North Atlantic simulations with HYCOM: Interannual 1/3° simulations

Z. Garraffo, G.Halliwell, E. Chassignet,

B. Molinari, J. Metzger, T. Townsend, A. Wallcraft, Claes Rooth

HYCOM Atlantic 1/3° interannual simulations (1948-present)

Initialization from year 20, ATLn0.32

with Price and Young Parameterization for Mediterranean overflow

Forcing:
NCEP from 1948
wind stress, wind speed, airtemp, radiation, water vapor
Rivers
SSS relaxation or E-P

Specified P-Y Model Parameters:

Bathymetry

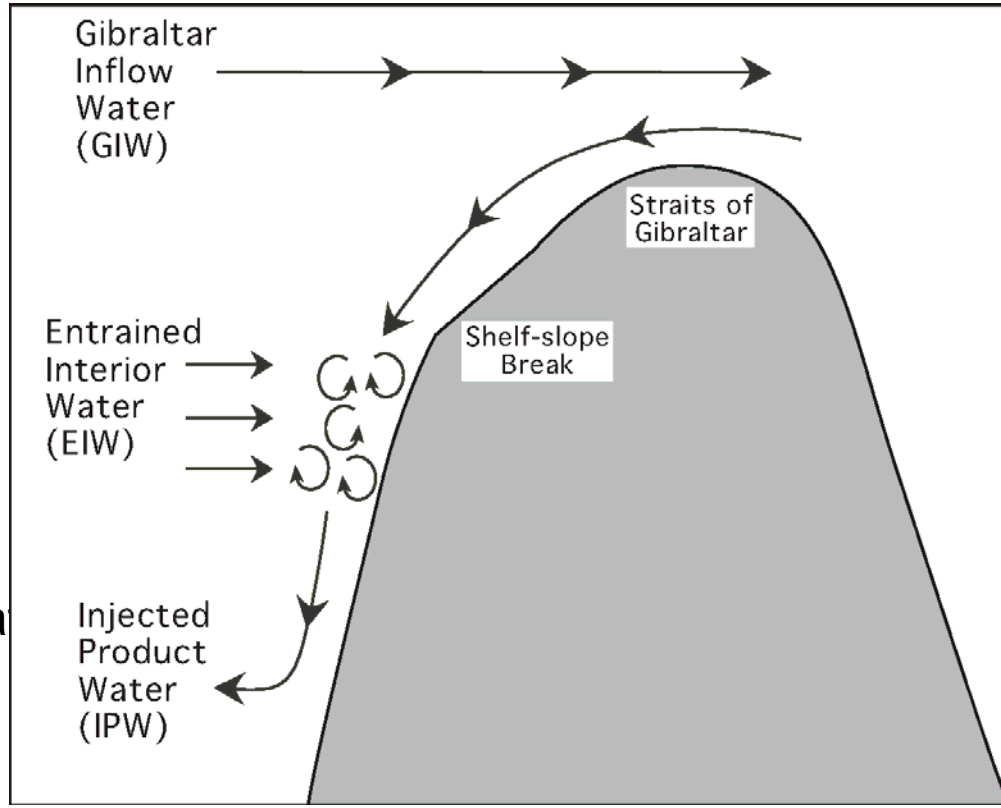
Gibraltar Width: 20km
Gibraltar Sill depth: 280m
Shelf-slope break depth: 400m
Slope of continental slope: 0.012

Specified Atlantic Ocean Water Properties

model • T, S of Gibraltar inflow water
model • T, S of entrained interior water a
shelf-slope break

P-Y Model Output

Gibraltar inflow transport (Mi)
Gibraltar outflow T, S, transport (Ms)
Med. Surf. Fluxes
E-P over Mediterranean
Net Q over Mediterranean
Entrained interior water transport (Me)
Mp – final product water T



Price-Yang Model

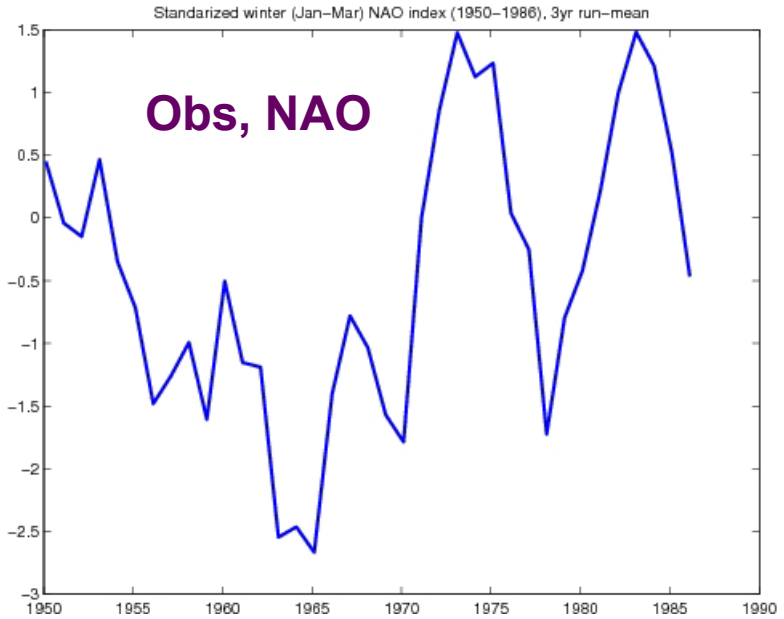
•E-P, Q over Med kept constant

More details, forcing and parameters:

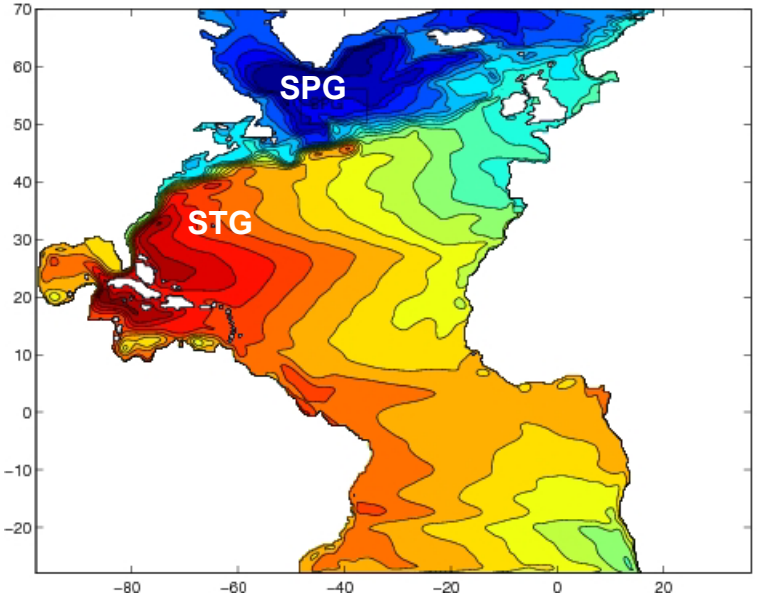
- used ncep ocean land mask
- ncep wind stress with ECMWF long term wind stress mean (ECMWF was used for spin-up).

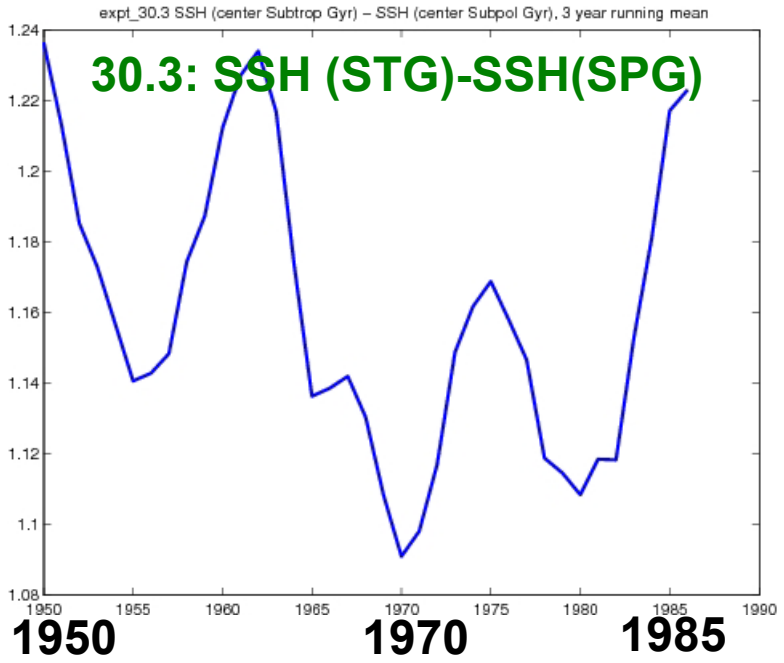
Expt 30.0	• ncep winds (with ncep mean) • surface SSS and SST relax • biharm horizontal diffusion
Expt 30.2	• ncep wndstr with ECMWF mean. • E-P, no SST relax. • Added laplacian diffsn
Expt 30.3	• SSS relax, no E-P. Otherwise as Expt 30.2.

Expt 30.3, SSH vs NAO (3yr running mean)



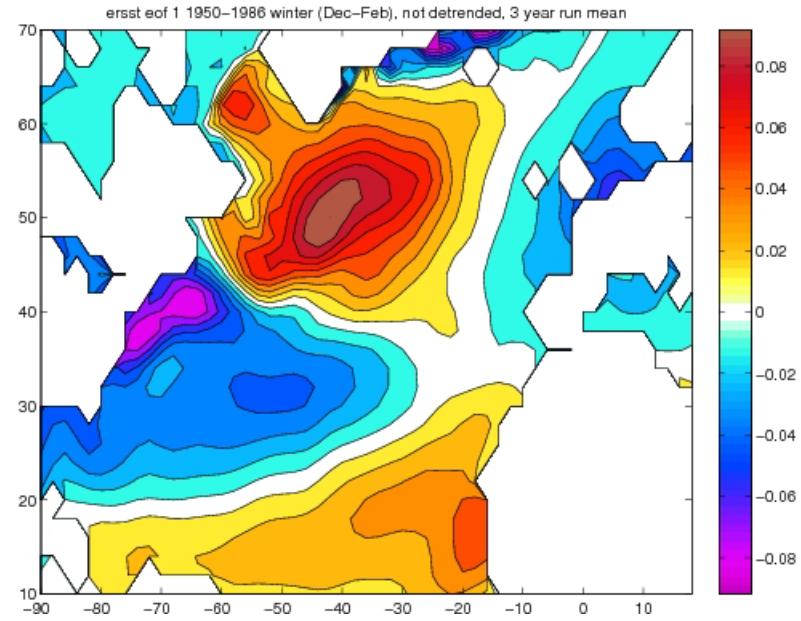
30.3: Mean SSH

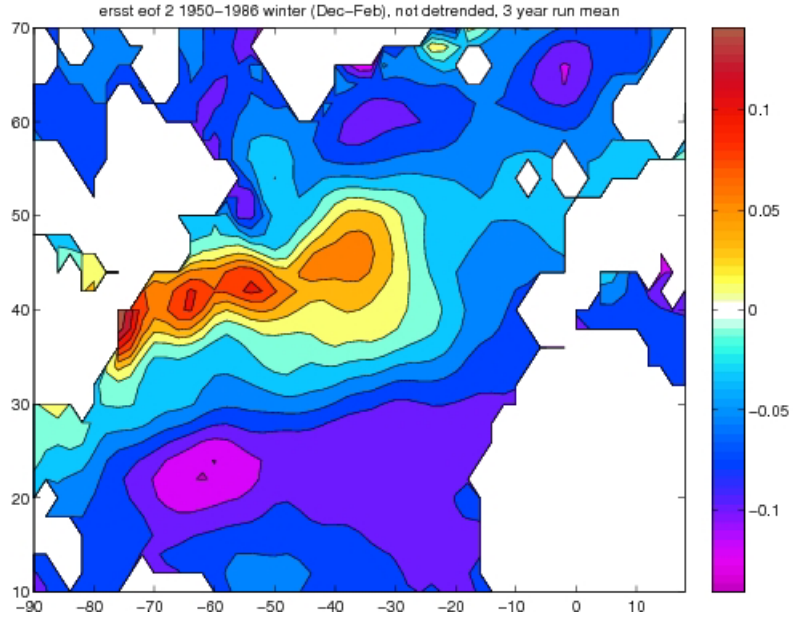


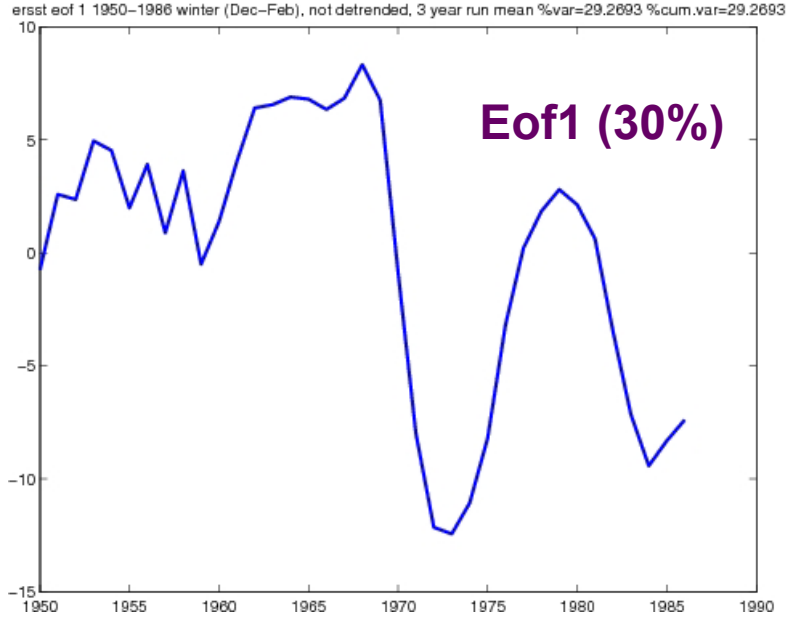


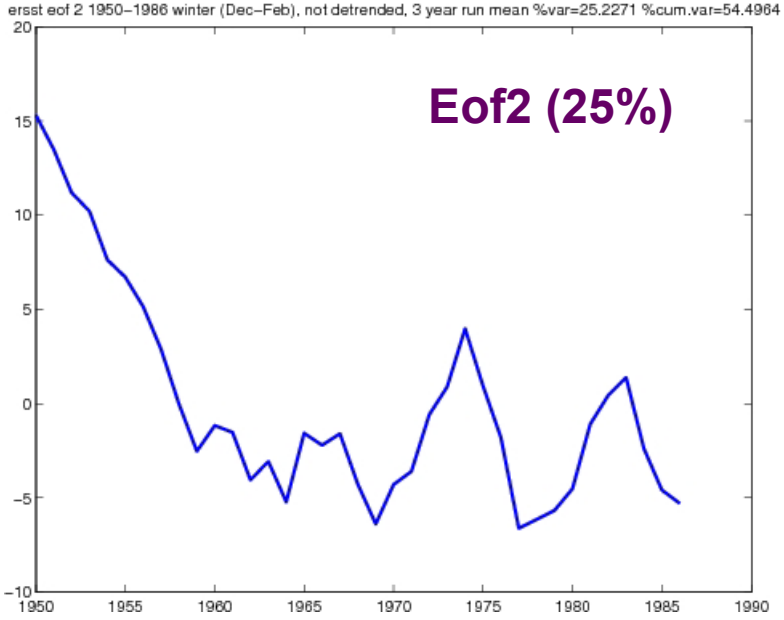
After 1960, minima in agreement with Curry-McCartney transport index minima in 1970, 1981.

Observed, ERSST, winter (JFM) eof





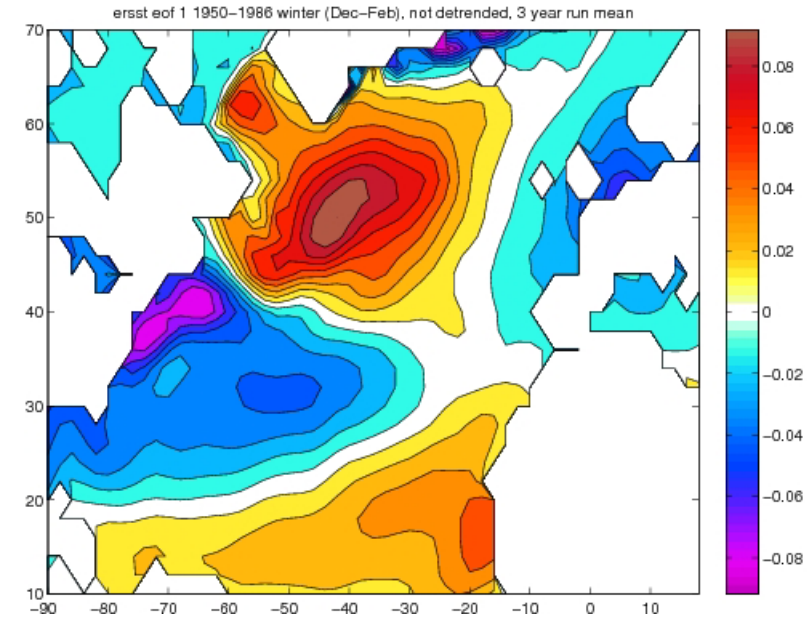


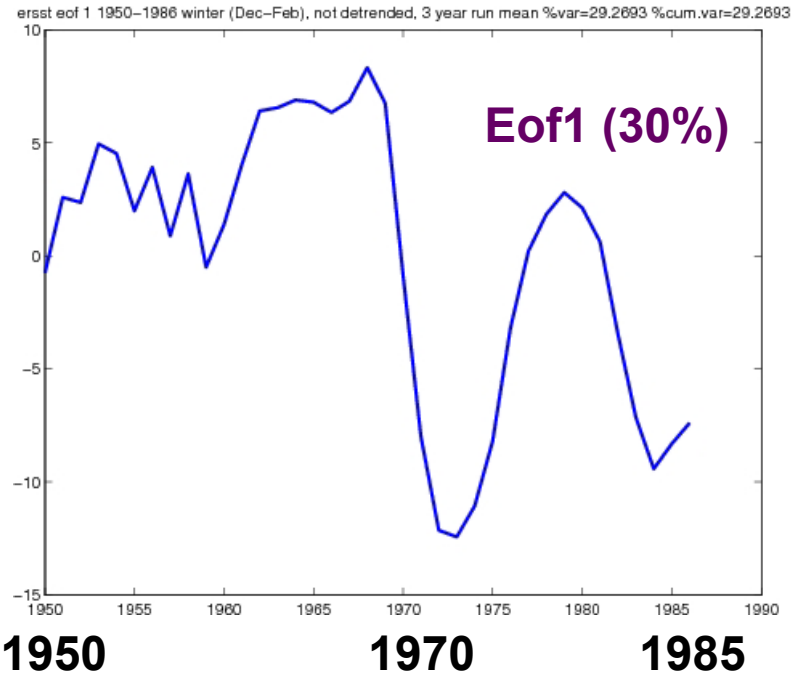


1950 1970 1985

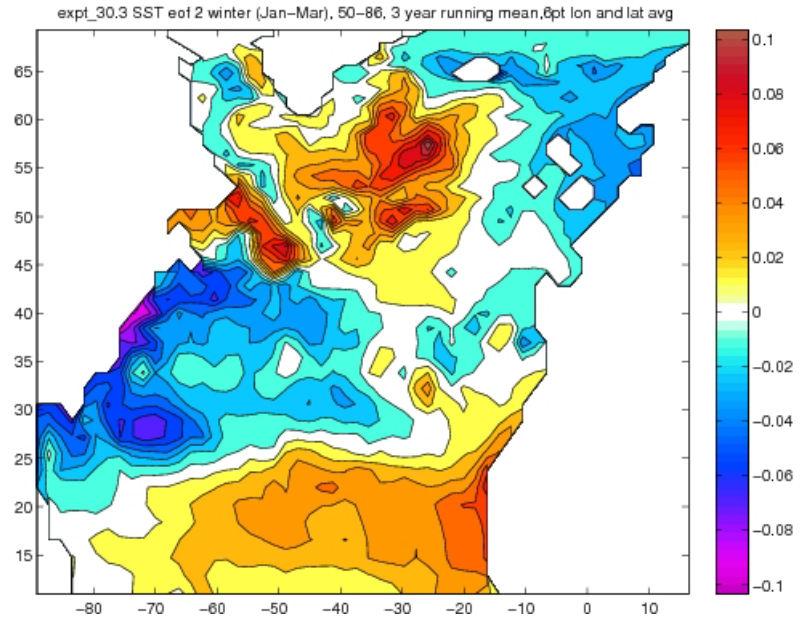
1950 1970 1985

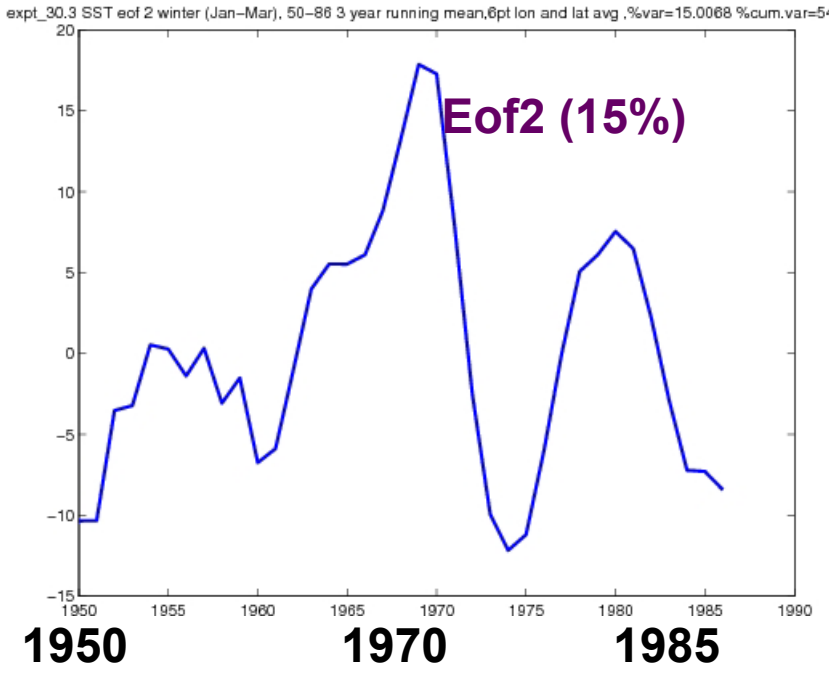
SST Observed eof1

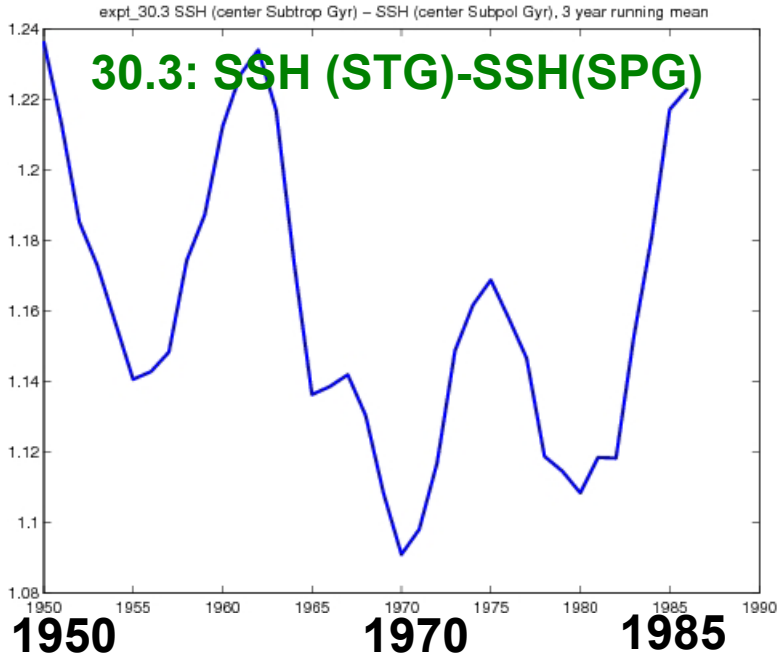




Expt 30.3 eof2



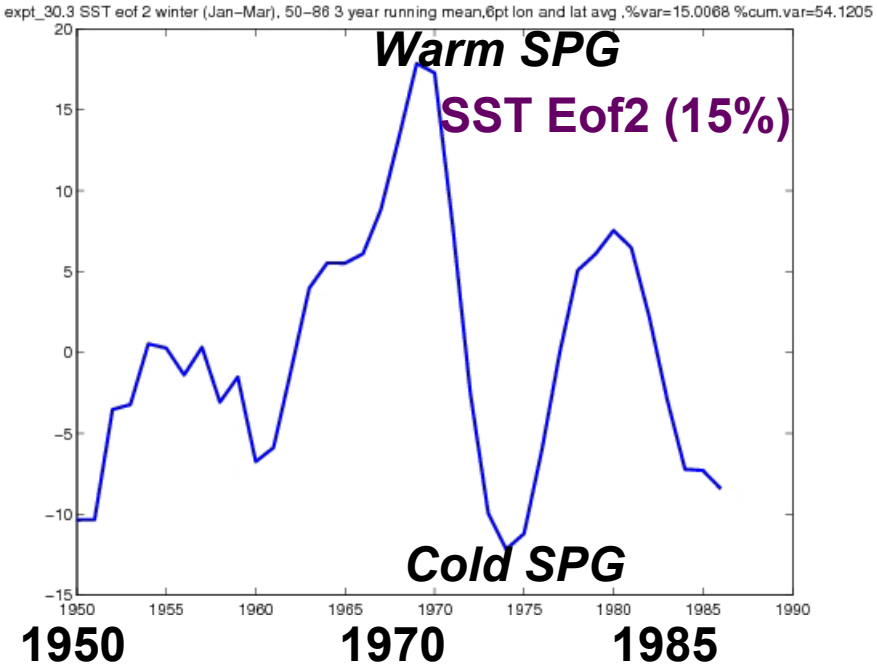


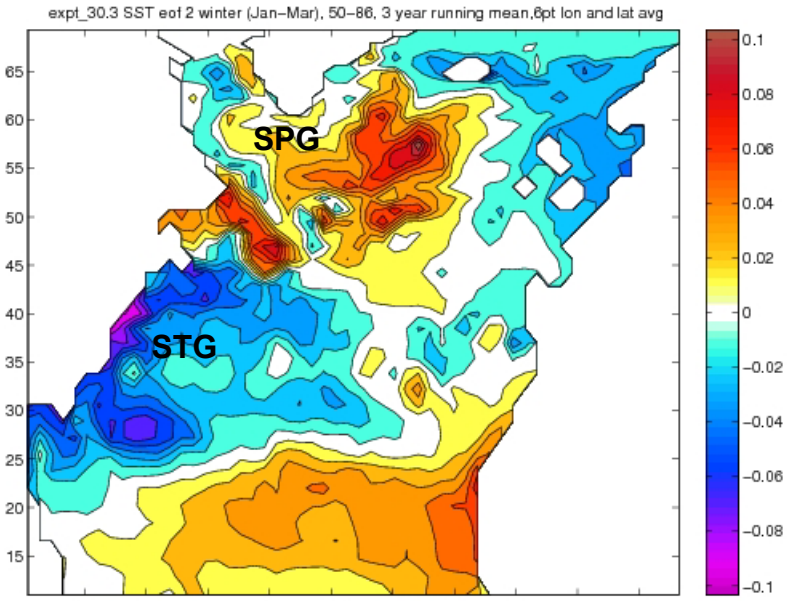


Expt 30.3:

SSH difference SPG and STG

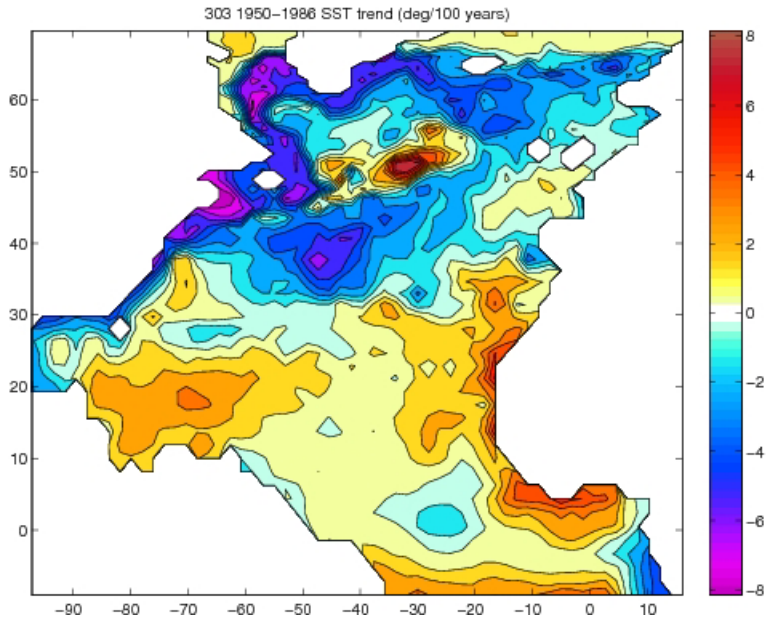
And SST 2nd EOF



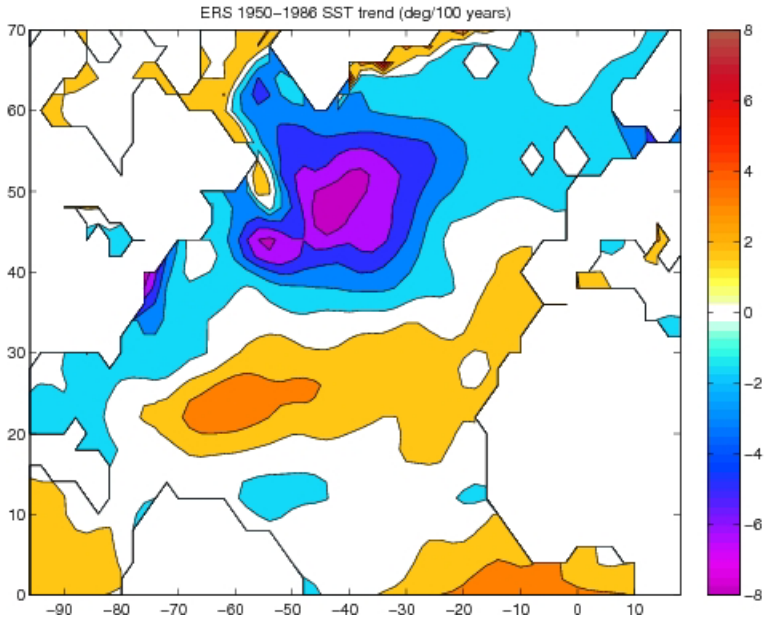


SST trend 1950-1986

Expt 30.3



ERSST



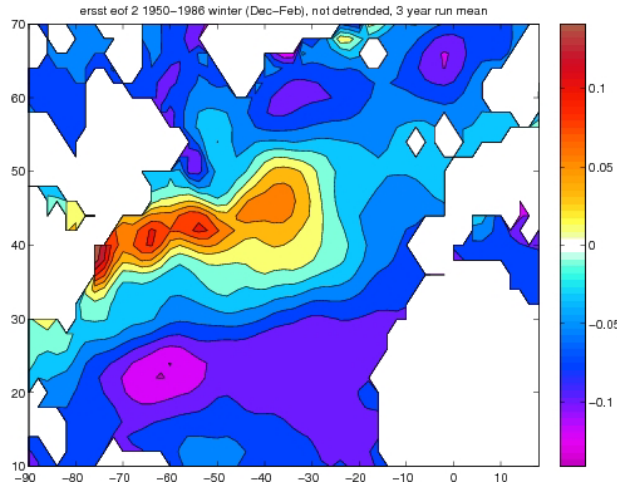
Differences

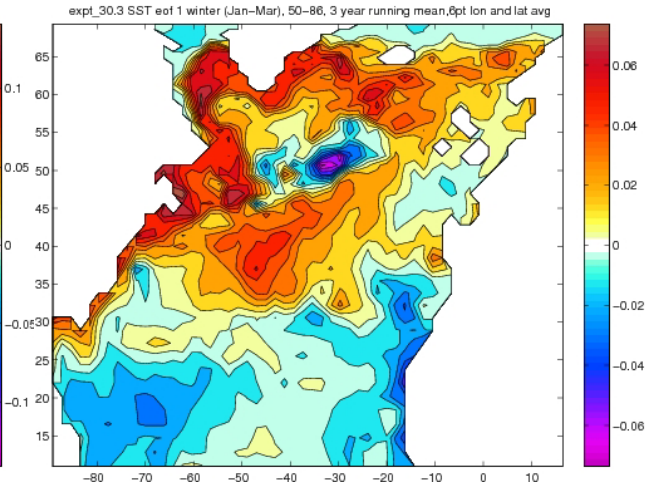
High latitudes: model shows extra cooling.

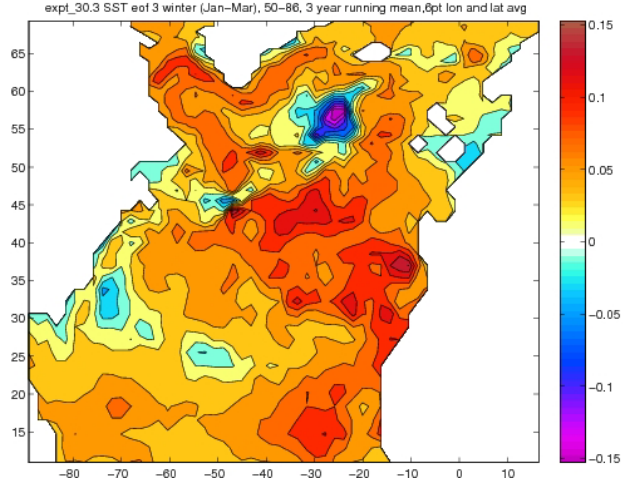
- ***Change in spin-up to interannual: suppress relaxation to seatmp***
- ***Sea Ice***

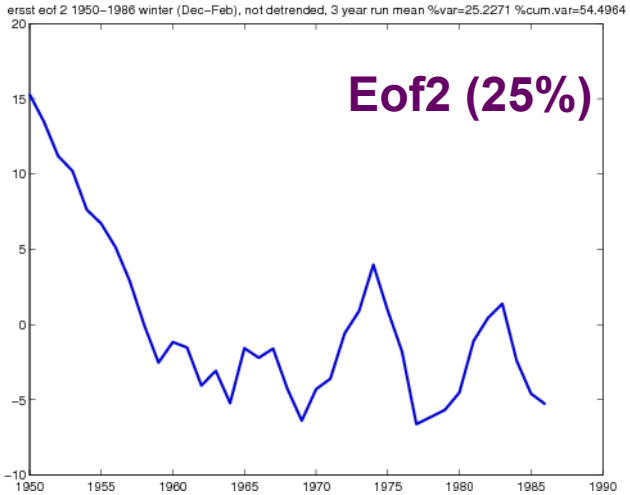
Low latitudes: upwelling regions.

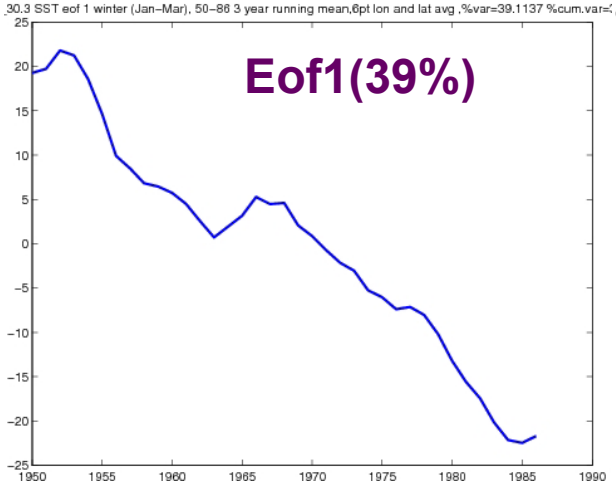
SST Observed eof2 Expt 30.3, eof1 and eof3

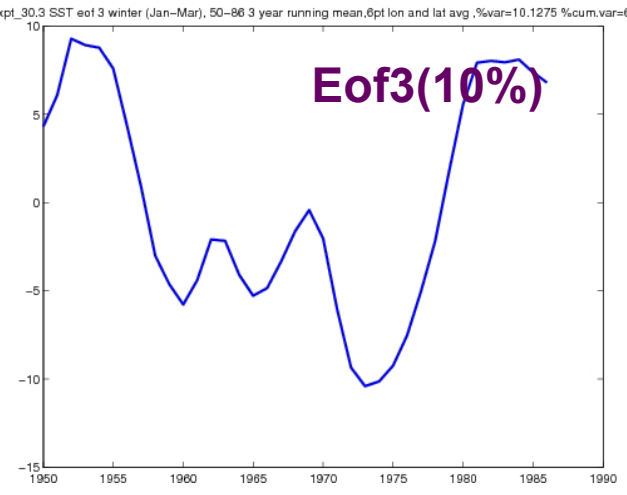






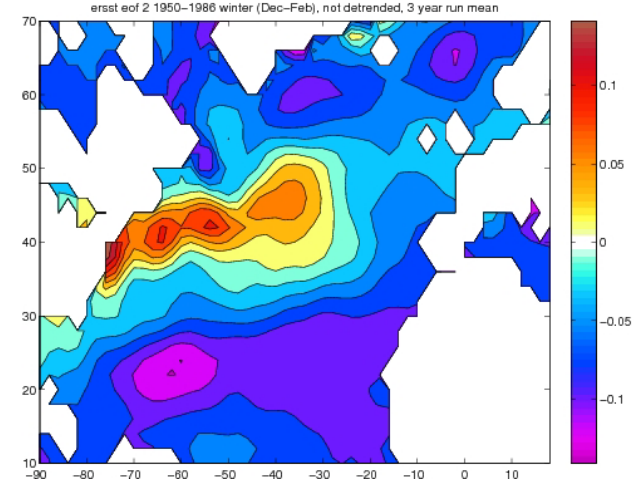


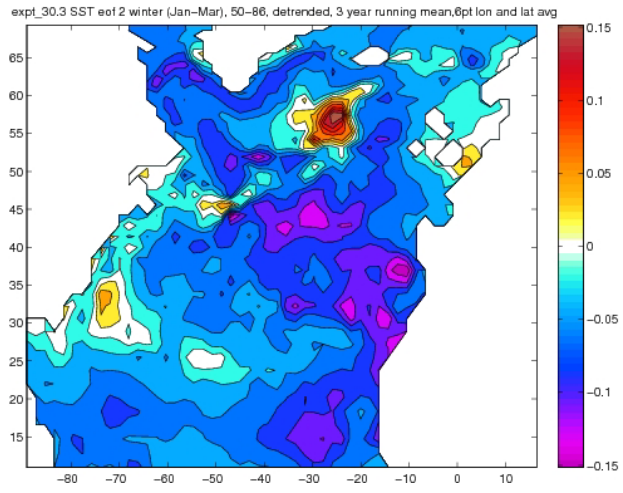


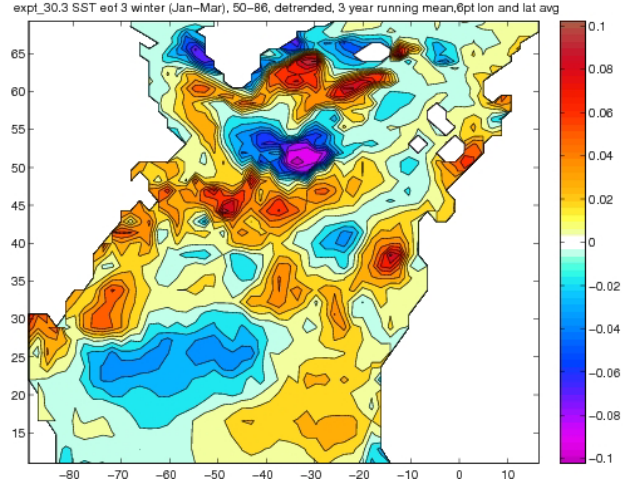


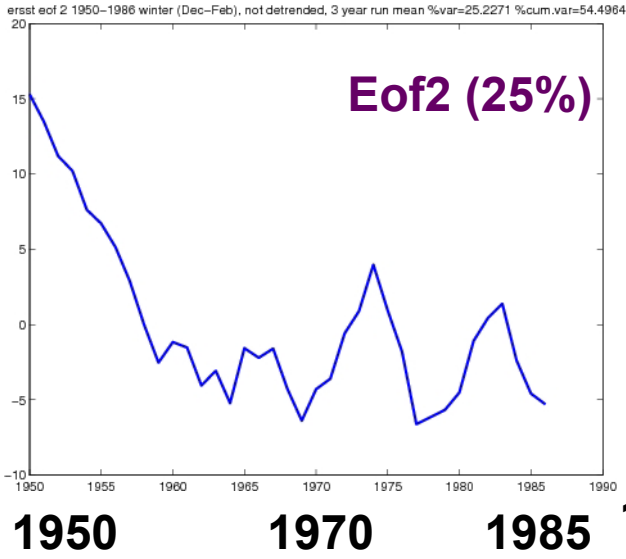
1950 1970 1985 1950 1970 19851950 1970 1985

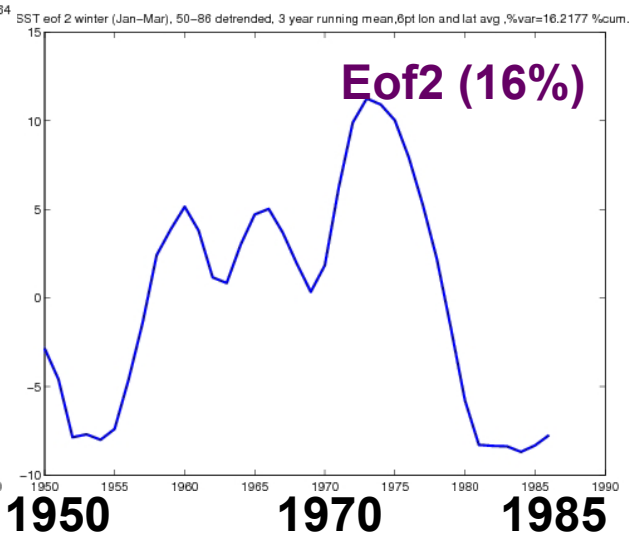
SST Observed eof2 If detrended, 30.3 eof2 and eof3

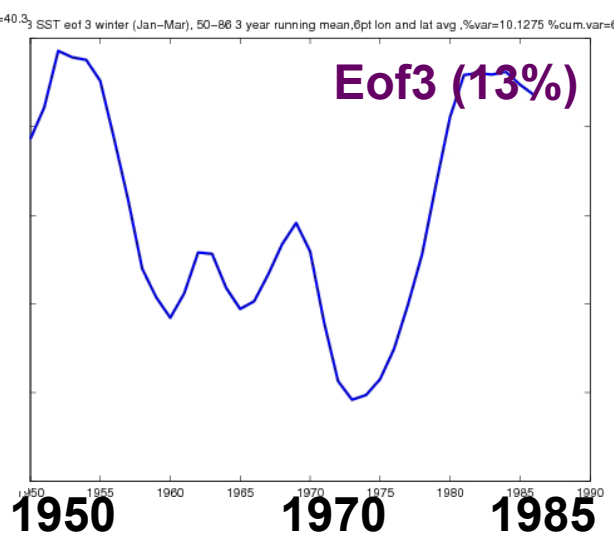






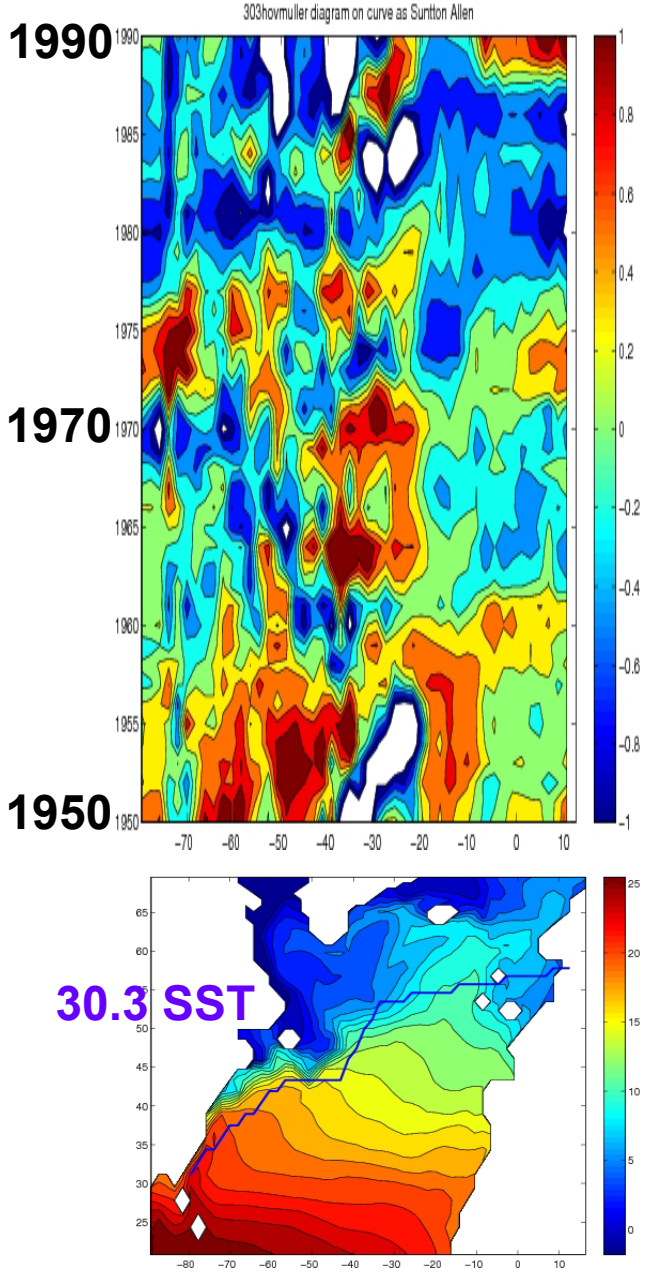




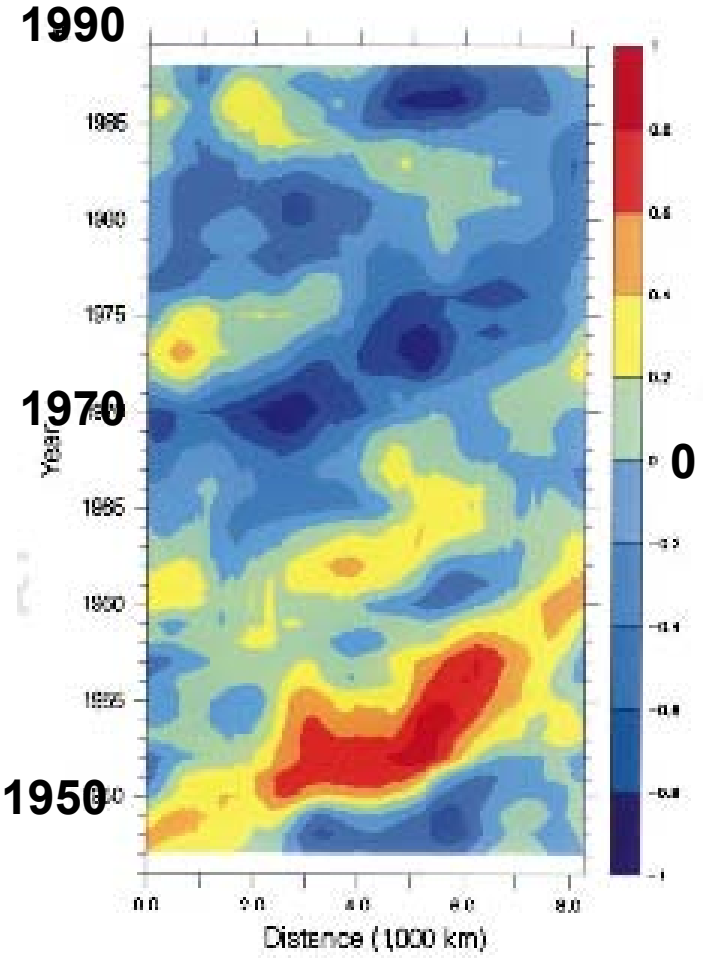


SST: Hovmuller diagram on Curve by Gulf Stream

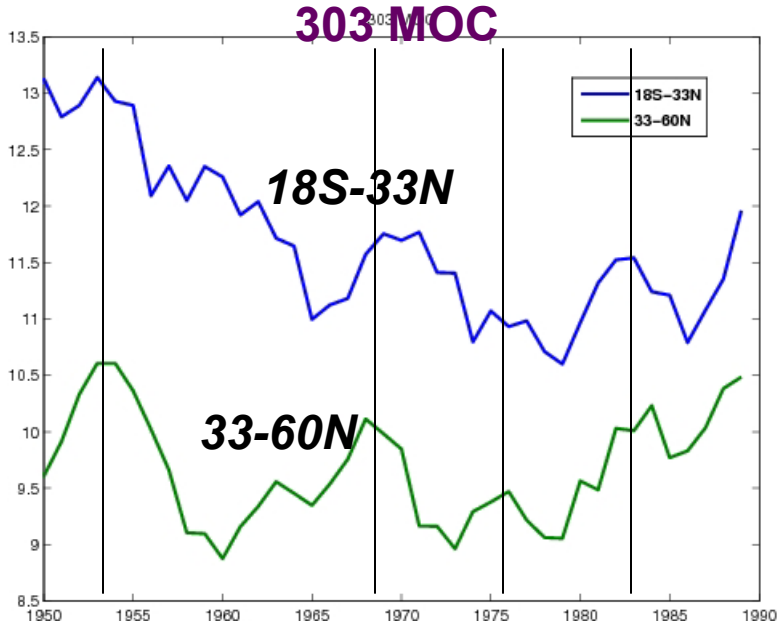
Expt 30.3, no SSSrel

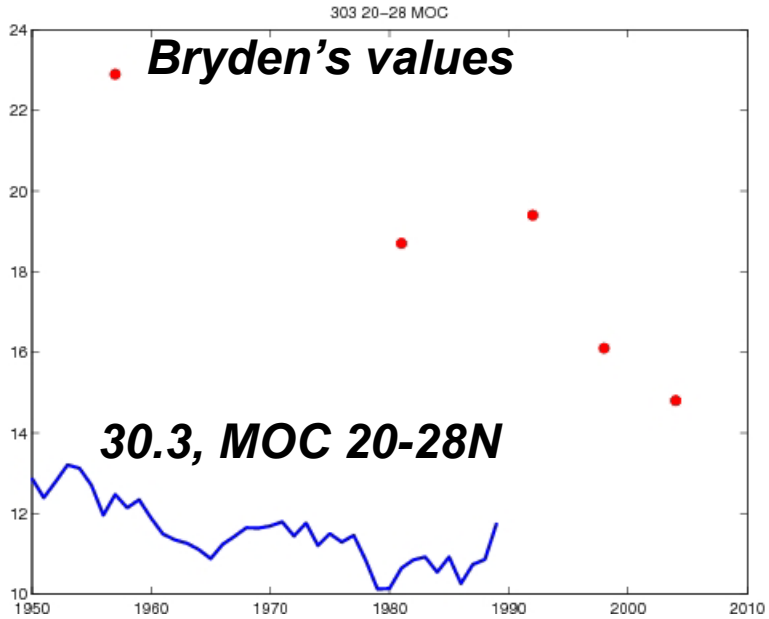


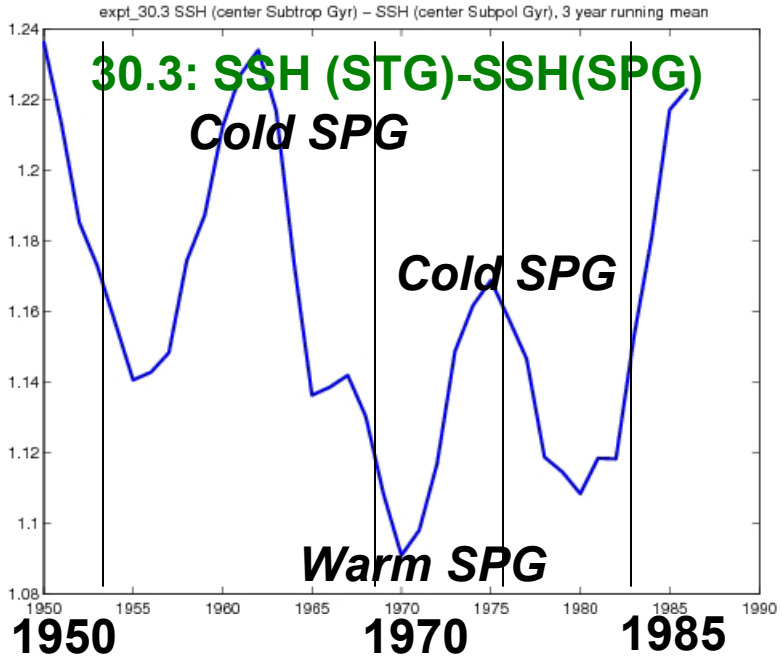
Sutton Allen observed SST

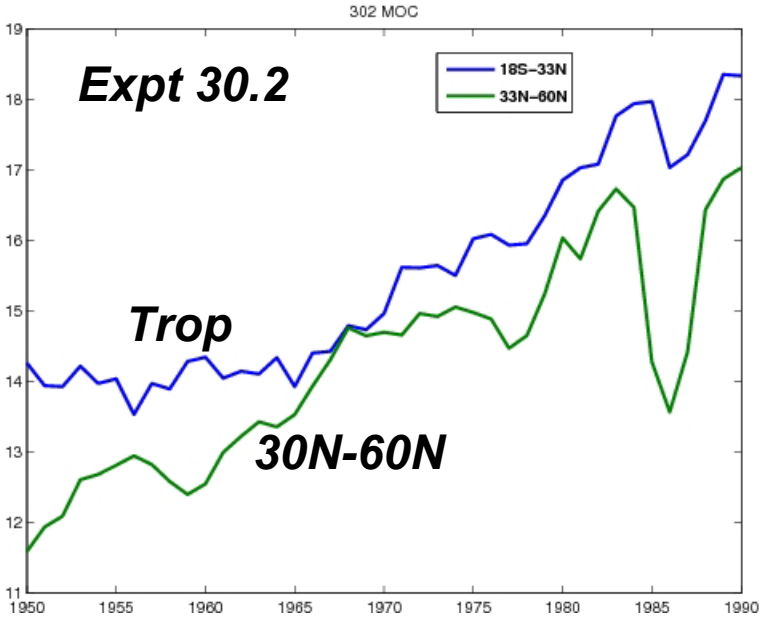


Expt 30.3 overturning (z coord)

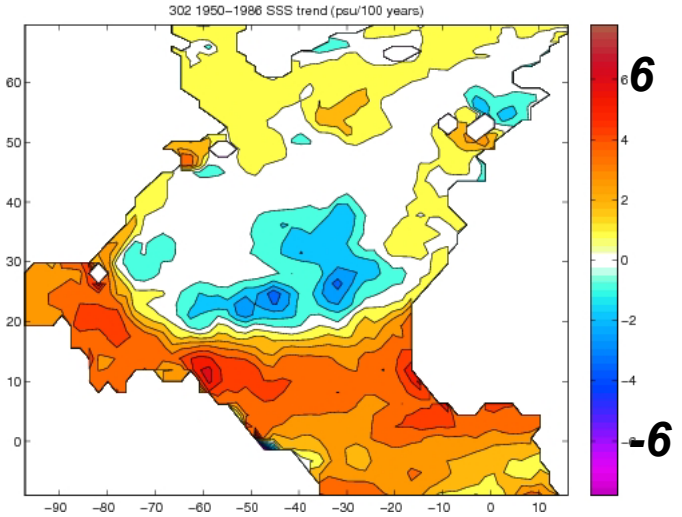


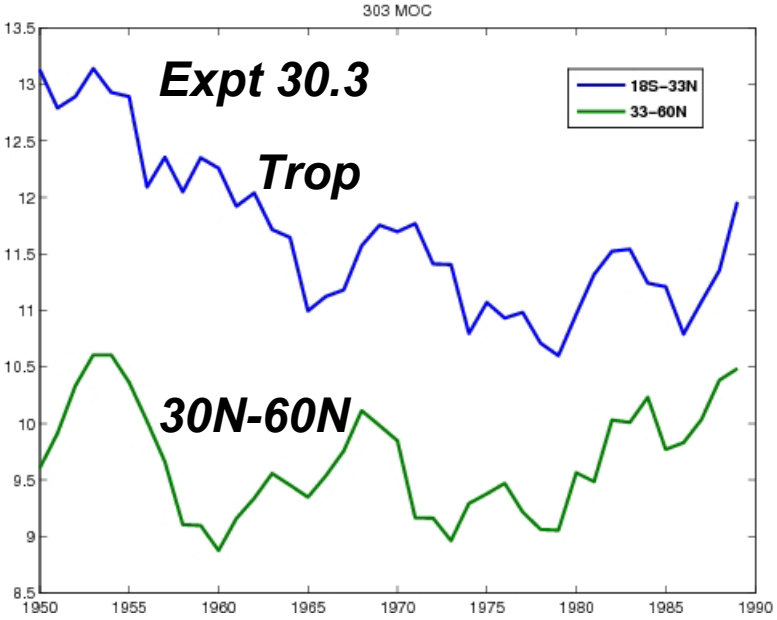




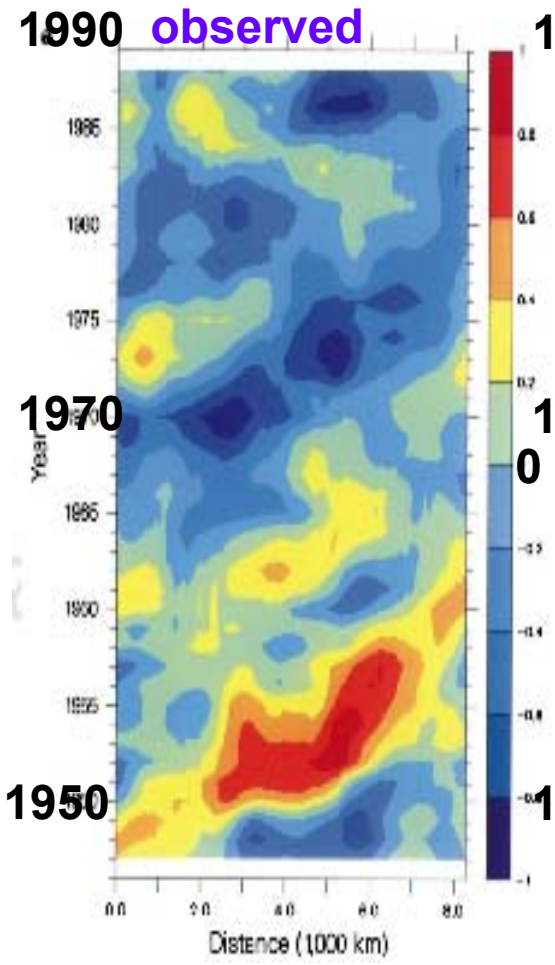


30.2 salinity drift (psu/100y)

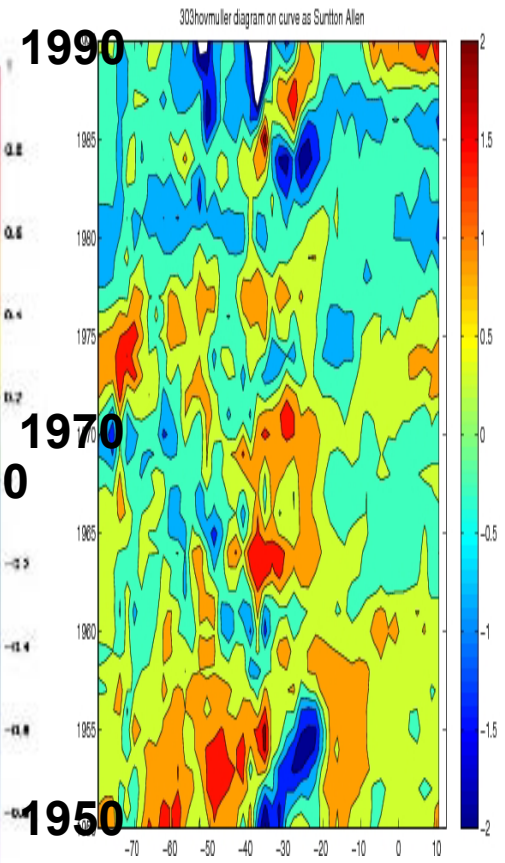




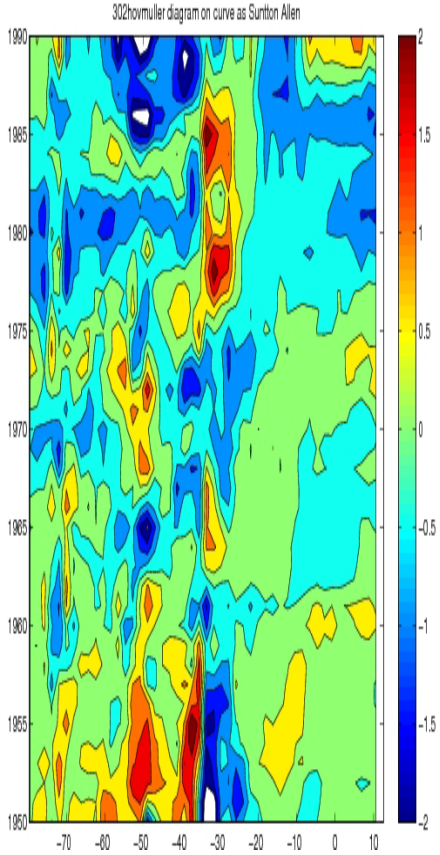
SST: Hovmuller diagram on Curve by Gulf Stream



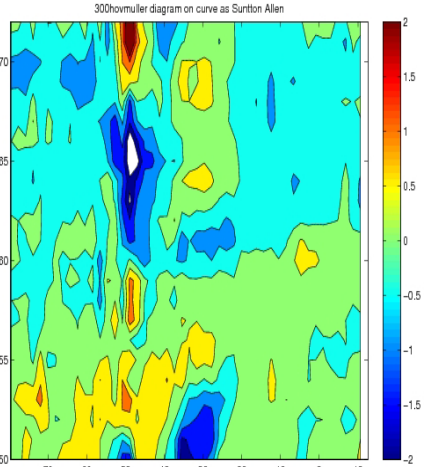
Expt 30.3,
no SSS relax



Expt 30.2,
SSS relax

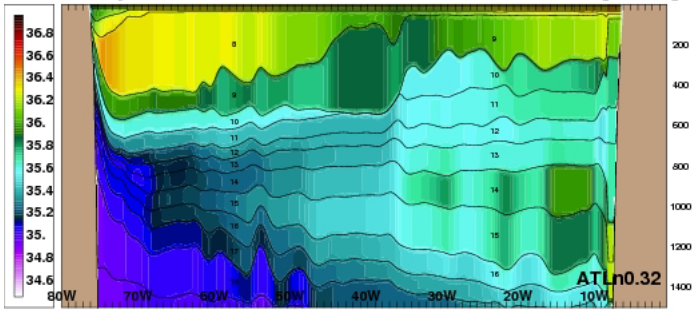


Expt 30.0,
SSS, SST relax

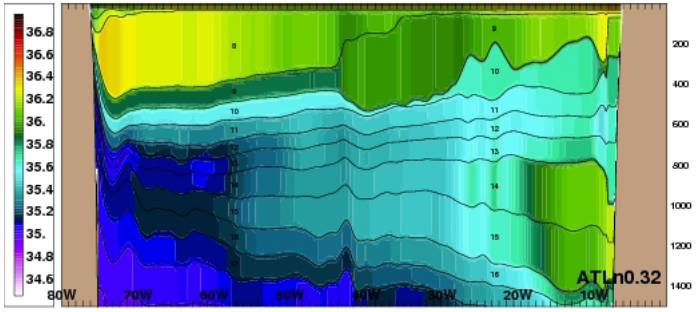


30.3:Salinity 35N section

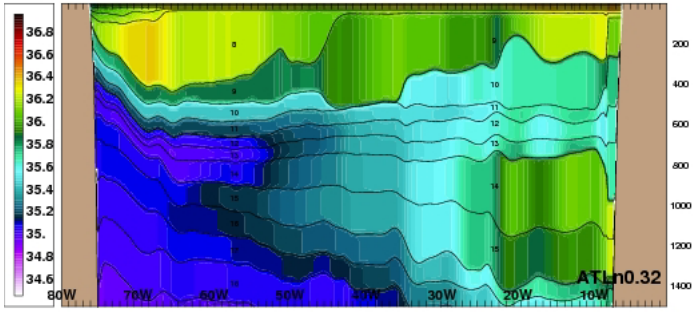
1950



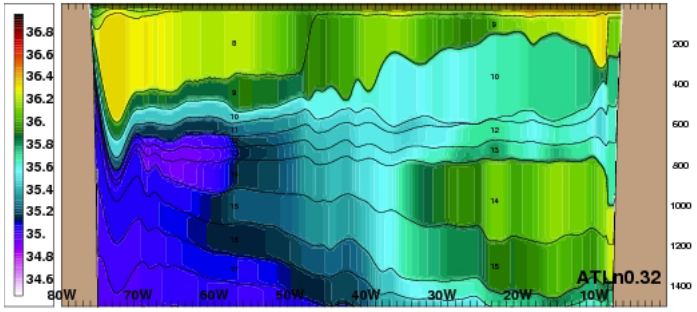
1960



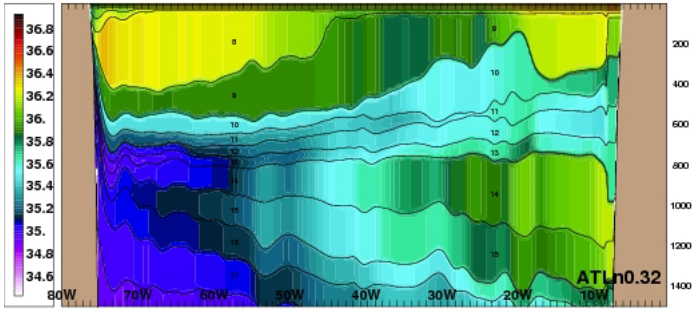
1970



1980



1990



Summary

Interannual 1/3 degree Atlantic simulation:

- **realistic SST anomalies**
- **anomaly propagation along the GS path**
- **MOC variations, to be further analyzed.**

For the moment, best case is with SSS relaxation.

Possible room for improvement:

For expt 30.3:

1)Smooth transition from climatological to interannual wind stress (keeping the mean)
But for thermal forcing: relaxation to SST (seatmp) was discontinued. Change to a condition with no discontinuity between spin-up and interannual.

2)Ice model

For expt 30.2:
Change E-P condition, salinity flux correction?

ERA40 with satellite wind correction

Future plans

Interannual simulations at 1/3 degree:

- Modified salinity flux simulation
-ERA40 simulation with wind correction

Atlantic climatological simulations at 1/12° resolution

-Started simulation similar to 11.8-12.1 with heat flux correction (it is in year 1.5 after flux correction applied)
Complete it together with twin with no flux correction.

Atlantic 1/12 interannual simulations

Simulations done at Pittsburgh Supercomputing Center and at ERDC.

Medium Range Computer Allocation (MRCA) proposal approved at PSC.
LRCA for high resolution inter-annual simulations can be resubmitted.