Coupled initialisation at the Hadley Centre

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Contents

This presentation covers the following areas

- Assessment of forecast from 2005
- 30 year forecasts from 2007
- Reanalysis of historical ocean observations
  - Will hindcasts from 1960 and 1980 be any good?

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Decadal Prediction System (DePreSys)

- Global coupled climate model (HadCM3)
- Include changes in greenhouse gases and sulphate aerosols (SRES B2 scenario – intermediate changes)
- Repeat previous 11-year solar cycle in forecasts
- Decay volcanic aerosol from the start of a forecast
- Include initial condition information to predict natural internal variability
  - ➢Atmospheric winds, temperature and surface pressure
  - ➢Ocean temperature and salinity
- Assimilate as anomalies to avoid model drift

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Global annual mean surface T

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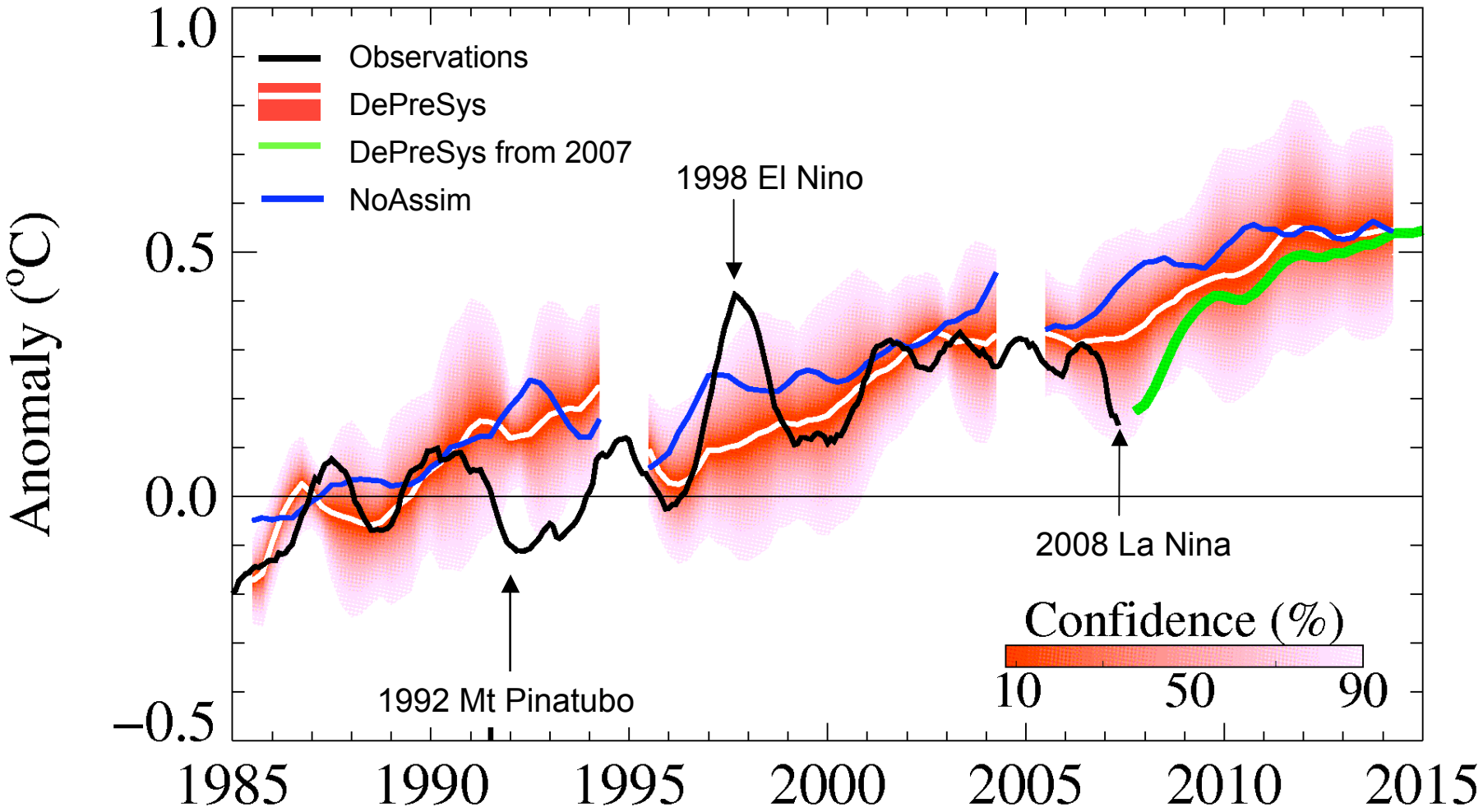
2014 predicted to be 0.3ºC warmer than 2004
Half of years from 2009-2014 predicted to be hotter than 1998



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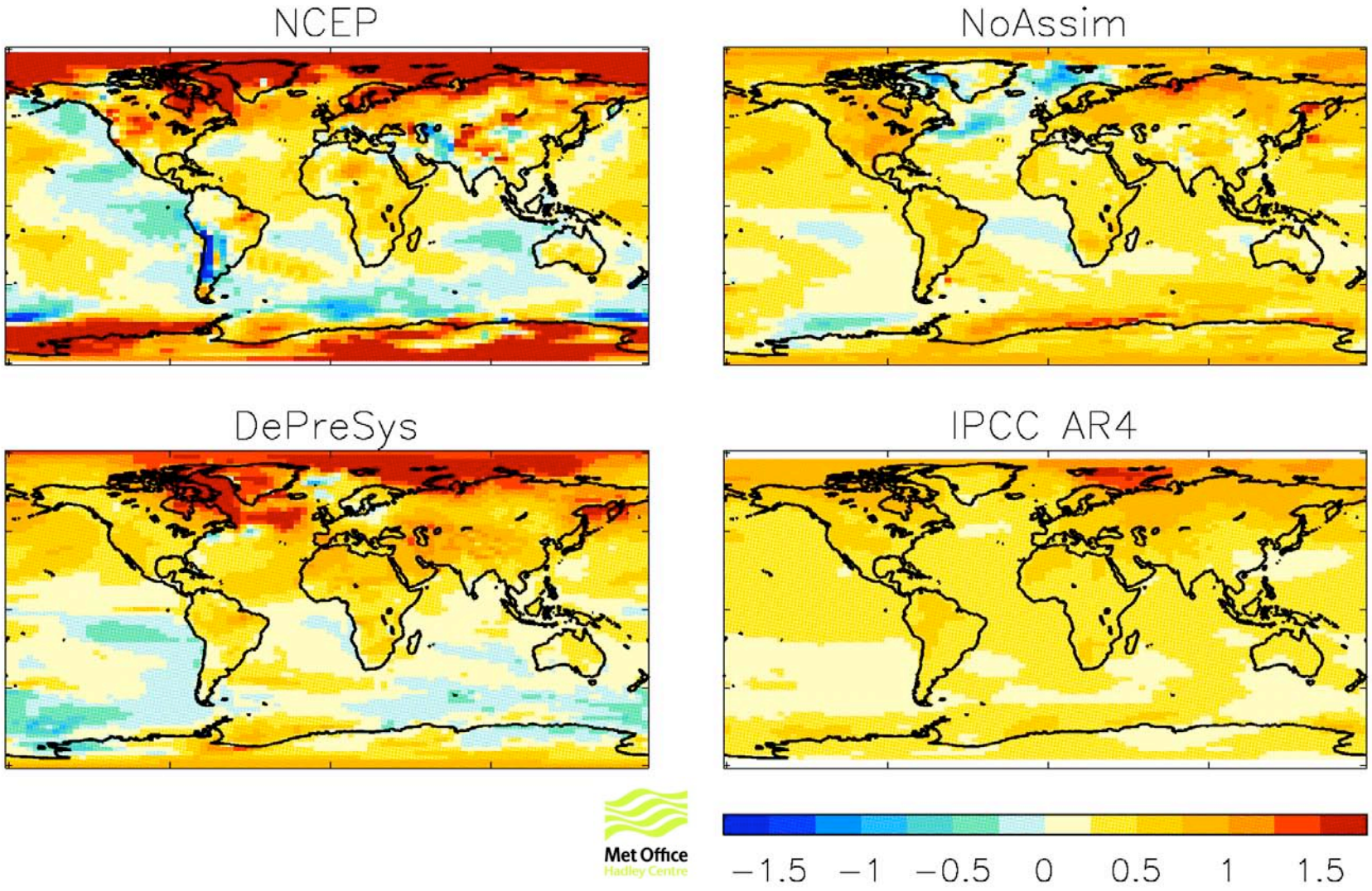
Assessment of forecast from June 2005

Temperature anomalies (wrt 1979-2001) for the period June 2005 to Feb 2008



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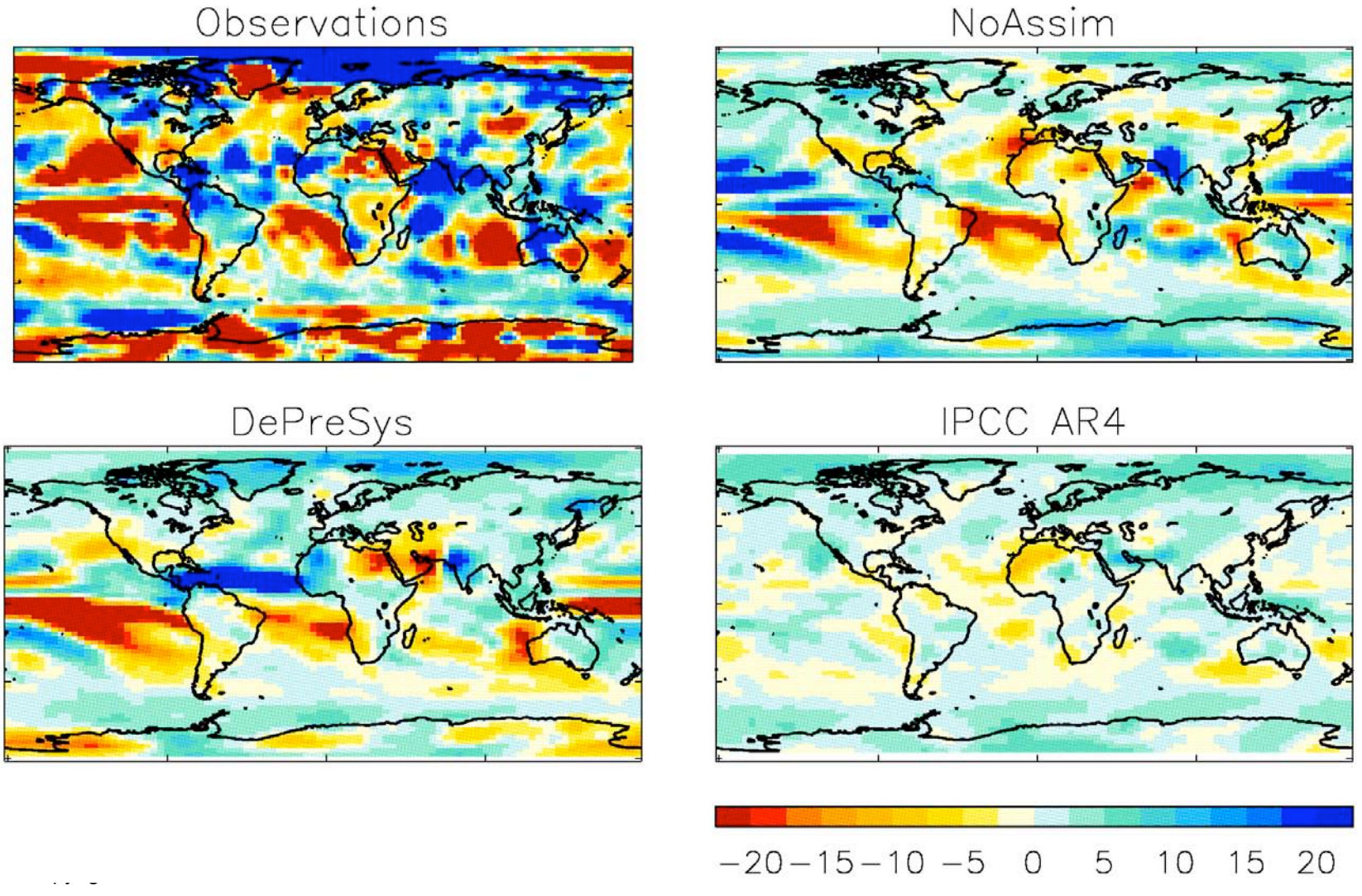
First 2 years of forecast from June 2005: Precip anoms (% of 1979-2001 mean)

Met Office
Hadley Centre



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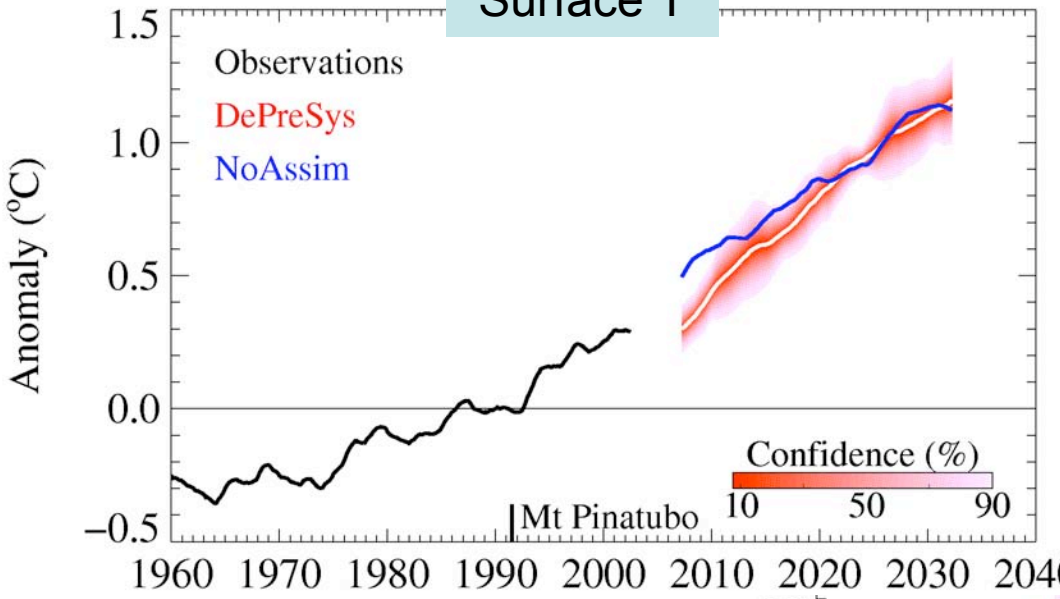
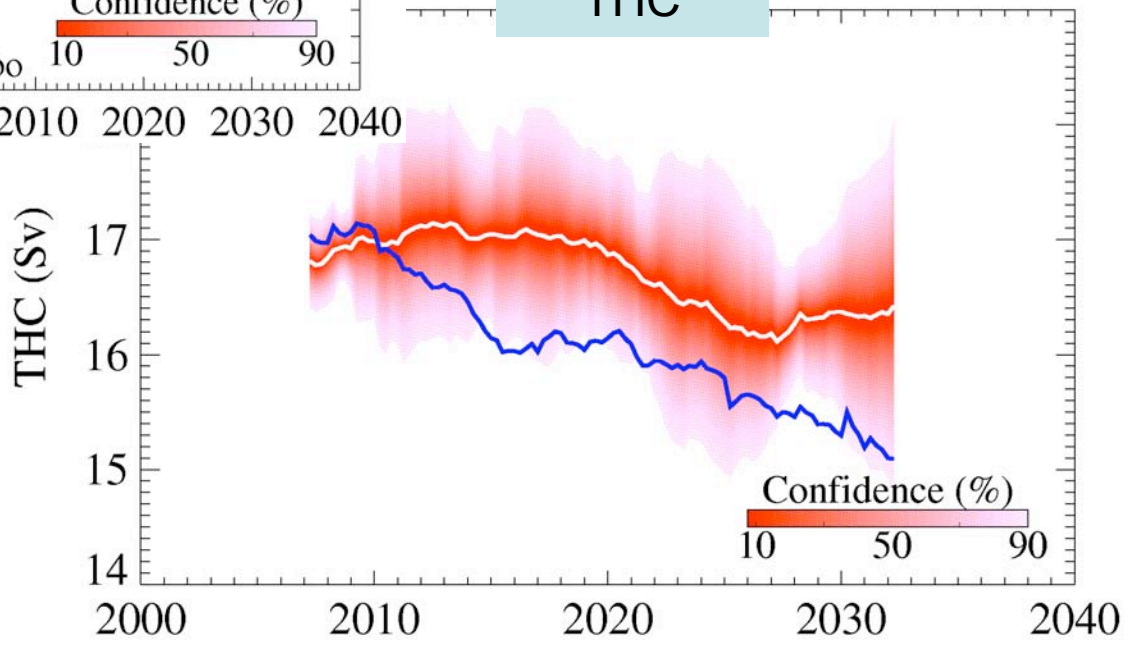
30 year forecasts from Mar 2007

Met Office

Surface T



THC



- 5-year means
- 10 members DePreSys
- 4 members NoAssim

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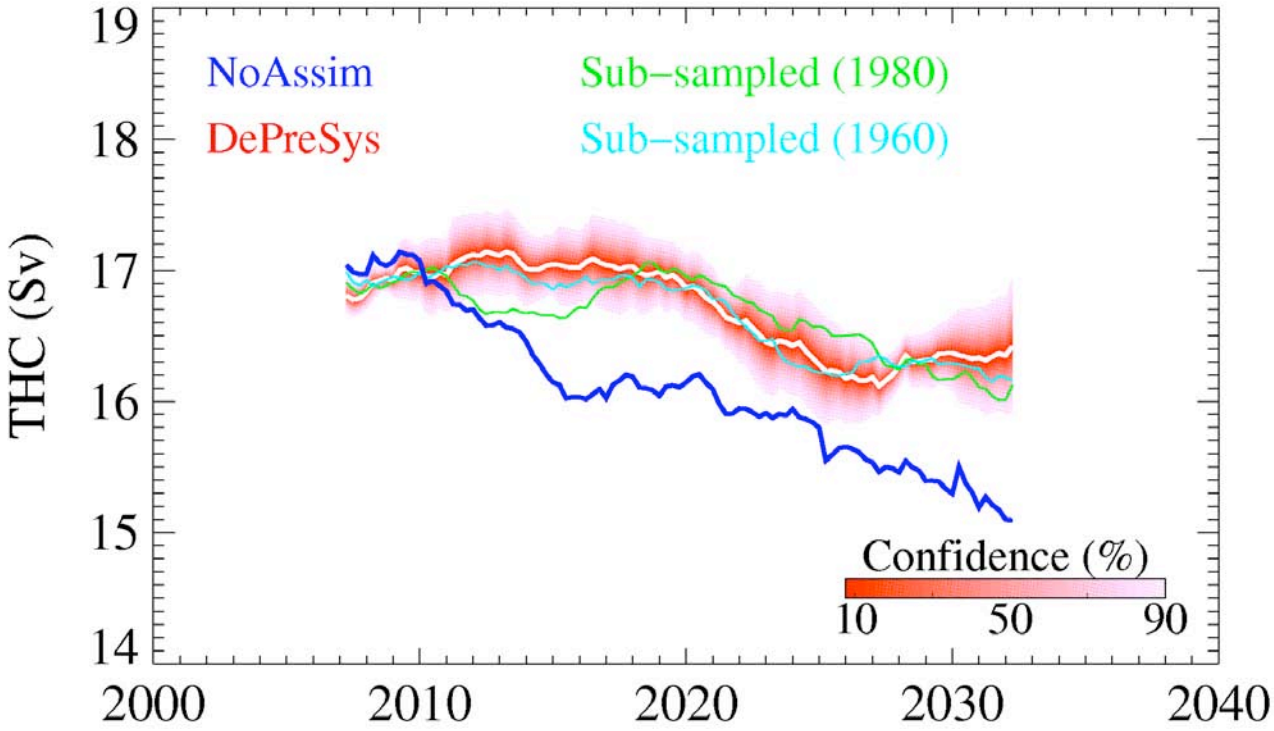
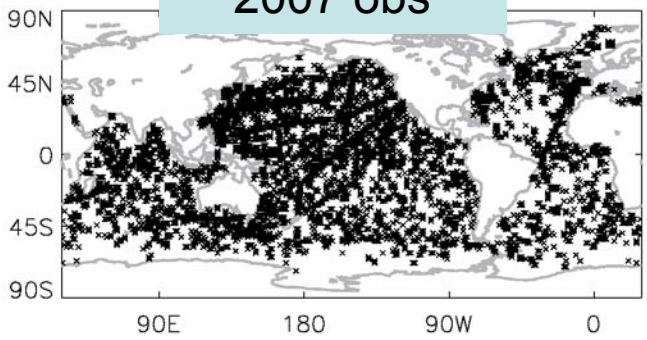
Impact of ocean observations on 30 forecast

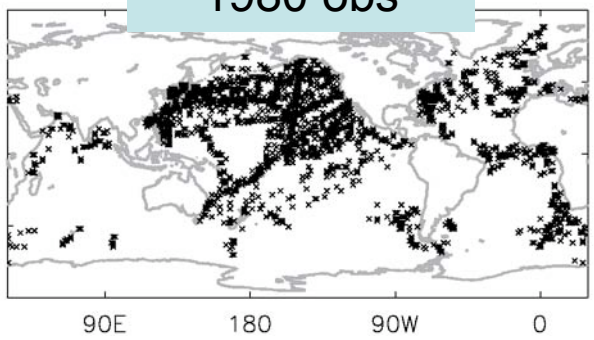
- Forecast from March 2007
- Sub-sampled = with 1980s or 1960s obs
- 5-year running means
- Shading = confidence of ensemble mean
- 10 members DePreSys and sub-sampled, 4 members NoAssim
- Max overturning at 30N



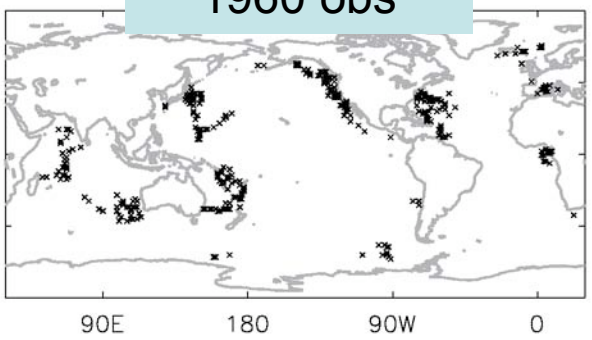
2007 obs



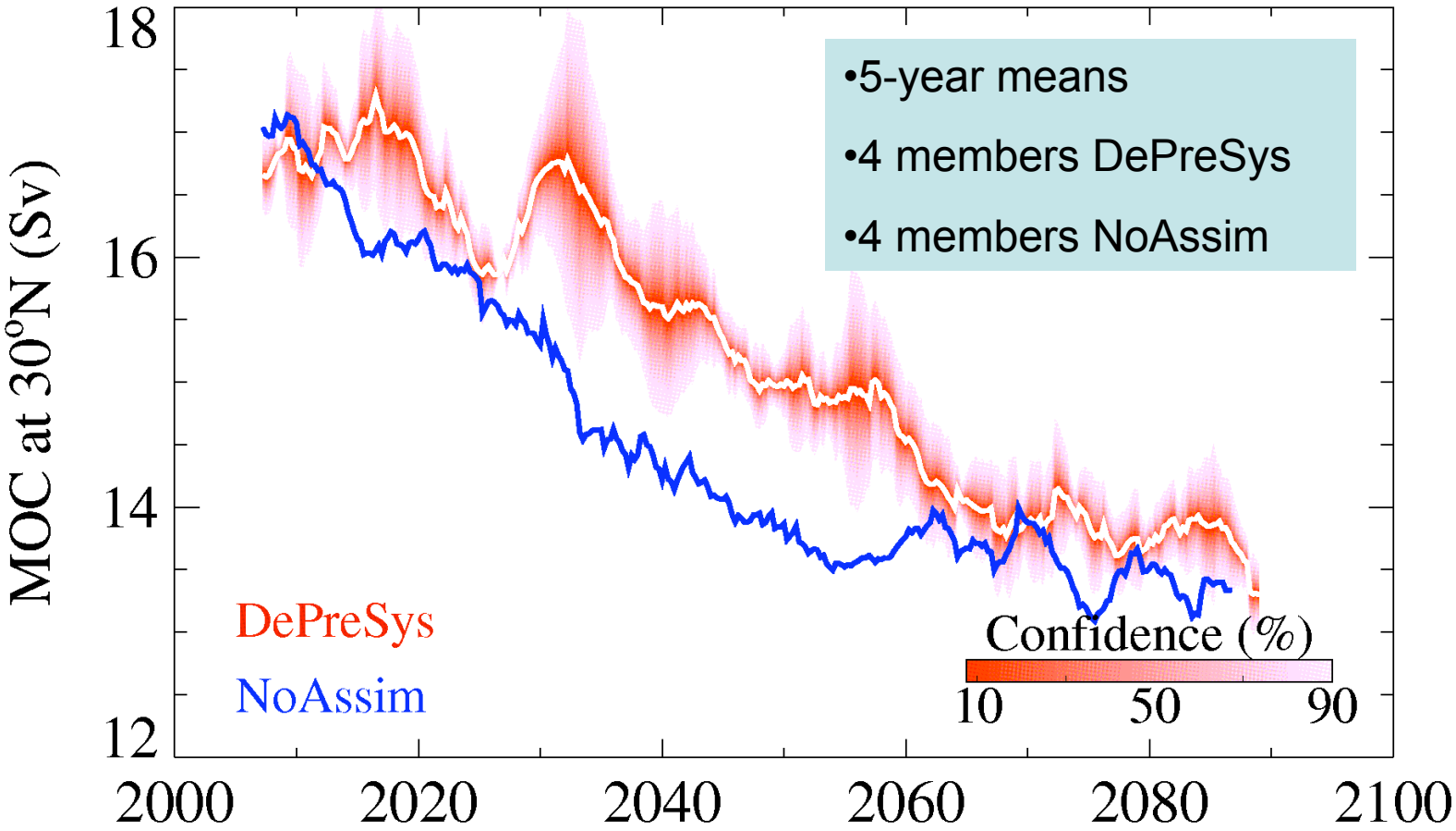
1980 obs



1960 obs



Forecast from March 2007



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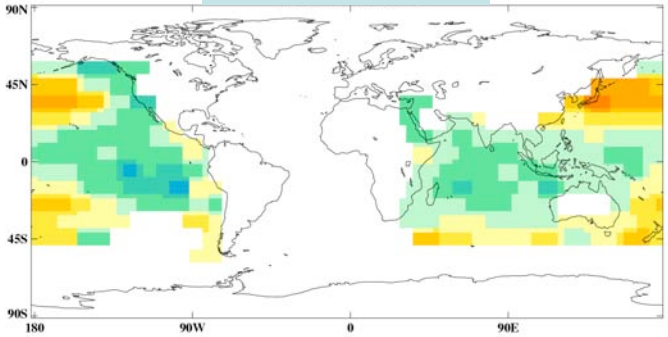
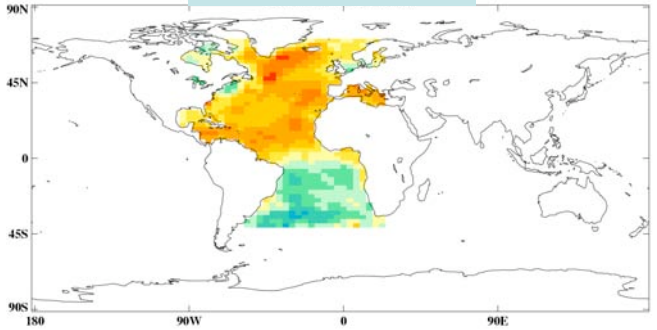
Impact of initial conditions on PDO and AMO

PDO

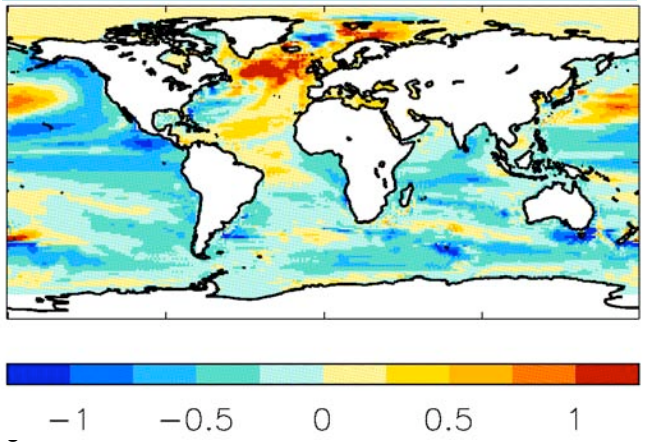


AMO

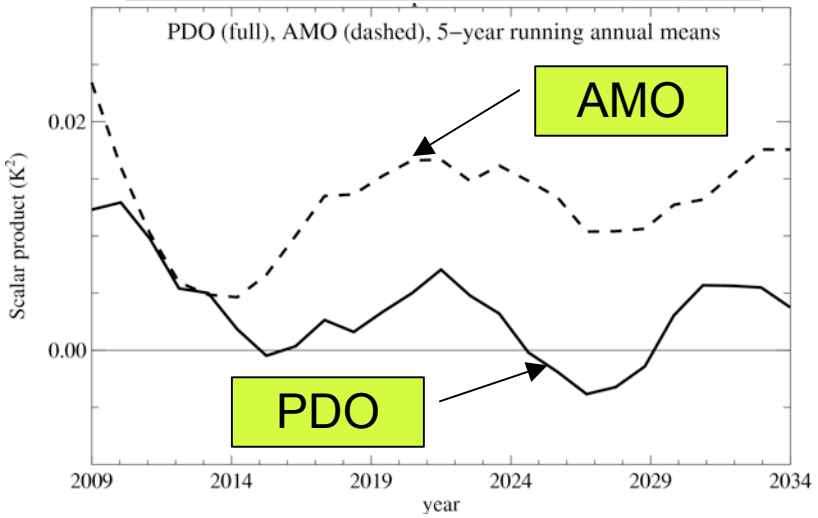


DePreSys – NoAssim

110m ocean T, 2007-12



DePreSys – NoAssim



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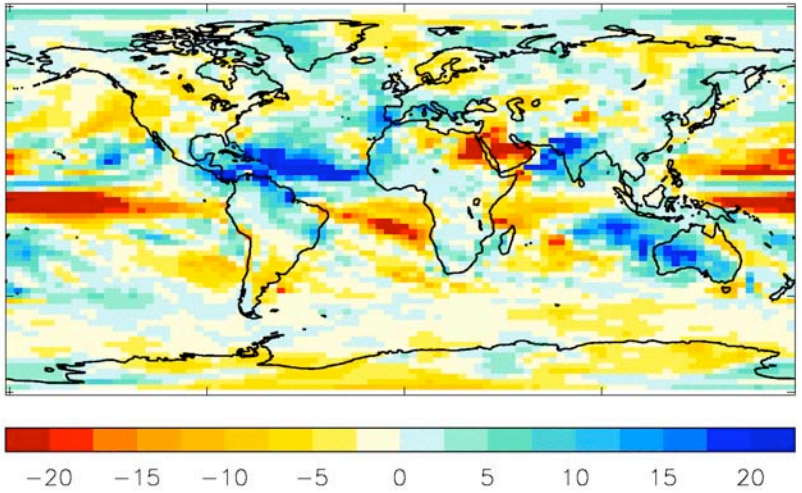
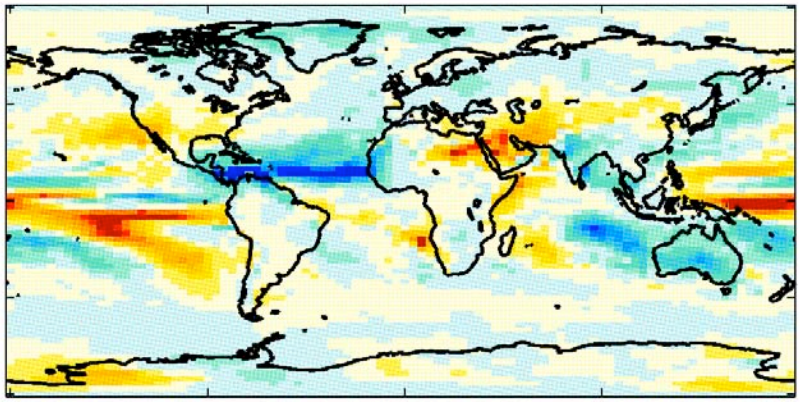
Precip reconstruction from PDO and AMO : 2007-2017

DePreSys – NoAssim Precip

2007-2017 (% of 1979-2001 mean)



Reconstructed from PDO and AMO multiple regression



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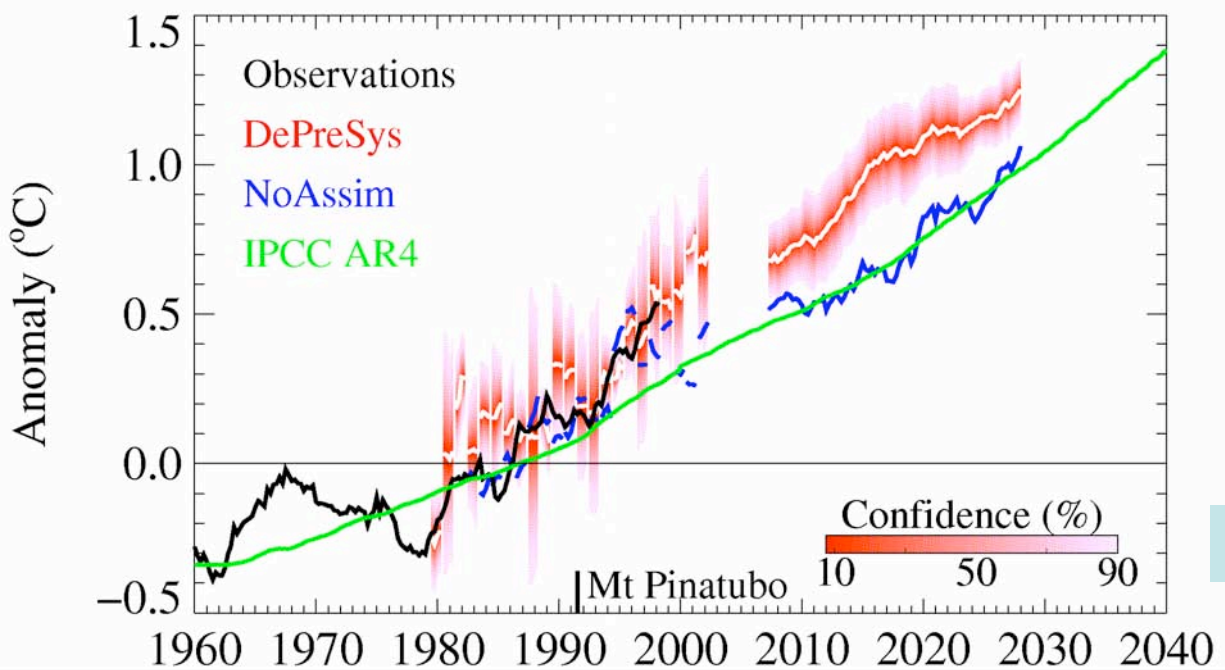
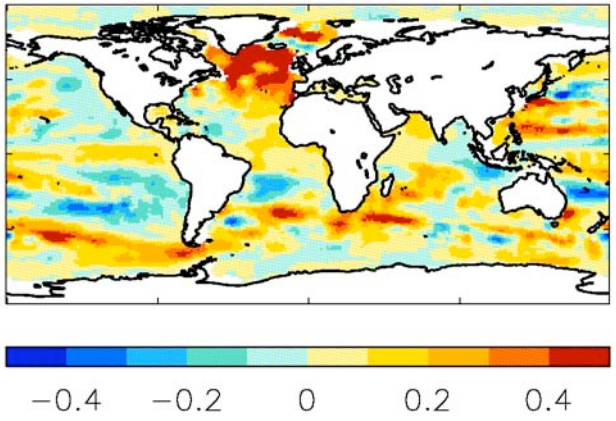
30 year forecasts from Mar 2007: UK 9-year mean T

UK 9-year mean T



360m ocean T, March 2007



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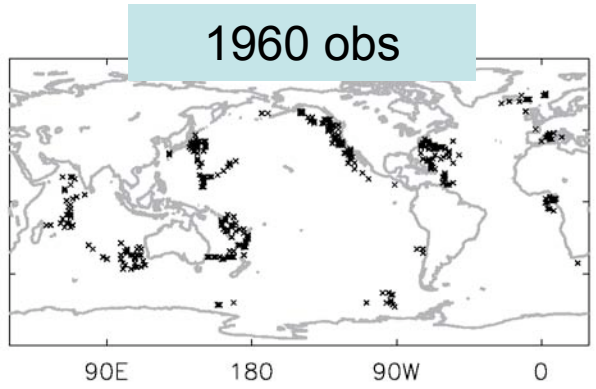
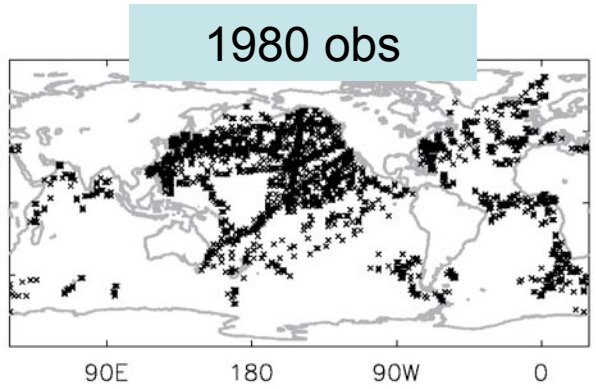
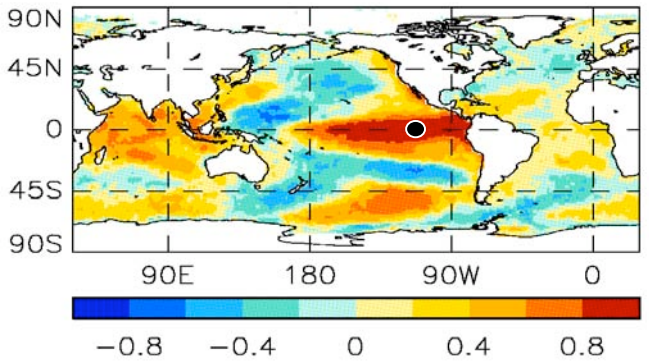
Analysis of historical ocean data

- Need hindcasts to assess likely skill of forecasts
- Problem with very sparse subsurface ocean observations
- Can we use optimal interpolation to reanalyse historical ocean data?







Correlation of SST anomalies with SST at 120^{0}W on the Equator (HadISST, January)

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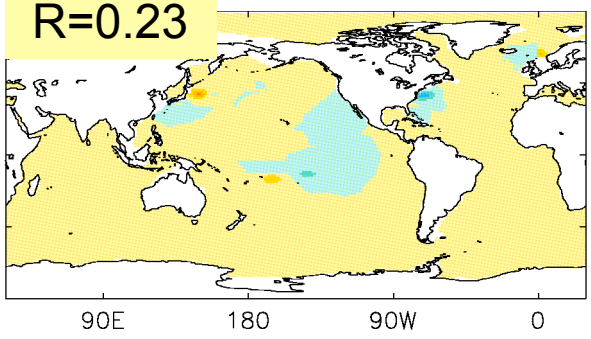
Reconstructed model temperature at 300m from Jan 1953 obs locations

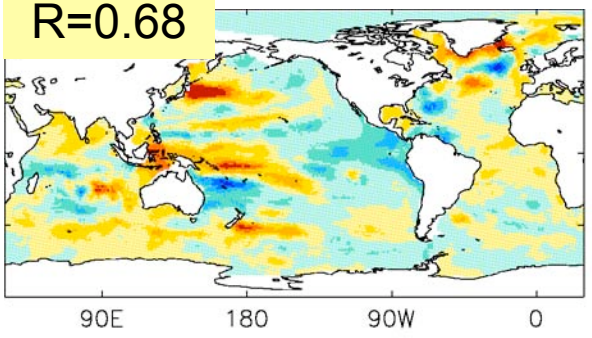
Parameterised covariances

R=0.23

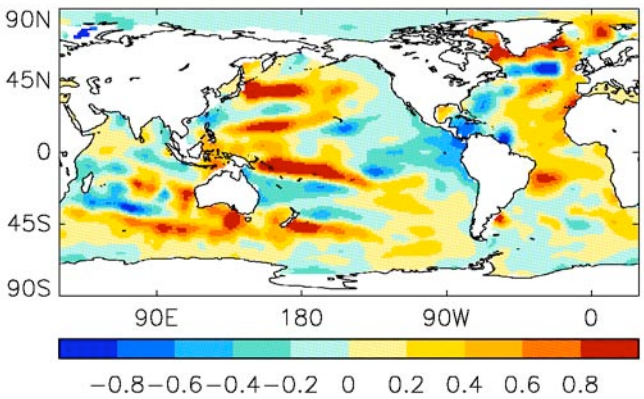


Actual covariances

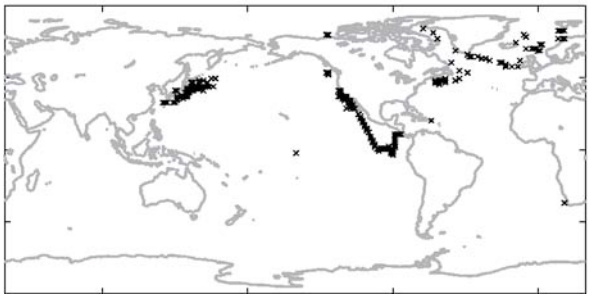
R=0.68



Truth



Observations: Jan 1953



If covariances are known, very accurate re-analysis of historical sub-surface temperature and salinity appears to be possible

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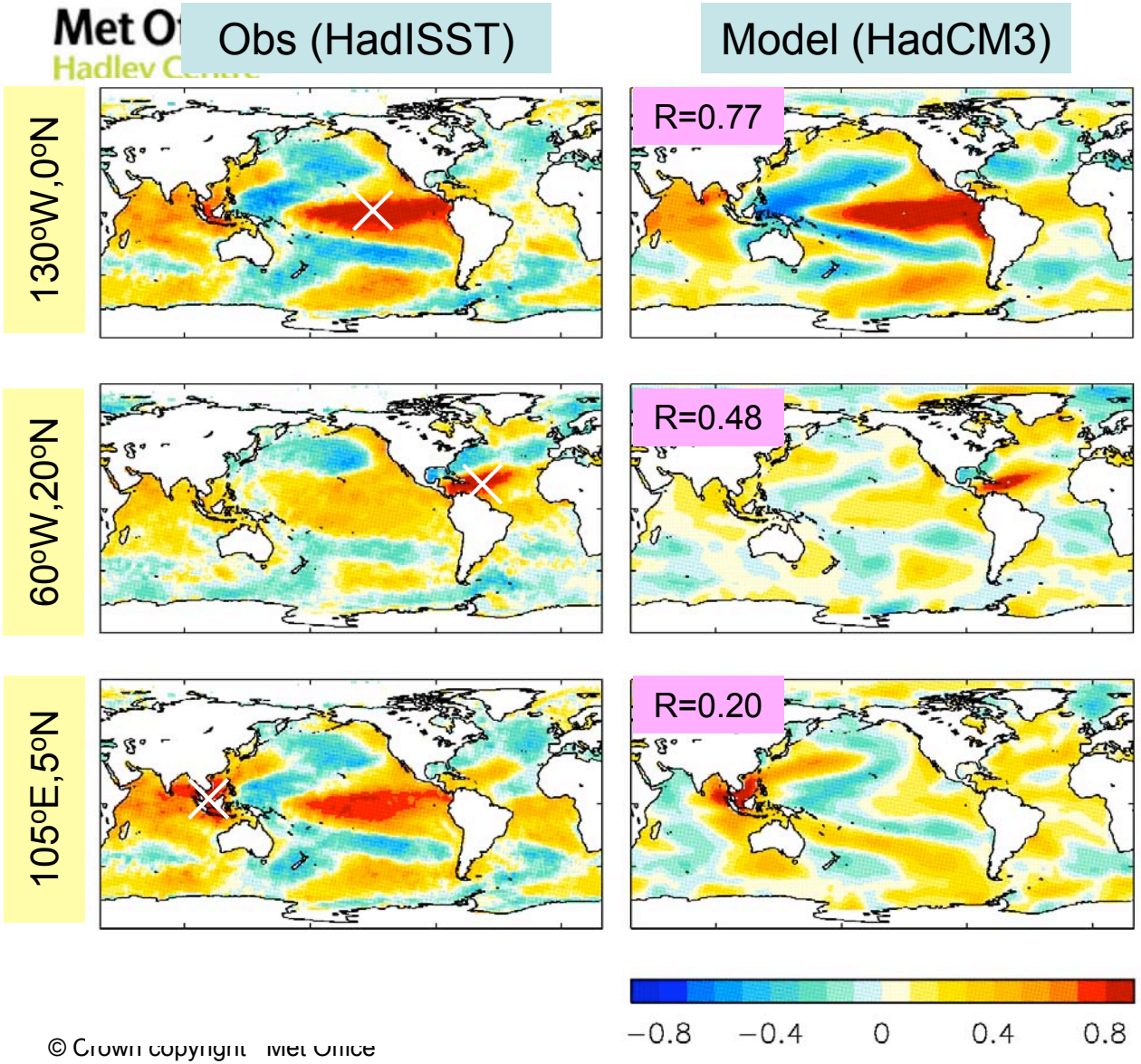
SST anomaly correlations: HadCM3



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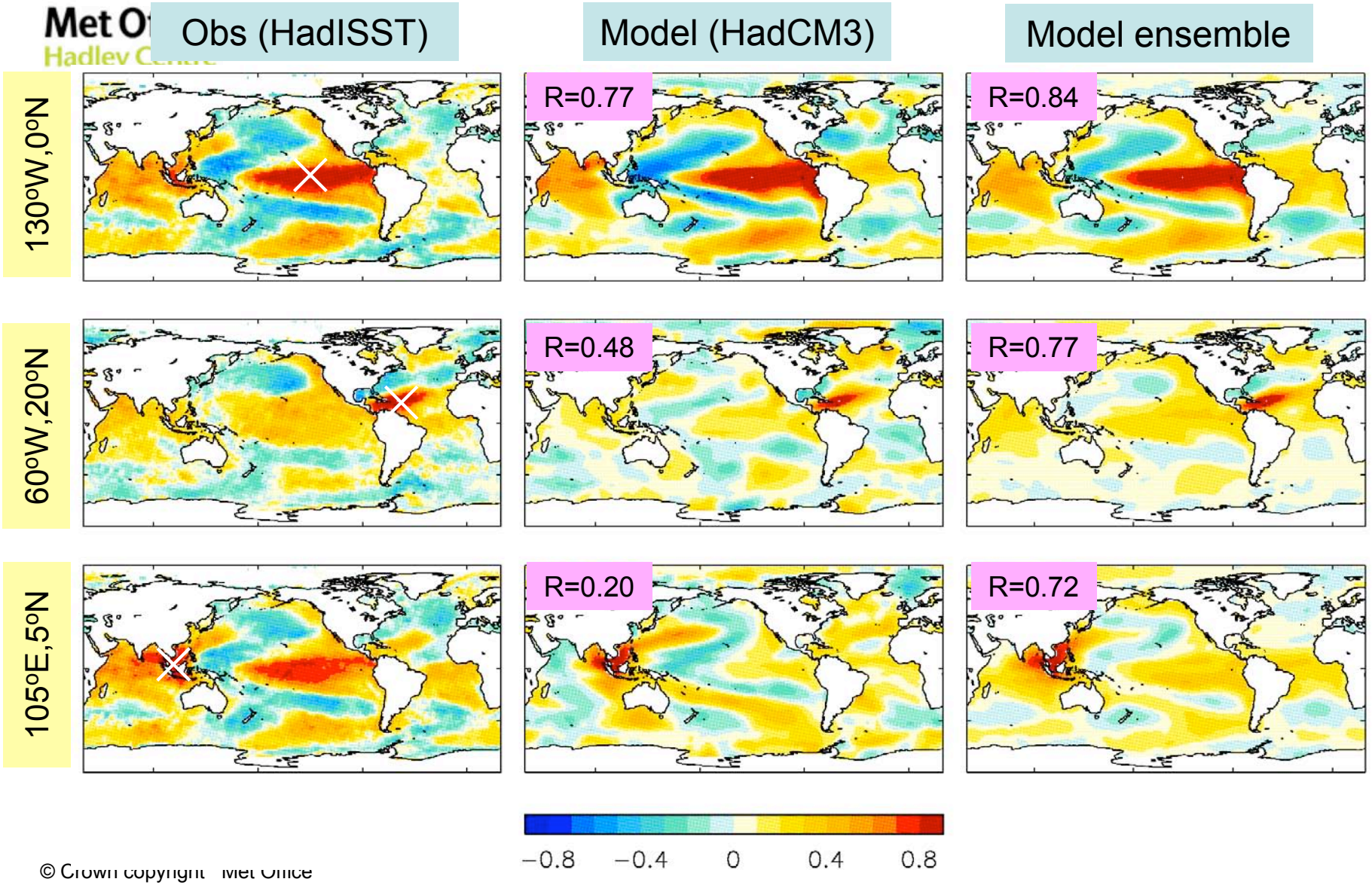
SST anomaly correlations: model ensemble



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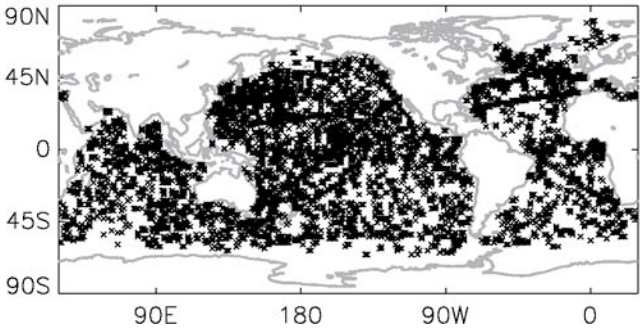
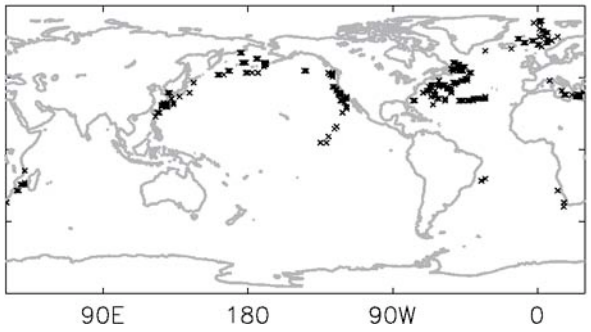
Temperature at 300m : June 2007 from 1960 obs

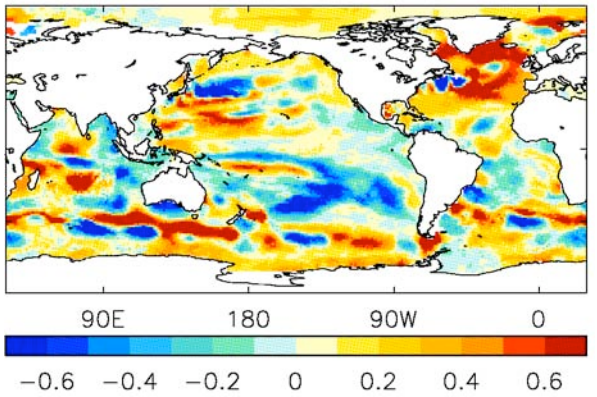
June 2007



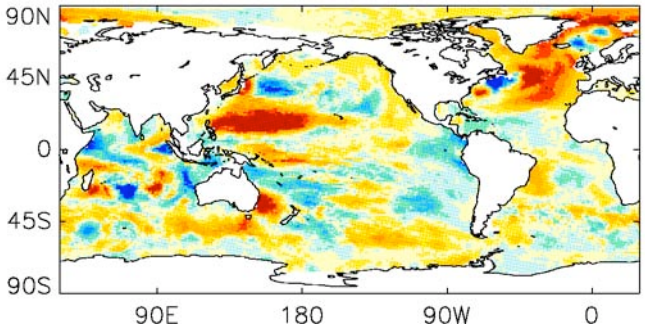
June 1960



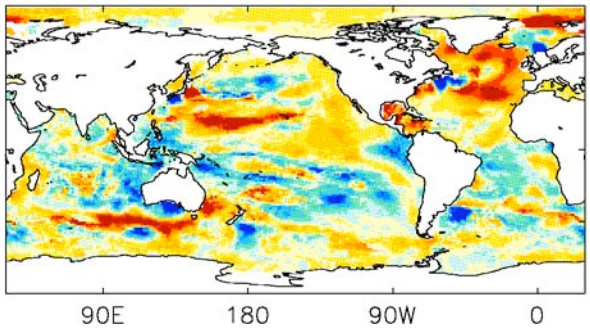
All obs



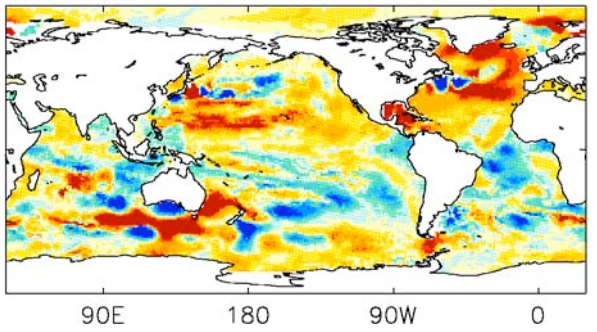
HadCM3 covariances



Iter01



Iter03



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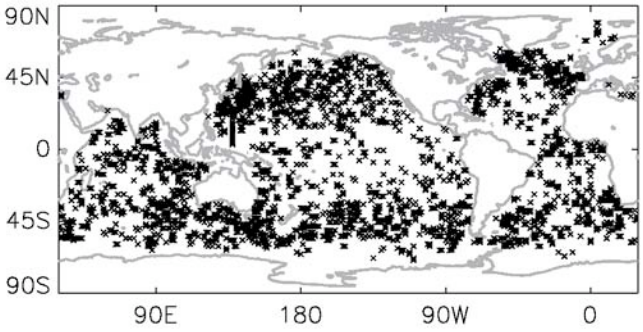
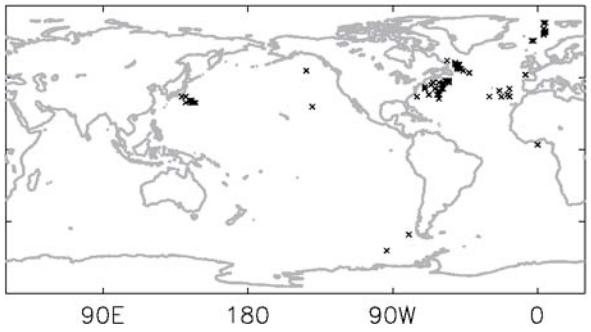
Salinity at 1500m : June 2007 from 1960 obs

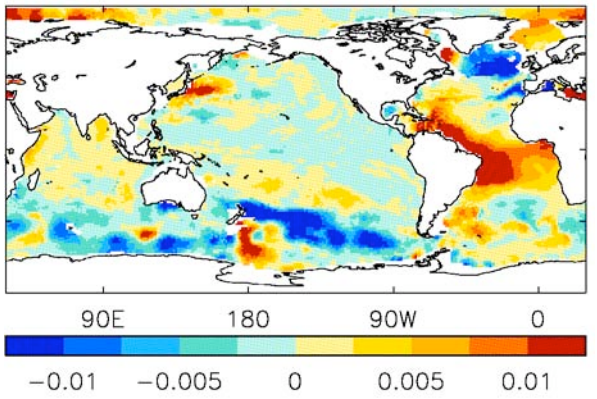
June 2007



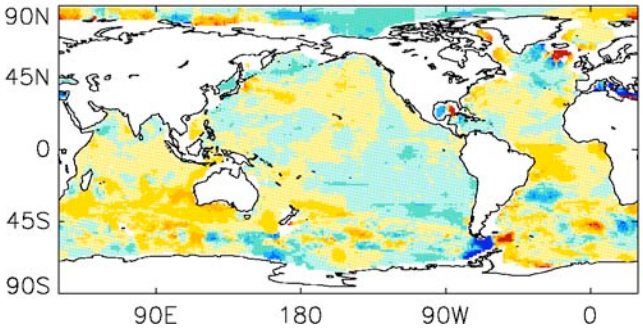
June 1960



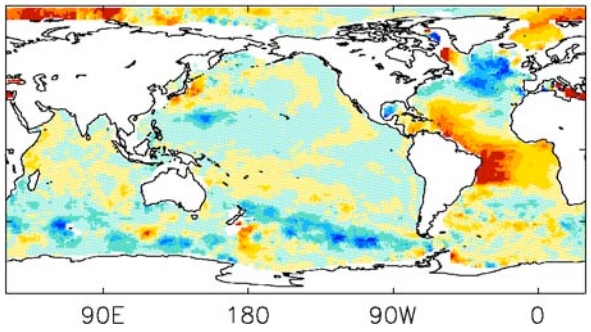
All obs



HadCM3 covariances



Iter01



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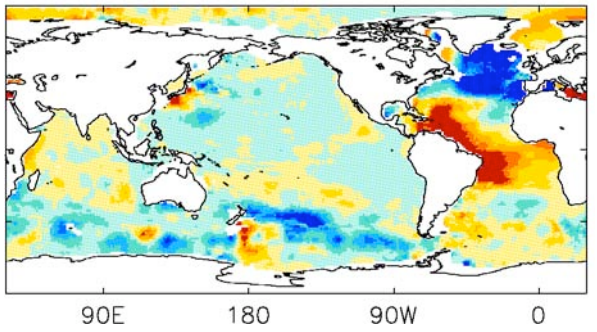

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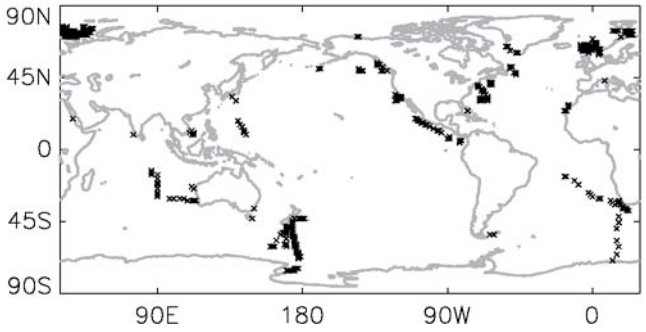
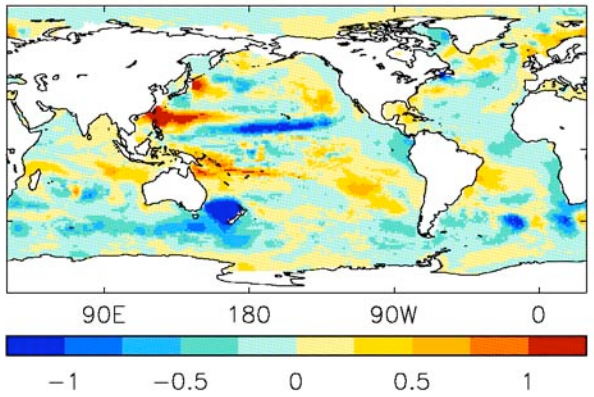
Iterative analysis: Jan 1960 temperature at 200m

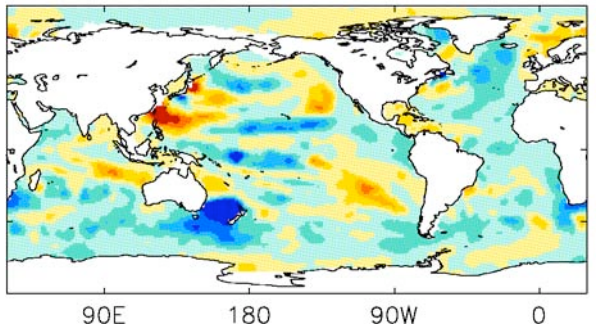
Observations



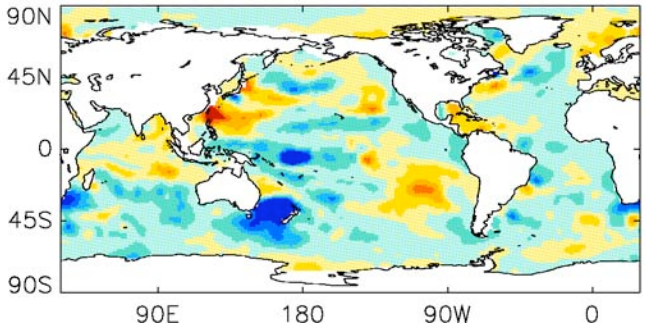
HadCM3 covariances



Iter01



Iter02



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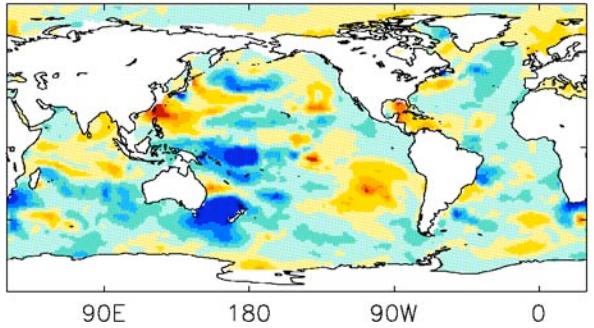

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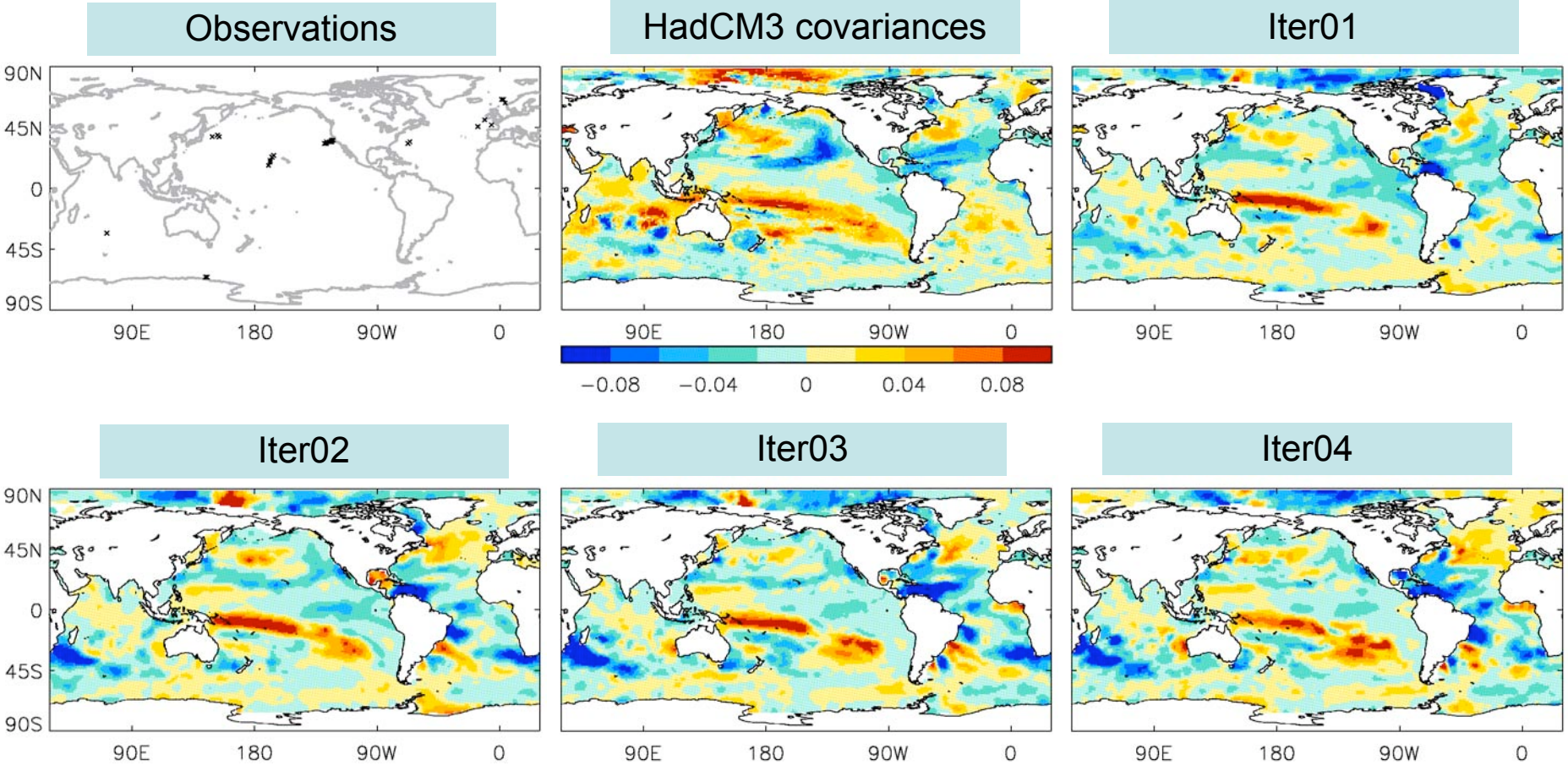
Iterative analysis: Jan 1950 salinity at 300m



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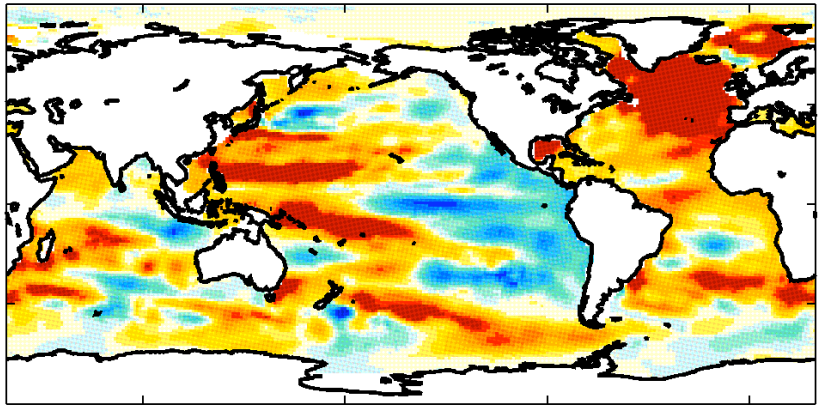
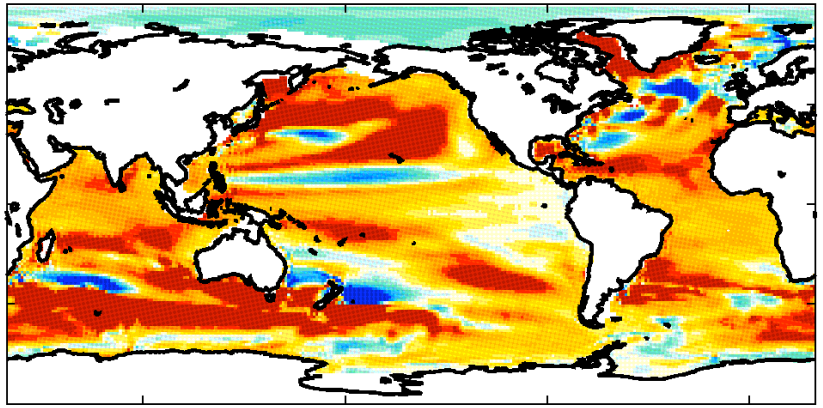
Forecast from June 2005 : First 2.75 years : upper 360m ocean T

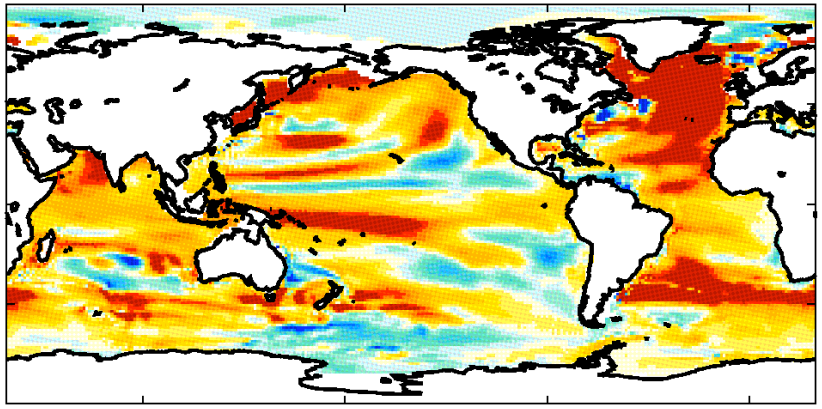
Observed

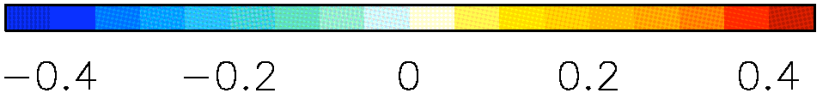


NoAssim (R=0.01)



DePreSys (R=0.48)





- June 2005 to Feb 2008
- 10 members DePreSys
- 4 members NoAssim

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Hindcast from Nov 1975 : First 2.75 years : upper 360m ocean T

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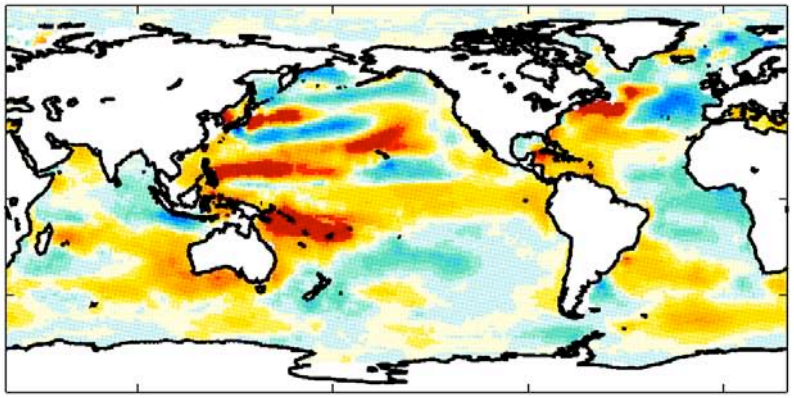
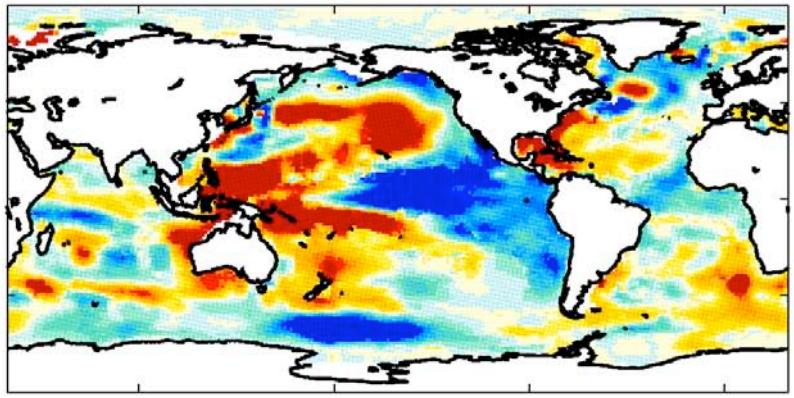
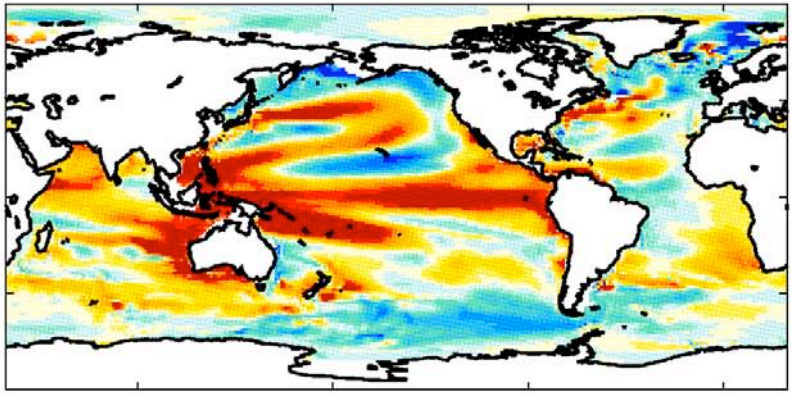
Observed

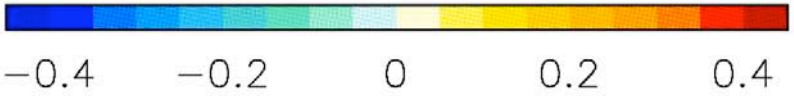


Persistence (R=0.38)



DePreSys (R=0.47)





- Dec 1975 to Aug 1978
- 10 members DePreSys
- Persistence of JJA 1975

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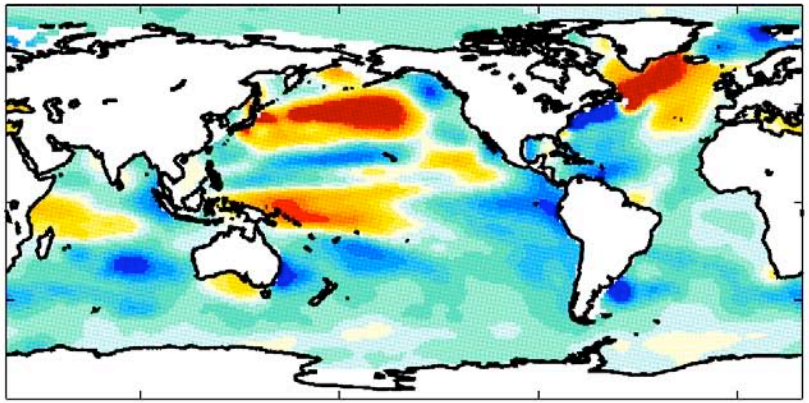
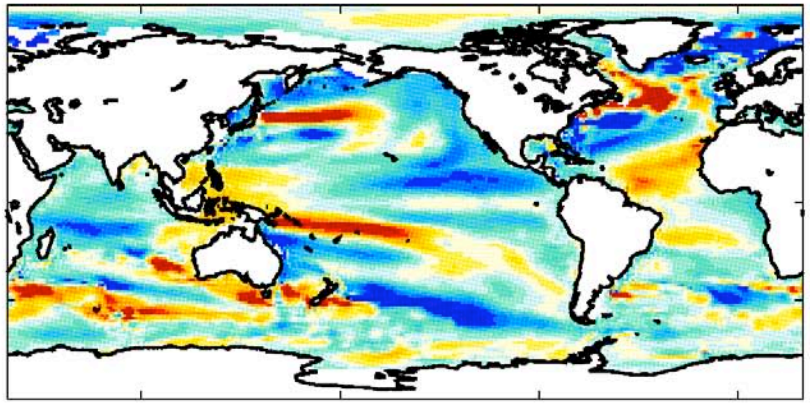
Hindcast from Nov 1965 : First 2.75 years : upper 360m ocean T

Met Office
Hadley Centre

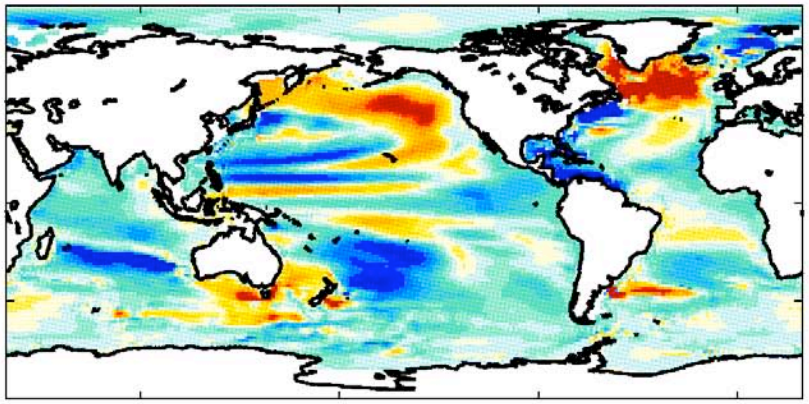
Observed

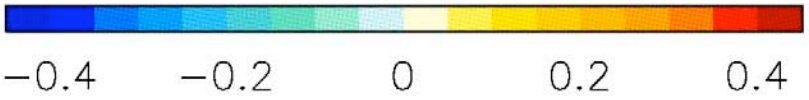


NoAssim (R=0.17)



DePreSys (R=0.43)





- Dec 1965 to Aug 1968
- 10 members DePreSys
- 4 members NoAssim

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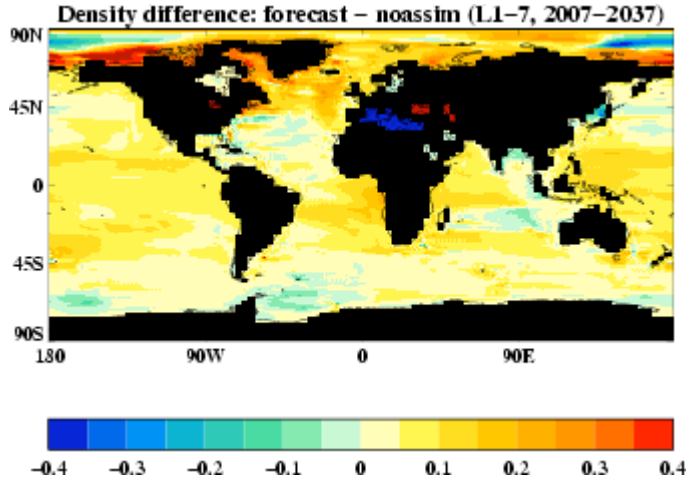
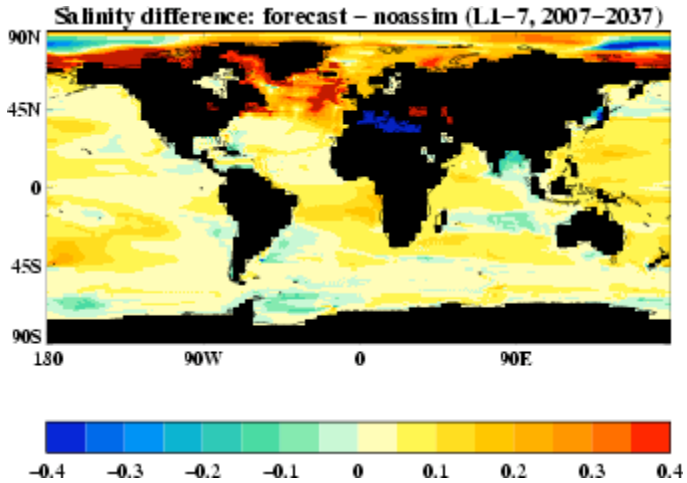
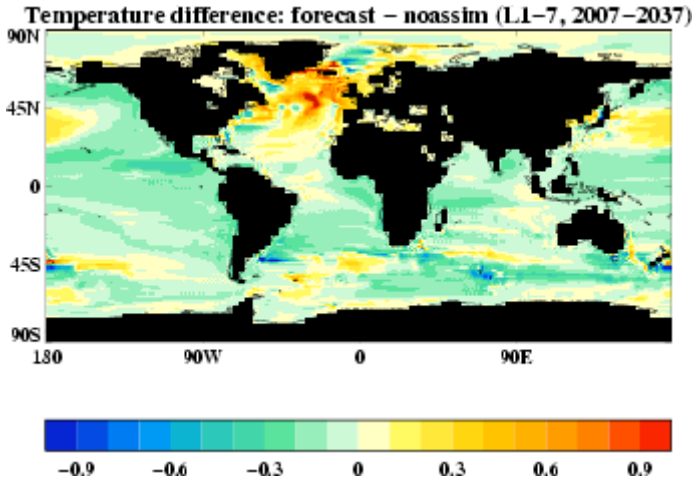
Salinity initialisation likely to be important in explaining maintenance of MOC in DePreSys 30 year forecast







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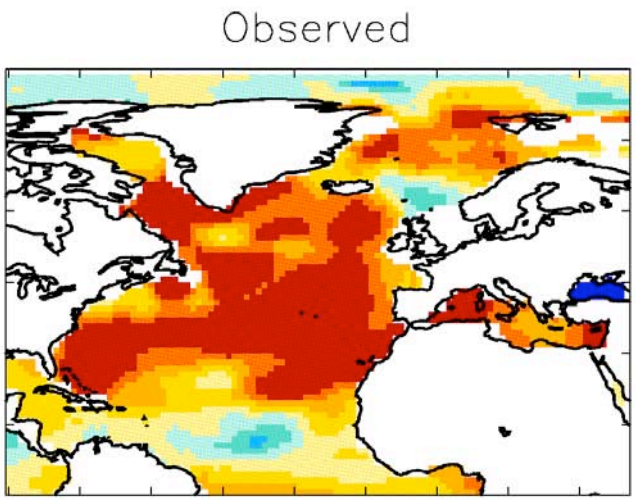
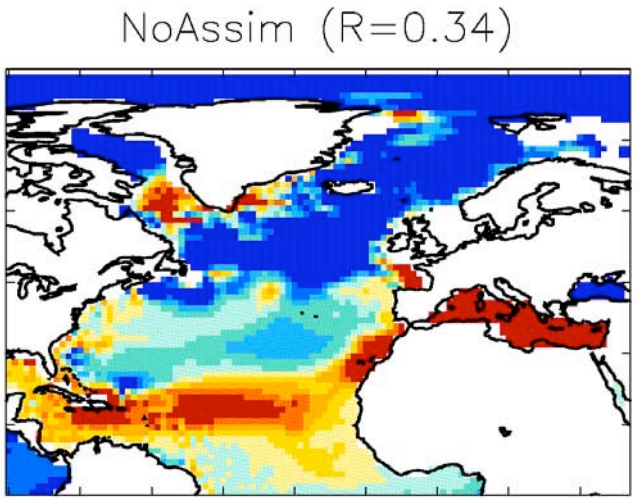
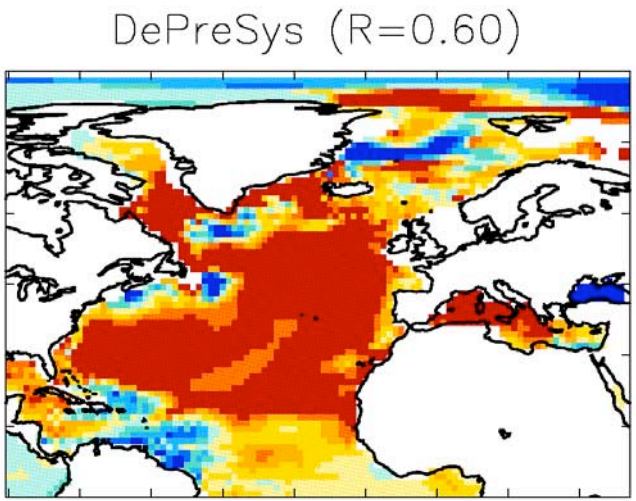
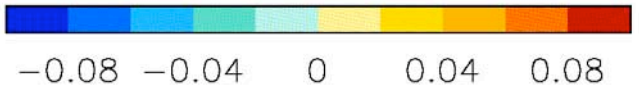
Forecast from June 2005 : First 2.75 years : upper 360m ocean S









- June 2005 to Feb 2008
- 10 members DePreSys
- 4 members NoAssim

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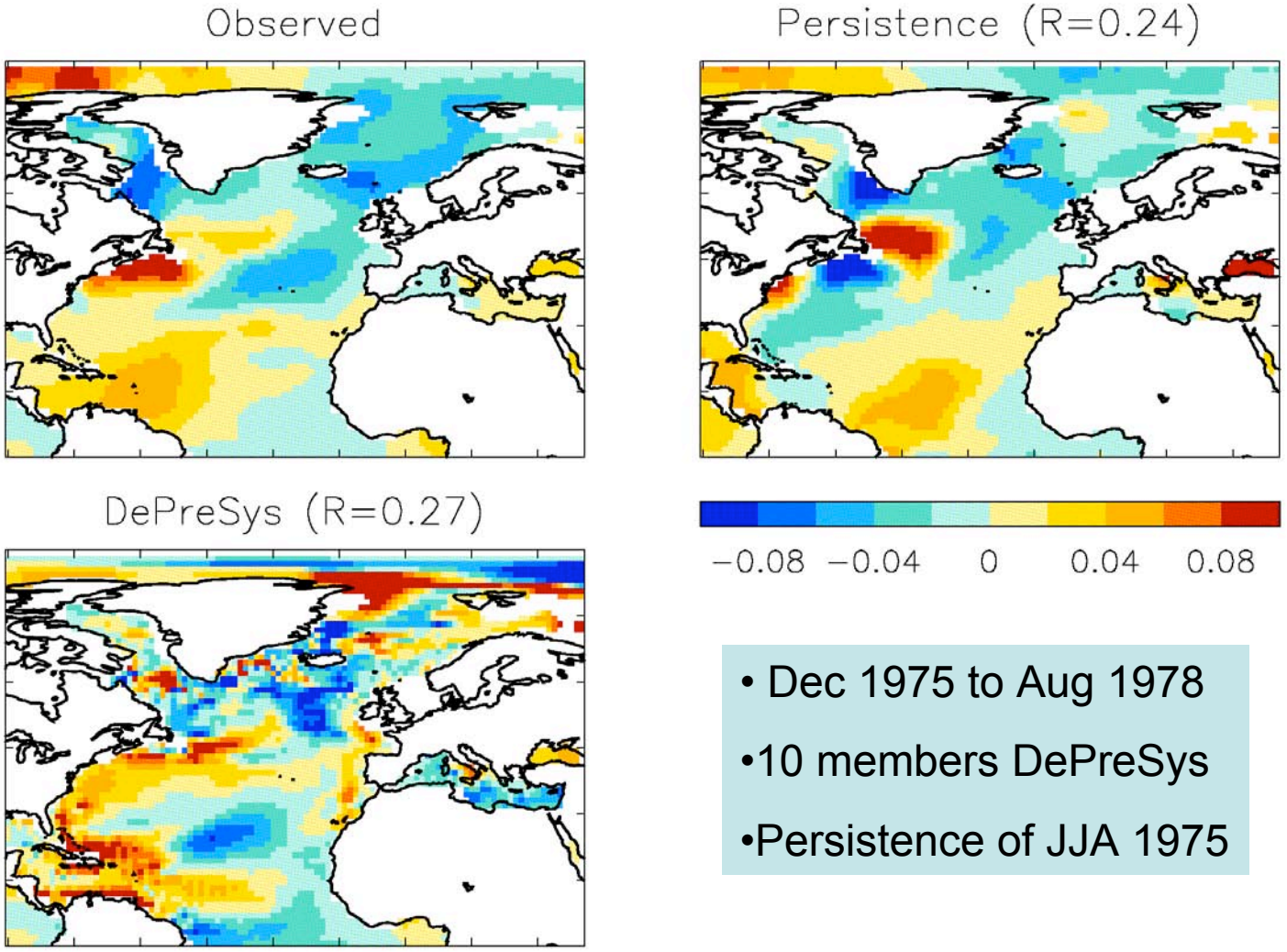
Hindcast from Nov 1975 : First 2.75 years : upper 360m ocean S



- Dec 1975 to Aug 1978
- 10 members DePreSys
- Persistence of JJA 1975

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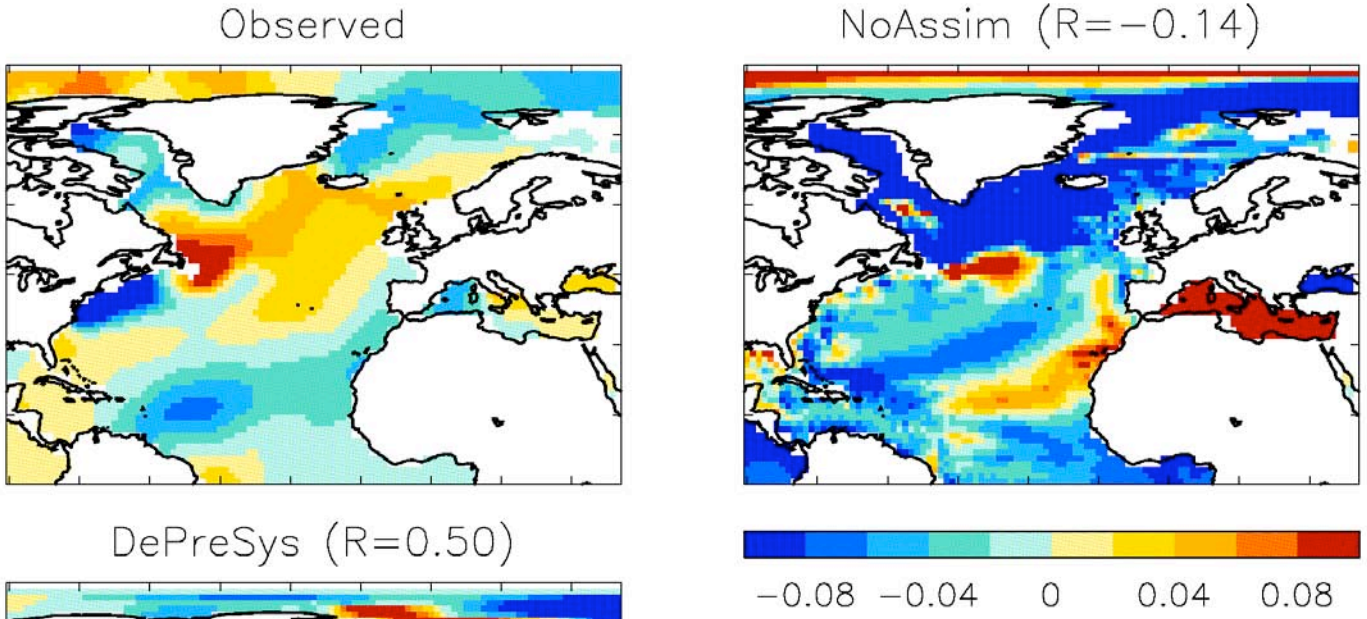
Hindcast from Nov 1965 : First 2.75 years : upper 360m ocean S



- Dec 1965 to Aug 1968
- 10 members DePreSys
- 4 members NoAssim

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Summary

- Forecast from 2005 ok so far
- AMO and PDO both have large signals now
  - Important to initialise models for forecasts
- Impact of initial conditions on THC for coming 60 years
  - Salinity in northern north Atlantic
- Need hindcasts to assess confidence
  - Promising reanalysis of historical ocean obs
- Hindcasts from 1965 and 1975 comparable skill to 2005 for first 2.75 years, but further analysis needed

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Questions and answers

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