Towards improved and more relevant seasonal forecasts of Arctic climate

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Workshop on polar-lower latitude linkages 11 December 2014

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Outline:

- How are seasonal forecasts produced?
- How can we improve them?
- How can we make them more relevant?
- Can we quantify impact of Arctic improvements on lower latitudes?

Sea ice outlook (North American Ice Services)

(produced June 1, 2014)

Table 2: Eastern Arctic - Outlook Dates

Arctic Events	Earliest Date (1968-2013)	Latest Date (1968-2013)	Median (1981-2010)	Outlook
Baffin Bay Northern Route				
- Open drift or less	10 Jun	18 Aug	13 Jul	5-7 Jul
- Bergy water	13 Jun	15 Sep	27 Jul	19-21 Jul
Baffin Bay Area				
- Bergy water	10 Aug	7 Oct	6 Sep	22-24 Aug

- Outlooks produced <2007: Based on 'analog year' method (look for year with similar conditions like freeze-up date, ice thickness, summer air temperature outlook)
- After 2007: no analogs → MLR models
- But statistical models like MLR assume stationarity, which is violated in rapidly changing Arctic → look for other tools

Dynamical models:

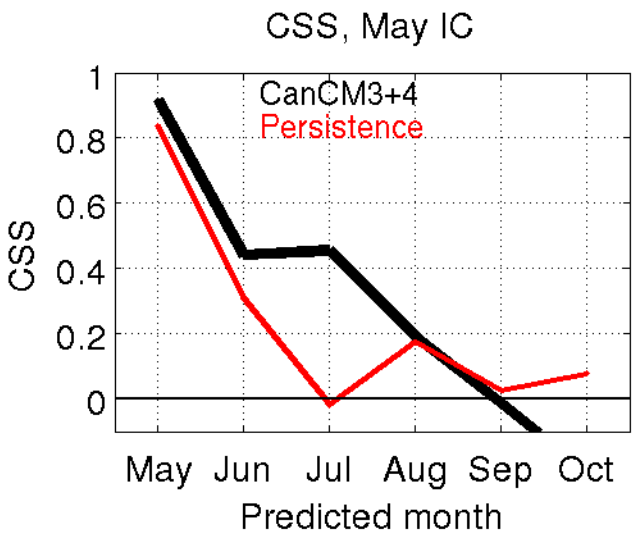
- Global climate models initialized close to obs

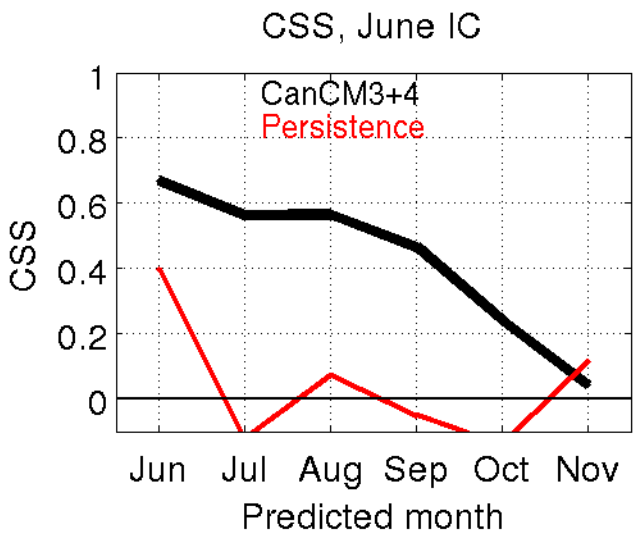
- Generally based on coupled atmosphere-ocean models (climatological or persistent sea-ice)

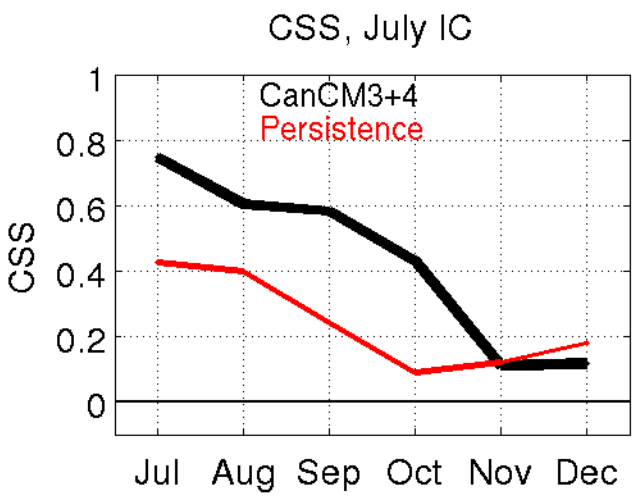
- In recent years more models with interactive sea ice, representing a huge step forward

- Recent studies suggest the forecast skill of SIE is (slightly) higher than that of persistence

Skill in CanSIPS (detrended SIE)



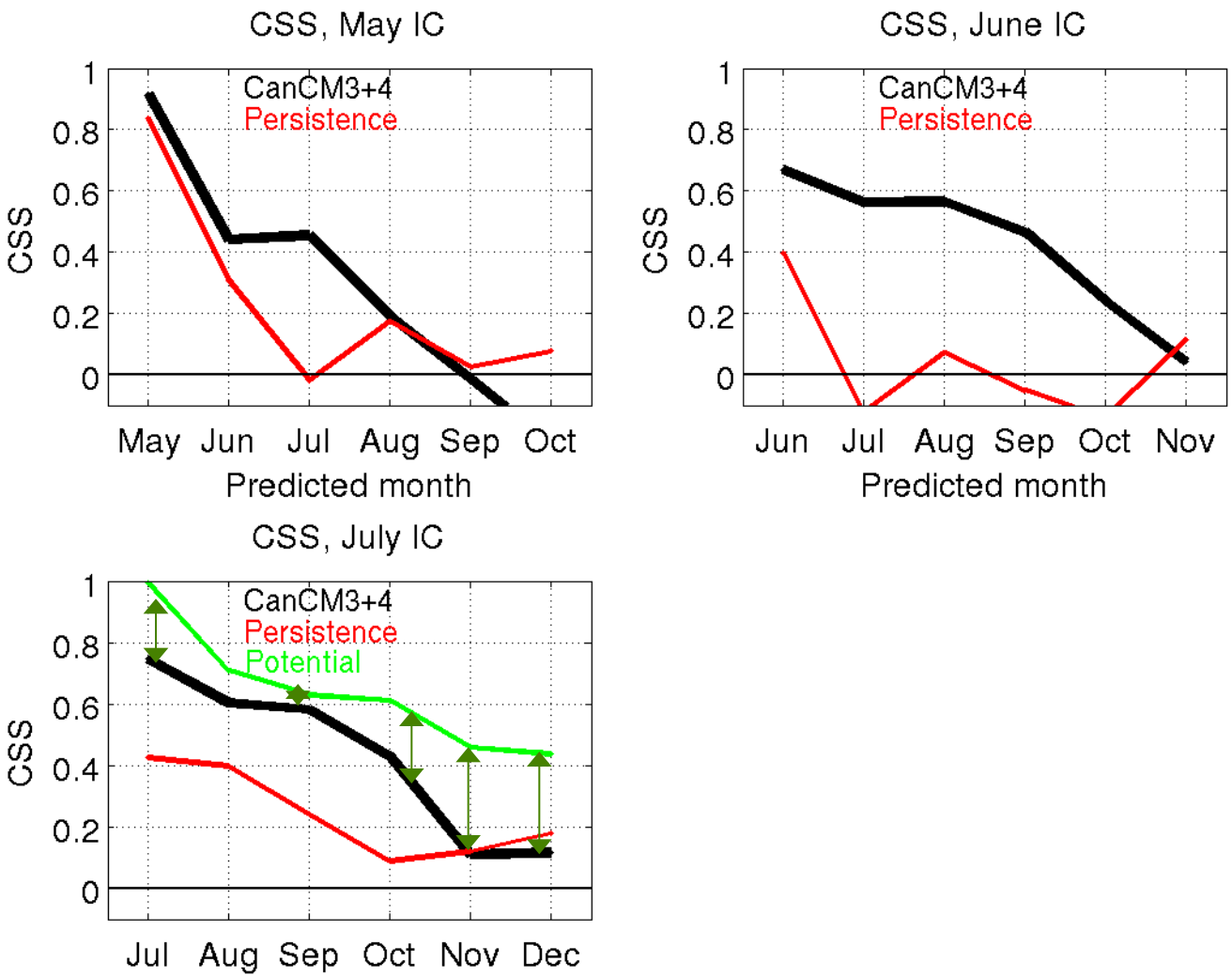




1) What is the source of skill that exceeds persistence? (mechanisms)

2) How much room is there for improvement?

Skill in CanSIPS (detrended SIE)



How can we improve the predictions?

1) Improve models
2) Improve model initialization
3) Improve observations

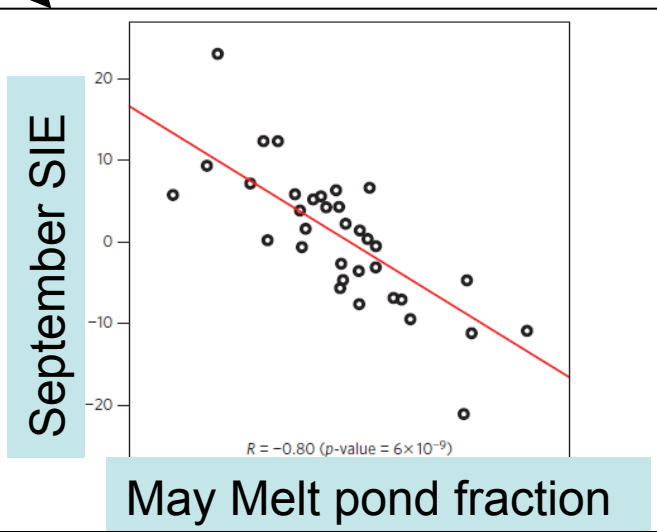
Improve the models

- Improve (or add) physically relevant processes

Melt ponds

Aerosols (Black carbon)

Stratosphere



Schroder et al. , 2014

Improve the models

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Melt ponds

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Stratosphere

Improve the models

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Melt ponds

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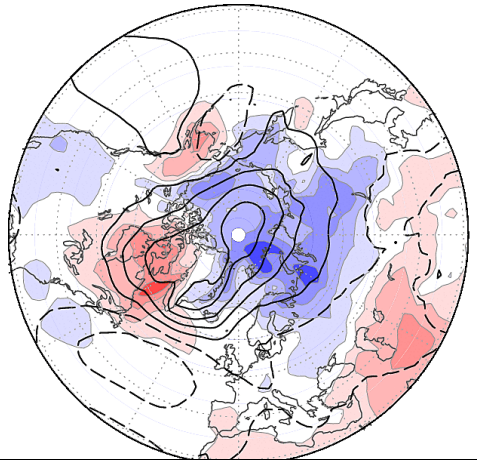
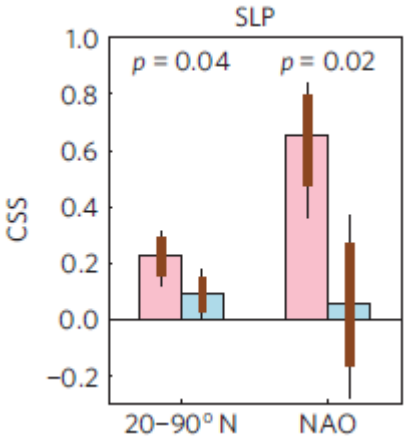
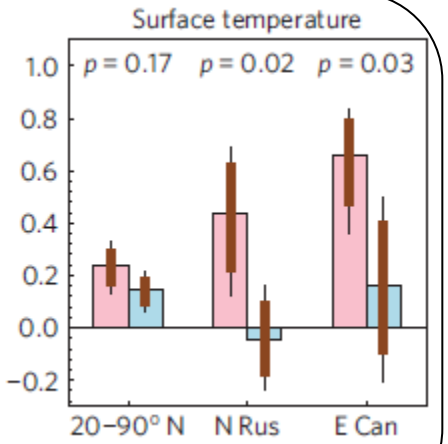
T_{surf} & SLP after SSWs

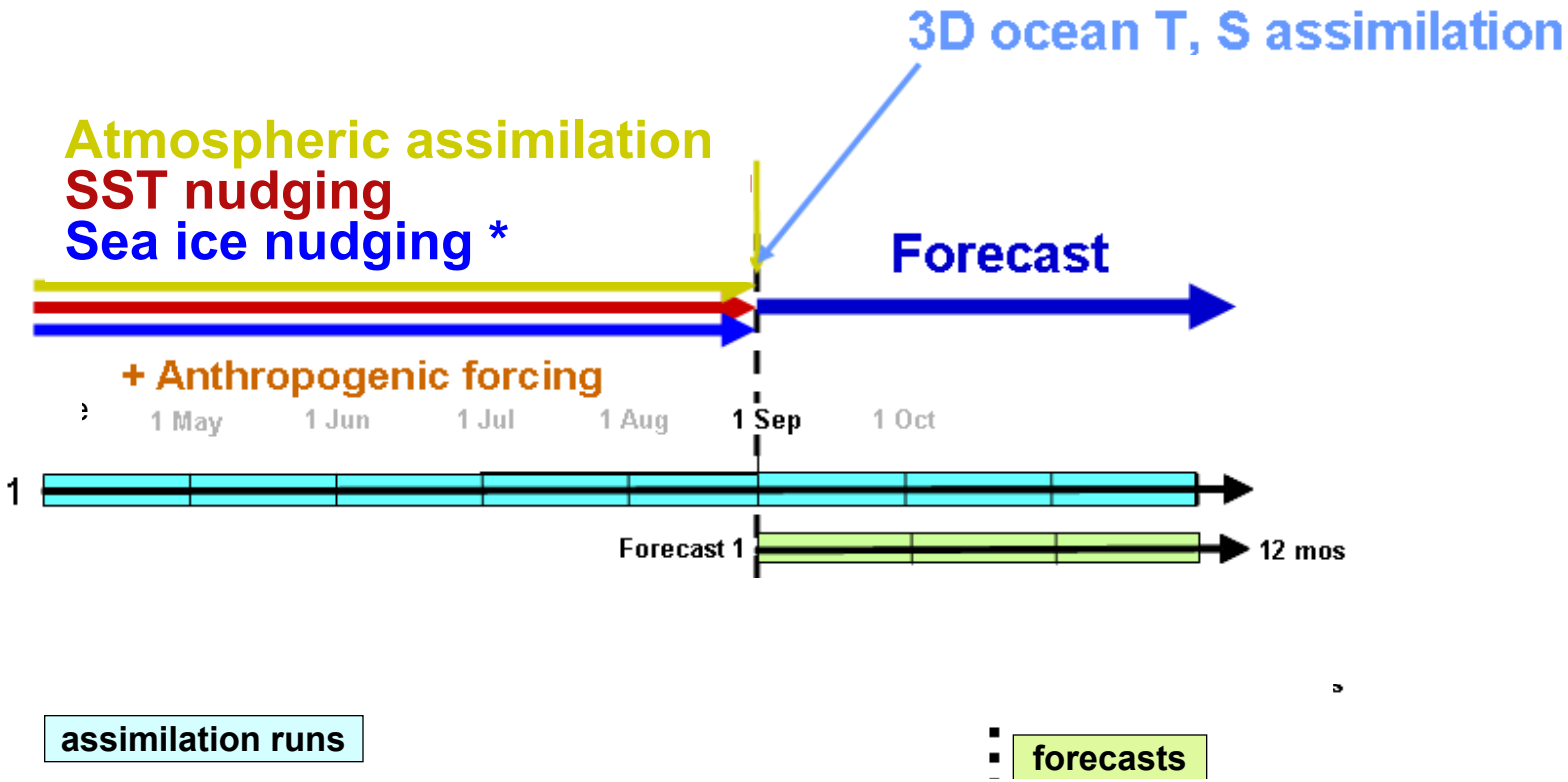






Sigmond et al. , 2013

Improve the model initialization

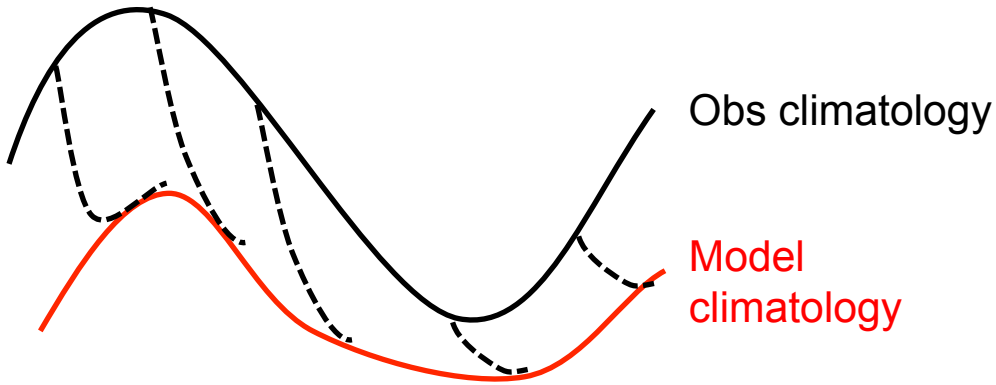


*** concentration to observed timeseries,**
but thickness generally not assimilated!

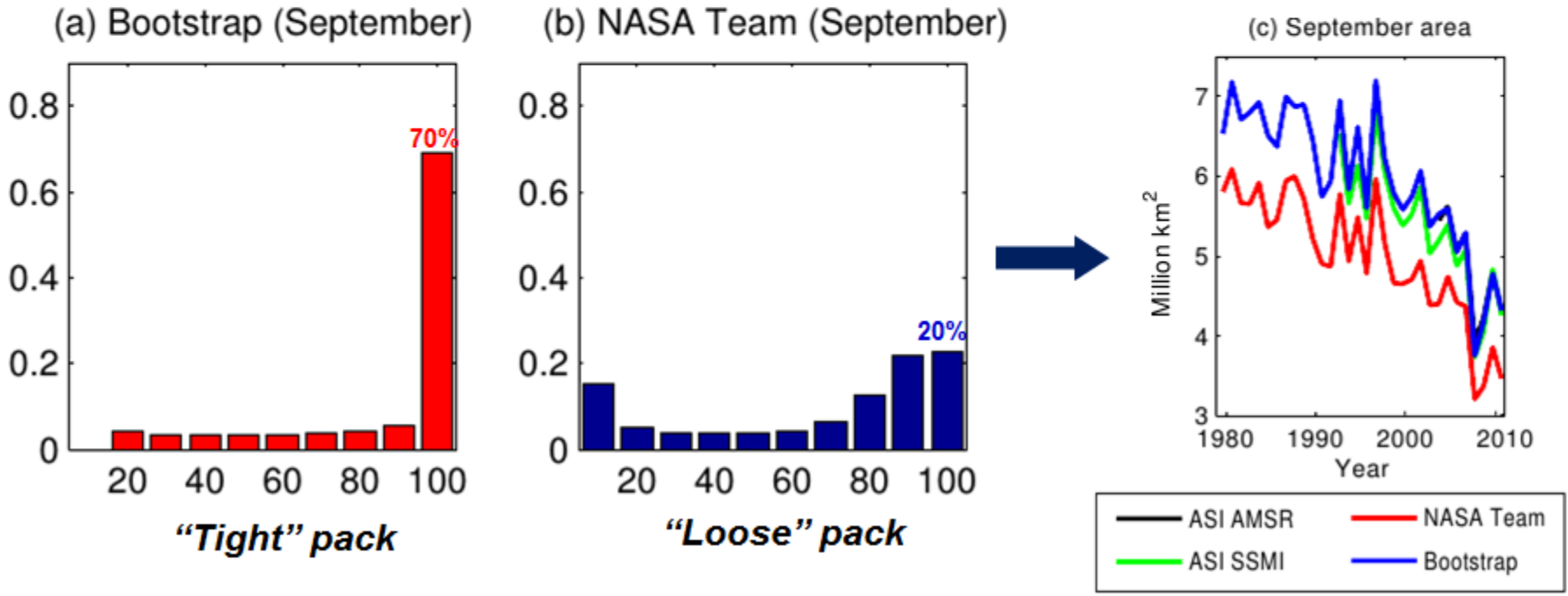
Improve the observations

- Long term, consistent (homogeneous) observations of sea ice variables (concentration, thickness) important for:

  1) initialization of forecasts
  2) Verification/skill assessment
  3) initialization of hindcasts (calibration, bias correction)



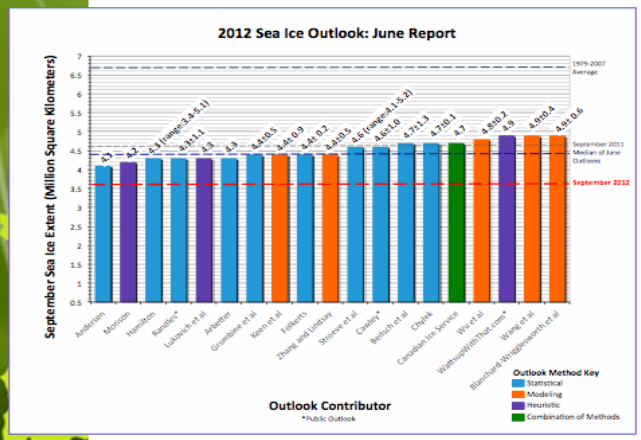
Uncertainties in observations – an example



Notz et al. , 2014

How can we make the predictions more relevant?

Towards more relevant (sea ice) predictions



Towards more relevant (sea ice) predictions

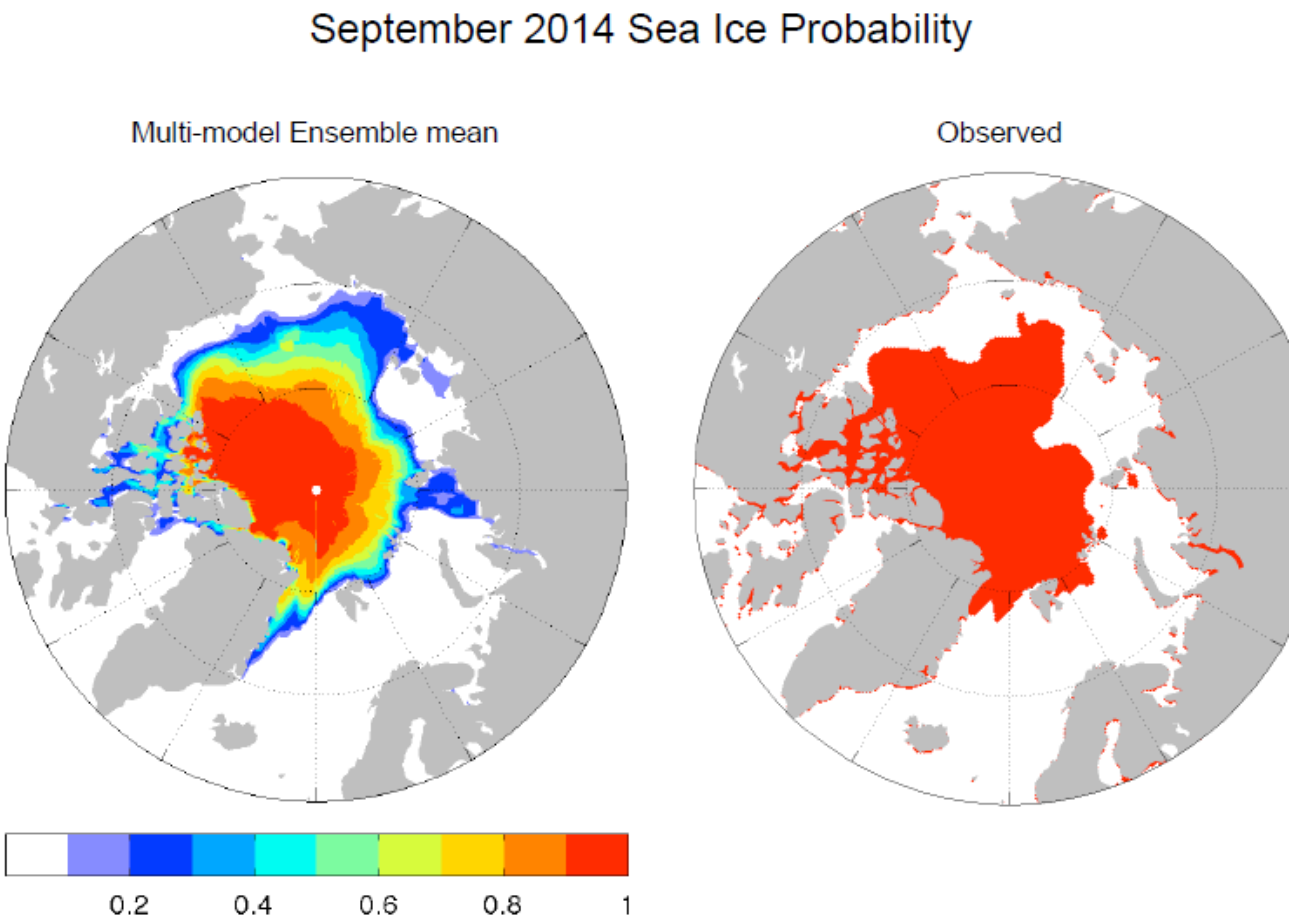
1) Need more assessment of skill on regional scales

2) Need to produce more relevant forecast products (date of melt onset, sea ice break-up and freeze-up)

3) Need to start including probabilistic information

4) Need to increase model resolution or statistically downscale model output to tailor user needs

sea ice probability

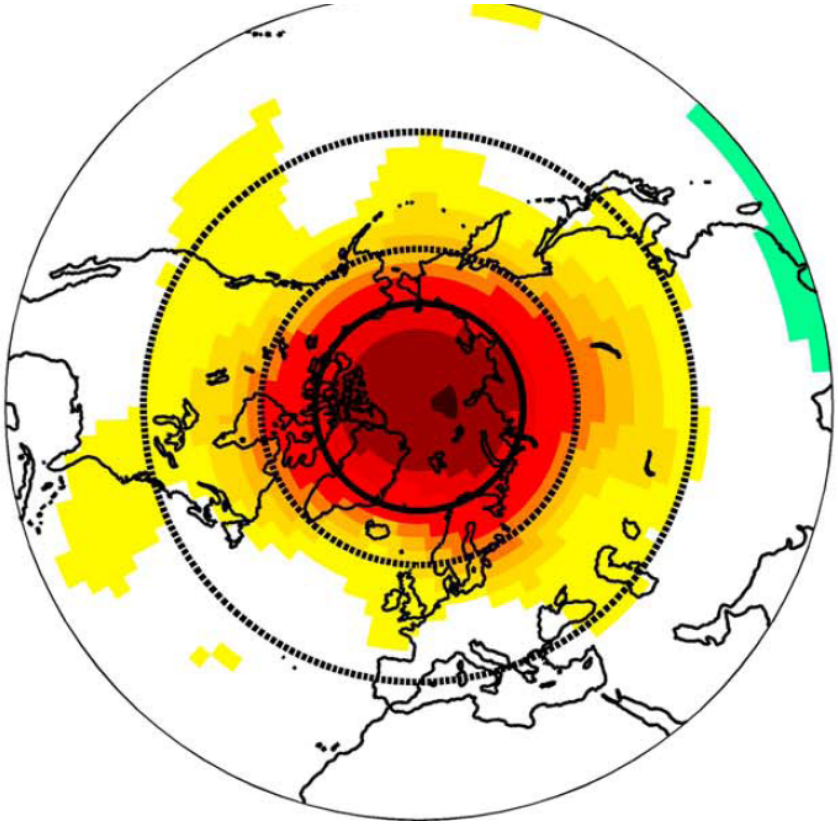


Source: SIPN, E. Blanchard-W

Impacts of forecast improvements in the Arctic on lower latitudes

Potential impacts on forecast skill

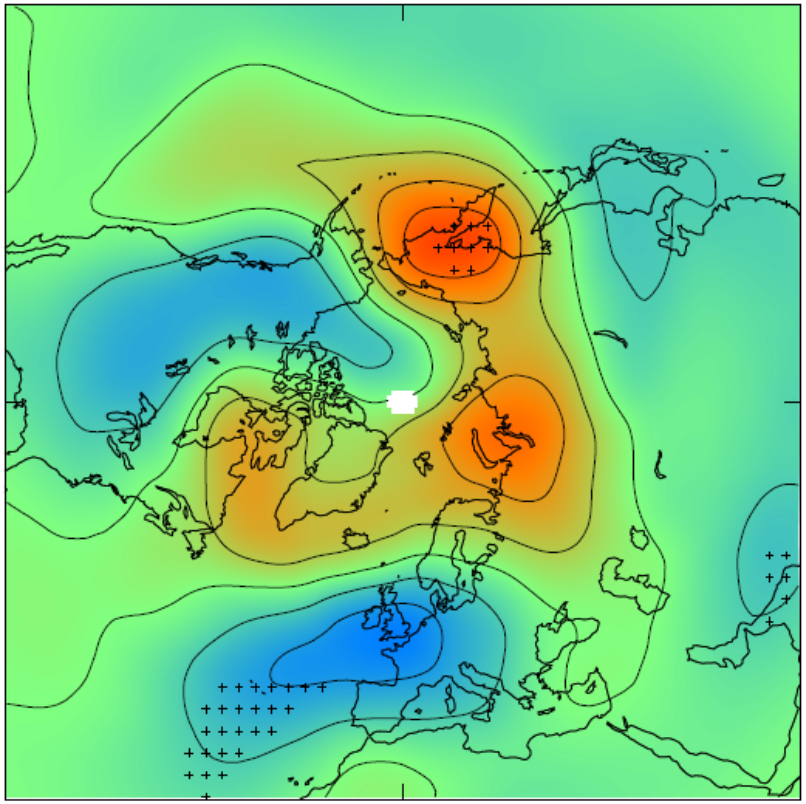
Relative Reduction RMSE Z500 with Arctic nudged to obs



Jung et al. , 2014

Impacts on lower latitudes: IceHFP

Multi model average Z500 DJF
Nov 1 initial cond. [2007 (low ice) minus 1996 (high ice)]

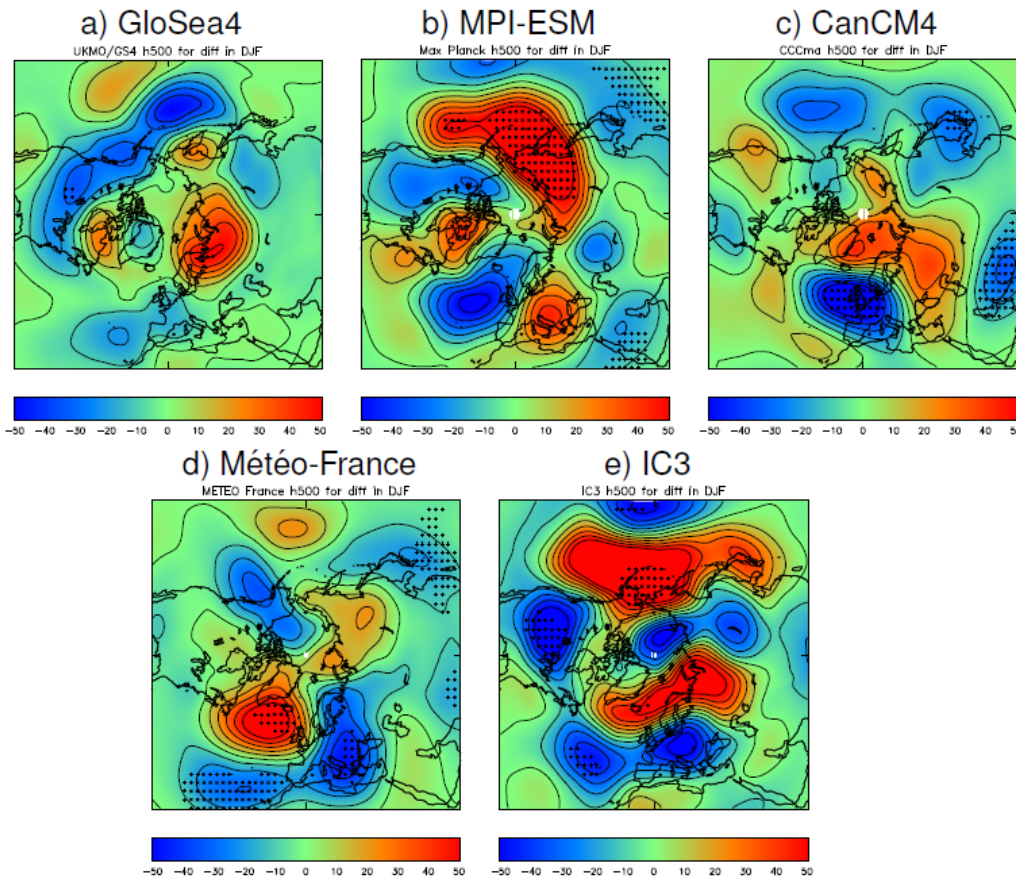


Average of 42 pairs of simulations!

Courtesy: Drew Peterson

Impacts on lower latitudes: IceHFP

Lot of spread between models!

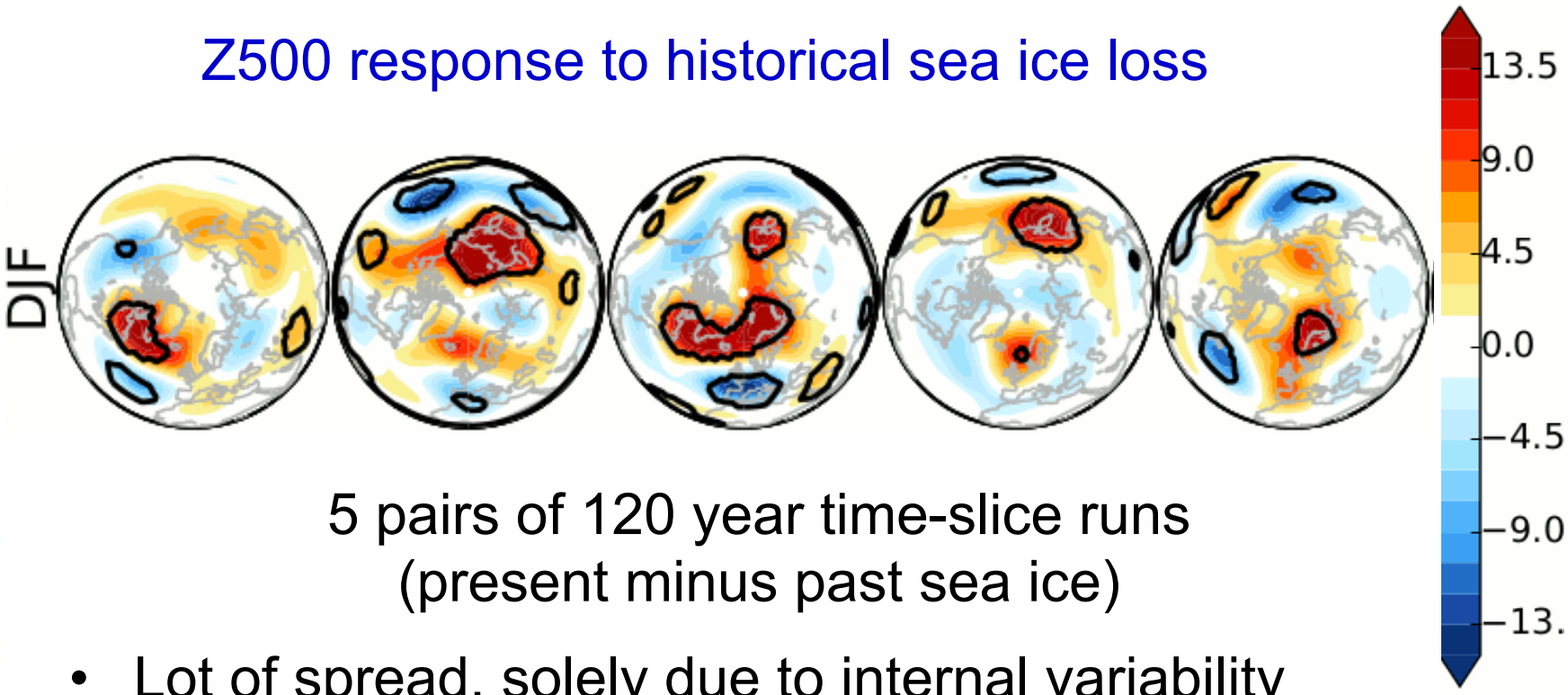


- Very low SNR
- Impact on skill of forecasting obs (=1 realization) likely lost in noise

Courtesy: Drew Peterson

Impacts on lower latitudes: very noisy!

Z500 response to historical sea ice loss



5 pairs of 120 year time-slice runs
(present minus past sea ice)

- Lot of spread, solely due to internal variability
- Confirms low SNR

McCusker et al, in prep

Conclusions:

- Rapidly changing Arctic makes statistical methods less useful

- Seasonal forecasts using dynamical models shows some promise

- Improved model predictions feasible by improving models and observation-based products

- More useful forecast products needed

- Impact on lower latitudes likely lost in noise