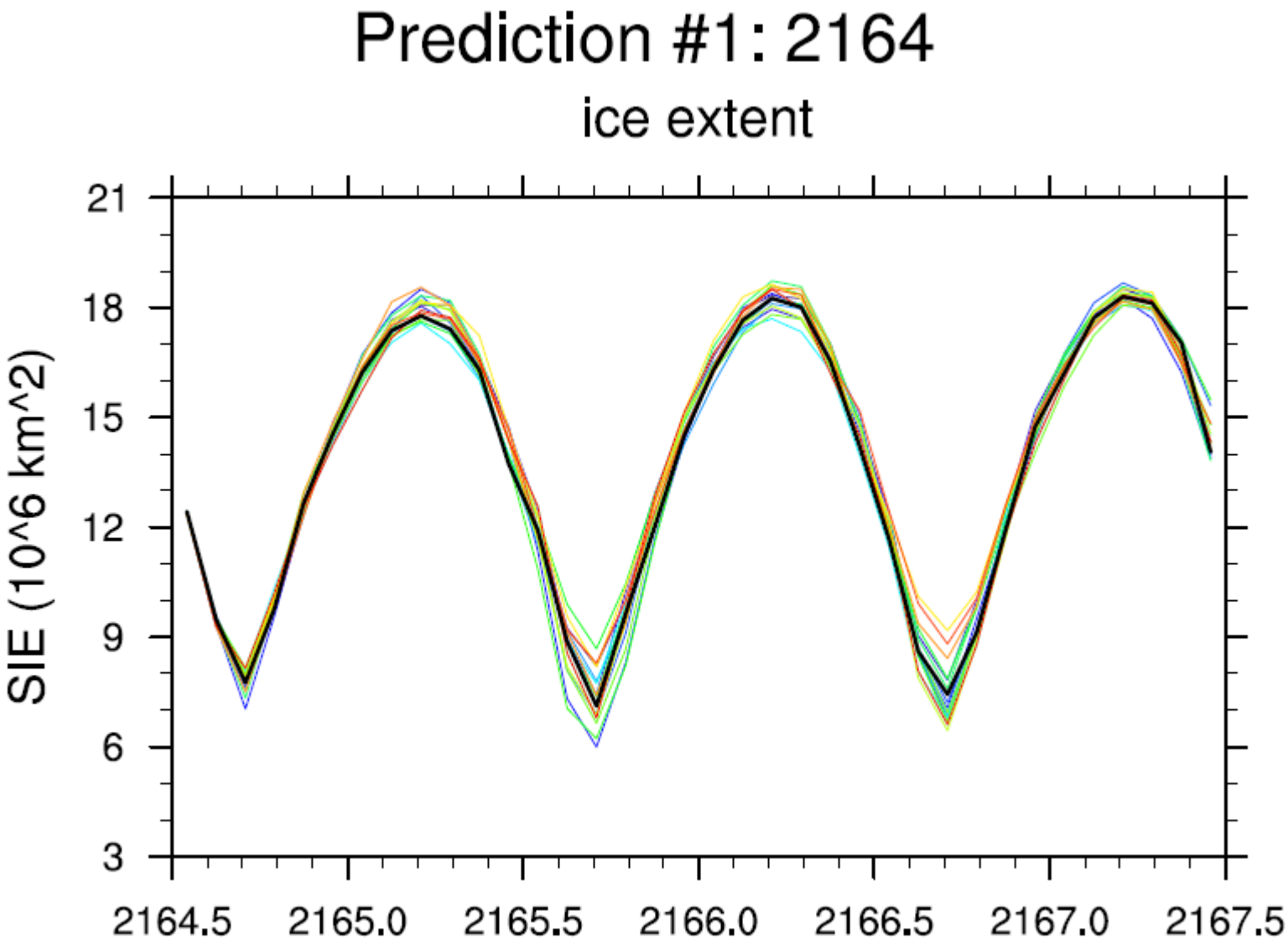

Predictability measures

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$$RMSE = \sqrt{\frac{1}{N}\sum_{j=1}^{8}\sum_{i=1}^{16}\sum_{k\neq i}(x_{kj} - x_{ij})}$$

$$\mathrm{ACC} = \frac{\sum_{j=1}^{12}\sum_{i=1}^{5}\sum_{k\neq i}(x_{kj} - \bar{x})(x_{ij} - \bar{x})}{\sqrt{\sum_{j=1}^{12}\sum_{i=1}^{5}\sum_{k\neq i}(x_{kj} - \bar{x})^2 \sum_{j=1}^{12}\sum_{i=1}^{5}\sum_{k\neq i}(x_{ij} - \bar{x})^2}}$$

Where x_{kj} is the k*th* member of the j*th* ensemble (e.g. Collins 2002).

Pan-Arctic multi-model lagged correlation properties: extent (control)

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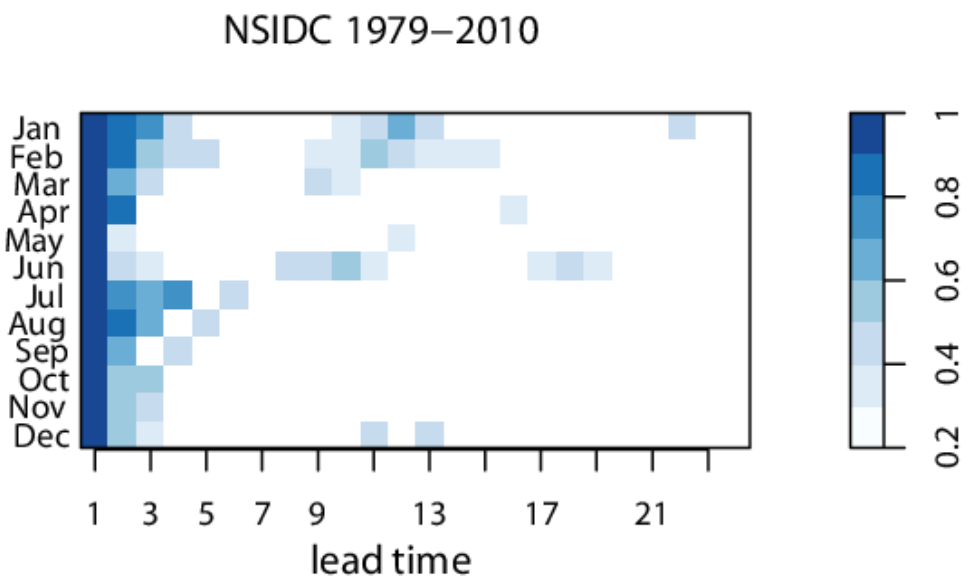
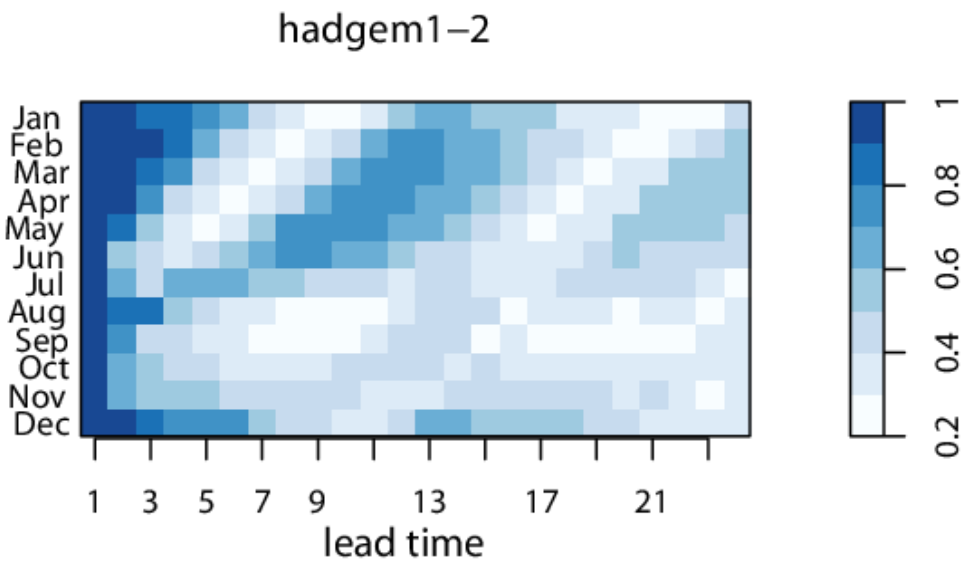
- Lagged correlation is a measure of predictability.
- Initial decay in correlation is dependent on the start month.
- Blanchard-Wrigglesworth *et al.* (2011) discuss melt to freeze season re-emergence mechanism.
- Not all start dates are equal.





Comparing ensembles to lagged correlation

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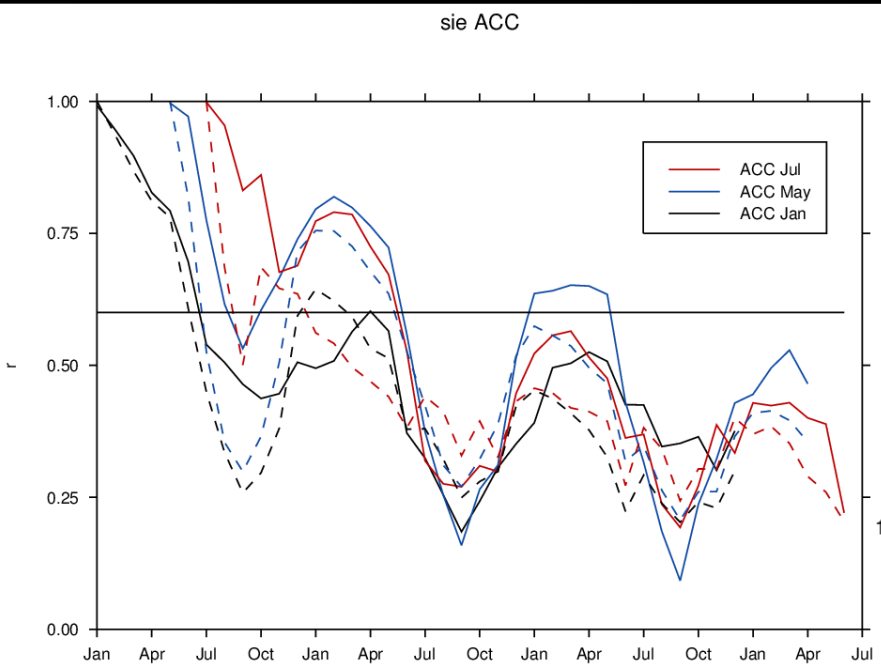
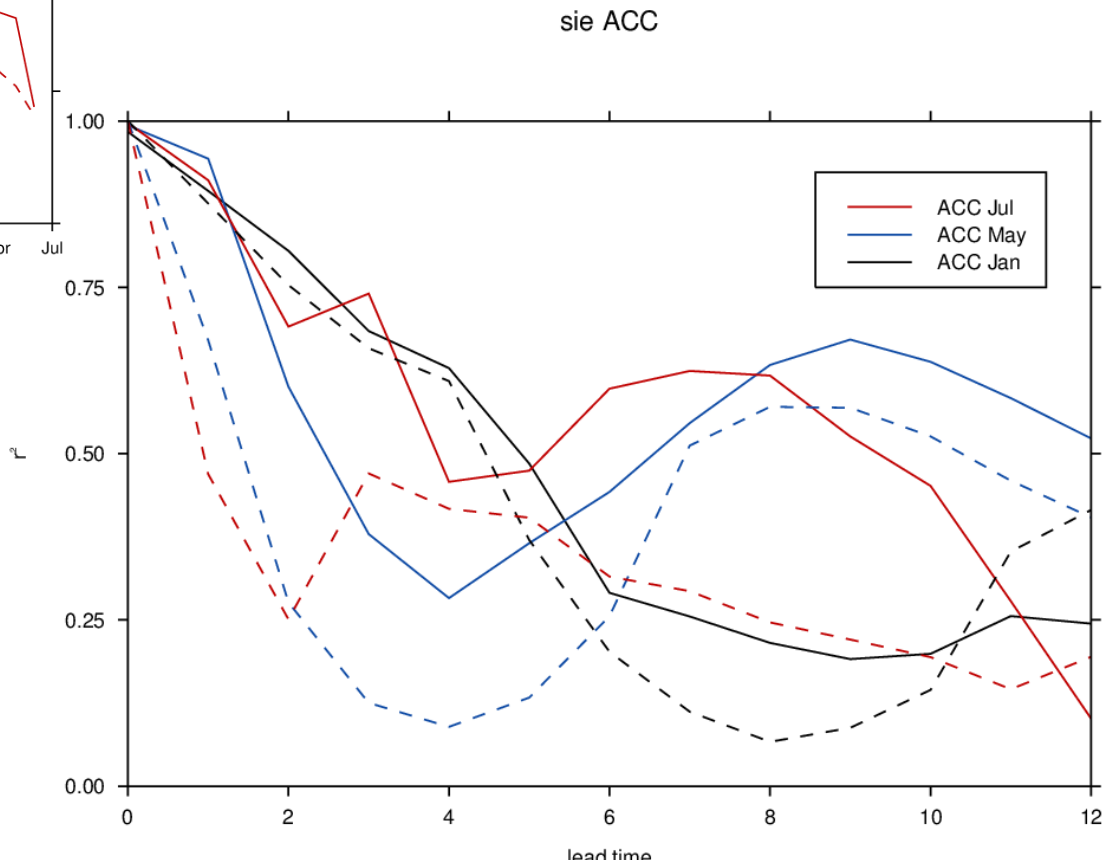


May ensemble skill decreases faster than January or July (<6 months)



Map of Basins

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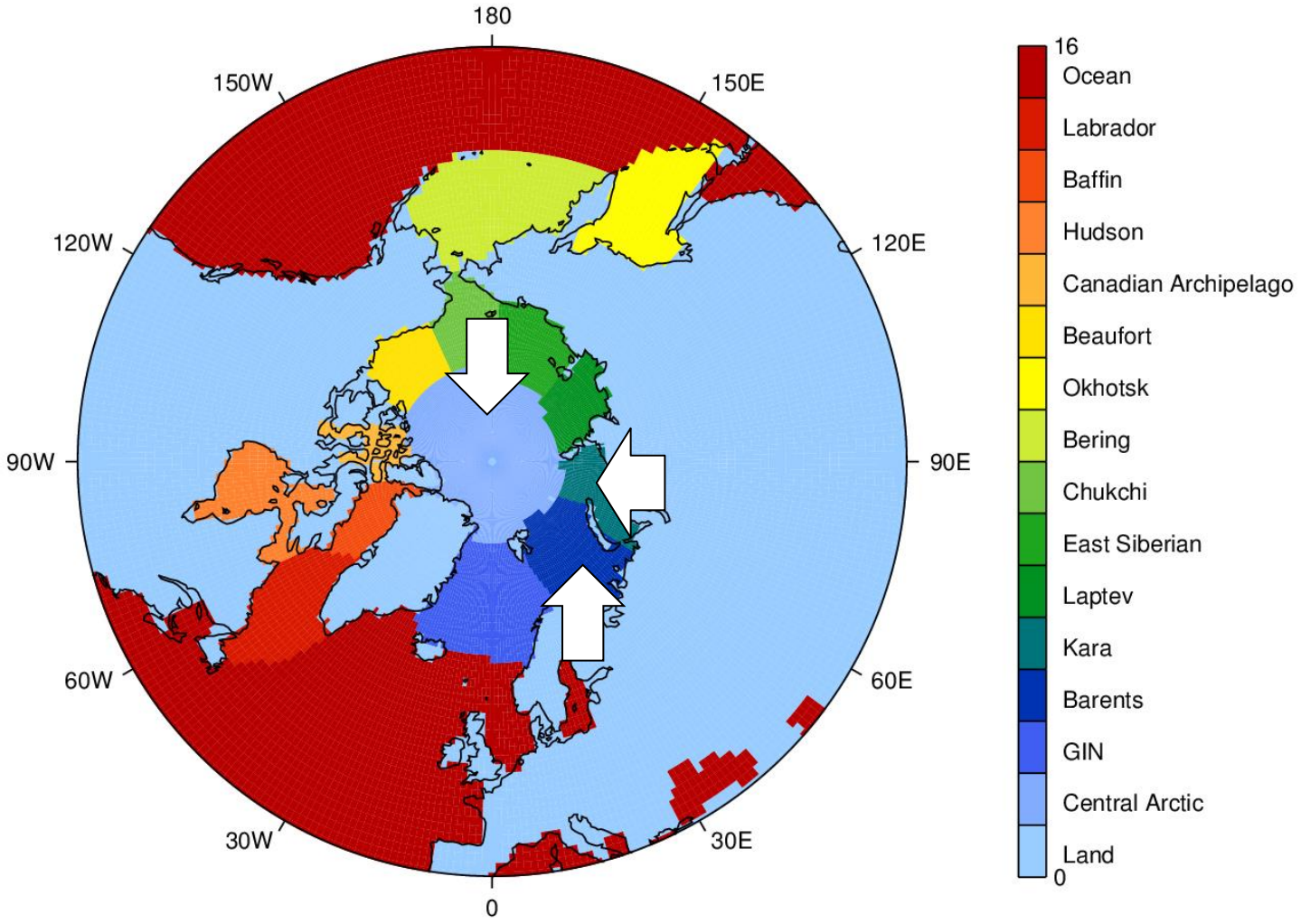

Extent predictability for individual basin (RMSE)

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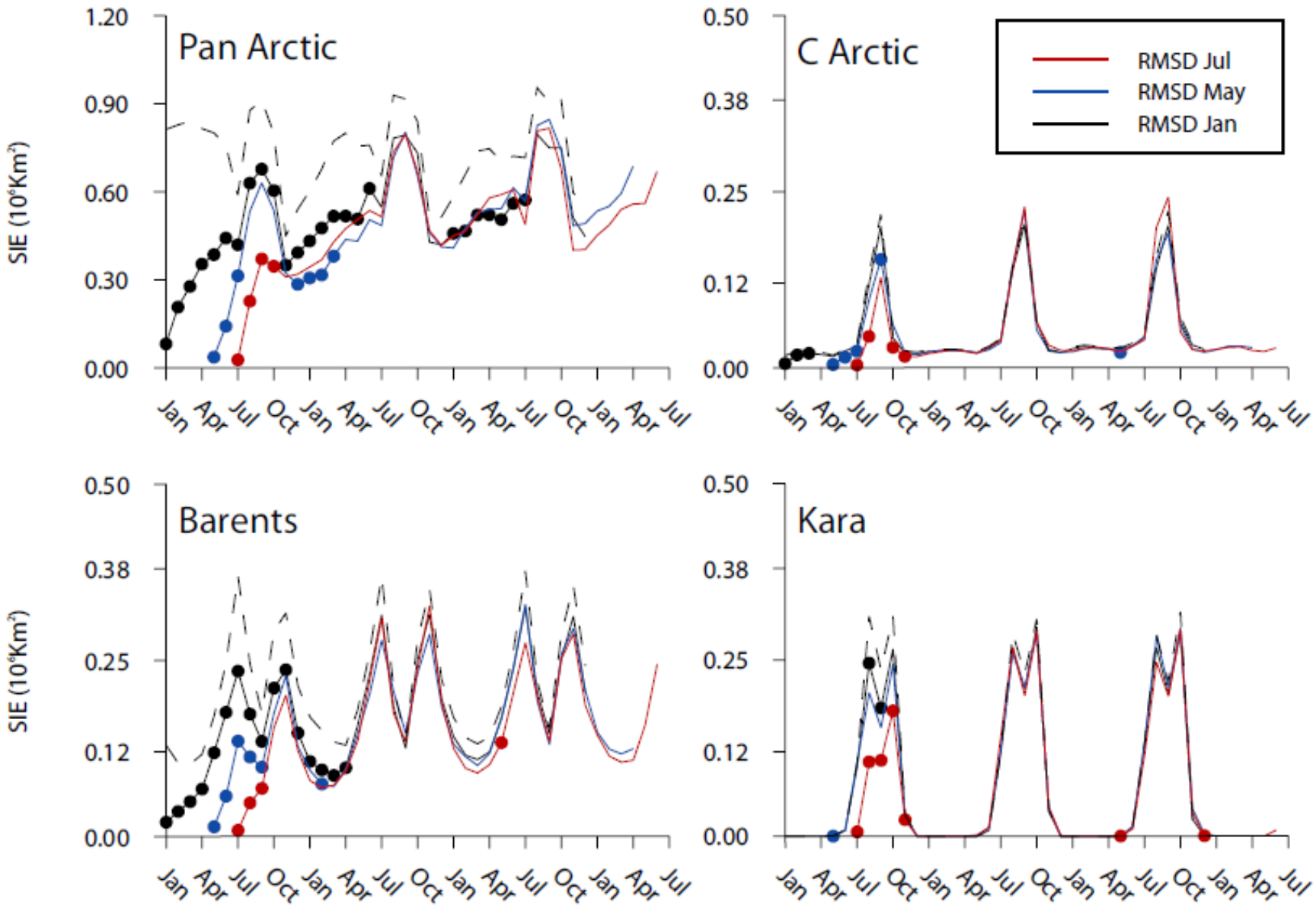

Map of Basins

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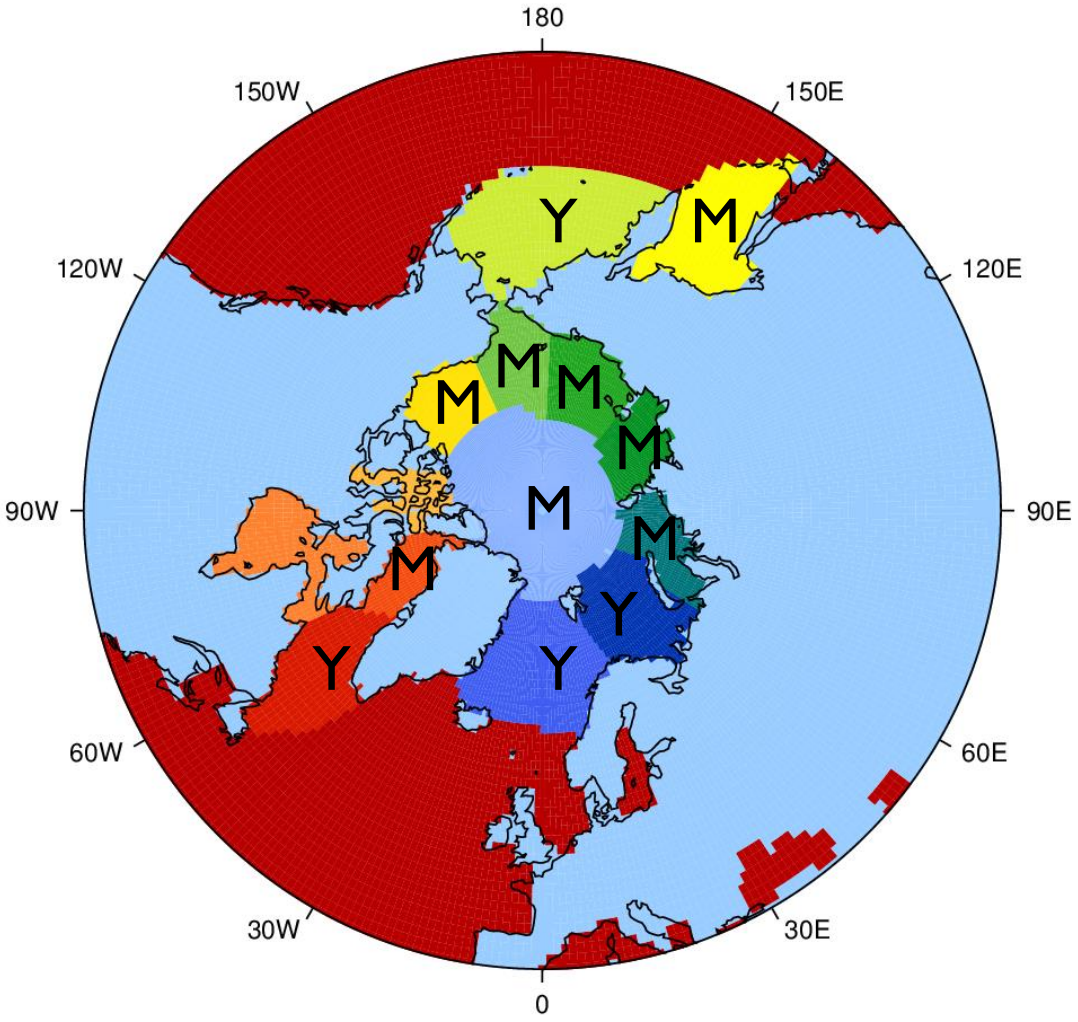

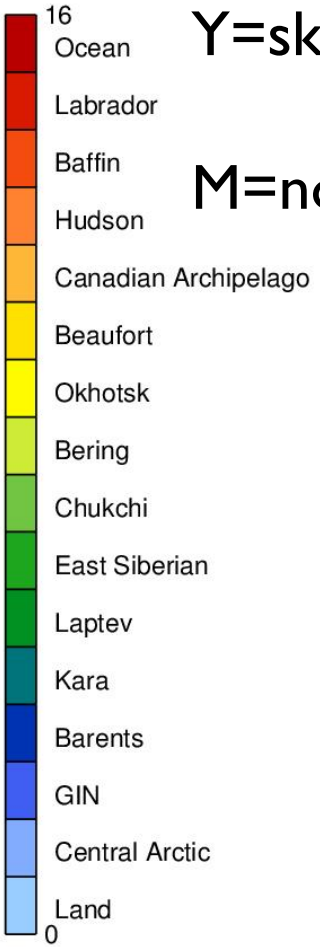

Y=skill after a year

M=no skill after a year

Summary

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- Initialised predictions agree with lagged correlation properties (re-emergence etc.) for Jan, May and July.
- Ensemble skill decreases faster for May than Jan and July (<6 months)(Pan-Arctic).
- Extent in Central Arctic and marginal basins only exhibit skill from July (1st summer only).
- Predictability in peripheral (Atlantic/Pacific) seas at longer lead times (1-3 years).
- Volume has skill at longer lead times than extent in all basins (Pan-Arctic> 3yr).

Connections + Future work

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- Predictions of the summer minimum (September) in many basins may only be predictable from July.
  - Could be an issue for industry in the region.
- Predictability of the Barents/Kara sea ice could be important for predictions of cold winters (e.g. Yang & Christensen 2012).

- Similar APPOSITE experiments are being run by:

  MPI; GFDL; ECMWF; IC3; Meteo France; CNRM; Met Office.

  Keen for more groups to join in.

Extent predictability for individual basin (I) (RMSE)

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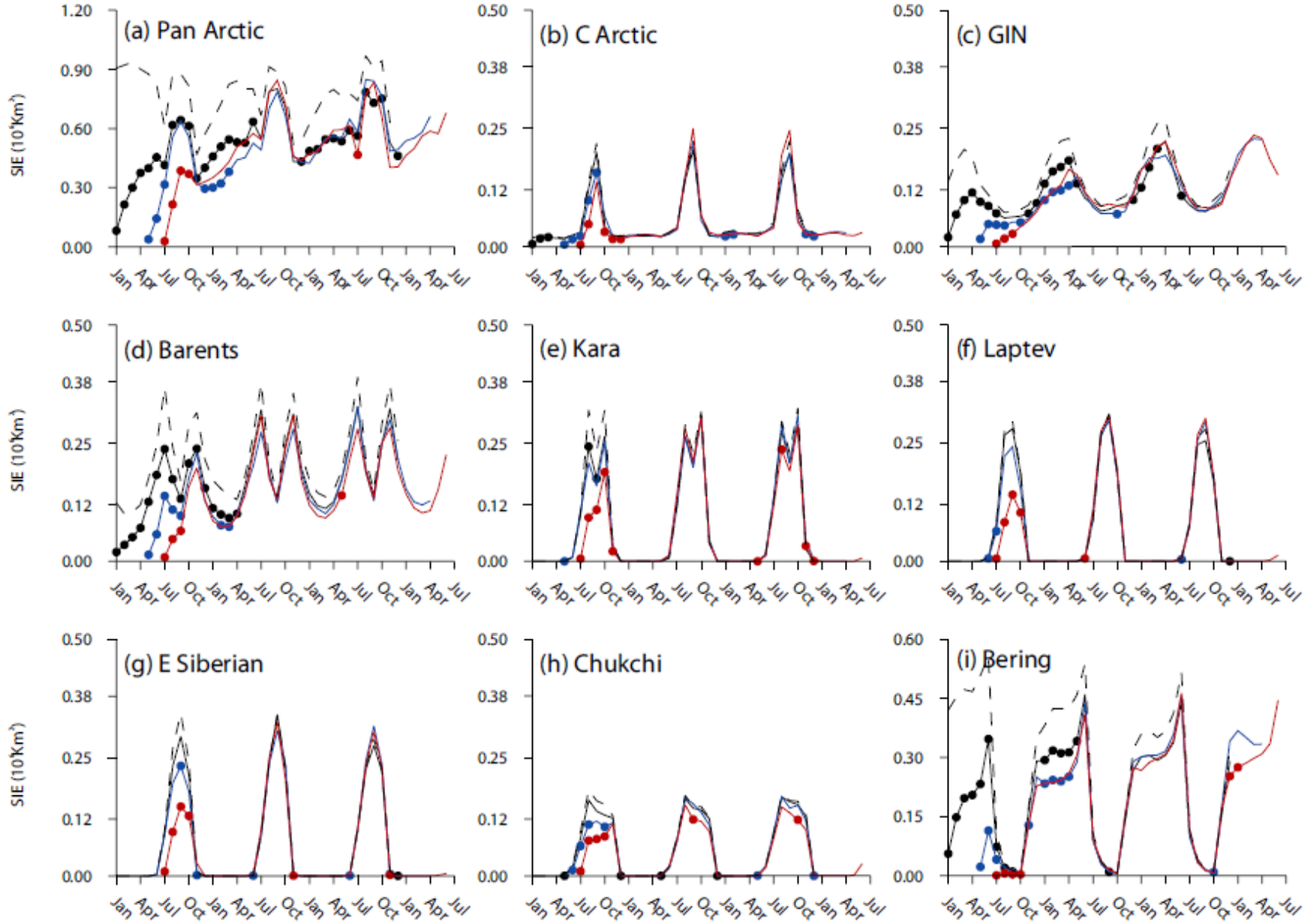

Extent predictability for individual basin (2) (RMSE)

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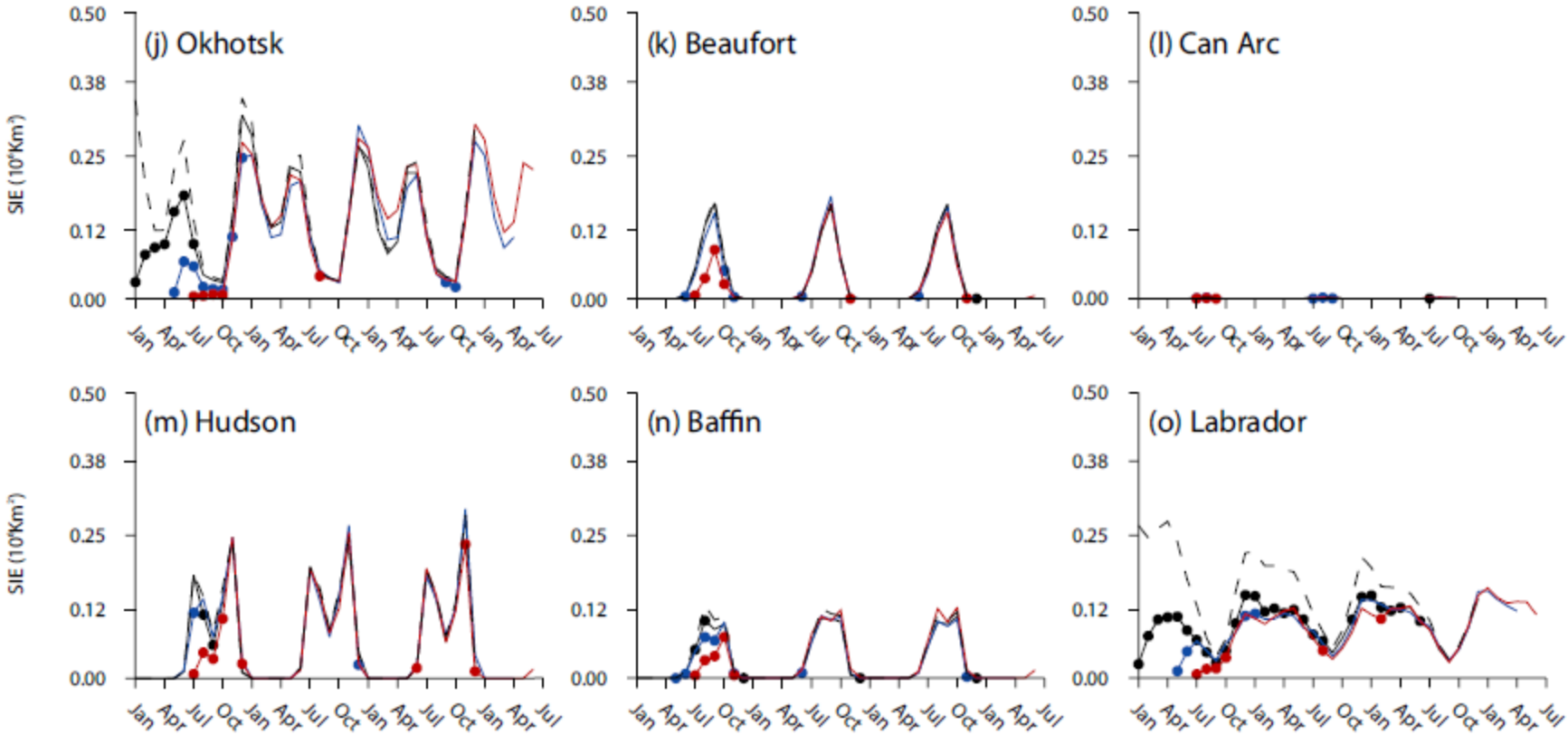

Volume predictability for individual basin (I)(RMSE)

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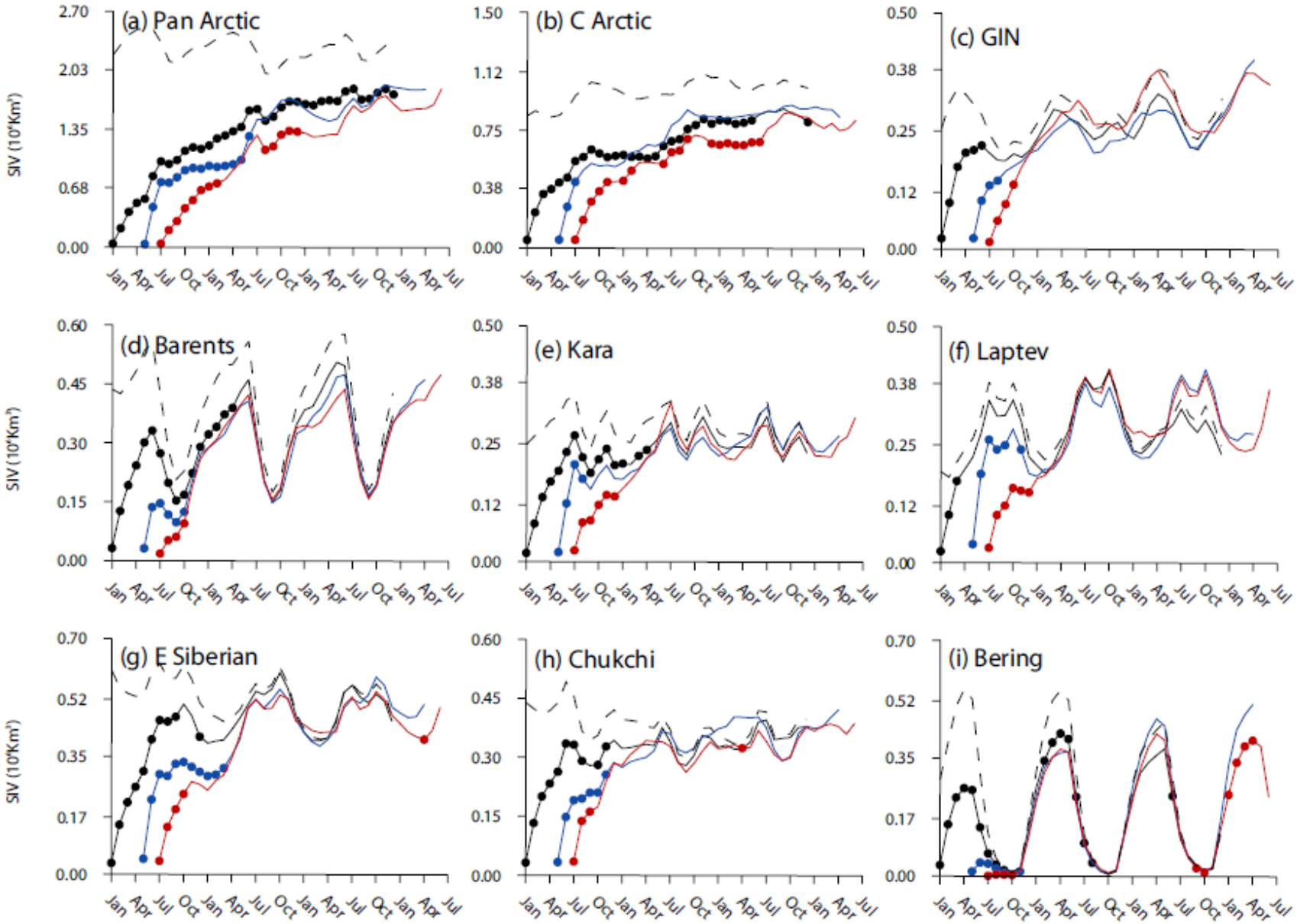

Volume predictability for individual basin (2) (RMSE)

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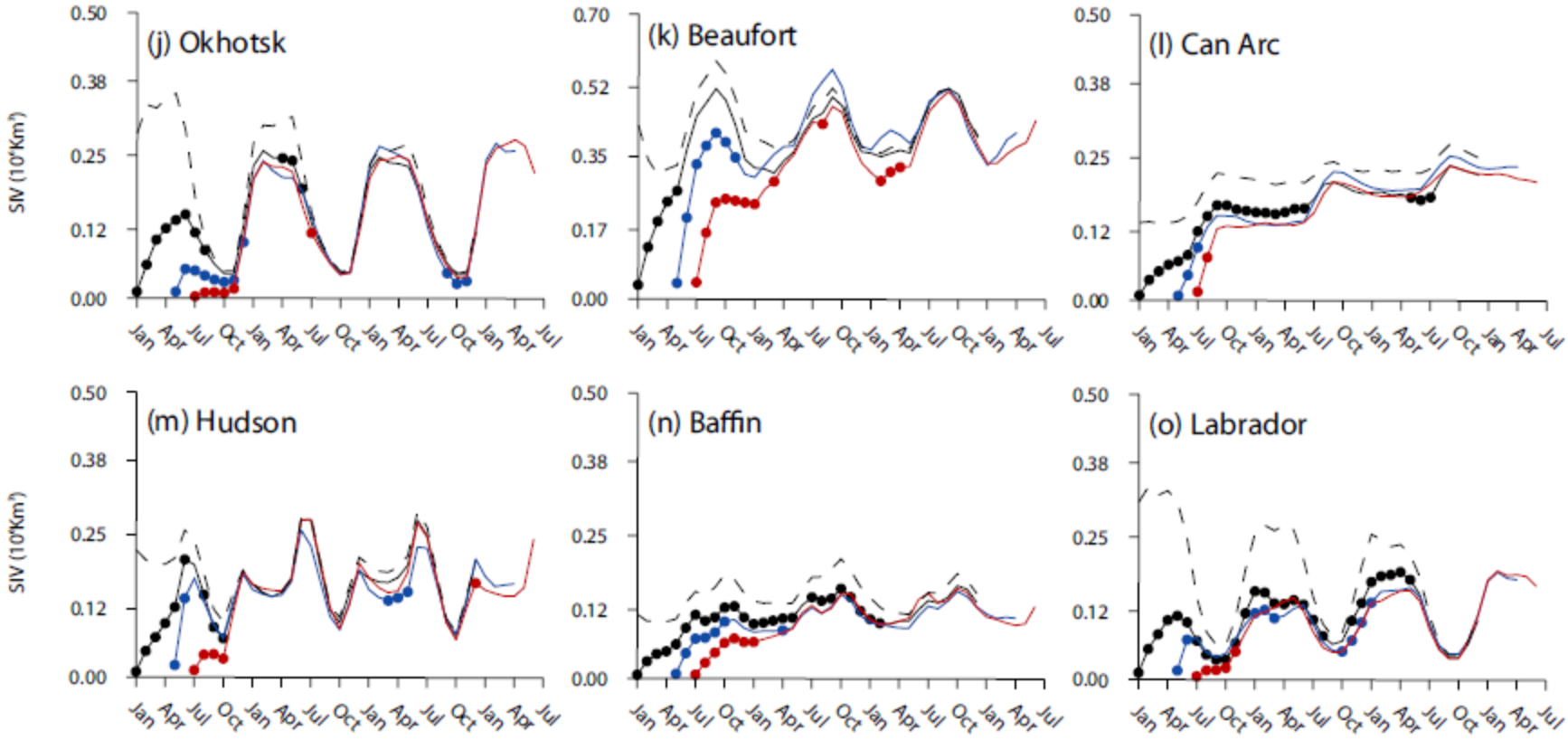

Perfect model experiments

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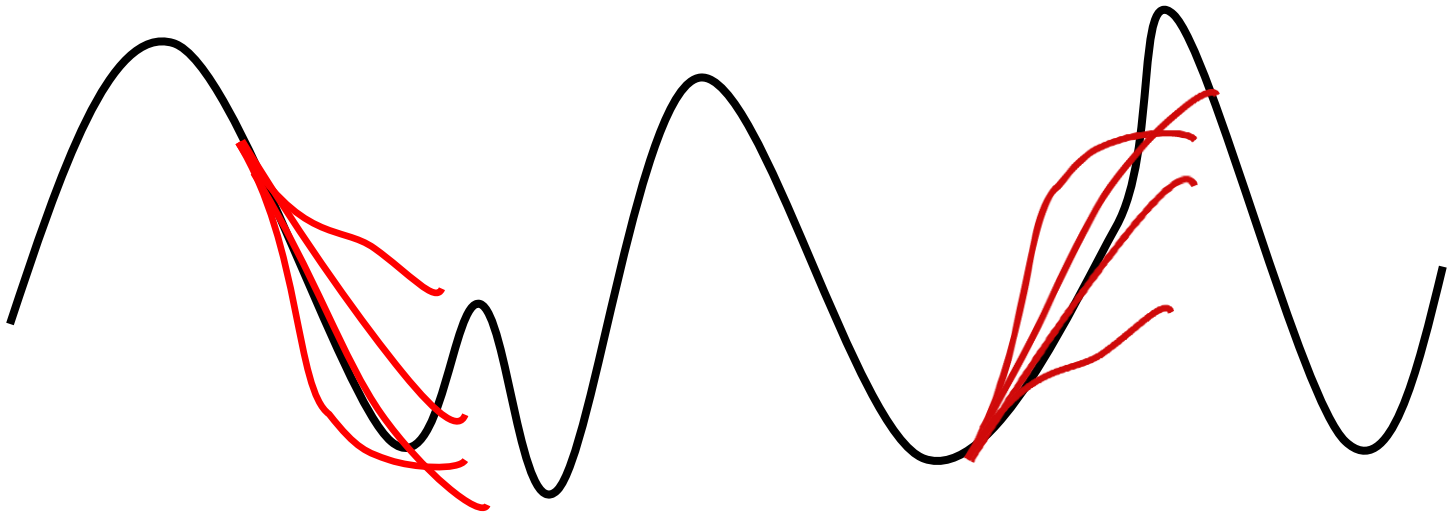

Design:

- initialise from "present-day" control simulation
- multi-member ensembles with identical ocean/ice conditions
- start dates sampled for 'different' types of initial condition

Pan-Arctic multi-model persistence properties: volume (control)

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- Volume is more persistent than extent.
- exhibits a melt season barrier.
- Winter to winter re-emergence in PIOMAS
- Melt to freeze season re-emergence in HadGEM.