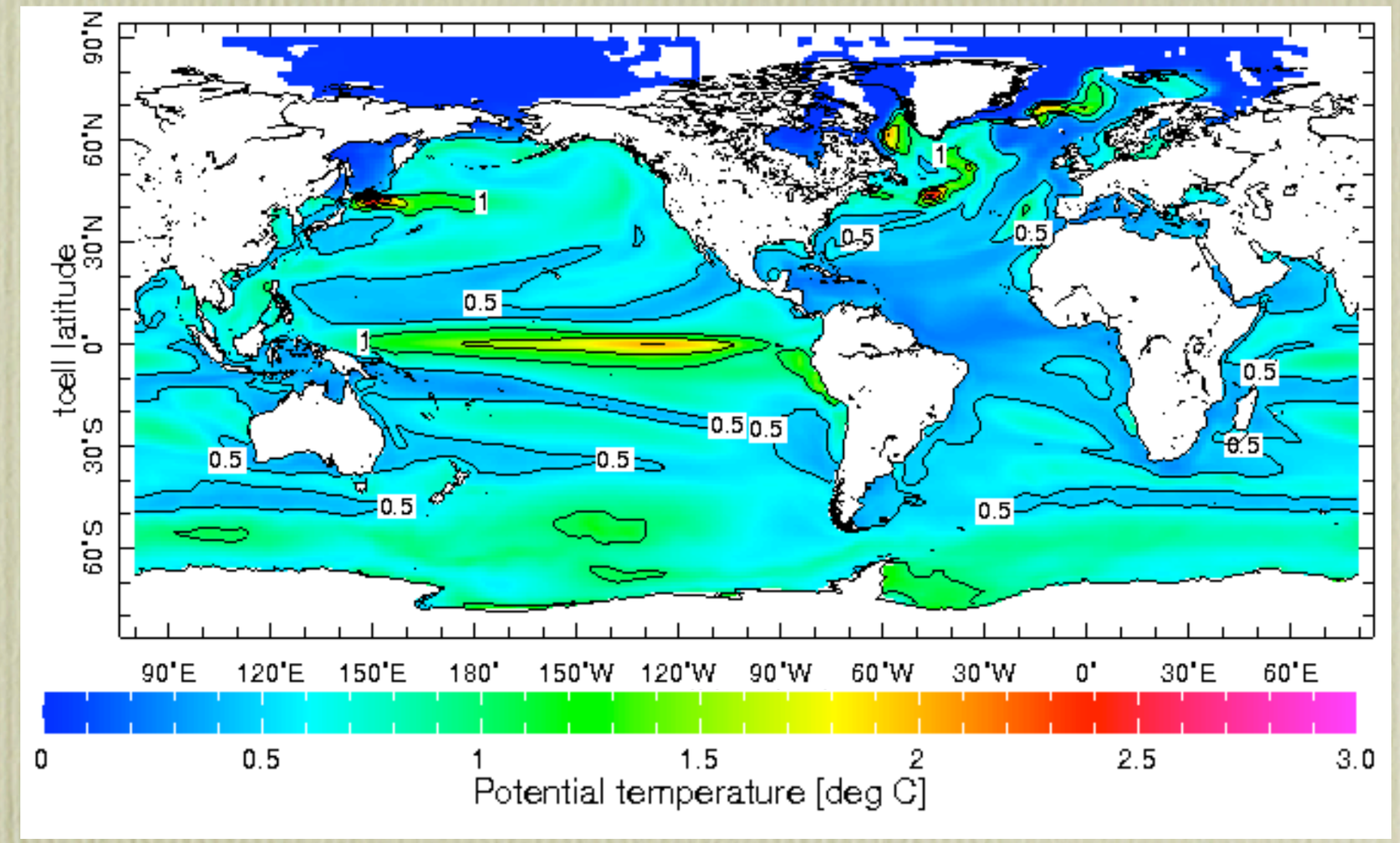
Mechanisms of Multidecadal Variability in the CM2.1

Preliminary results from analysis of atmosphere and ocean processes associated with the leading pattern of the CM2.1 multi-decadal SST variability

Y. Kushnir and N. Naik / GloDecH meeting, 8 Feb 2011

RMS of 5m Temperature



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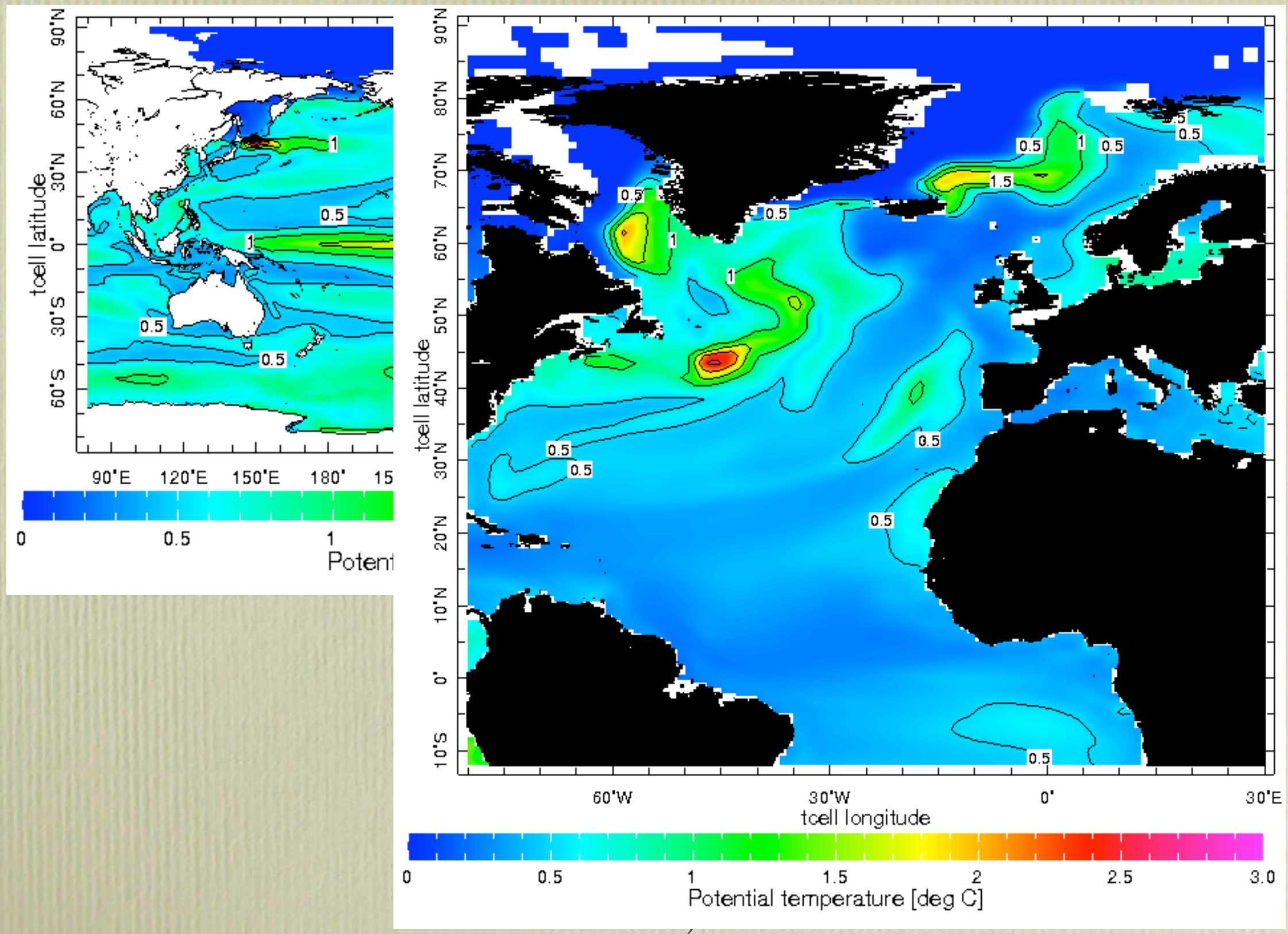
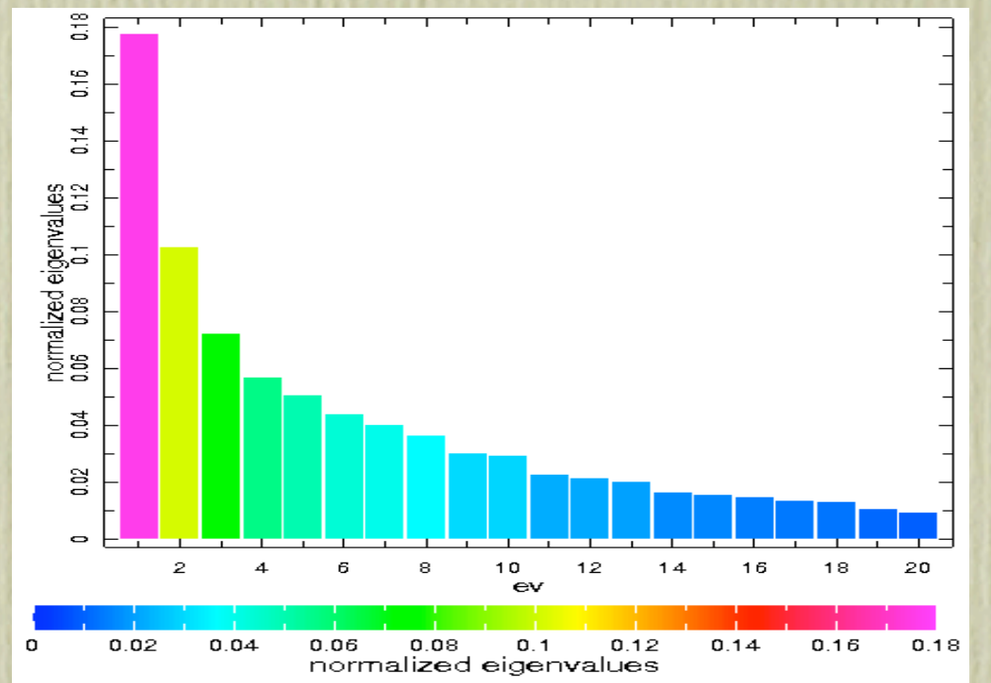
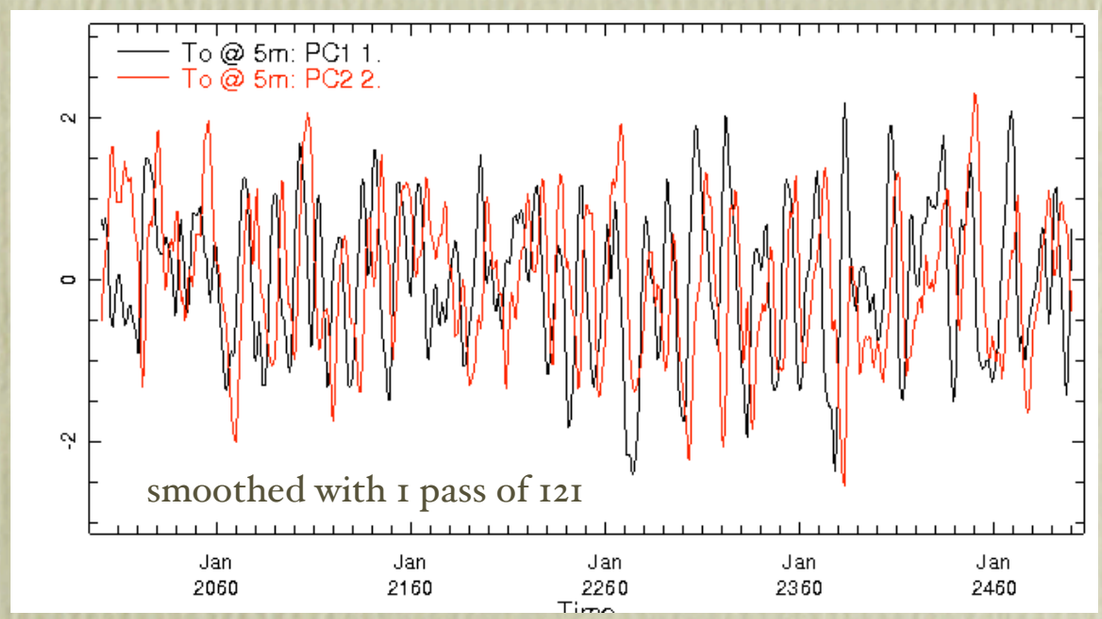
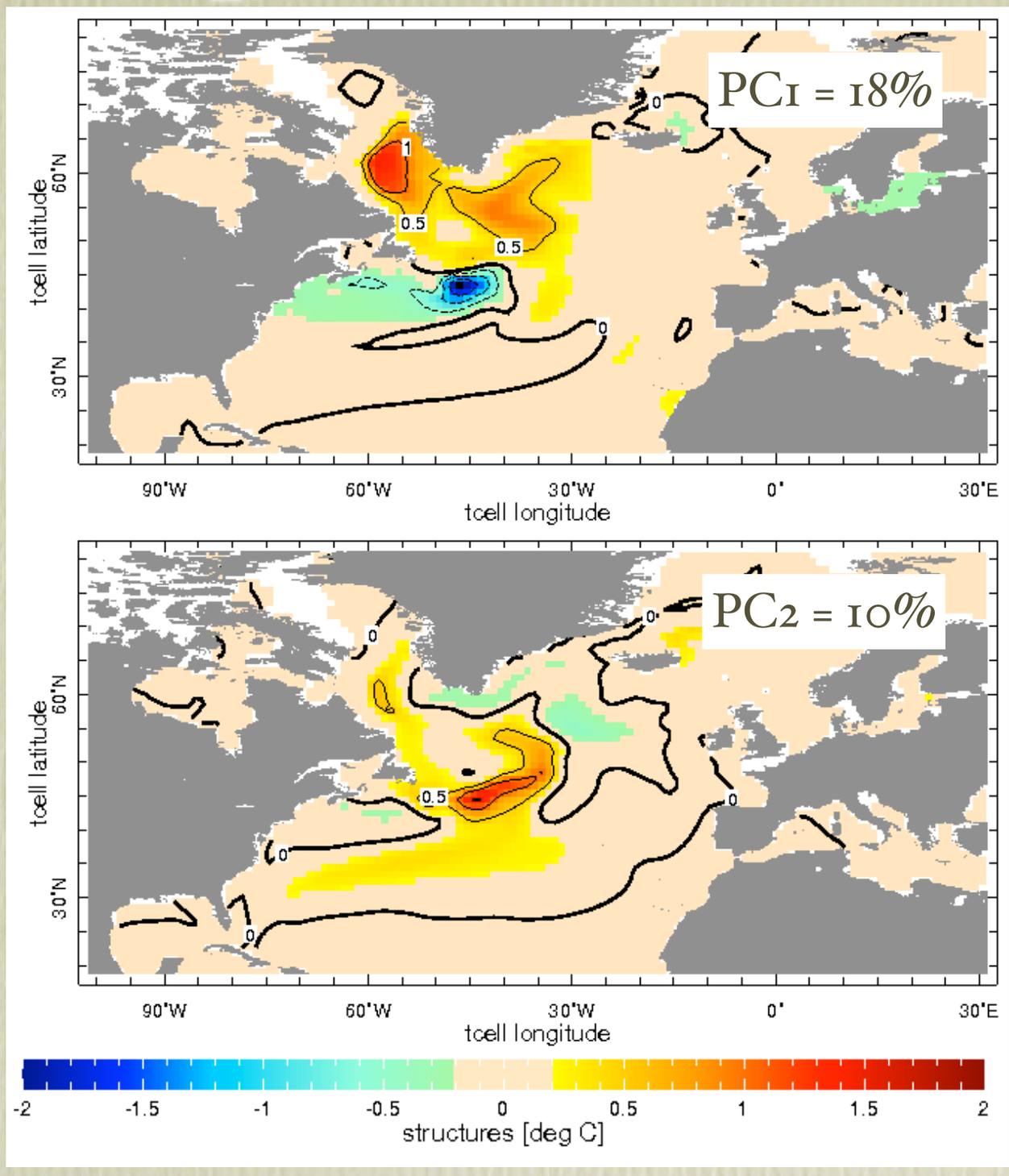


PCA of 5m Temperature







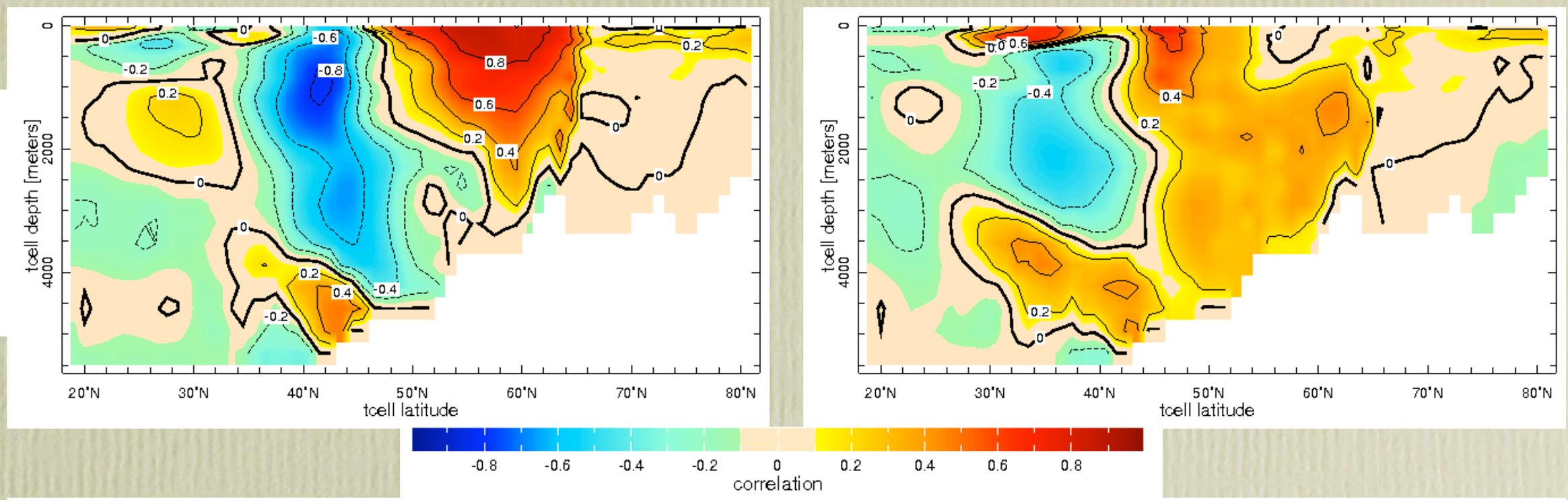
Patterns appear in quadrature in time. Does this imply propagation?

Vertical Structure (Atl x-average)

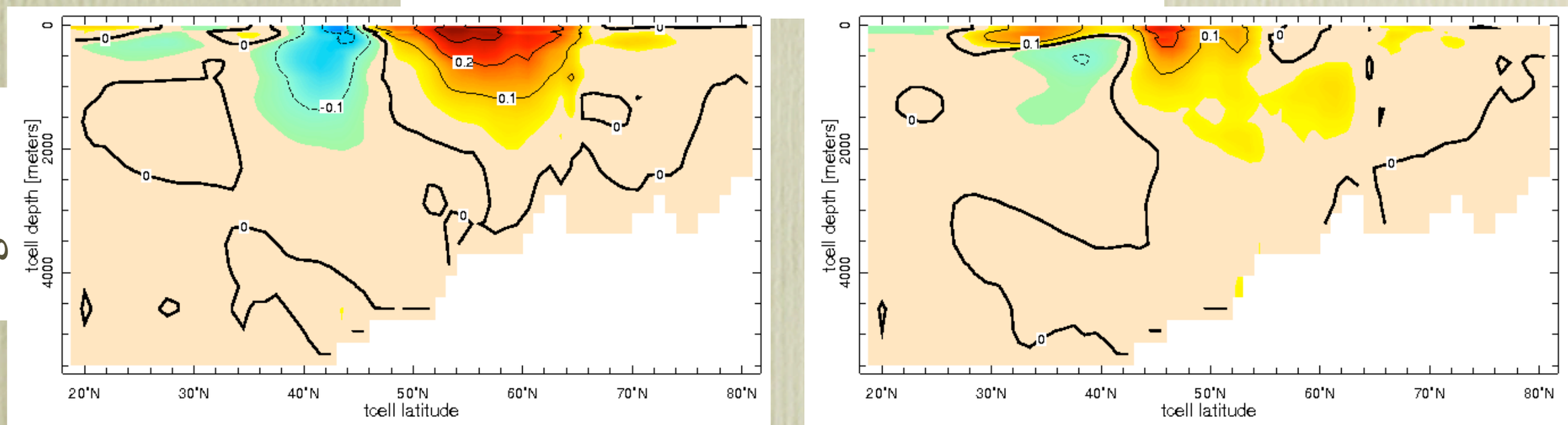
PC1 T_0(5m)

PC2 T_0(5m)

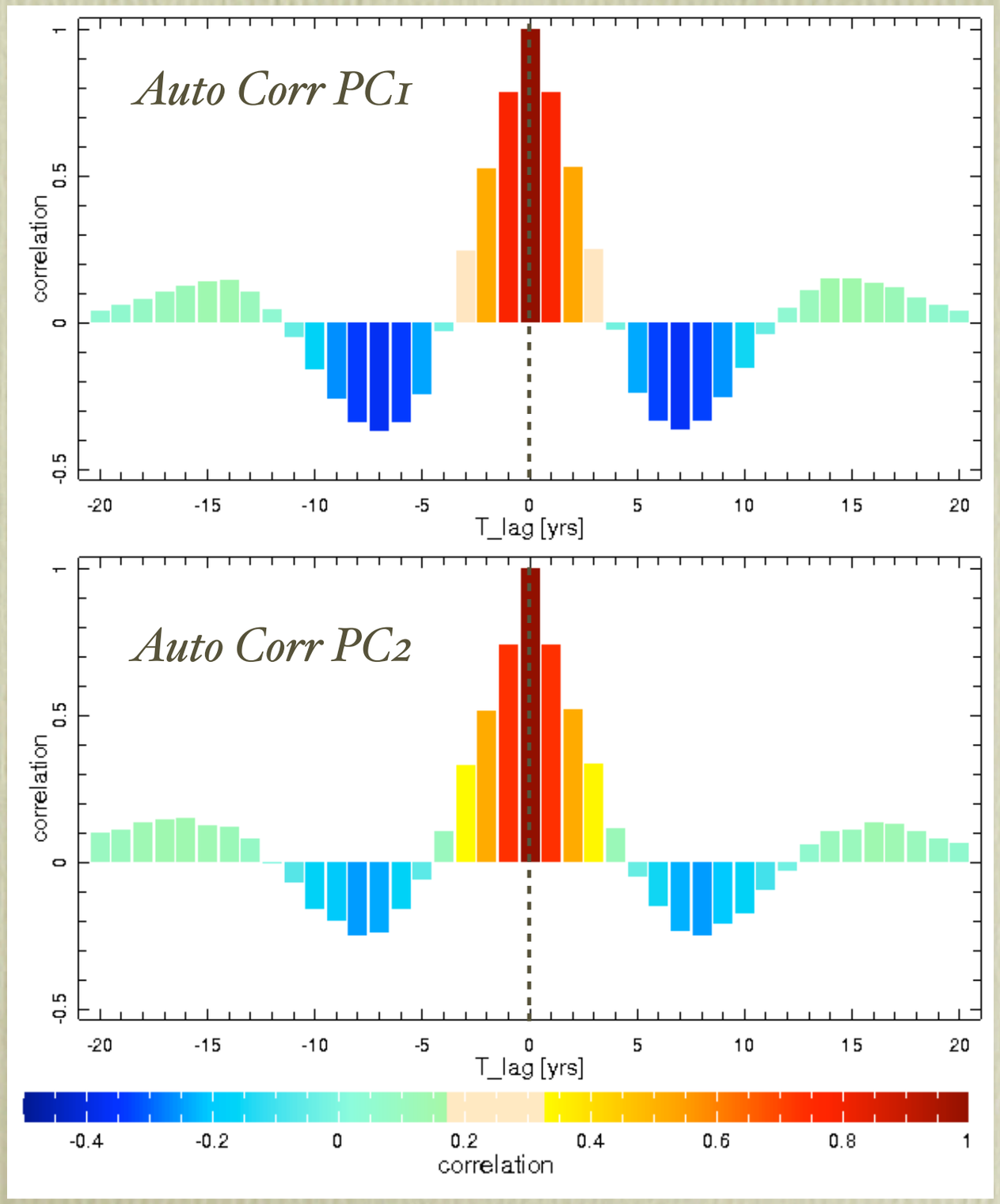
Correlation



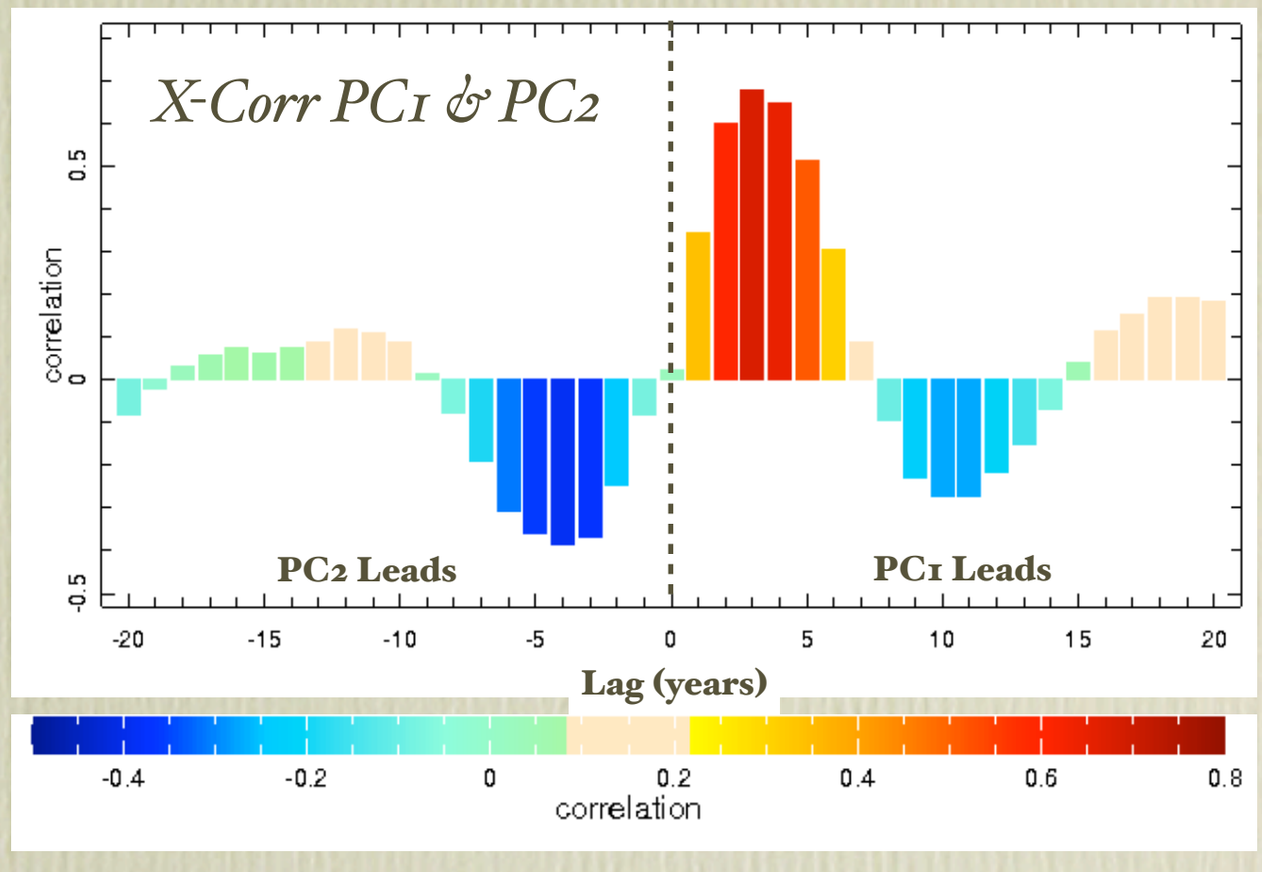
Regression



Time Scales of Variability

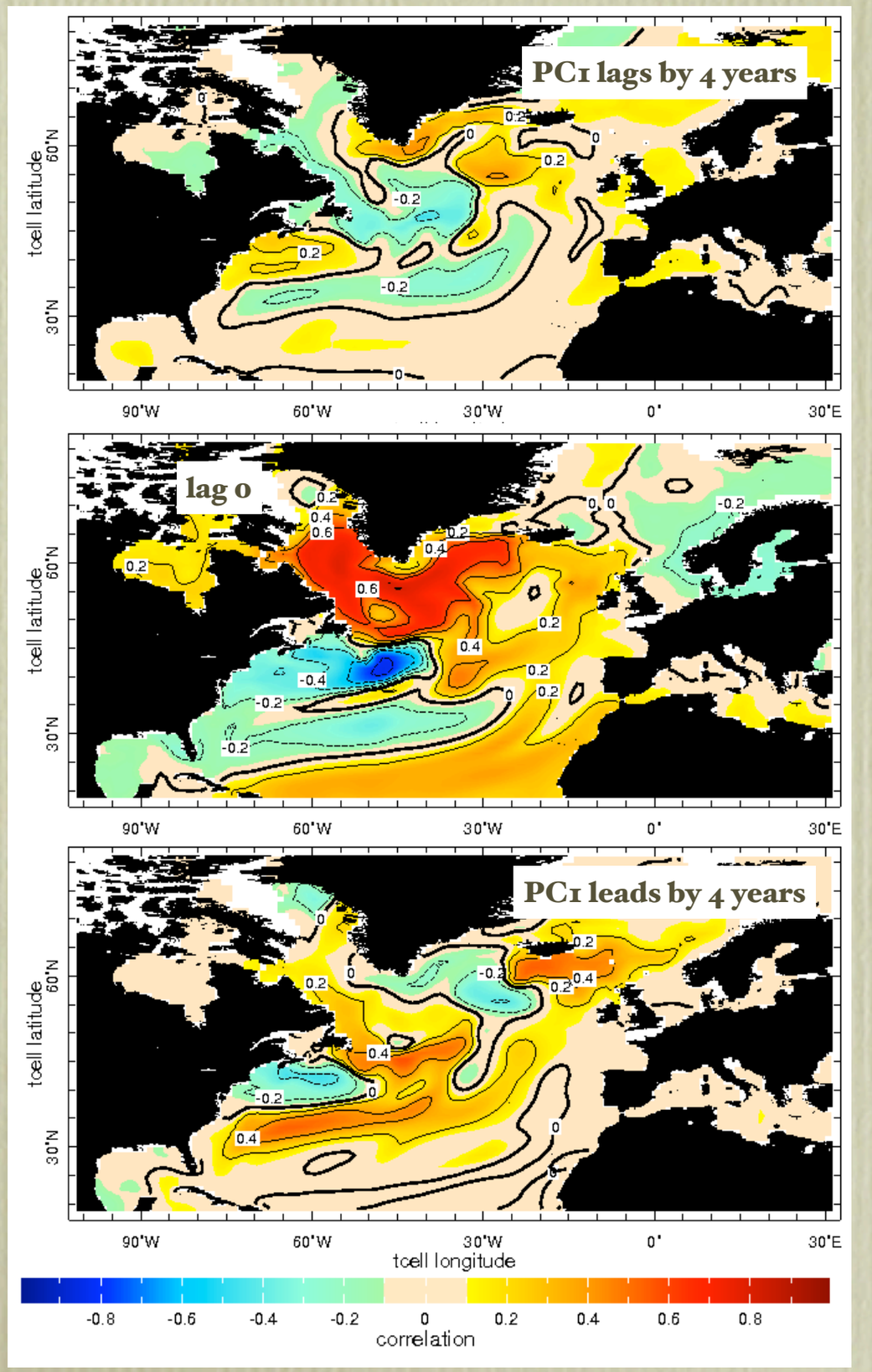


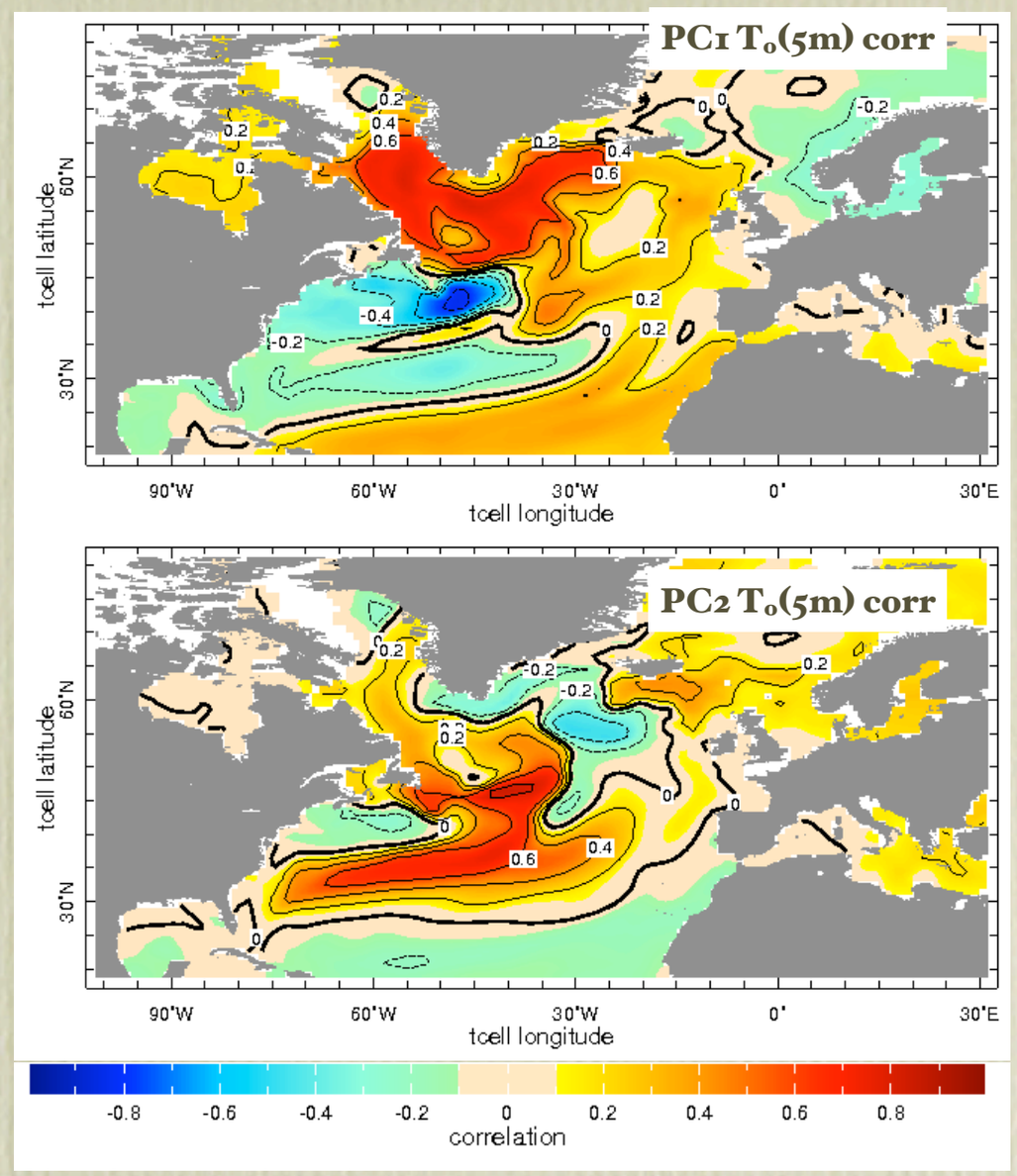
- Autocorrelation implies ~15 year period
- Time series are in quadrature with PC2 lagging PC1 by 3-4 years



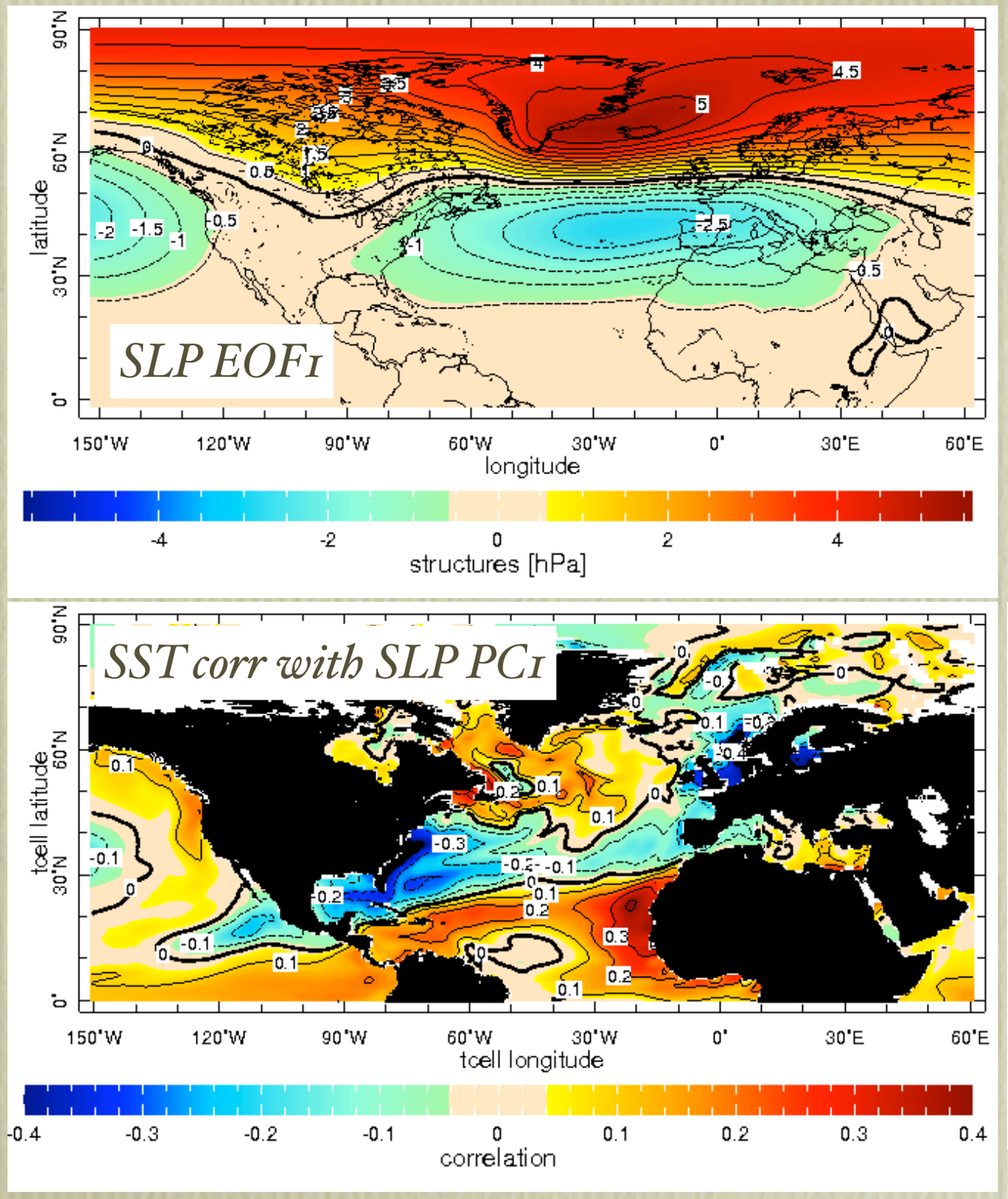
SST evolution

- Damped oscillations with transition between two states.
- Impression of southward propagation

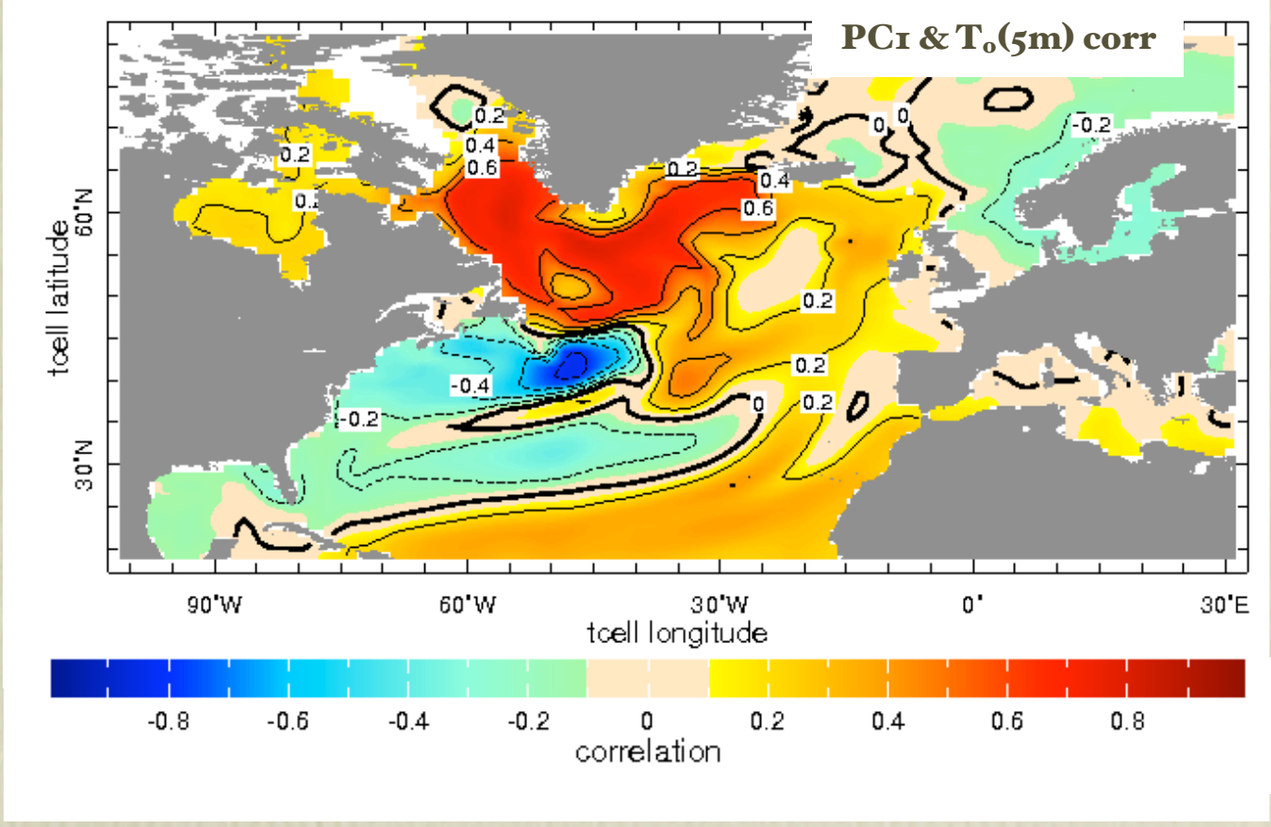




SLP EOF1 - models NAO



- SLP variability dominated by annular mode pattern (NAO) explaining 36% of total variance.
- SST footprint similar to observed, NAO forced, SST tripole, somewhat different from SST PC1
- Autocorrelation implies a very weak "oscillation" of about the same period as that of SST.



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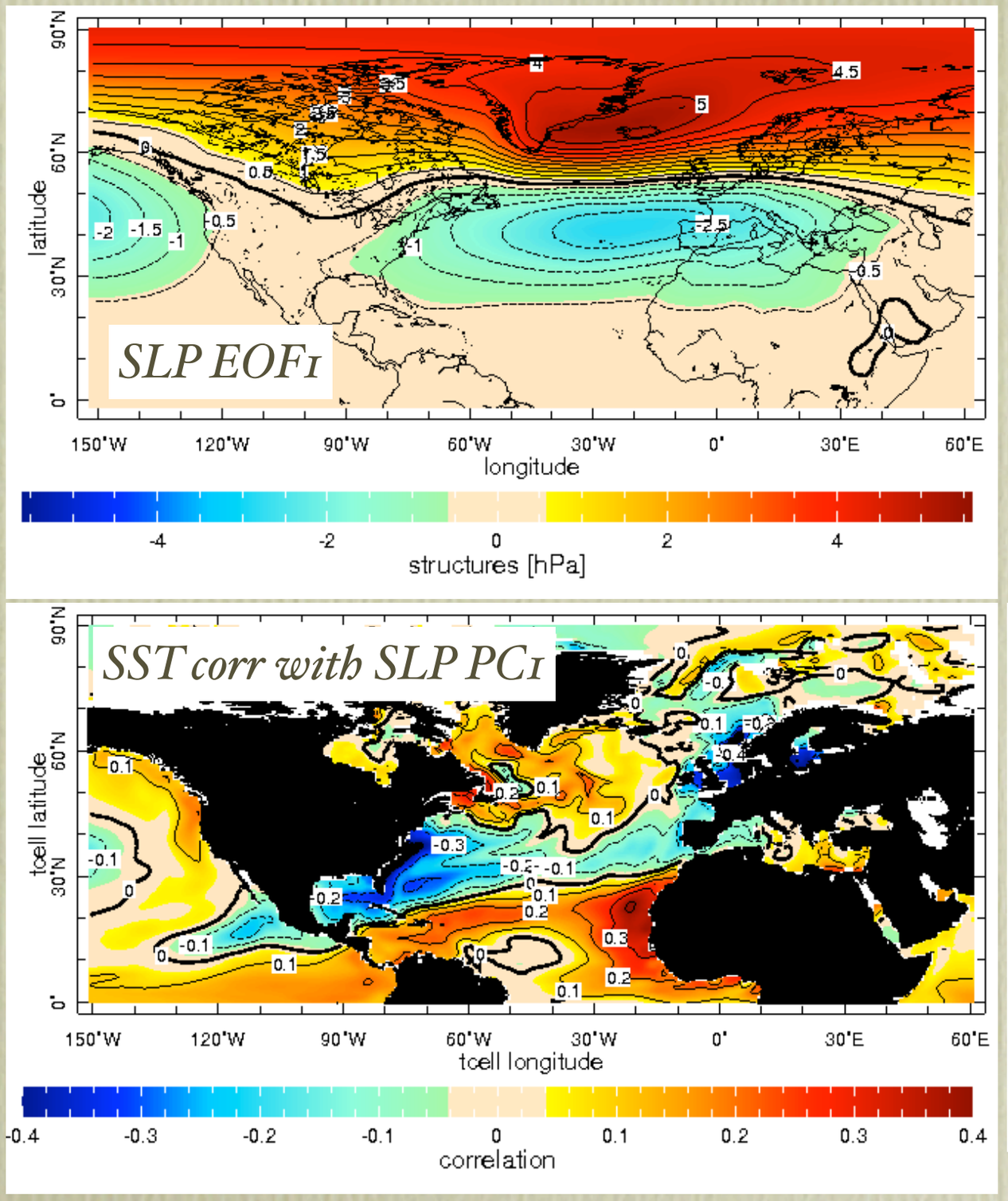

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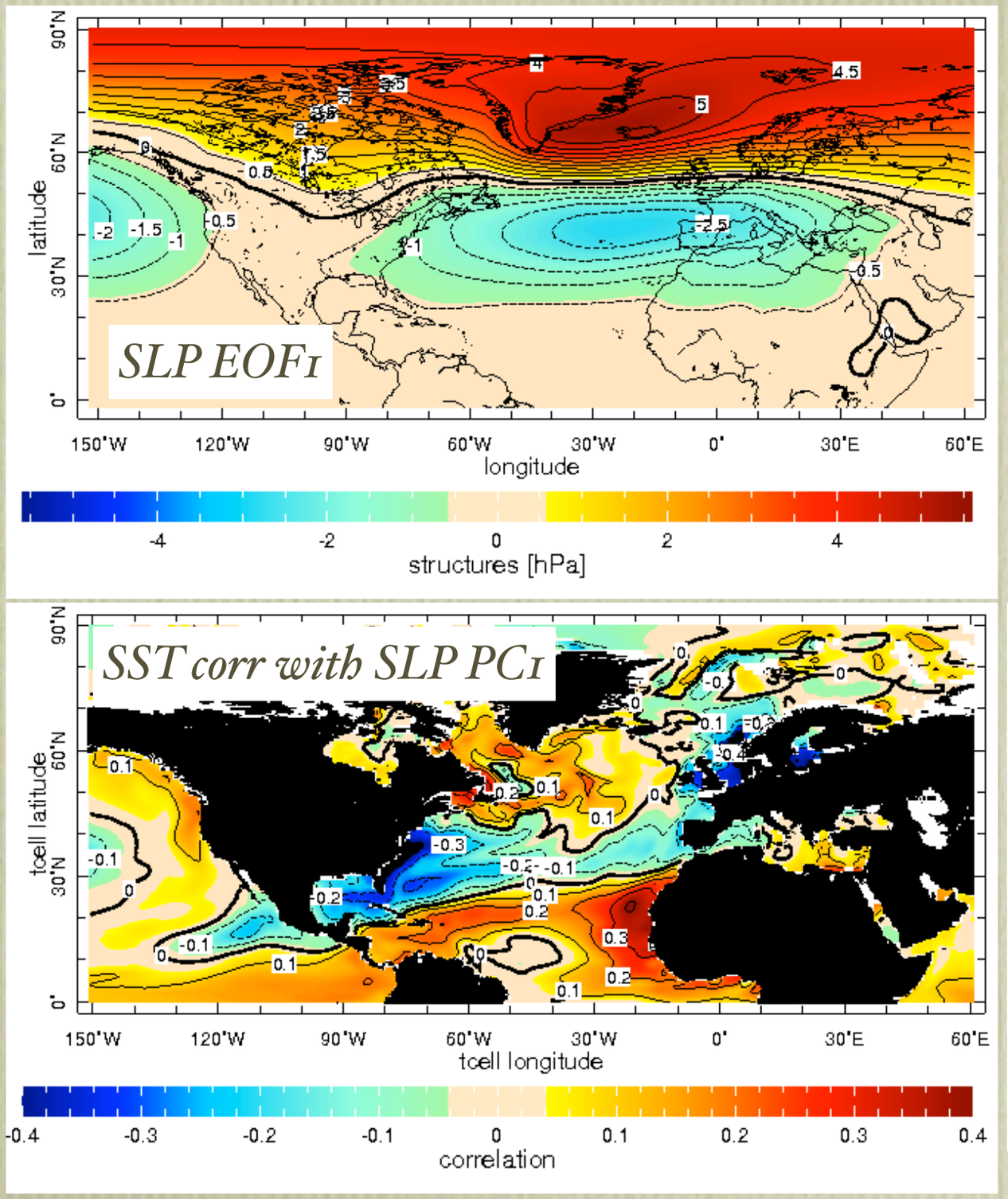

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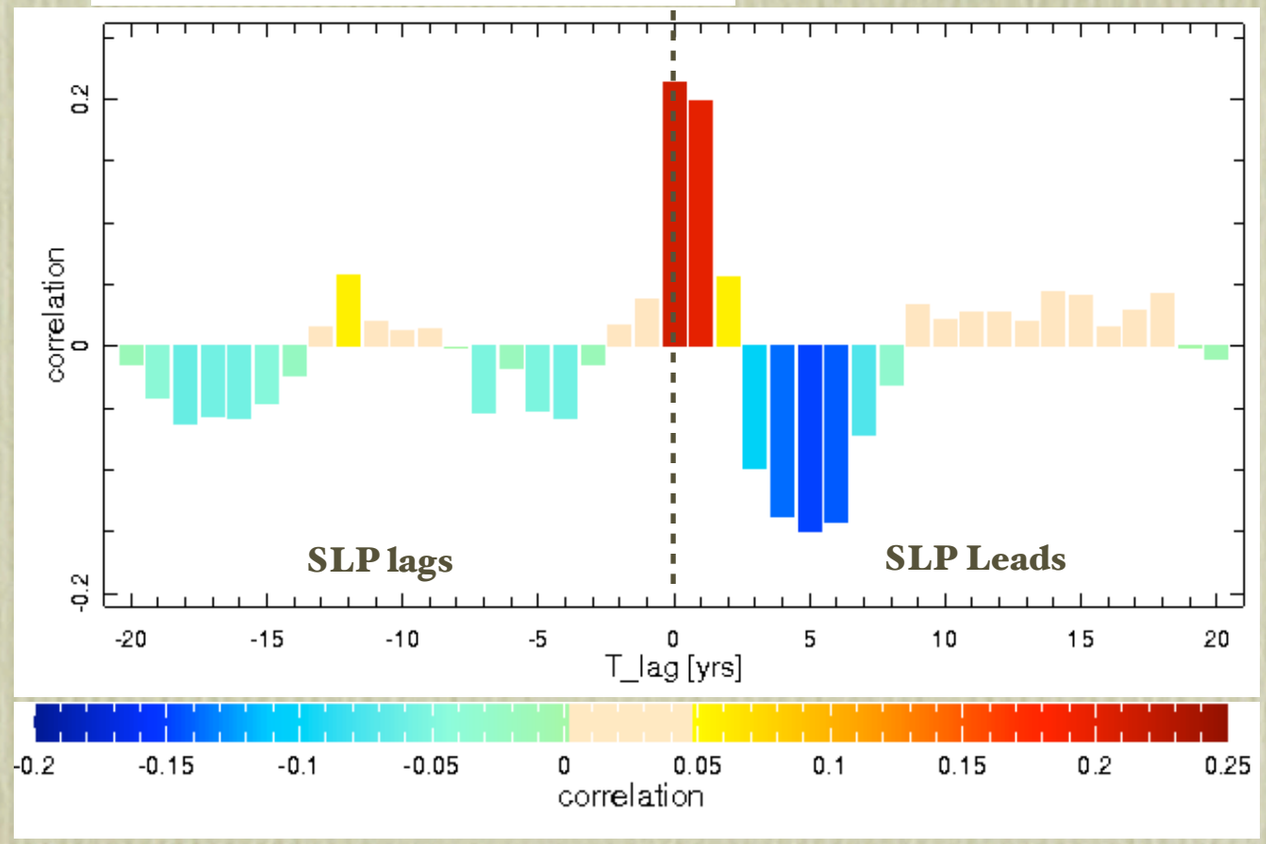
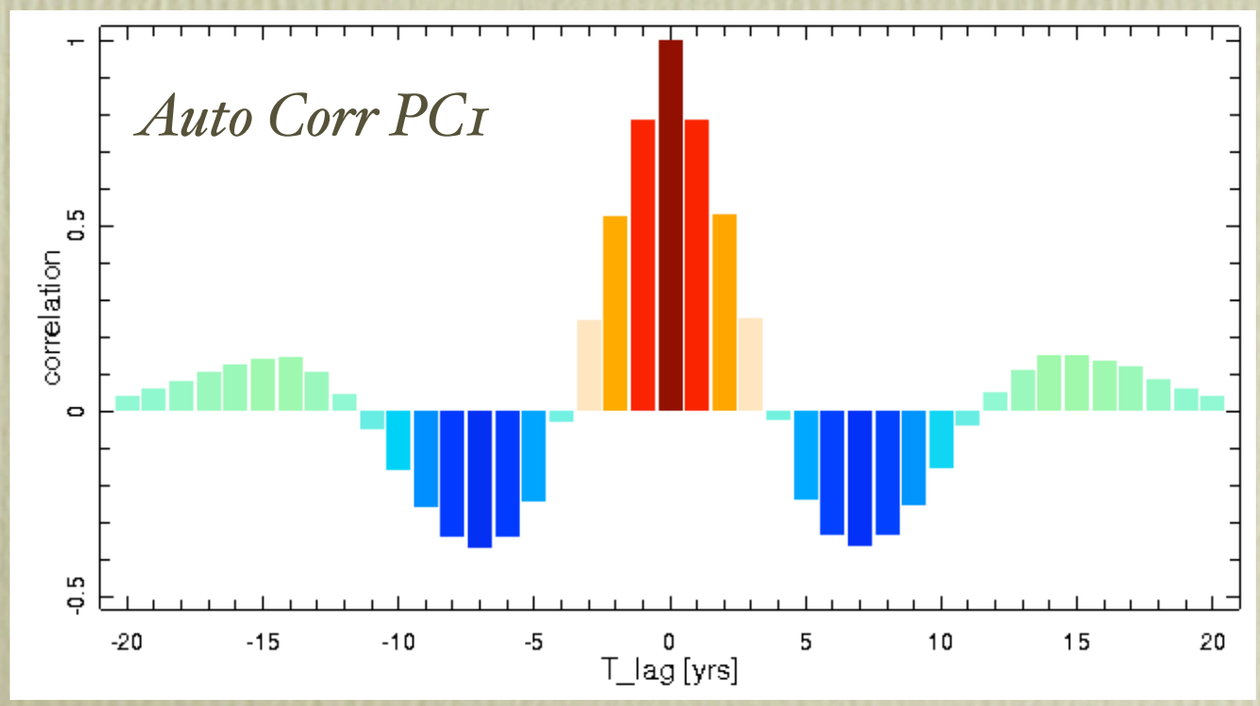
NAO forcing

Corr SLP PC1 & SST PC1





SLP variability dominated by annular mode pattern (NAO) explaining 36% of total variance. PC has very weak "oscillation" of about the same period as that of SST.

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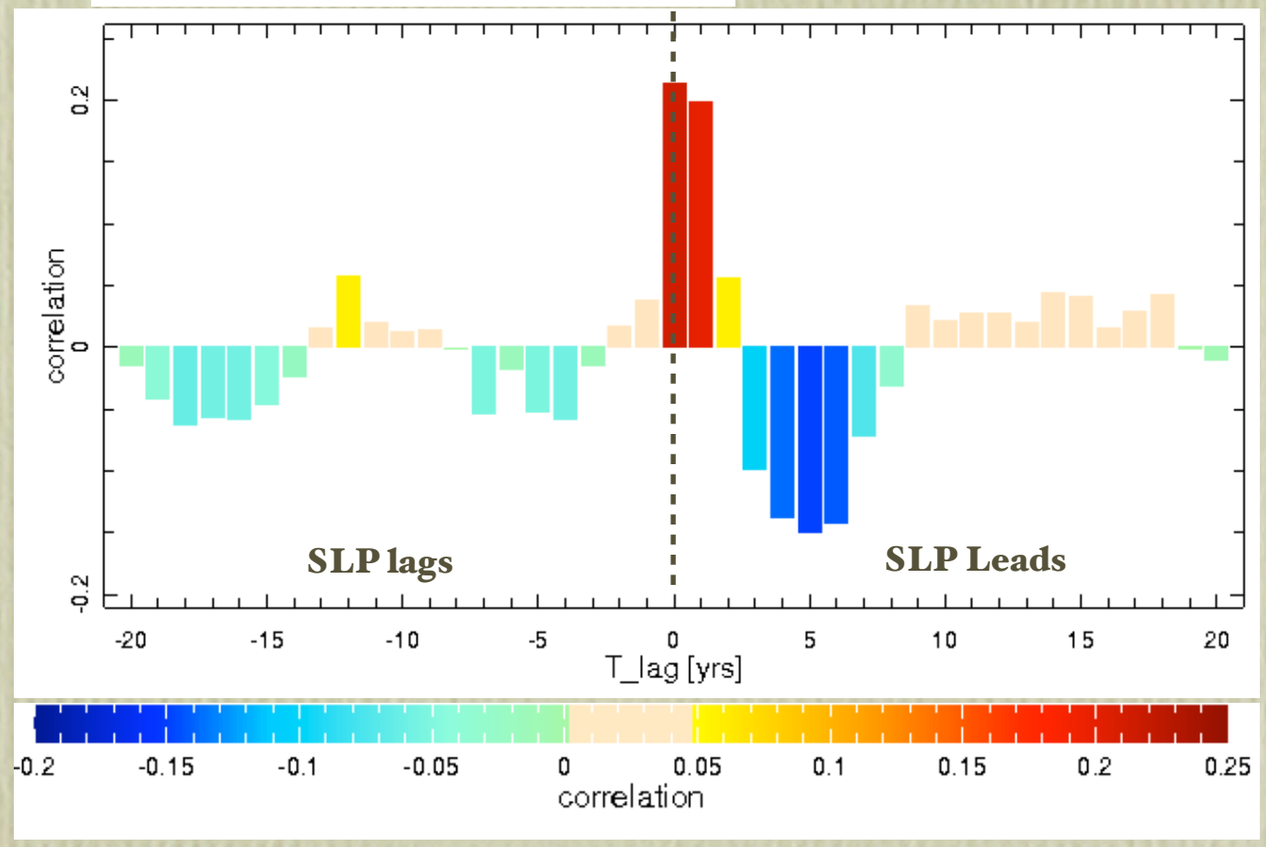
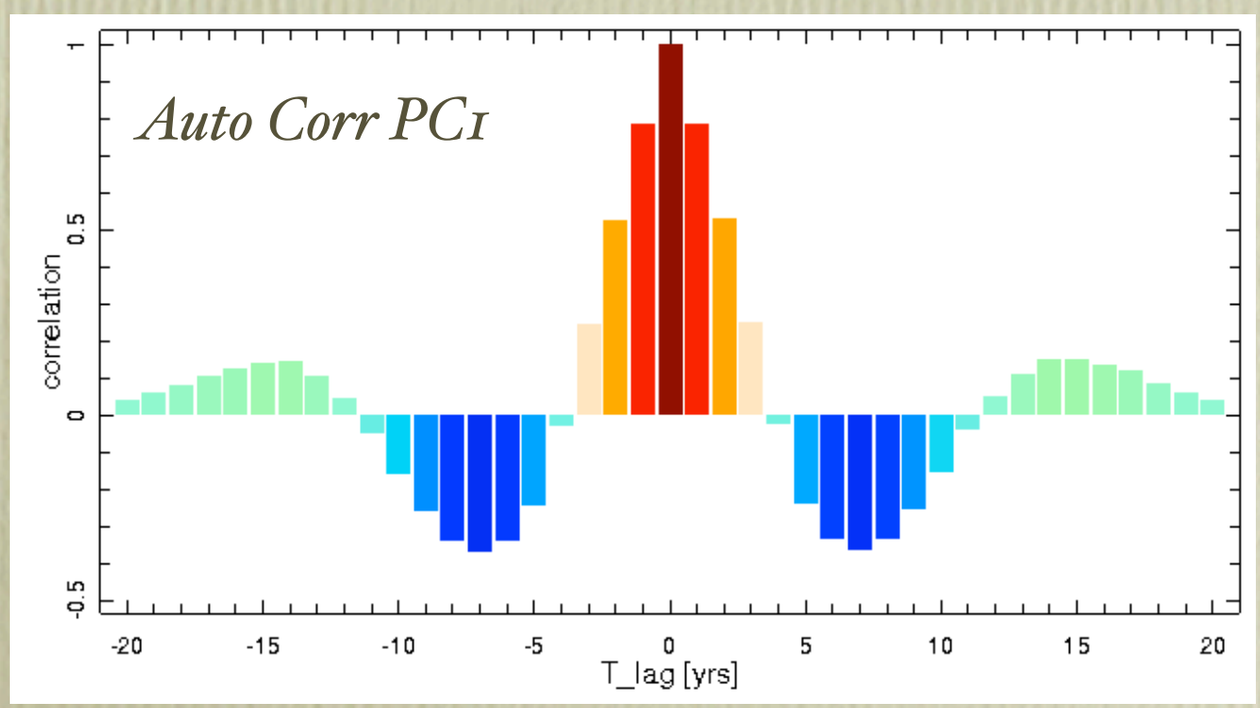
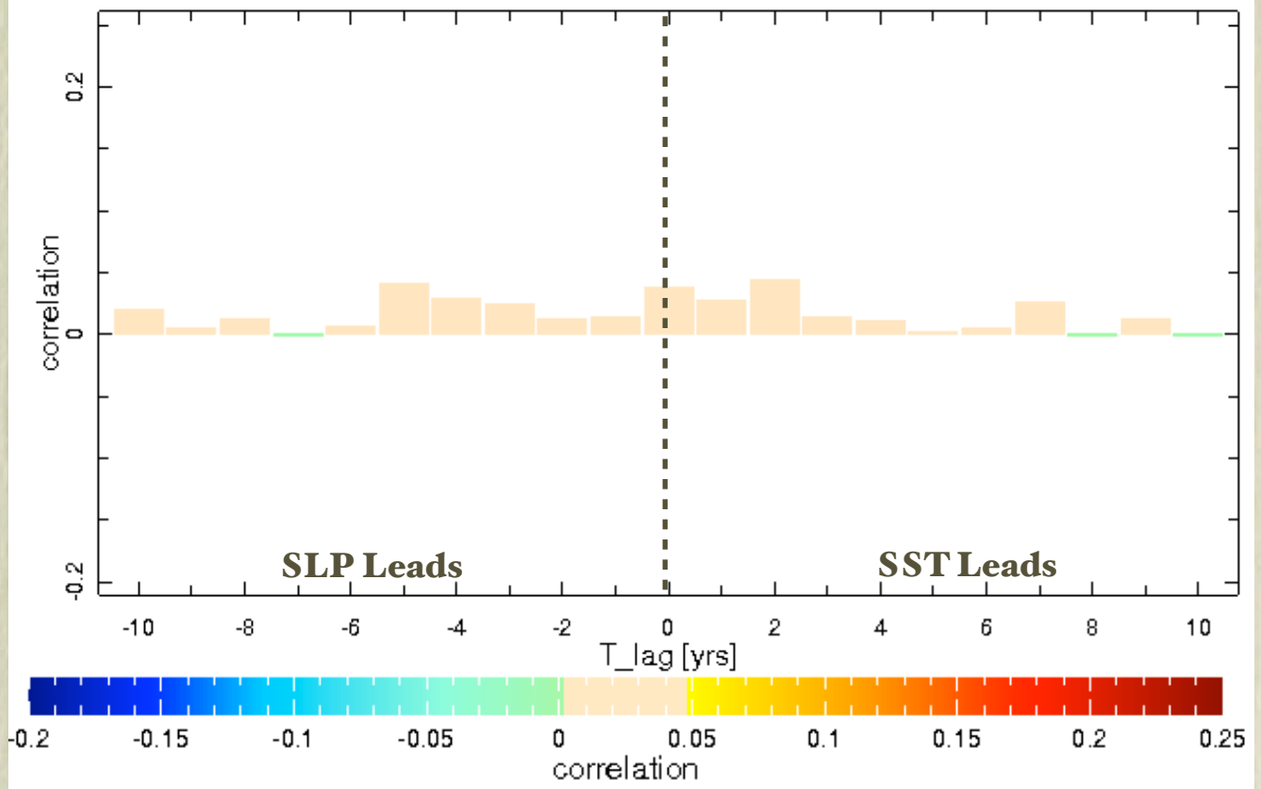


SLP variability dominated by annular mode pattern (NAO) explaining 36% of total variance. PC has very weak "oscillation" of about the same period as that of SST.

Auto Corr PC1

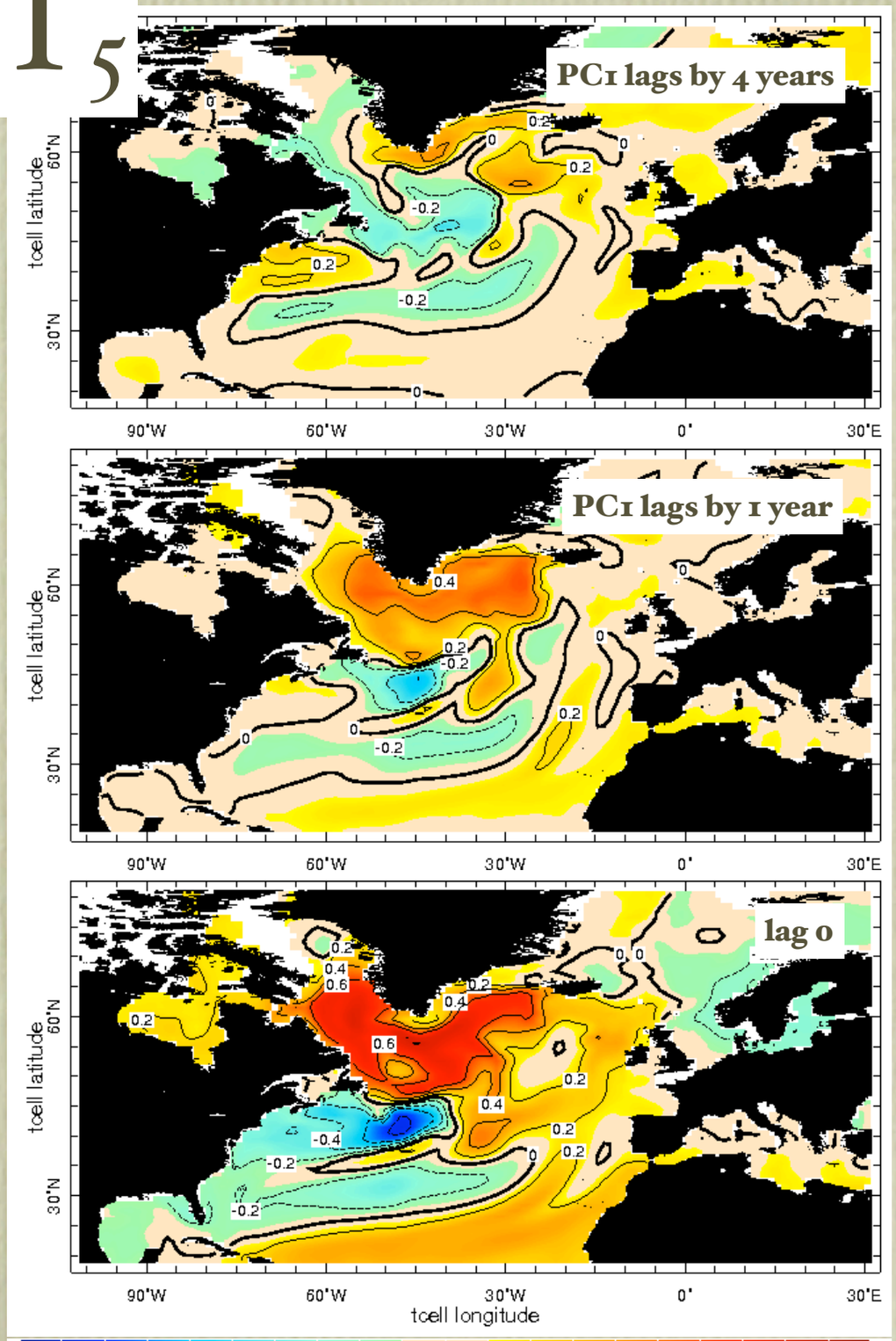


Corr SST PC1 yrs 2001-2500 & SLP PC1 yrs 1-500

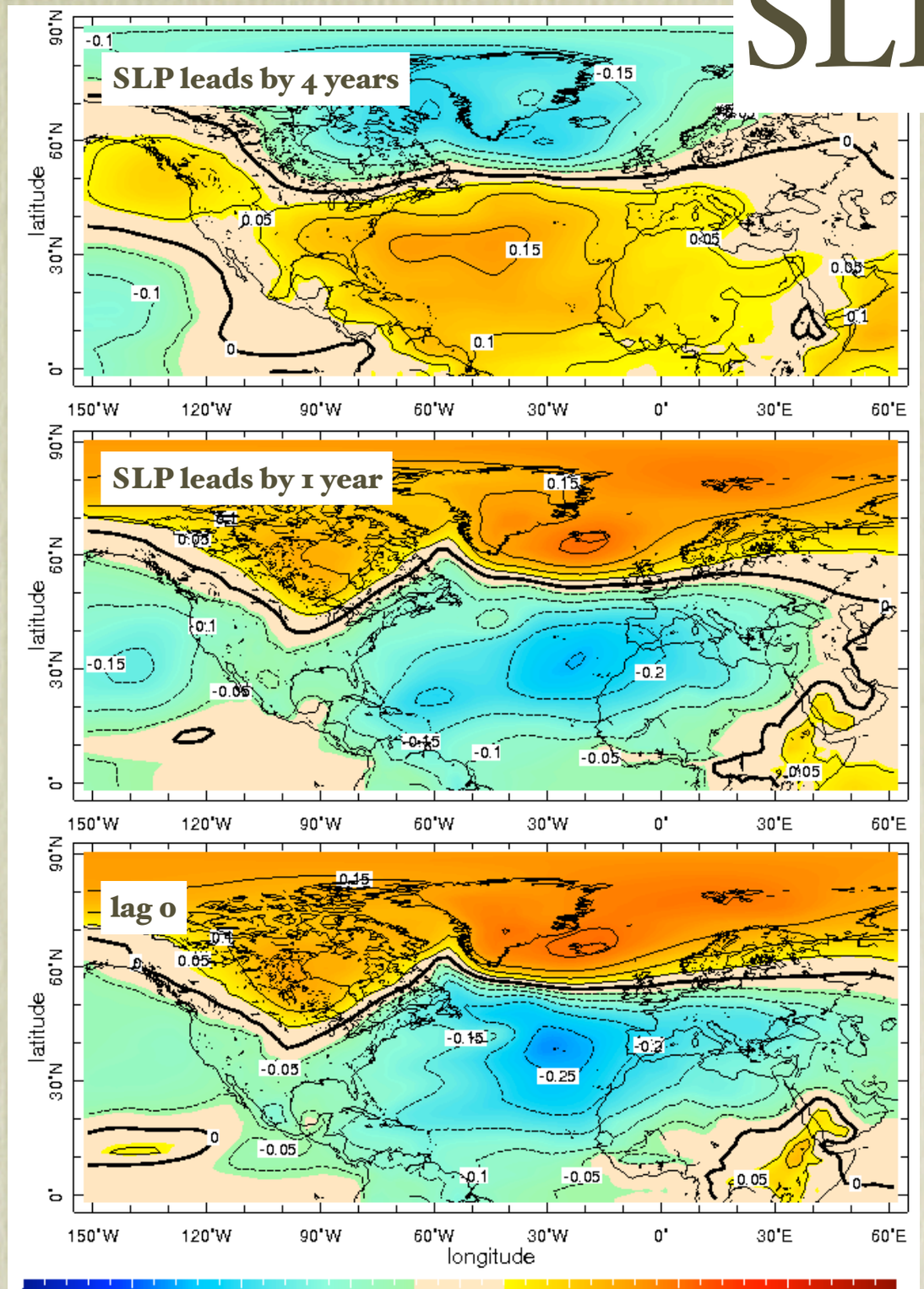


T5 PC1 correlation with T_5 & SLP

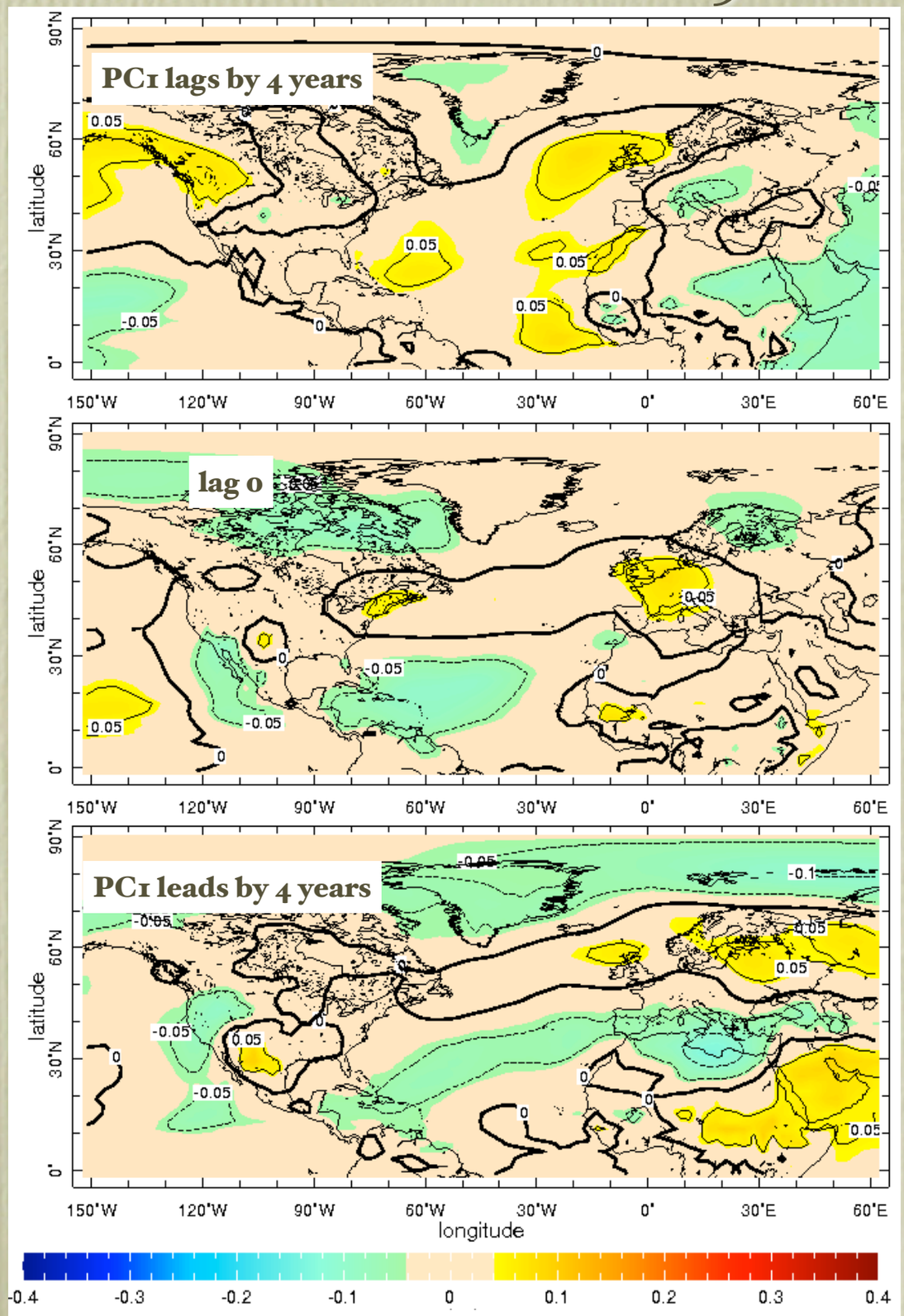
T_5



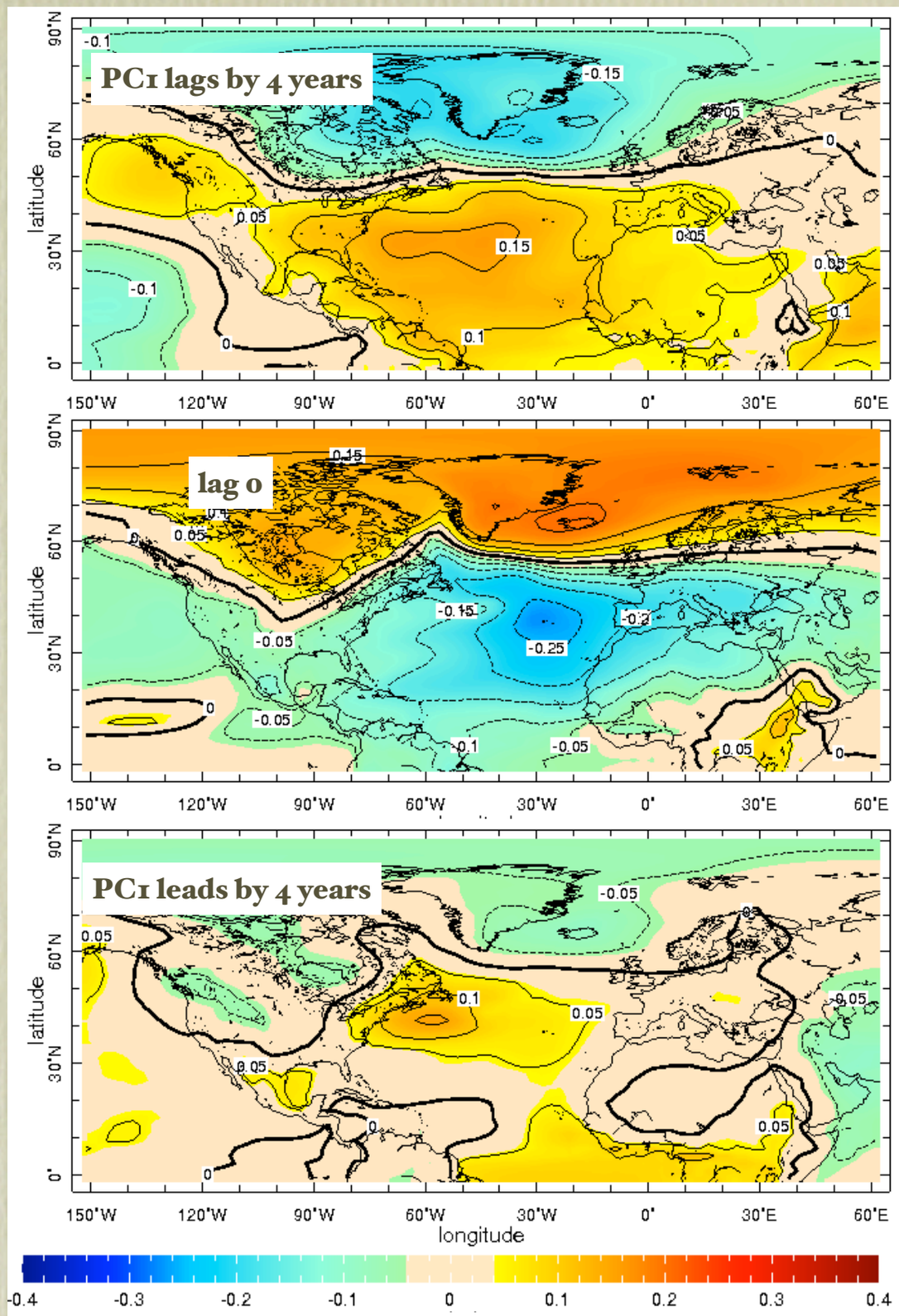
SLP



PC1 of T_5 - SLP correlation

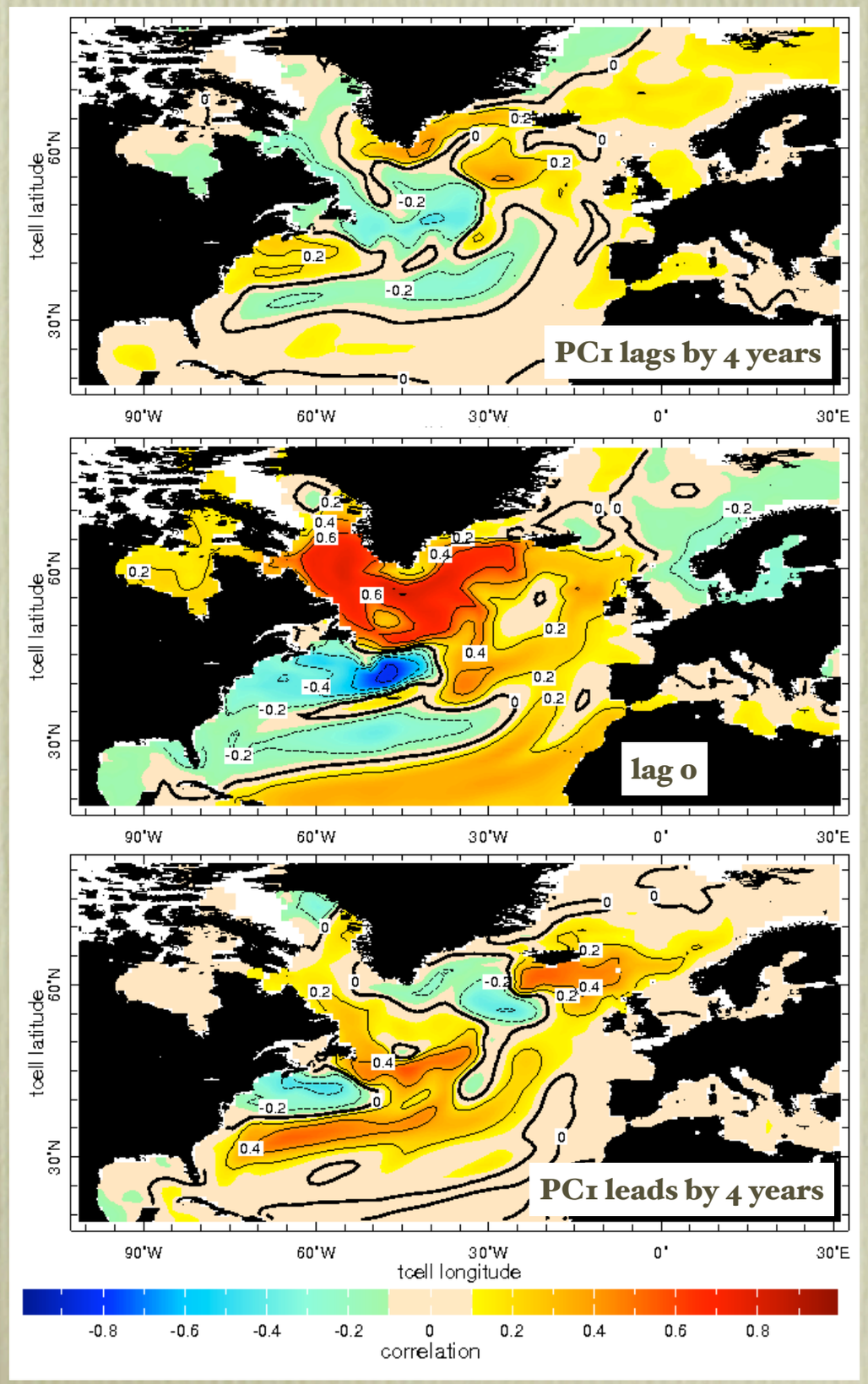


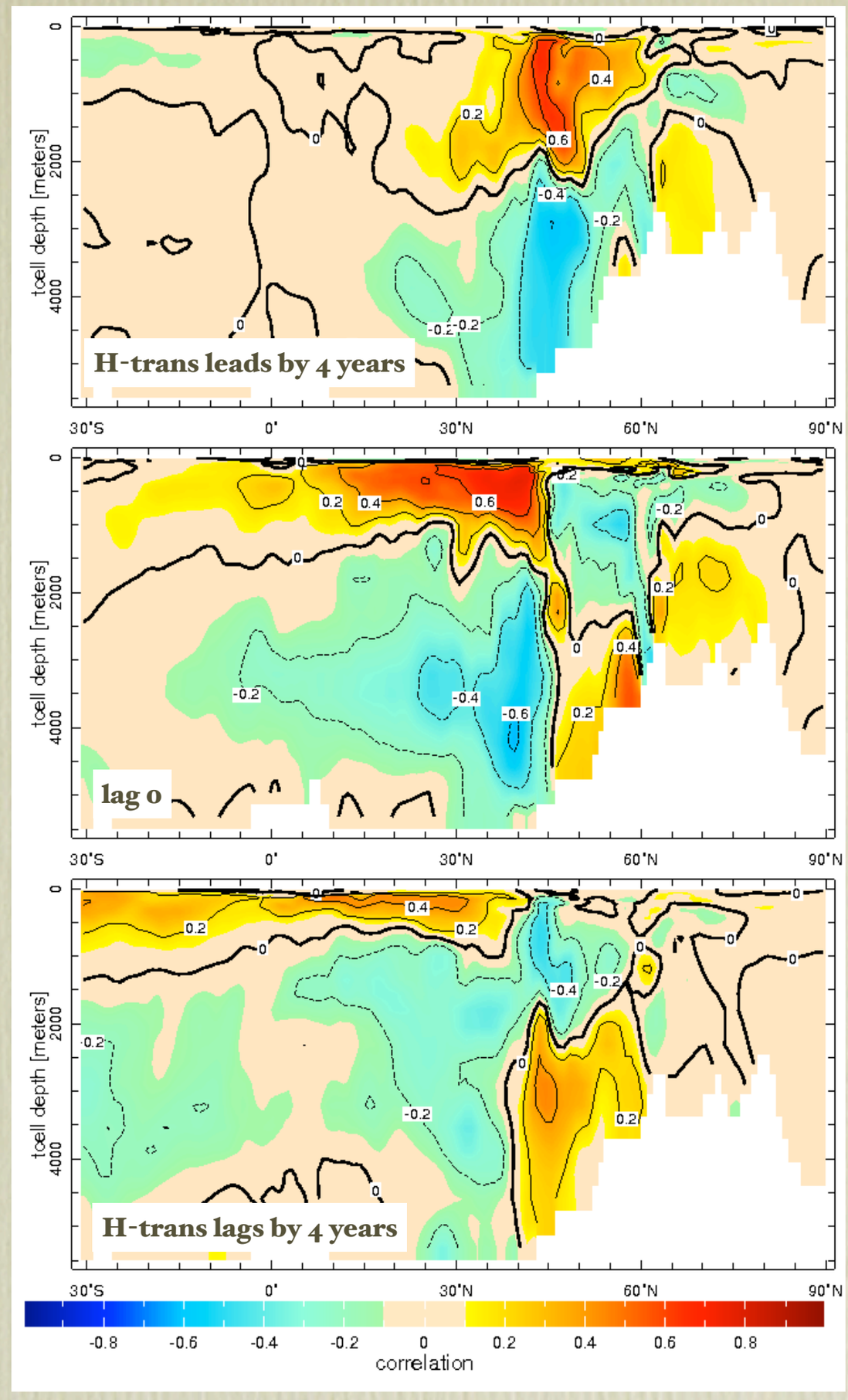
SLP from YEARS 1-500



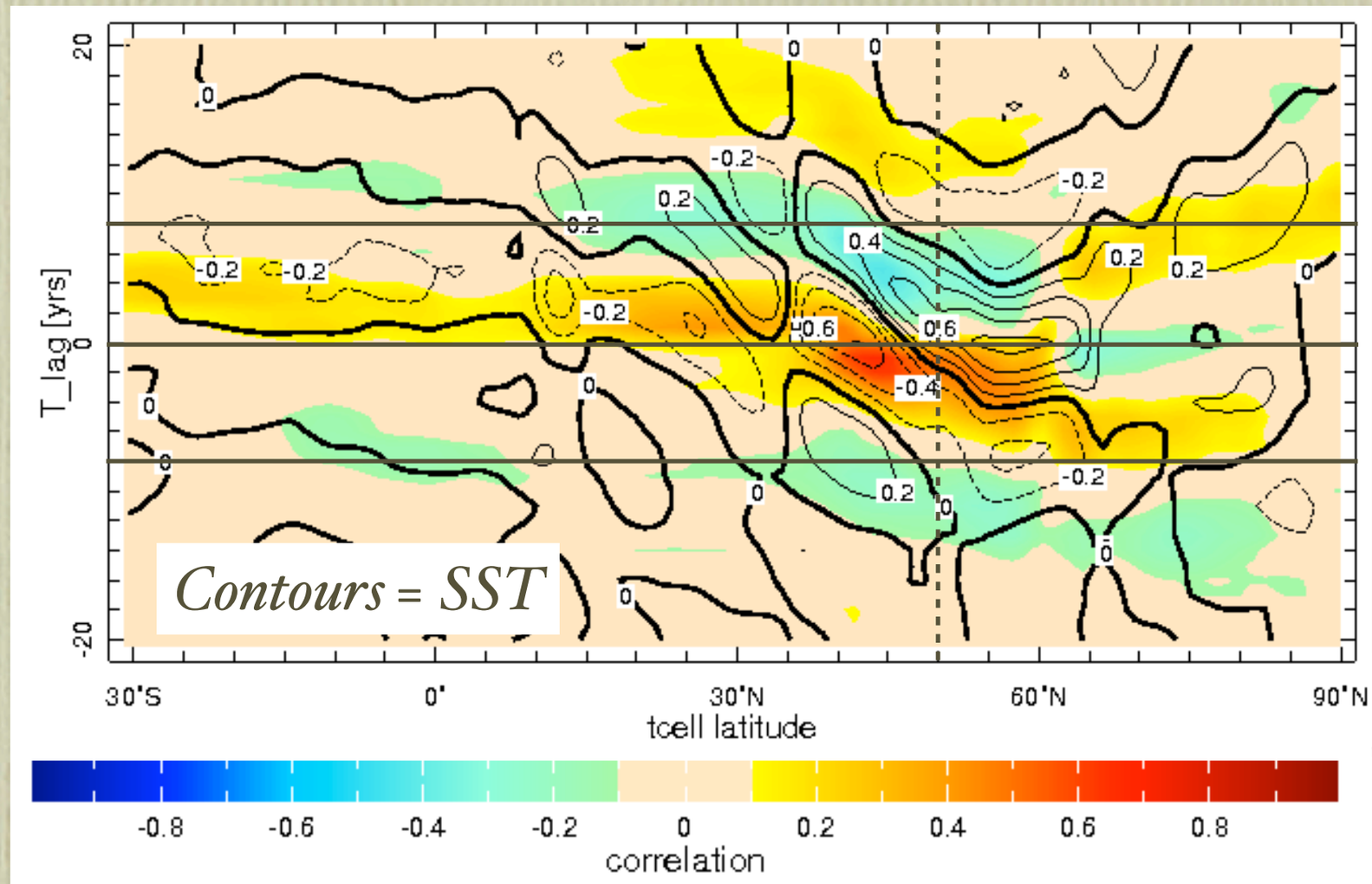
SLP from YEARS 2001-2500

SST & Heat transport

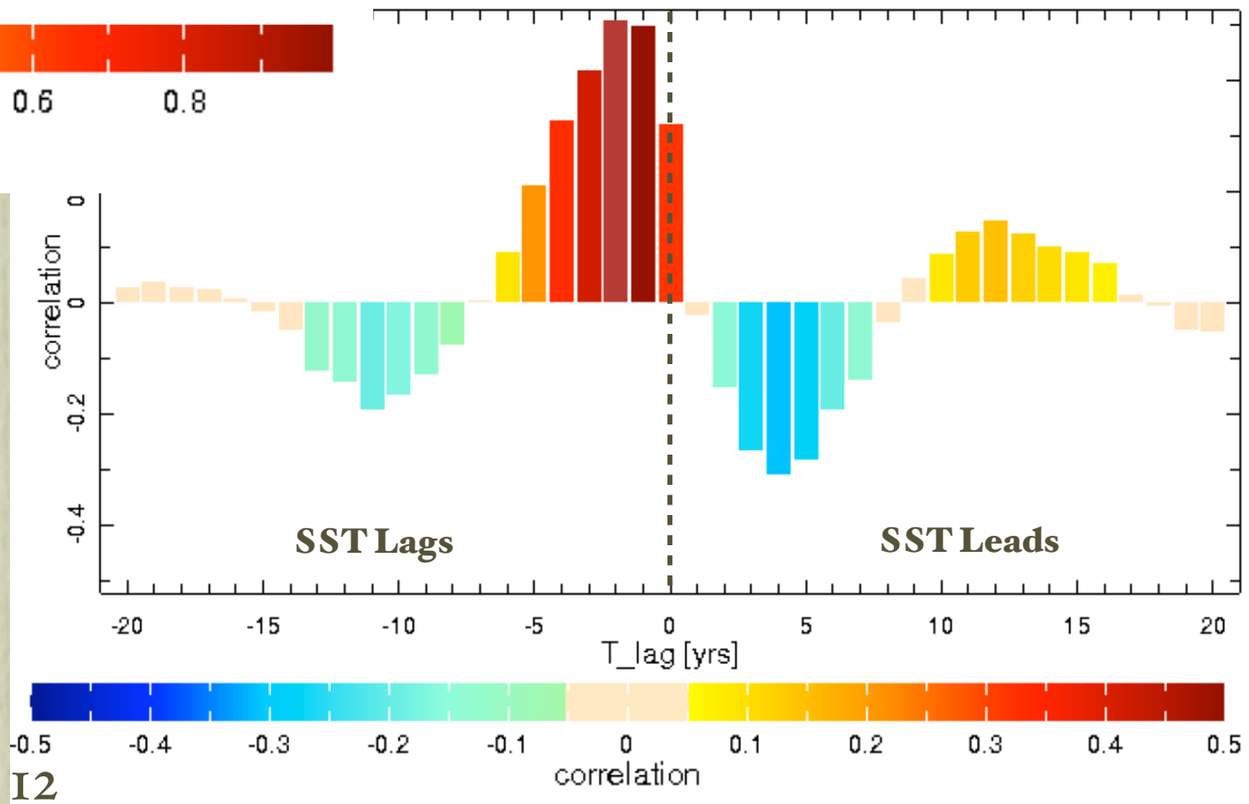




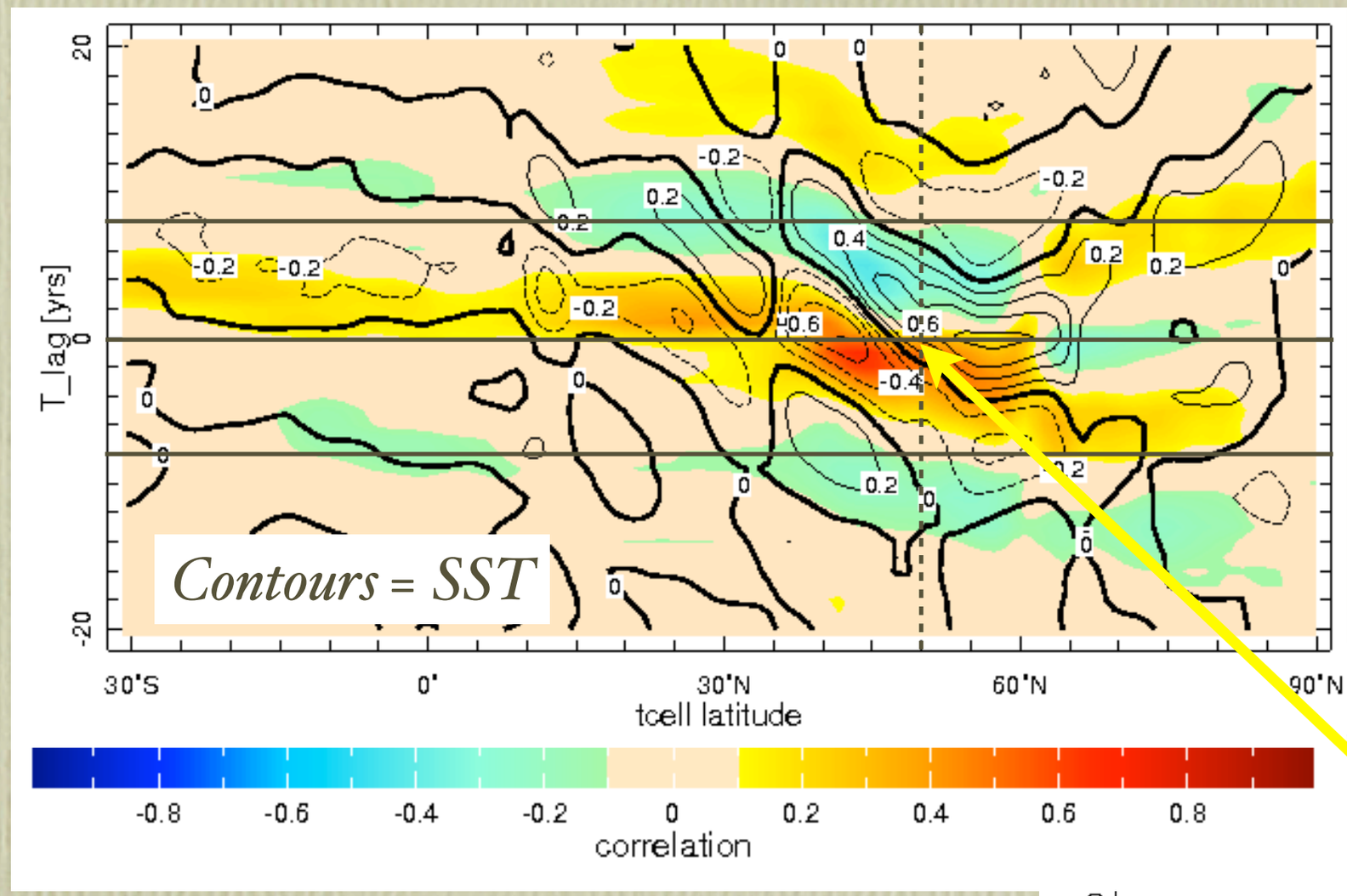
0-1000 m H-content & H-ytrans



Corr SST PC1 & H-ytrans @ 50°N



0-1000 m H-content & H-ytrans



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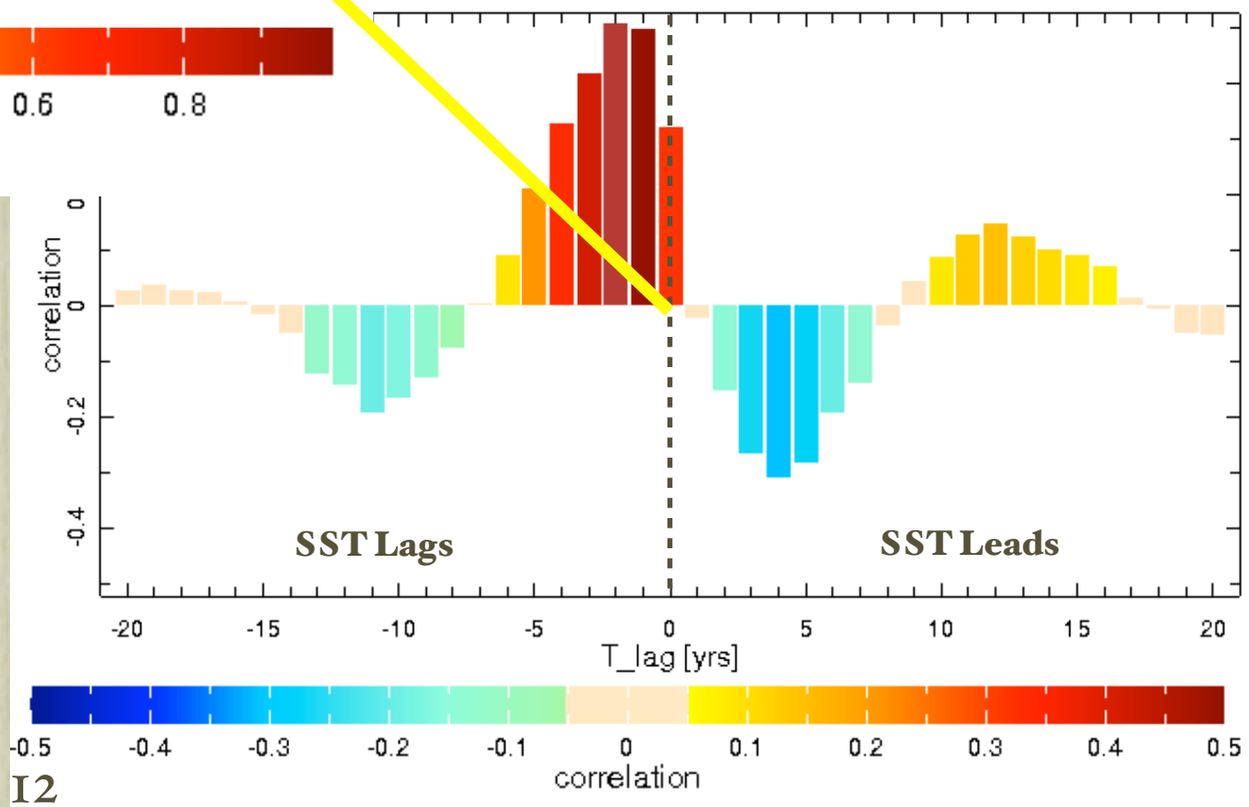
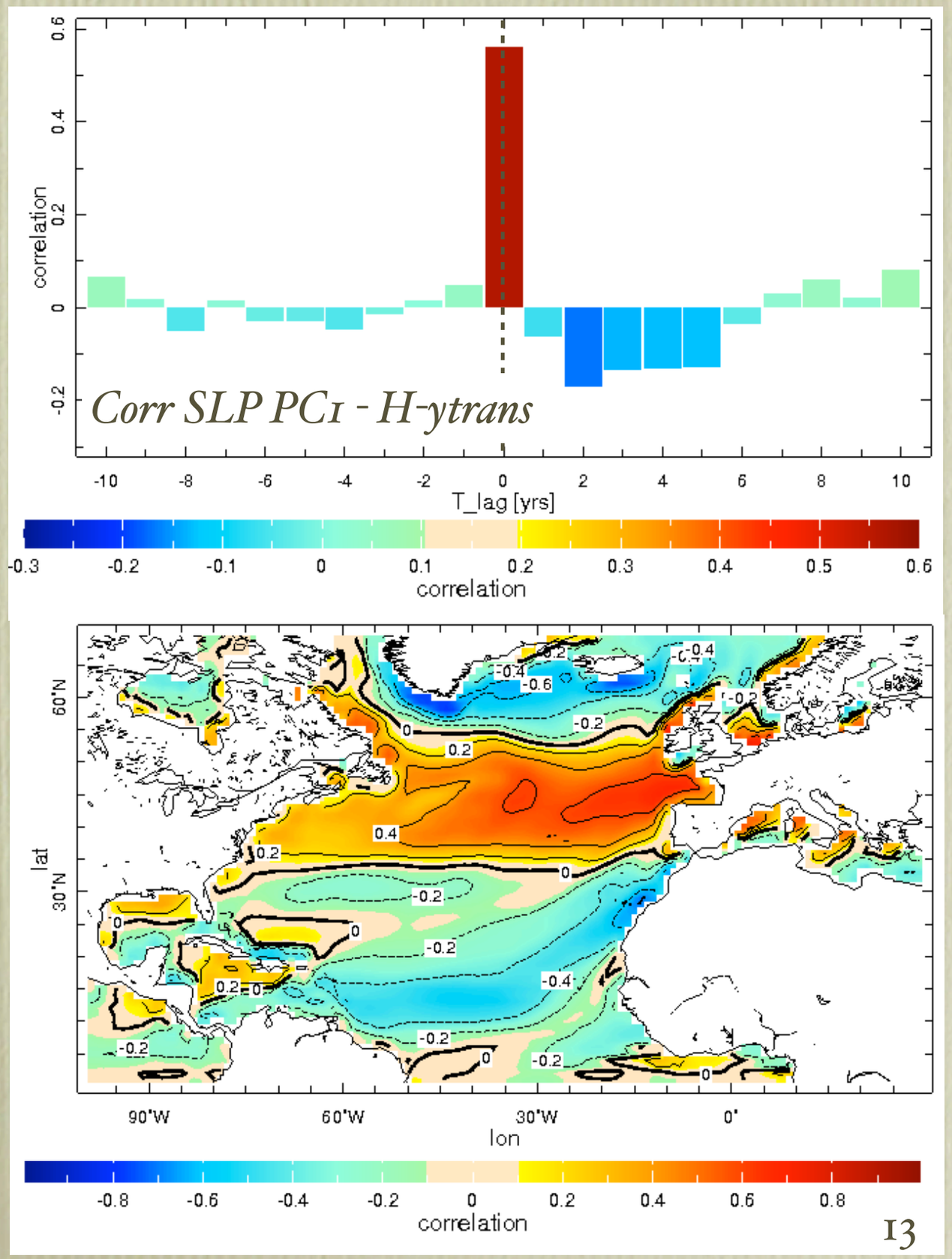
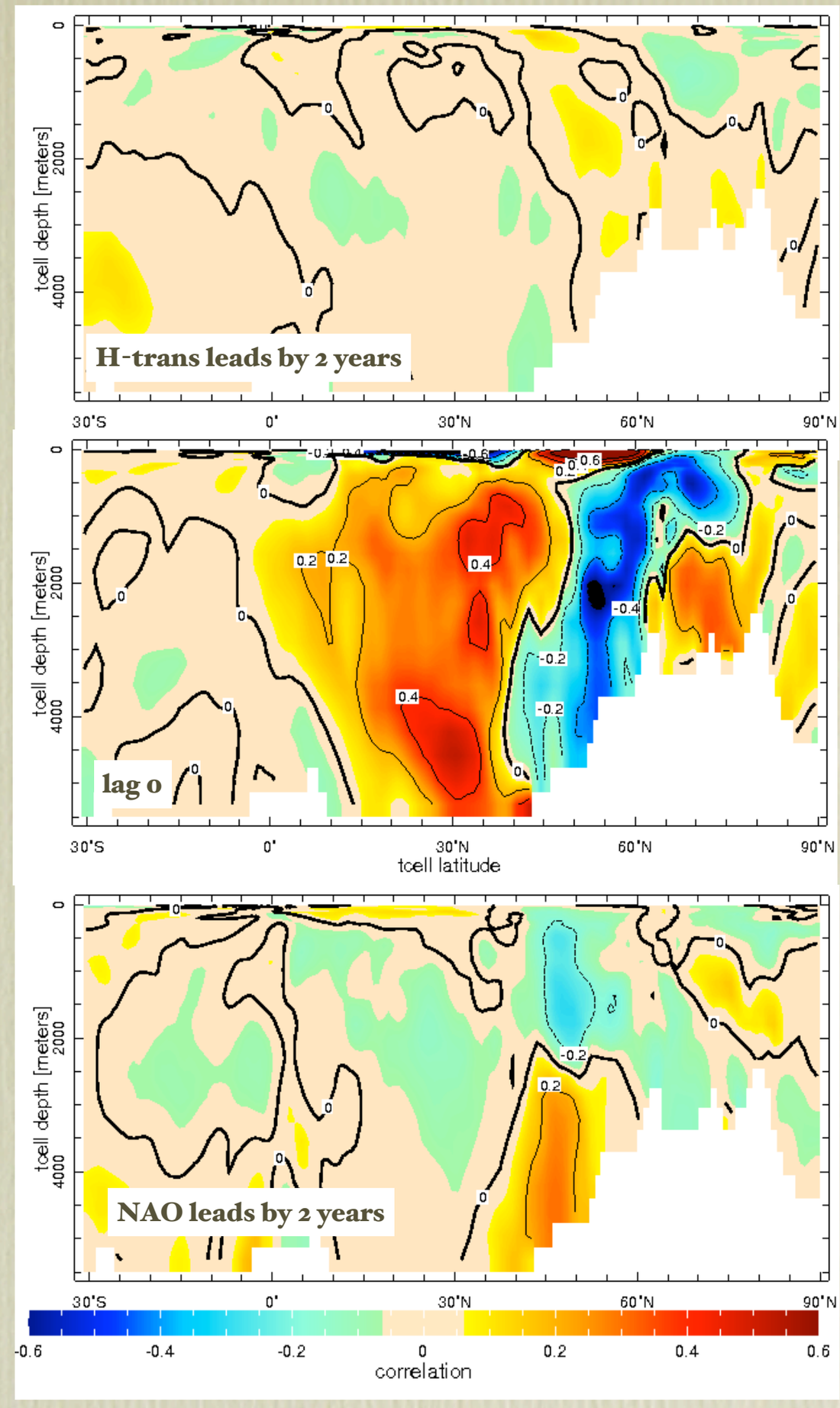
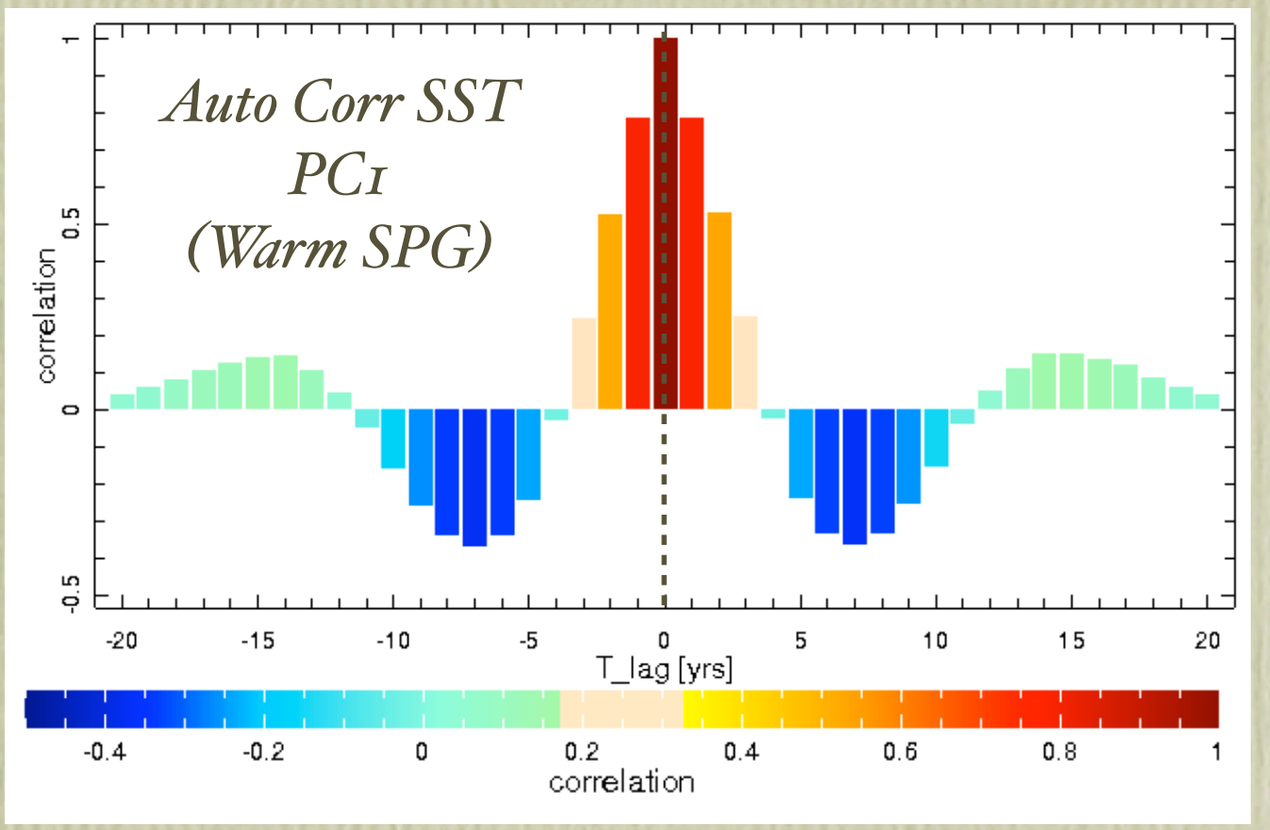


NAO & Heat transport





NAO & AMV relationships



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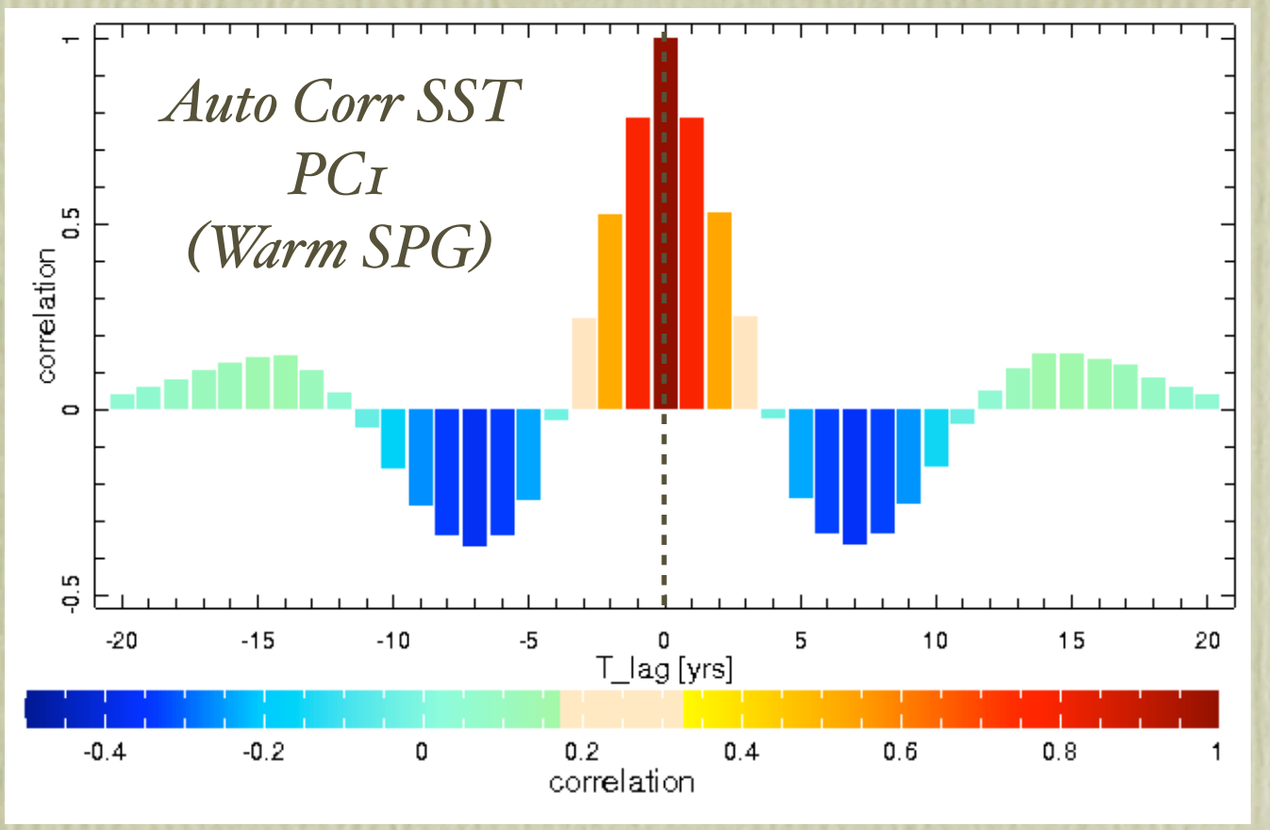

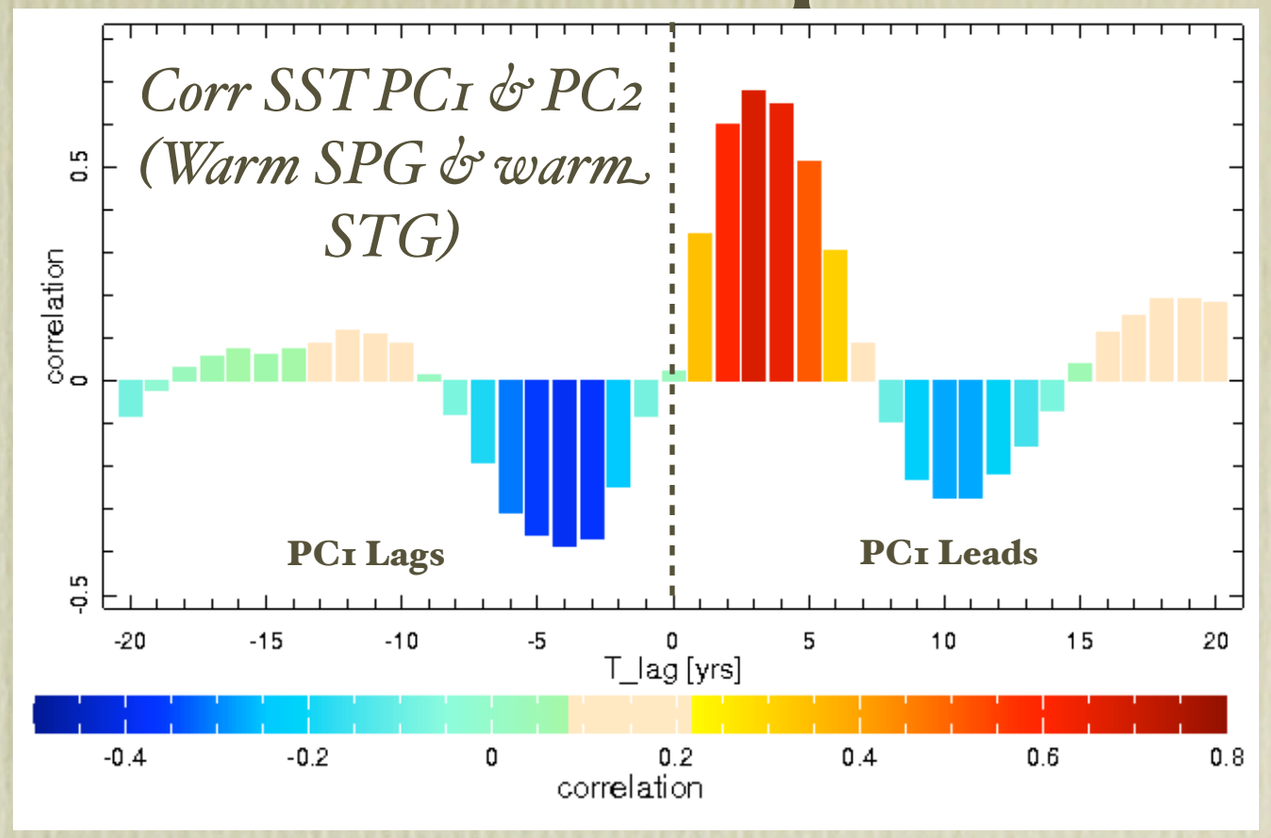

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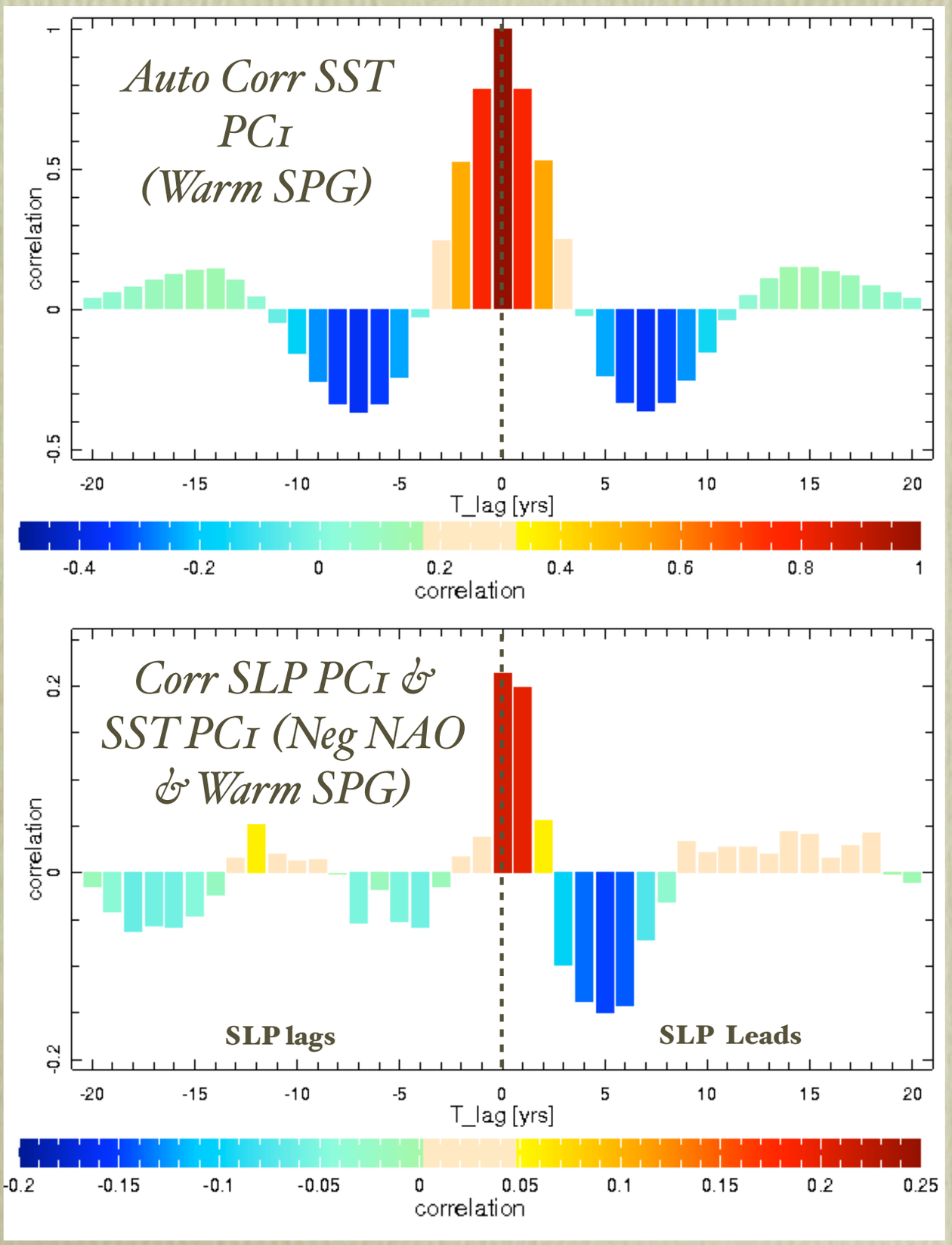

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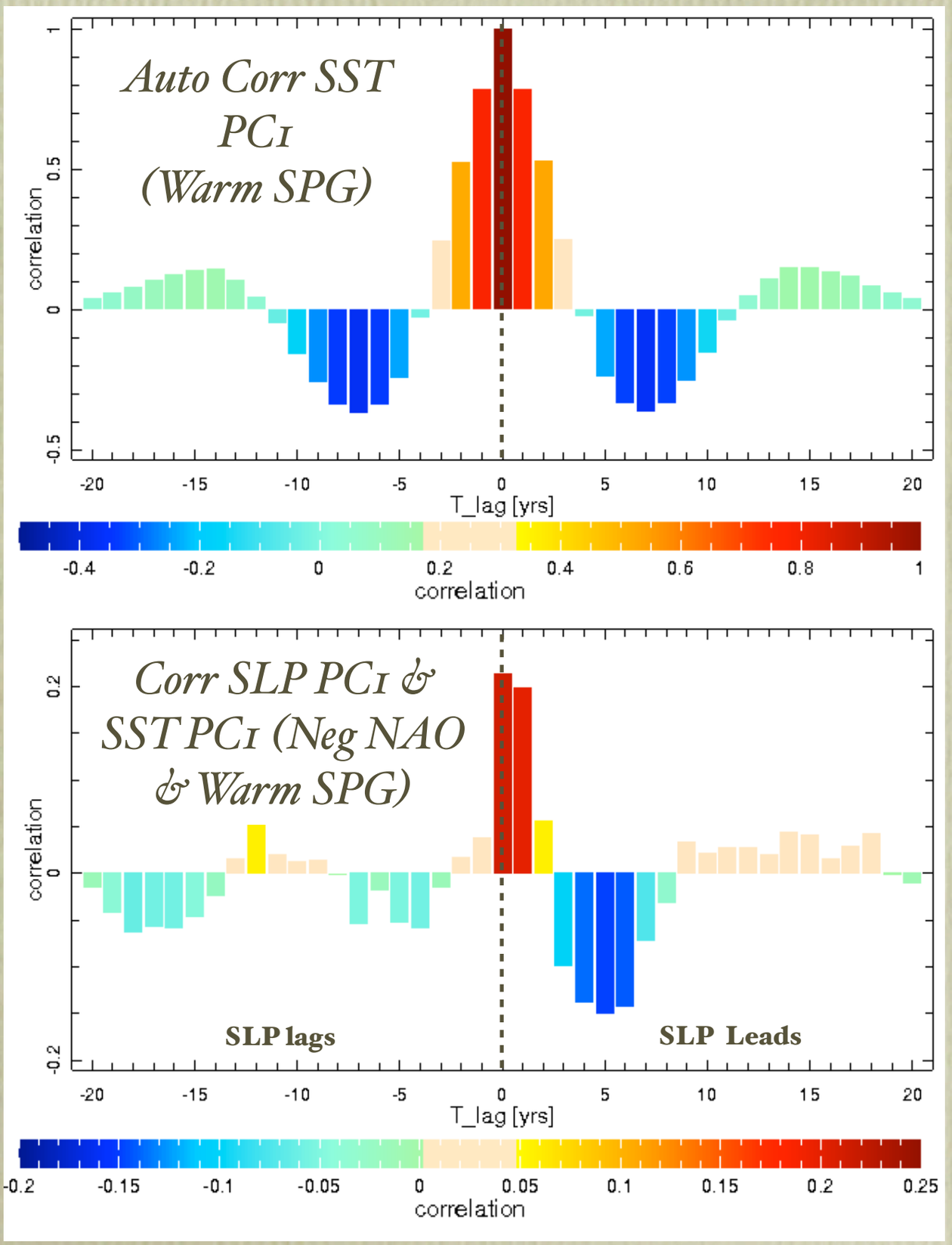
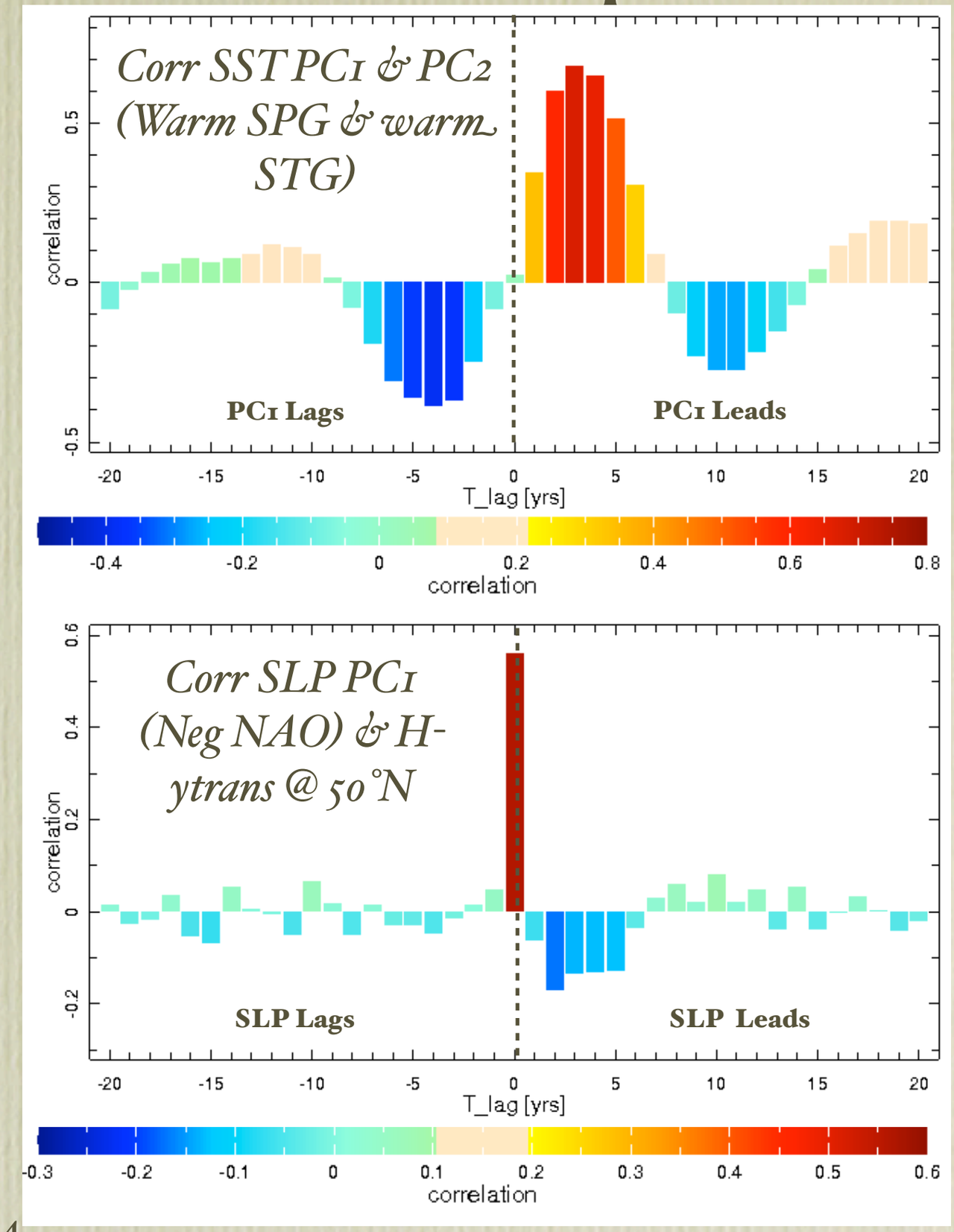
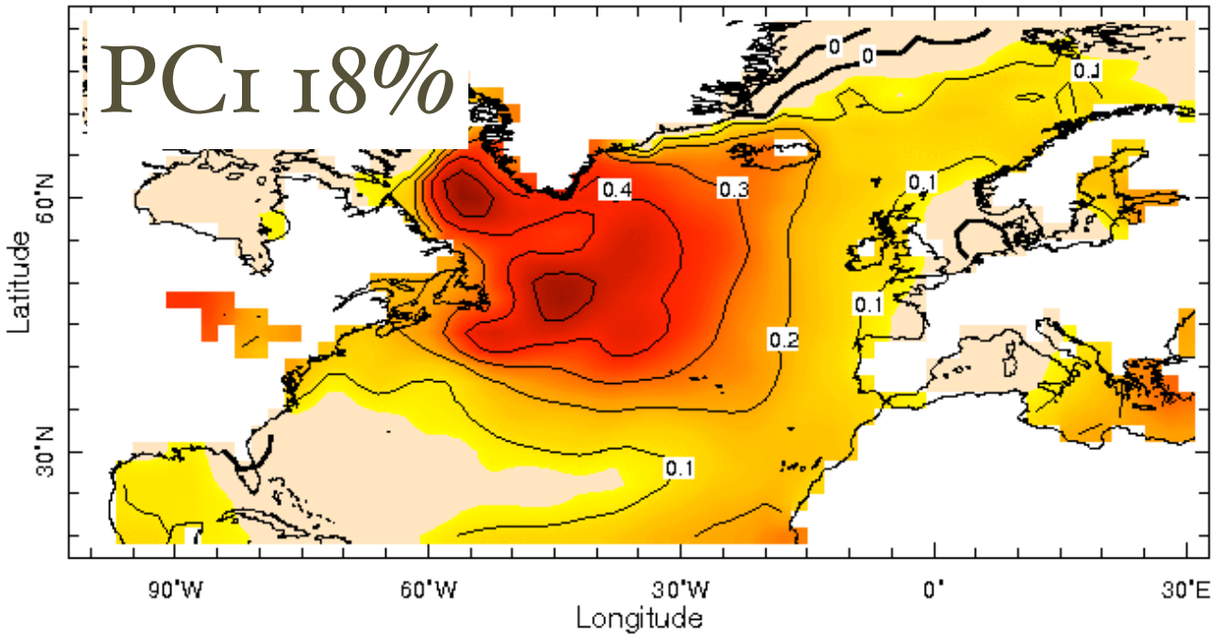


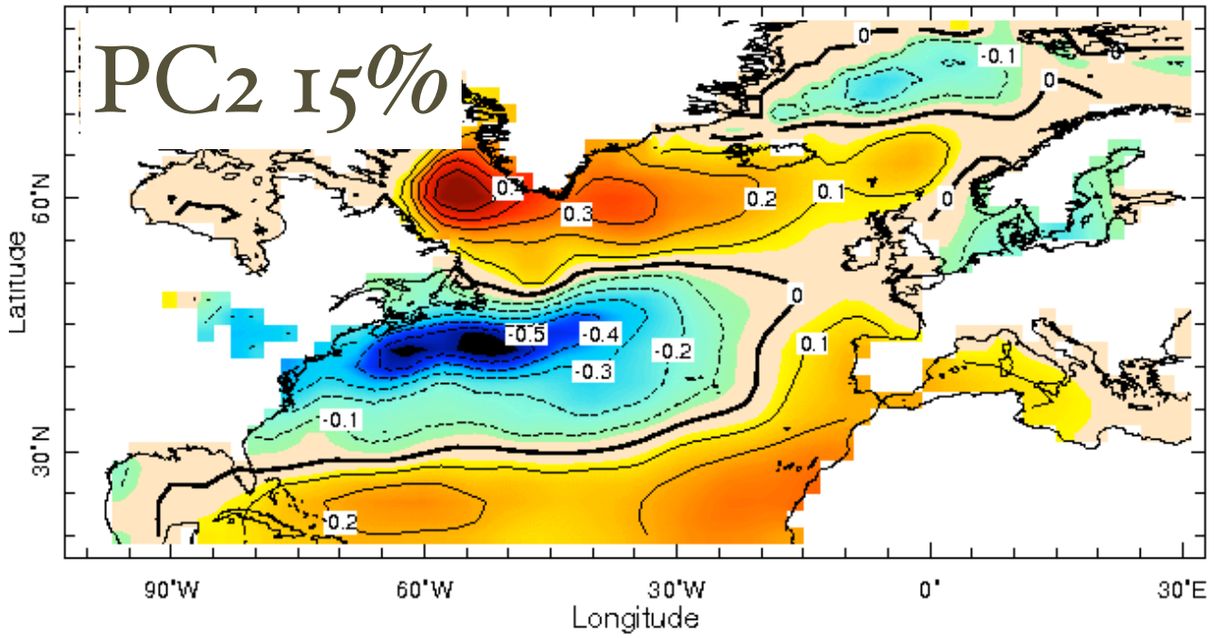


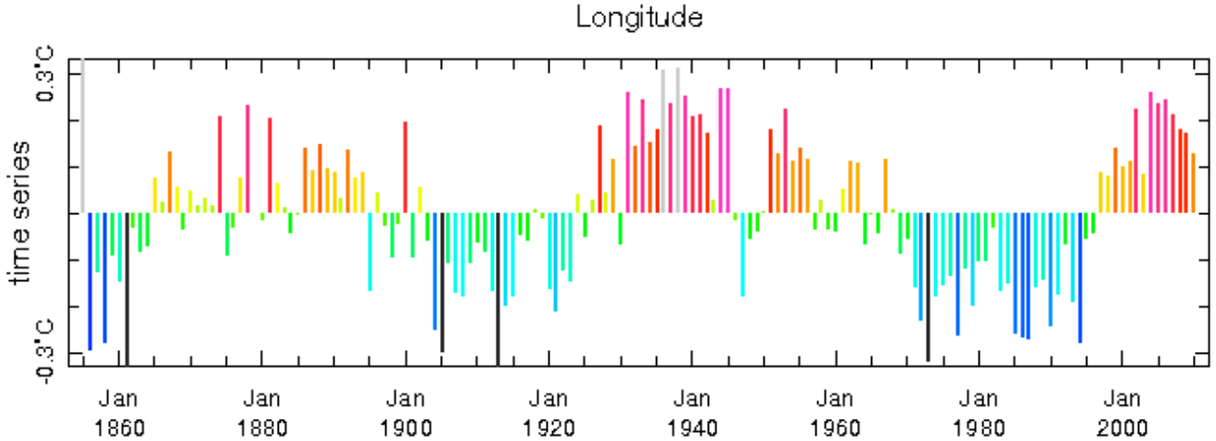
References

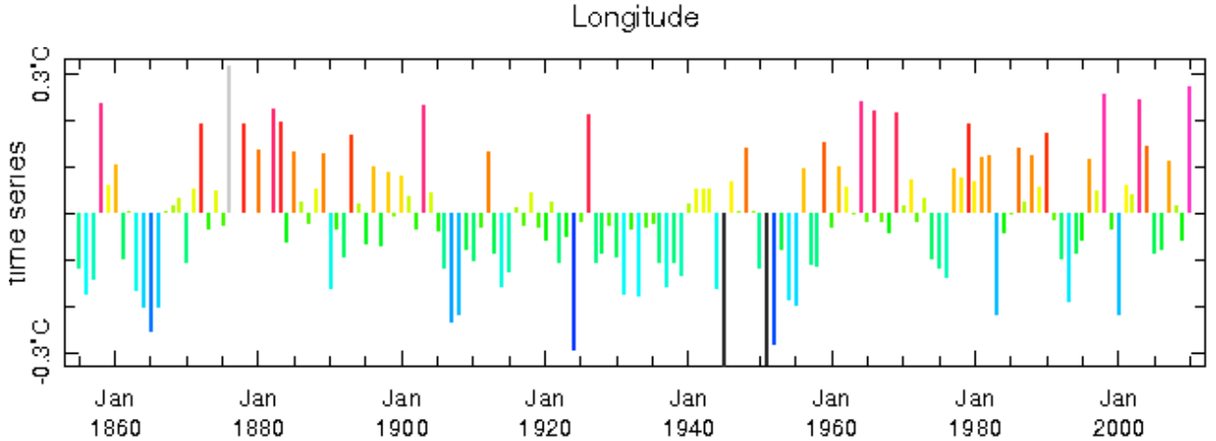
- Bjerknes (1964), Kushnir (1994), Curry and McCartney (1998 *(with Joyce)* and 2001)
- Delworth et al. (1993), Delworth and Greatbatch (2001)
- Eden and Willebrand (2001), Eden and Junge (2001), Eden and Greatbatch (2003)
- Dong and Sutton (2005), Knight et al. (2005 and 2006), Danabasoglu (2008)...

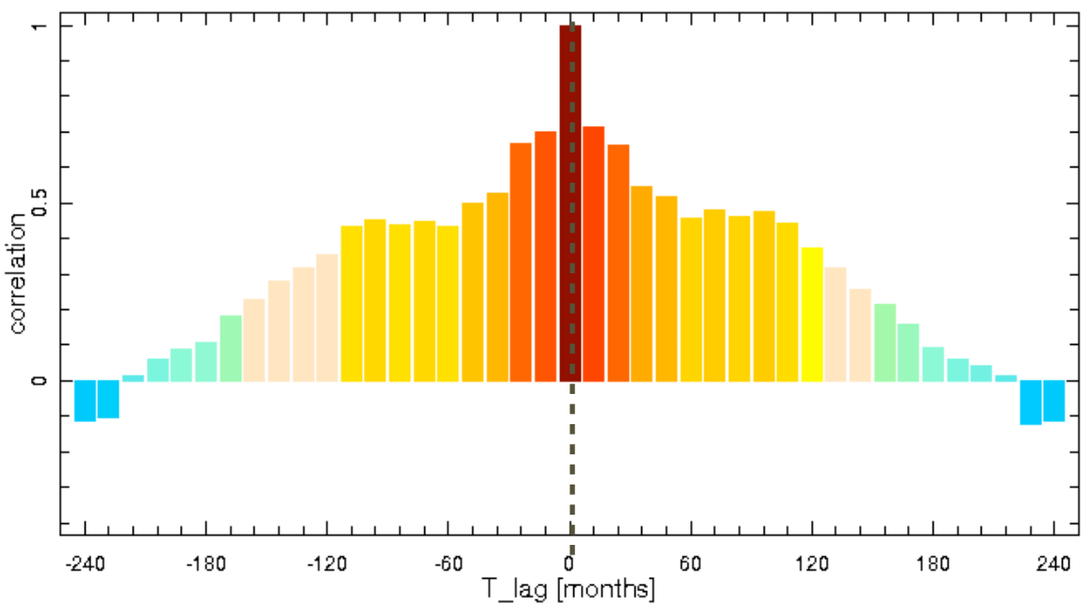
Observed SST

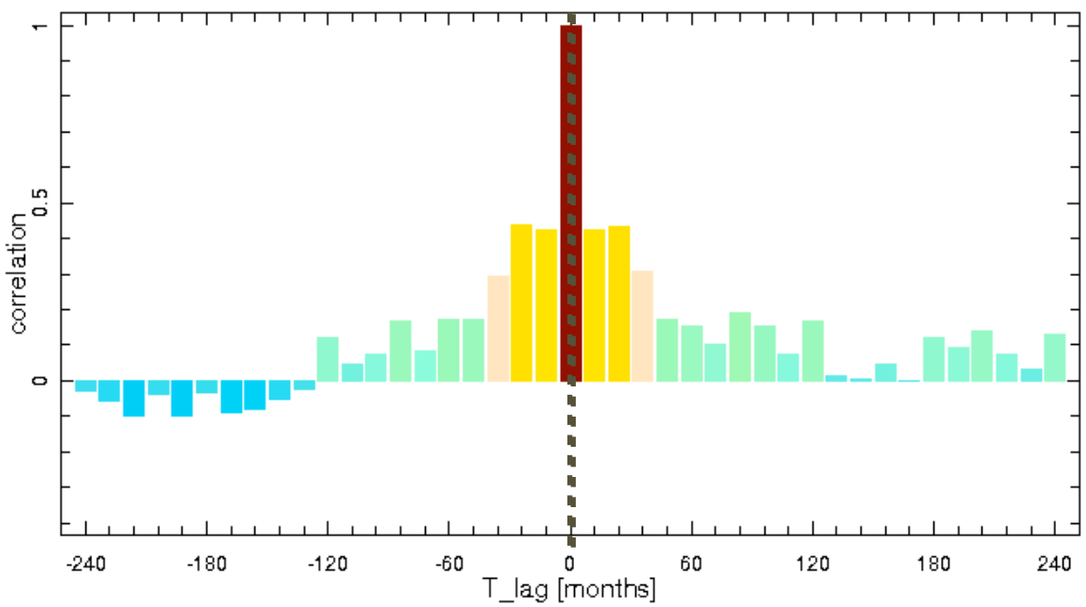












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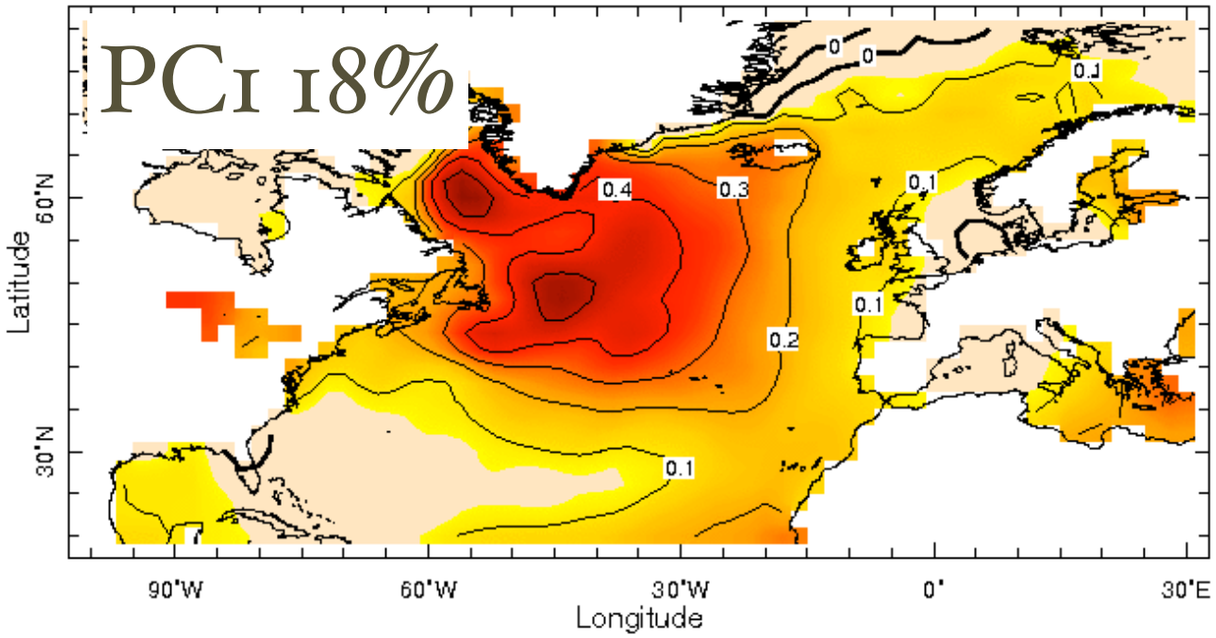

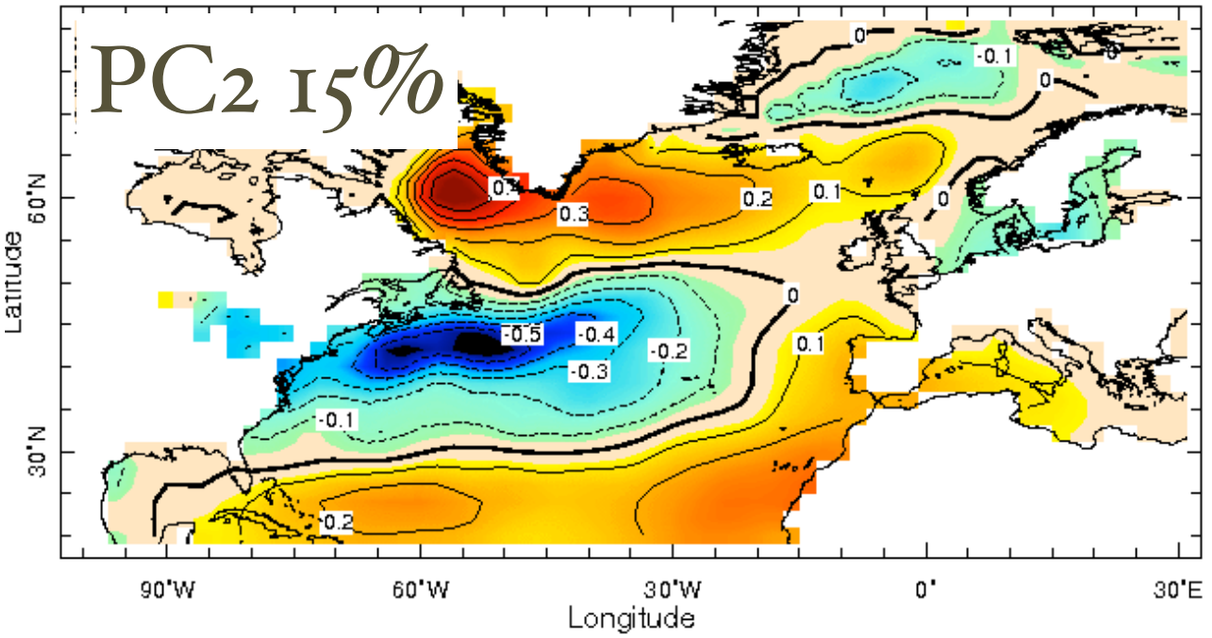

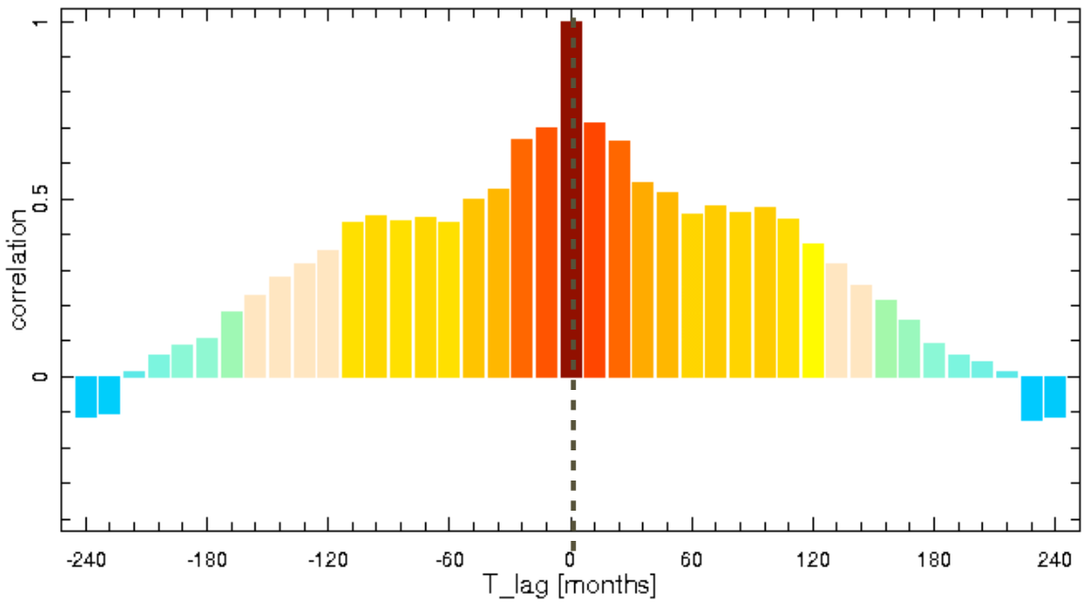

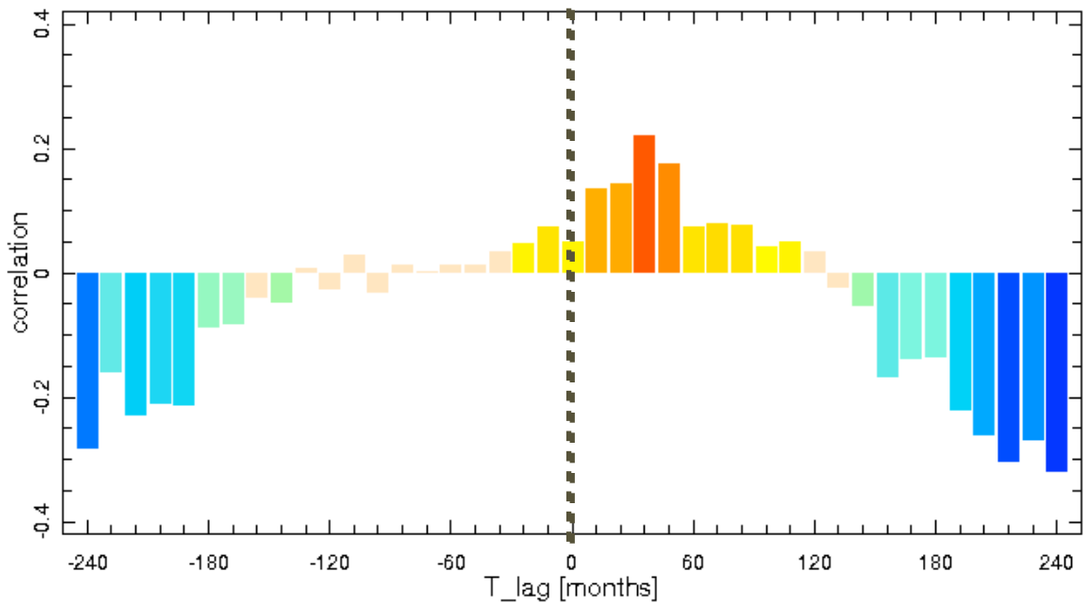

Questions?

- What is the role of salt? Sea ice?
- What is the relation to convection?
- How does the atmosphere feel the ocean?
- What determines the time scale?
- Is the “mode” realistic?
- What are the impacts on land? the tropics (SST & ITCZ)?