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The value of decadal predictions & links to the Arctic

Ed Hawkins

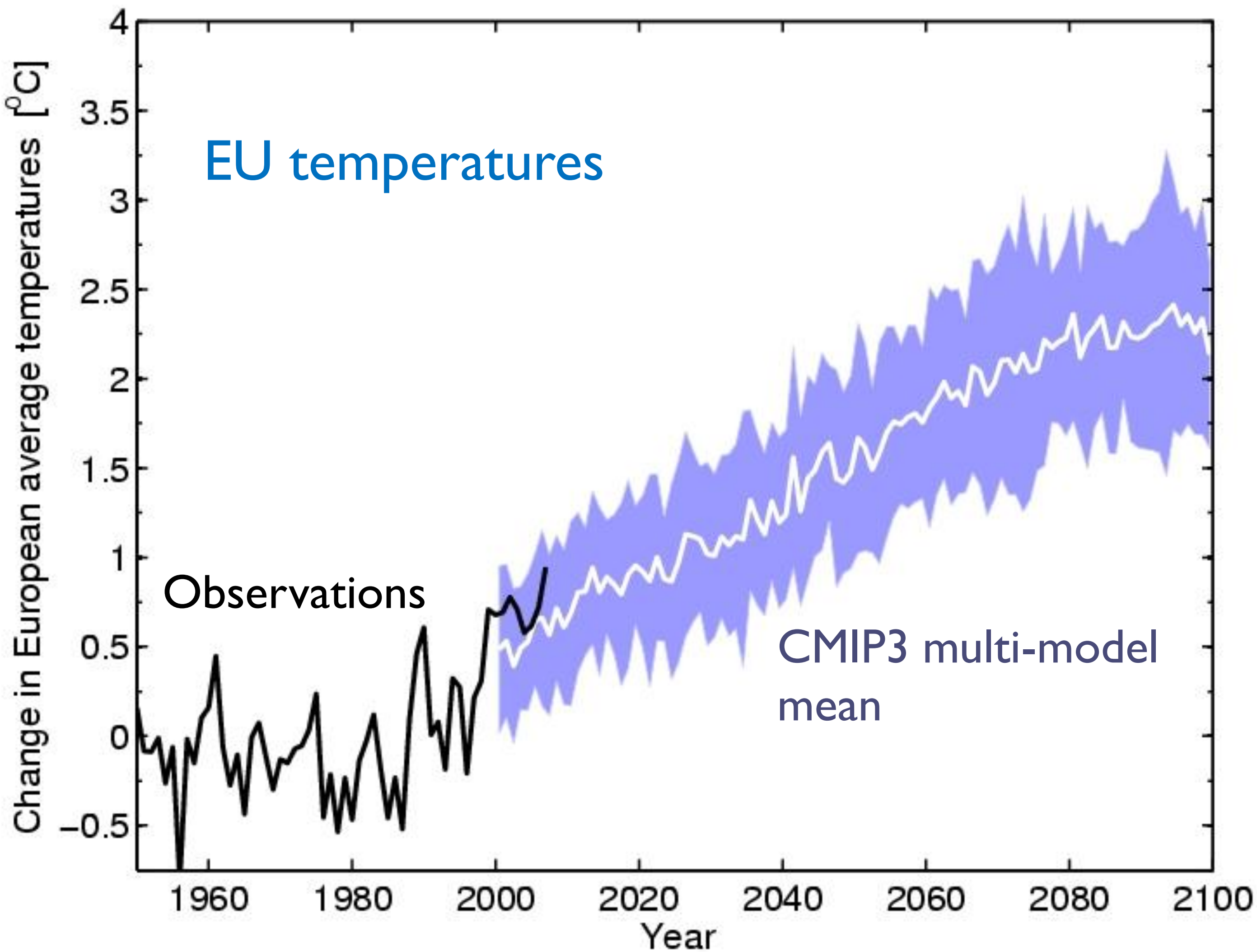
Thanks to: Rowan Sutton, Jon Robson, Buwen Dong, Sarah Keeley, Dan Hodson, Len Shaffrey

NCAS-Climate, University of Reading

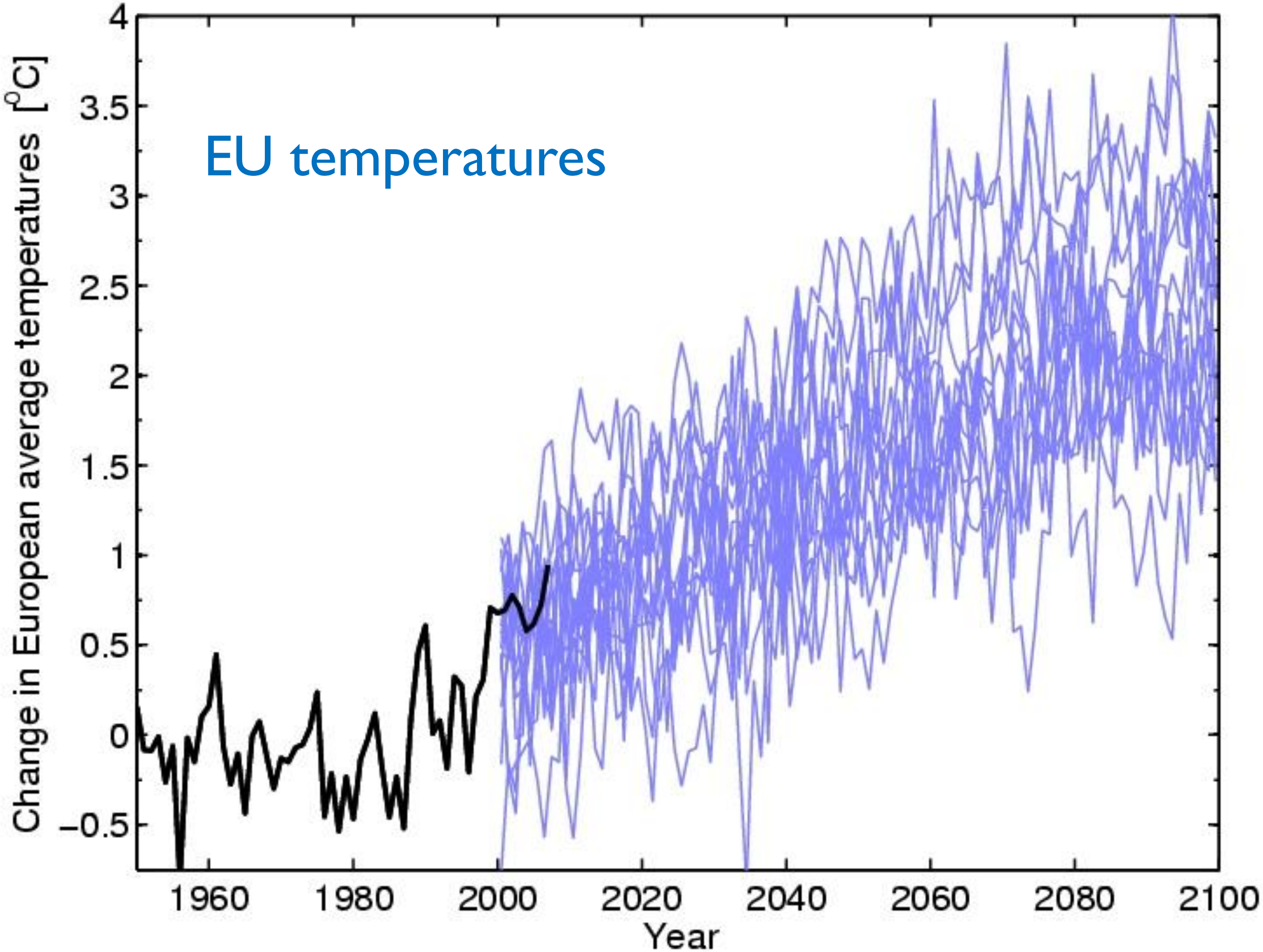
University of Reading

Walker INSTITUTE

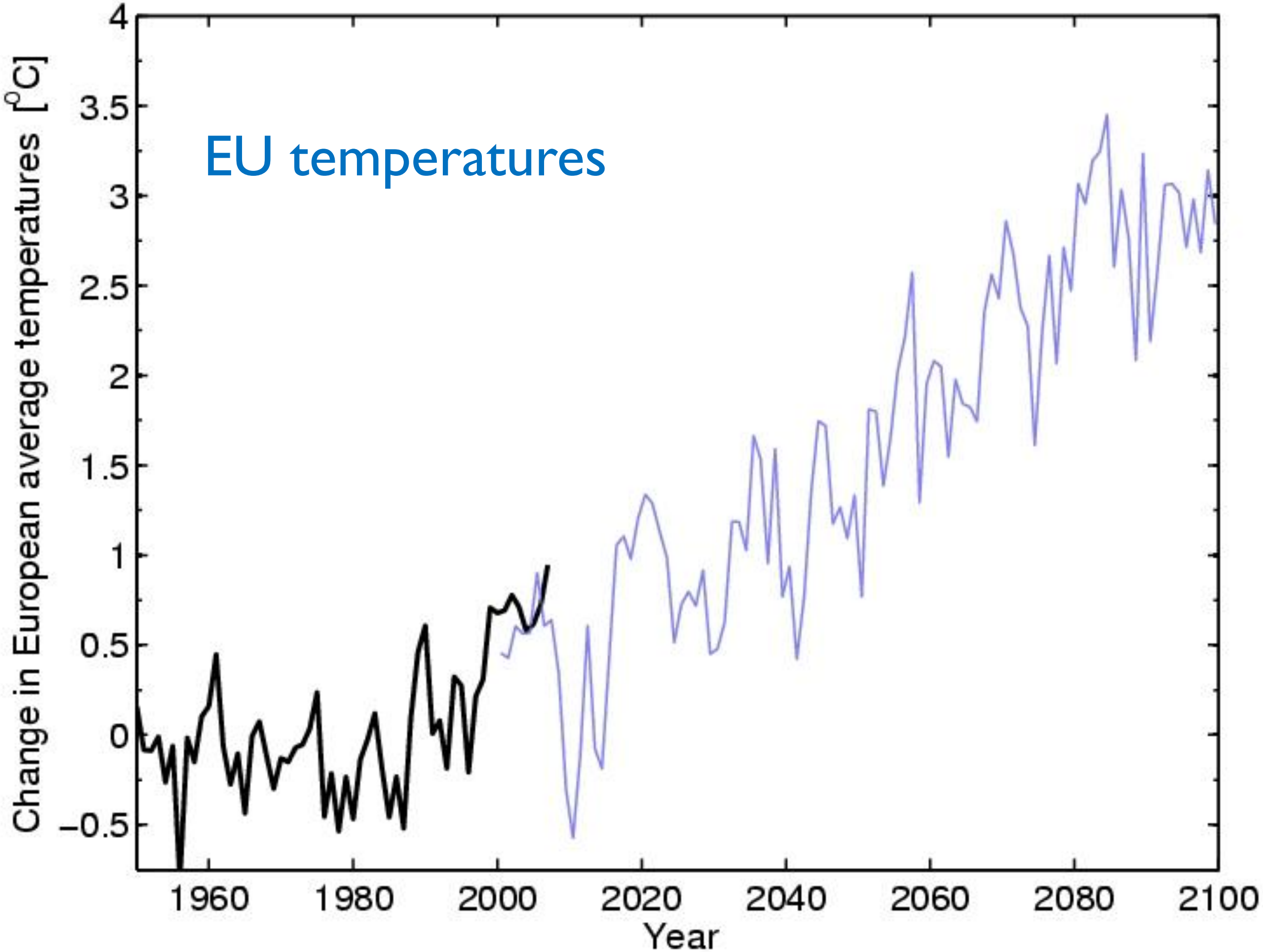
Decadal variability



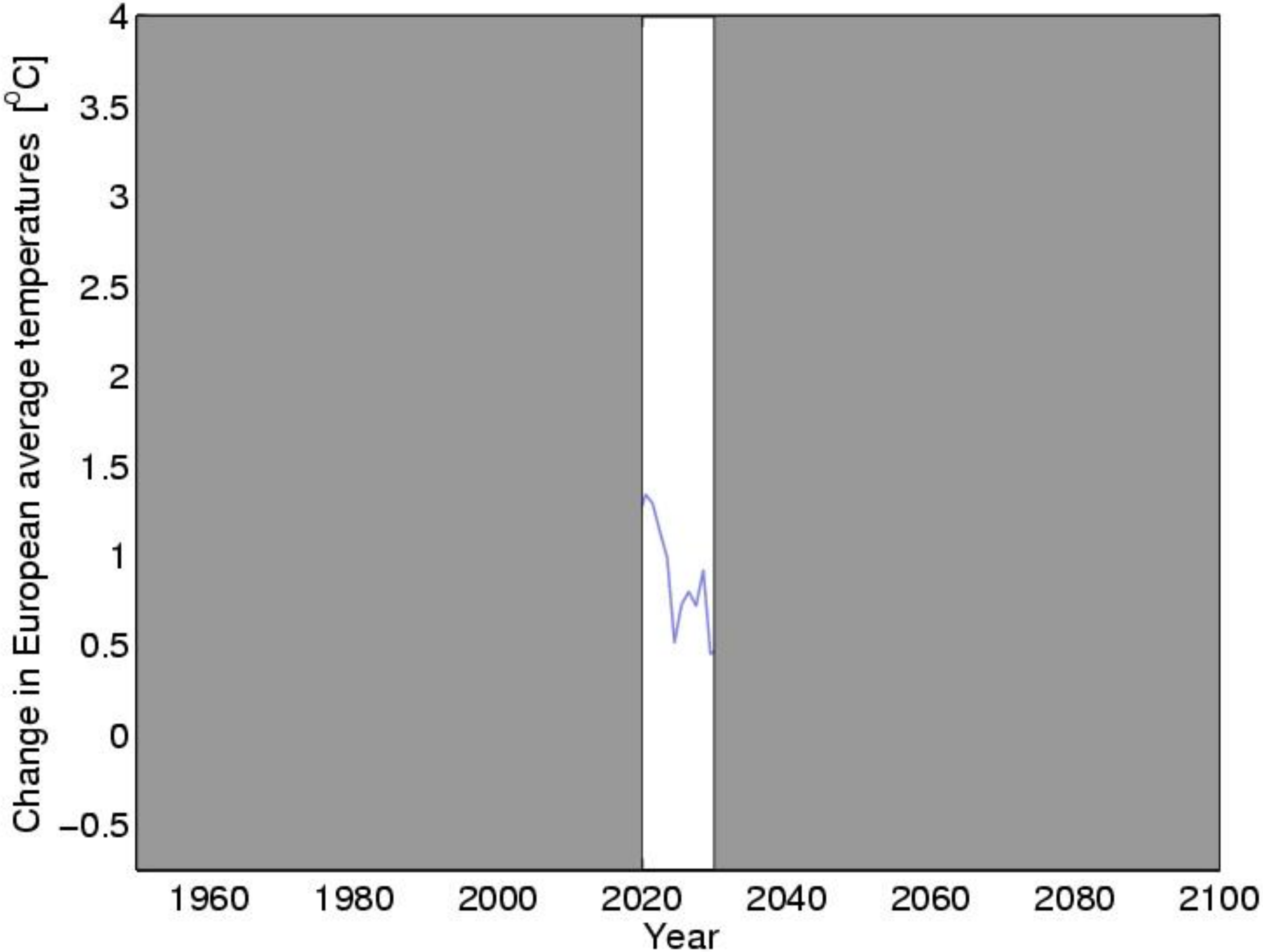
Decadal variability



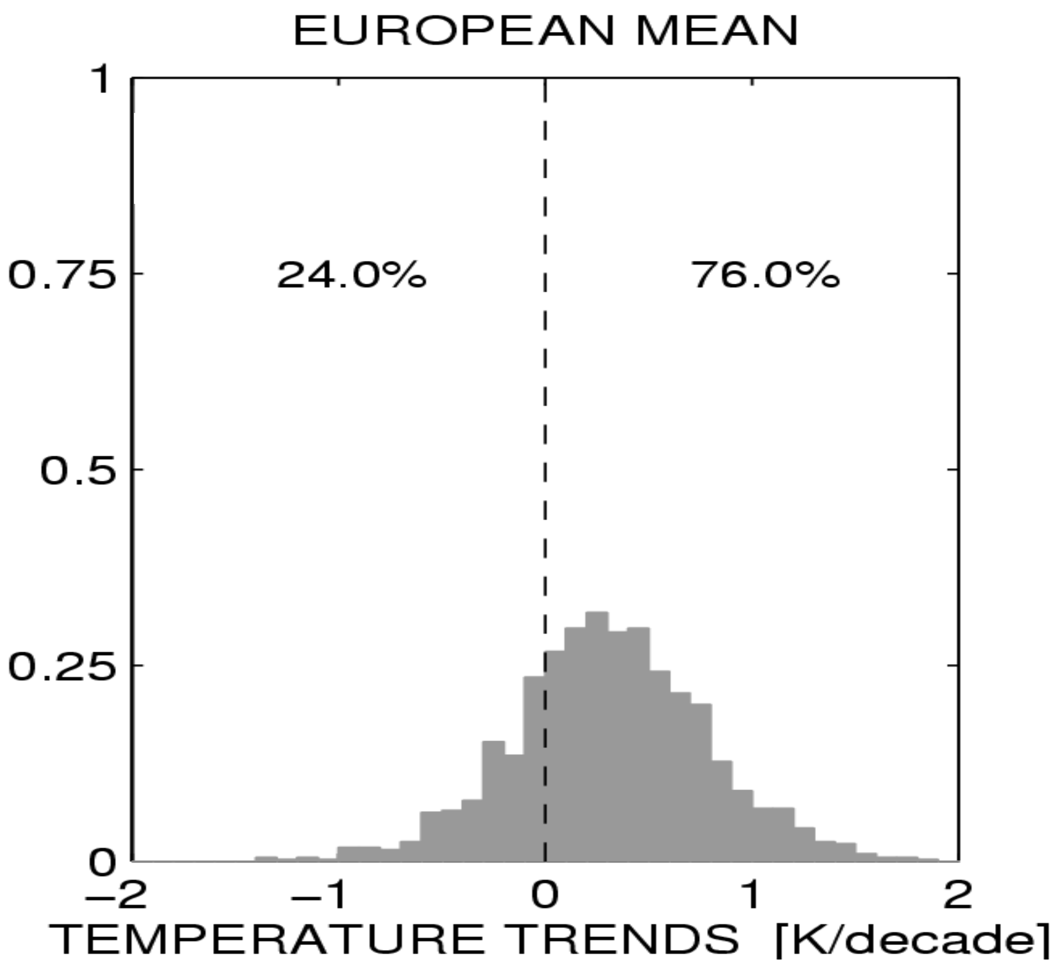
Decadal variability



Decadal variability



EU decadal temperature trends



21st century EU decadal temperature trends

CMIP3 SRES A1B

Outline

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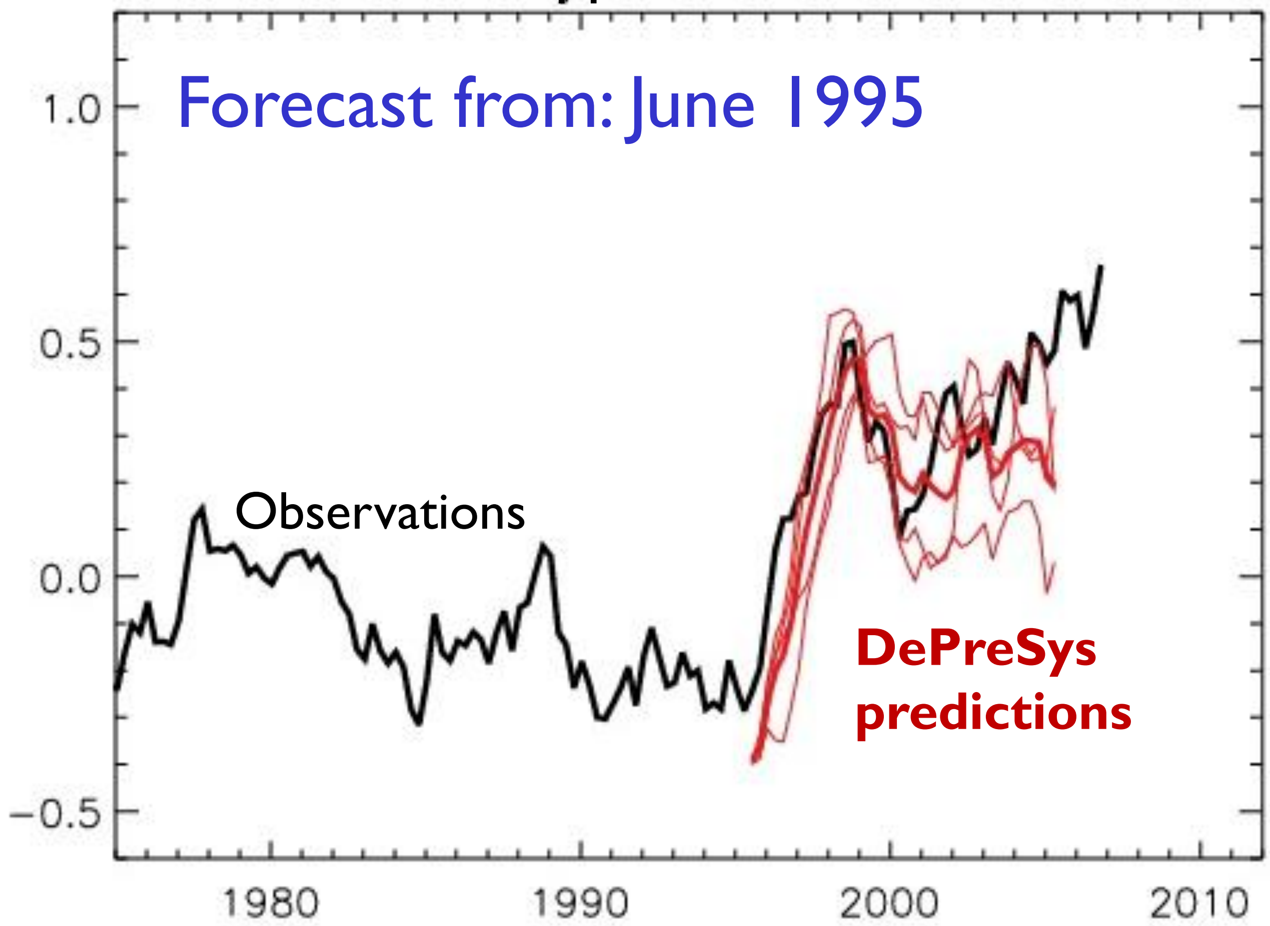
- The value of decadal predictions
  - The case study approach
  - Learning about model bias and ocean monitoring
  - How about statistical decadal predictions?
- What about the Arctic?
  - Quantifying uncertainty
  - Potential predictability

1995 rapid Atlantic warming

North Atlantic upper ocean heat content



Hypotheses:
was the rapid warming because of the MOC or the NAO?

Thanks to Jon Robson

Example decadal predictions

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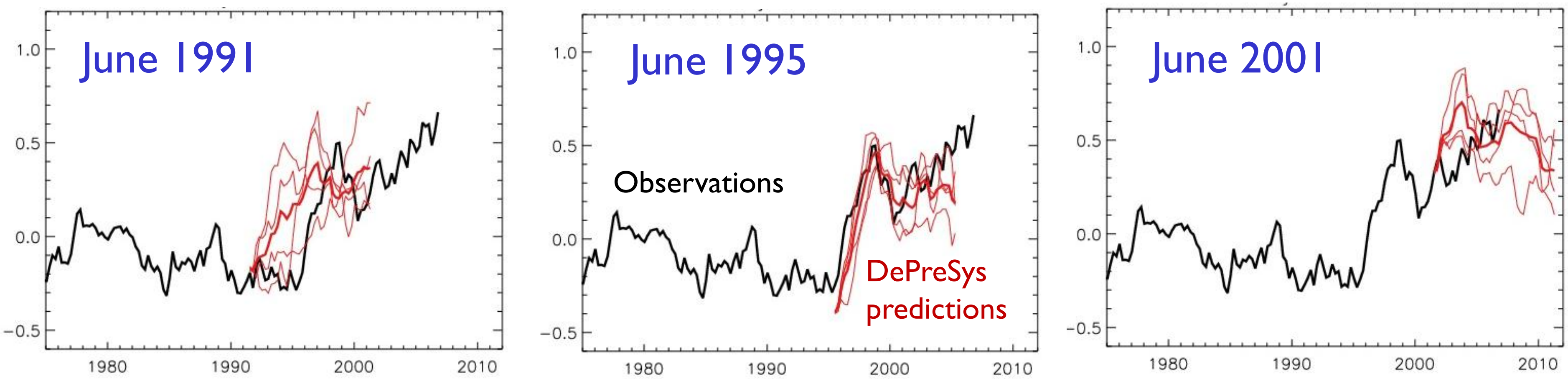
Retrospectively predicting North Atlantic
upper ocean heat content

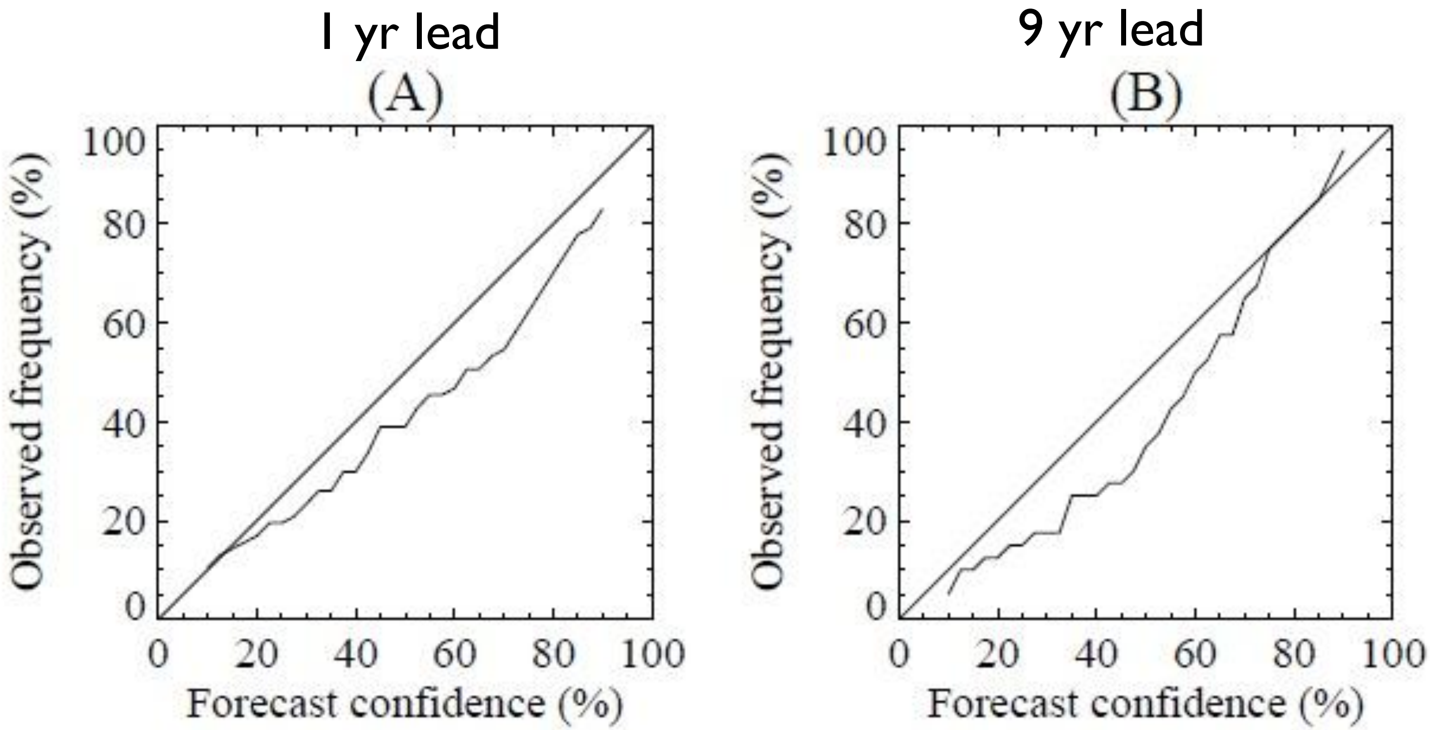


Decadal predictions allow:

- building trust in GCMs for making predictions and projections,
- the understanding of mechanisms causing variability,
- to identify processes causing forecast errors

Thanks to Jon Robson

Reliability of DePreSys hindcasts



For global temperature, the DePreSys hindcasts are slightly overconfident, suggesting the need for greater spread in the predictions.

Smith et al. 2007

Oceanic optimal perturbations

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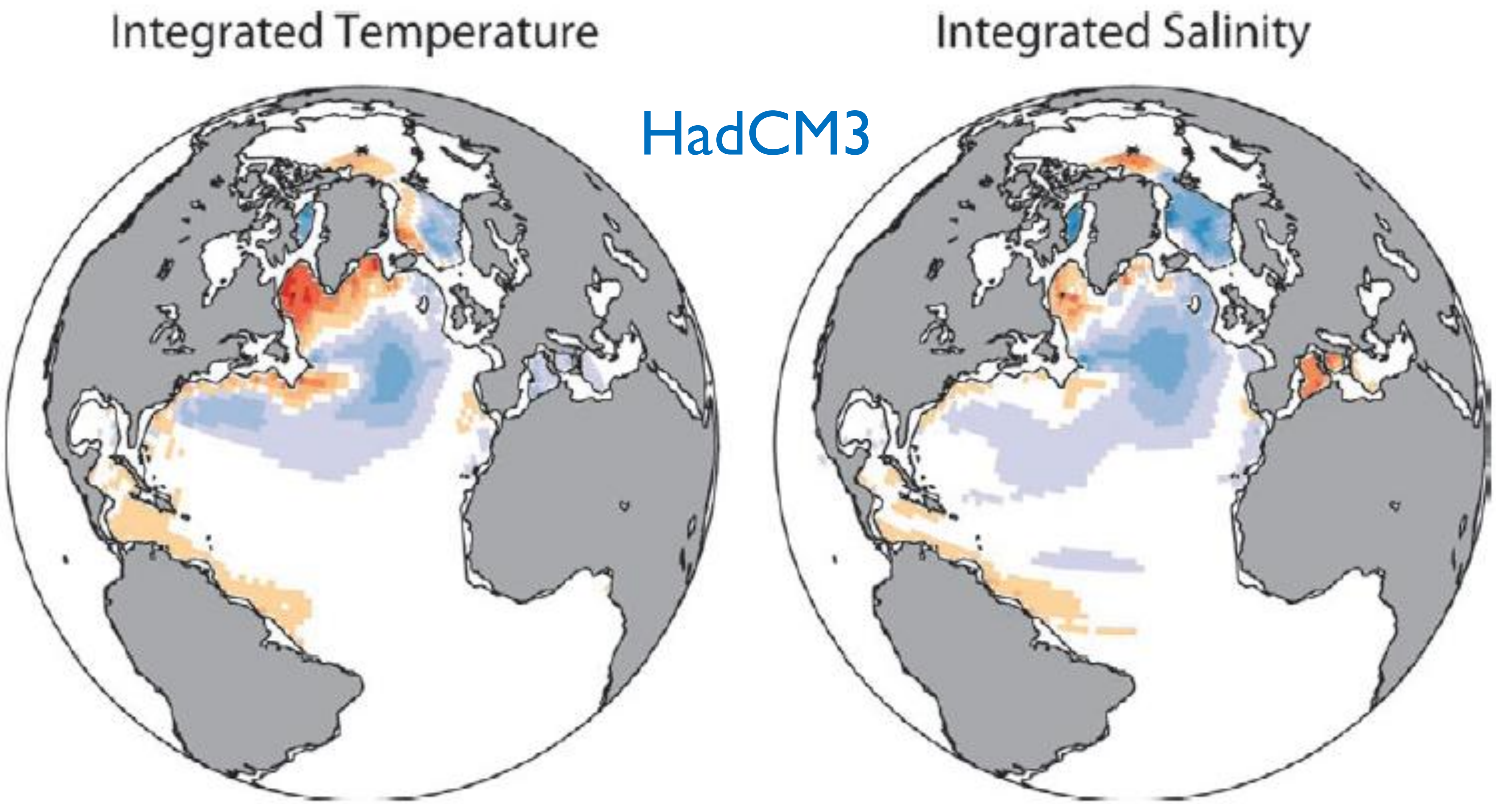

→ Learning about predictability and optimal observations

See Tziperman et al. 2008, Hawkins & Sutton 2009, 2010

LEARNING FROM MODEL FORECAST BIAS

Learning about model bias

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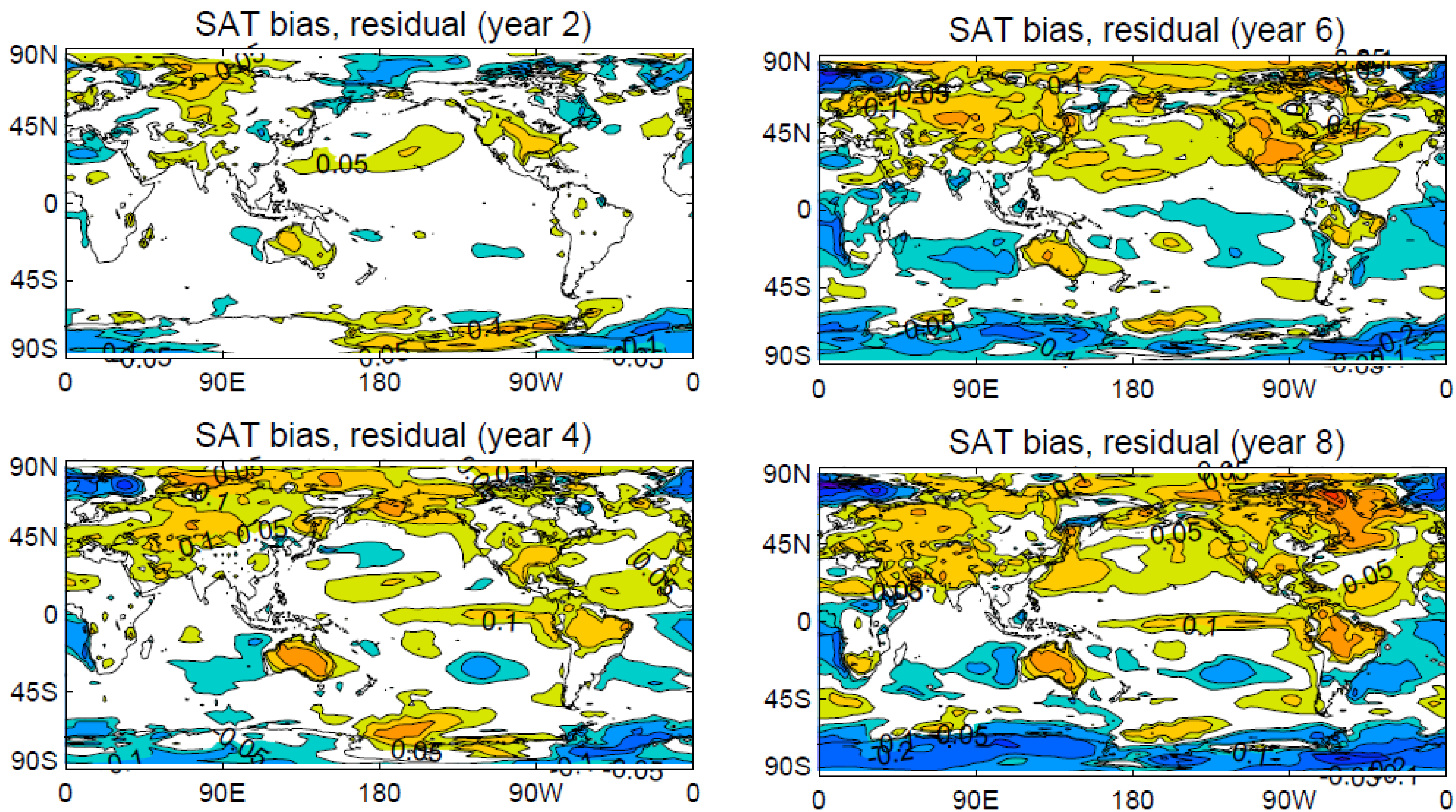
Thanks to Buwen Dong

The growth of forecast bias in HadCM3



→ future projections constrained by the past

LEARNING FROM STATISTICAL DECADAL PREDICTIONS OF SSTs

Empirical decadal predictions in HadGEM1

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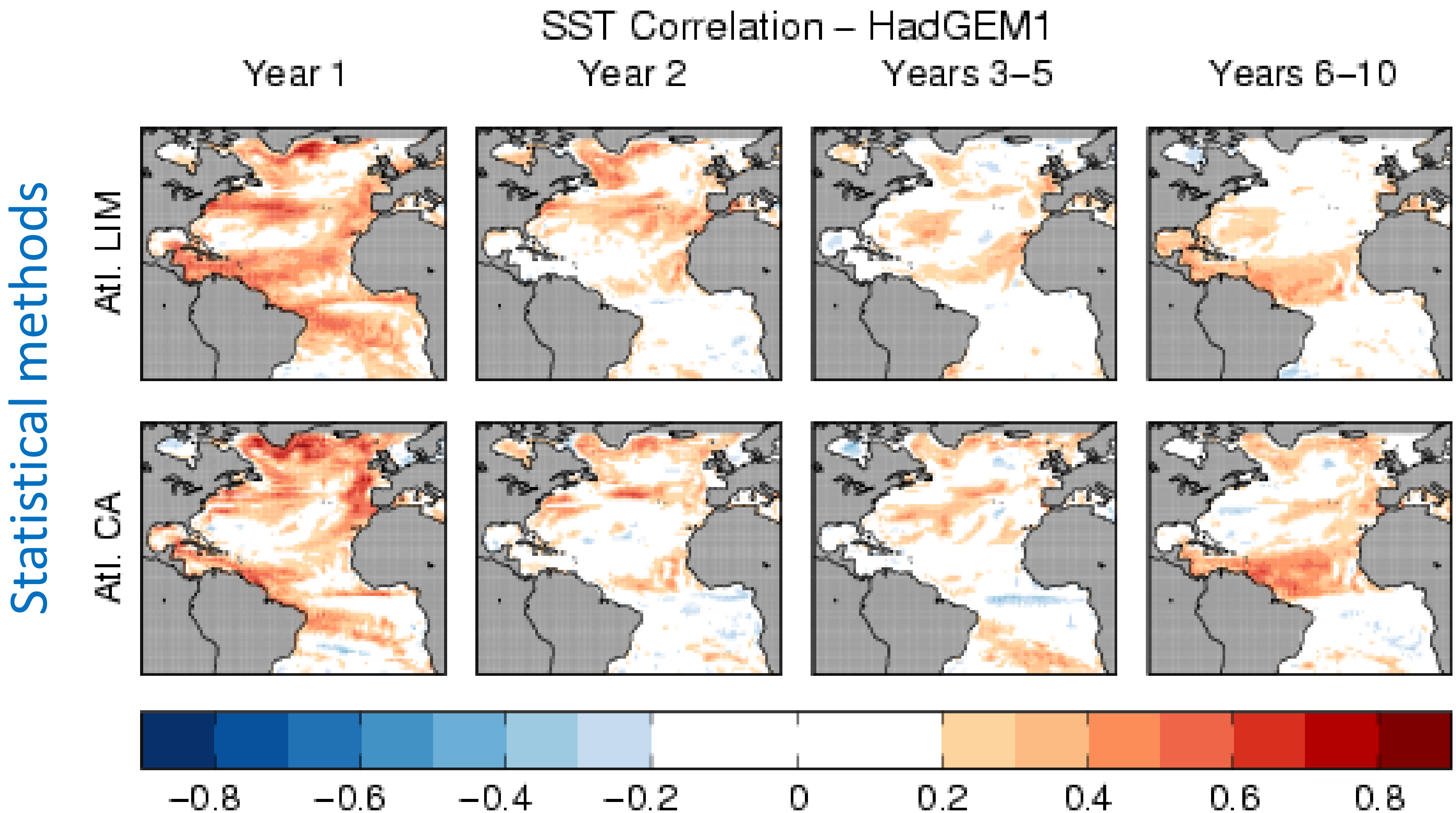
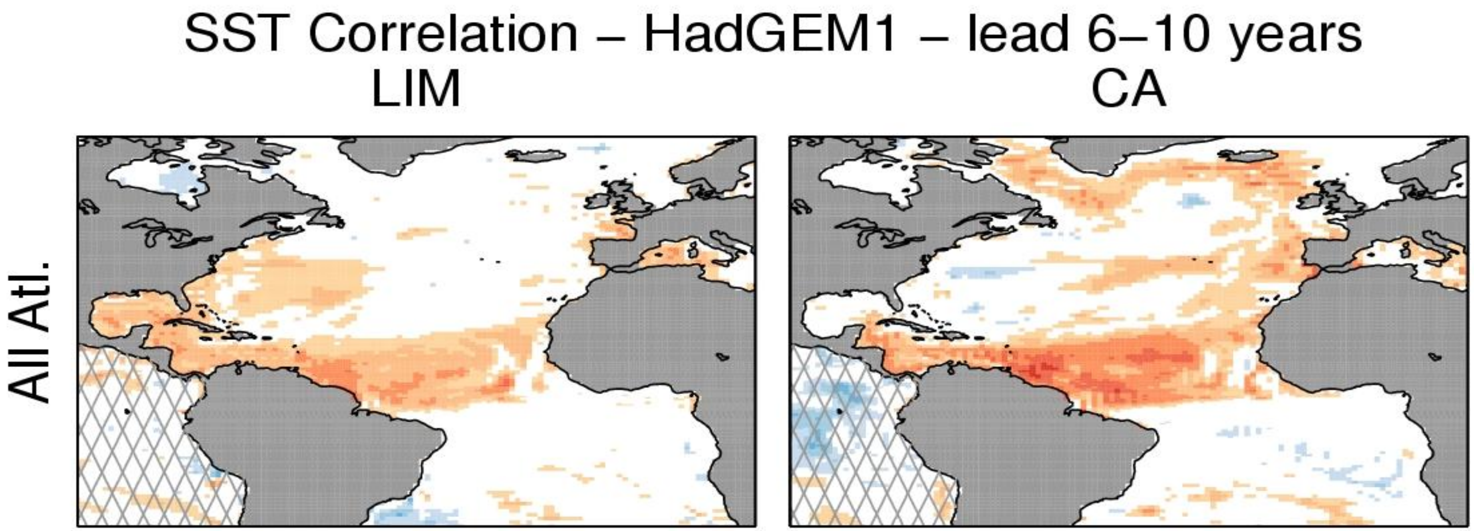


Correlation skill of idealised SST predictions
(perfect model framework, control run)

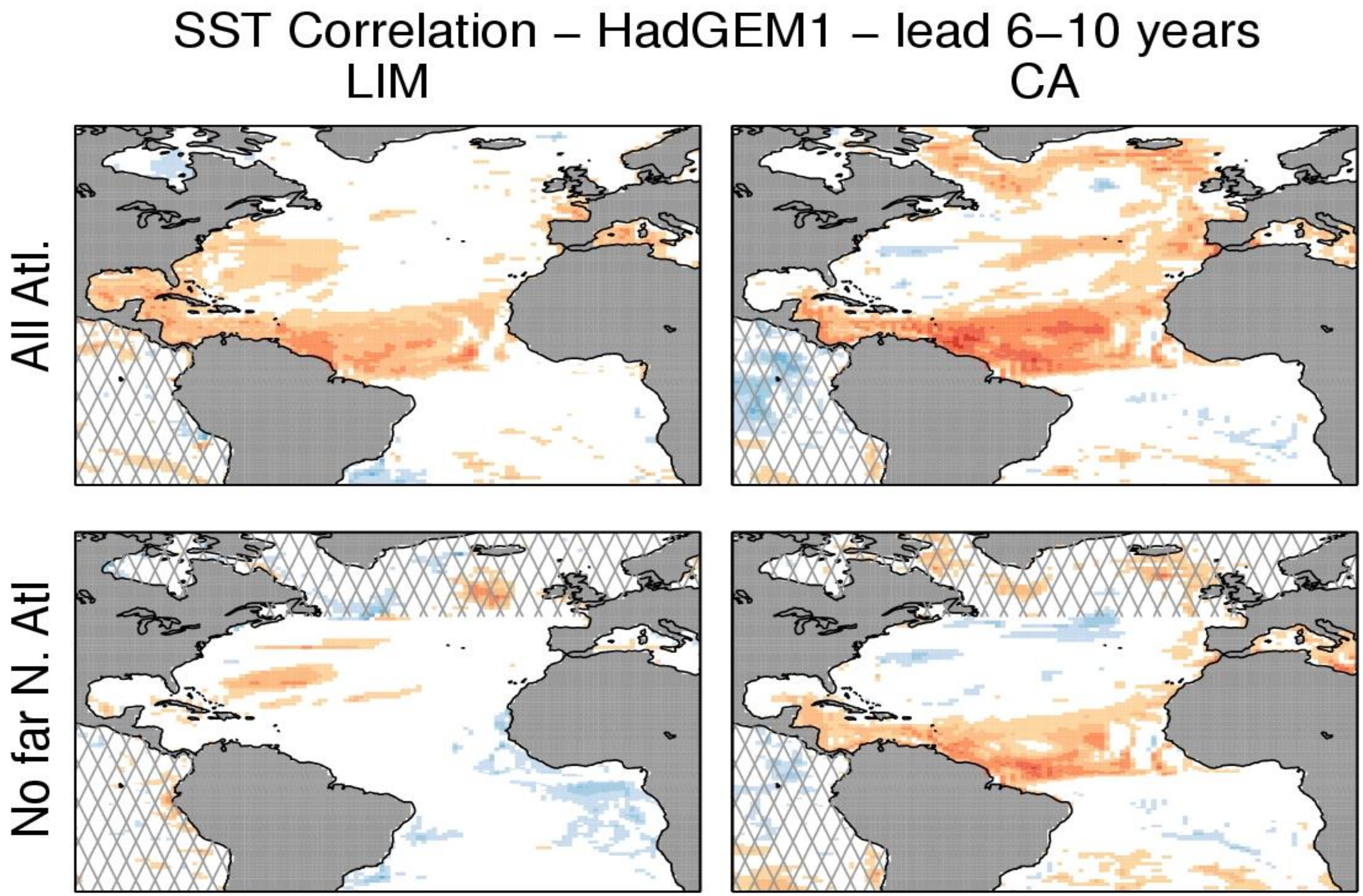
Hawkins et al., in revision

Optimal regions for observations?



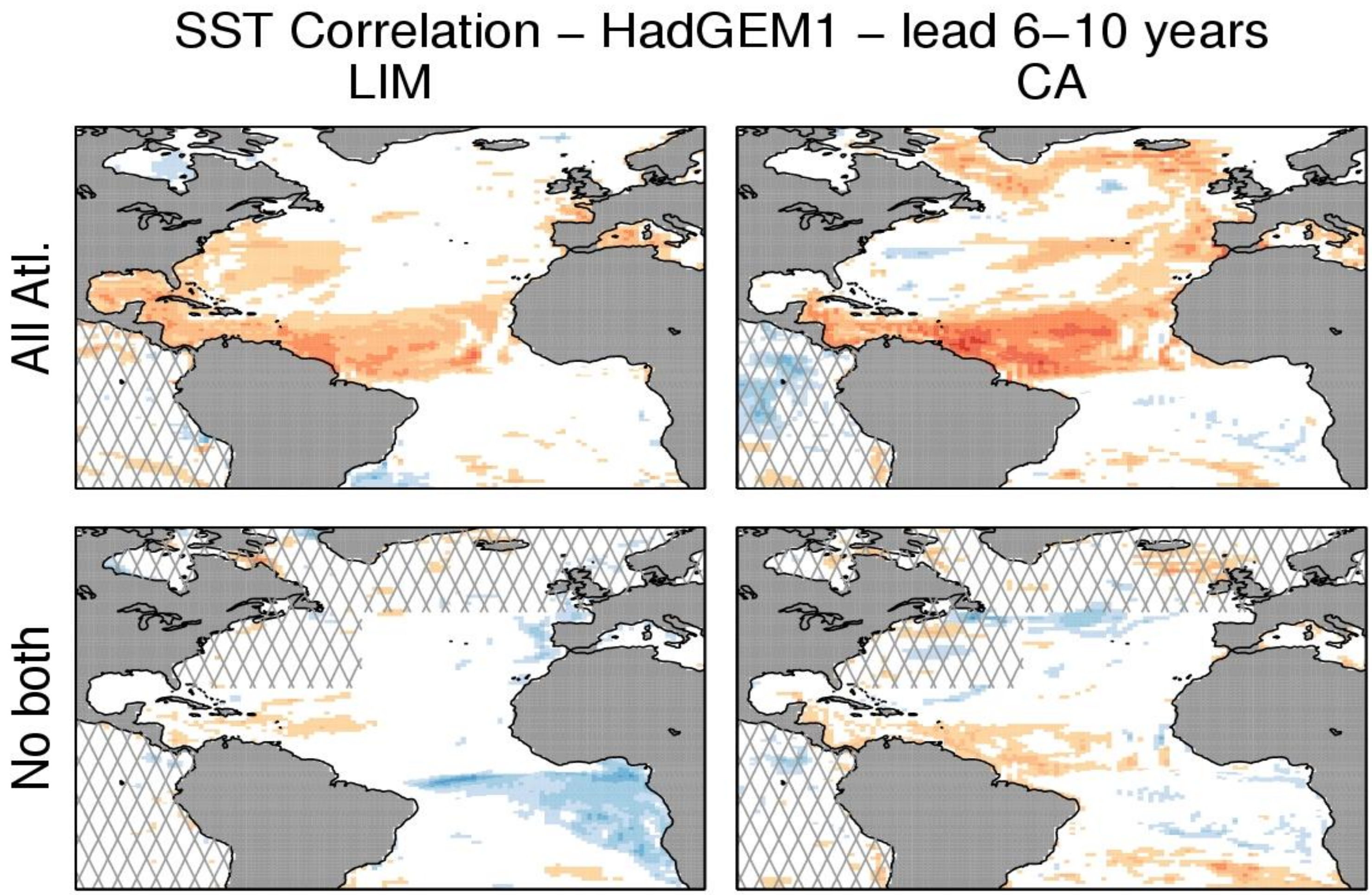
Correlation skill of SST predictions

Optimal regions for observations?



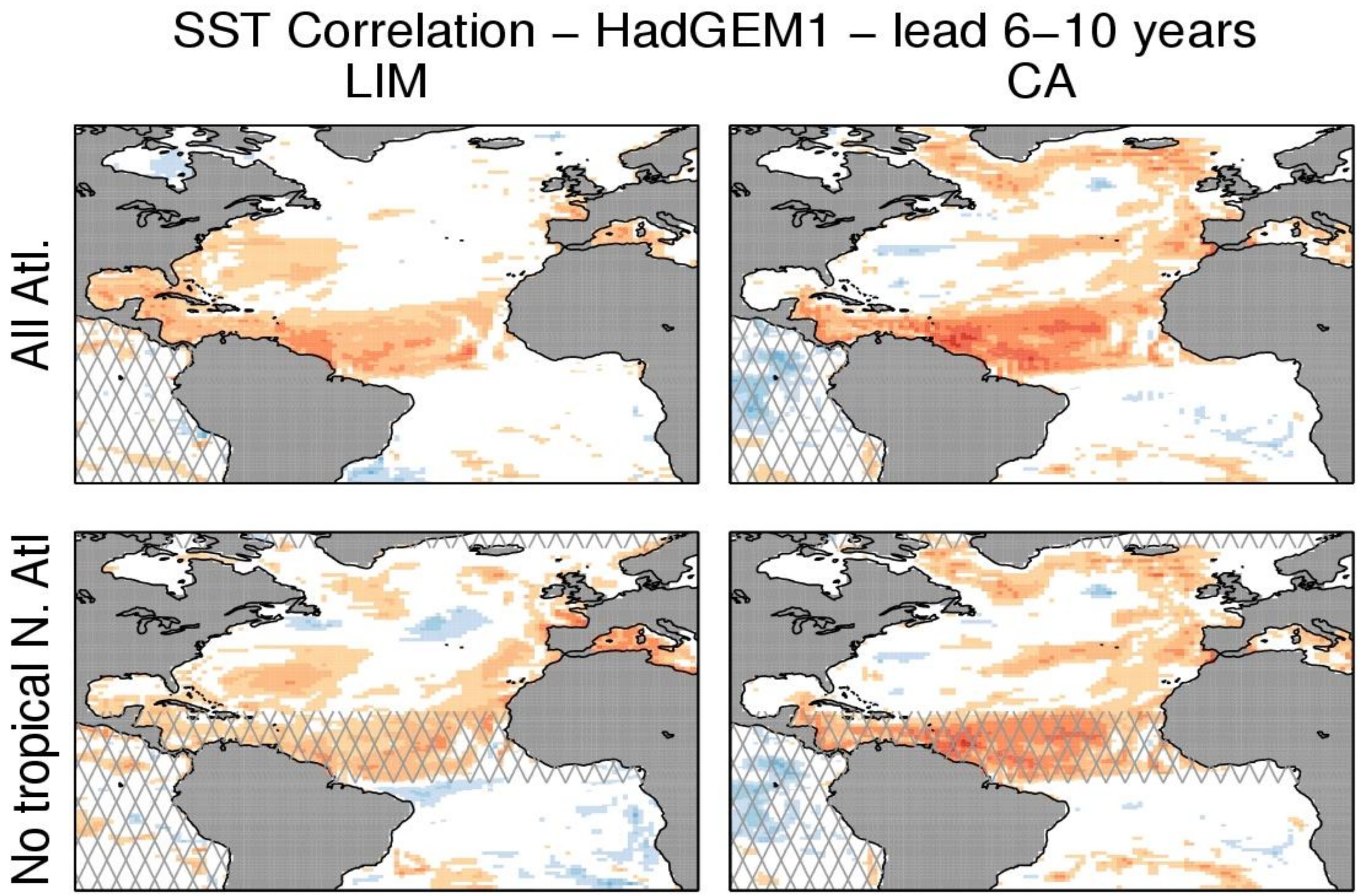
Correlation skill of SST predictions

Optimal regions for observations?



Correlation skill of SST predictions

Optimal regions for observations?



Correlation skill of SST predictions

→ methods to be extended to analyse observations

LINKS TO THE ARCTIC

Sources of uncertainty in Arctic projections

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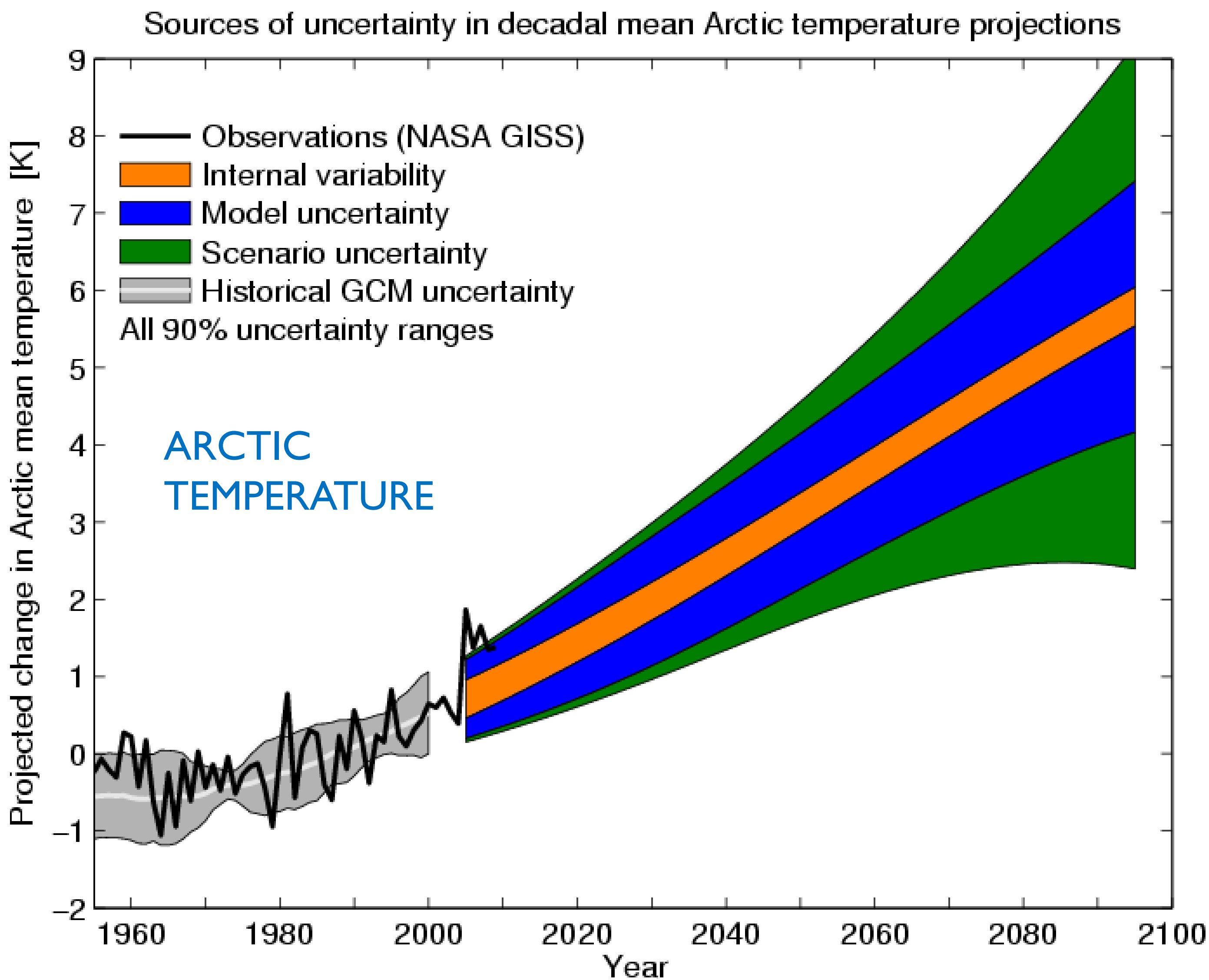

Sources of uncertainty in Arctic projections

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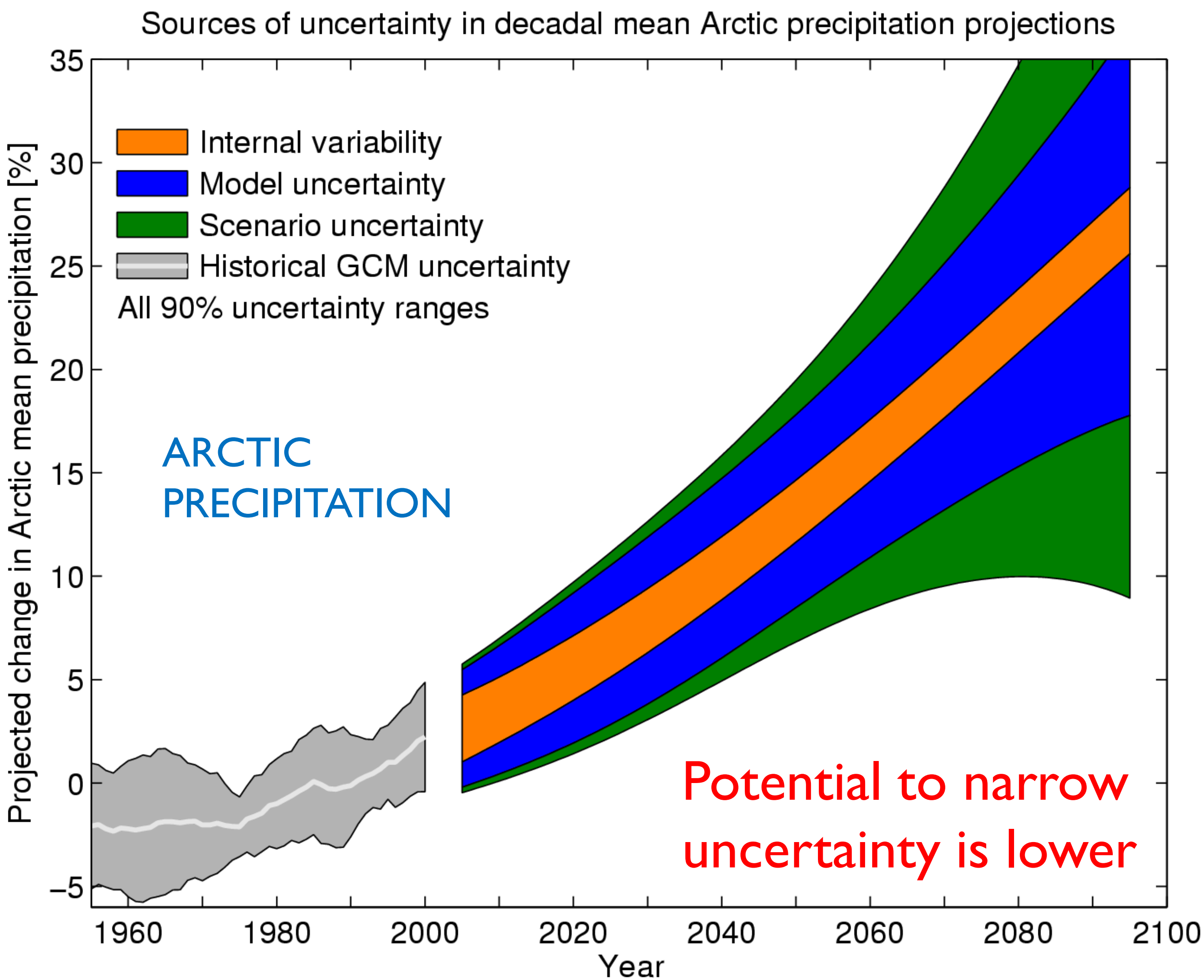
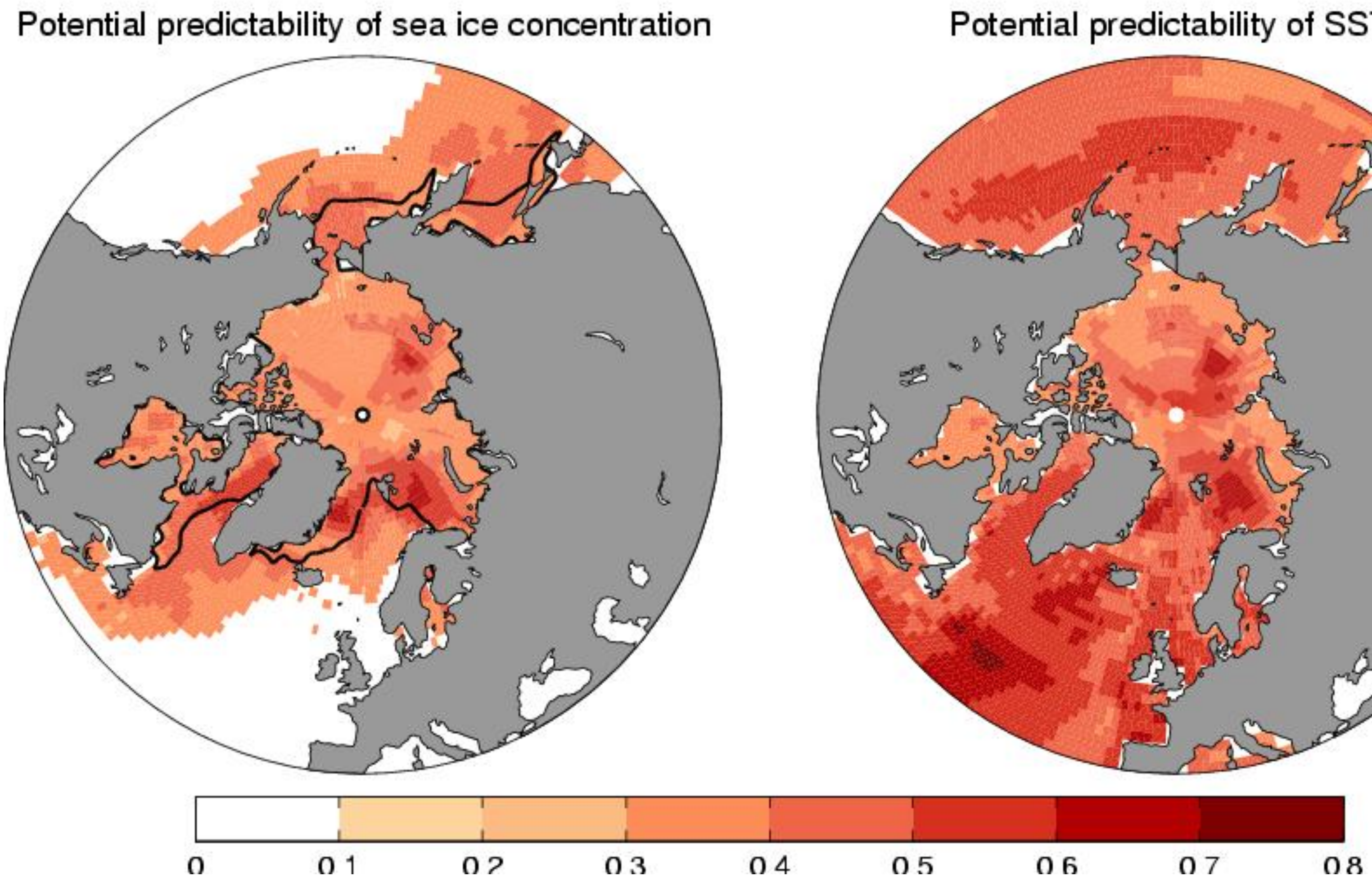


Potential predictability (PP)

$PP = \sigma_{10} / \sigma_1$

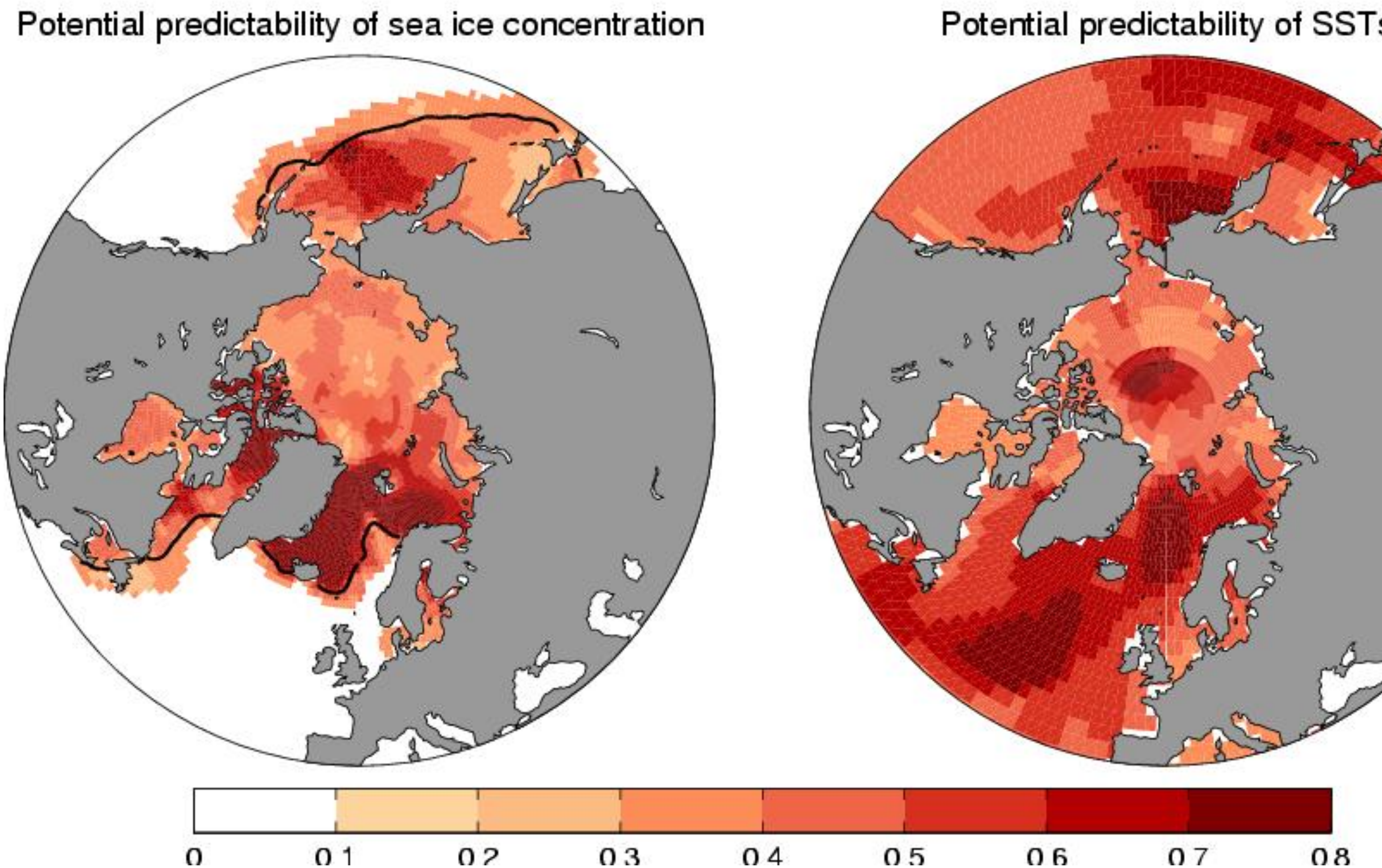
HadCM3



“Potential predictability”

$PP = \sigma_{10} / \sigma_1$

Bergen CM



Initialised (decadal) climate predictions are not just about improving forecast skill

- They have the potential to:
  - help build trust in climate model projections
  - learn about model bias and climate variability
  - learn about physical processes leading to forecast error
  - inform model development and improvements
  - inform design of effective climate monitoring systems

- "Decadal" = anything longer than seasonal

- Need to test Arctic predictability in idealised GCM settings as well as (or before?) tackling real predictions

Summary

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- Case study approach useful
- HadCM3 weakly too sensitive, mainly over land
$\rightarrow$ constrained projections?
- Statistical decadal predictions also potentially possible as a benchmark or source of skill
- Targeted observations in far North Atlantic should be beneficial for predictions
- Arctic sea ice shows significant decadal variability in (some) GCMs