CCSM Annual Meeting OMWG
(Breckenridge, CO; June 16, 2009)

Multi-decadal Variability of Atlantic Meridional Overturning Circulation in CCSM3 T85x1 Control Integration

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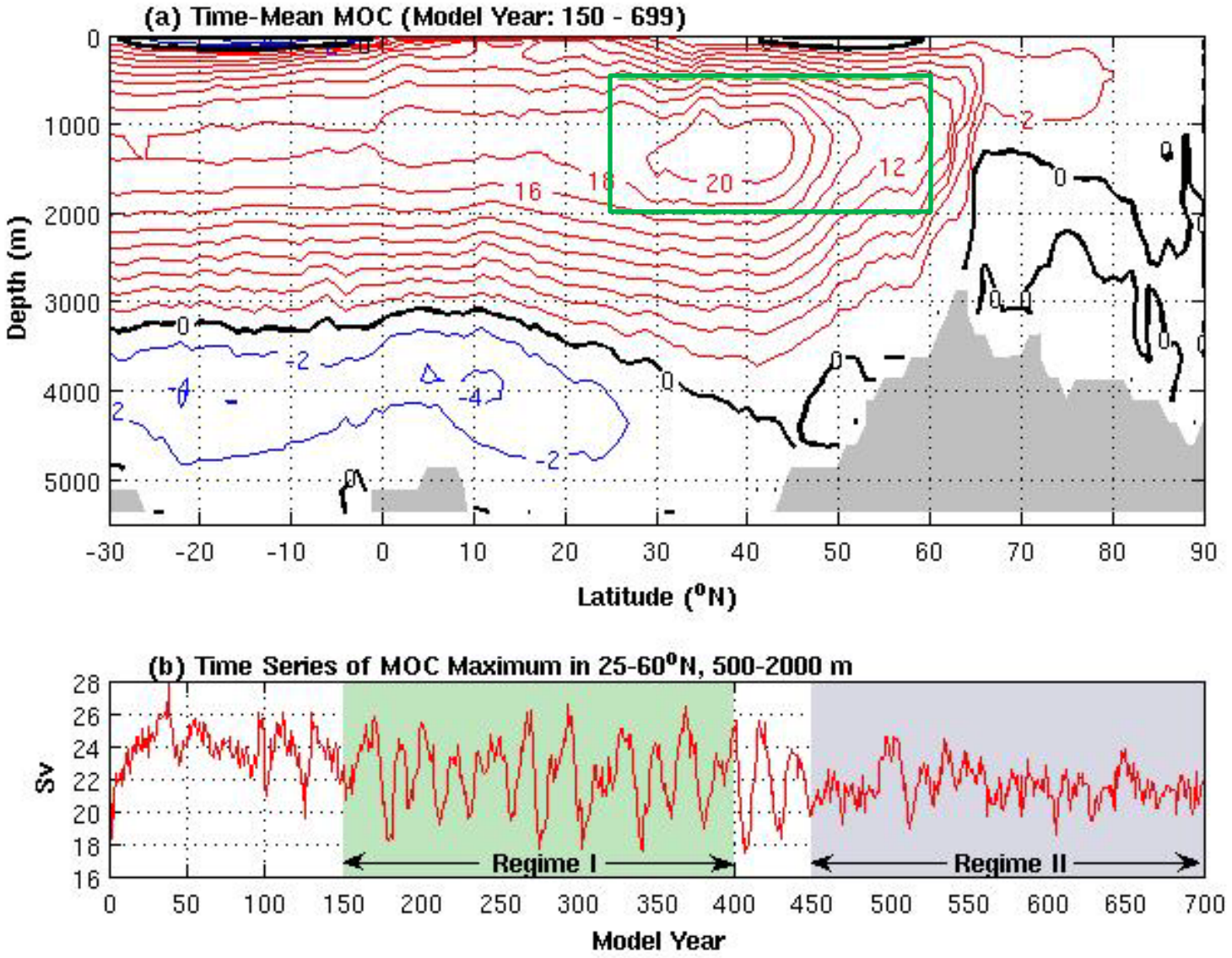
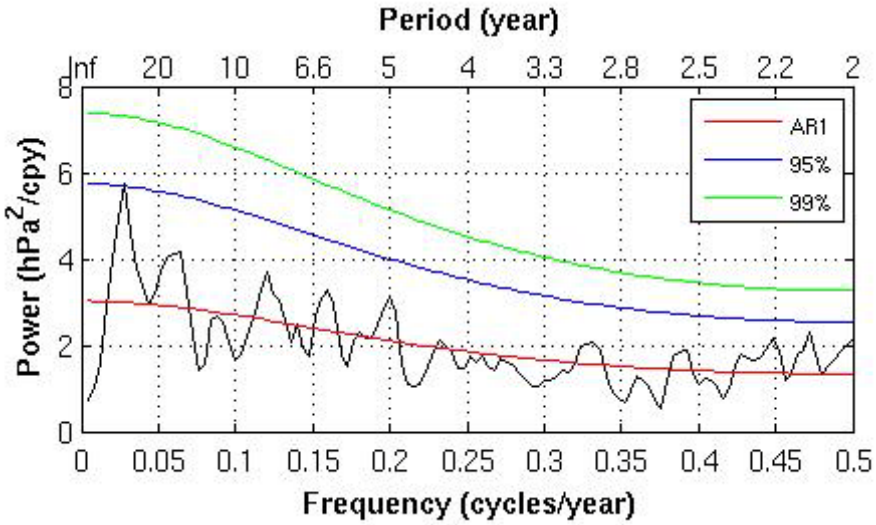
CCSM3 T85x1 Control Integration AMOC

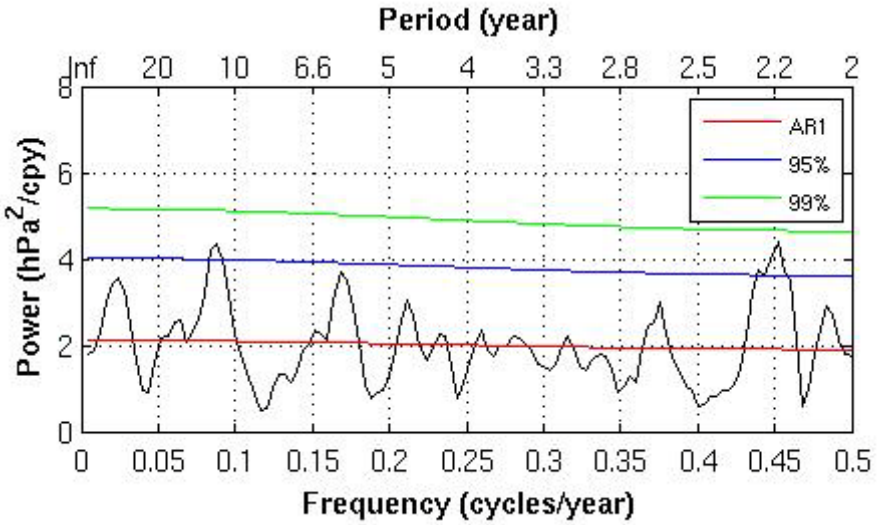


Atmosphere: North Atlantic Oscillation (NAO)

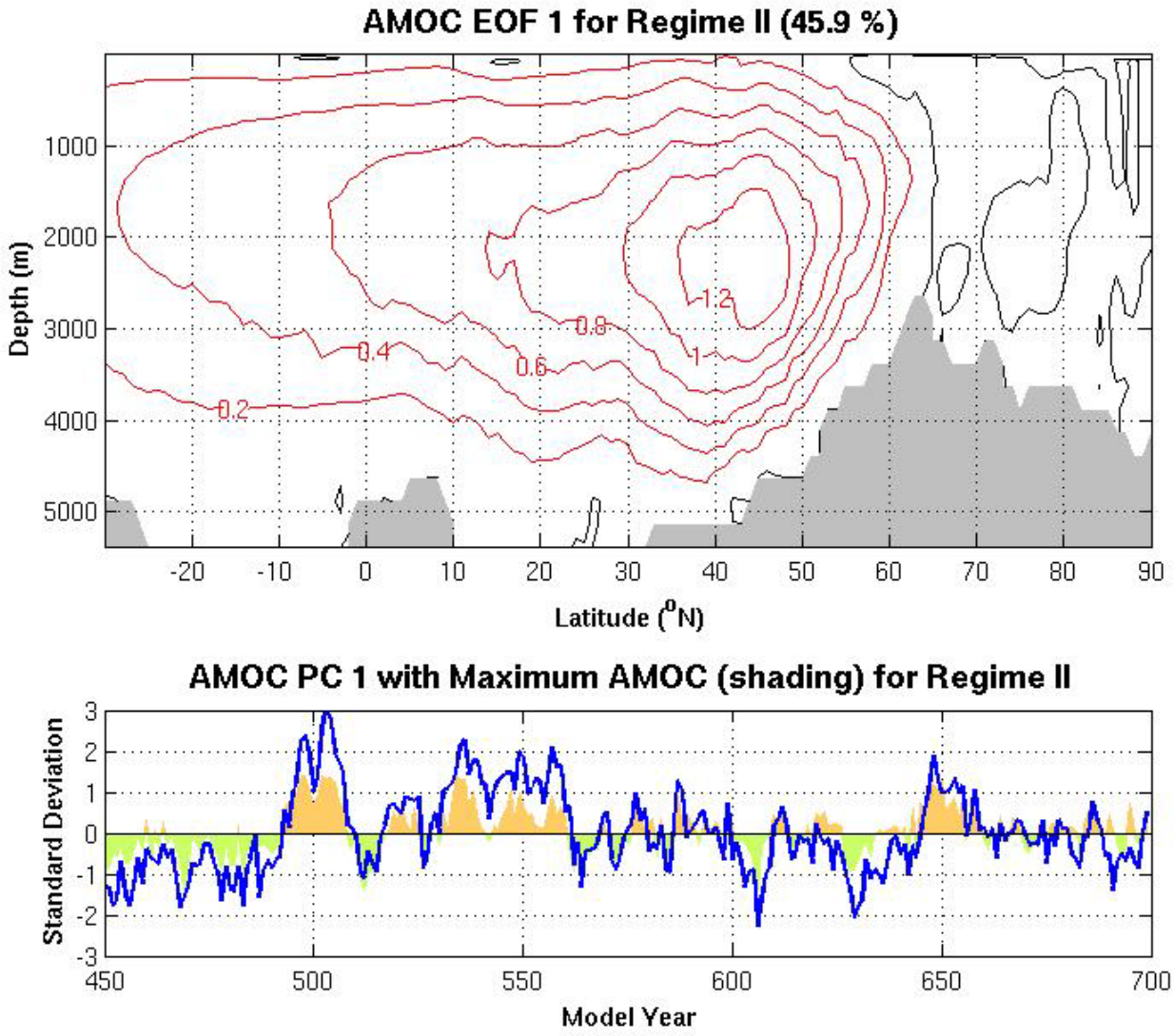
Regime I
(Model Year: 150-399)



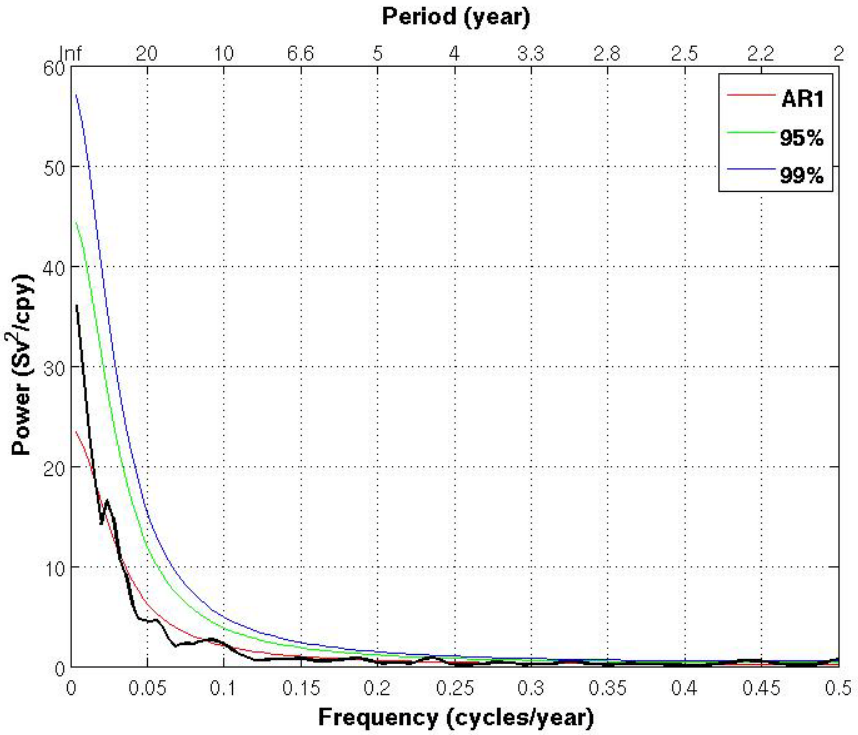
Regime II
(Model Year: 450-699)

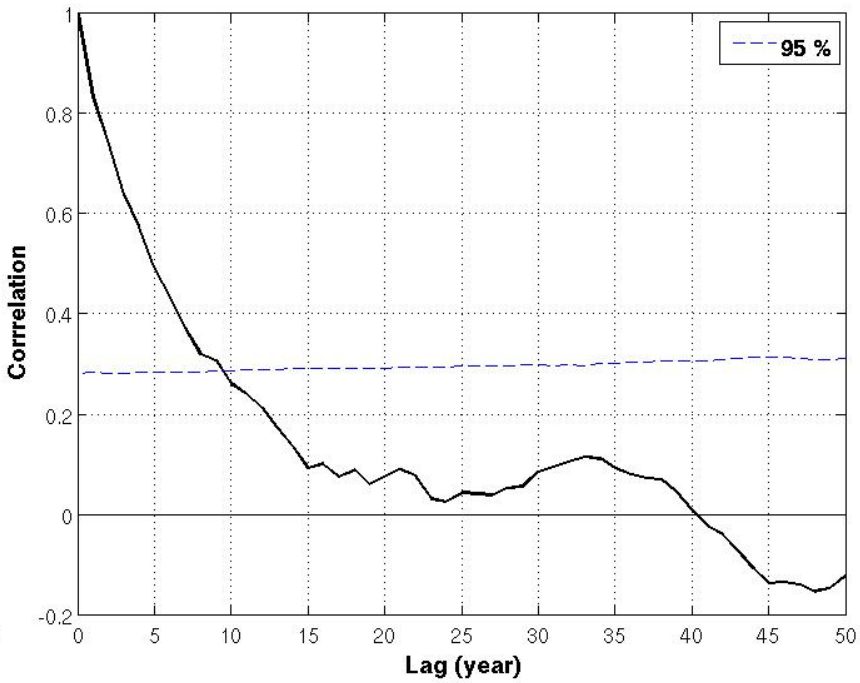


AMOC Leading Empirical Orthogonal Function (EOF)



AMOC Time Series (= PC 1 Time Series)
Power Spectrum & Auto-Correlation

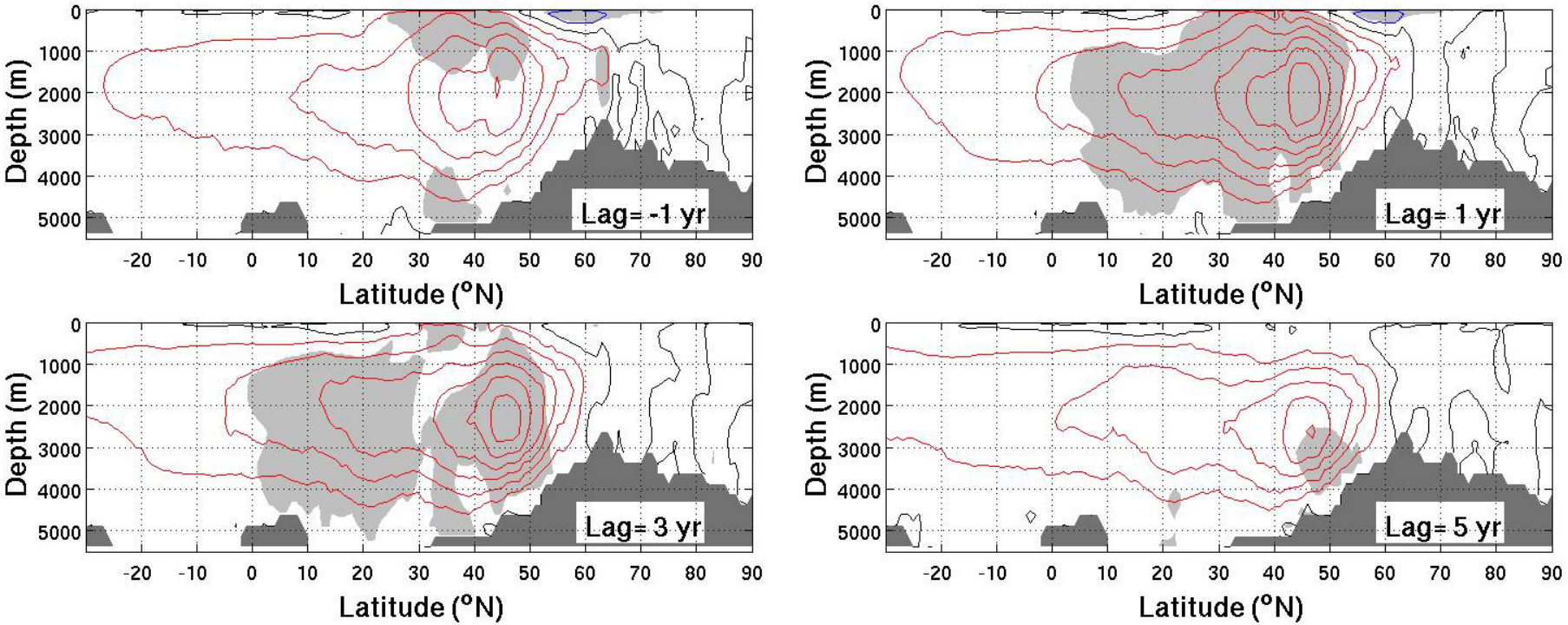




~ Red noise

Long persistence (~10 years)

AMOC Regression on NAO
(low-pass filtered > 10 years)

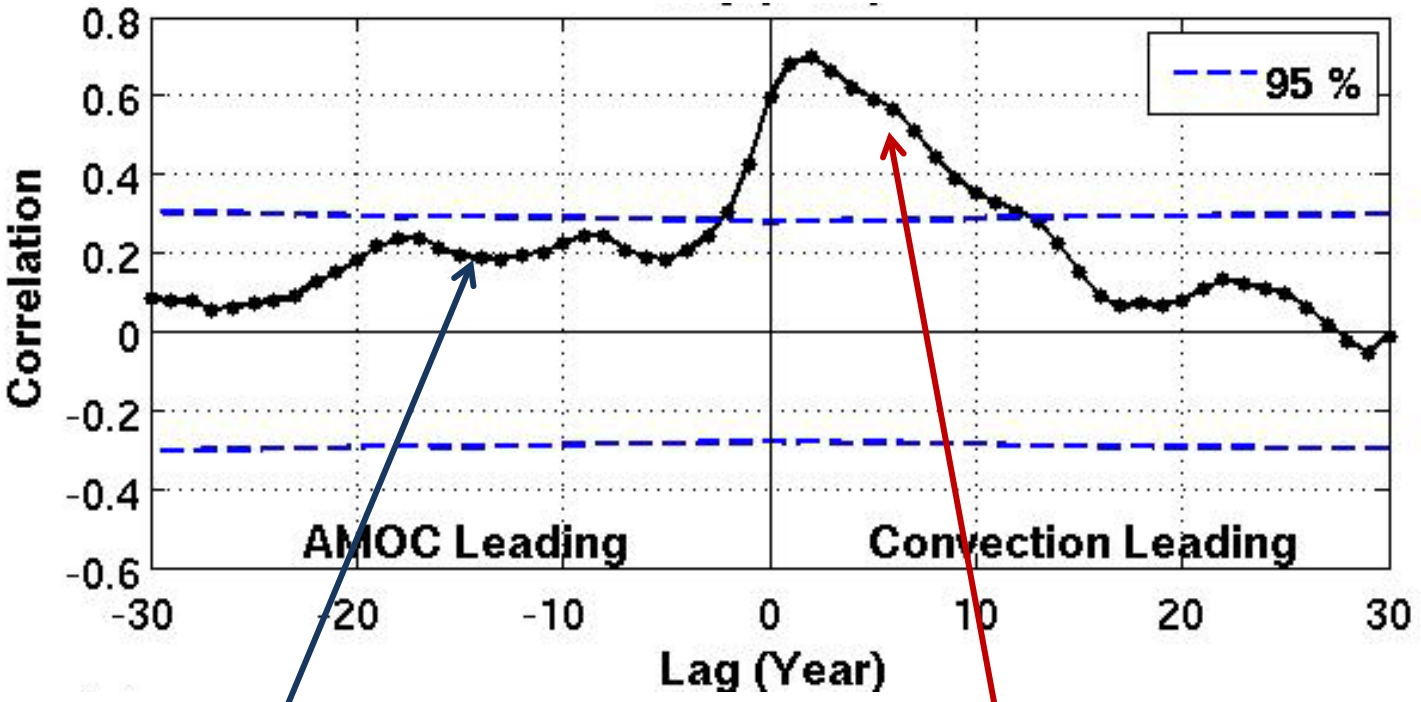


Positive Lags: NAO Leads (Contour Interval = 0.1 Sv)

AMOC integrates NAO forcing ⇒ Short persistence (< 5 years)

AMOC PC-1 & Deep Convection: Lag-Correlation

(Deep Convection Time Series: Upper 500 m Density in the Convection Site)



AMOC integrates the convection variability

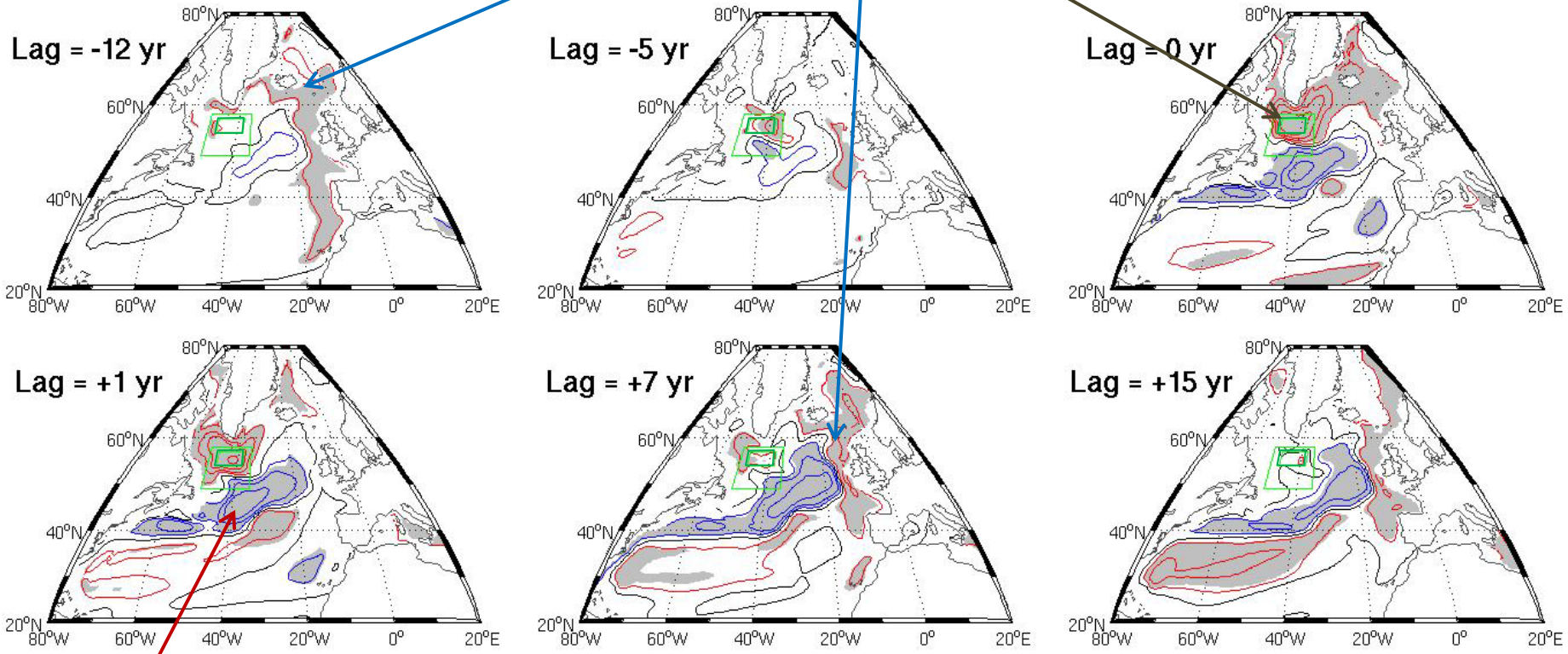
Hint of weak positive feedback

Long Persistence (~10 years)

Upper 500 m Density Correlation with Deep Convection

Positive Feedback due to increased subpolar water

Deep Convection Site

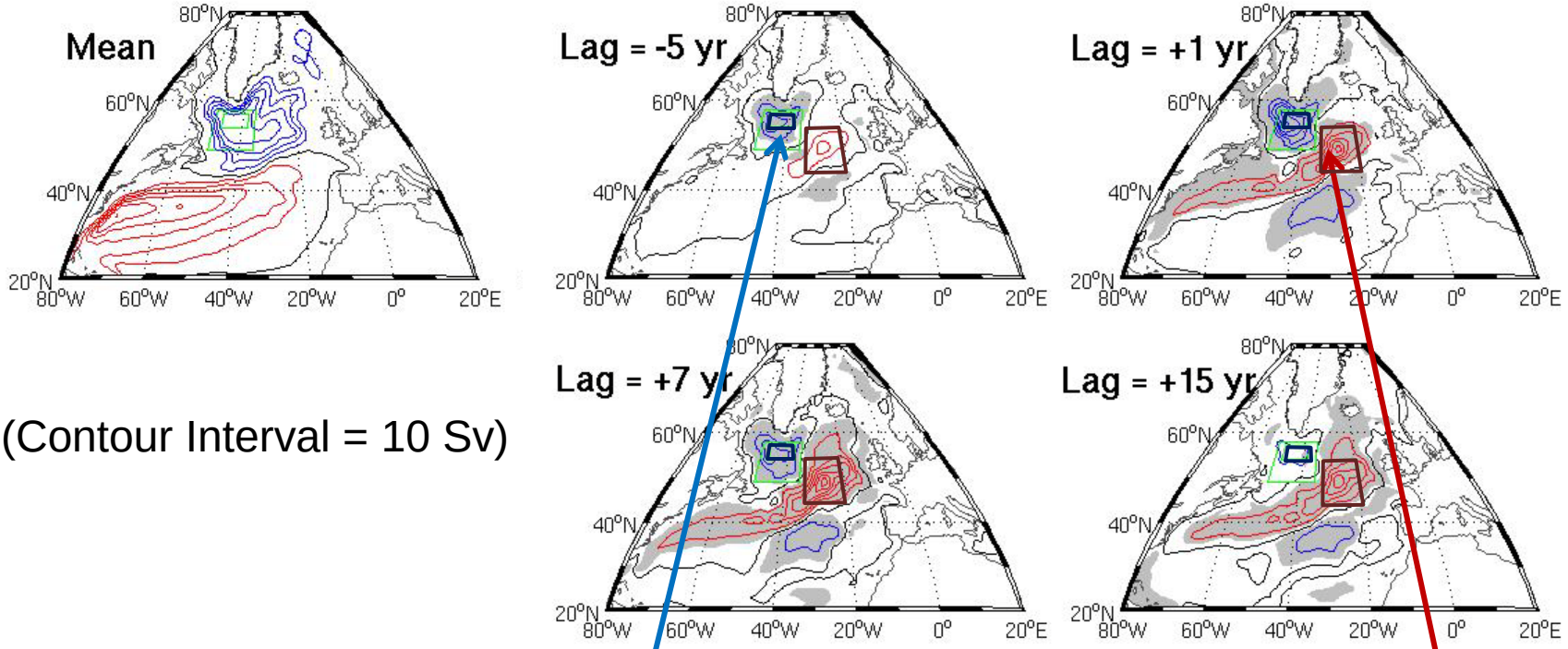


Positive Lags: Deep Convection Leads

(Contour Interval = 0.2)

Gulf Stream – North Atlantic Current northward shift

Horizontal Circulation Regression on Deep Convection



(Contour Interval = 10 Sv)

Anti-clockwise circulation intensification

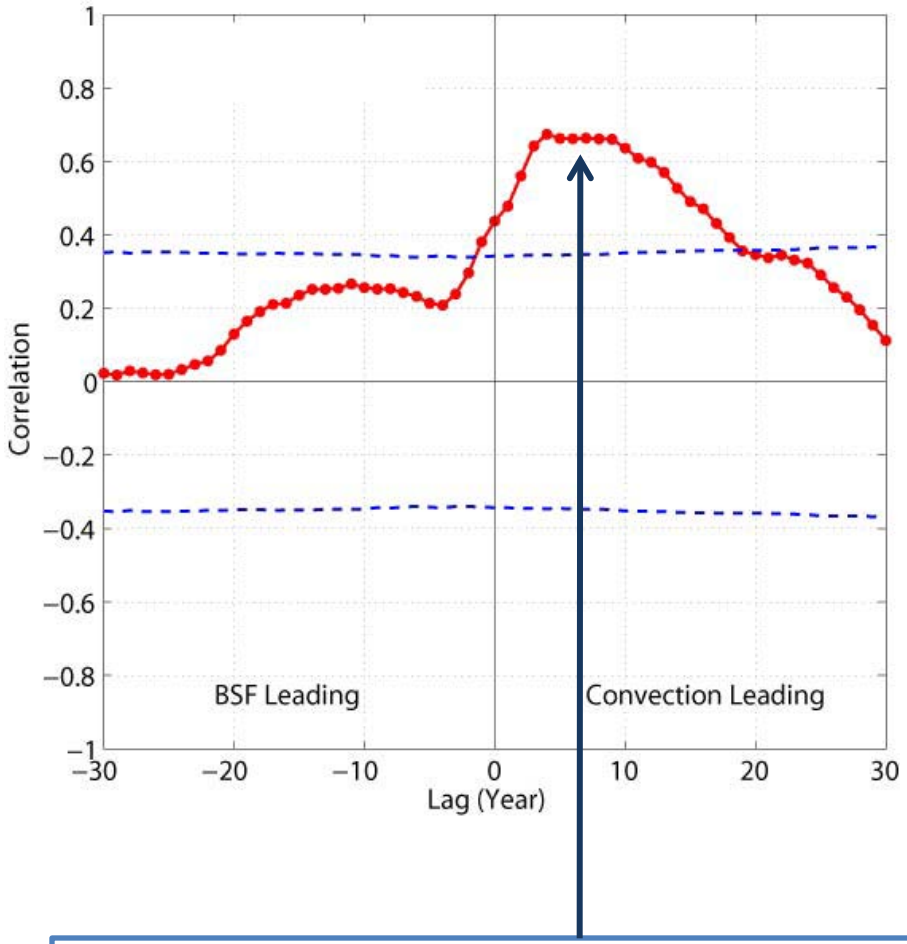
Gulf Stream – North Atlantic Current northward shift

Positive Lags: Deep Convection Leads

(Contour Interval = 1 Sv)

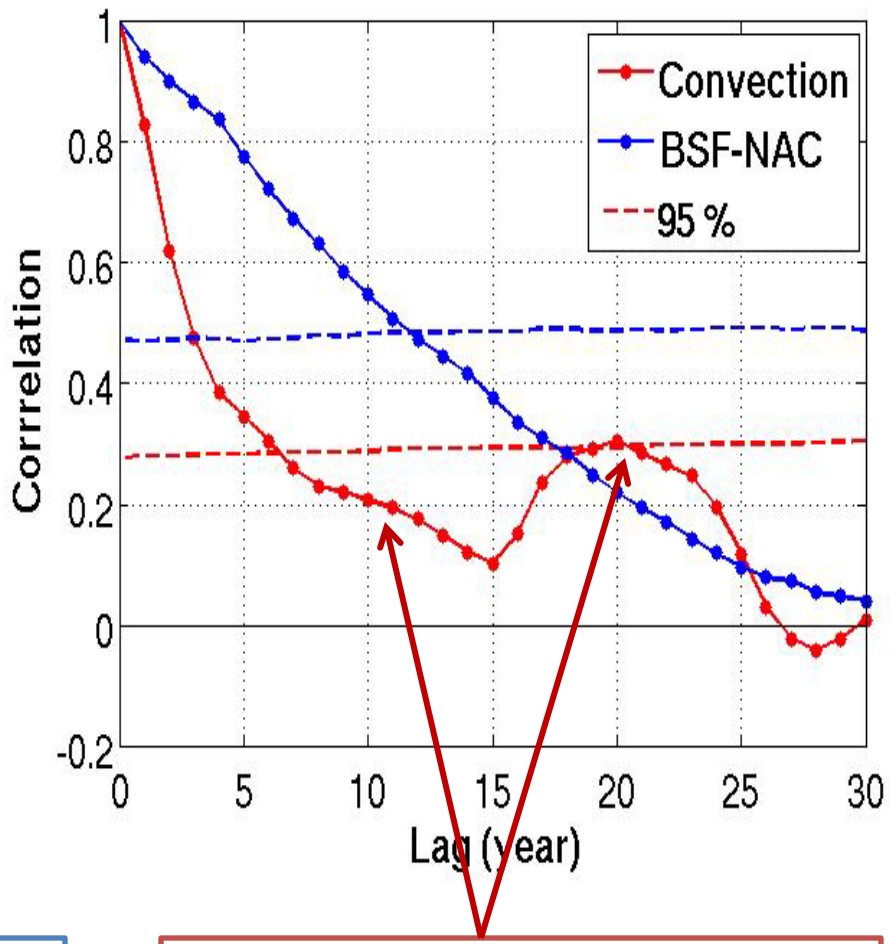
Convection and Horizontal Circulation (at NAC box)

Lag-Correlation



NAC BSF lags and integrates convection

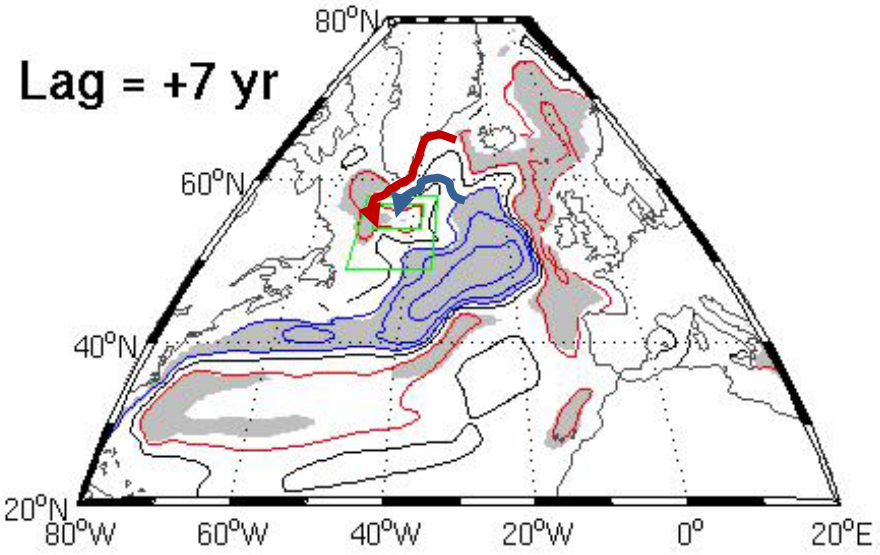
Auto-Correlations



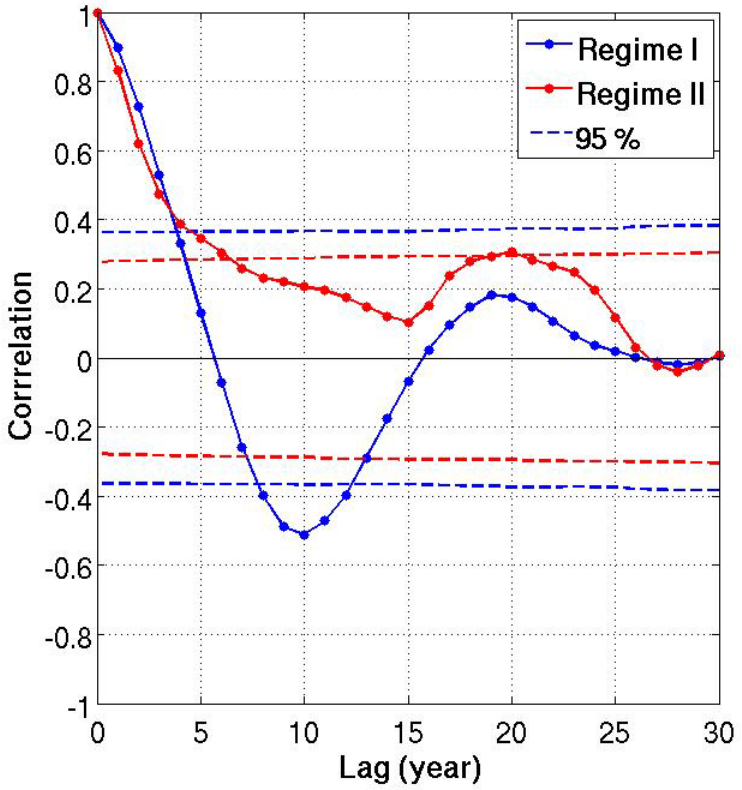
Hint of 20-year oscillation

Alternative Possibility :
Feedback between the convection and horizontal circulation

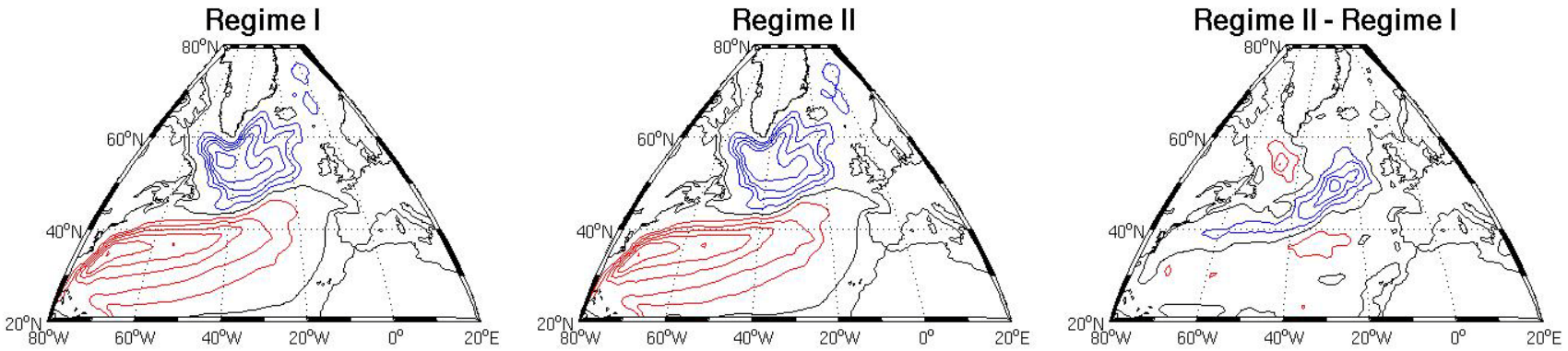
Upper 500m density correlated on convection index



Auto-correlation of convection index



Mean Barotropic Streamfunction



(Contour Interval = 10 Sv, 10 Sv, 2 Sv)

Conclusions

Regime II AMOC variability

- Short Persistence (< 5 years)
  : **Stochastic atmospheric NAO forcing**
  NAO $\Rightarrow$ Deep convection $\Leftrightarrow$ Anti-clockwise Gyre $\Rightarrow$ AMOC
  (***Please see the poster!***)

- Long Persistence (~10 years) :
  Ocean circulation feedback from the eastern subpolar gyre
  Deep Convection $\Leftrightarrow$ GS/NAC Circulation $\Leftrightarrow$ AMOC

Factors to be considered for the Regime I AMOC variability

- Ocean-to-atmosphere feedback

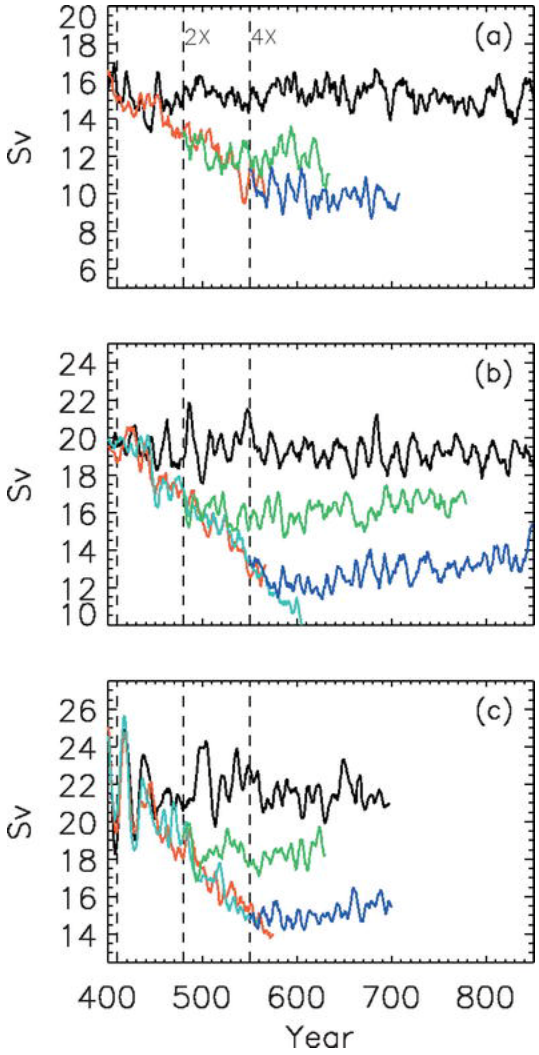
- Strength and location of Gulf Stream / North Atlantic Current

Climate Change Simulations using CCSM3

Lower resolution
T31x3

Medium resolution
T42x1

Higher resolution
T85x1



Control Integration

Transient Integration A
(1% per year Increasing CO_2)

Transient Integration B
(1% per year Increasing CO_2)

Double CO_2 Stabilization

Quadruple CO_2 Stabilization

Bryan et al. (2006)

Thank You