Department of Earth and Planetary Sciences
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GEO266: AMOC Freshwater Hosing

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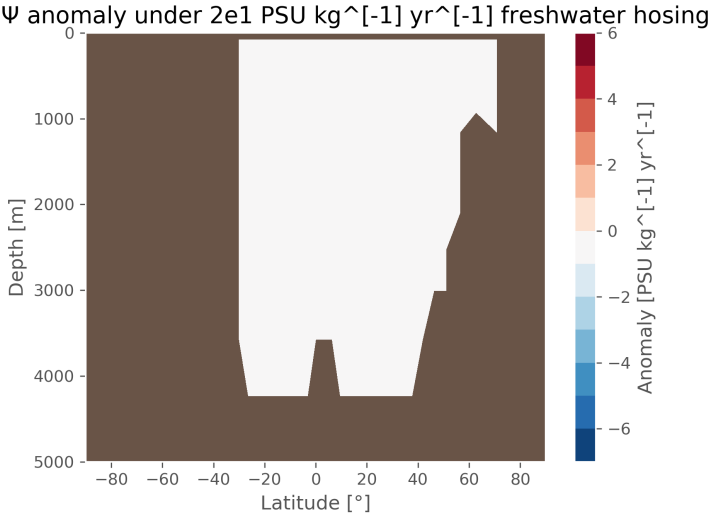
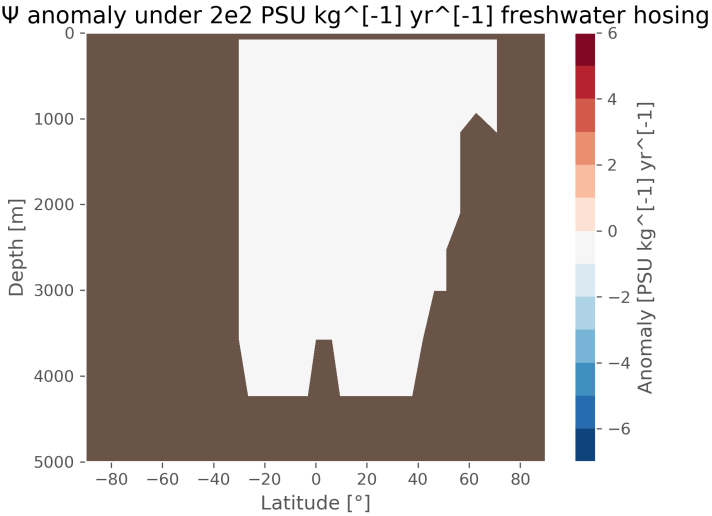
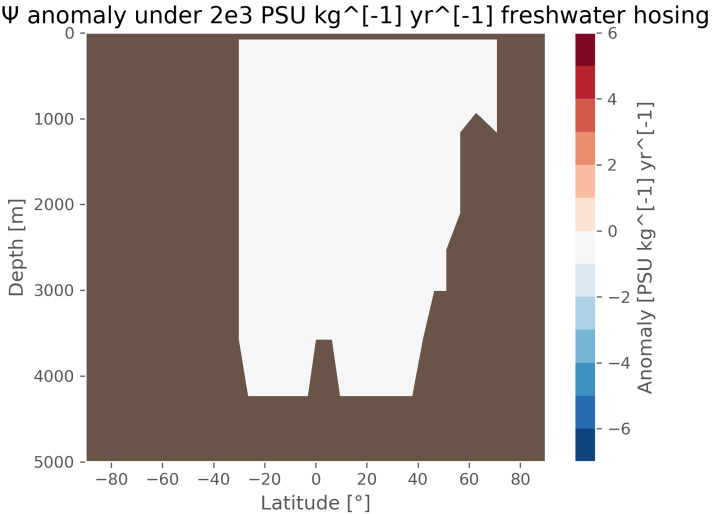
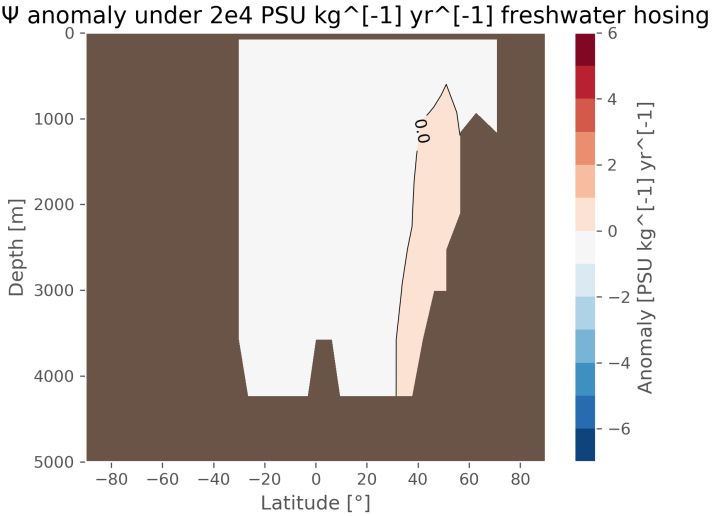
Experiments were conducted by introducing freshwater input at intervals spanning from 2×10^1 to 2×10^{17} PSU kg^{-1} yr^{-1} (with 10^n Sv increment, $n = 1, \cdots, 17$) at the coordinates i $= 22$, j $= 33$, and k $= 16$ in the CGenie muffin version. Throughout this experiment, atmospheric CO_2 level remained at pre-industrial (278 ppm). Each experiment was executed with a 100-year duration and maintained a temporal resolution at an annual scale.

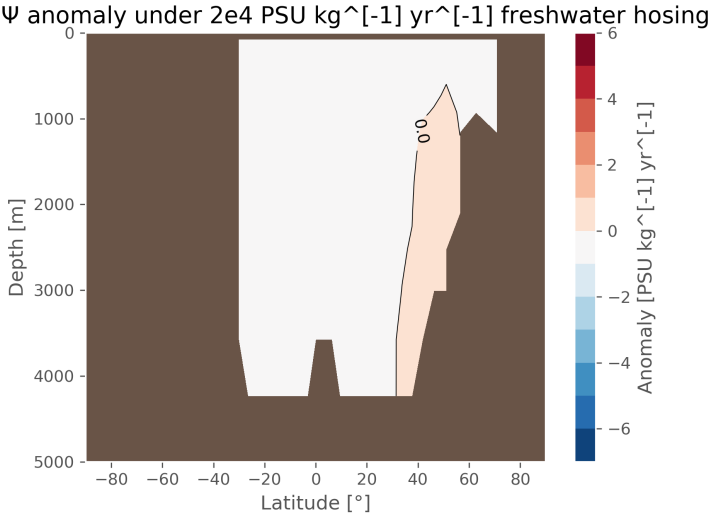
Anomalies were calculated based on the temporal average AMOC meridional stream function (Ψ) in each experiment with a control (zero freshwater input).

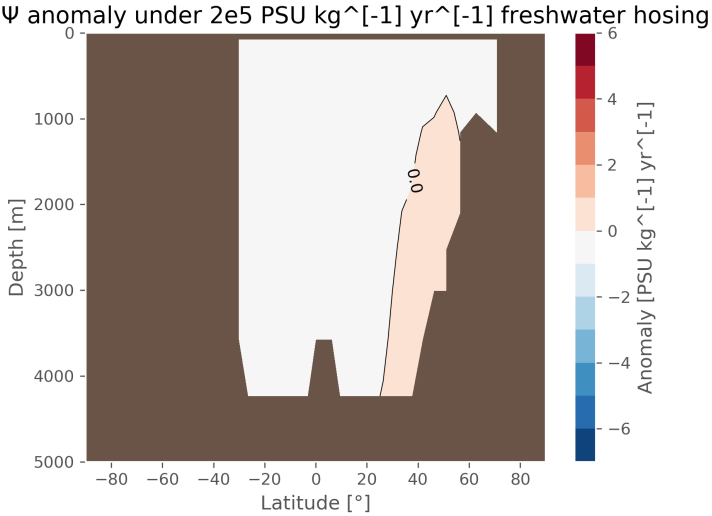

Ψ anomaly under 2e1 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
Latitude [°]
−80
−60
−40
−20
0
20
40
60
80
Anomaly [PSU kg^[-1] yr^[-1]]
6
4
2
0
−2
−4
−6

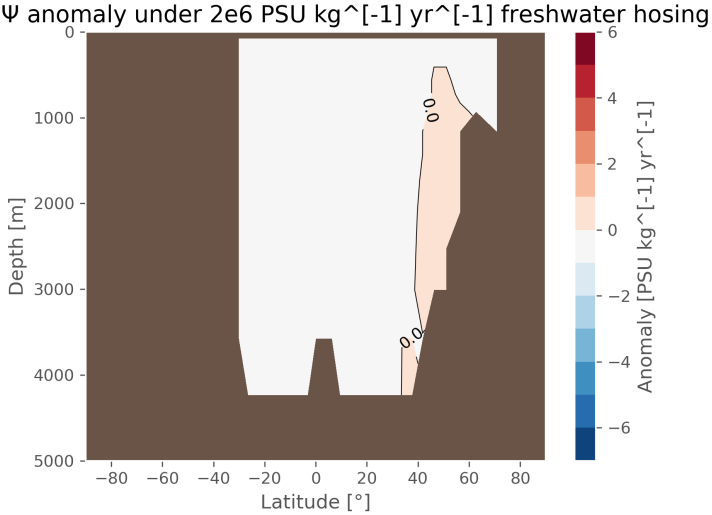

Ψ anomaly under 2e2 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
Latitude [°]
−80
−60
−40
−20
0
20
40
60
80
Anomaly [PSU kg^[-1] yr^[-1]]
6
4
2
0
−2
−4
−6

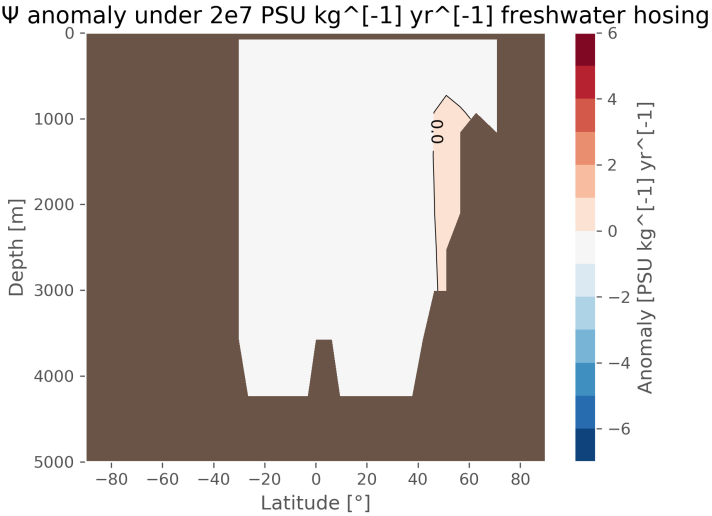

Ψ anomaly under 2e3 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

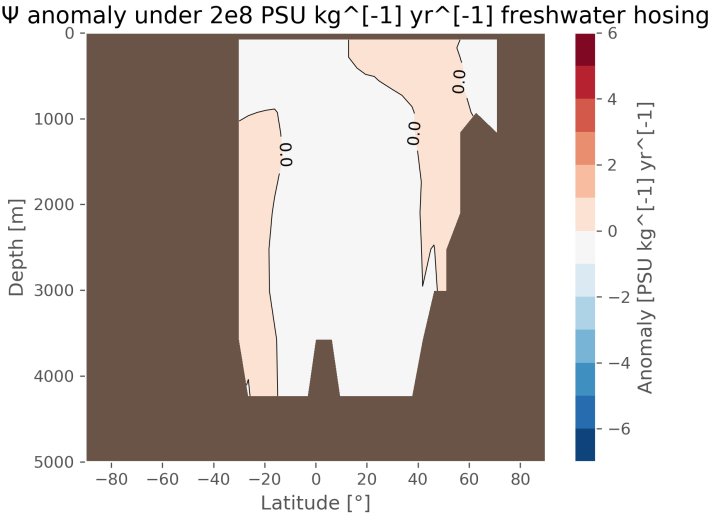

Ψ anomaly under 2e4 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

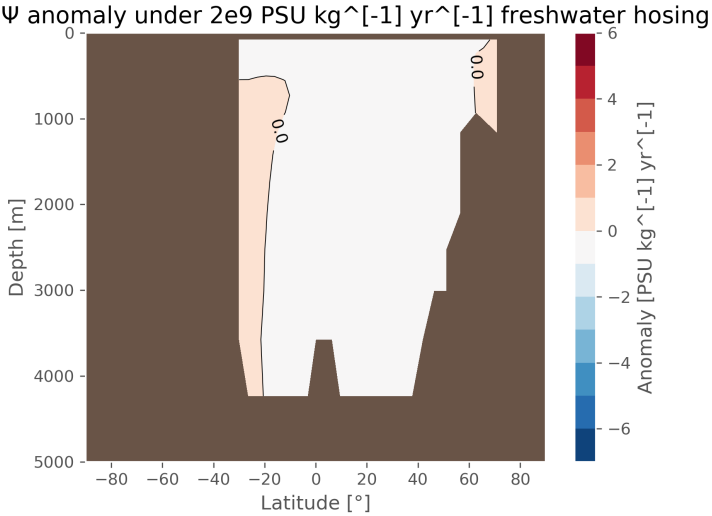

Ψ anomaly under 2e4 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

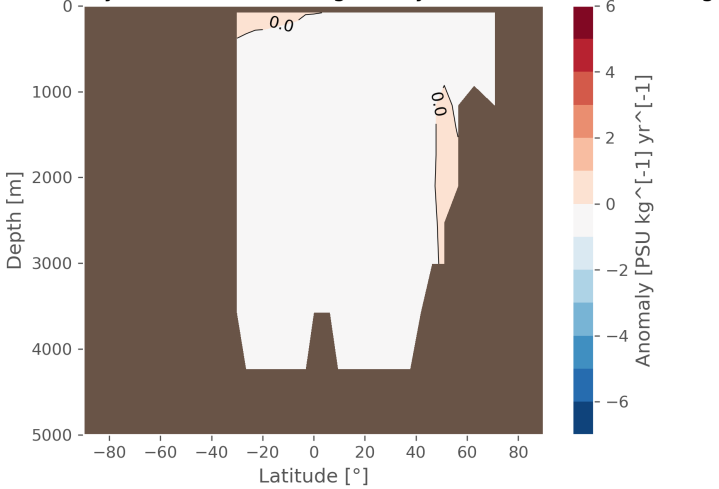

Ψ anomaly under 2e5 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

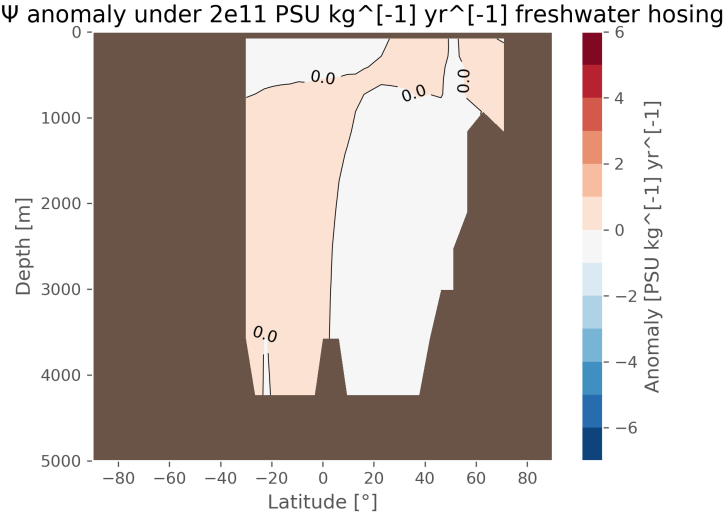

Ψ anomaly under 2e6 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

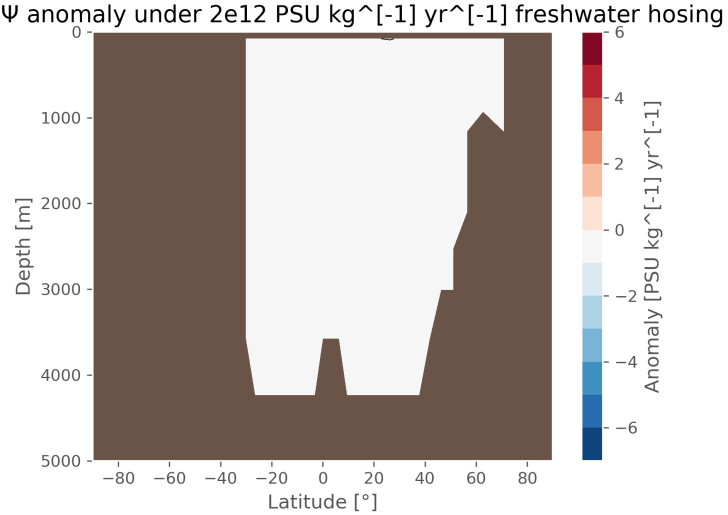

Ψ anomaly under 2e7 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
0.0
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

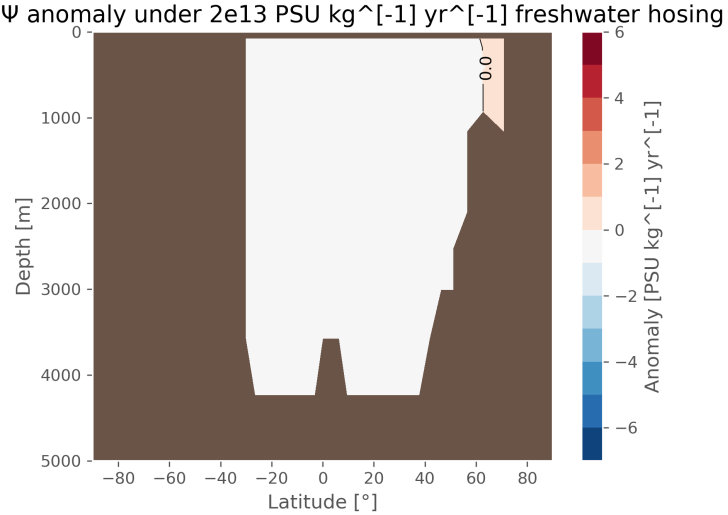

Ψ anomaly under 2e8 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
0.0
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

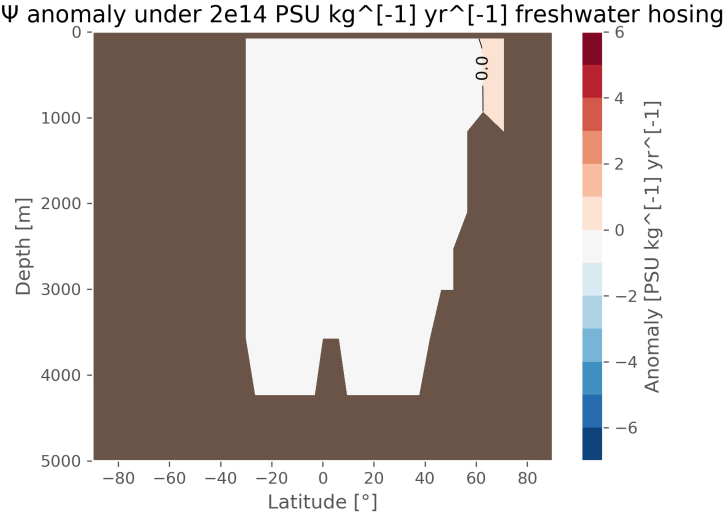

Ψ anomaly under 2e9 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
Latitude [°]
−80
−60
−40
−20
0
20
40
60
80
0.0
0.0
Anomaly [PSU kg^[-1] yr^[-1]
6
4
2
0
−2
−4
−6

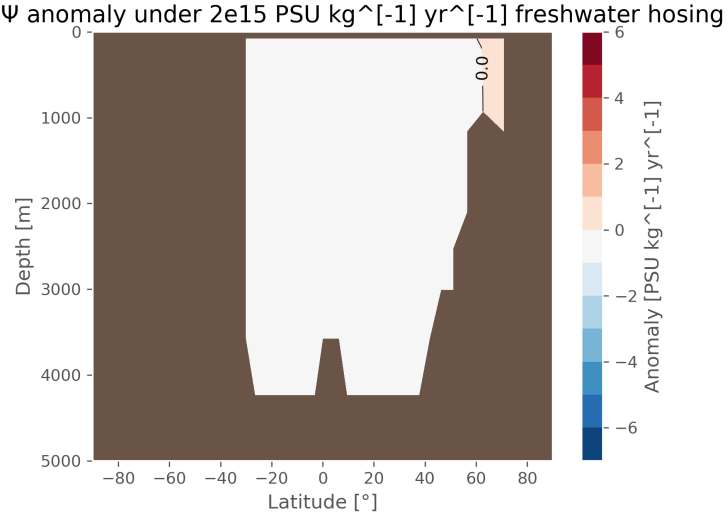

Ψ anomaly under 2e10 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

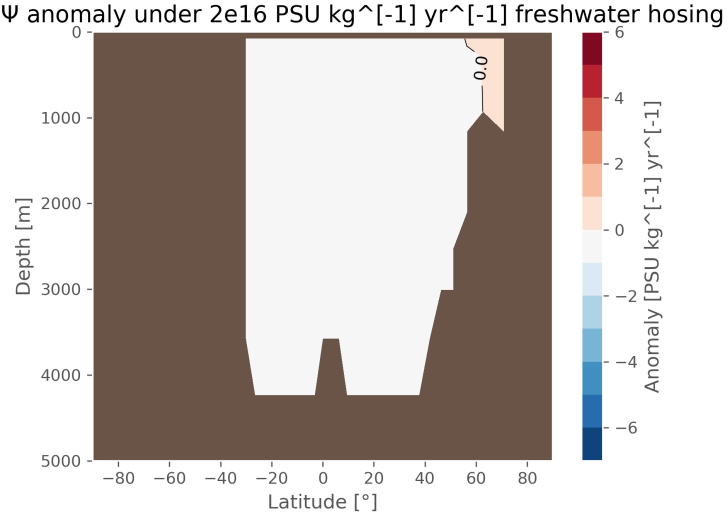

Ψ anomaly under 2e11 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
Latitude [°]
−80
−60
−40
−20
0
20
40
60
80
0.0
0.0
0.0
0.0
Anomaly [PSU kg^[-1] yr^[-1]]
6
4
2
0
−2
−4
−6

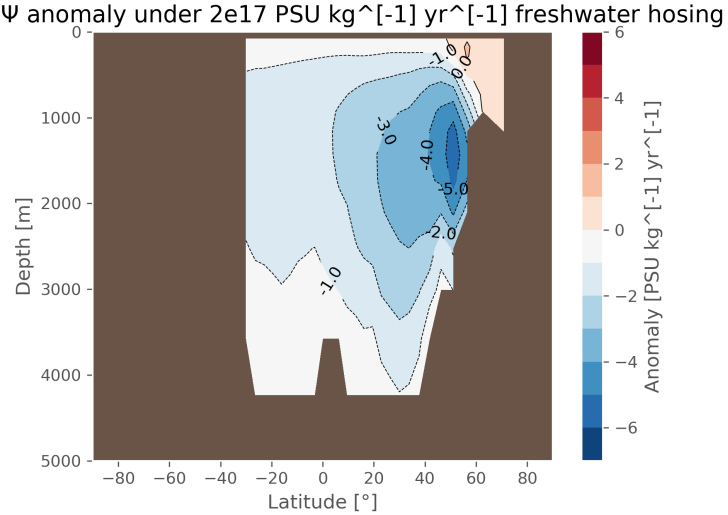

Ψ anomaly under 2e12 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]


Ψ anomaly under 2e13 PSU kg^[-1] yr^[-1] freshwater hosing
0.0
Depth [m]
0
1000
2000
3000
4000
5000
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]


Ψ anomaly under 2e14 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]

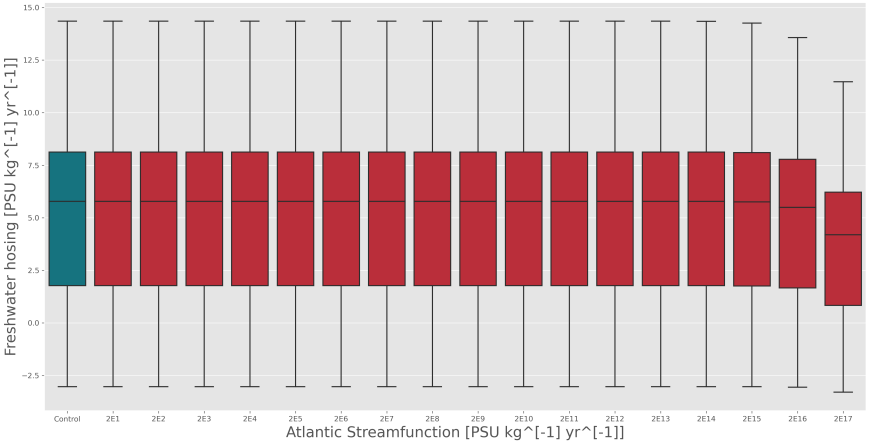

Ψ anomaly under 2e15 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]


Ψ anomaly under 2e16 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
0
1000
2000
3000
4000
5000
0.0
−80
−60
−40
−20
0
20
40
60
80
Latitude [°]
6
4
2
0
−2
−4
−6
Anomaly [PSU kg^[-1] yr^[-1]


Ψ anomaly under 2e17 PSU kg^[-1] yr^[-1] freshwater hosing
Depth [m]
Latitude [°]
Anomaly [PSU kg^[-1] yr^[-1]]
0
1000
2000
3000
4000
5000
−80
−60
−40
−20
0
20
40
60
80
6
4
2
0
−2
−4
−6
-1.0
-0.0
-3.0
-4.0
-5.0
-2.0
-1.0

A Mann-Whitney U test was conducted for each grid streamfunction based on the temporal average in each experiment compared to the control experiment. The only experiment that exhibited a significant difference ($U = 54901$, p-value < 0.01) was the experiment involving freshwater hosing of 2×10^{17} PSU kg^{-1} yr^{-1}.

AMOC streamfunction distribution



Open Research

- Python code:
  `https://github.com/sandyherho/muffins_playground/tree/main/lab_hosing_amoc`
- LaTeX Beamer slide: `https://www.overleaf.com/8549483868qctwcvbsybxw`