



Met Office
Hadley Centre

Decadal prediction with Argo

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Murphy, Holger Pohlmann, Adam Scaife

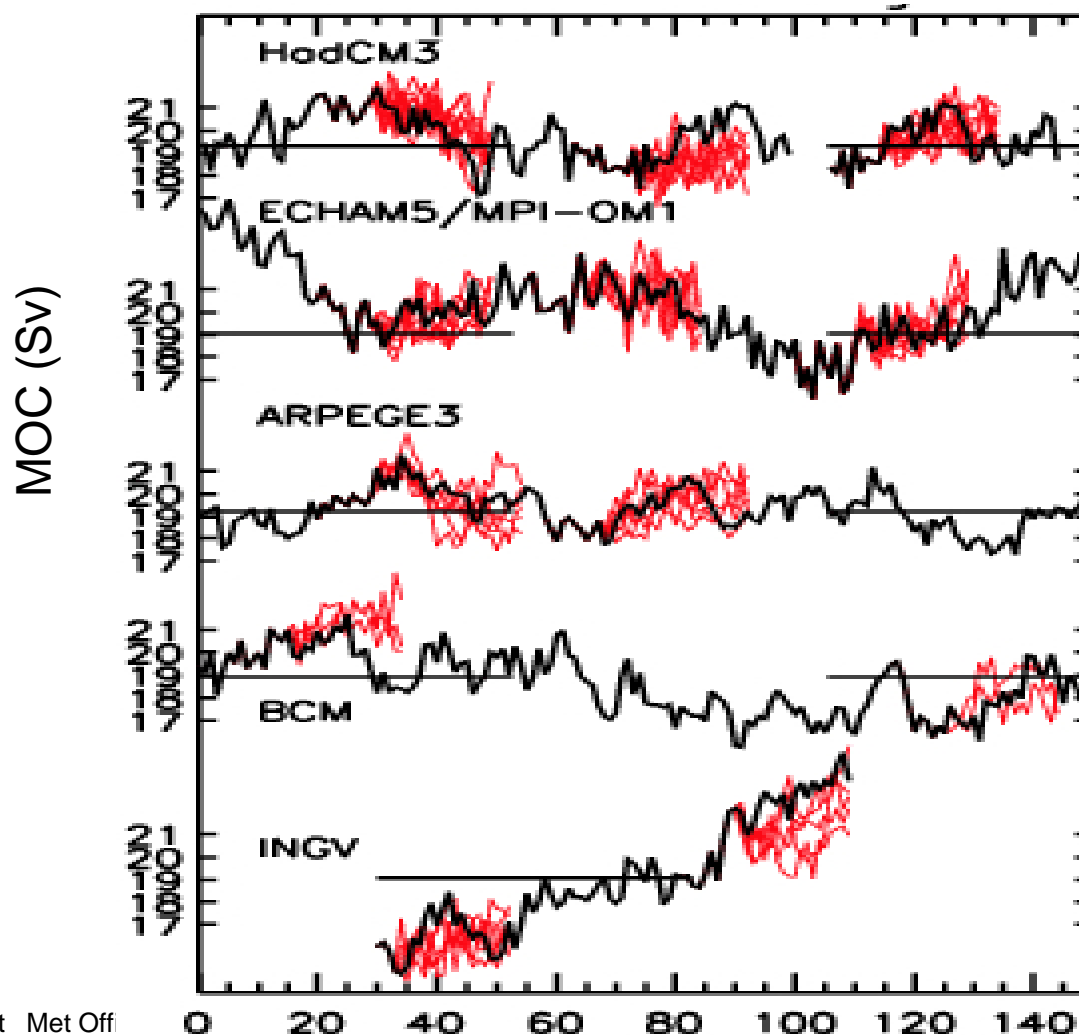


Contents

- Motivation for decadal predictions
- Idealized experiments
- Decadal prediction experiments
 - AMOC
 - Atlantic hurricanes

Atlantic overturning circulation is potentially predictable

Atlantic MOC (30N)



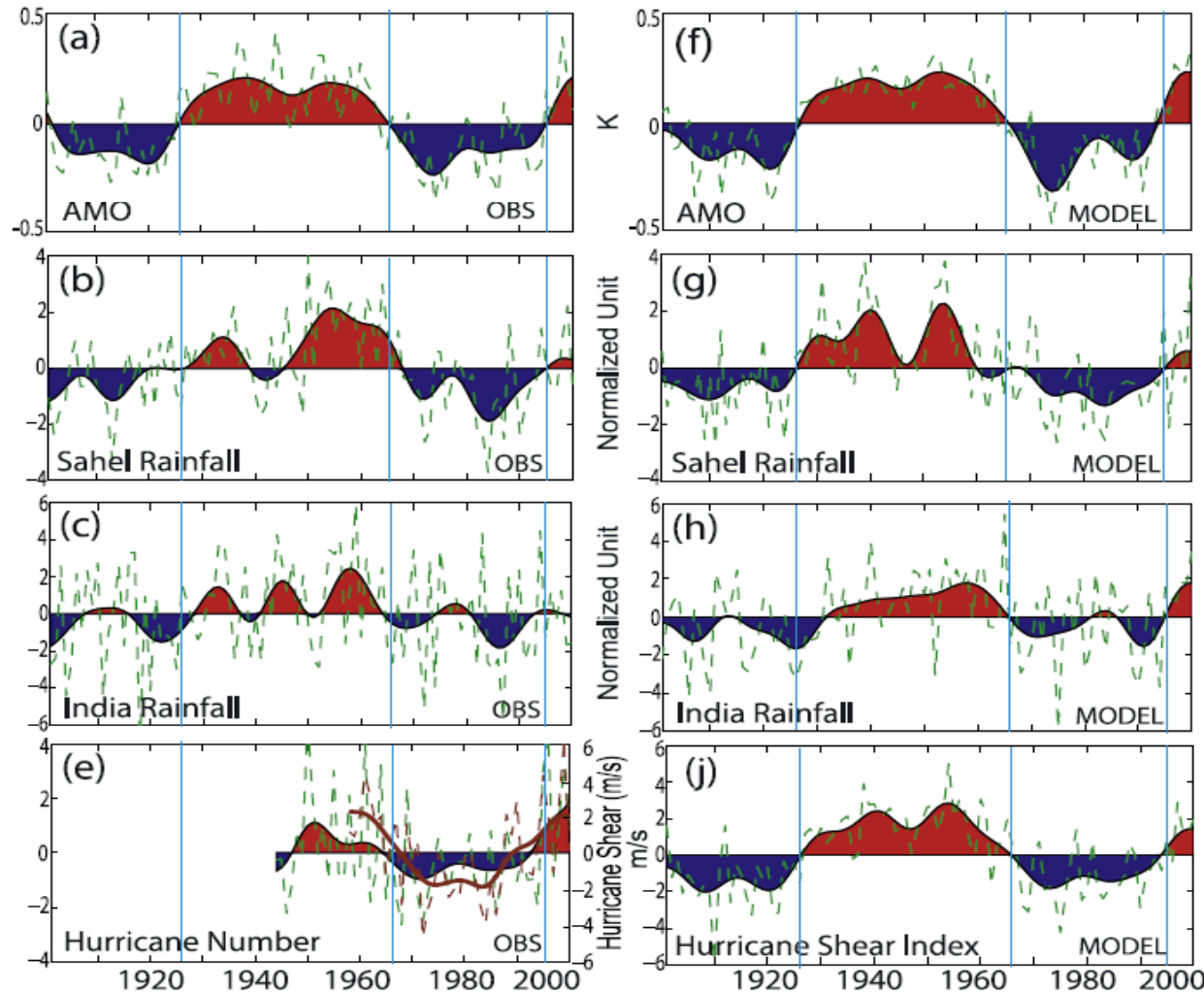
(Collins et al. 2006)

North Atlantic variability and impacts

Observations

Model

North Atlantic SST



Sahel rainfall

India rainfall

Hurricanes

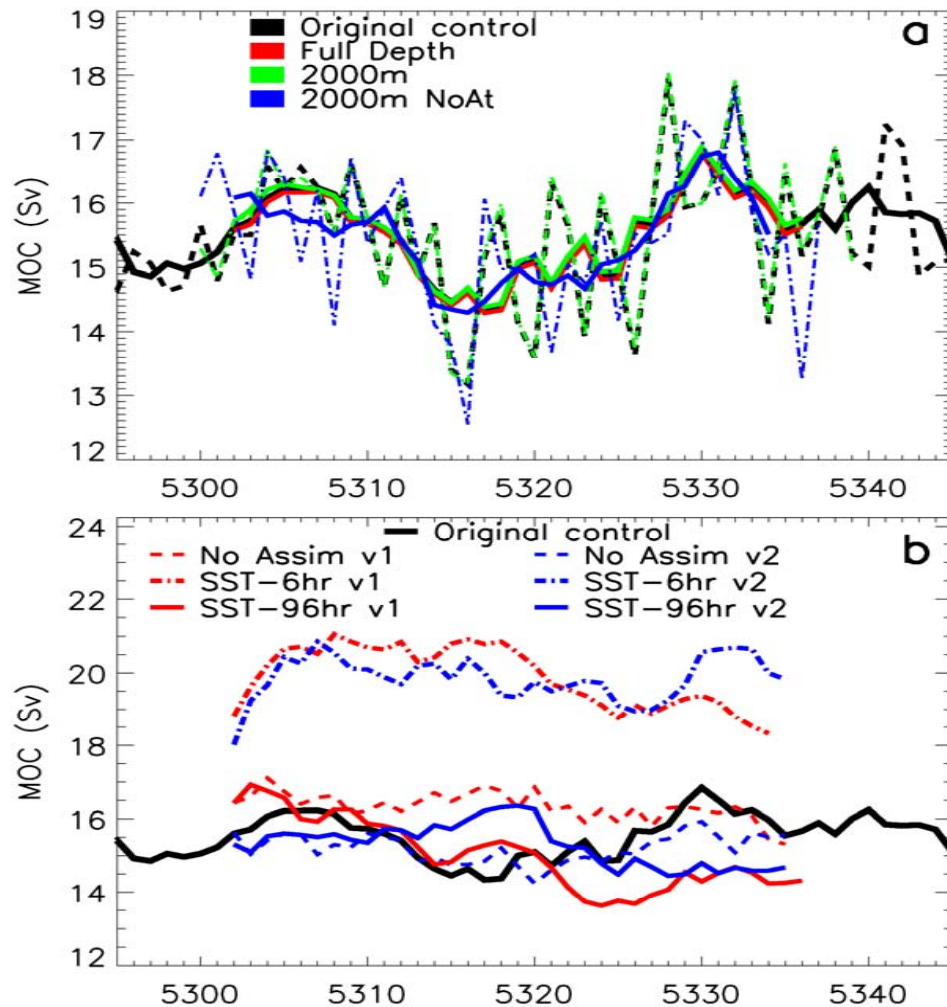


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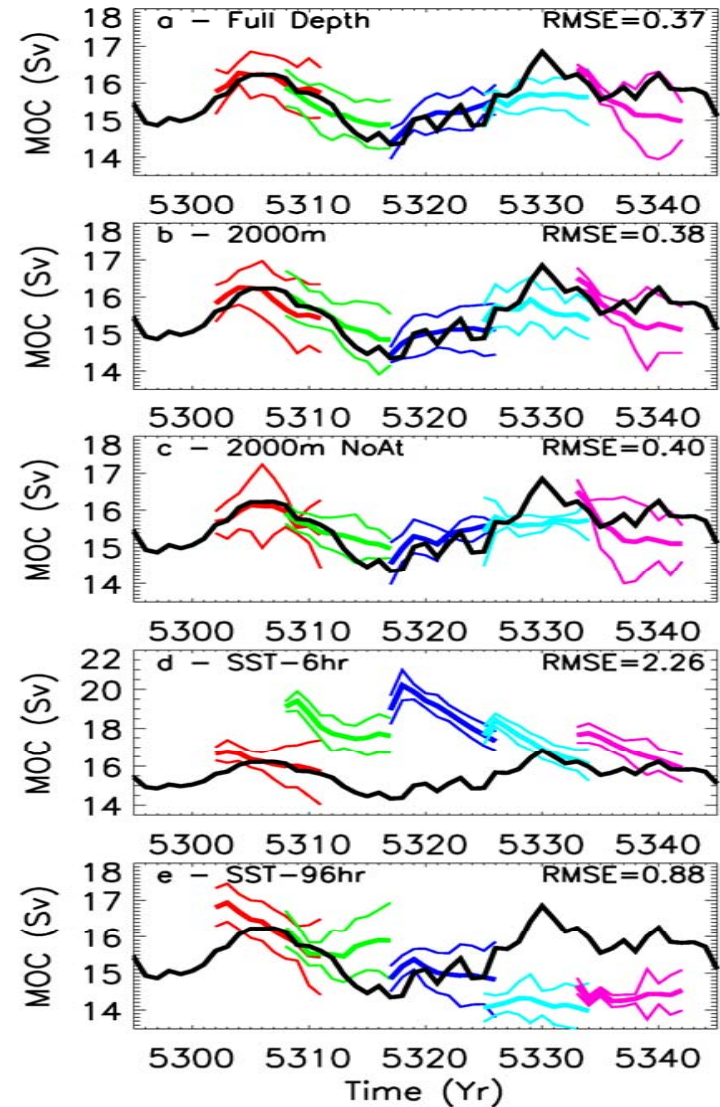
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Idealized experiments: AMOC

Initialisation



Forecasts

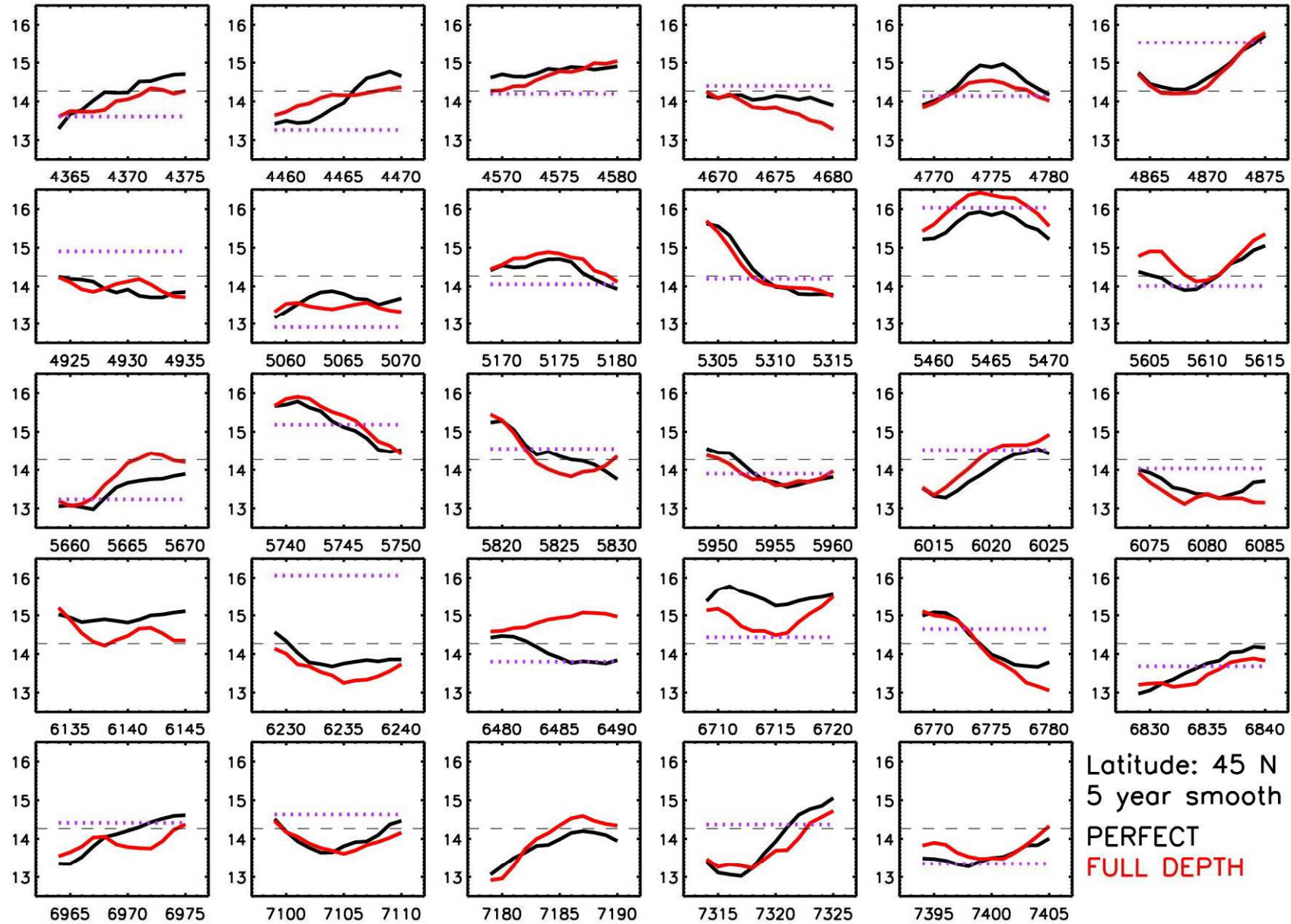




New set of experiments underway...

- Subsample ocean data at 2007/08 Argo locations and then at pre-Argo (1990's) locations. Use co-variances from another climate model (HadGEM) to infill data. Predict HadCM3 original evolution.
- **TEST:**
 - realistic density and locations of observations
 - imperfect model covariances
 - impact of initial conditions on forecast skill
- 29 start dates are planned, with at least four different ensembles:
 - ✓ • A **Perfect** member ensemble
 - ✓ • A **Full Depth** ensemble – monthly T & S everywhere
 - • A **sub-sampled 2008** ensemble (EN3 profile locations)
 - • A **sub-sampled 1998** ensemble (EN3 profile locations)
- Each start date consists of a 5 member ensemble created by a small random SST perturbation and is run for 16 years.

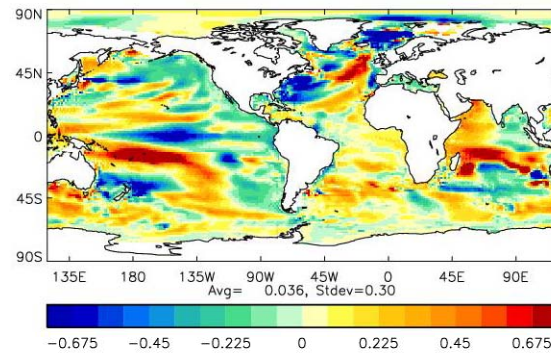
MOC predictions from the 29 start dates:



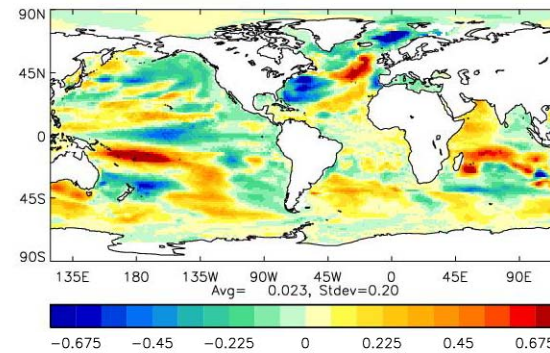
Ocean analysis

- Gaussian white noise is added to the pseudo observations, picked from real observation locations, then spatially complete fields of anomalies are generated using imperfect covariances.
- These fields are then assimilated into the model for one year

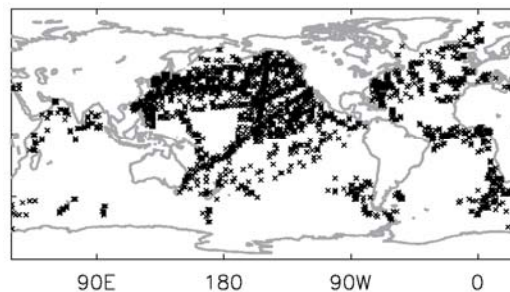
True anomaly



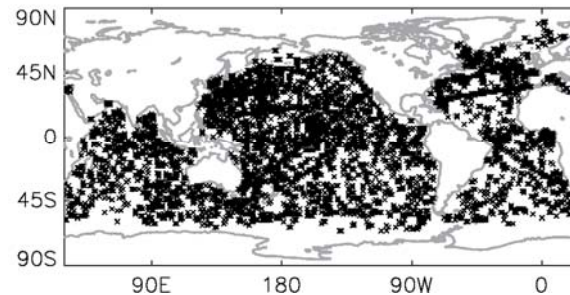
From 2008 obs



Pre-Argo



Argo

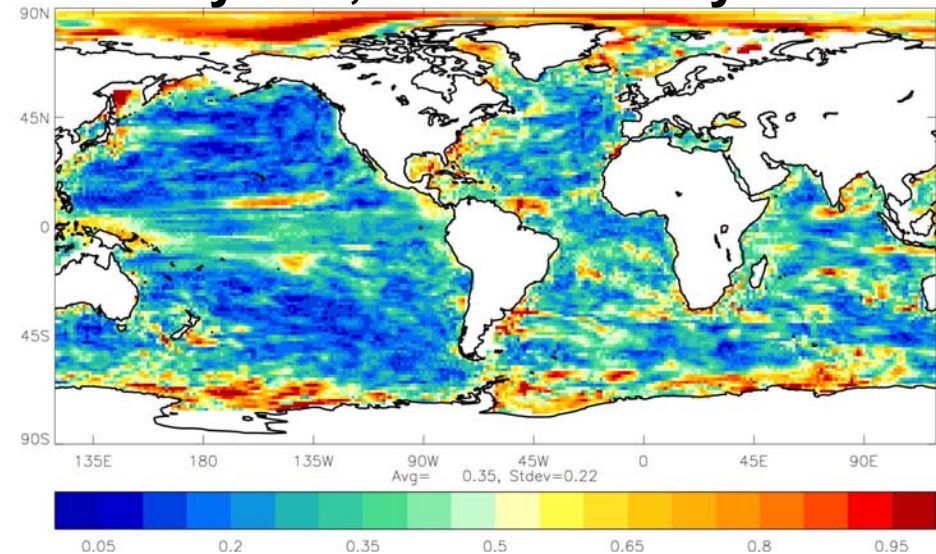




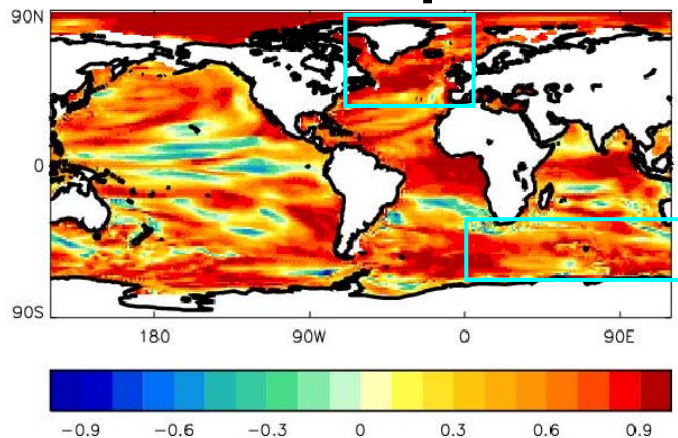
Assimilation errors and forecast skill: 2008 obs

As expected, some of the largest errors occur in the western boundary currents. However, also in the Nordic Seas (a main sinking region in HadCM3) and the Southern Ocean.

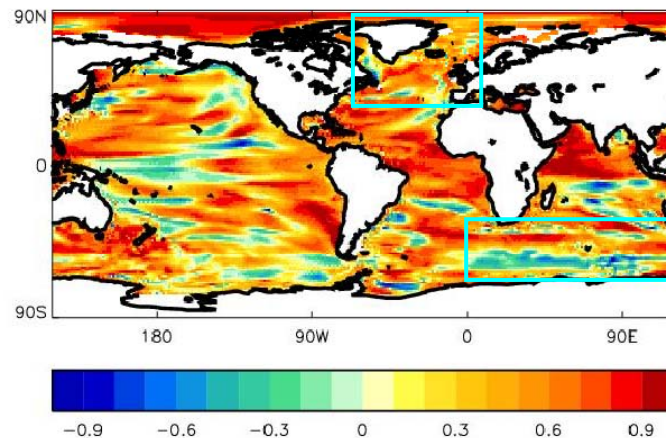
Mean absolute error of top 360m temperature from the 7 assimilation years, normalised by σ :



Full Depth



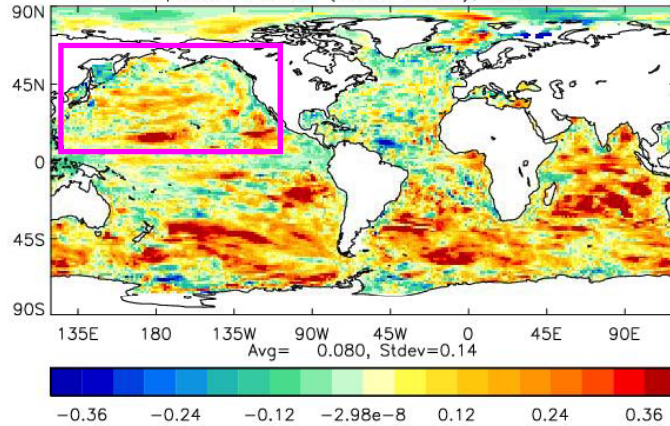
Sub 2008



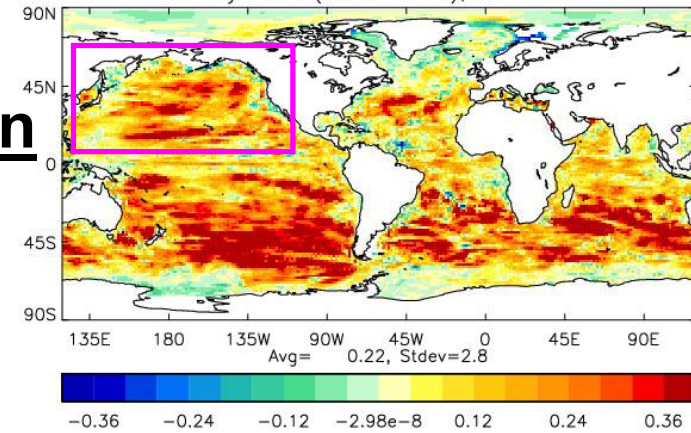
← Correlations for forecast years 10-15 against the Perfect ensemble mean:

Comparing 2008 and 1998 obs

Temperature



Salinity

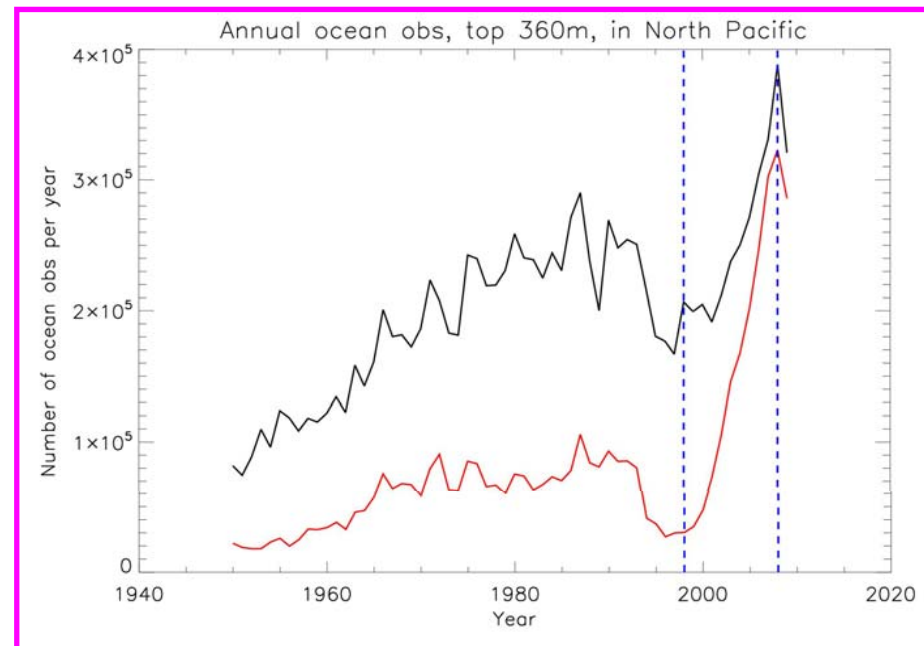
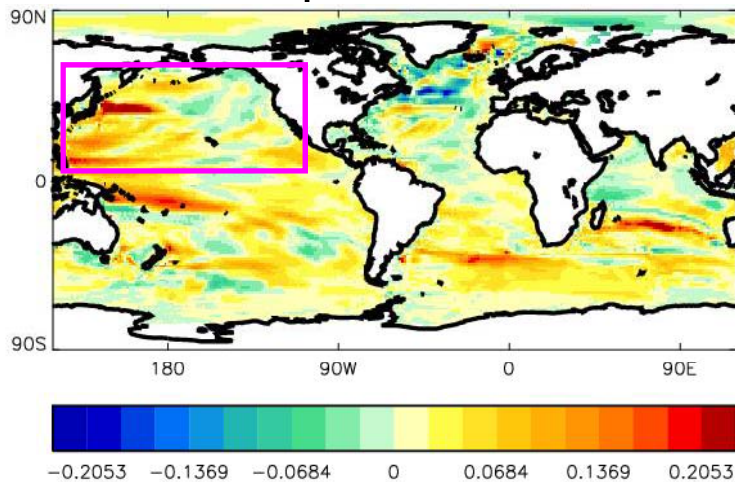


Assimilation errors

(Red – 2008 more skillful, Blue – 1998 more skillful)

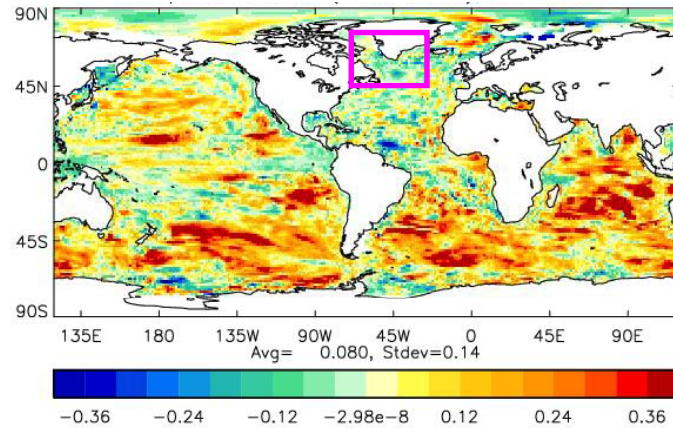
Forecast errors

Temperature

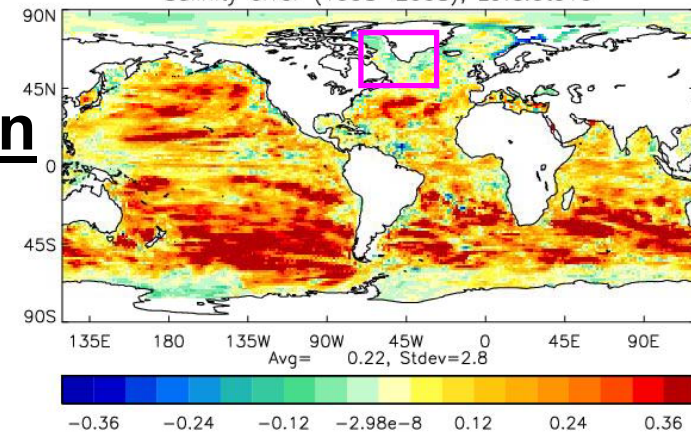


Comparing 2008 and 1998 obs

Temperature



Salinity

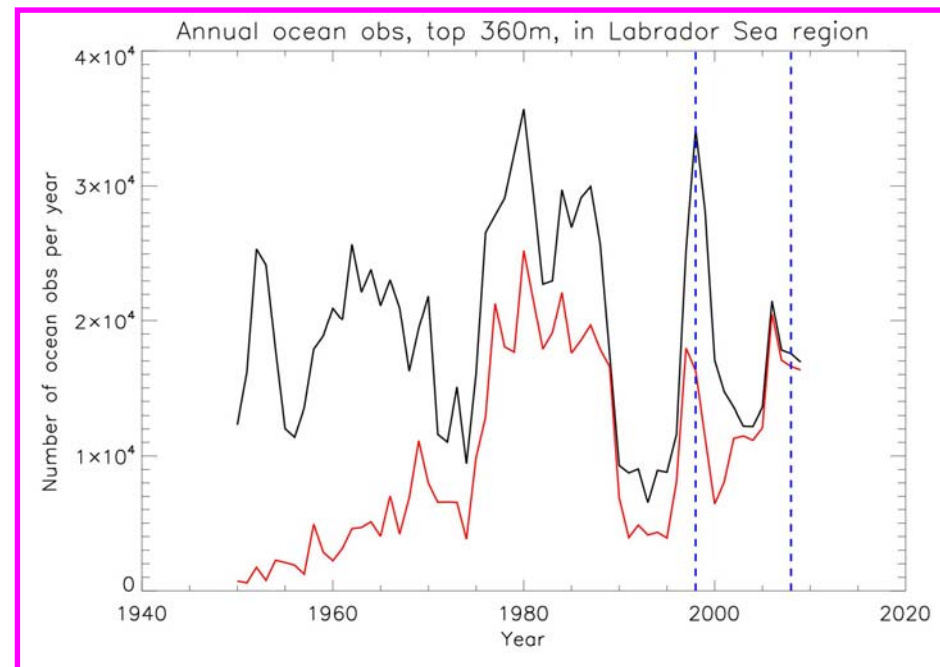
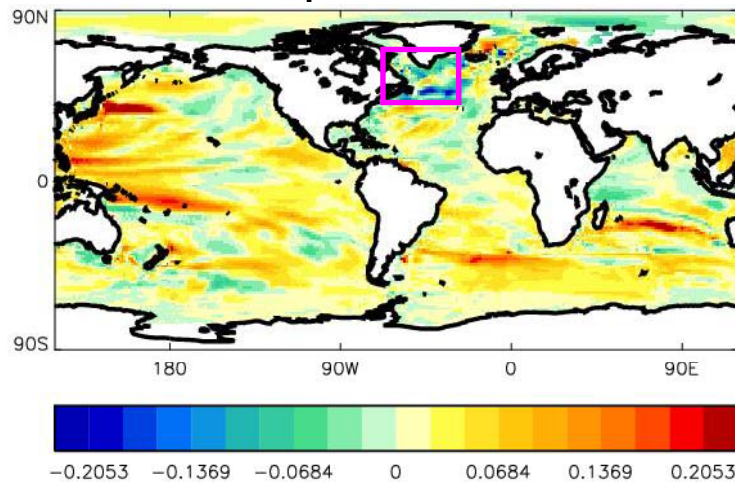


Assimilation errors

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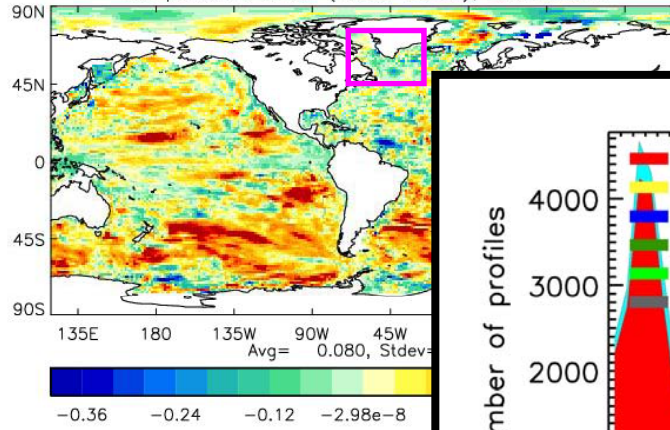
Forecast errors

Temperature

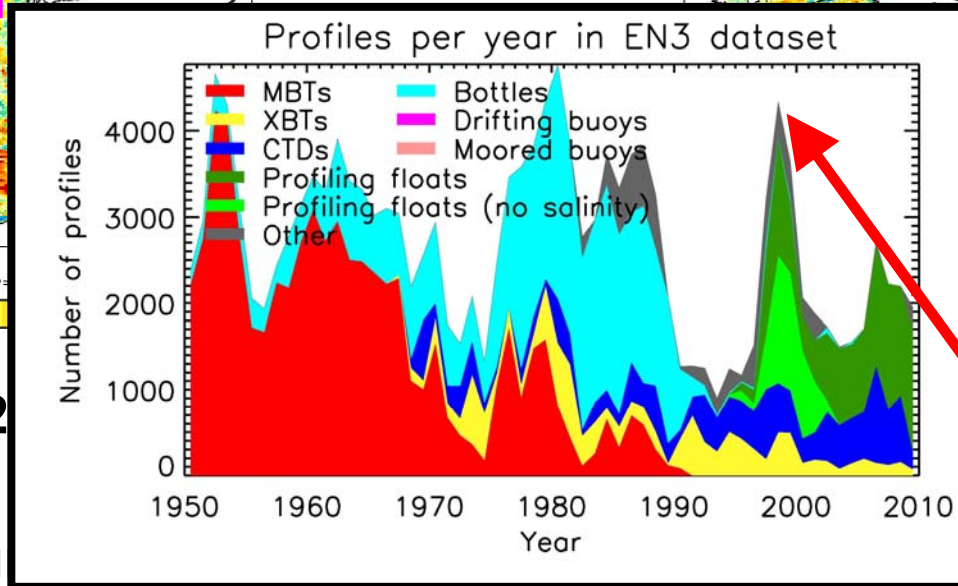
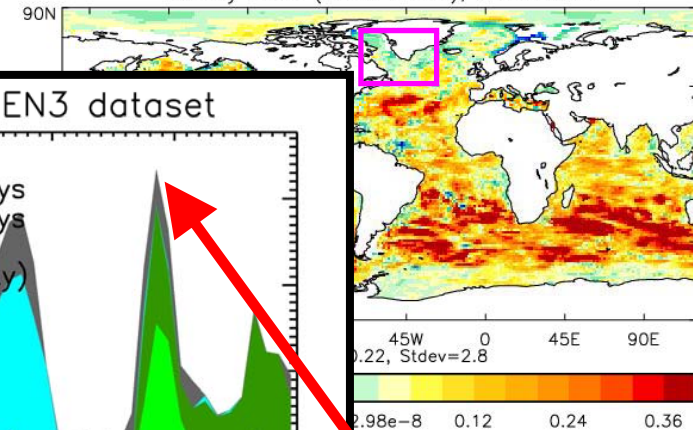


Comparing 2008 and 1998 obs

Temperature



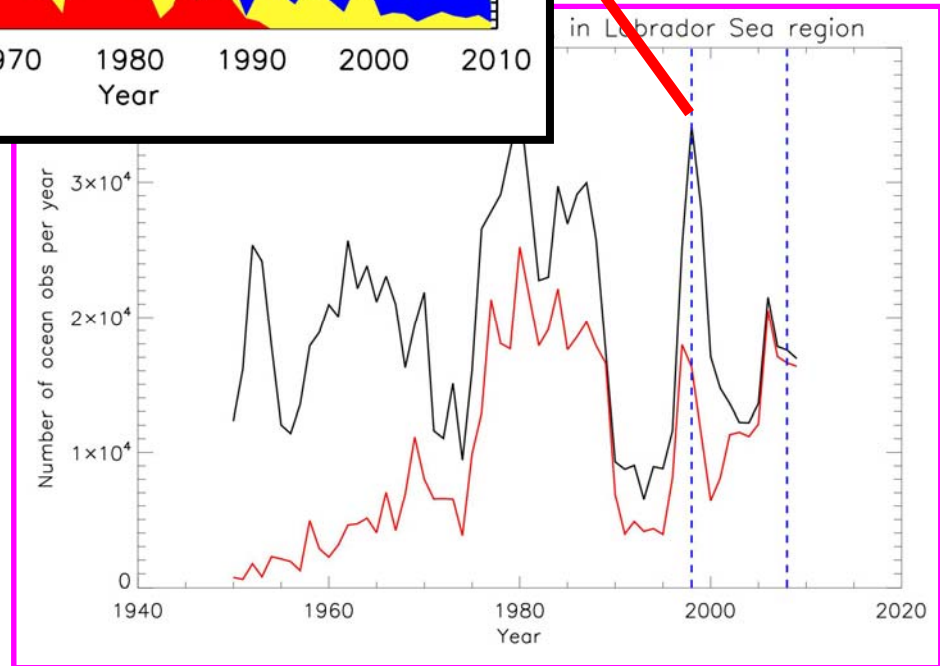
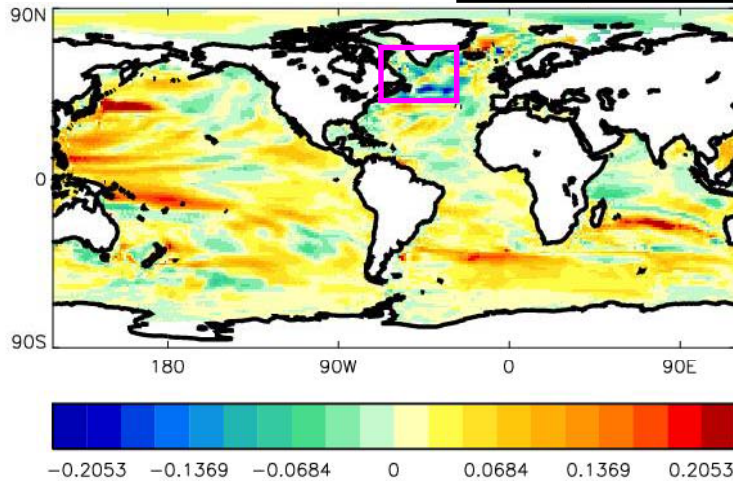
Salinity



(Red - 2
Forecast errors

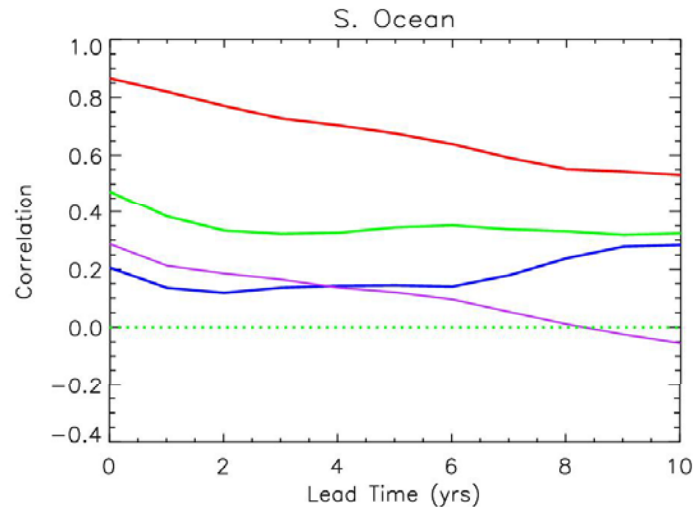
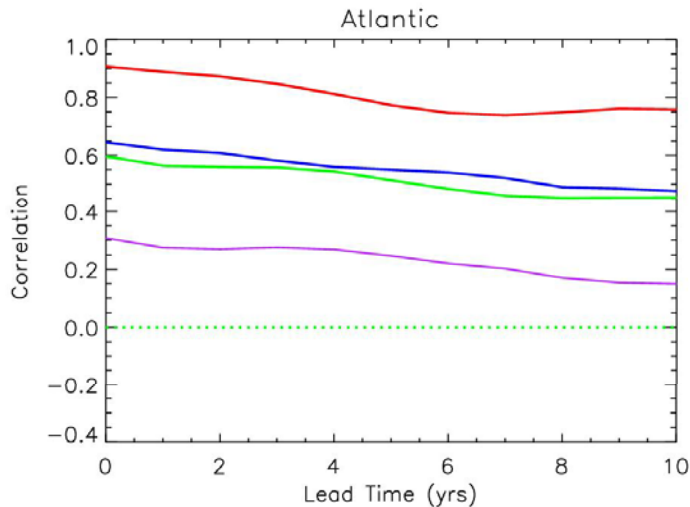
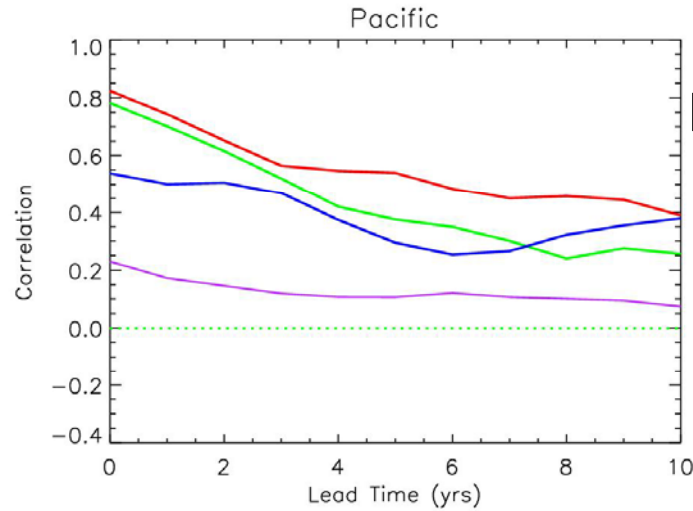
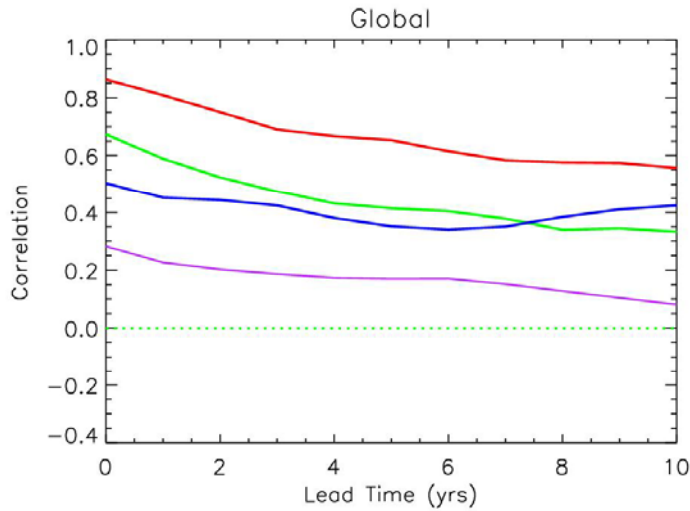
skillful)

Temperatu





Forecast skill – Top 360m temperature (5 yr means)



- Verify against Perfect ensemble mean.

Full Depth

2008 obs

1998 obs

Persistence



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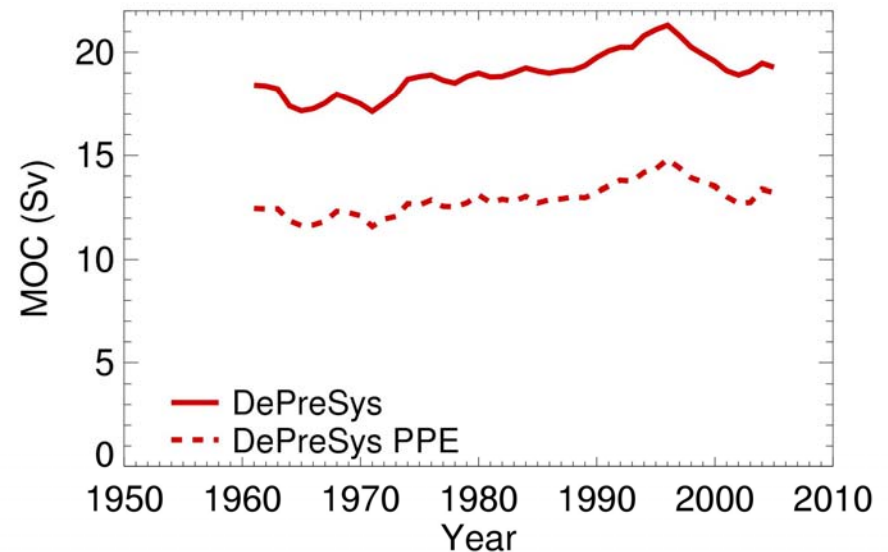
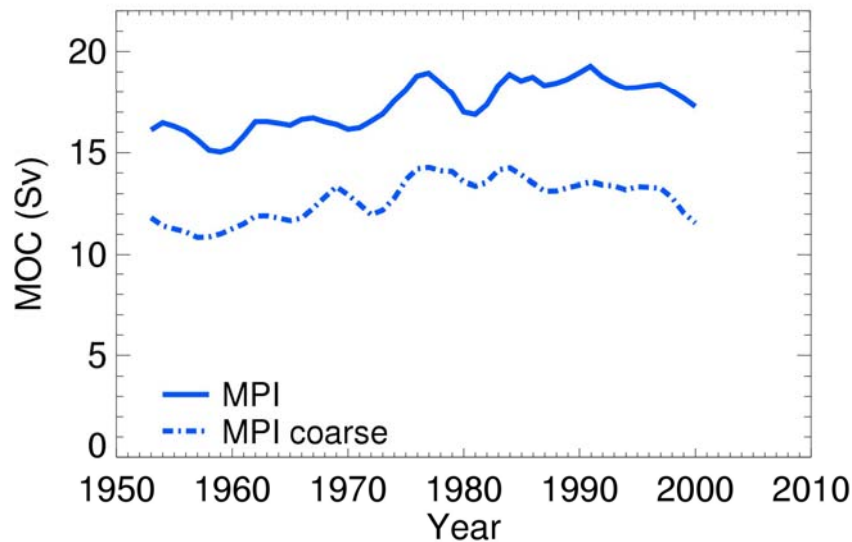
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AMOC Variability 1960-2005

Assimilation Experiments:

AMOC* (45°N)



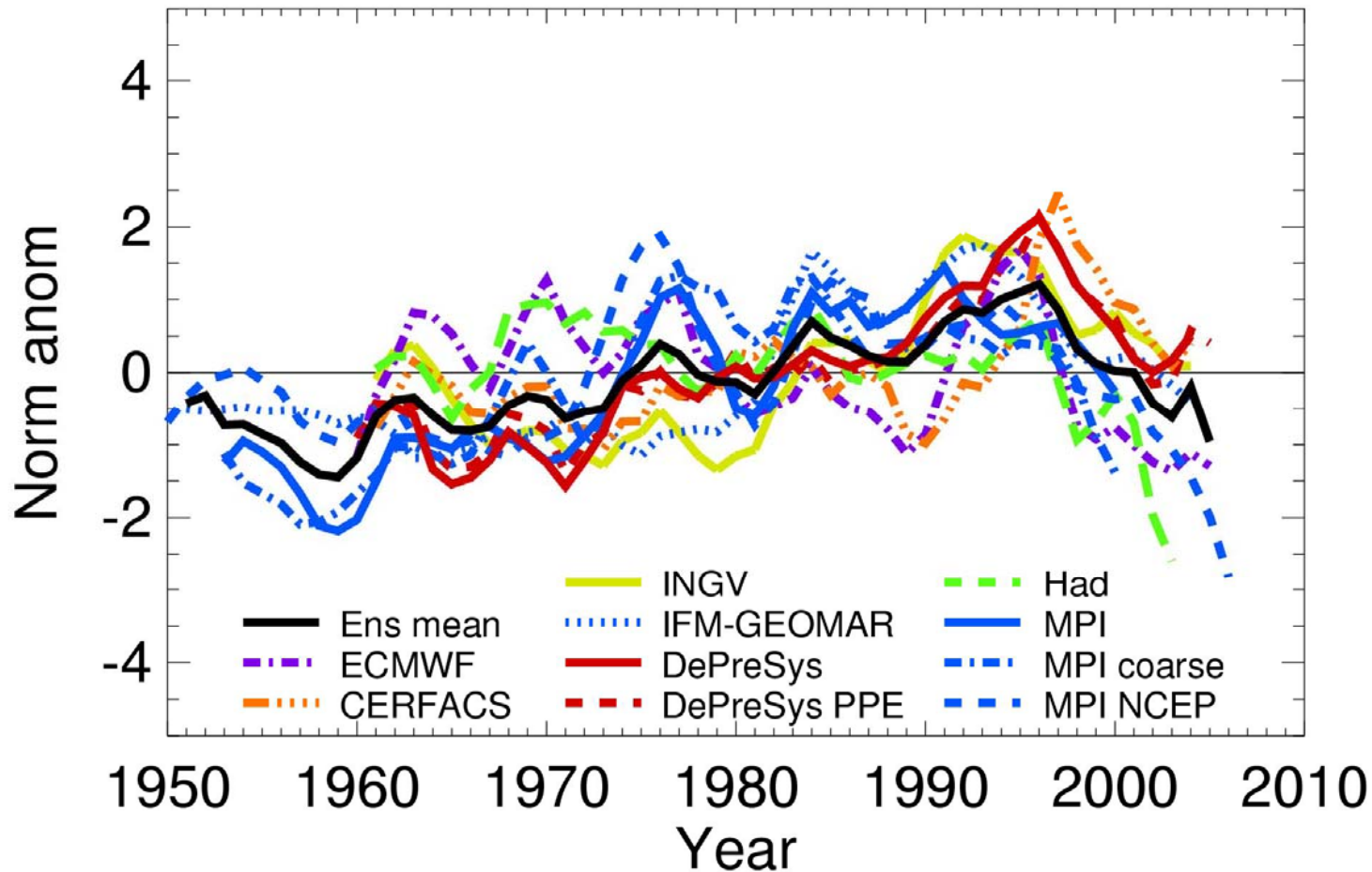
*(3yr running means)



AMOC Variability 1960-2005

Assimilation Experiments:

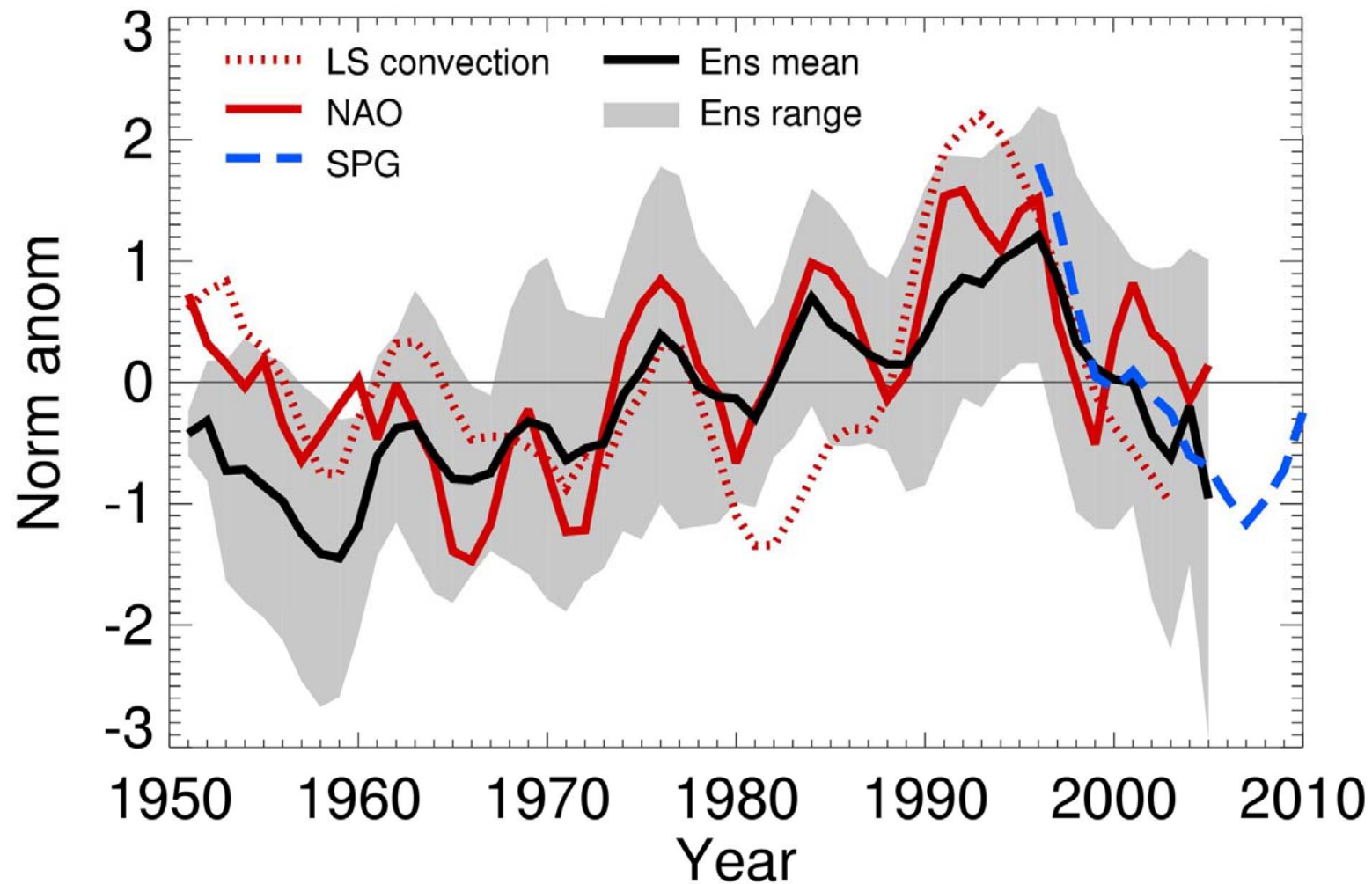
AMOC* (45°N)



*(3yr running means)

AMOC Variability 1960-2005

Assimilation Experiments, AMOC 45°N

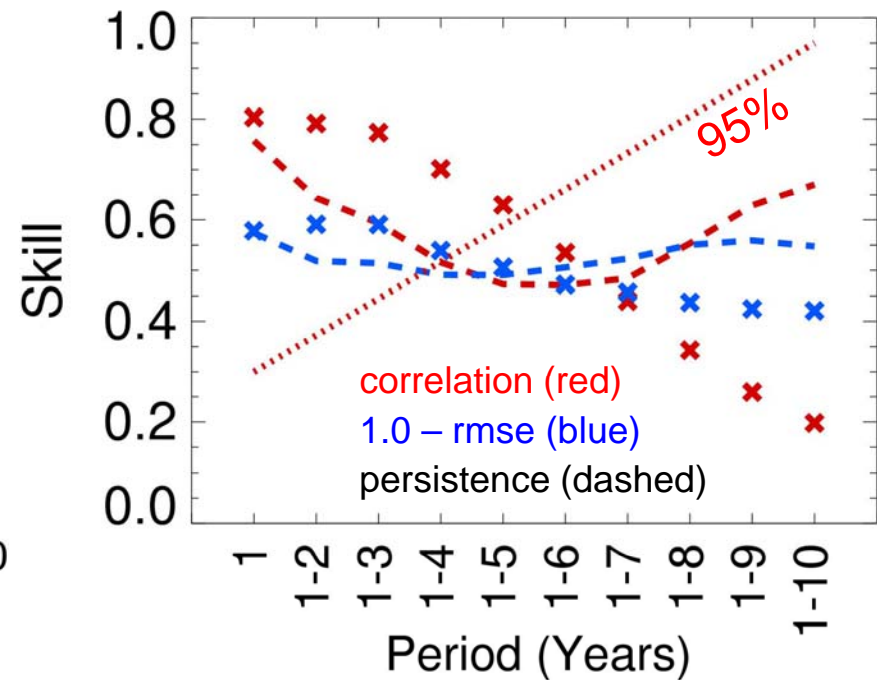
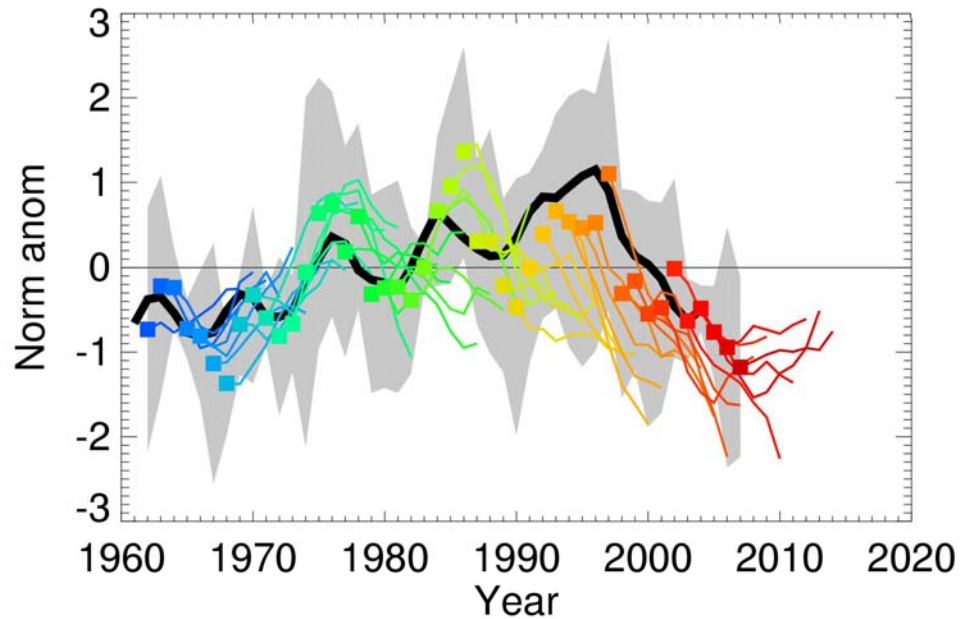




AMOC in Decadal Predictions

Multi-model mean:

AMOC (45°N)





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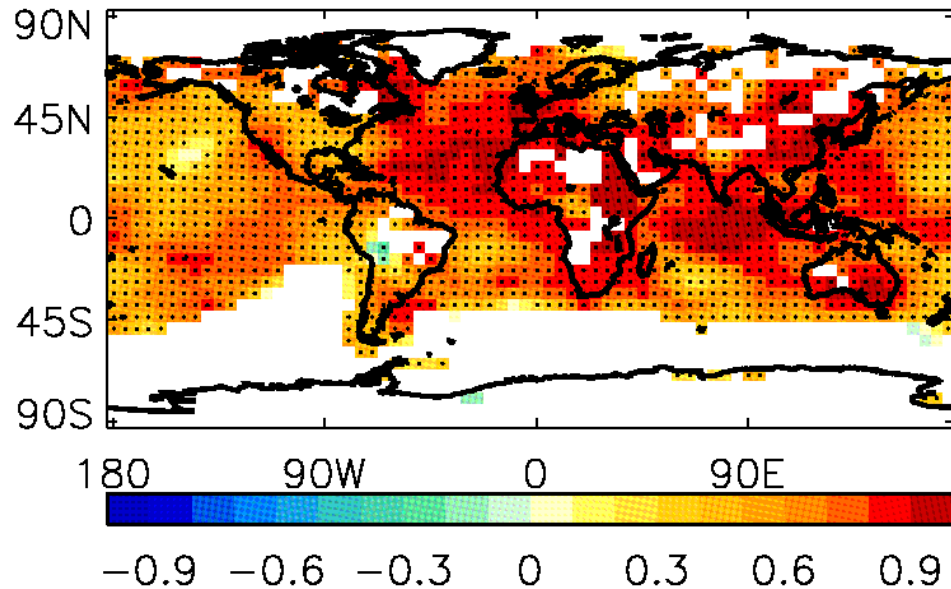
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Impact of initialisation on hindcast skill

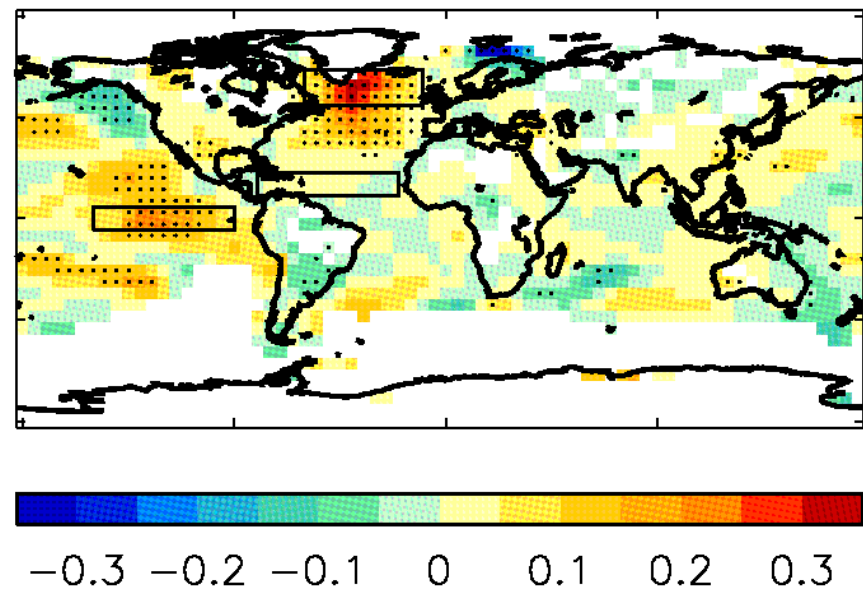
5 year mean (Jun-Nov) surface temp :

15x15 degrees : start dates each Nov 1960 to 2005

DePreSys anomaly correlation



DePreSys-NoAssim correlation

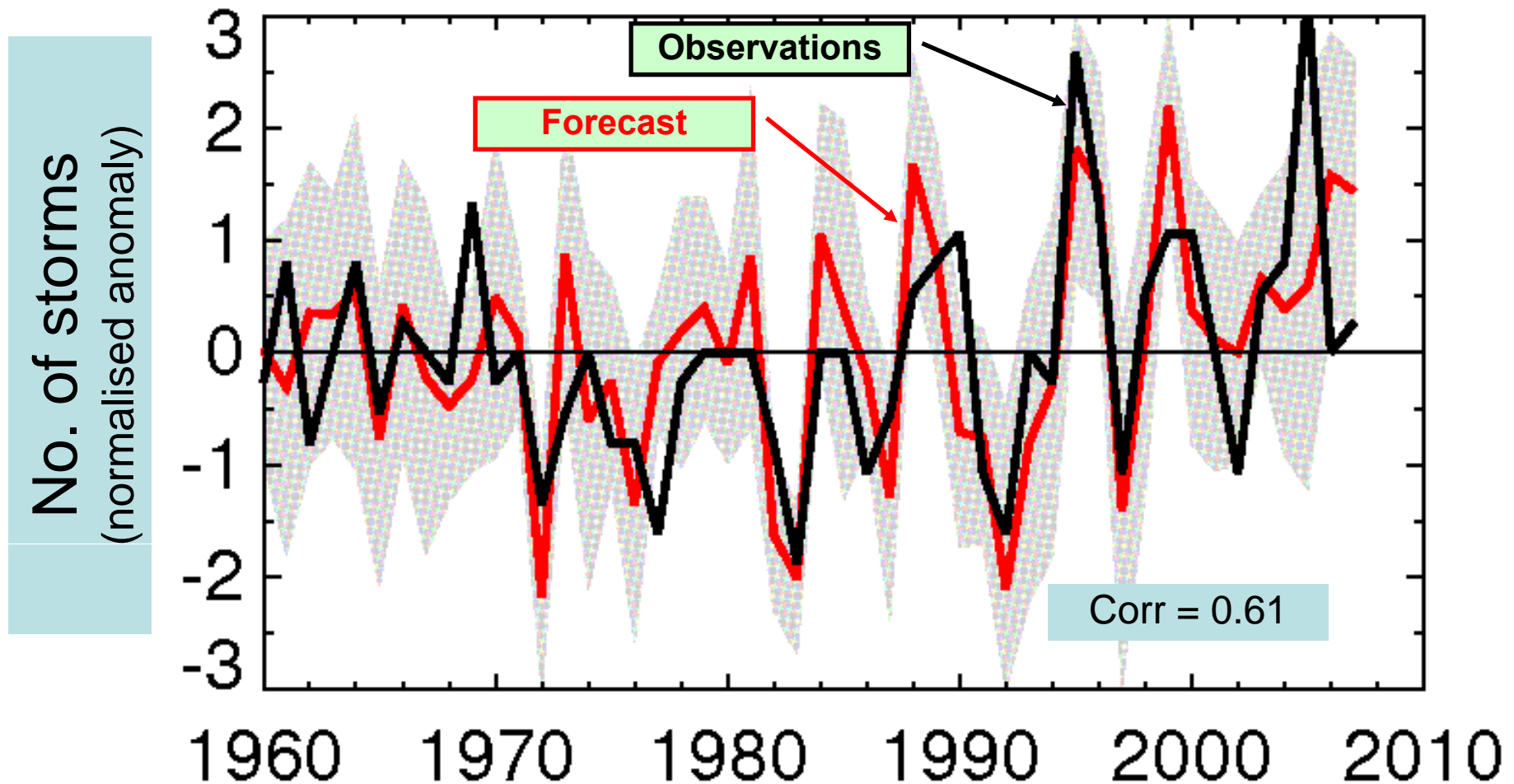


- HadCM3
- 9 member perturbed physics ensemble
- Starting every Nov from 1960 to 2005

Atlantic tropical storms

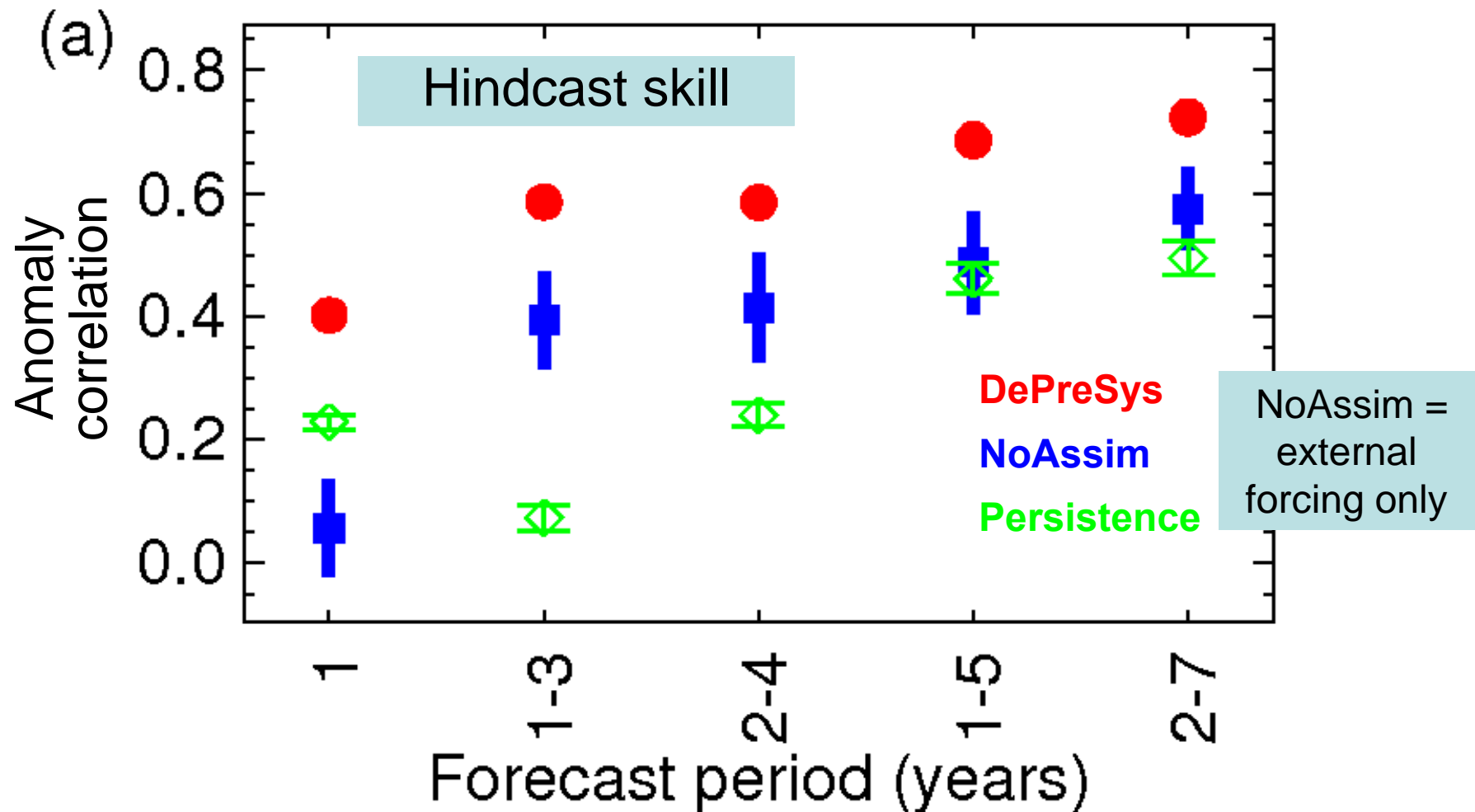
Seasonal forecasts from May for June-Nov

HadCM3 (DePreSys) forecasts



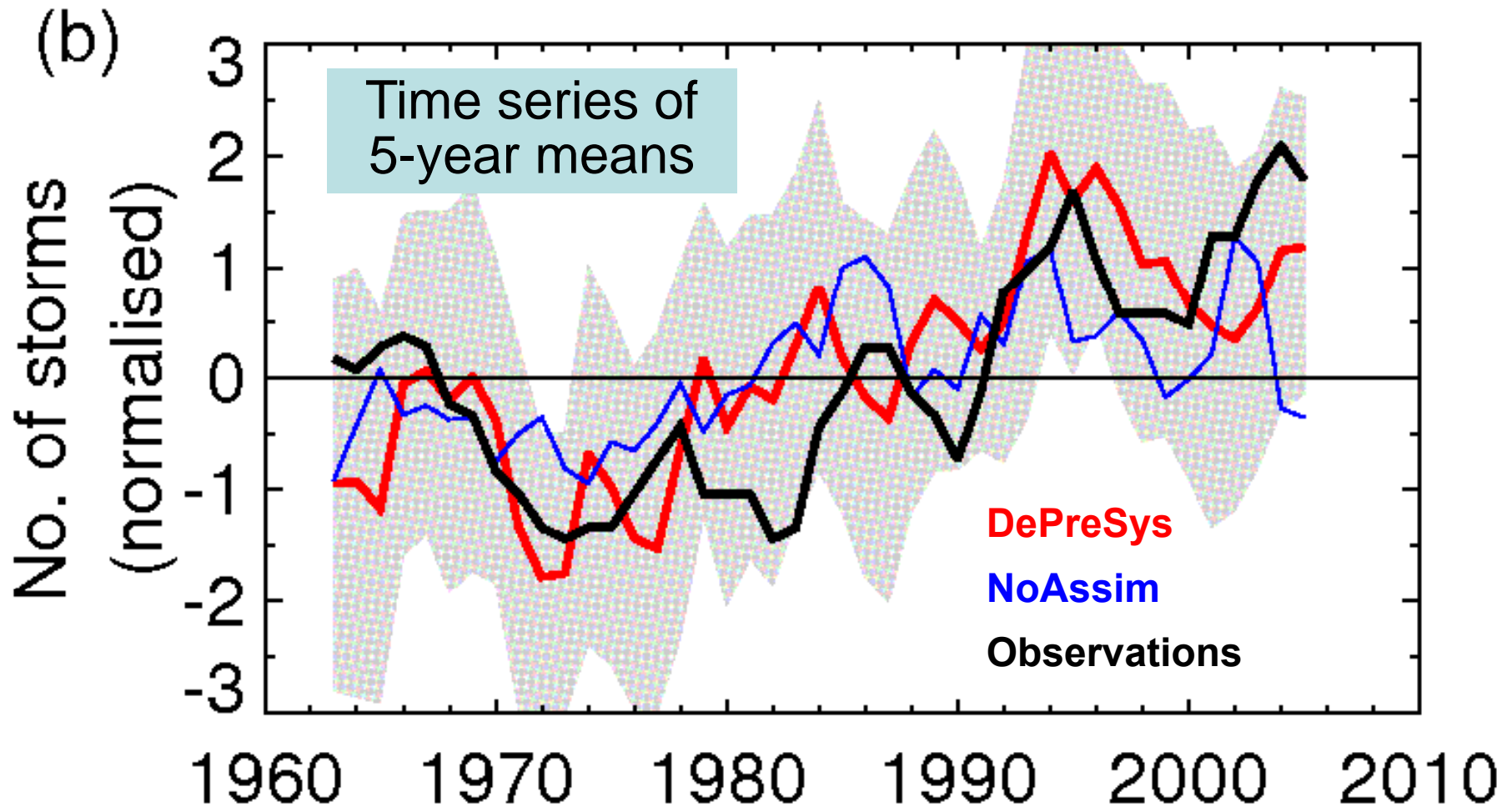
Atlantic tropical storms

Forecasts from Nov for June-Nov



Atlantic tropical storms

Forecasts from Nov for June-Nov



Summary

- Idealized prediction experiments are potentially a powerful tool for assessing the observing array
 - Preliminary results highlight the northern north Atlantic
 - More skill overall with Argo obs, but room for improvement!
- Multi-model ensemble shows signal of AMOC at 45°N that is consistent with related observations
 - Also skilful predictions out to about 5 years ahead
- Some skill for predicting hurricane frequency (but not perfect!).
 - Low frequency variability appears to be partly externally forced



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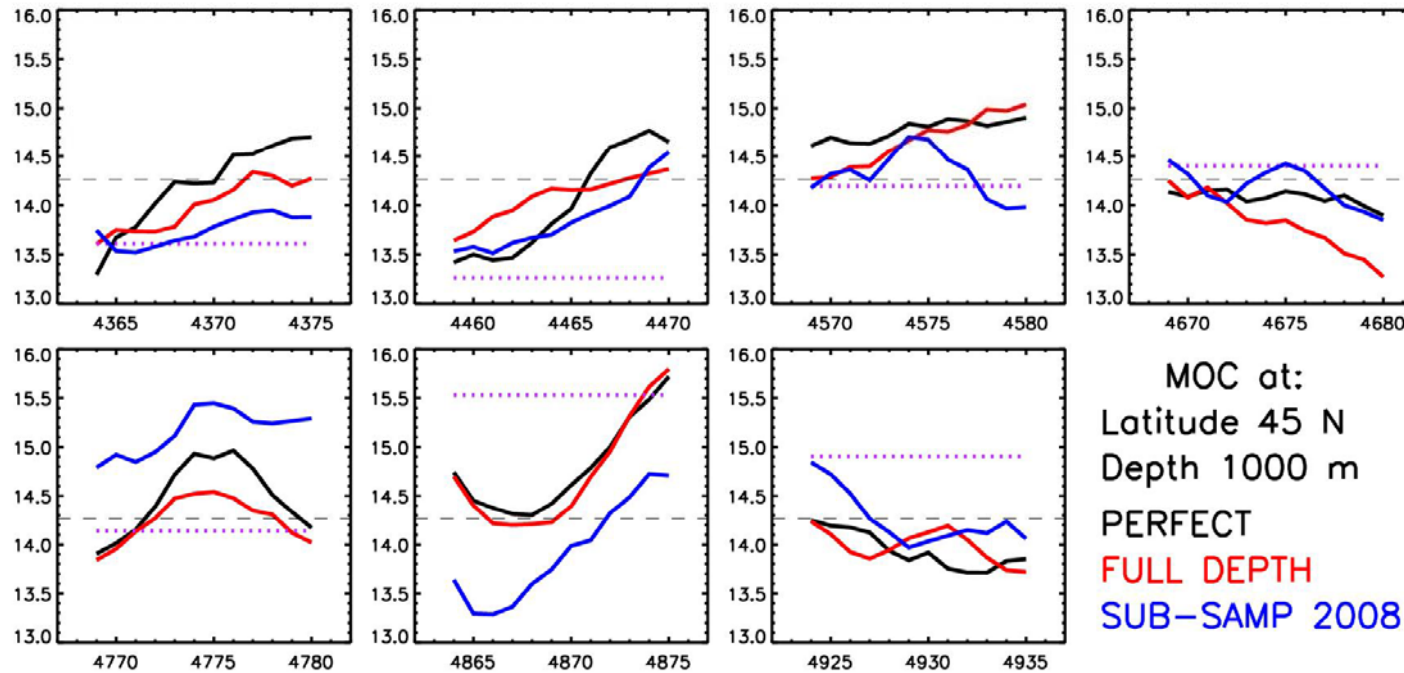


Any questions?



15 year predictions of MOC variability

(FIVE YEAR SMOOTHED)



- Sub-sampled 2008 obs generally show correct MOC variability however biases appear to be present.