Arctic sea ice predictability

Ed Blanchard-Wrigglesworth,
University of Washington,

with Cecilia Bitz (UW), Richard Cullather (NASA), Wanqiu Wang (NOAA), Jinlun Zhang (UW)… and the rest of the SIPN team

Arctic sea ice predictability

or can we forecast September sea ice extent (at seasonal time-lags)

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What is the Sea Ice Outlook (SIO)

Forecast of September sea ice extent

Organized by the Study of Environmental Arctic Change (SEARCH). Since 2013, hosted by the Sea Ice Prediction Network - SIPN.

Initiated in 2008, triggered by 2007 summer record melt

Each summer, 3 submission calls - early June, early July, early August

All types of forecast techniques welcome: dynamical models, statistical, heuristic, public polls.

2008 - 2014: 7 years, 21 submission calls, 300+ submissions. 112 from dynamical models. *June 2015 record 30 contributions*

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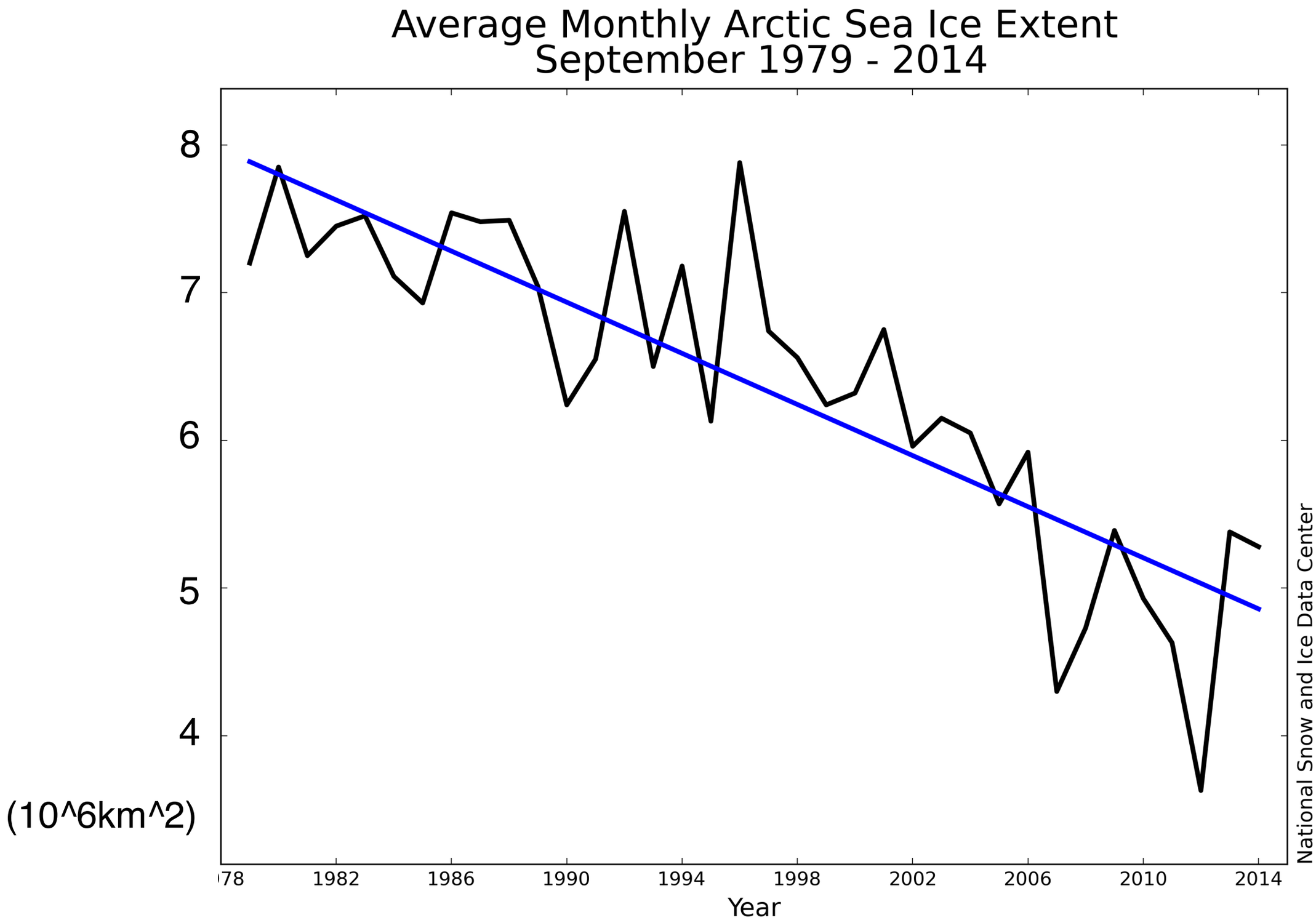
While sea ice extent is of very little practical use to stakeholders, it is considered a simpler problem than prediction of regional fields.

Lots of attention (200k unique views in summer 2014)

www.arcus.org/sipn

What is the Sea Ice Outlook (SIO)



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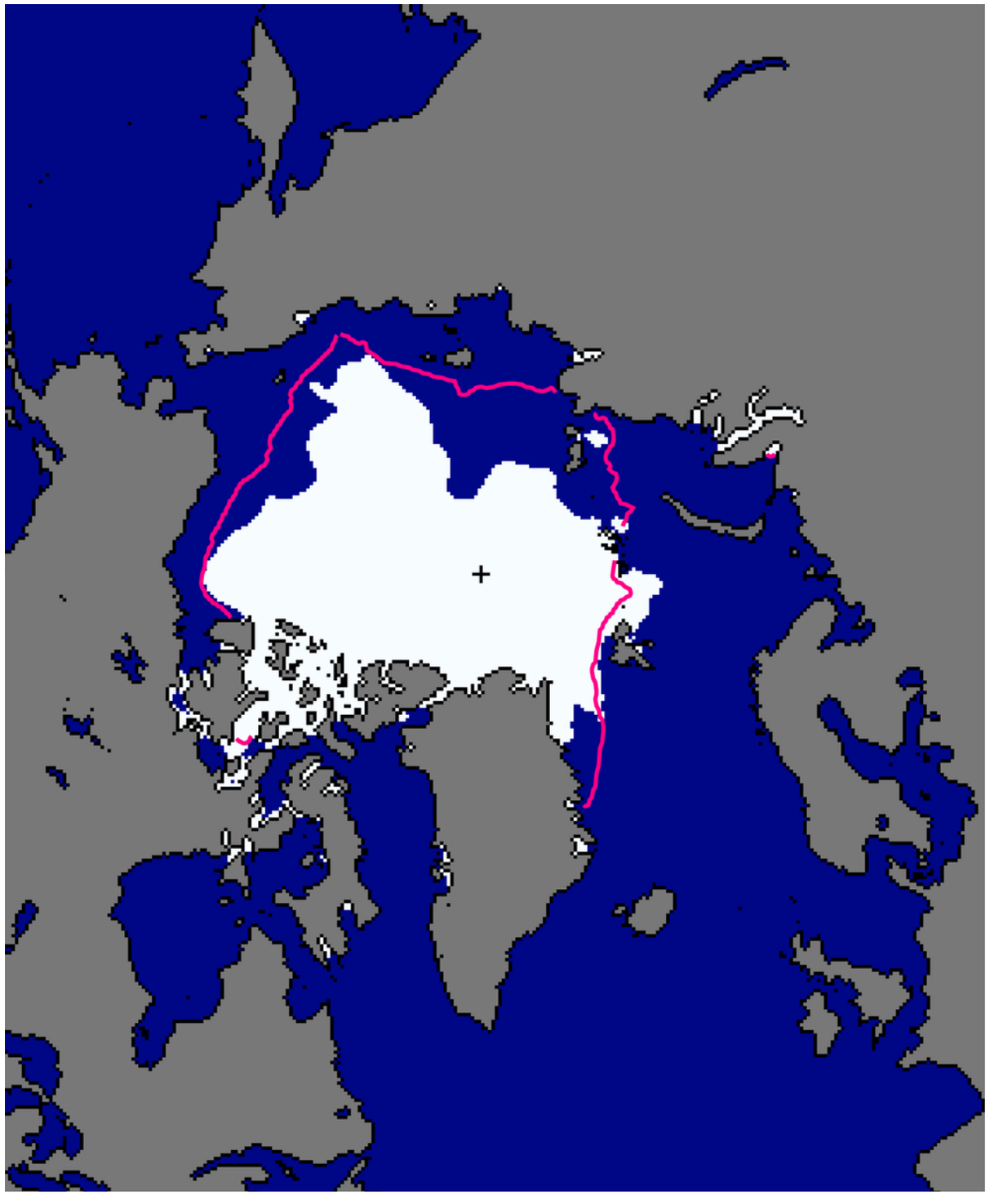

September 2014

median climotology ice edge

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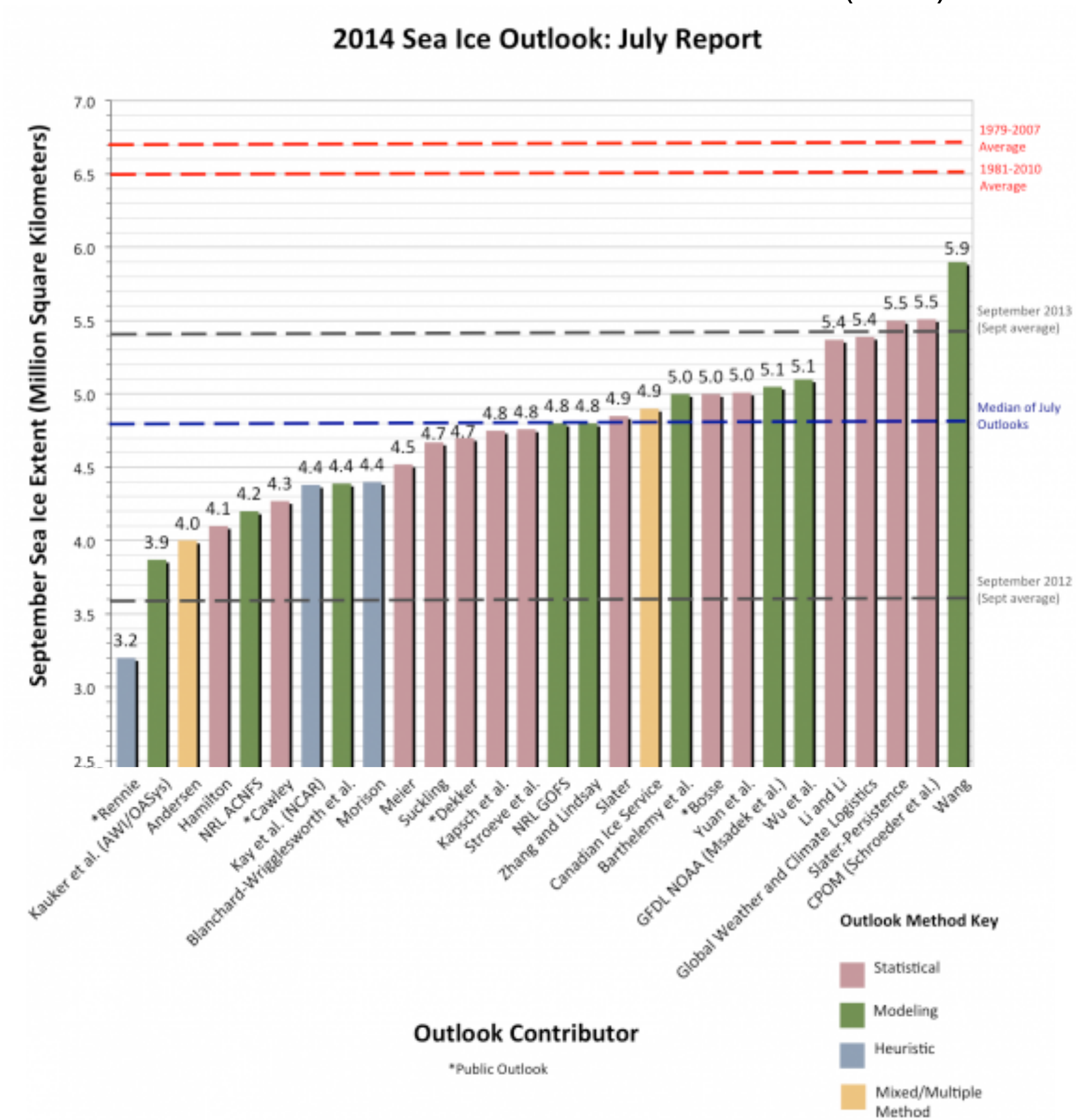

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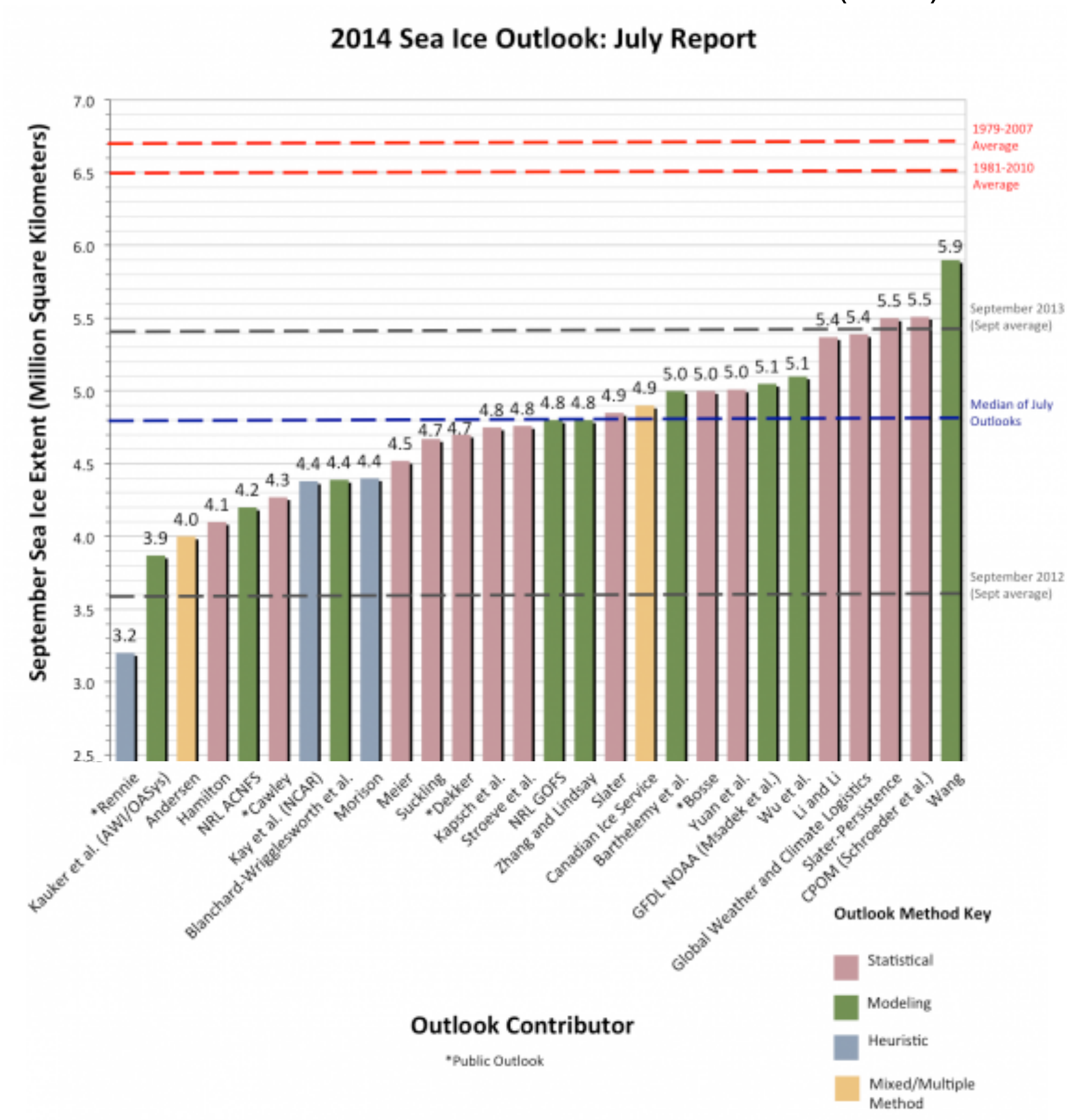
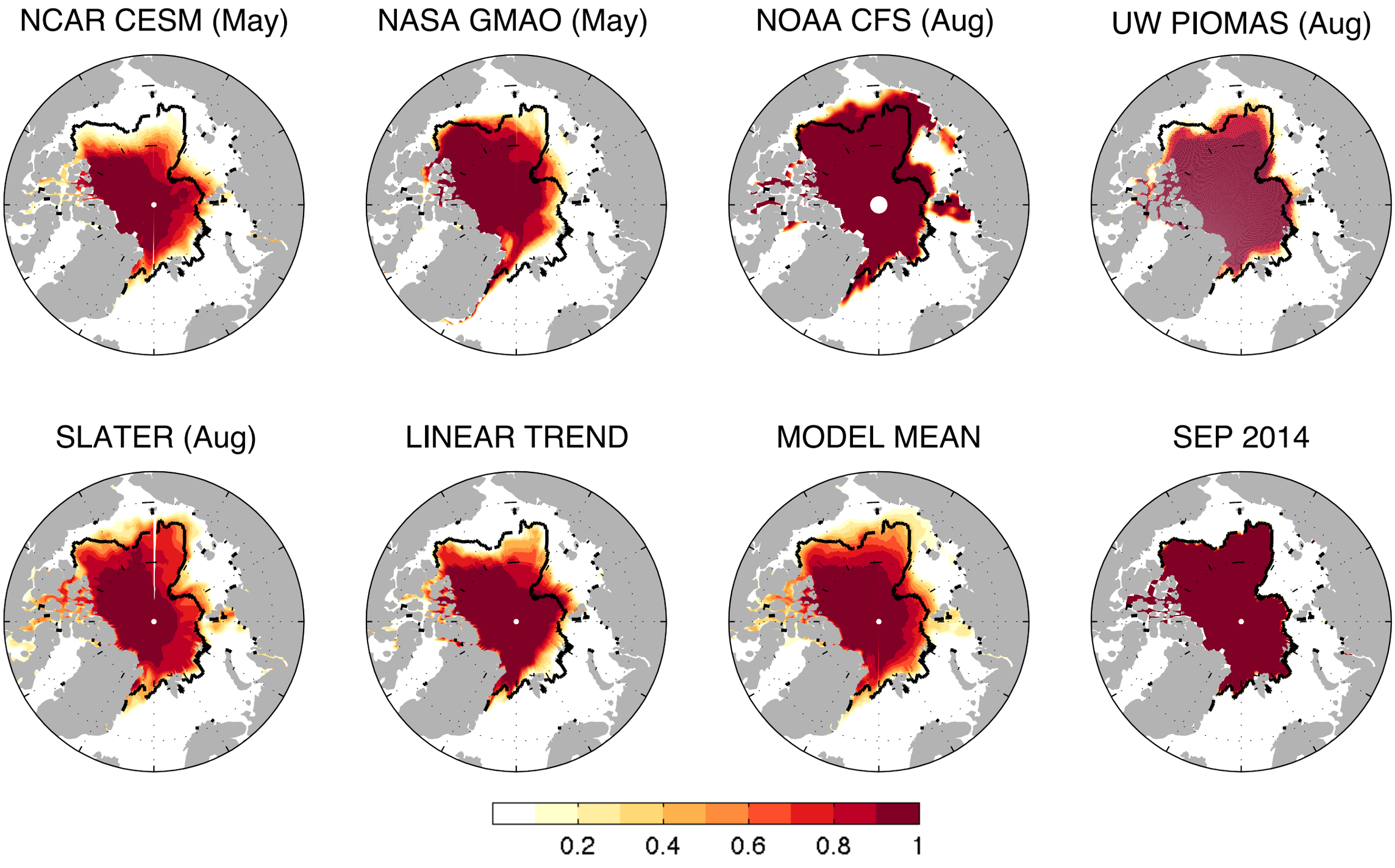


(+/- sigma)

What is the Sea Ice Outlook (SIO)

Beginning in 2014, regional fields also included: e.g., **sea ice probability:**



What is *the skill* of the Sea Ice Outlook (SIO)

Strove et al (2014), years 08-13: Overall, little skill. Good when years are close to linear trend, poor when years depart from linear trend.

Statistical forecasts slightly better than dynamical models.

Not much improvement as season progresses (lead 4 month to lead 2 month forecasts)

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In this talk...

Analyze SIO dynamical models. Is there skill? Should one expect skill?
If there's no skill, why…?

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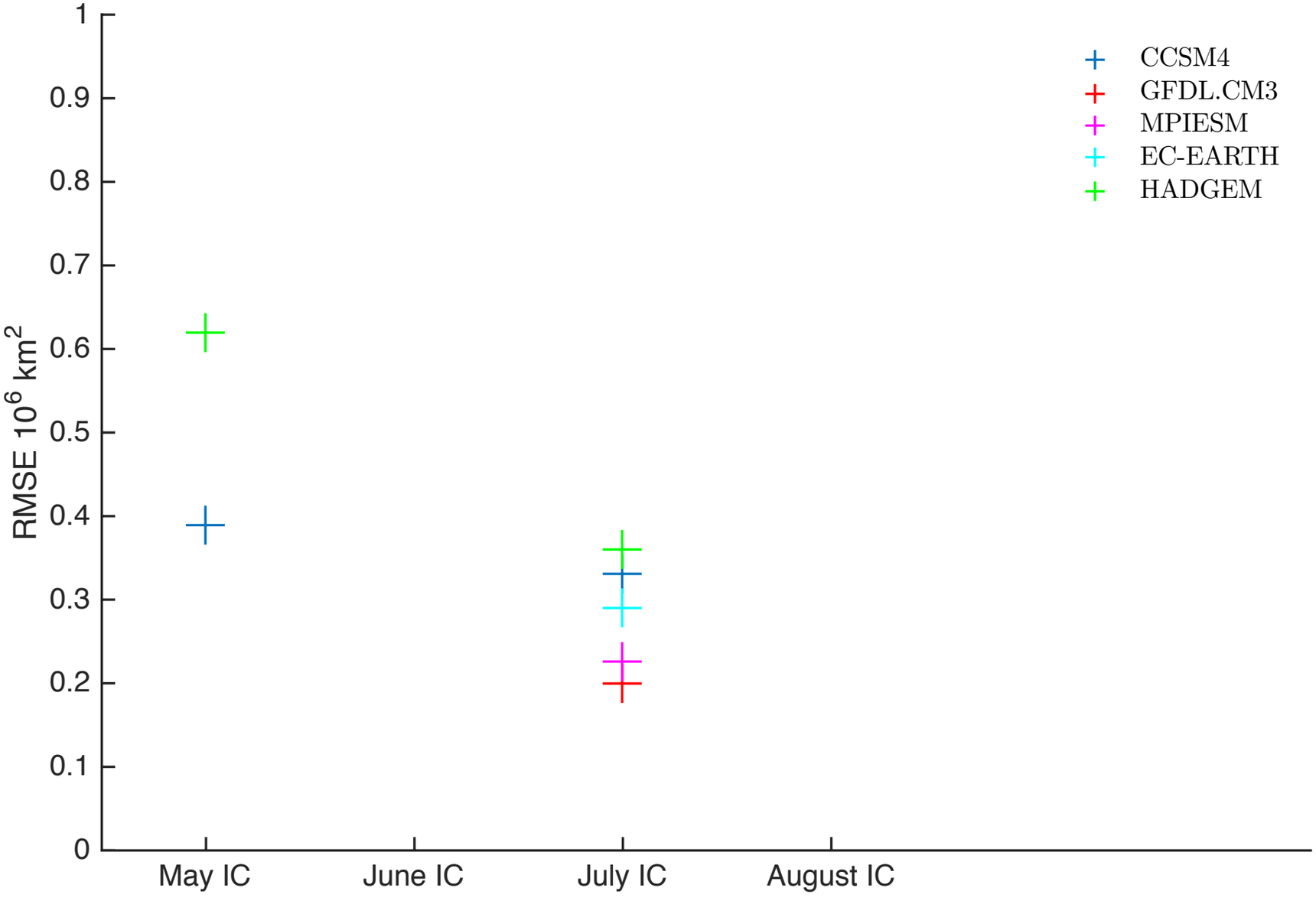
SIO dynamical models 2009-2014:
115 total submissions - 35 June, 43 July, 37 August

Forecast skill of September sea ice extent



+ Perfect-model

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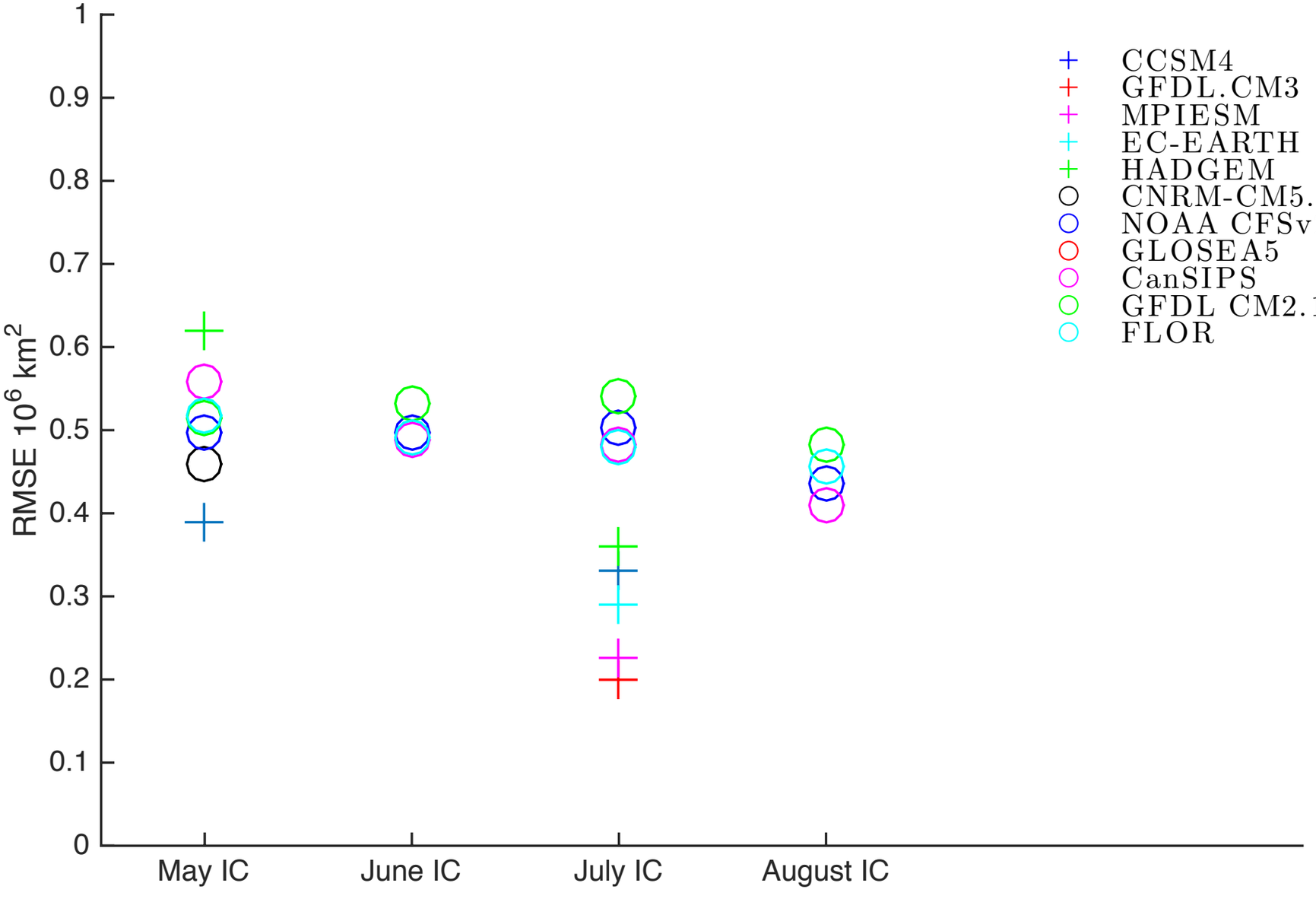

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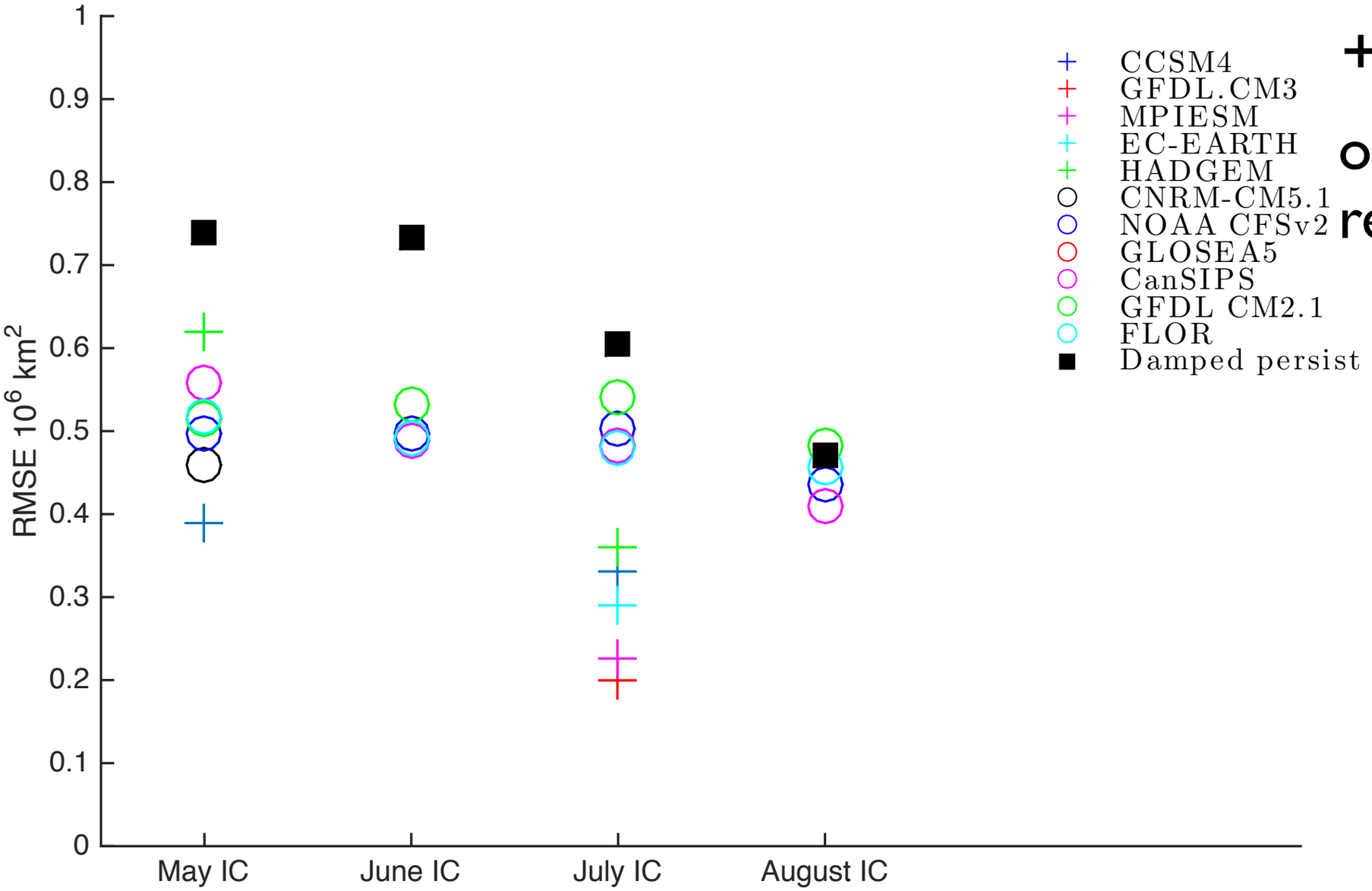

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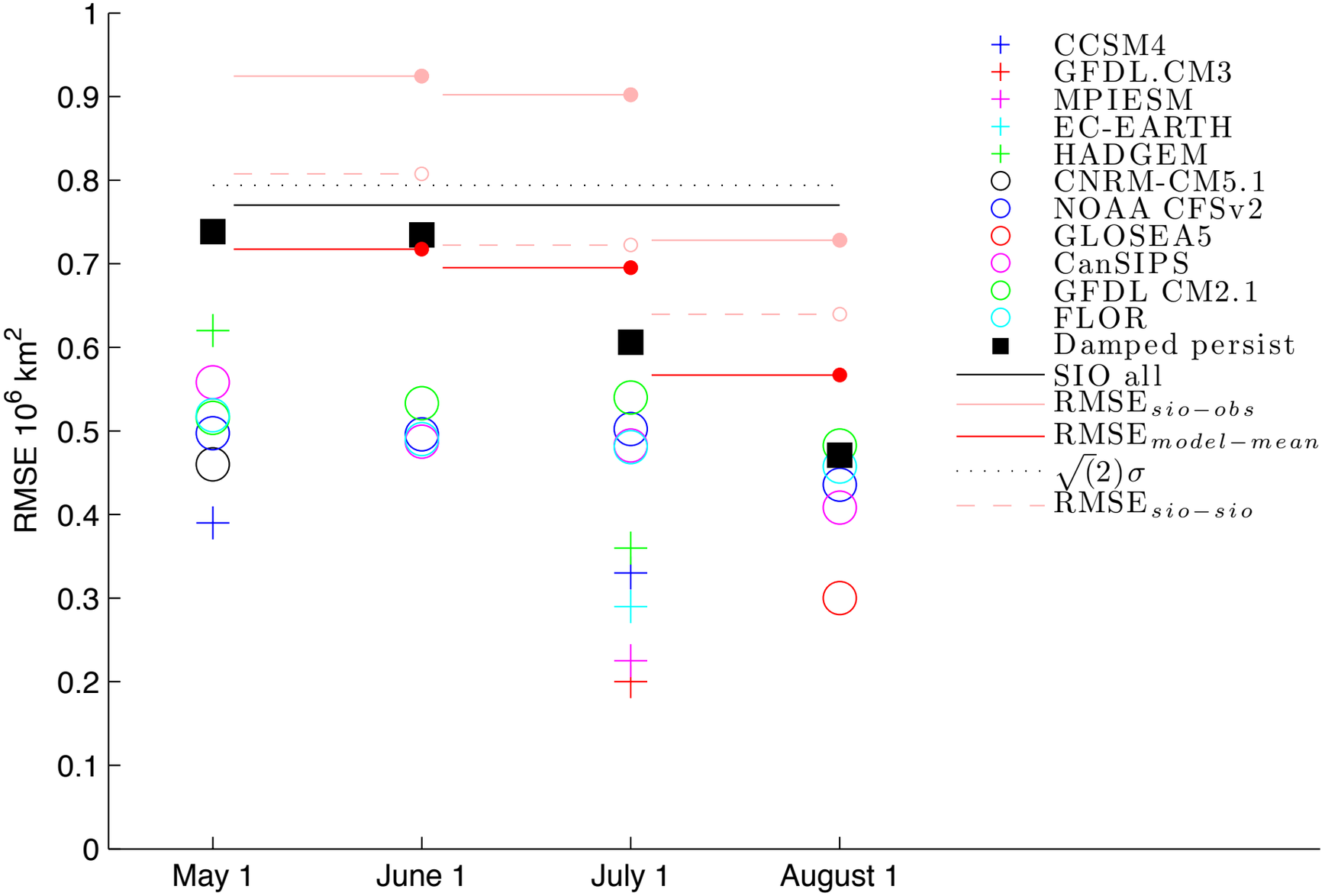

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= SIO

Should we expect skill?

Results from perfect-model experiments, hindcasts, and studies of persistence timescales of sea ice say yes.

SIO models do not even beat damped persistence forecast.

Why is skill so much lower than hindcasts? Some of the models in SIO have performed hindcasts over historical period, found much higher skill.

Has recent period been inherently more unpredictable than earlier decades?

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METOFFICE GLOSEA5: hindcast RMSE (1996-2009): 0.3 million km
SIO RMSE (7 forecasts): 1 million km

SIO models are about as unskilled at predicting each other as at predicting observations.

How different are the initial conditions they use?

Even if they used identical initial conditions, what effect would different physics have?

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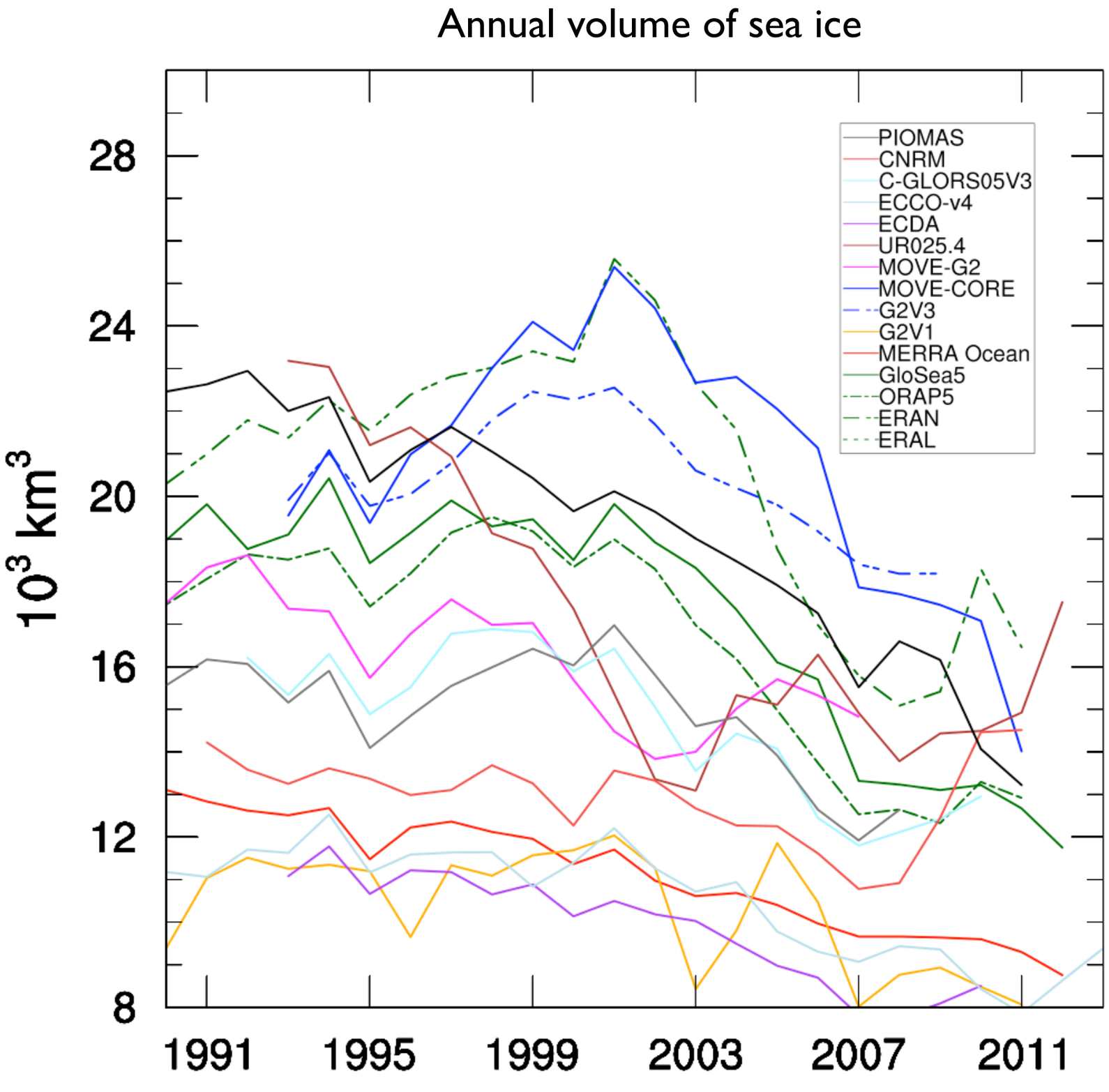
Start by focusing on sea ice thickness/volume

Errors in reanalysis/recon (from which ICs are taken)



Chevallier et al (in review)

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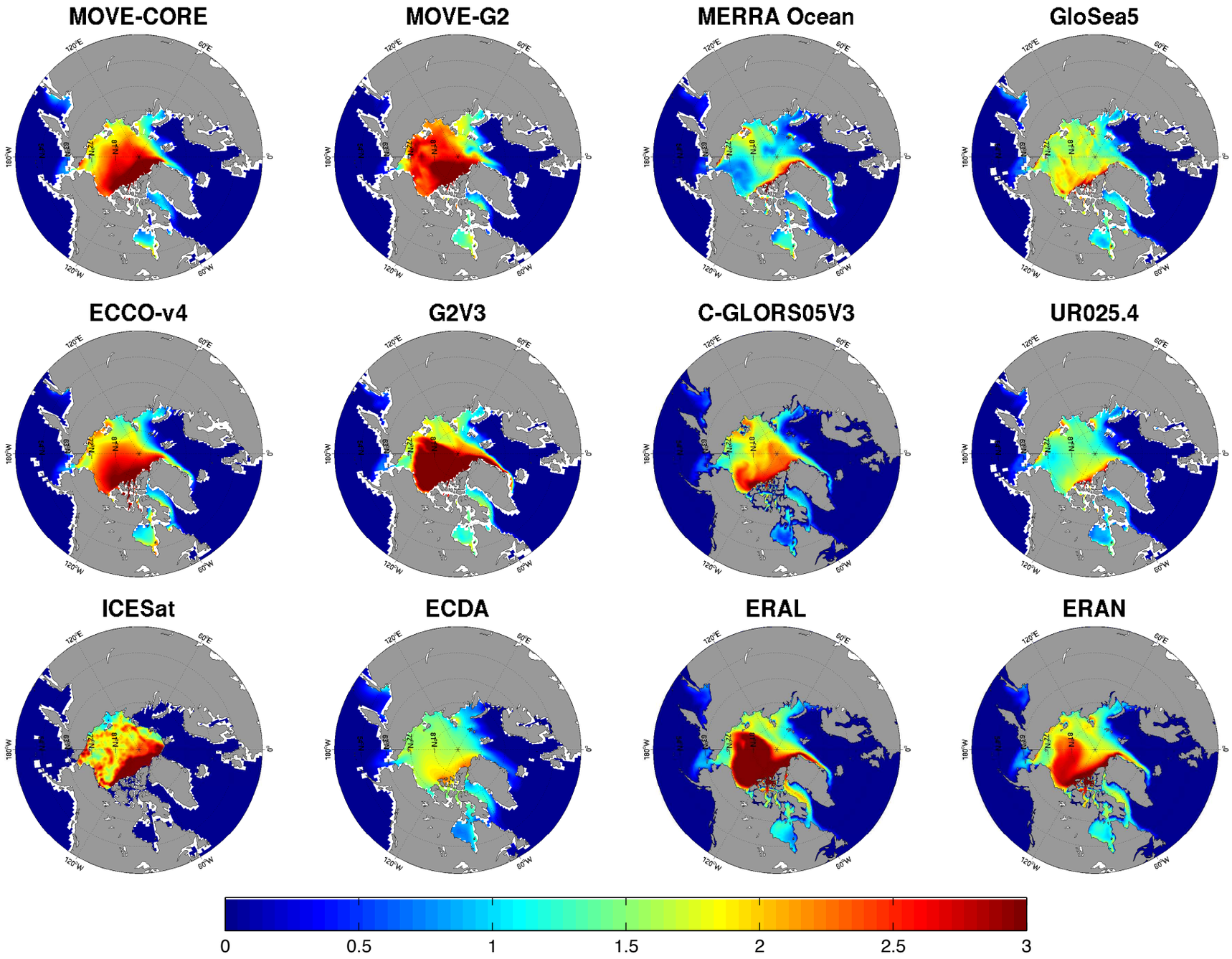

March 2007 Sea Ice Thickness (m) in global ocean-sea ice reanalyses with assimilation of sea ice concentration

Chevallier et al (in review)

ICs are extremely different. But even if they were identical...

For the 2014 SIO workshop, we proposed an initial condition perturbation experiment, inviting all SIO dynamical model groups to re-run their 2013 forecasts with a -1m sea ice thickness perturbation

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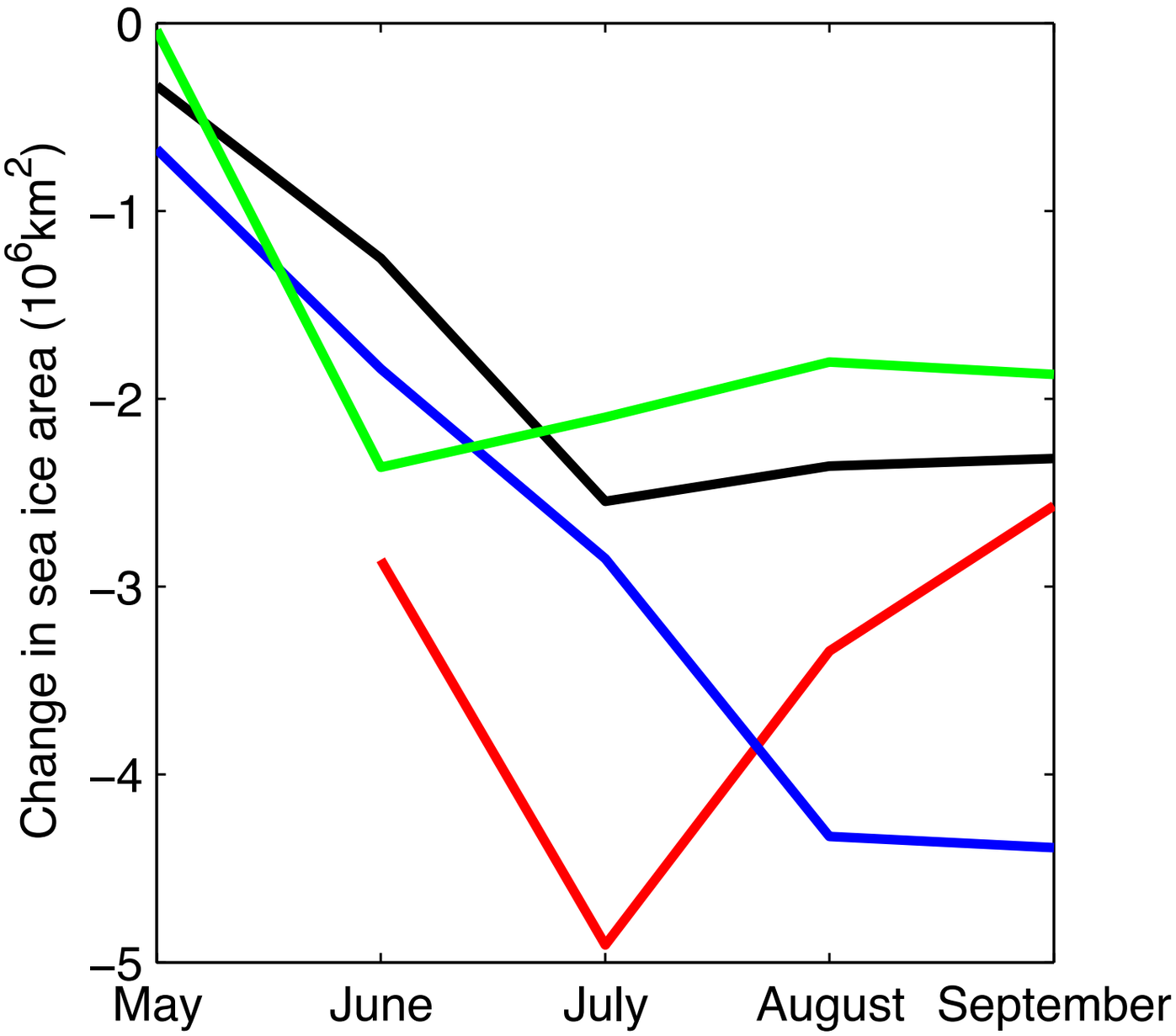
GCM with ice thickness anomalies from PIOMAS

Regional ice-ocean model forced with past atmospheres

Seasonal forecasting systems

Arctic sea ice area response (exp - control)



NCAR CESM

PIOMAS

NOAA CFSv2

NASA GMAO

All models have their own unique response, not only in September sea ice, but through summer season (relevant for ice-free dates).

So….. how about 2015?

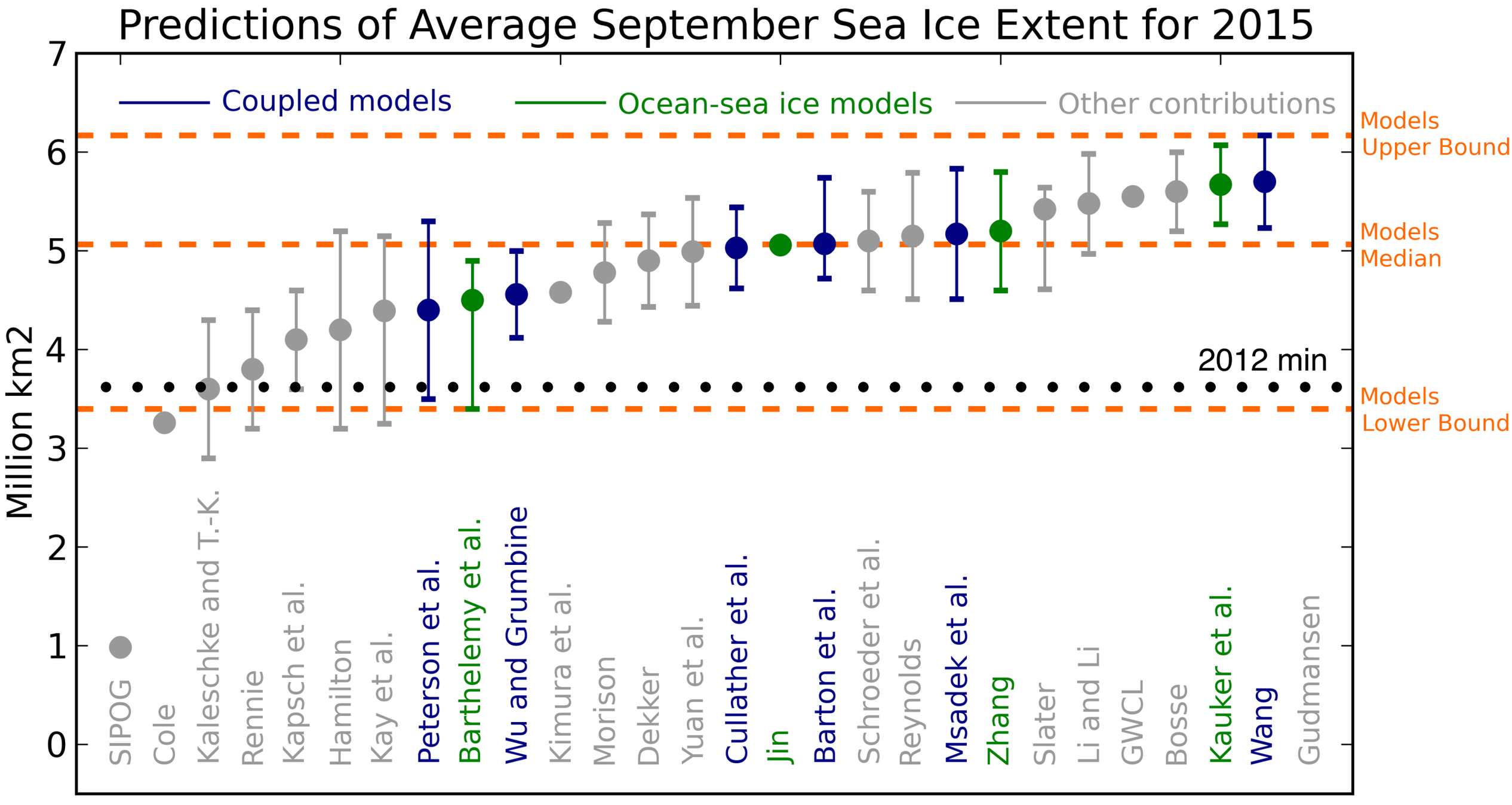


Figure by Francois Massonnet

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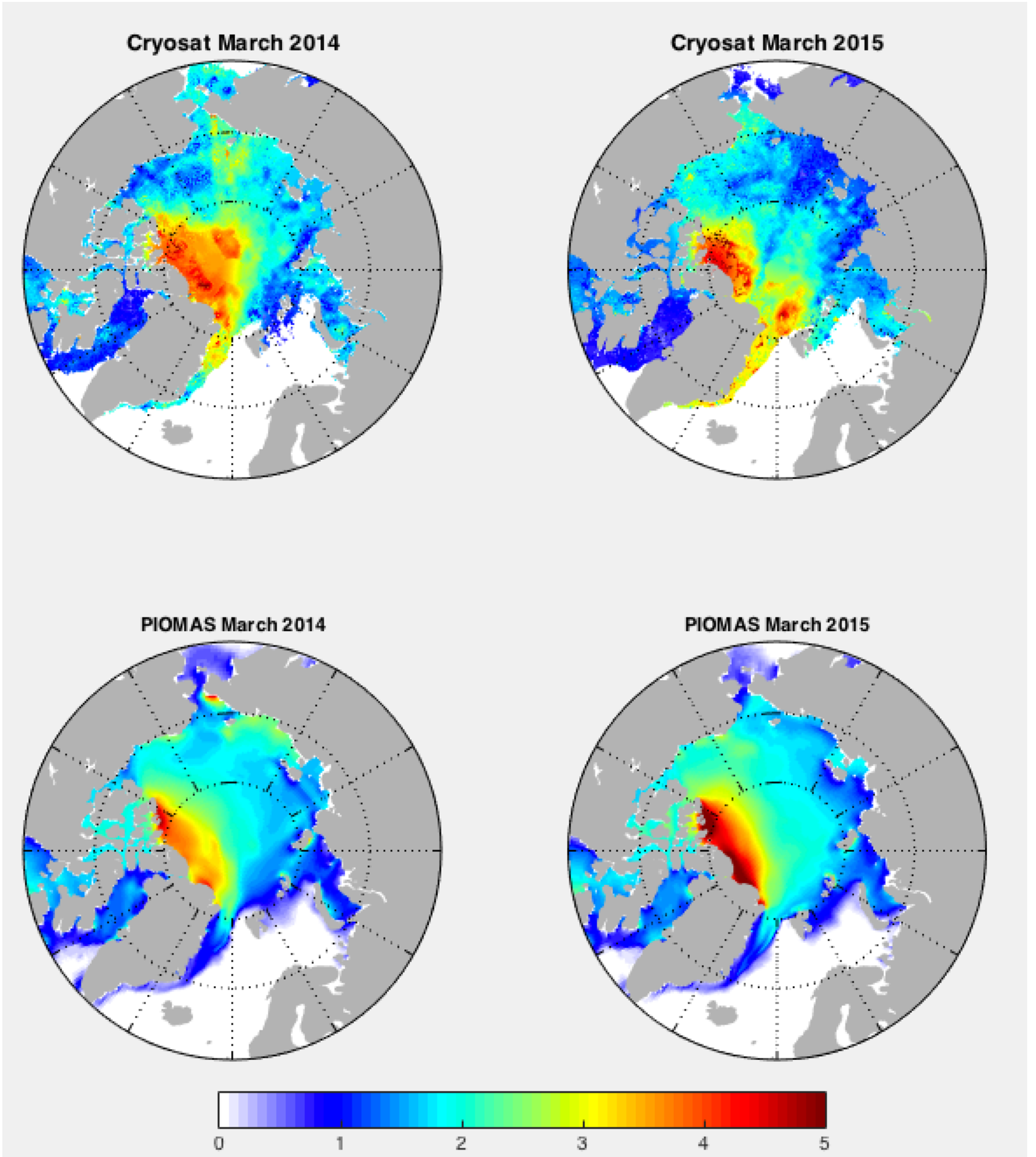

satellite ice thickness

recon ice thickness

Final thoughts

Dynamical models in SIO show negligible skill. The multi-model mean is only slightly better, and does not beat damped persistence.

Historical hindcasts (and perfect models) show better skill.

It is unclear why this gap occurs. It is possible that recent years have been inherently more unpredictable, yet summer persistence has not decreased.

Tellingly, models are almost as unskilled at predicting each other, indicating large divergence in initial conditions and/or model physics.

SIO models respond very differently to the same IC perturbation: role of different model physics in forecast spread/skill deterioration?