NCAR
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DOE/UCAR Cooperative Agreement
Regional and Global Climate Modeling Program
U.S. DEPARTMENT OF ENERGY
Office of Science

Influence of the freshwater forcing pathway on the AMOC during 8.2k event

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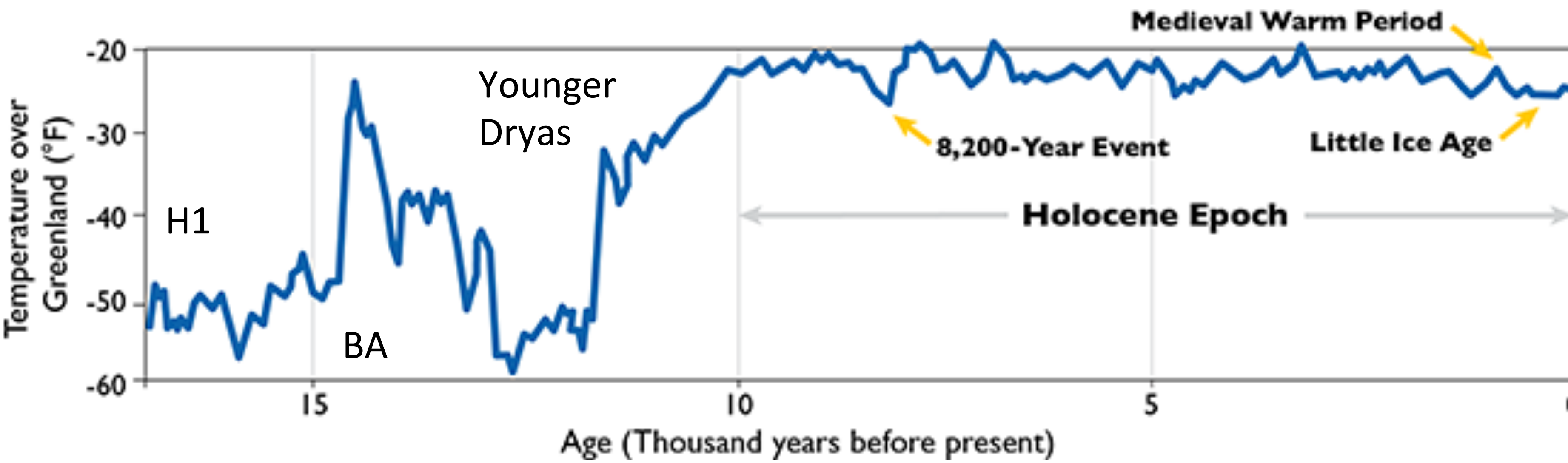
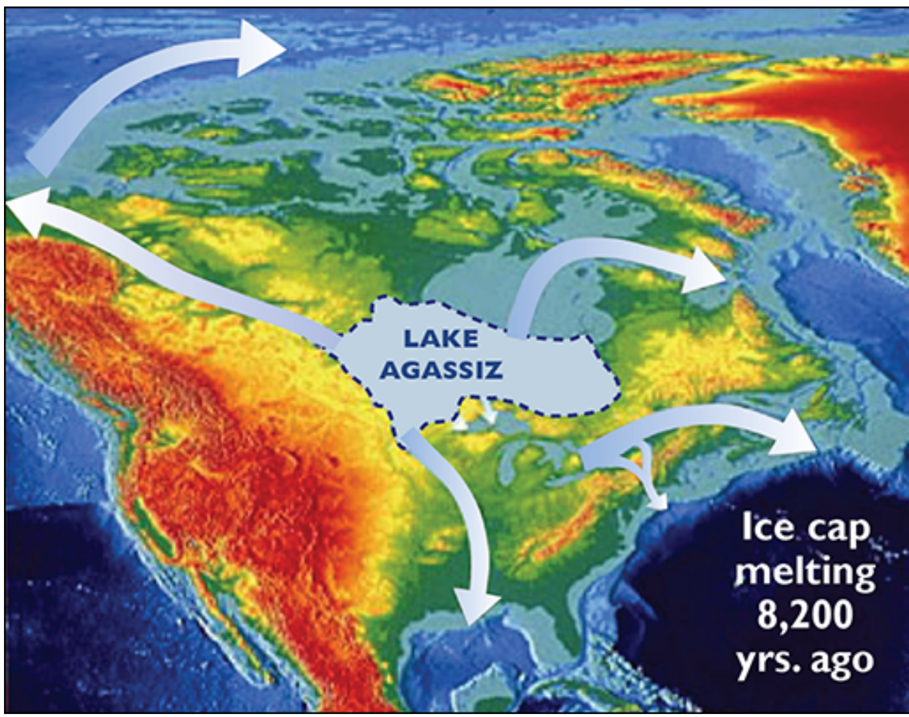
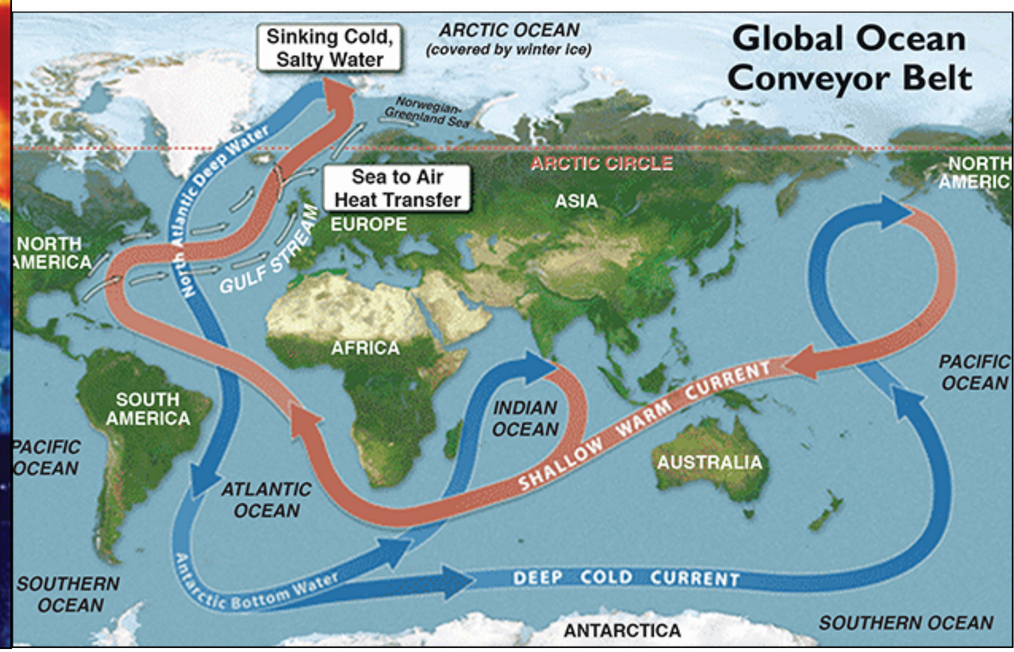
2017 US AMOC Science Team Meeting

What is 8.2 kyr event

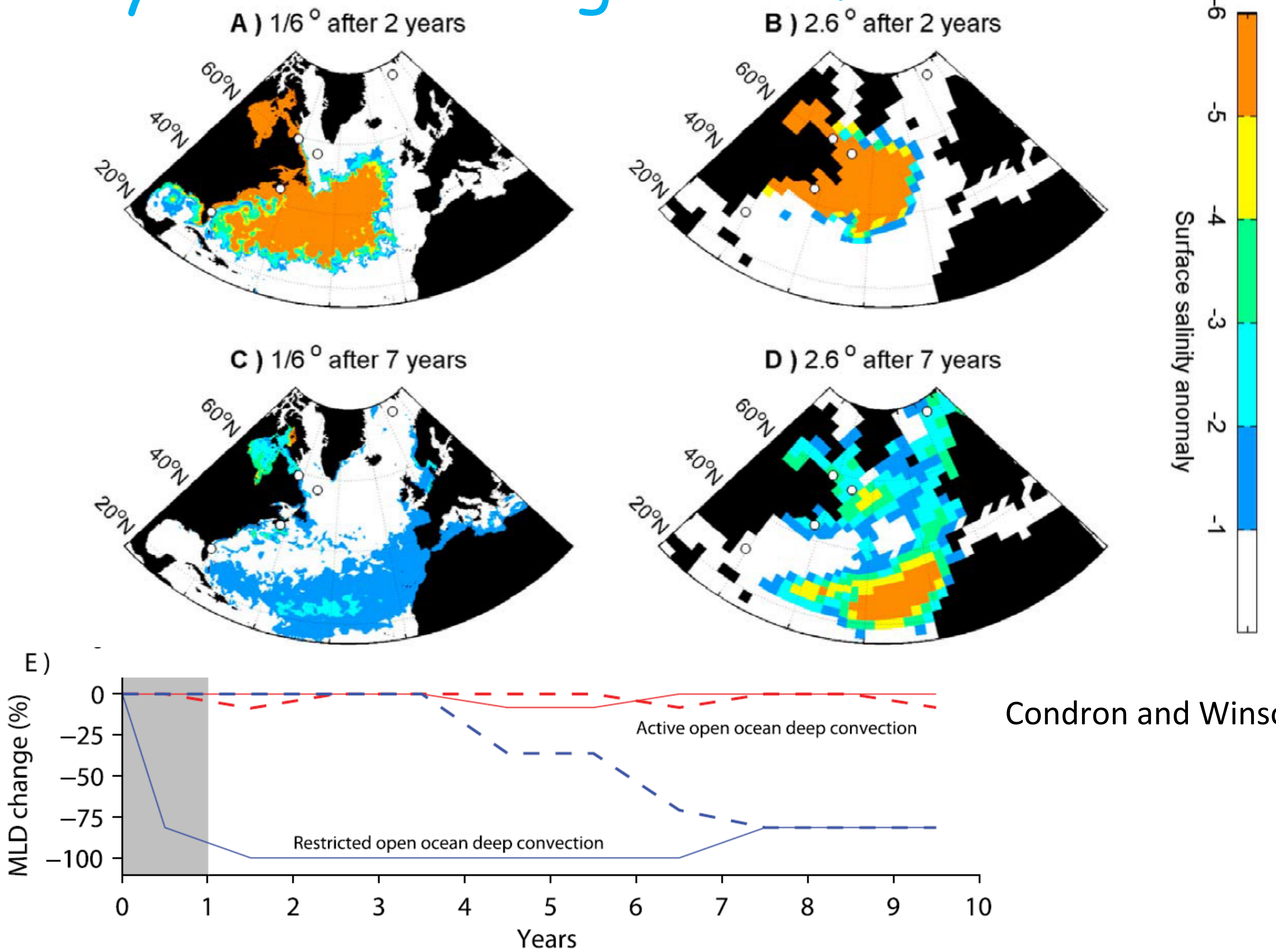




http://www.chesapeakequarterly.net/V12N4/main1/



Why do we use high-res model



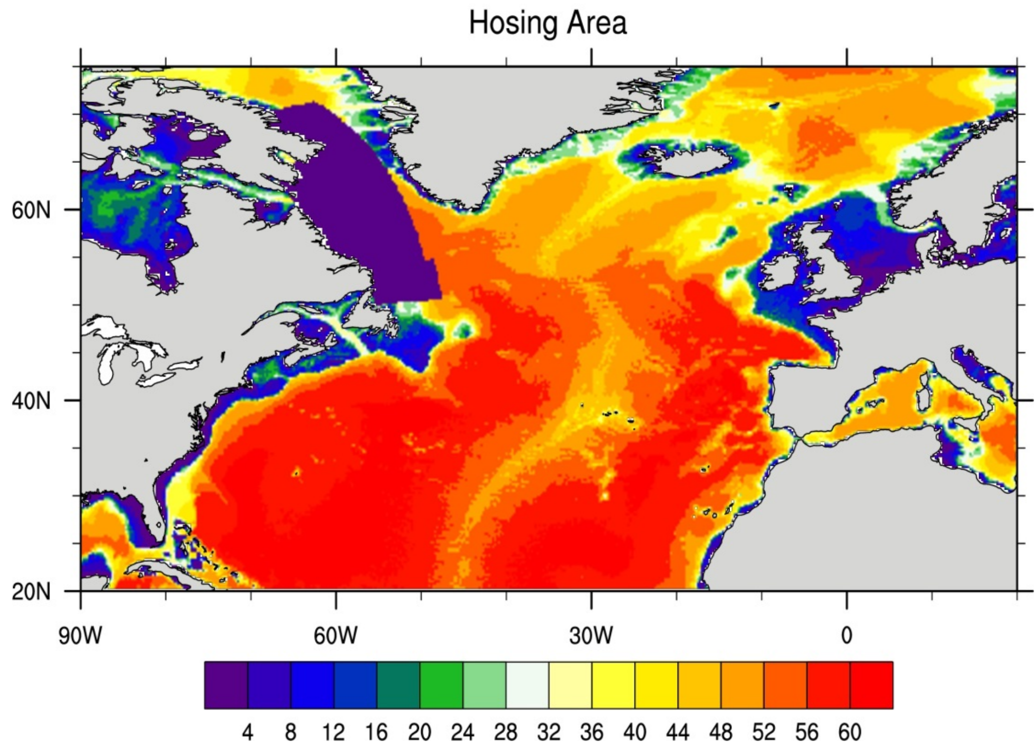
Condron and Winsor, 2011

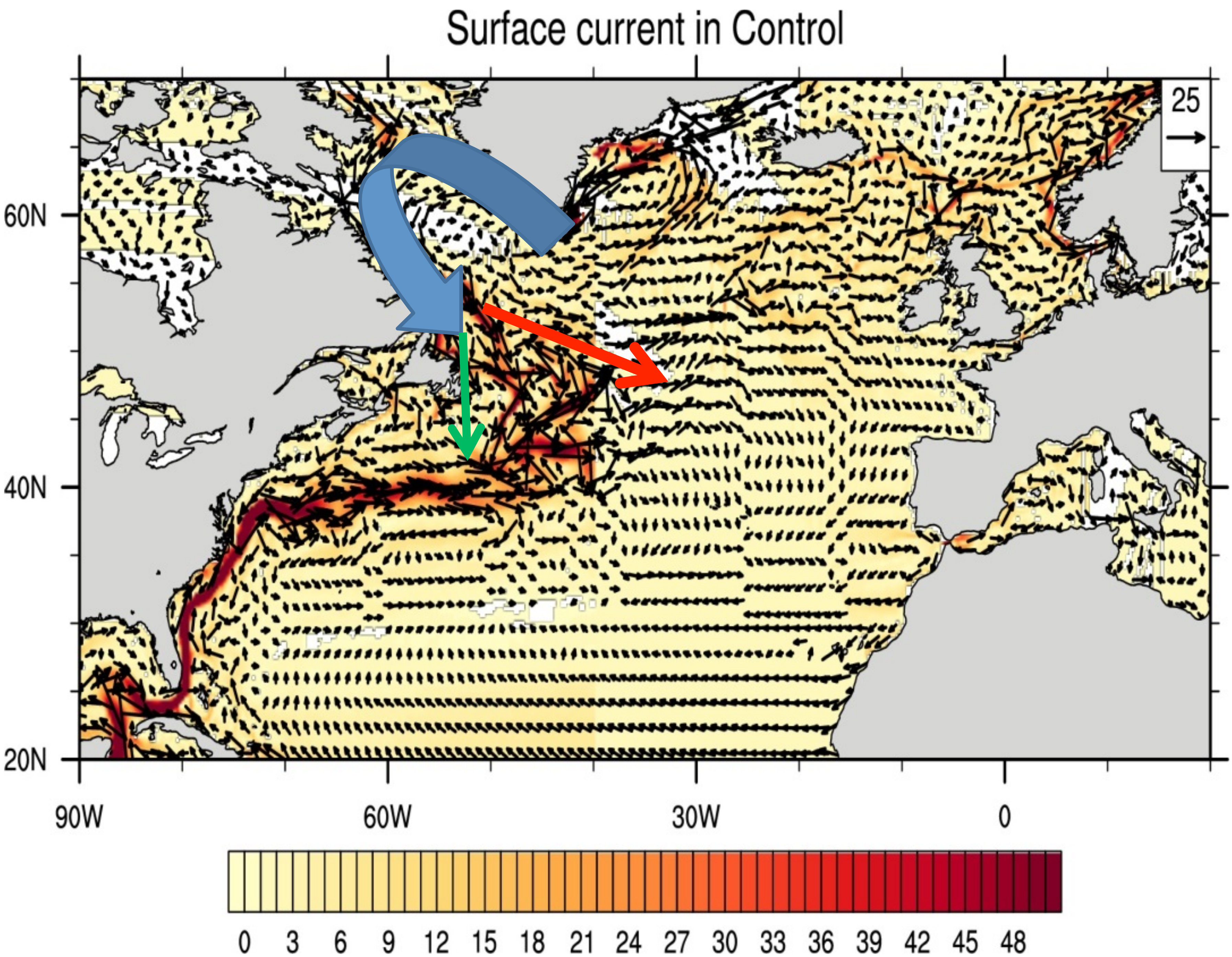
Model and Experiment:

Community Earth System Model version 1 (CESM1):
High-res: ASD version:
0.1^o ocean and sea ice
0.25^o atmosphere and land

Climate background: present day

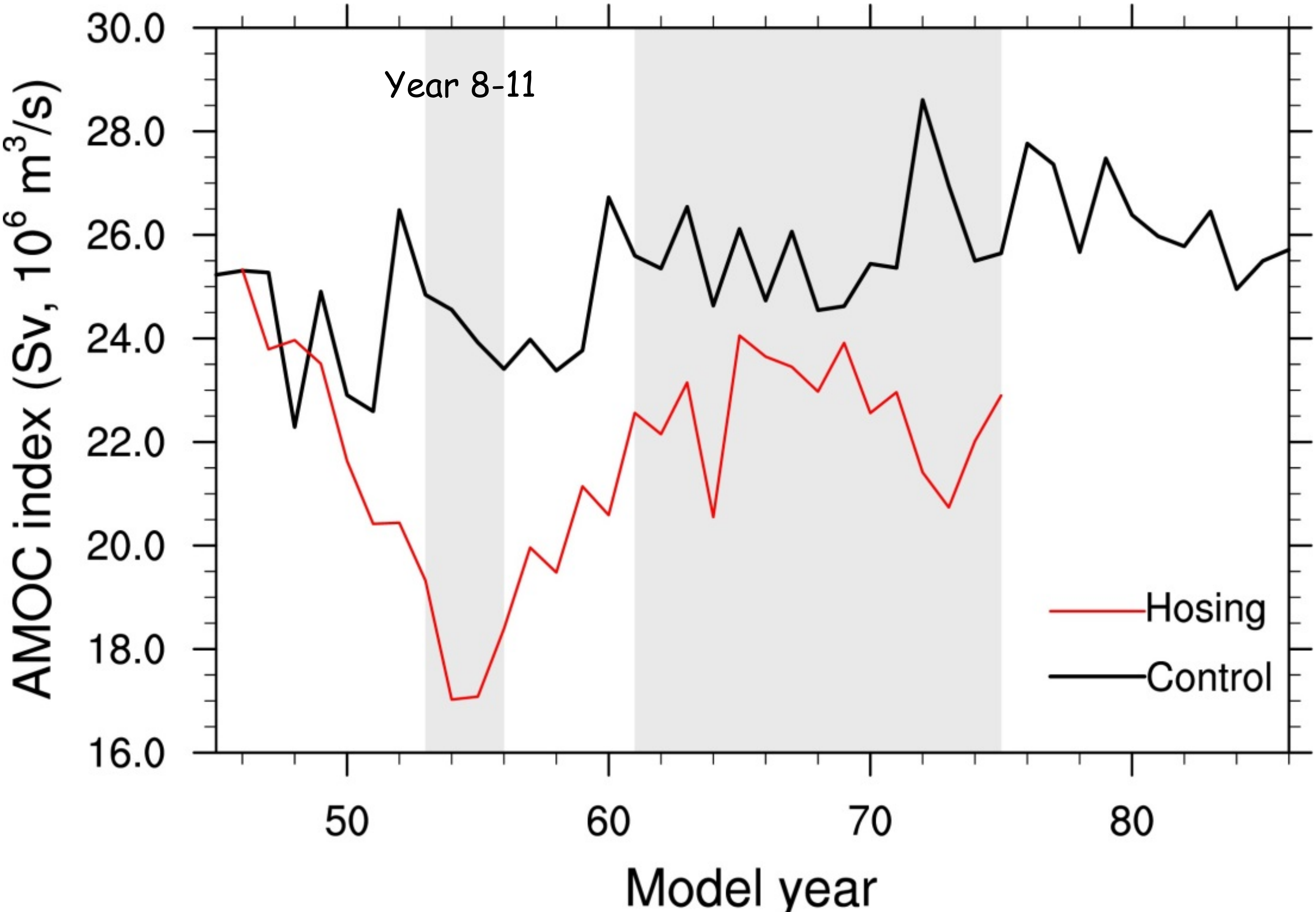
2 Sv freshwater added into the Labrador sea and Baffin Bay regions for two years, then freshwater forcing is switched off. The model was integrated for 30 years



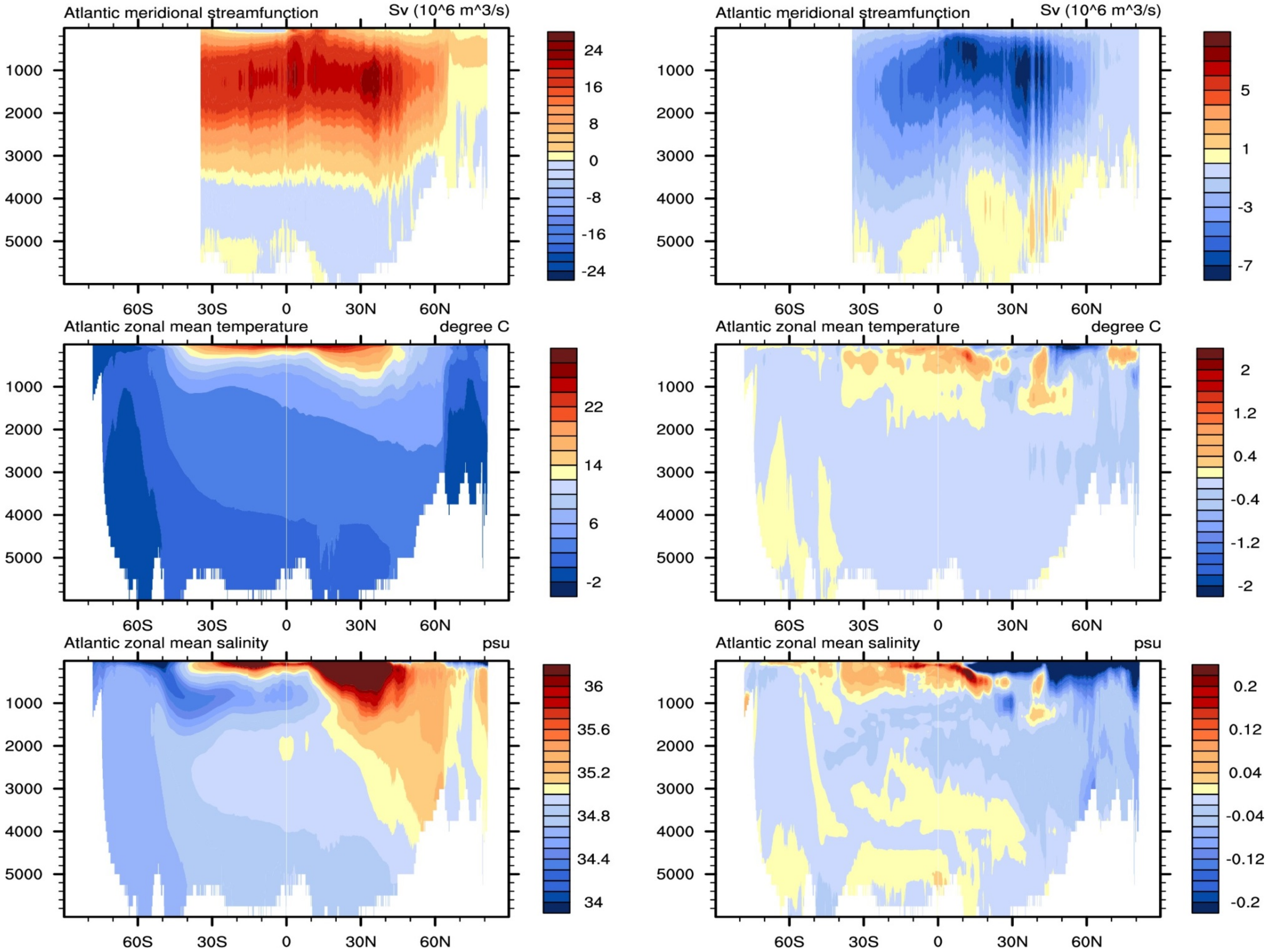


Surface current in Control
25
60N
40N
20N
90W
60W
30W
0
0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48

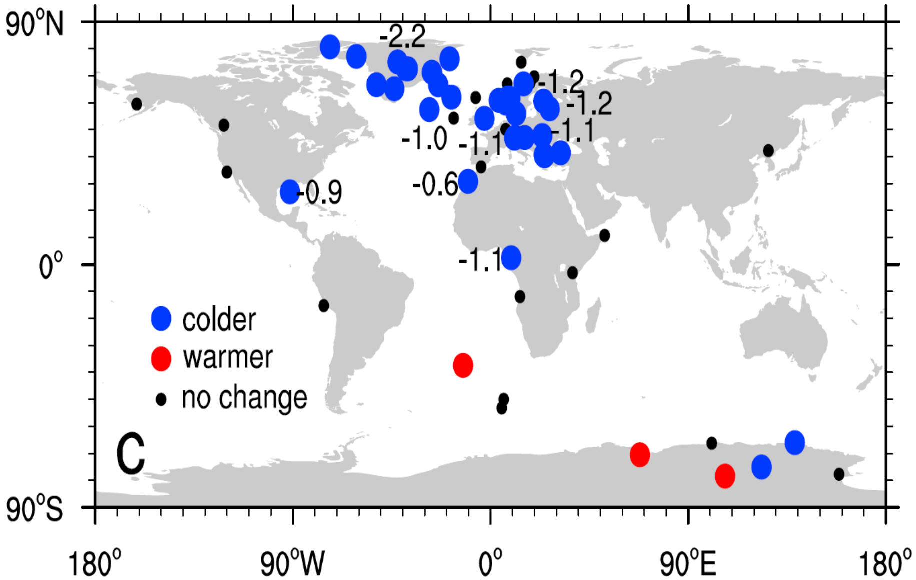
Changes of AMOC:



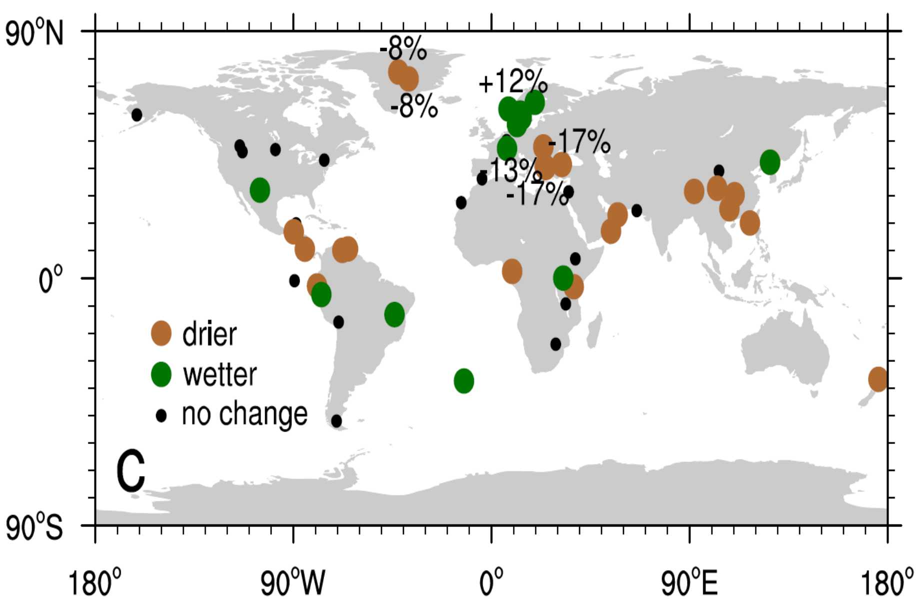
Zonal mean MSF, T, S in Control Run and anomalies (years (8-11))



Temperature anomaly (° C)

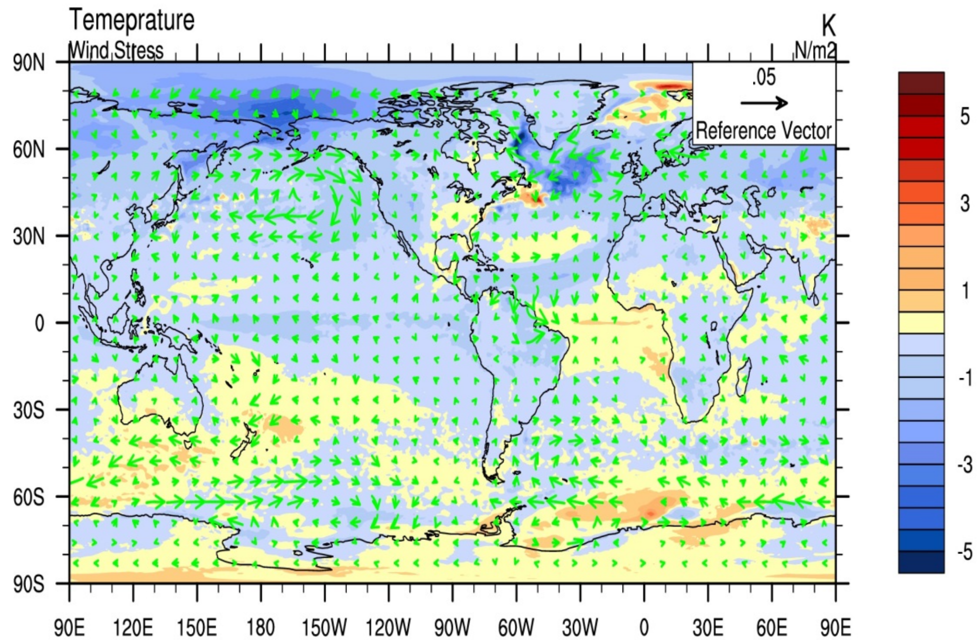


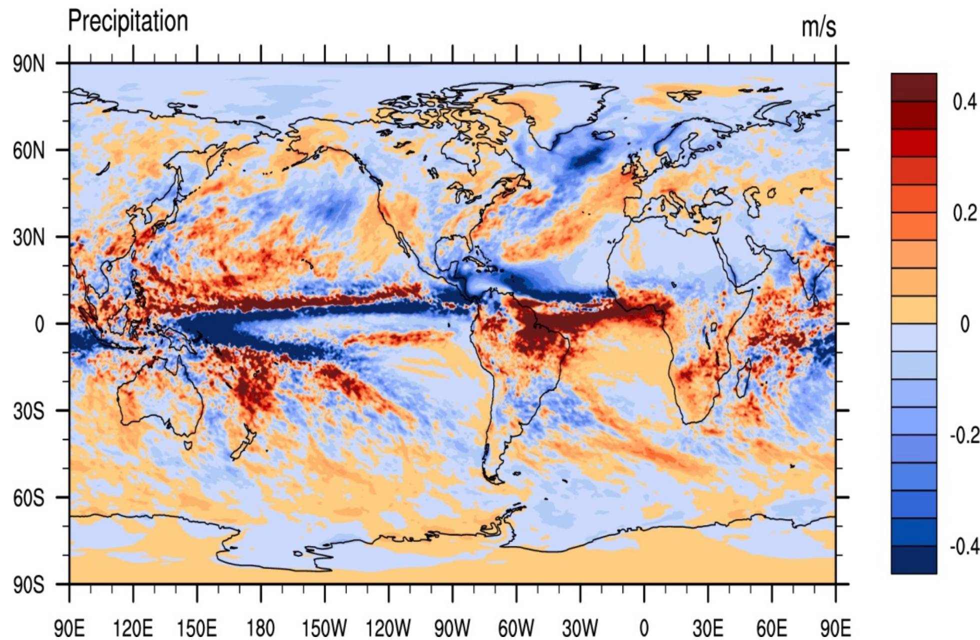
Precipitation anomaly (%)

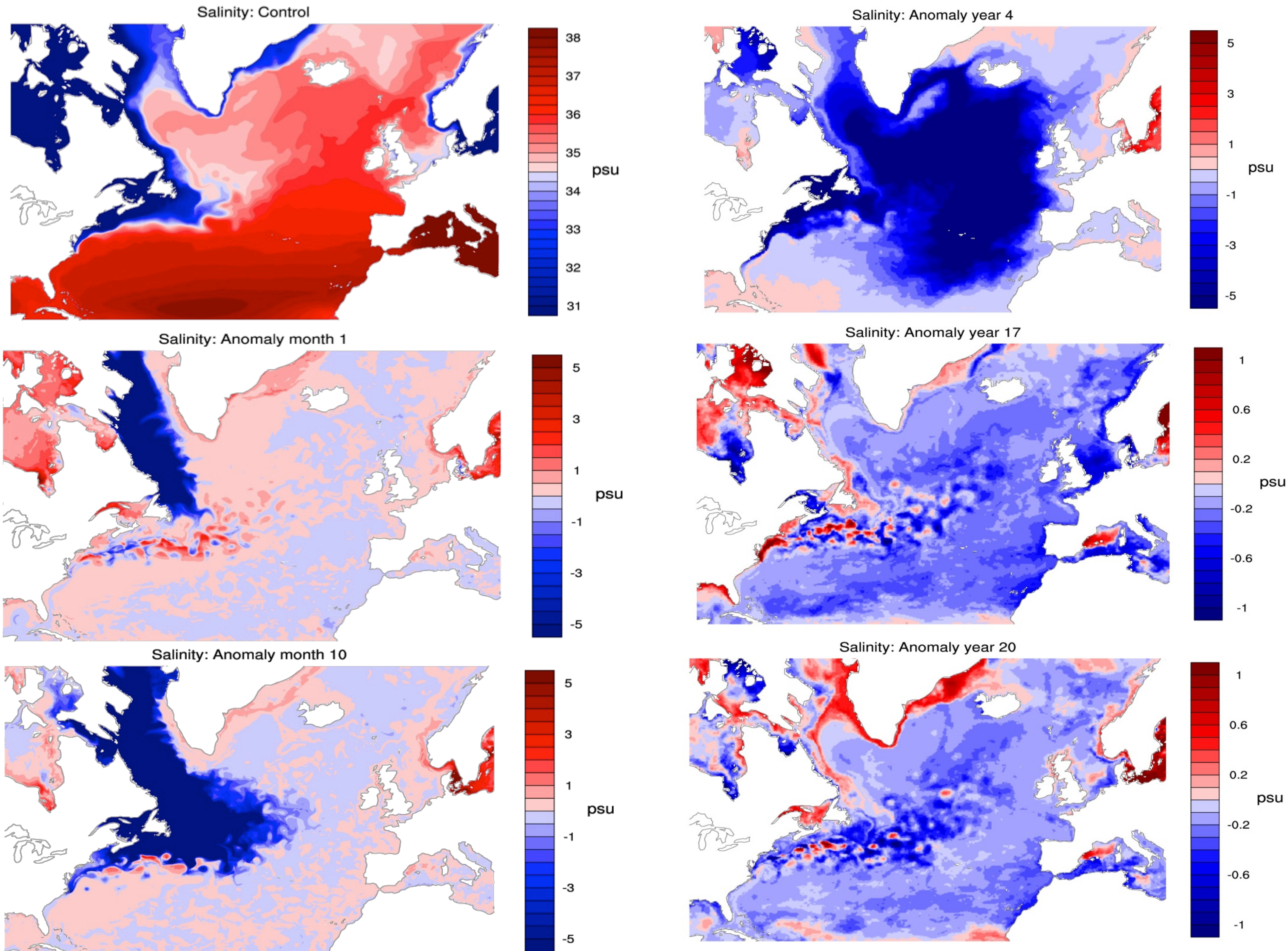


Morrill et al, 2013

Anomaly years 8-11

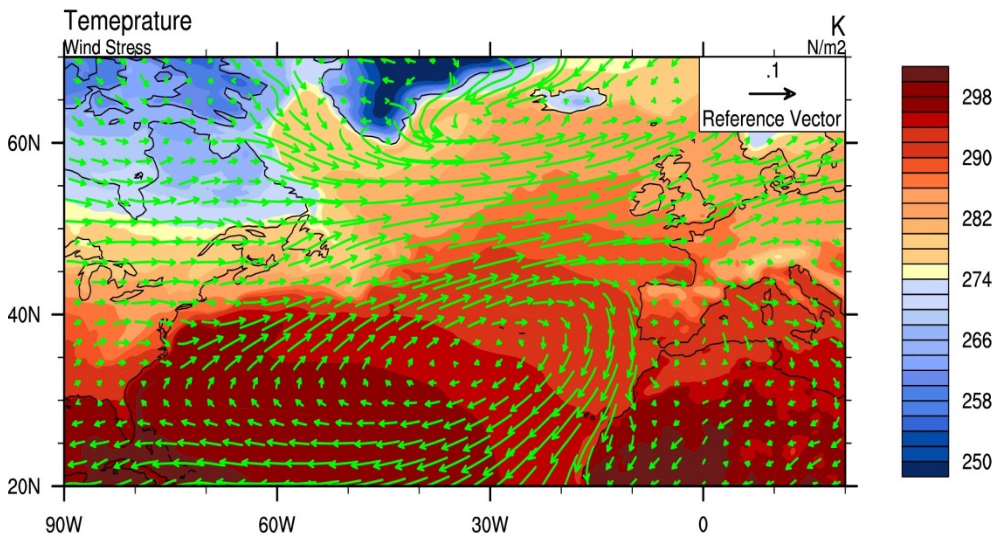




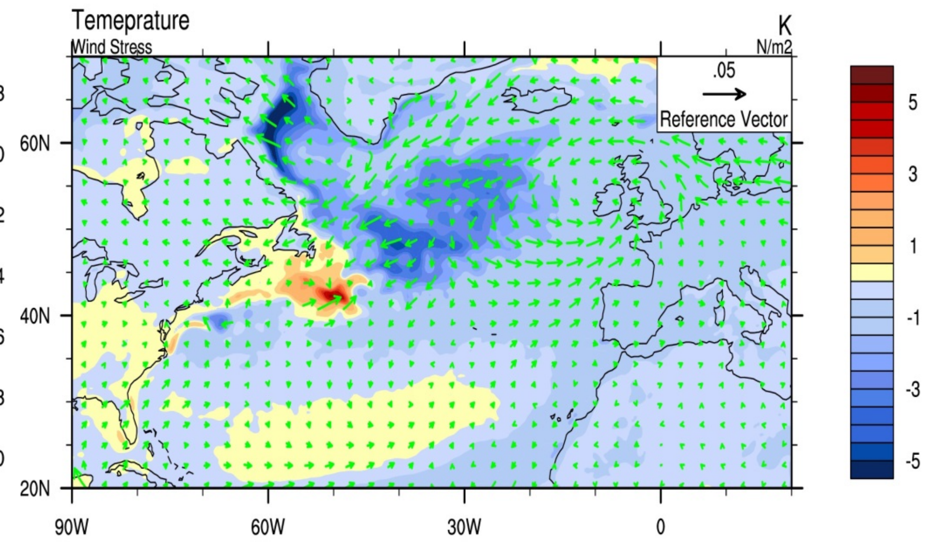

Salinity: Control
38
37
36
35
34
33
32
31
psu
Salinity: Anomaly year 4
5
3
1
-1
-3
-5
psu
Salinity: Anomaly month 1
5
3
1
-1
-3
-5
psu
Salinity: Anomaly year 17
1
0.6
0.2
-0.2
-0.6
-1
psu
Salinity: Anomaly month 10
5
3
1
-1
-3
-5
psu
Salinity: Anomaly year 20
1
0.6
0.2
-0.2
-0.6
-1
psu

Surface temperature and wind stress

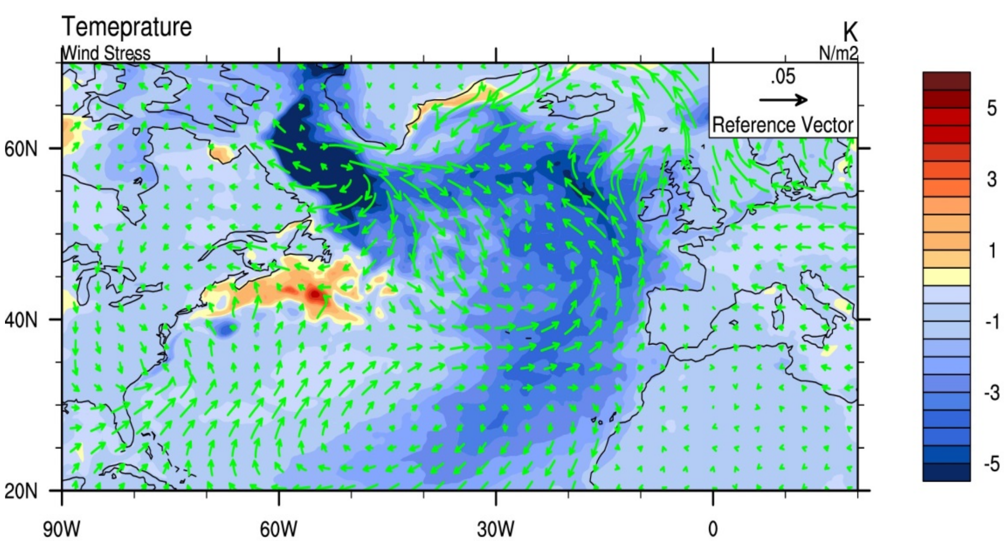
Control Run



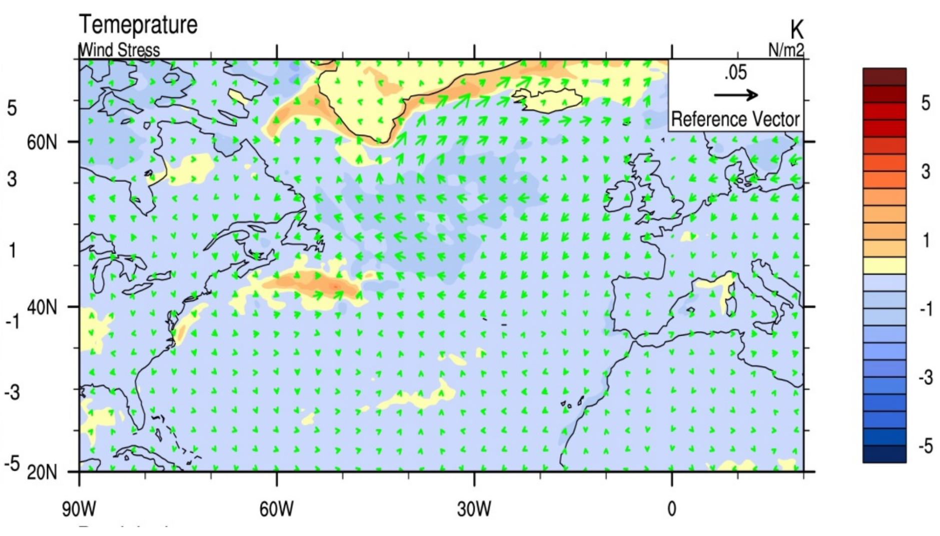
Anomaly years 8-11



Anomaly at year 4



Anomaly years 17-30



Summary

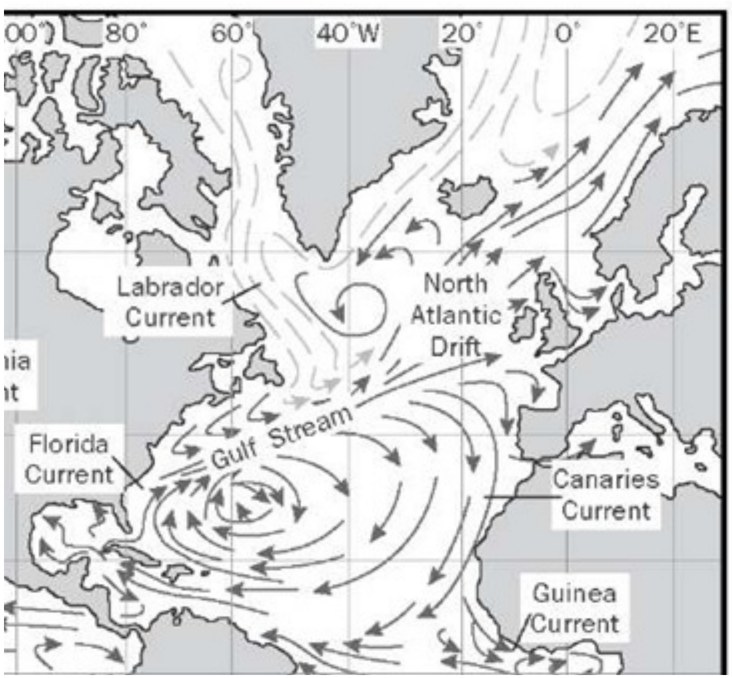
1. Our simulation gives reasonable changes of the surface climate due to a weaken AMOC in comparison with proxy data for the 8.2k event.
2. In our high resolution fully coupled simulation, the freshwater runoff into the Labrador Sea can be transported three ways: entering subpolar gyre, entering subtropical gyre, and southward penetration along US coastal region.
3. The freshwater anomaly entering the subpolar gyre can directly affect deep convection there and modify the AMOC strength.
4. The freshwater anomaly entering the subtropical gyre will circulate the subtropical gyre and re-enter the subpolar gyre, inducing delayed effect on the deep convection there.
5. The freshwater anomaly penetrated south along the US coast will also be transported back into the subpolar gyre causing a delayed effect on the deep convection.
6. The changes of the wind stress in response to the cooling induced by the freshwater anomaly are the major cause for the different pathways of the freshwater anomalies.

AMOC metrics

Is Fov a good indicator of AMOC related freshwater transport?

$$F_{\mathrm{ov}}(\Phi) = -\frac{1}{S_0}\int_{-D}^{0} \overline{v^*}(z,\Phi)\langle S(z,\Phi)\rangle dz$$

Hawkins et al., GRL, 2011



McDonagh et al, J Clim, 2015