



Mechanisms for Multi-Season Memory in the Atlantic Ocean, and related Climate Impacts

As Simulated by the ECMWF Coupled
Ocean/Atmosphere System

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COAPEC Meeting, 2004



Overview

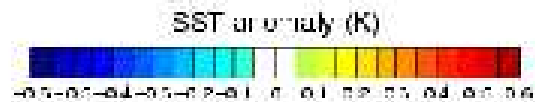
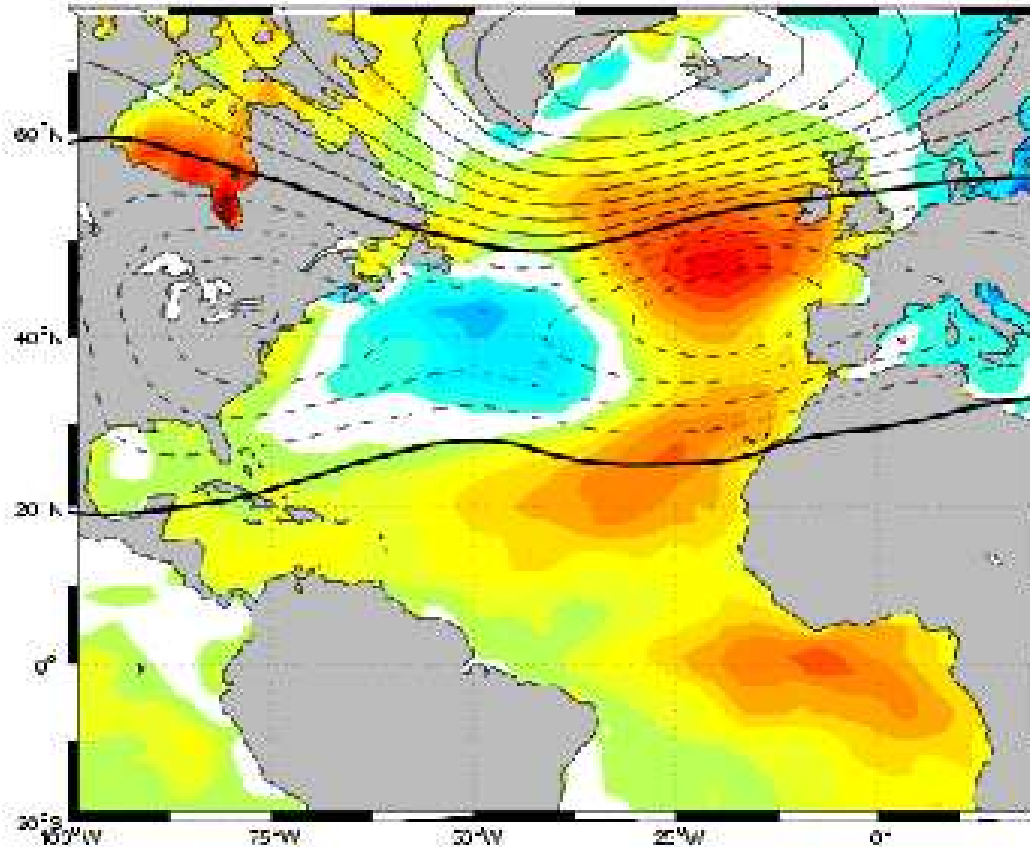
- Project justification and aims
- Experiment Details:
 - Coupled Ocean/Atmosphere Model
 - Experimental Method
- Results
- Conclusions & Future Work



Observational Evidence of an Ocean Influence on North Atlantic Climate

Pattern of maximum covariance between JAS SST and NDJ 500mb geopotential height

Czaja & Frankignoul, J. Climate, 2002

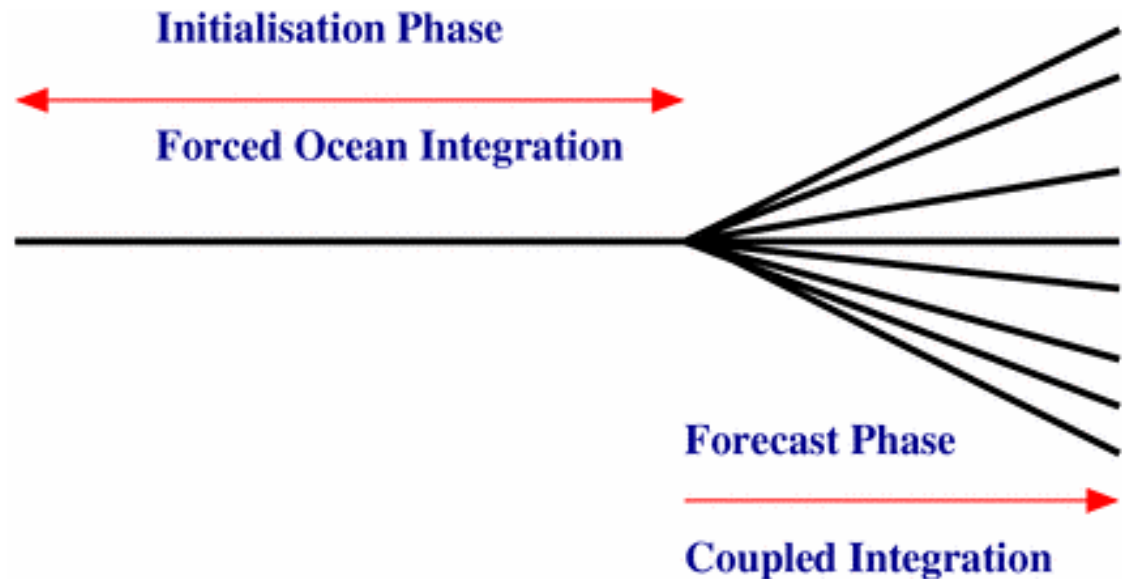


Project Aim:

To identify the impact of Atlantic Ocean anomalies on coupled seasonal forecasts.

Method

Initialise idealised anomalies in the Atlantic Ocean by applying anomalous surface forcing patterns to the ocean during initialisation phase



ECMWF Seasonal Forecasting System

- Variant of System II operational model
- ECMWF IFS Atmosphere: TL95, gaussian
~1.875deg, 29 levels
- HOPE Ocean: zonal 2.81 deg, meridional
0.25-1.2 (varied).
- Ensemble Creation: perturbations in SST and
surface winds.



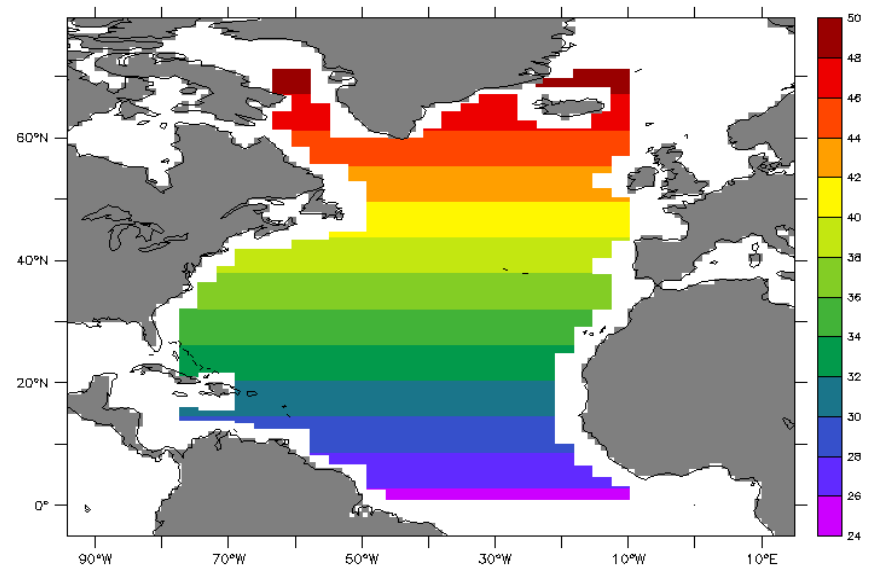
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Model Forcing

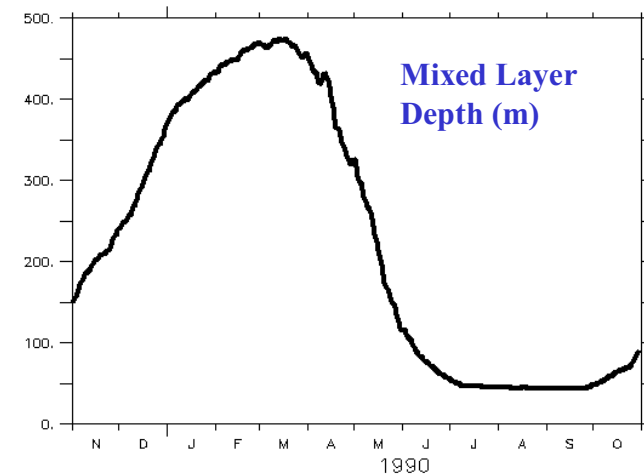
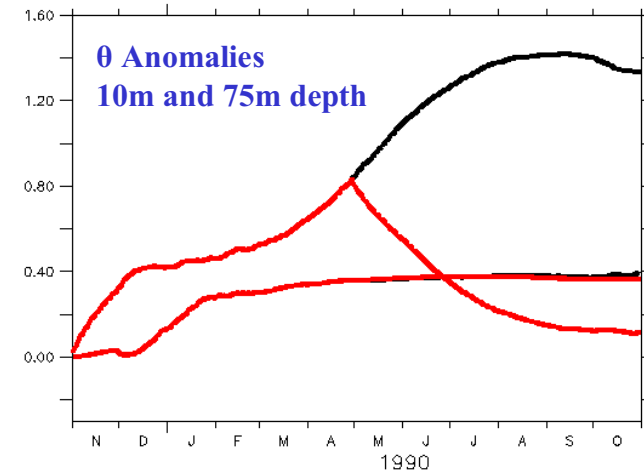
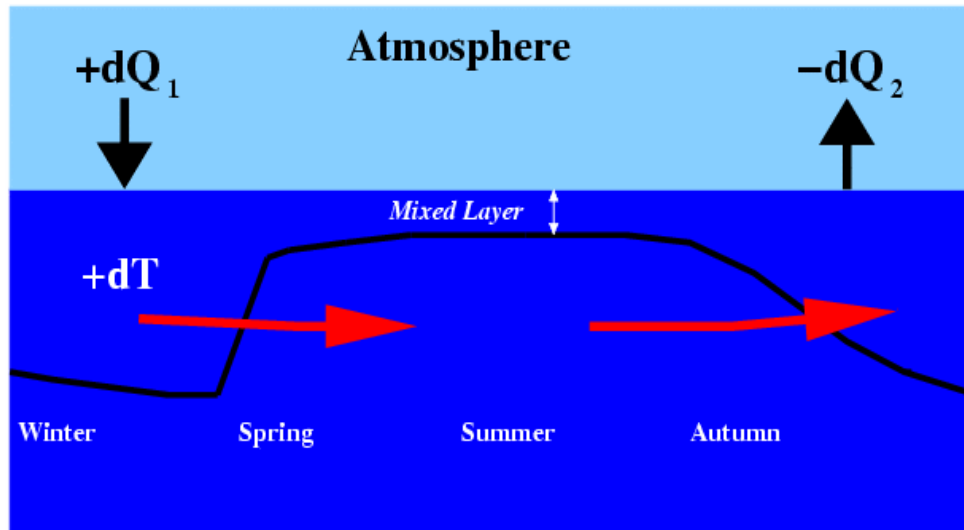
- Year long ocean run: surface forced by analysis fields.
- Heatflux anomaly applied to N.Atlantic. Duration: 6/12 months (Exp6,Exp12)
- Coupled 6-month forecast (20 member ensemble).



Region 0-75N. Flux 25-50 W/m²



Forcing Evolution



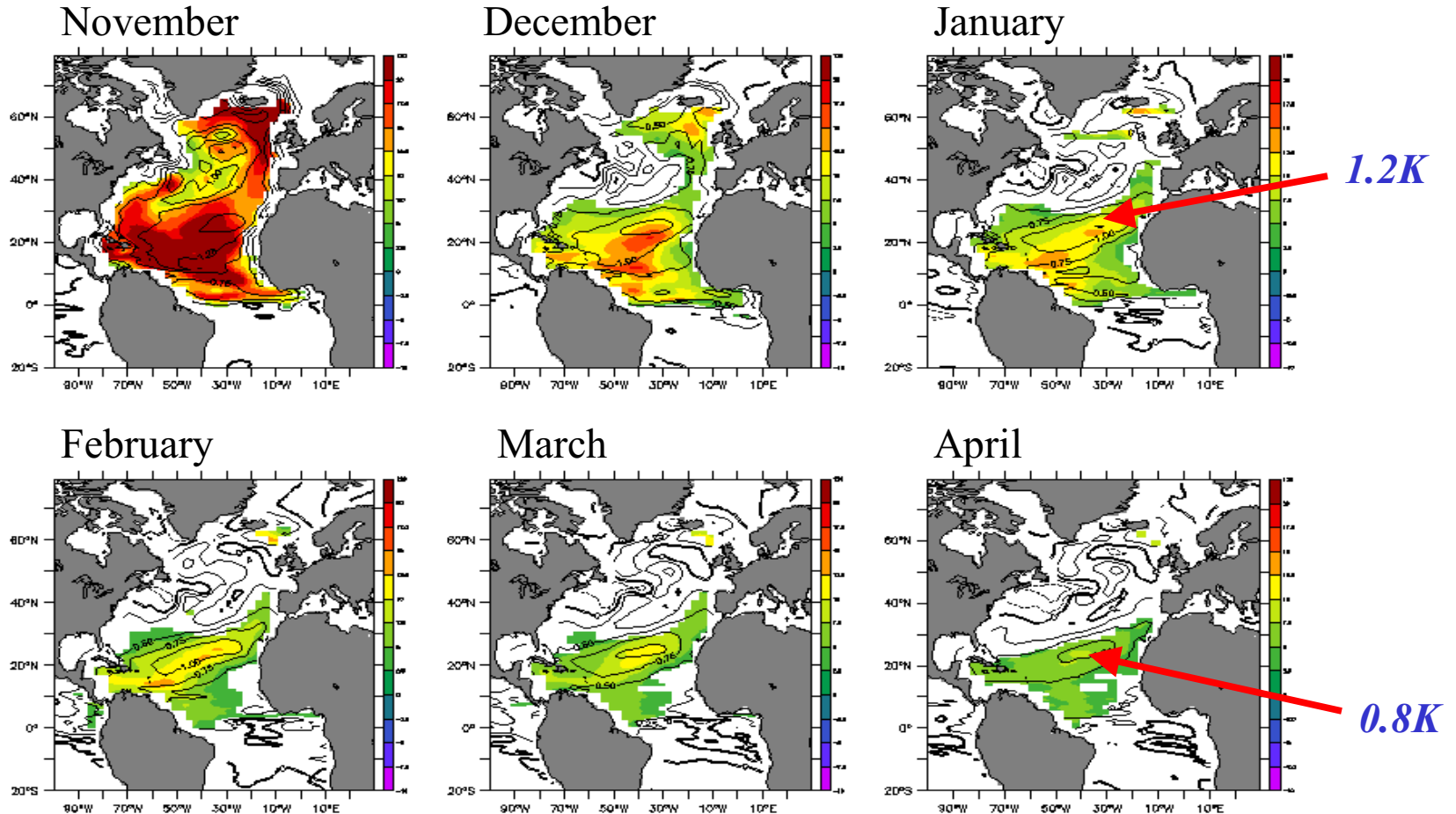
- Heat stored below summer thermocline
- Background surface relaxation ($-20\text{W/m}^2/\text{K}$) to Reynolds SST



Exp12 10m θ Anomalies



Contours: Exp12 ensemble mean anomalies wrt control.



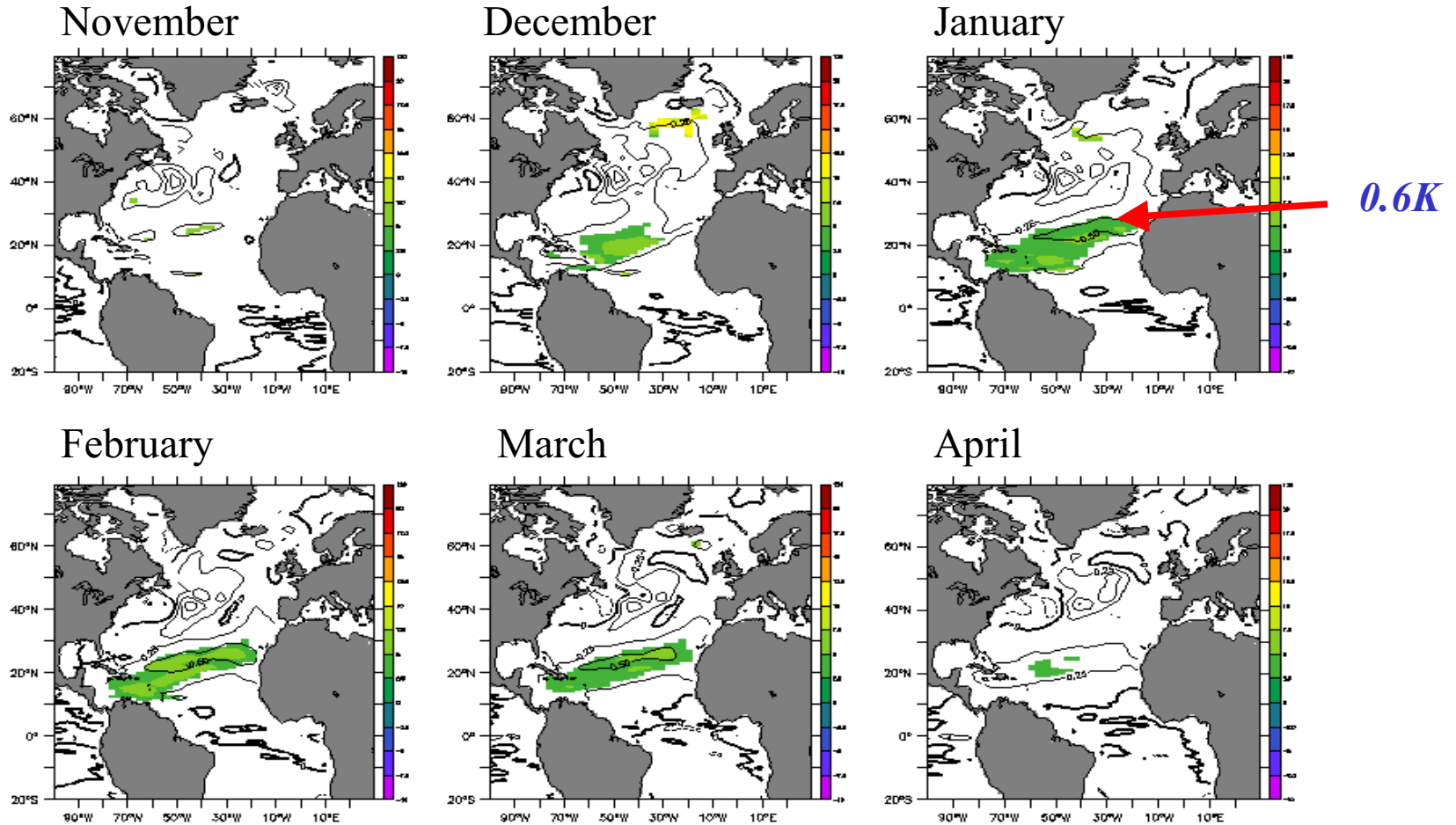
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Coloured regions: t-values of 99% significance or above.

Exp6 10m θ Anomalies



Contours: Exp6 ensemble mean anomalies wrt control.



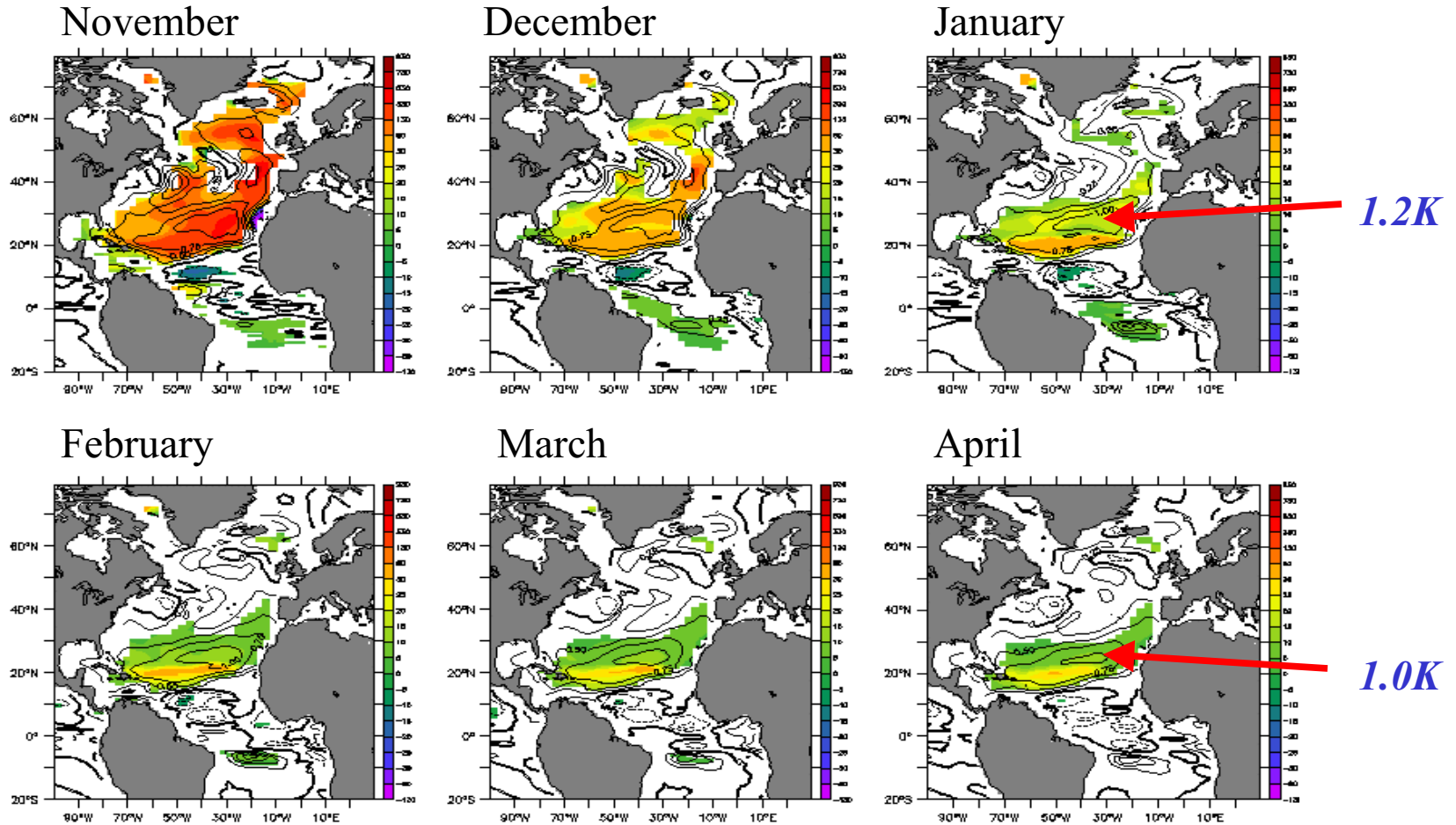
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Exp12 100m θ Anomalies



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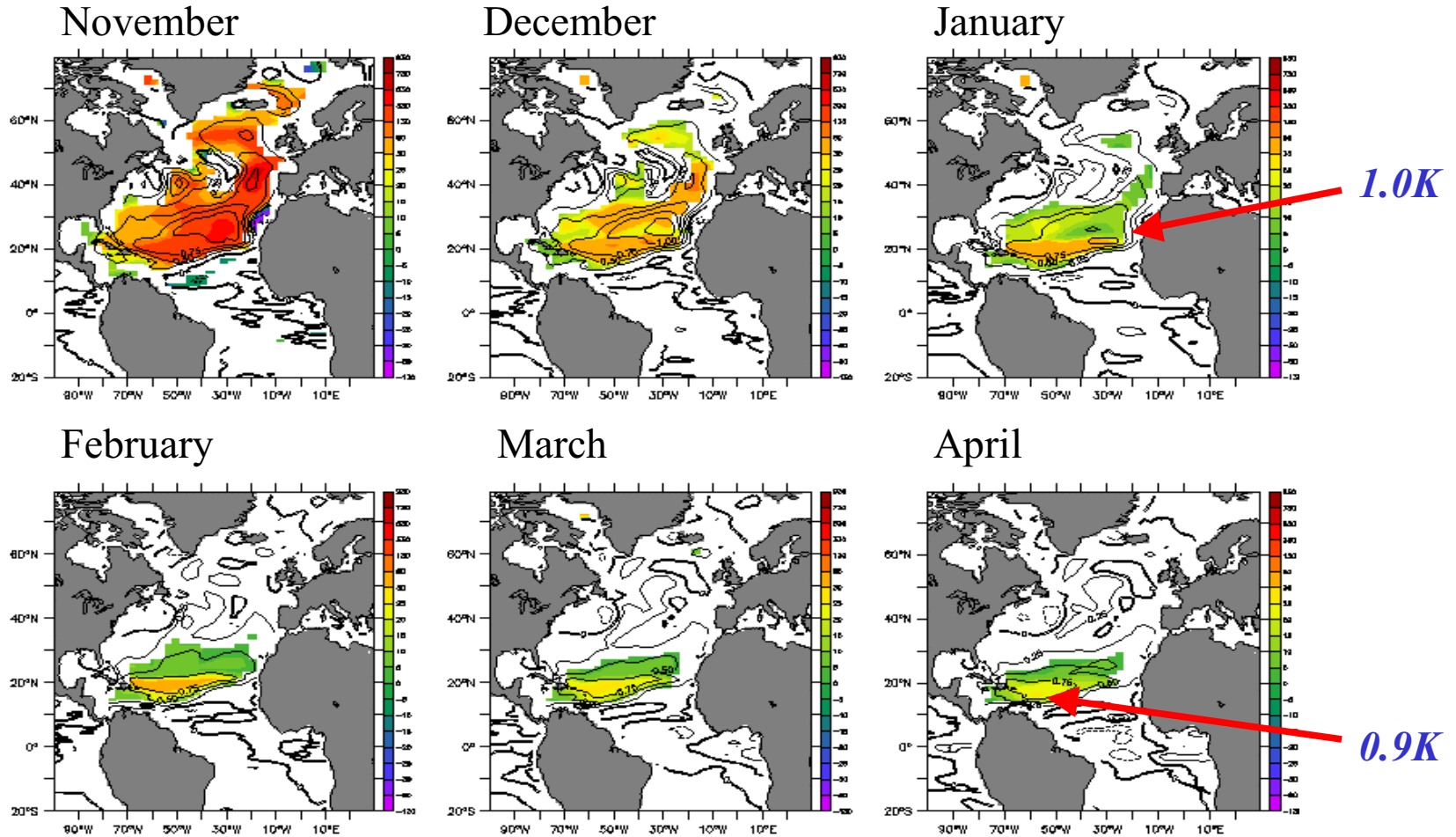
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Exp6 100m θ Anomalies



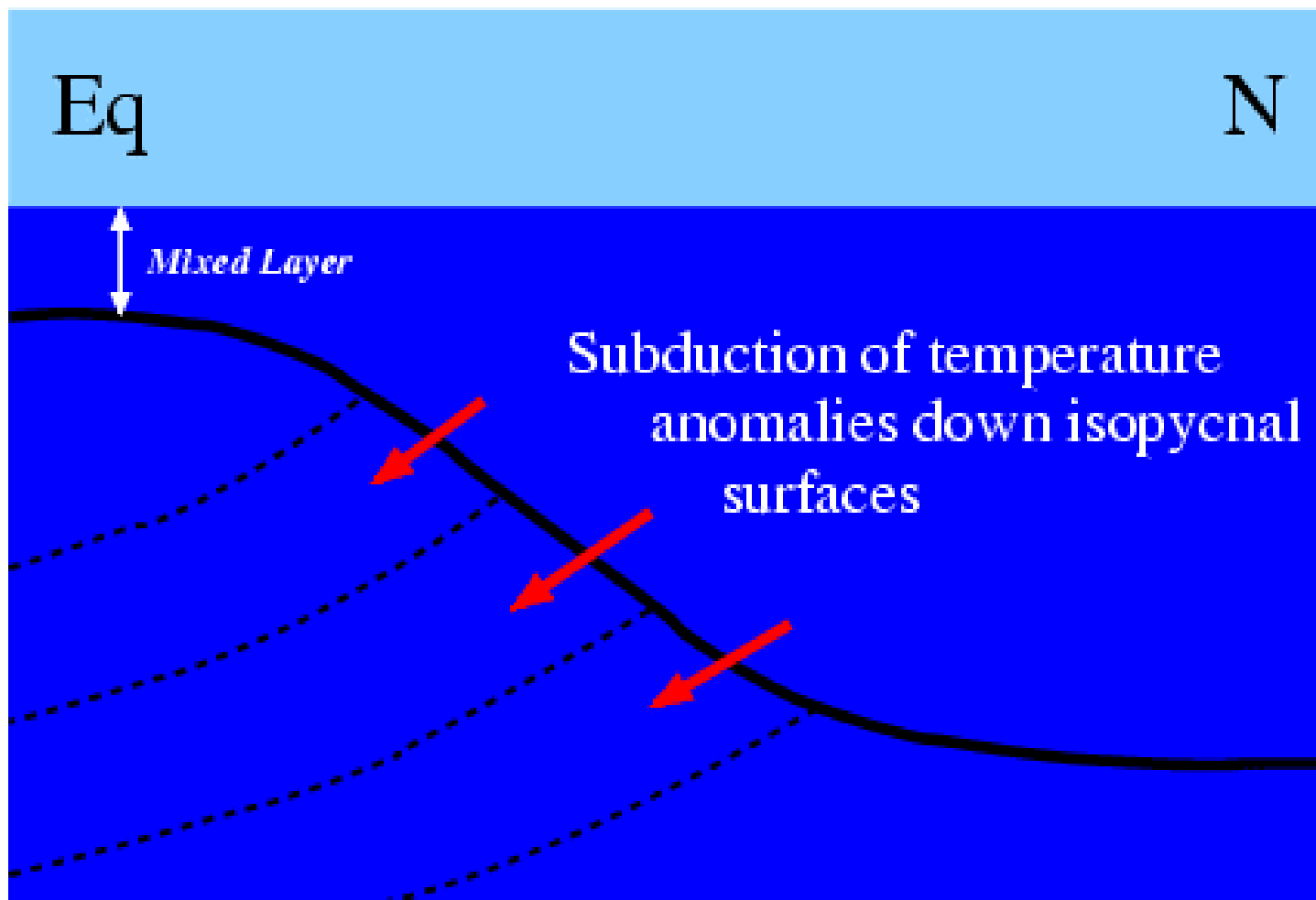
Contours: Exp6 ensemble mean anomalies wrt control.



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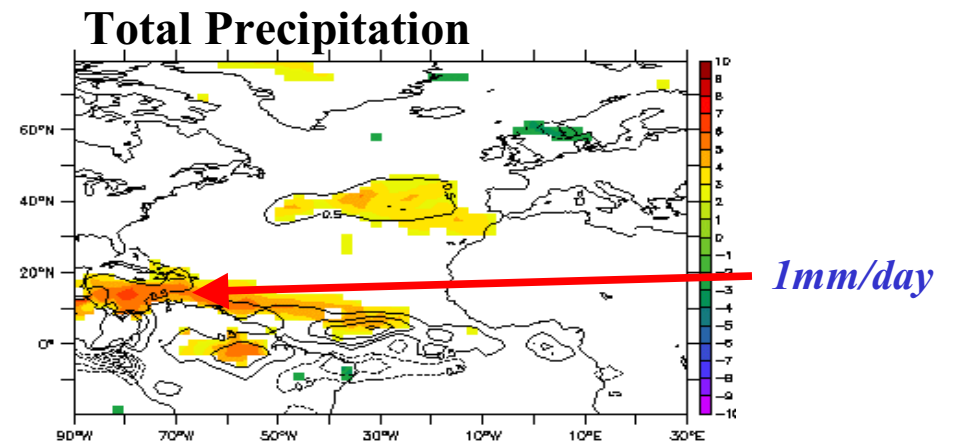
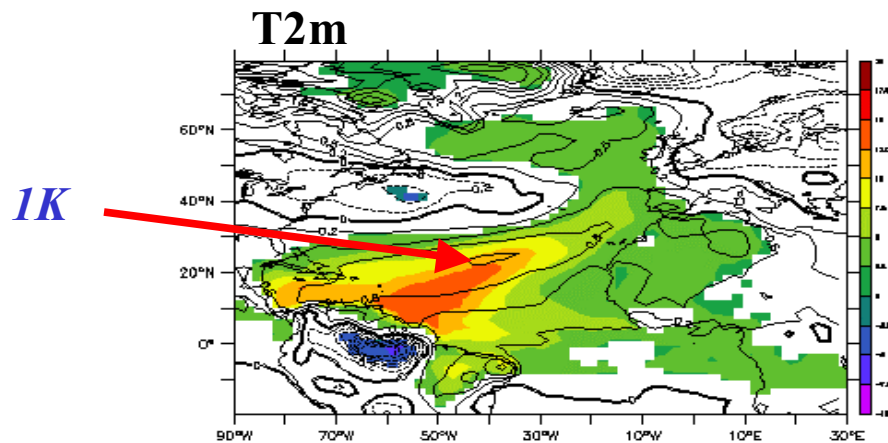
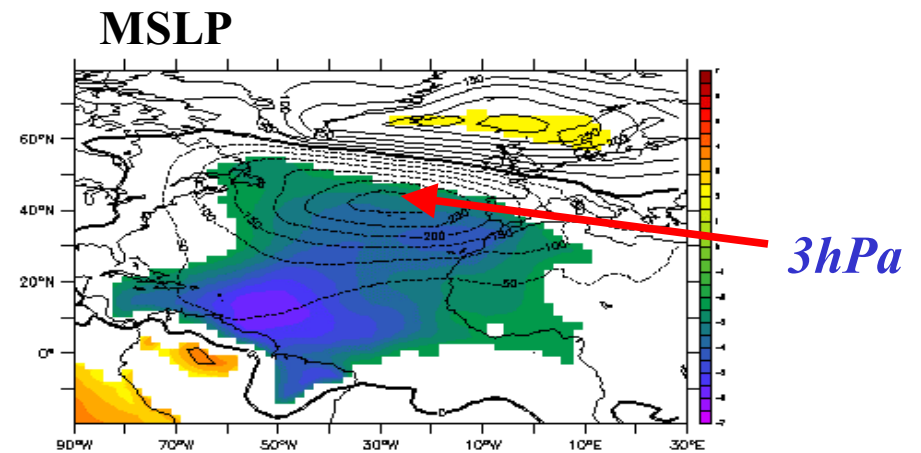
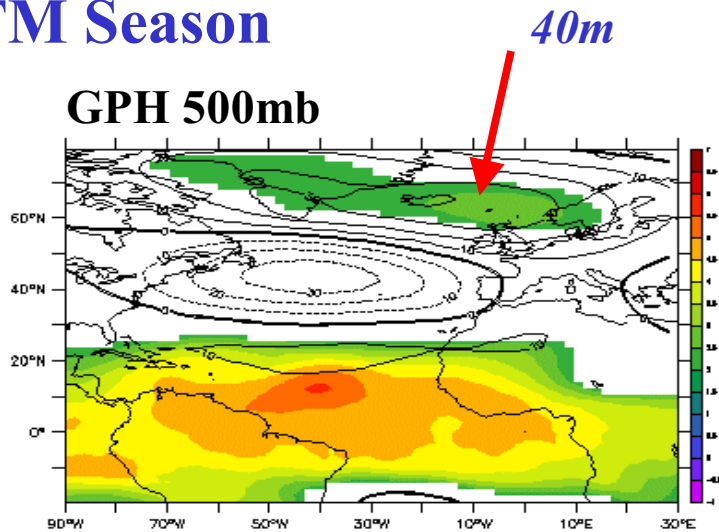
Anomaly Subduction



Exp12 Atmosphere Anomalies



DJFM Season



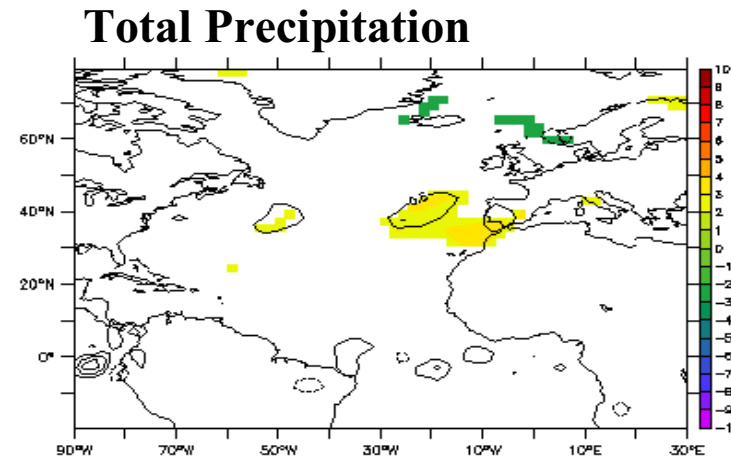
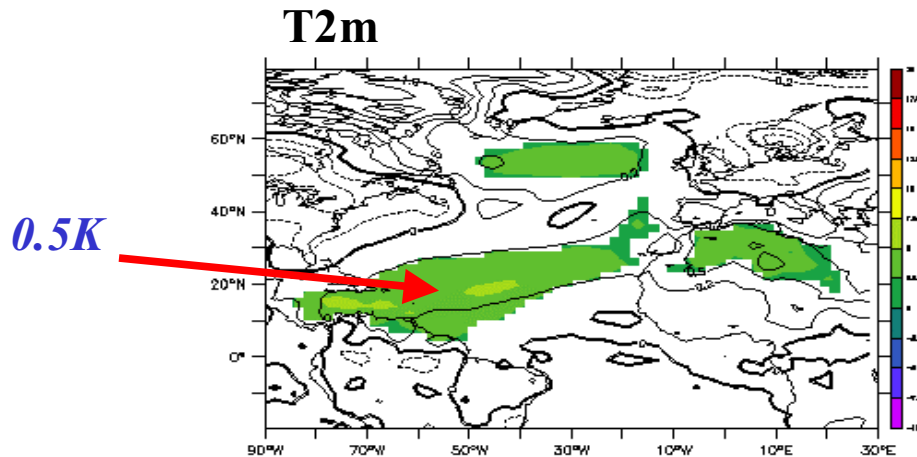
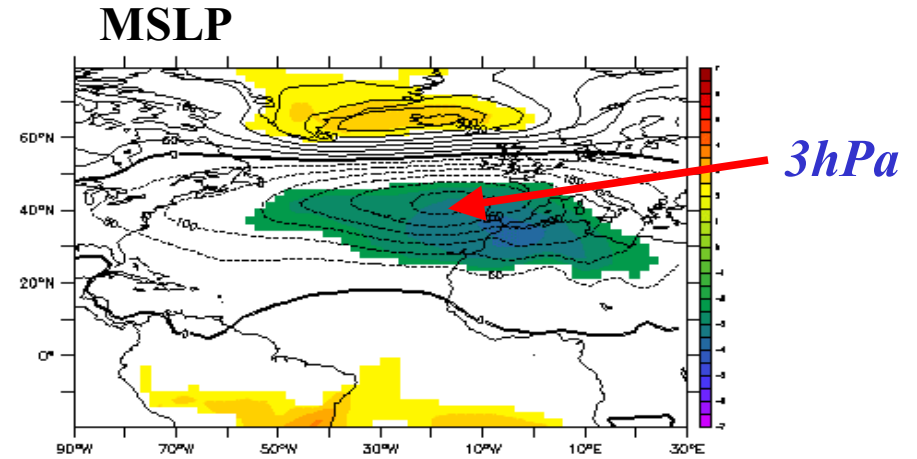
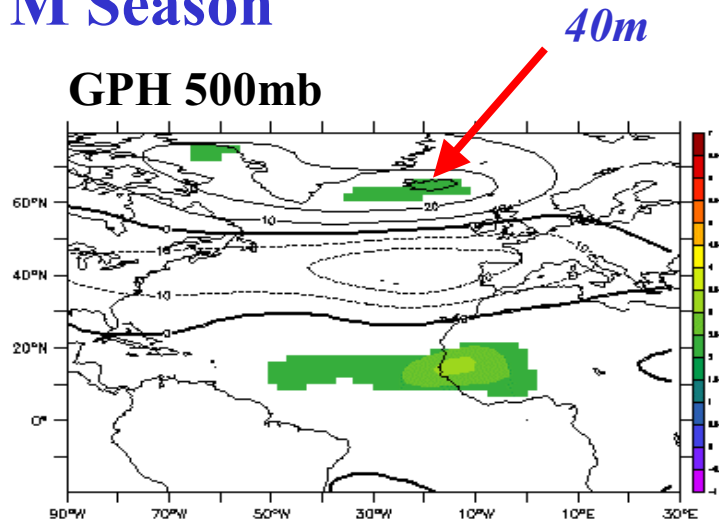
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Significance: 95%

Exp6 Atmosphere Anomalies



DJFM Season



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Significance: 95%



Conclusions & Future Work

- The (model) Atlantic is capable of storing heat from one winter to the next.
- Re-emerging heat anomalies induce a modest response in surface air temperature, tropical precipitation and atmospheric circulation.
- Such an oceanic feature in the real world system could be a major boon for European seasonal forecasting!
- Further experiments taking place with more realistic forcing patterns (NAO related heatflux and windstress)

