An aerial photograph of sea ice, showing a mix of white, snow-covered ice floes and dark, open water. The ice floes are irregular in shape and size, some appearing as large, flat sheets and others as smaller, more fragmented pieces. The water is a deep, dark blue, contrasting sharply with the white and light blue of the ice. A semi-transparent, light gray rectangular box is overlaid on the upper portion of the image, containing the title and author information in yellow text.

How Early Can We Predict the Sea Ice Summer Minimum?

by Cecilia Bitz and Eduardo Blanchard
Atmospheric Sciences
University of Washington



STUDY OF ENVIRONMENTAL ARCTIC CHANGE

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June Report: Outlook Based on June Data

Report Released 16 July 2008

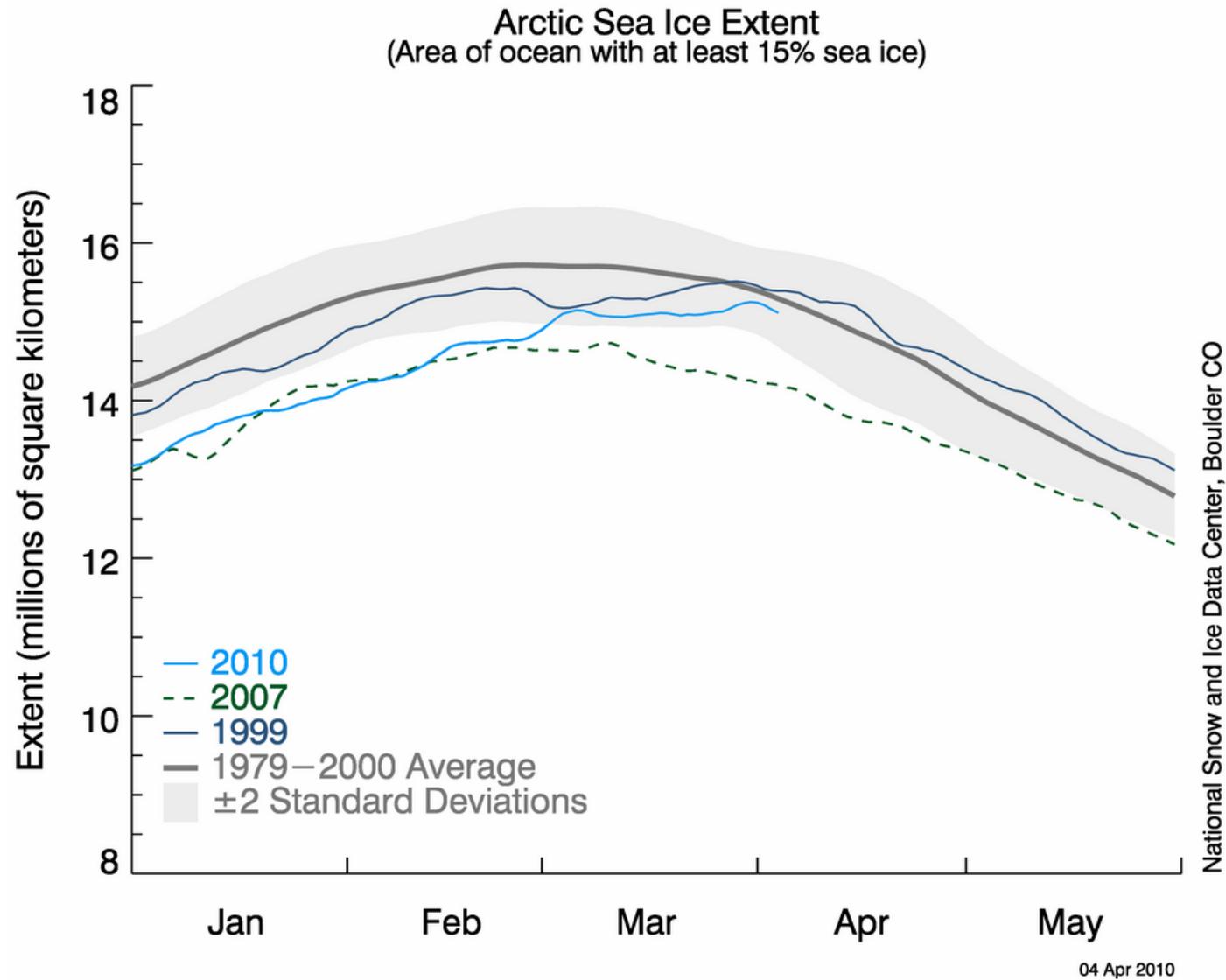
[Summary](#)

[Full Report](#)

SUMMARY

The outlook for the pan-arctic sea ice extent in September 2008, based on June data, indicates a continuation of dramatic sea ice loss. The June Sea Ice Outlook report is based on a synthesis of 17 individual projections, utilizing a range of methods. Projections based on June data are similar to those of the May report, with no indication that a return to historical sea ice extent will occur this year.

Outlook of Arctic sea ice total extent in September



<http://nsidc.org/arcticseaicenews/2010/040610.html>

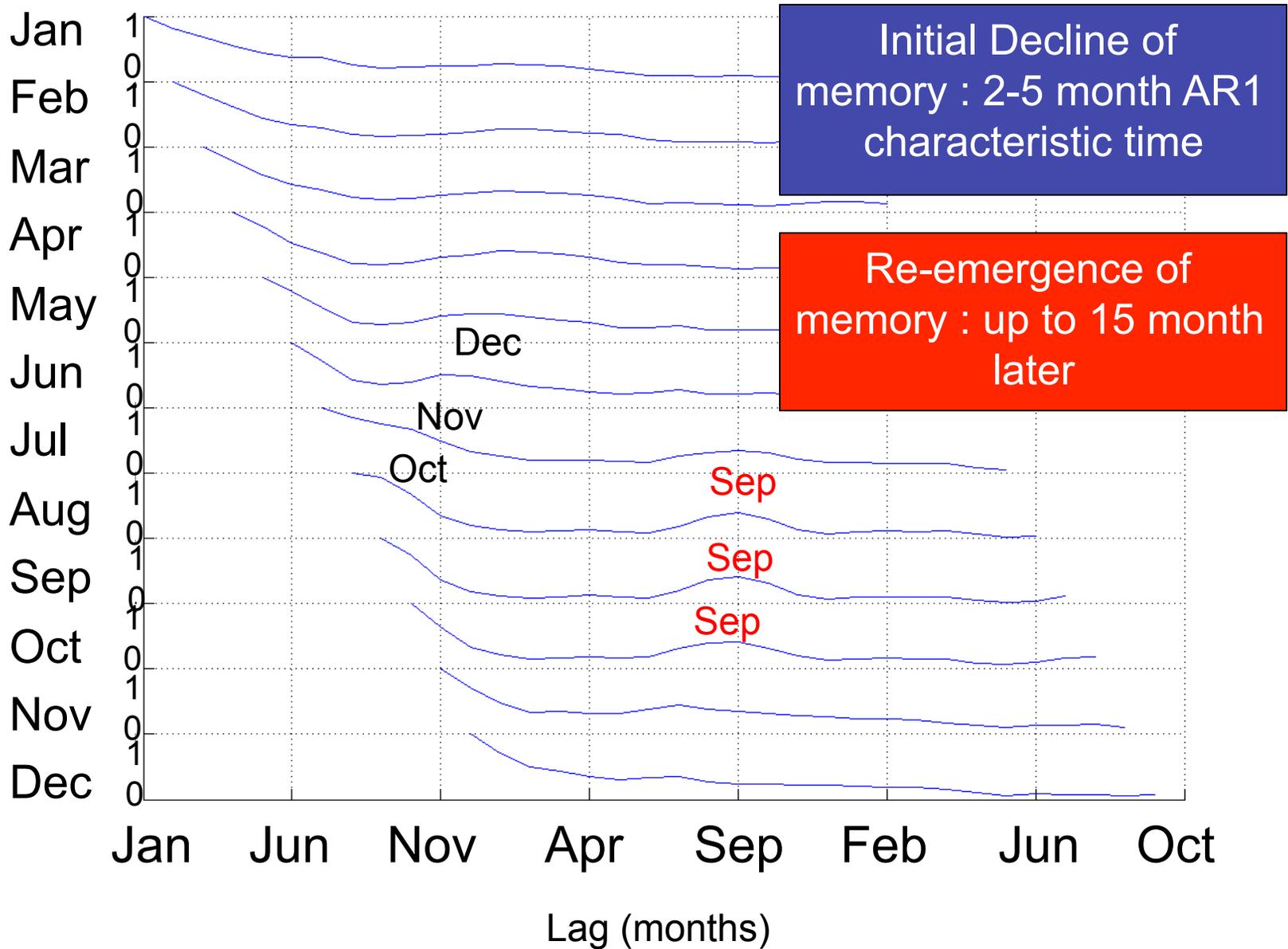
Part 1: Diagnostic predictability

Analysis of a 30 member ensemble of A1B scenario from CCSM3 T42 resolution

Thanks to H. Teng and C. Deser

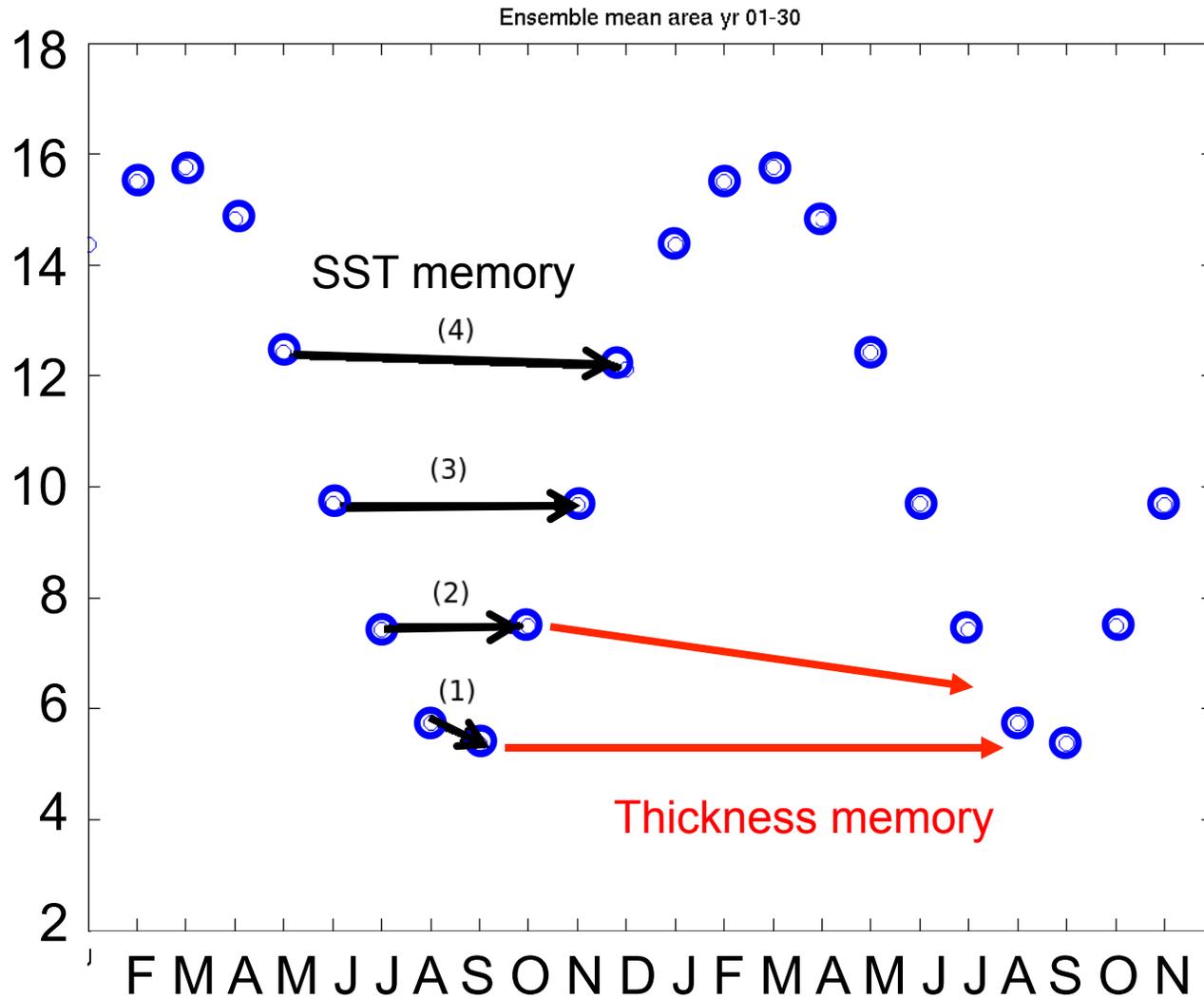
Compare model years 2000-2029 to
observed years 1979-2008

Lagged Correlation of Total Sea Ice Area in Ensemble Mean



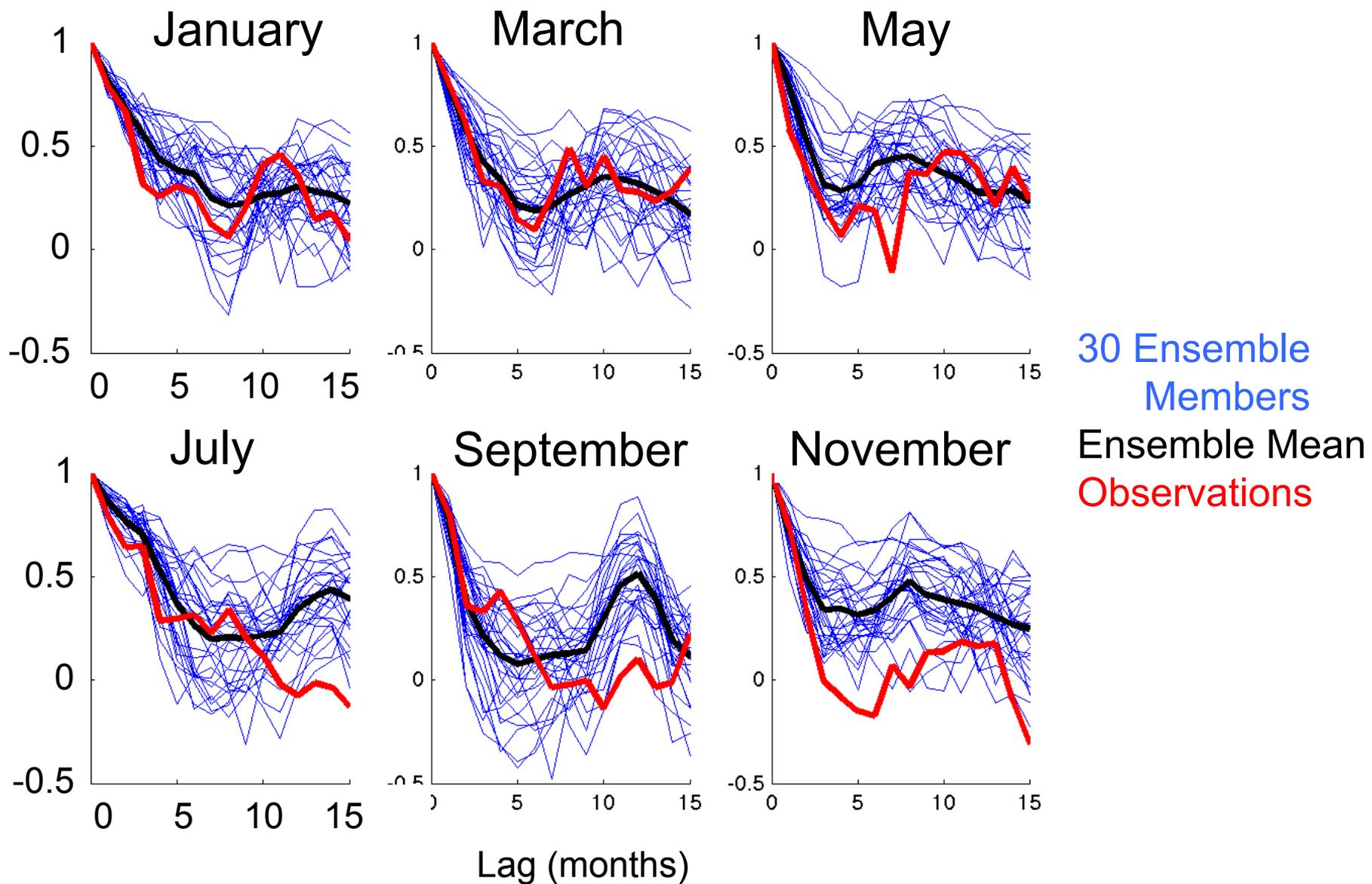
Blanchard, Armour, Bitz, and DeWeaver, 2010, J. Clim.

Sea ice Area Climatology in 10^6 km^2

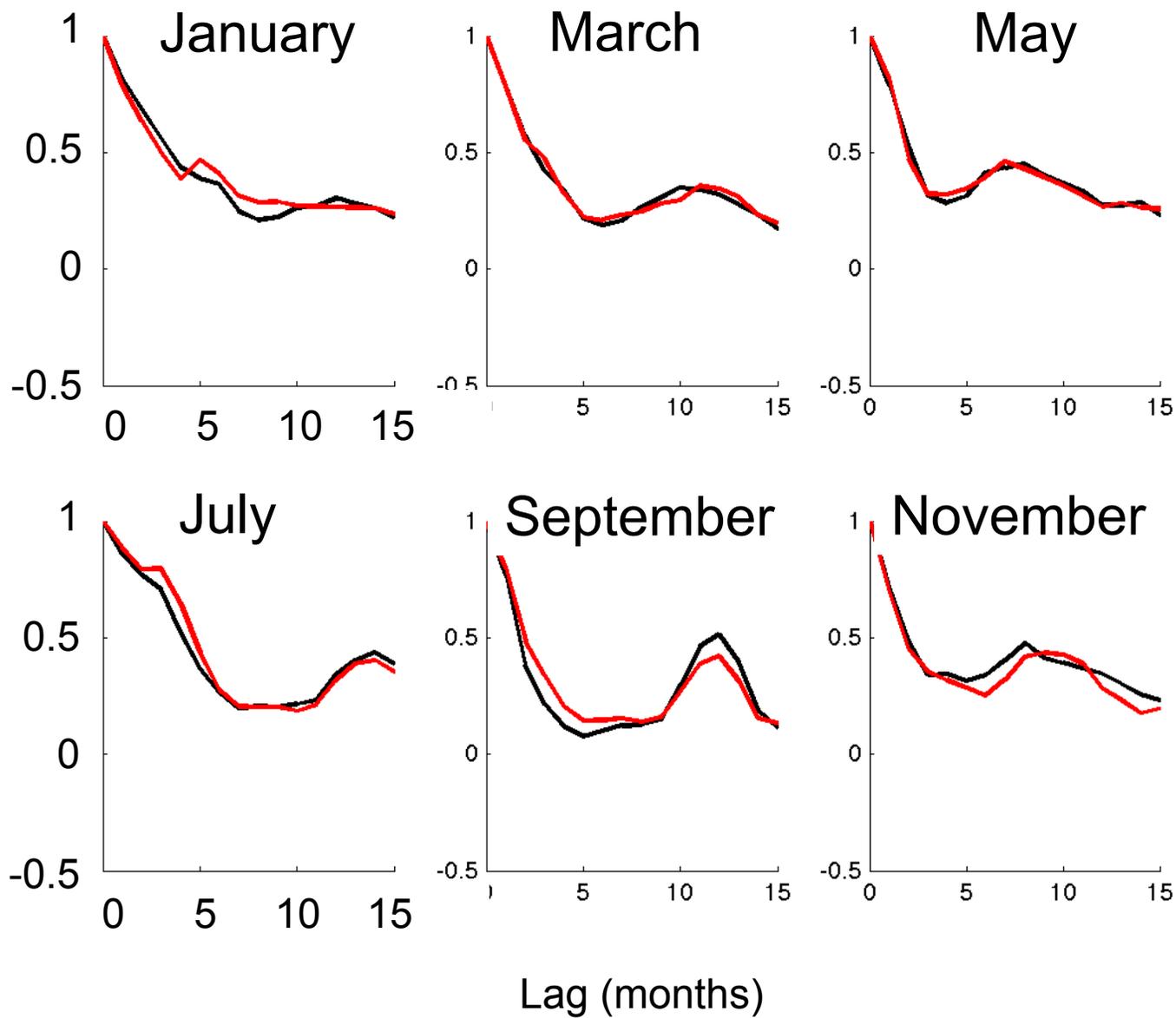


Blanchard, Armour, Bitz, and DeWeaver, 2010, J. Clim.

Lagged Correlation of Arctic Sea Ice area

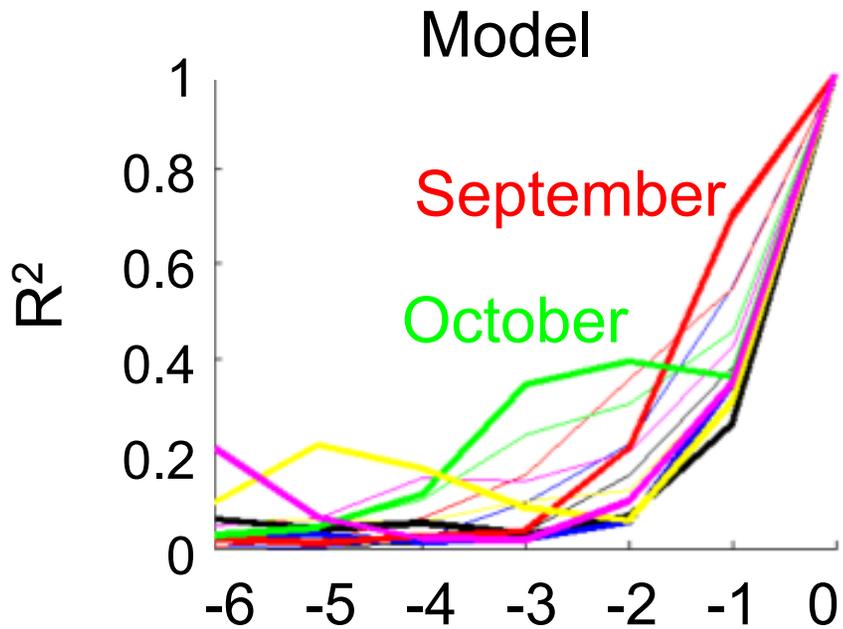


Lagged Correlation of Arctic Sea Ice area



Ensemble Mean
2000-2029

Ensemble Mean
2030-2059

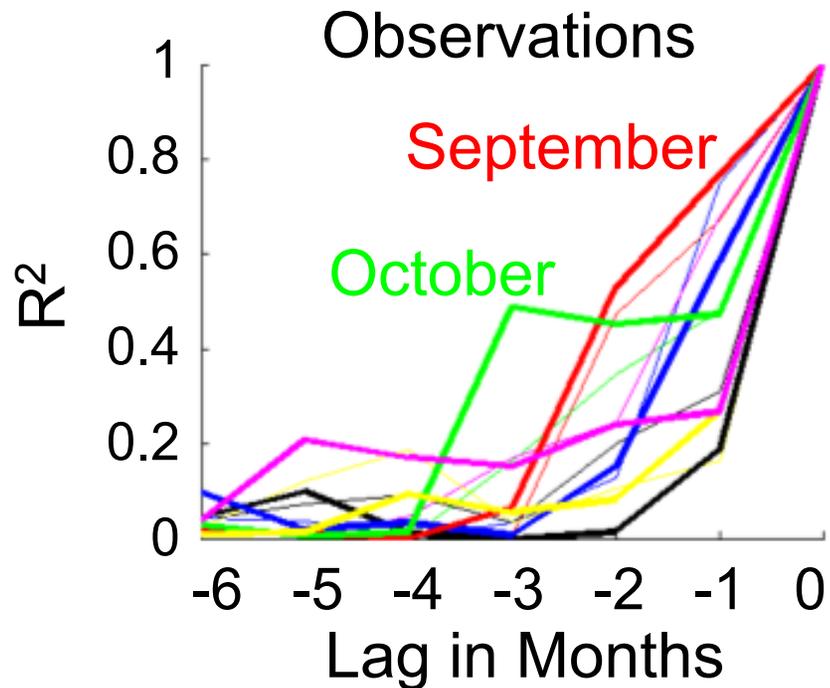


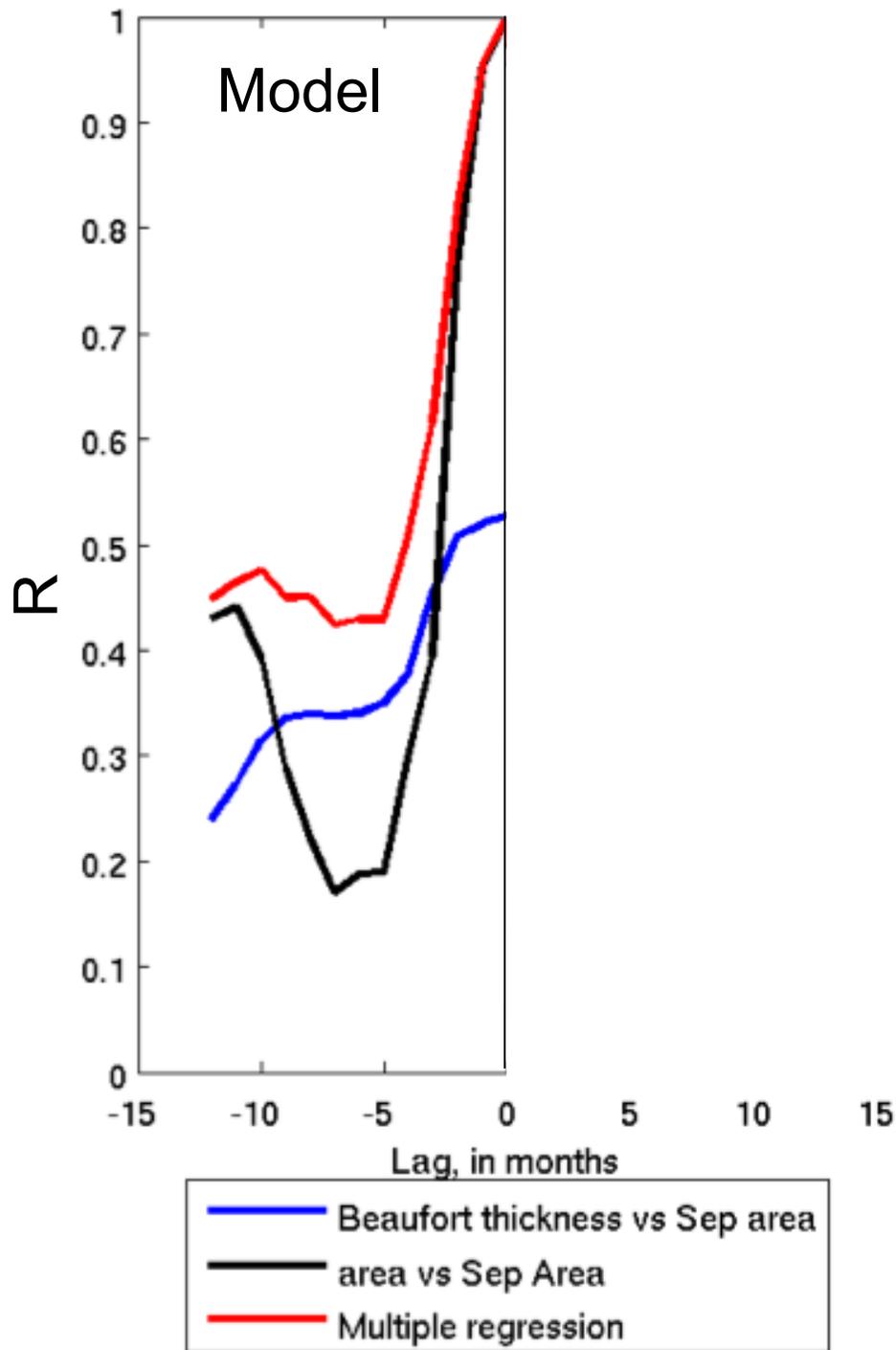
How far in advance can we predict anomalies in sea ice extent (ignoring summer to summer re-emergence)?

Can explain above 20% of variance in September's extent with July's extent

Have longer lead time for October

August is worse





Can increase lead time if we include knowledge of Beaufort Sea mean thickness

Given target is to explain above 20% of variance in September's extent

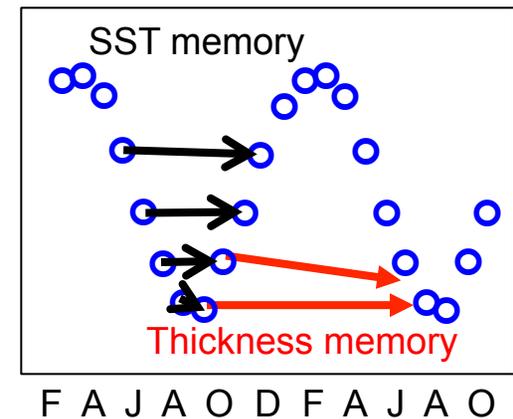
Part 1 Summary

Arctic sea ice area month-to-month persistence (decorrelation timescale) of 3-5 months, depending on the reference month

Arctic sea ice area re-emergence mechanism

Spring to Fall re-emergence is due to SST, seen in model and observations

Summer to Summer is due to thickness, only seen in model

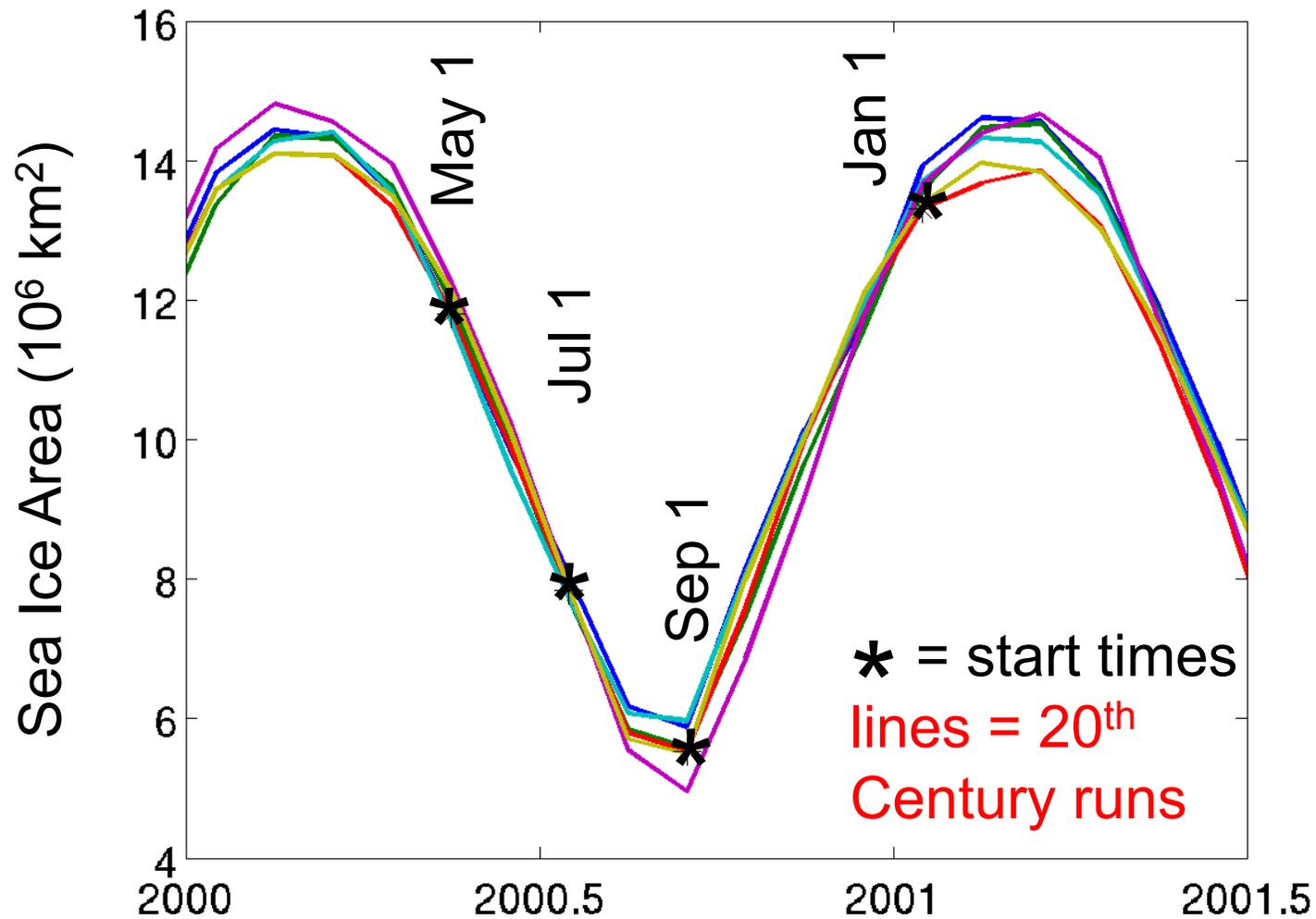


Re-emergence mechanism modulates seasonal cycle of initial decorrelation timescale. Longest persistence is seen following an anomaly in July

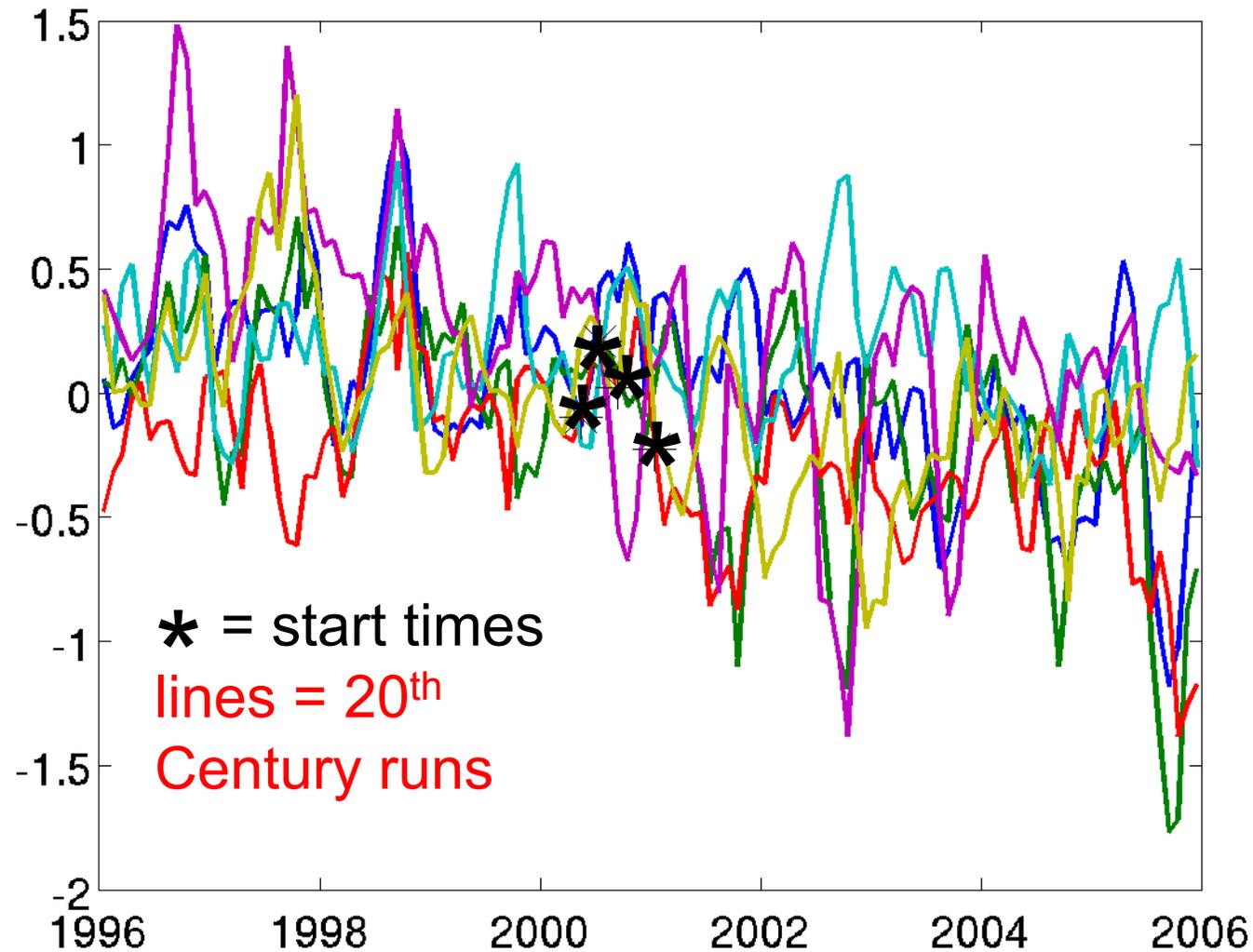
Most predictable month of total area given total area anomaly is September, can explain at least 20% of the variance starting a year in advance but this value raises to 70% only one month in advance.

Part 2: Prognostic Predictability in “Perfect Model” Studies with CCSM4

Initialized in year ~2000 Identical Ice, Ocean, and Land
Perturbed Atmosphere to create ensemble



Arctic Monthly Sea Ice Area Anomaly (10^6 km^2)



20 Ensemble members for each
start date (80 runs)

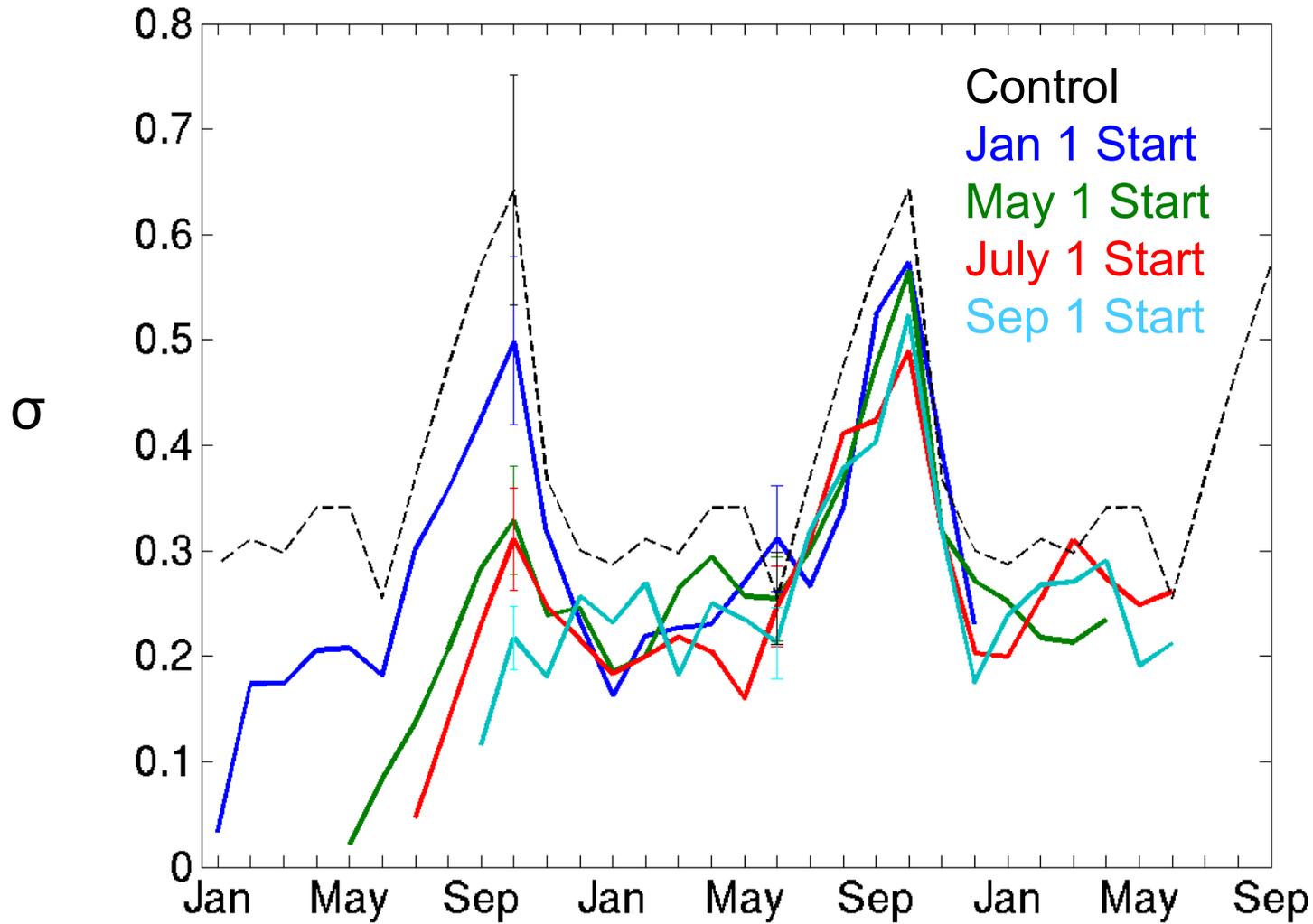
CCSM4 1deg resolution

Runs are 2 years long

Initialized from 20th century run
year 2000 with atmosphere
perturbed using adjacent days

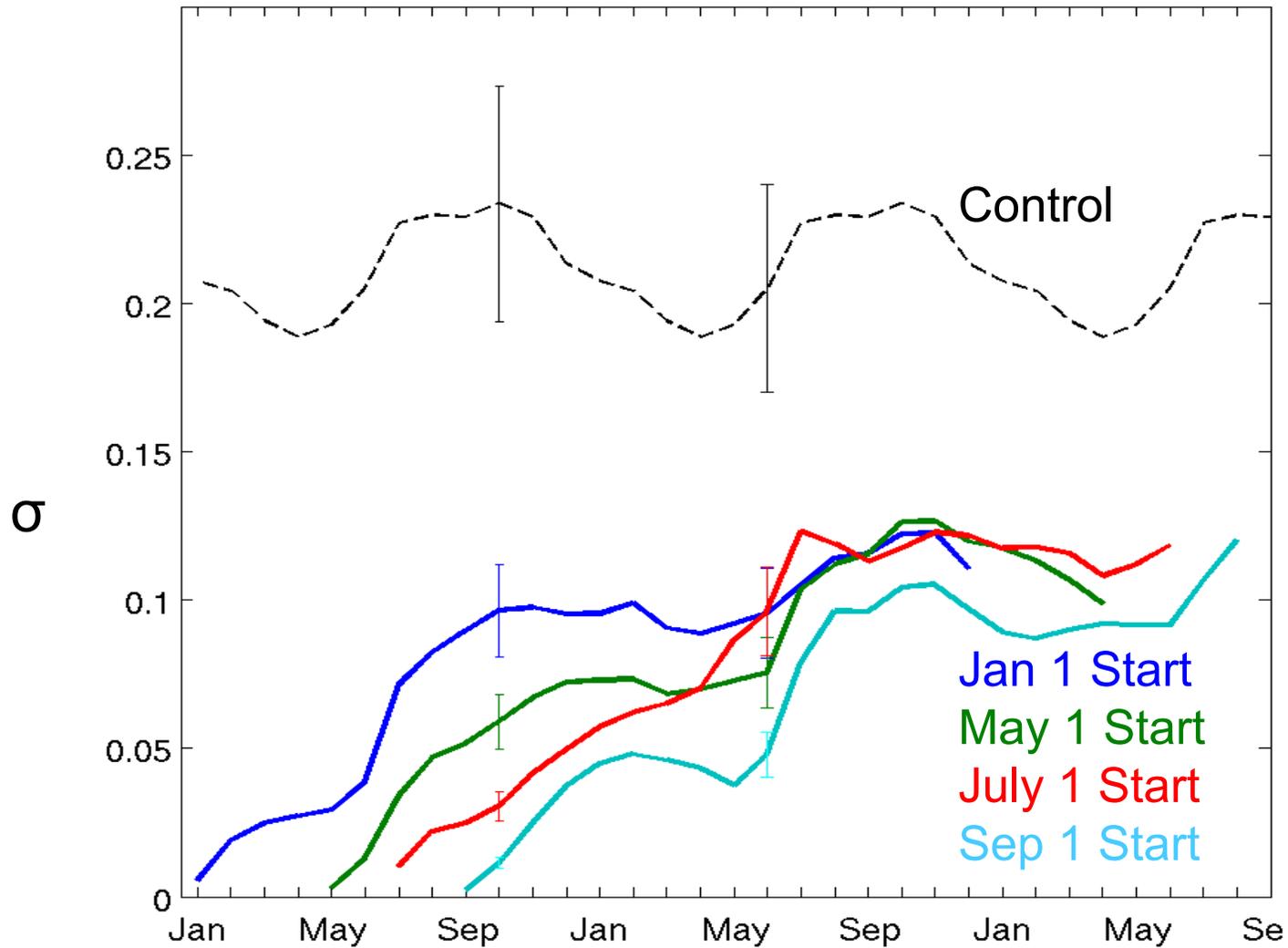
Blanchard and Bitz, in preparation

Growth of the Standard Deviation of Sea Ice Area (10^6 km^2)



error bar is standard error of the standard deviation

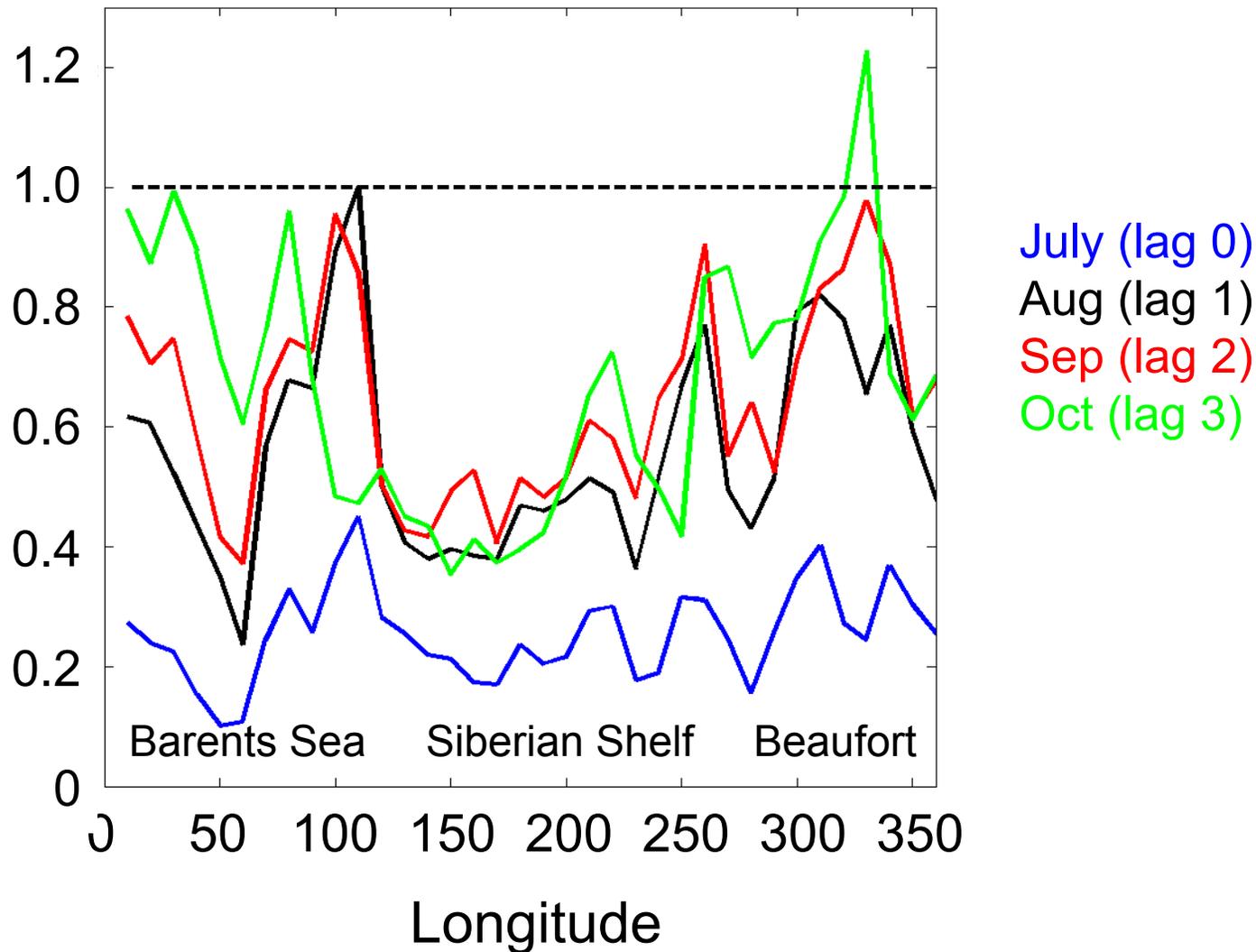
Growth of the Standard Deviation of Sea Ice Volume (10^{13} m^3)



error bar is standard error of the standard deviation

Ratio of $\sigma_{\text{predicted}}/\sigma_{\text{control}}$ by sector in the Arctic of Sea Ice Area

All Curves are from the ensemble with July 1 I.C.'s

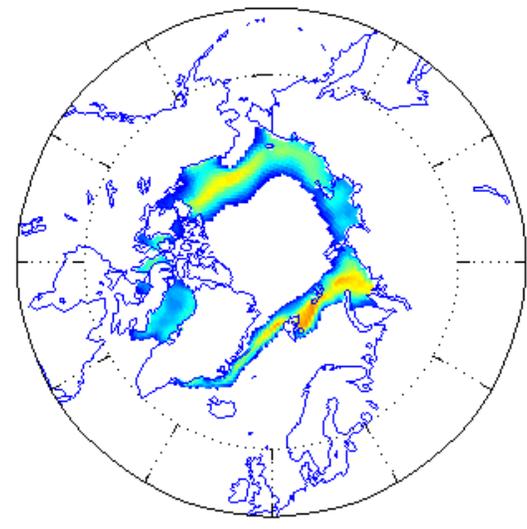
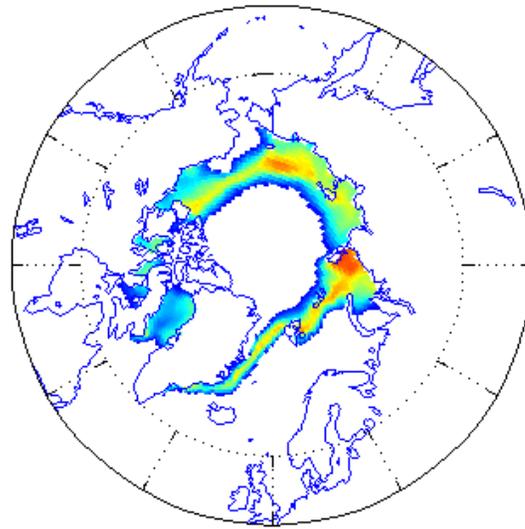
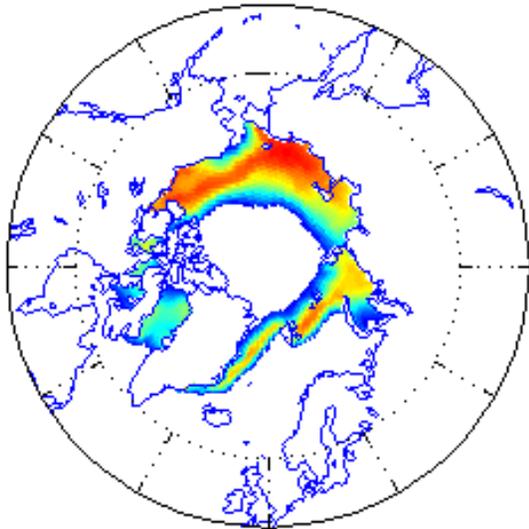


Standard Deviation of Ice Area in October (similar for September)

σ_{control}

$\sigma_{\text{predicted}}$ May start

$\sigma_{\text{predicted}}$ July start



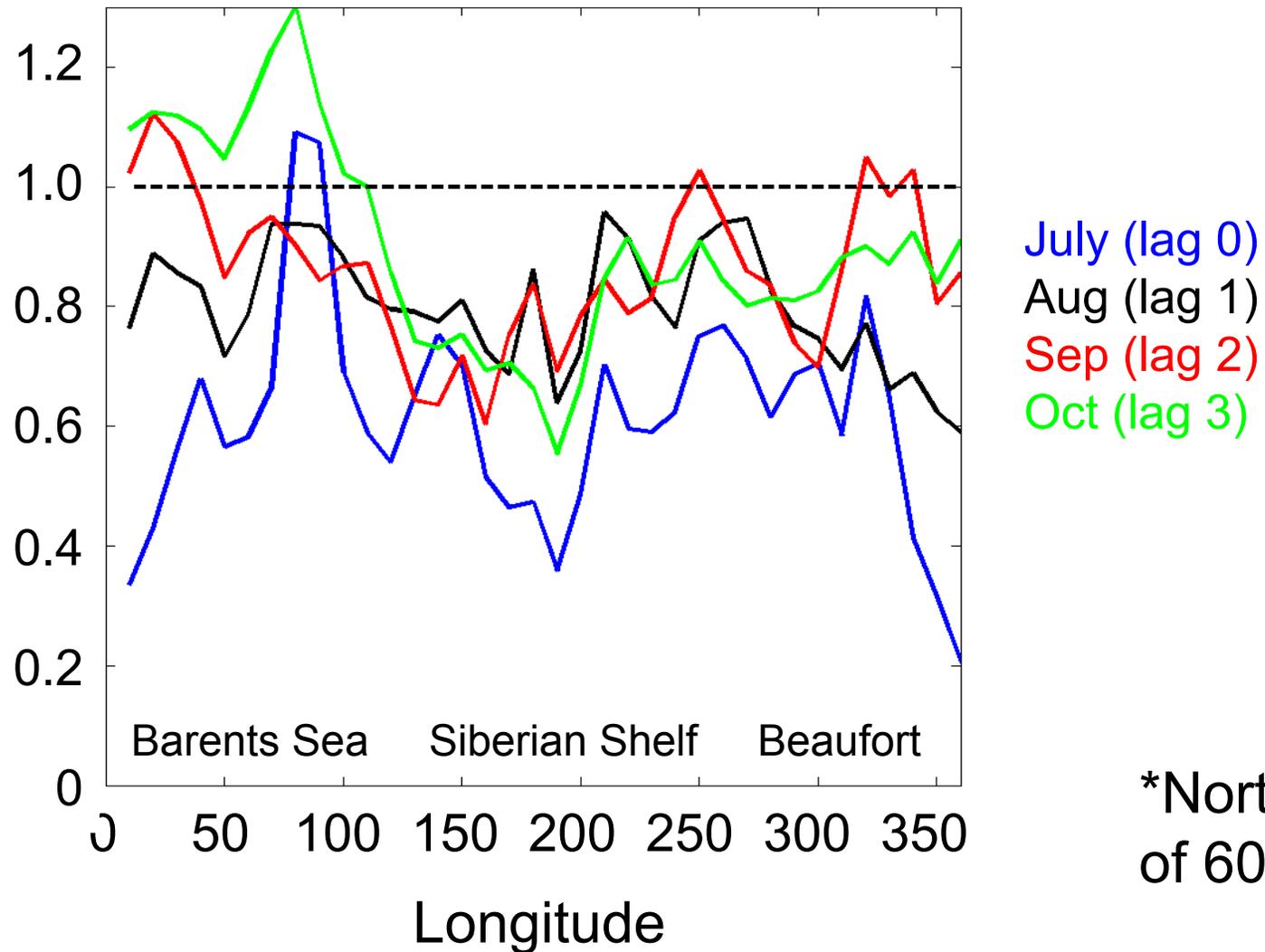
0.5 0.4 0.3 0.2 0.1 0



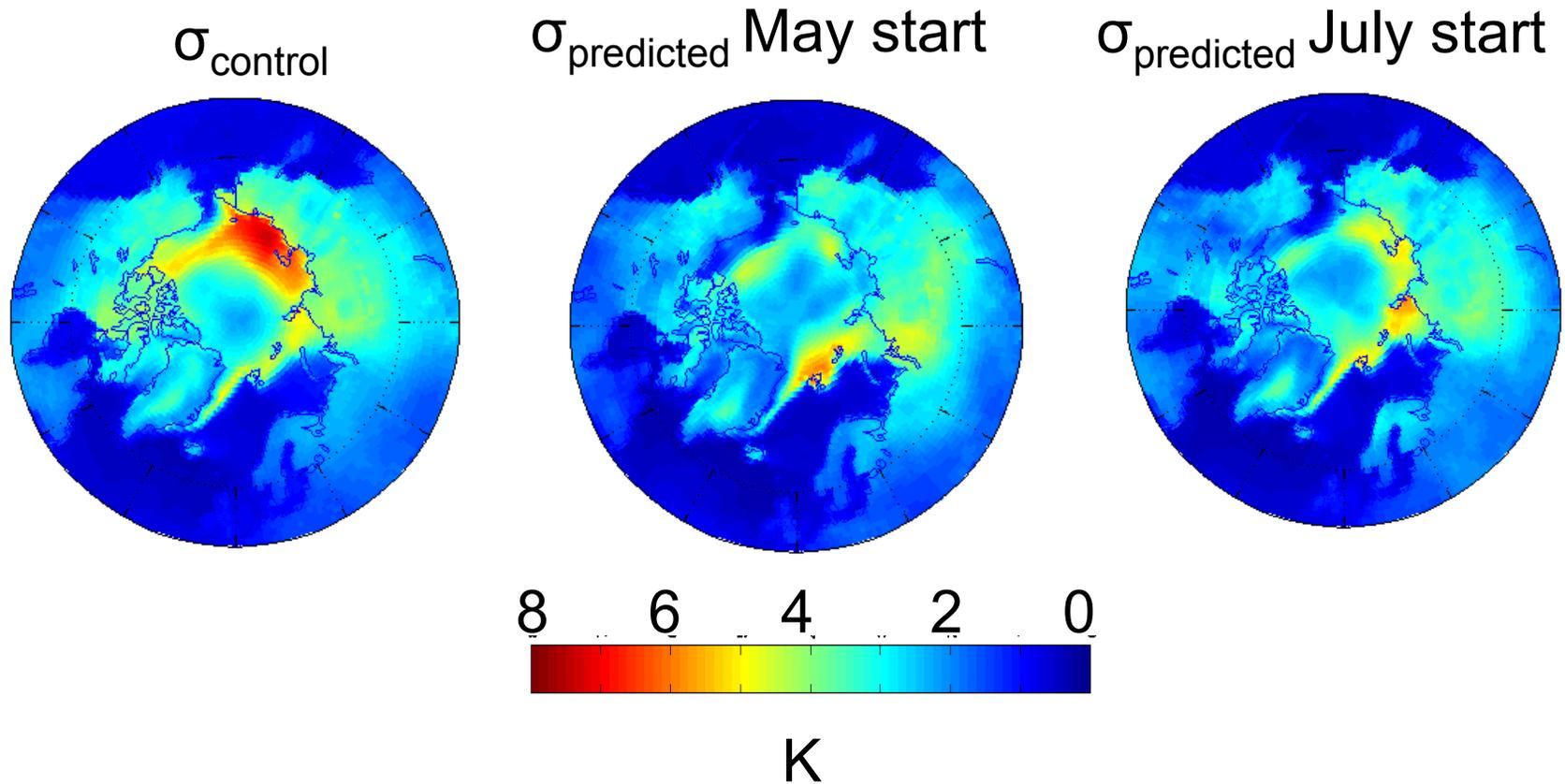
10^6 km^2

Ratio of $\sigma_{\text{predicted}}/\sigma_{\text{control}}$ by sector of Arctic* Surface Temperature

All Curves are from the ensemble with July 1 I.C.'s



Standard Deviation of Surface Temperature in October (similar for September)



Summary of Part 2

CCSM4 perfect model studies indicate

Significant predictability of late summer and Fall sea ice and temperature for initialization in July owing to persistence and re-emergence. May offers less good but still significant predictability of late summer and Fall.

Much of the memory is carried by the multiyear ice and SST

When normalized by the standard deviation of the “control”, the predictability of sea ice area is largest in the Siberian Sea sector.

For total Arctic sea ice area, the normalized predictability is longest following July, but without normalization, predictability is longest for January.