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Decadal Predictions and the role of the ocean in the mid 1960s cooling of the North Atlantic

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Atlantic Multidecadal Variability (AMV) and its climate impacts

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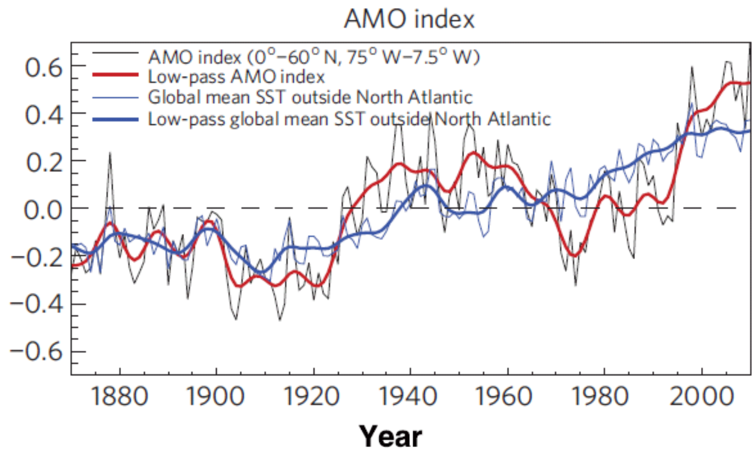
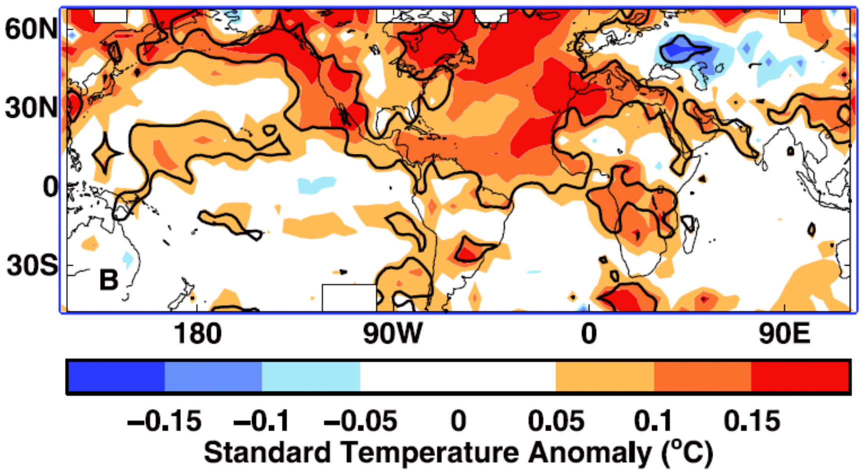
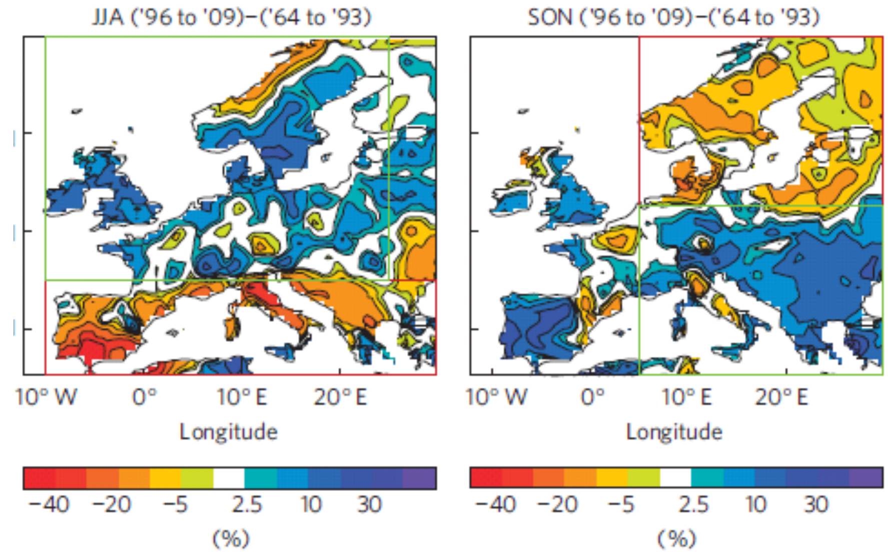




Knight et al, 2005



Sutton and Dong, 2012

Evidence that North Atlantic SSTs can effect the surface climate across The Americas, Europe and Africa

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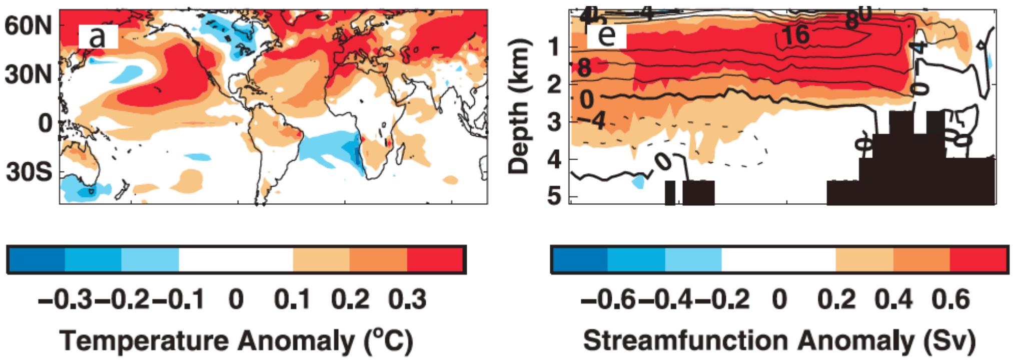
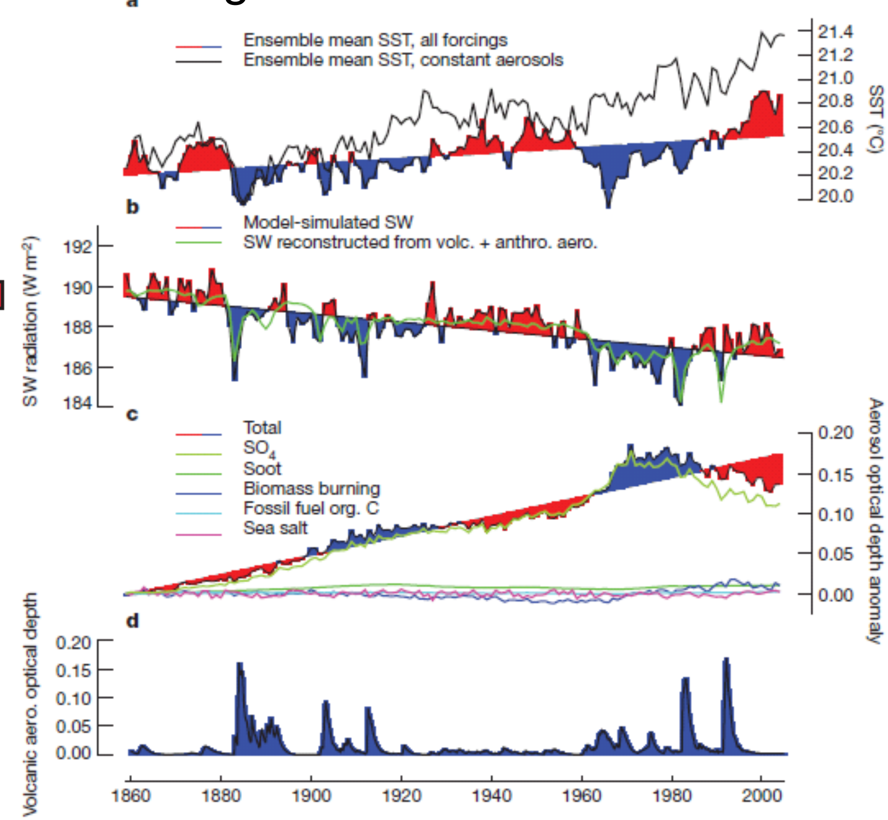
What caused it?

Dynamical Ocean change; i.e. AMOC?



Knight et al, 2005

Surface flux changes due to Forcing? i.e. Aerosols?



Booth et al, 2012

Case studies of decadal prediction

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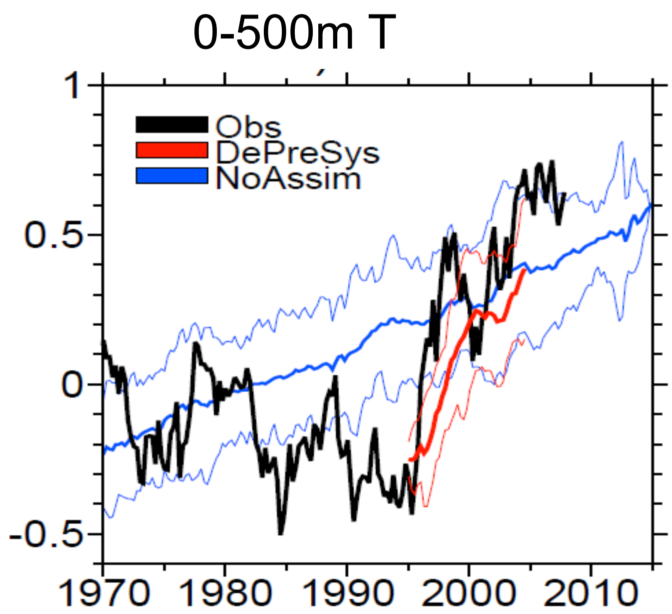

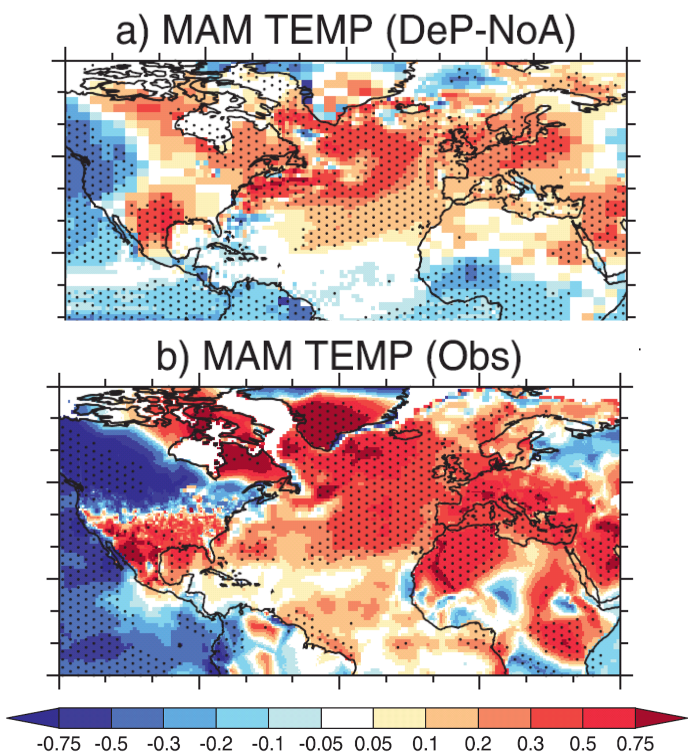

<u>The mid 1990s warming of the subpolar gyre</u>

- Prediction captures the subpolar gyre warming due to the initialisation of a strong AMOC
- Also captures many aspects of surface climate changes

See Poster

Robson et al, 2012, GRL
Robson et al, 2103, J Clim

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Experiments and data

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- We will be looking at predictions made with DePreSys PPE
  - Based on HadCM3 (1.25° Ocean, 3.75 x 2.5° Atmosphere)
  - 9 member perturbed physics ensemble
  - Uses **anomaly assimilation** for 3D ocean T, and S, and atmospheric U,V,T and MSLP
  - Hindcasts initialised every November between 1960-2005
  - Forced with historical anthropogenic, and projected natural forcings
- Comparison ensemble that does not assimilate observed information (NoAssim PPE)
- Compare the predictions with observations
  - Met Office ocean analysis
  - HadISST
  - CRU TS 3.0
  - HadSLP

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Predictions of subpolar 0-500m T and S

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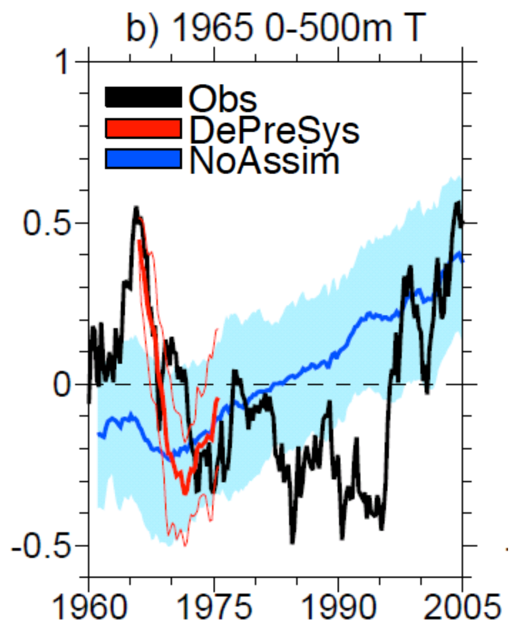

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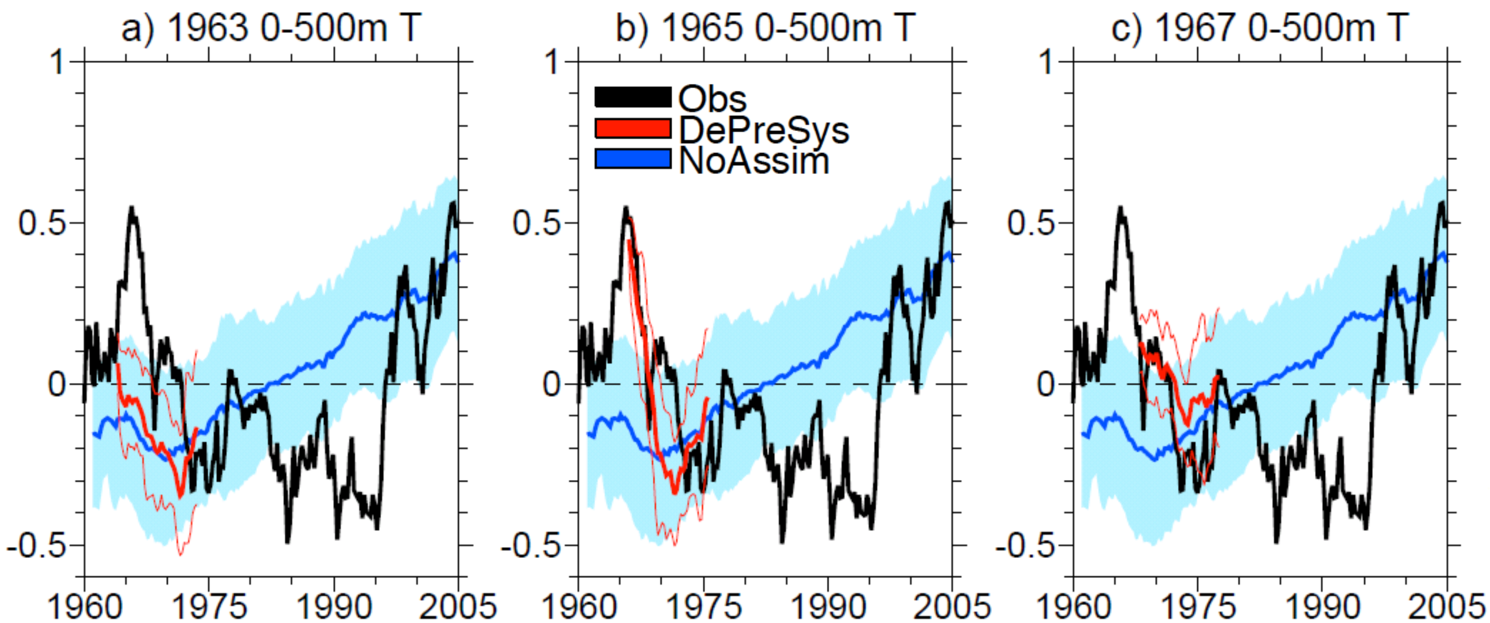
Predictions of subpolar 0-500m T and S



Predictions of subpolar 0-500m T and S

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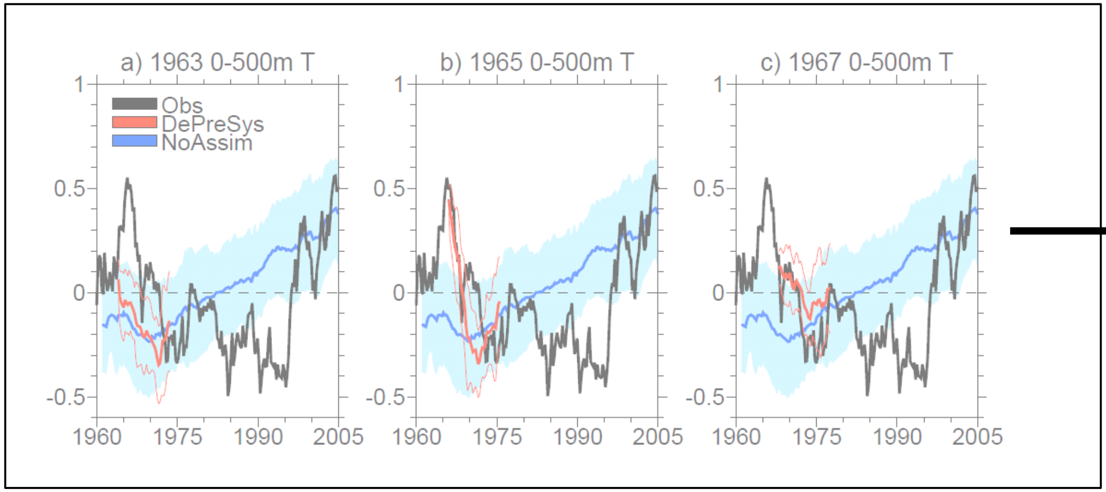
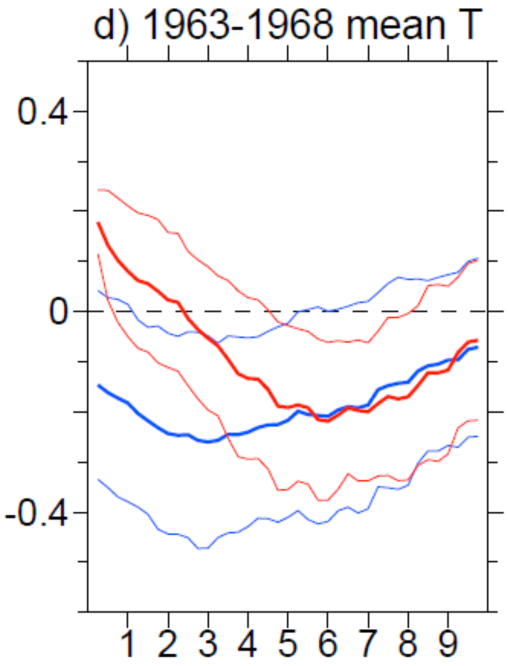
Mean over all hindcasts 1963-1968





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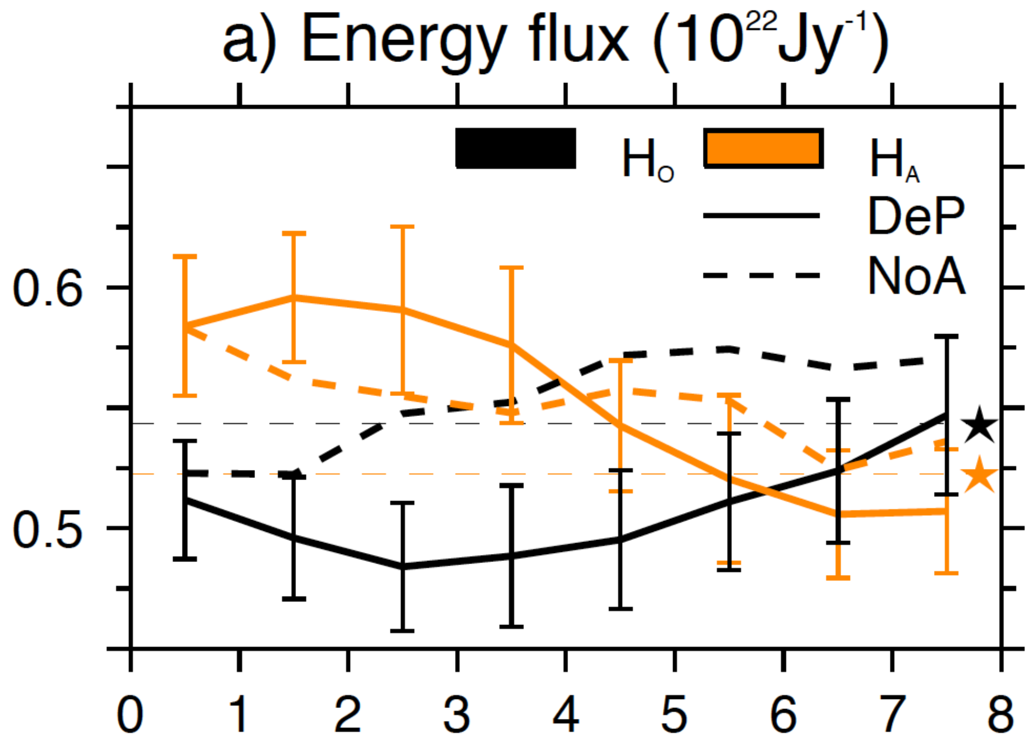
SPG energy budget

$\Delta E = H_O - H_A$

H_O = Ocean heat transport convergence
And
H_A = Atmospheric heat loss integrated over the latitude of the subpolar gyre (50N-65N)



SPG energy budget

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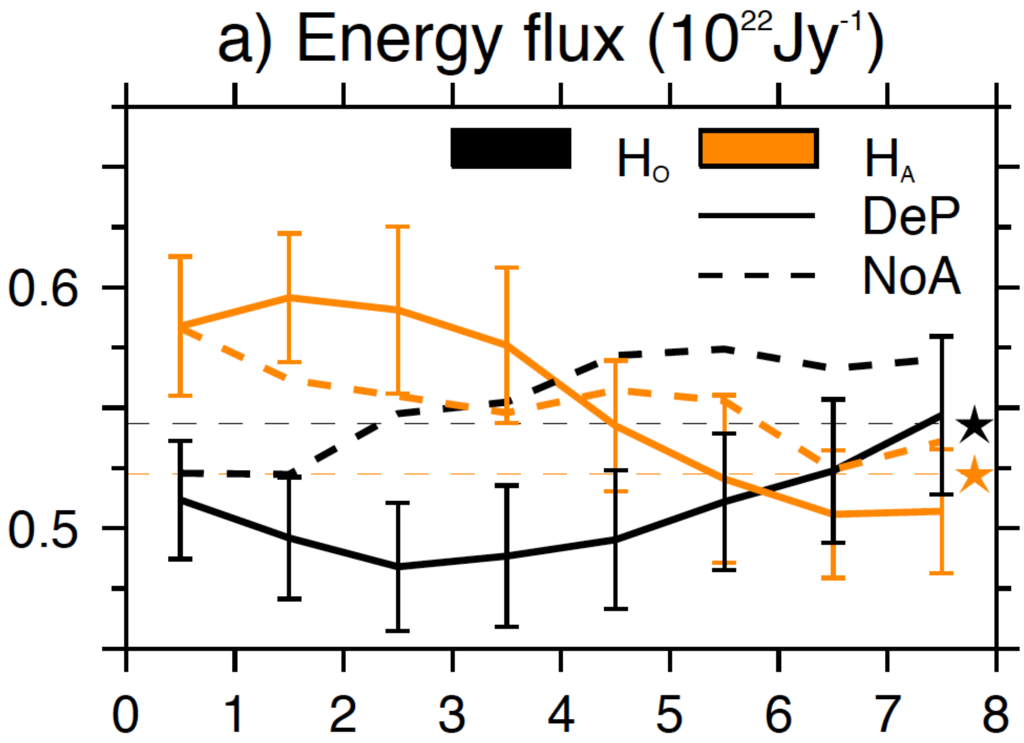
Ocean heat transport convergence key to predict the cooling



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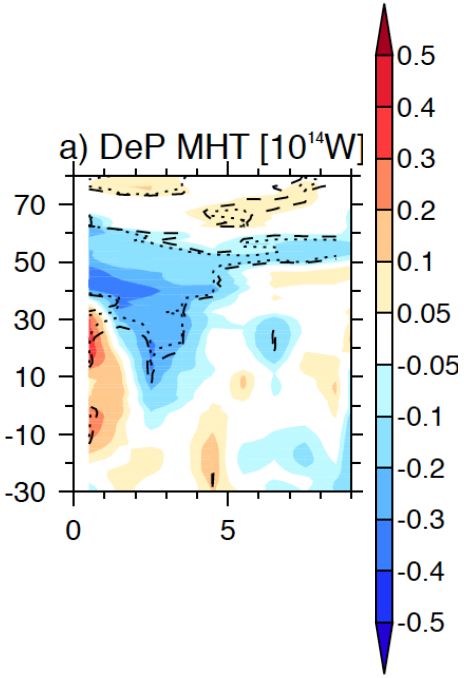
Ocean heat transport



Ocean heat transport

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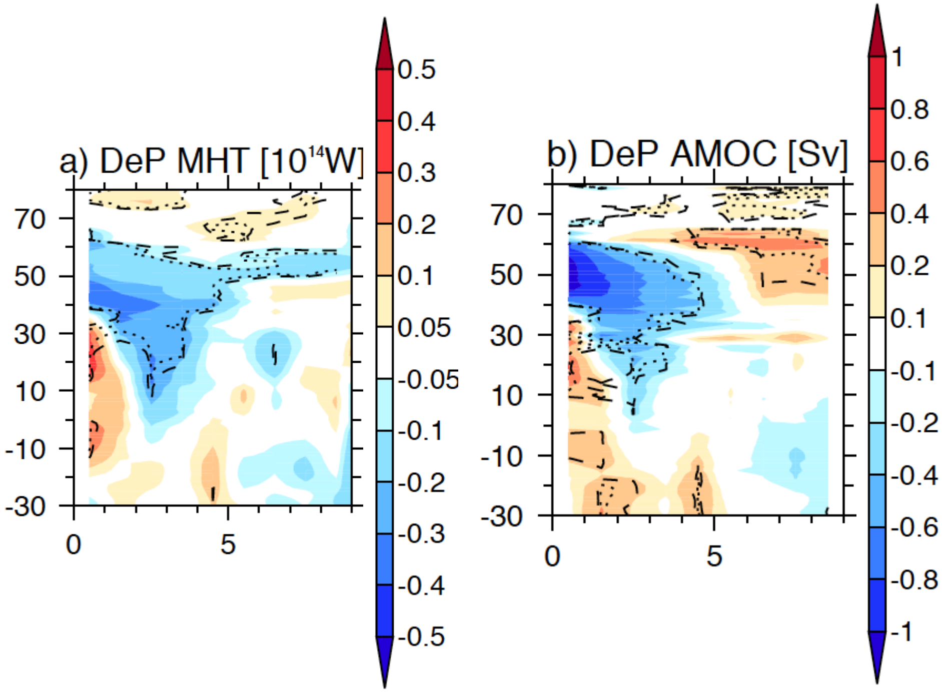

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Ocean heat transport

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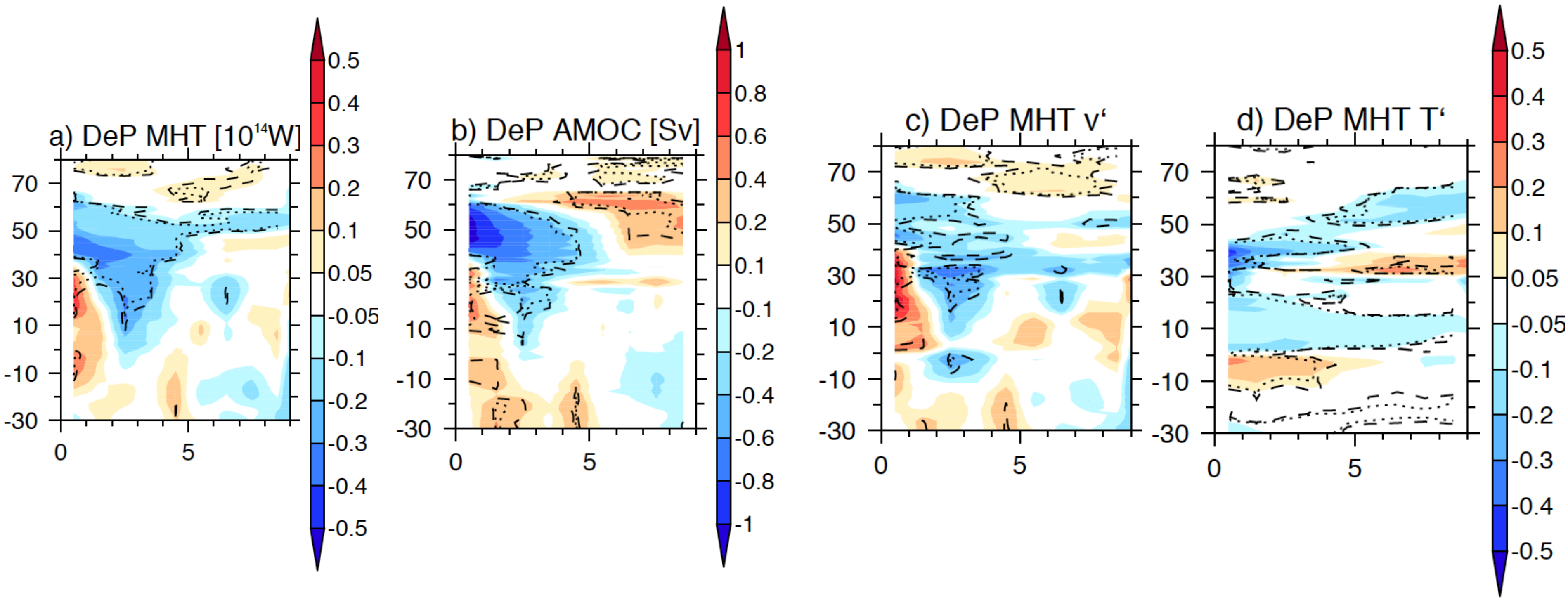

Weak ocean circulation → weak northward heat transport

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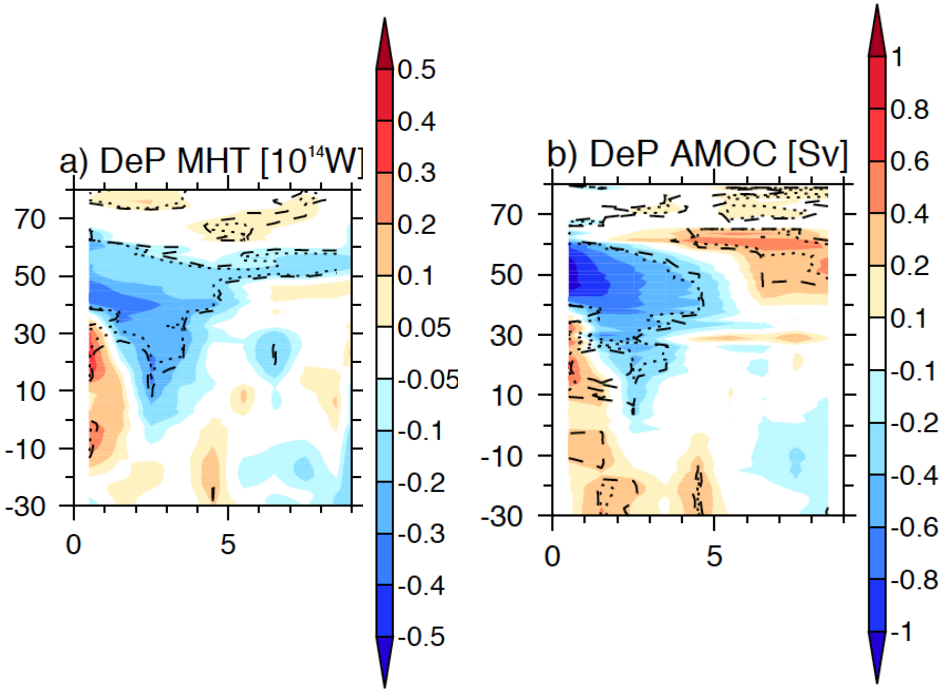
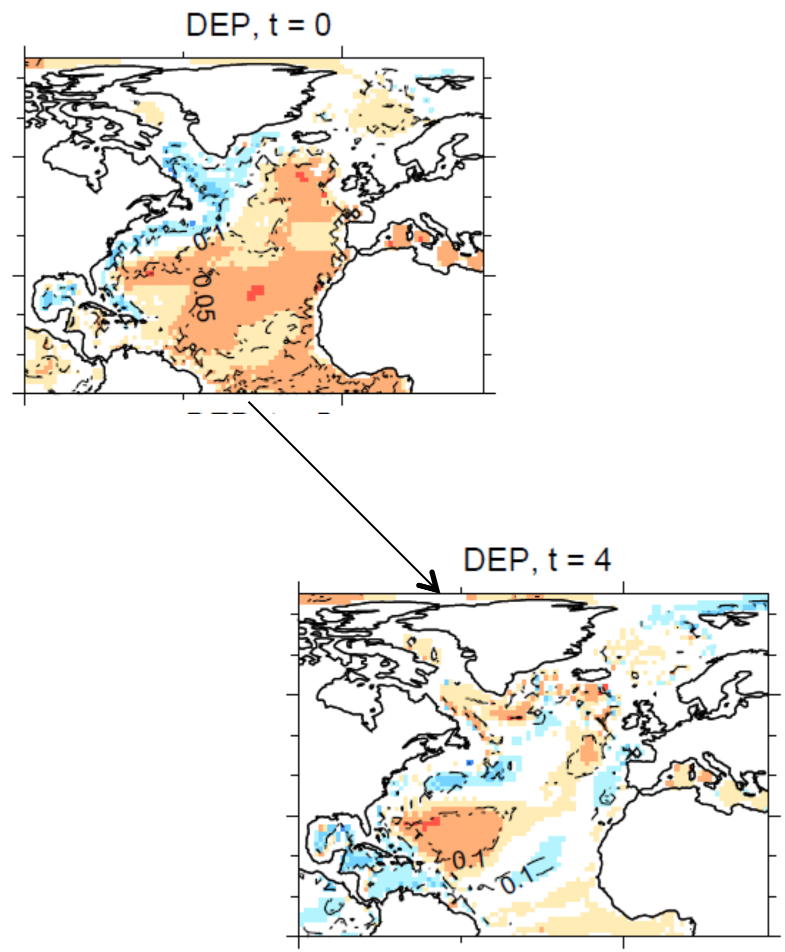
Ocean heat transport



1200-3000m density anomalies



Ocean heat transport - NoAssim

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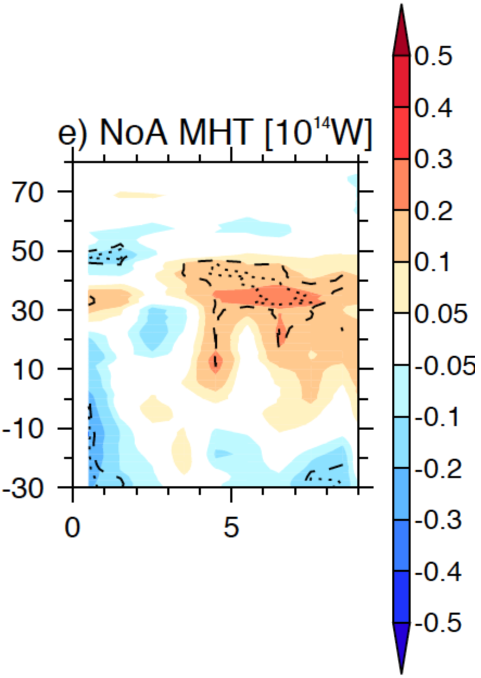

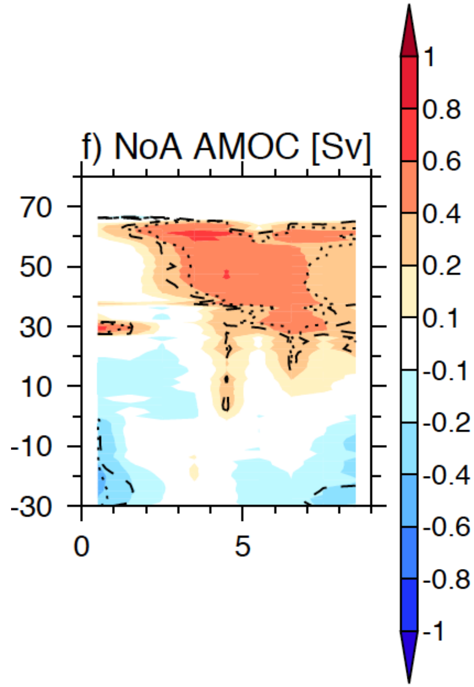

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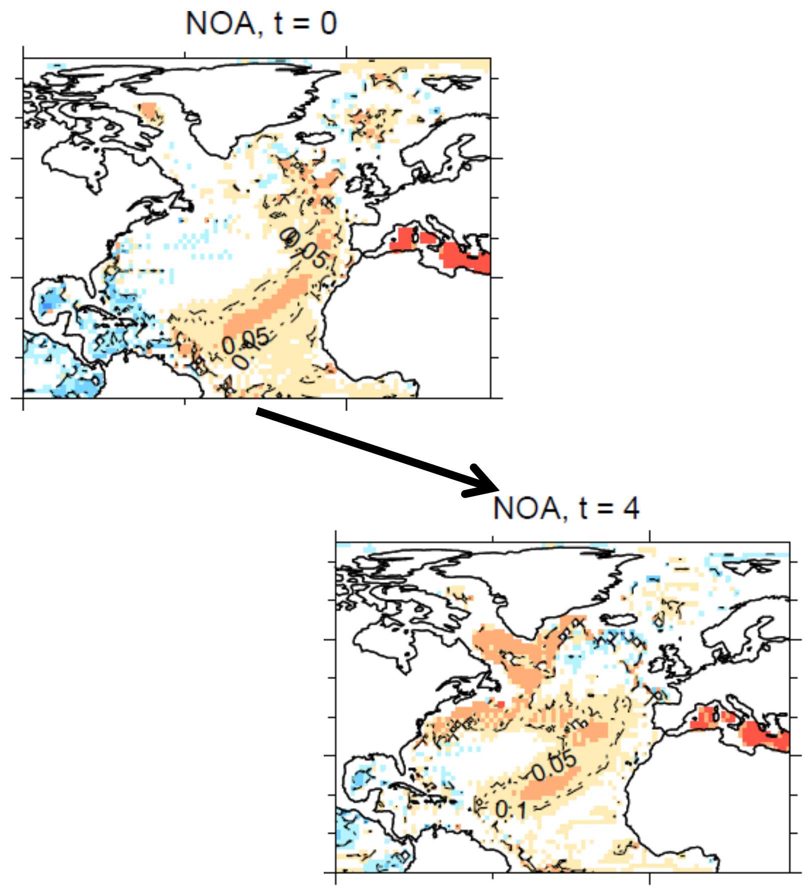

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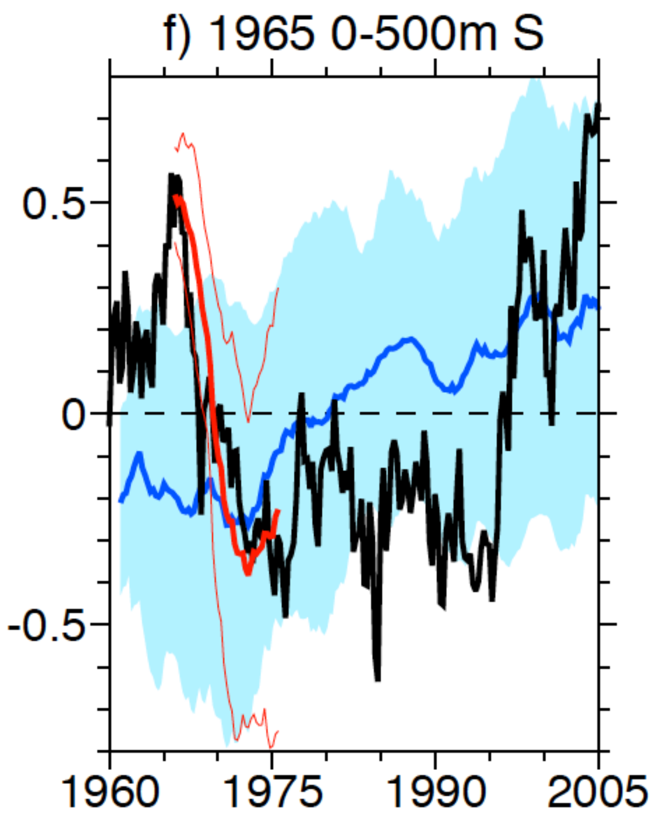
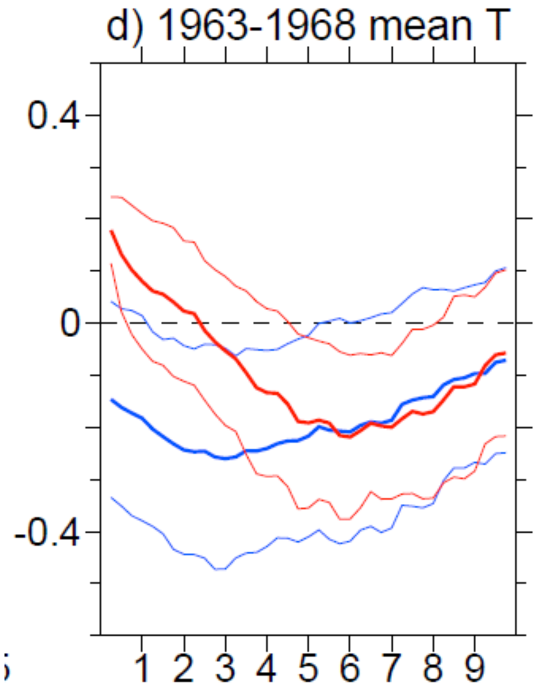
Prediction of the GSA



DePreSys also successfully predicts the Great Salinity anomaly

Surface climate impact



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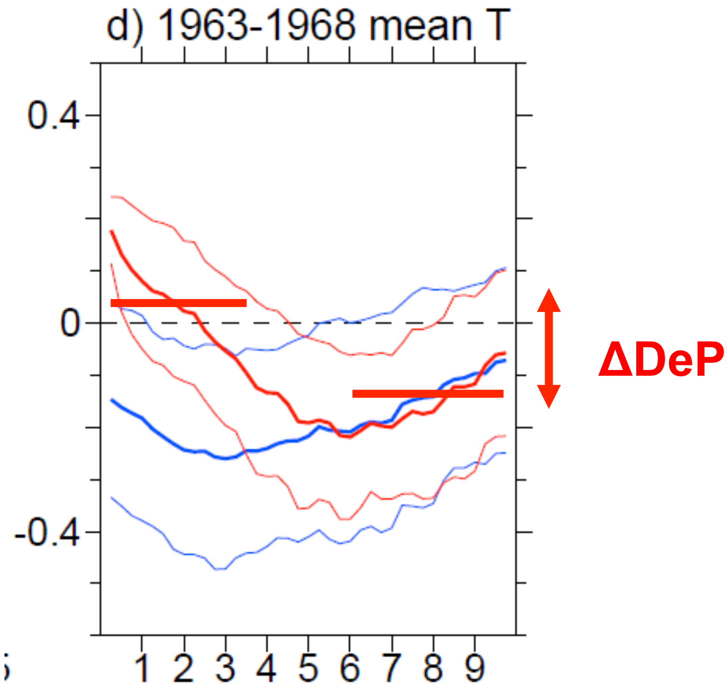

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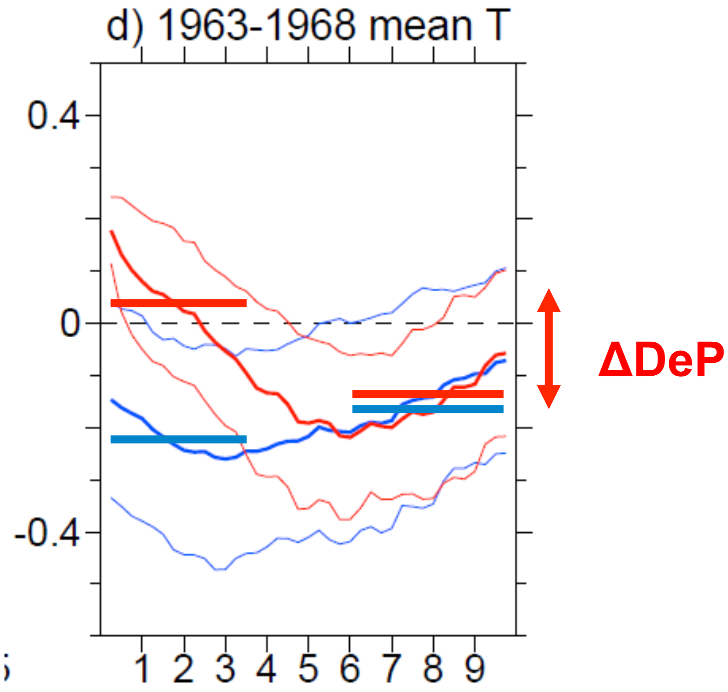
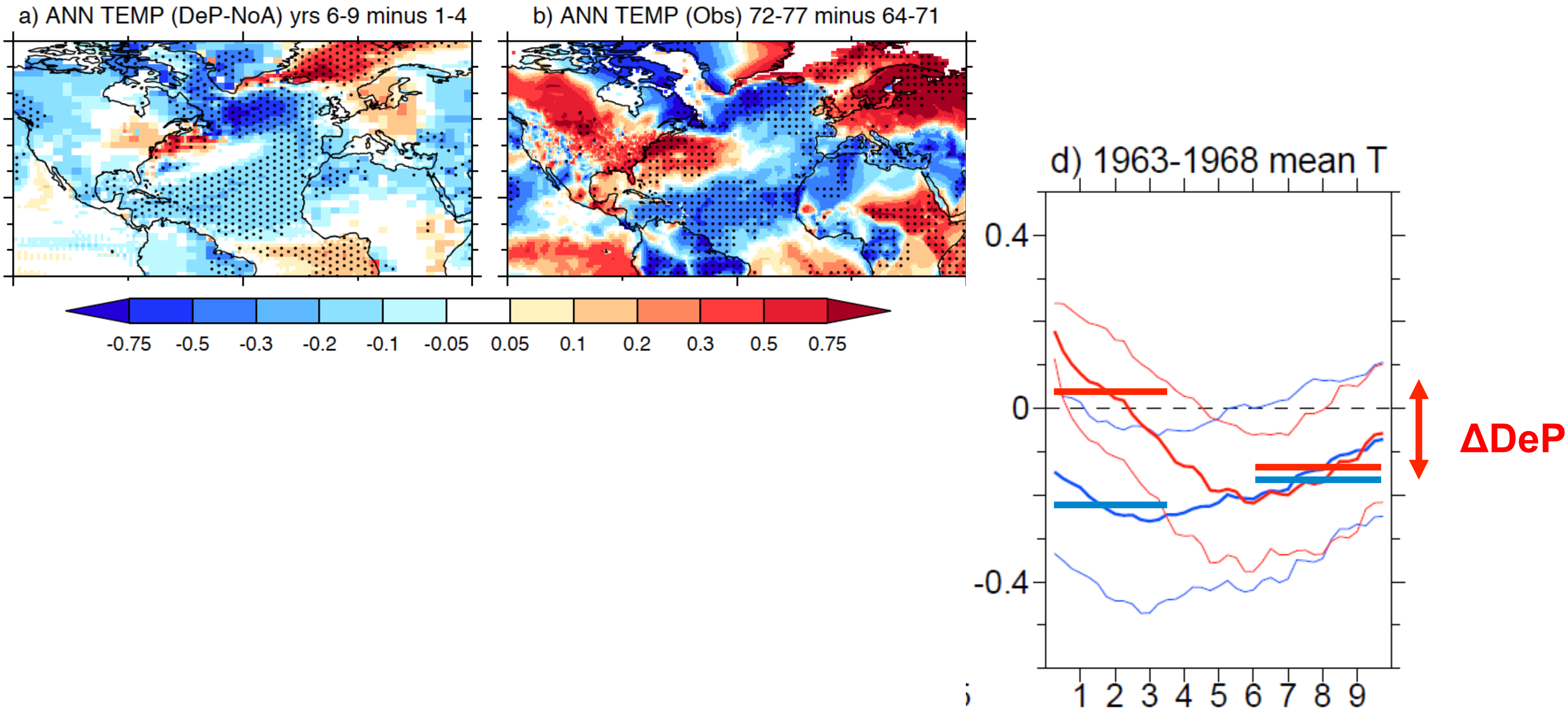


Impact of initialisation = ΔDeP - ΔNoA

Surface climate impact



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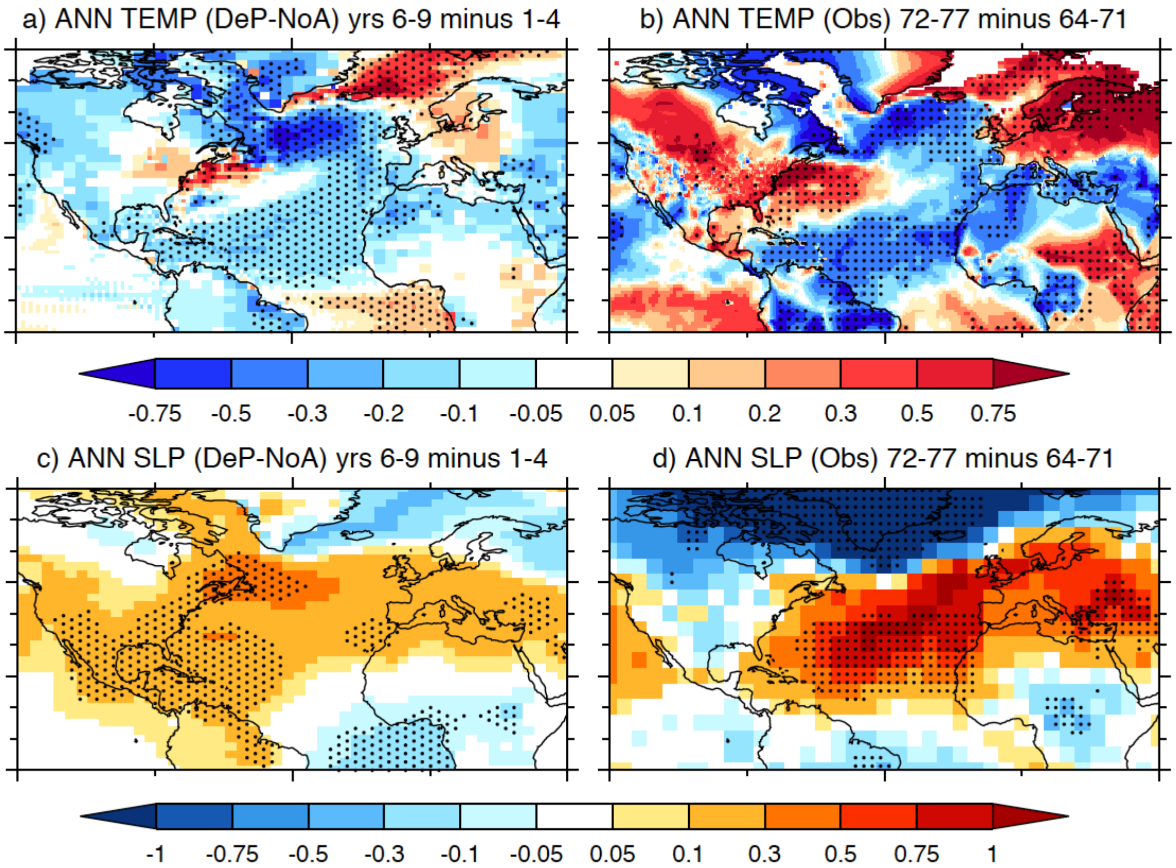

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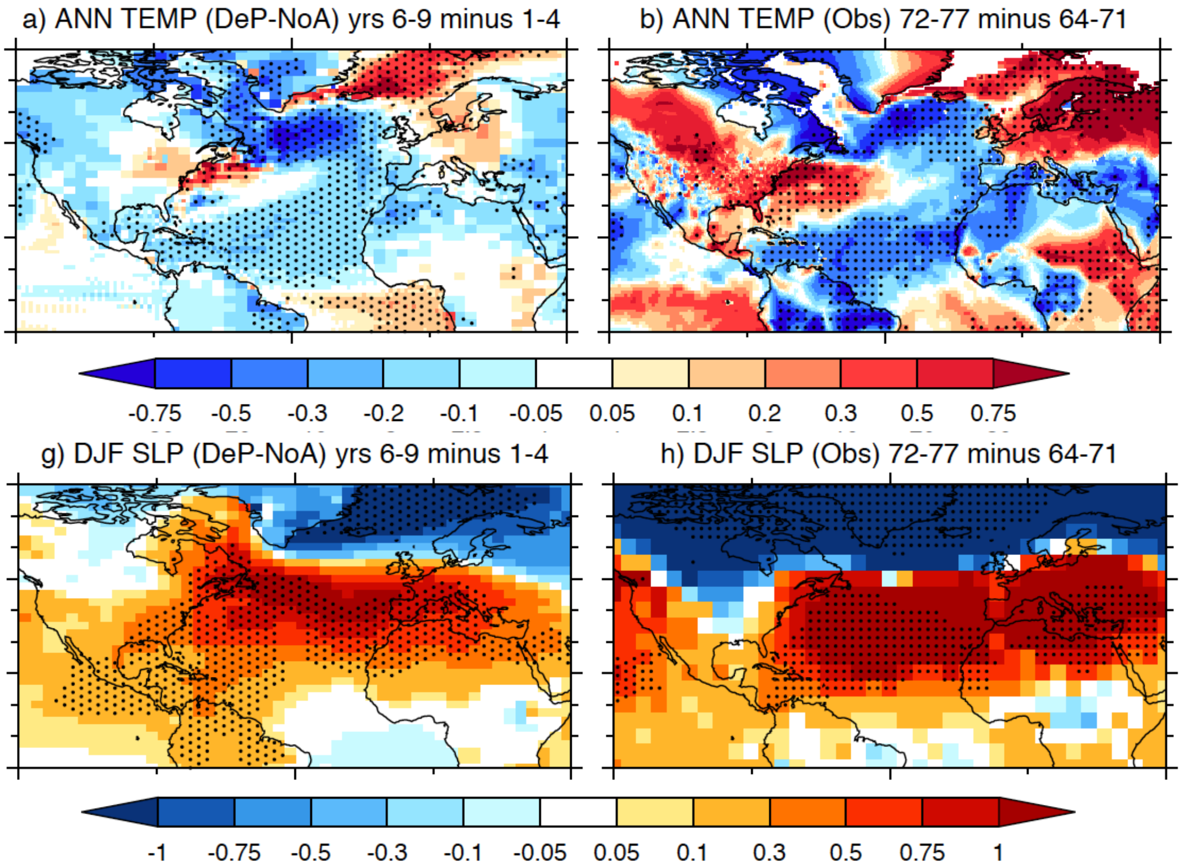

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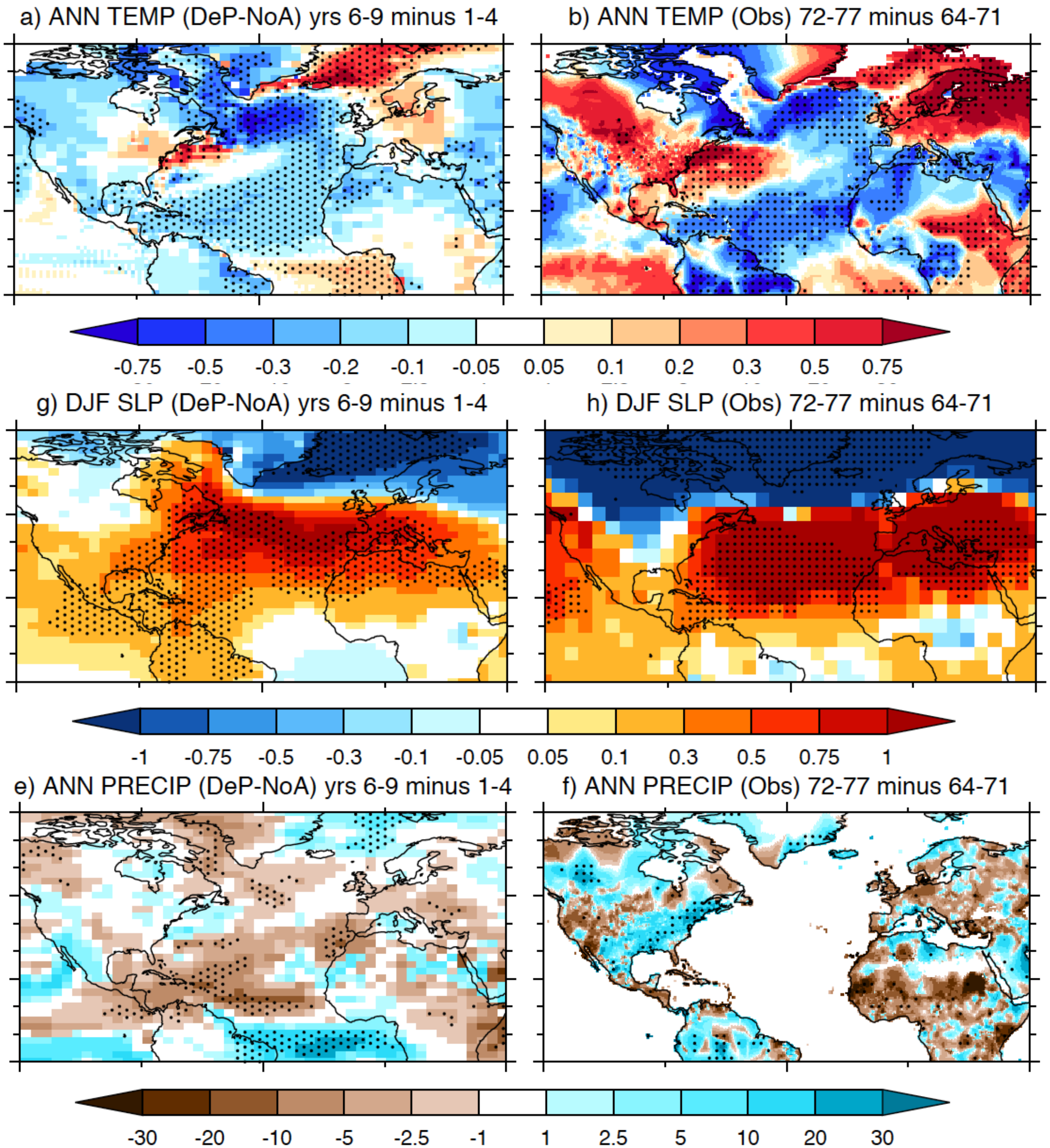

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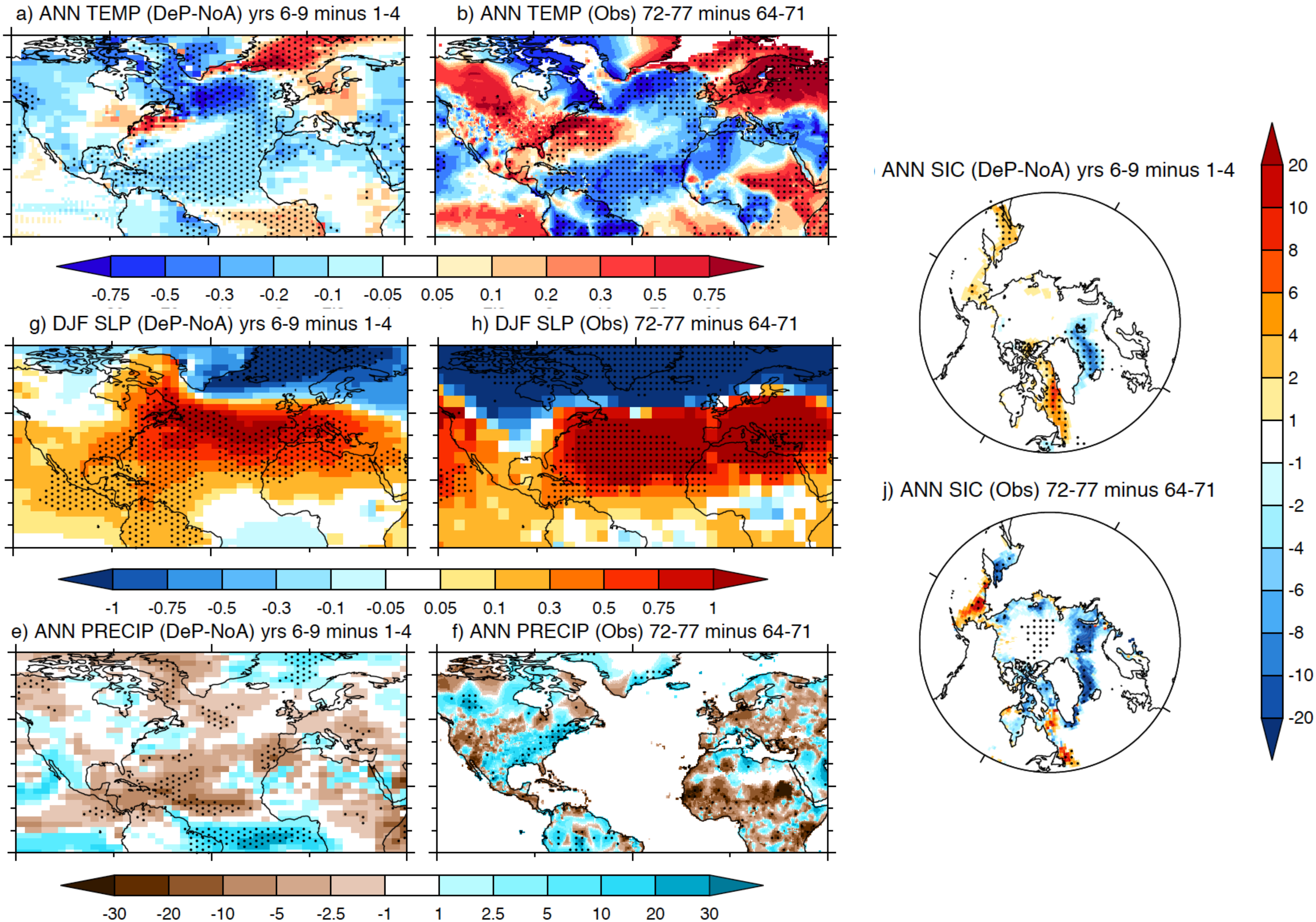

Summary

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- Initialised decadal predictions successfully predict the cooling and freshening of the North Atlantic in the 1960s
- The initialisation of weak ocean circulation, and hence weak ocean heat transport is key – it is *not* a forced response in this model
- **Main Caveat -** the quality of the subsurface ocean data in 1960s
- However, it is interesting that DePreSys also predicts many other aspects of the observed cooling, including the GSA and surface climate response

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- **Main Caveat -** the quality of the subsurface ocean data in 1960s
- However, it is interesting that DePreSys also predicts many other aspects of the observed cooling, including the GSA and surface climate response
- Results provide further evidence that ocean dynamical changes played a key role in the observed changes
- **But**, What was the origin of the weak AMOC?

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