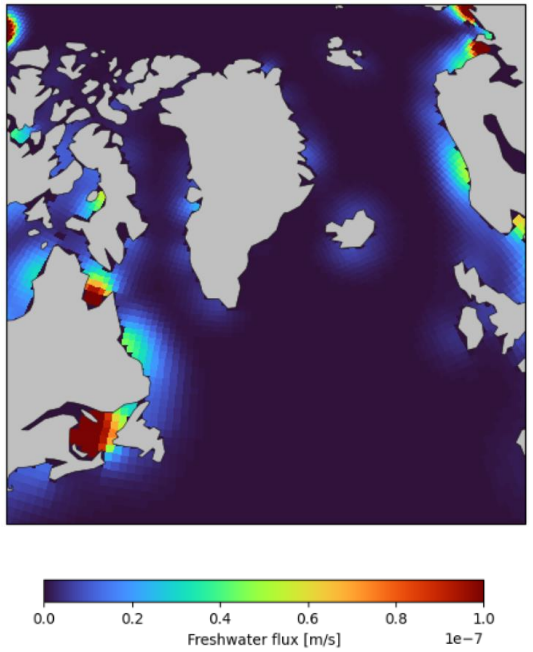
ICEUP

Iceberg Contribution to ECCO Upgrade and Performance

Sara Jensen, DTU Space

MOTIVATION

- Is the freshwater forcing from Greenland used in ECCOV4 realistic?
- Icebergs carries freshwater away from glacier outlet
- What happens when the freshwater flux is increased?



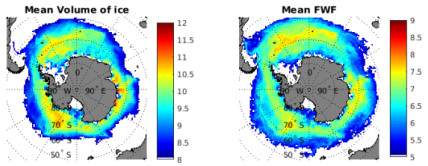
Daily fields of FW from icebergs derived by altimetry

Doc. Techni.LOPS 2025-01

Ifremer cnes CNRS LOPS

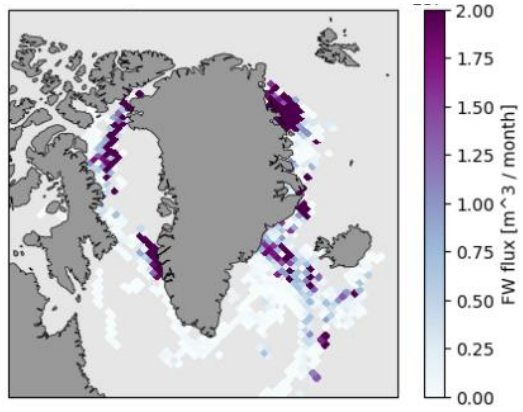
The ALTIBERG Antarctic and Arctic Fresh Water Flux data sets, v1.0

J. Tournadre, J.F. Piollé, D. Segalla, F. Girard-Ardhuin



Ref.: Doc. Techni.LOPS 2025-01
Version: 1.0
Date: Feb 2025

Example: September 2016



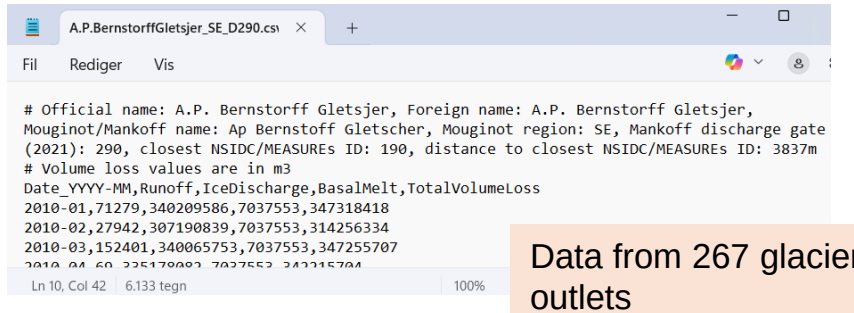
GEUS Bulletin | Geological Survey of Denmark and Greenland

DATA ARTICLE | SHORT

A data set of monthly freshwater fluxes from the Greenland ice sheet's marine-terminating glaciers on a glacier–basin scale 2010–2020

Nanna B. Karlsson*[1], Kenneth D. Mankoff[1,2,3], Anne M. Solgaard[1], Signe H. Larsen[1], Penelope R. How[1], Robert S. Fausto[1], Louise S. Sørensen[4]

[1]Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark. [2]Autonomic Integra LLC, New York, NY, USA. [3]NASA Goddard Institute for Space Studies, New York, NY, USA. [4]DTU Space – National Space Institute, Technical University of Denmark, Kgs. Lyngby, Denmark



Data from 267 glacier outlets

Table 2 Annually averaged volume loss in solid and liquid form (2010–2020)

Region	Annual average solid flux, 10^9 m³	Annual average liquid flux, 10^9 m³	Total flux, 10^9 m³
CE	76.7 ± 21.5	41.0 ± 11.5	117.7 ± 33.0
CW	87.7 ± 24.5	33.8 ± 9.5	121.4 ± 34.0
NE	27.8 ± 7.8	17.7 ± 5.0	45.5 ± 12.7
NO	26.7 ± 7.5	25.4 ± 7.1	52.1 ± 14.6
NW	109.1 ± 30.6	49.0 ± 13.7	158.2 ± 44.3
SE	140.9 ± 39.5	53.4 ± 14.9	194.3 ± 54.4
SW	18.8 ± 5.3	32.5 ± 9.1	51.3 ± 14.4

The seven regions are defined in Fig. 3: south-west (**SW**), central west (**CW**), north-west (**NW**), north (**NO**), north-east (**NE**), central east (**CE**), and south-east (**SE**).

Total FW flux from Greenland is $\mathbf{740.5 \cdot 10^9}$ **m3/year**

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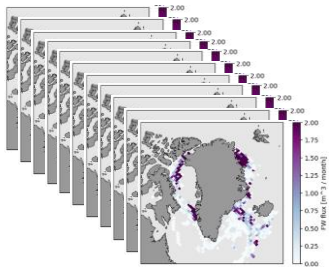
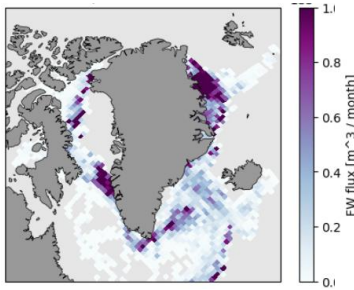
APPROACH

ECCO SUMMER SCHOOL

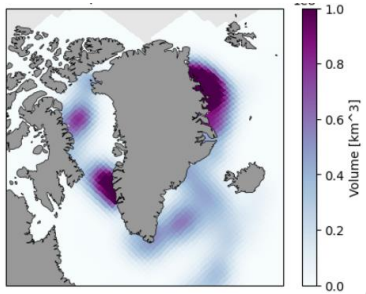


ALTIBERG data

Compute 11 year monthly mean



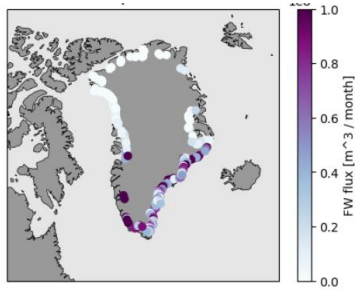
Apply smoothing



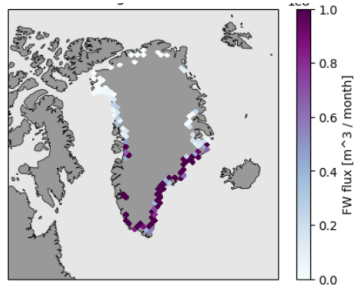
Large icebergs climatology

GEUS data

Compute 11 year monthly mean



Grid data



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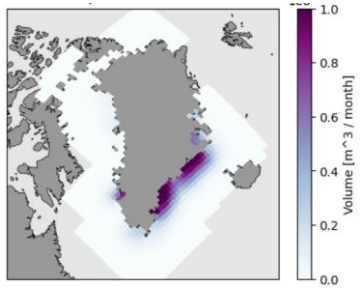
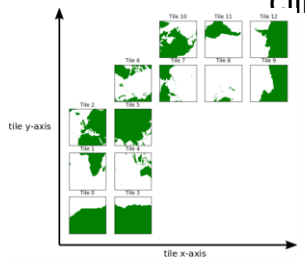


Liquid runoff, basal melt, small icebergs climatology

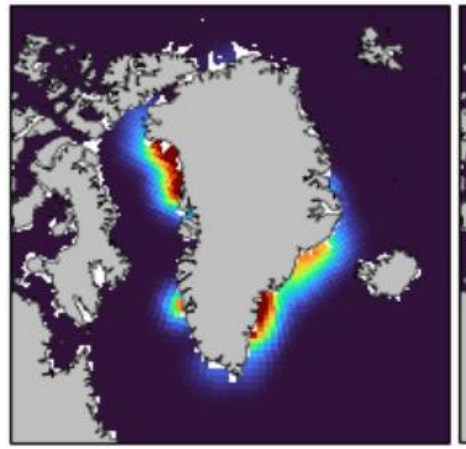


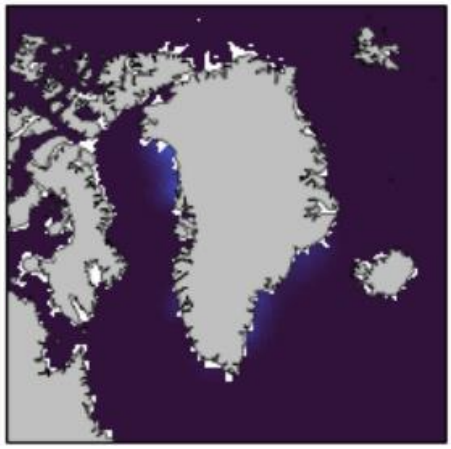
Reproject to LLC90 grid

July climatology:

Runoff

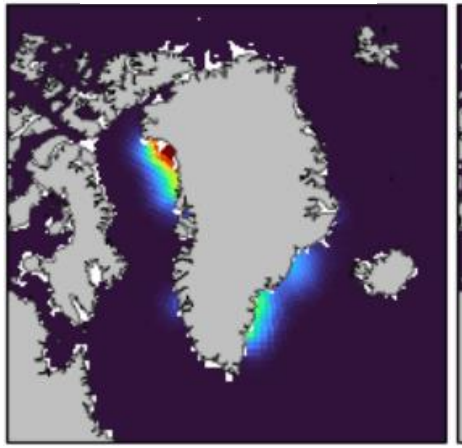
Basal melt

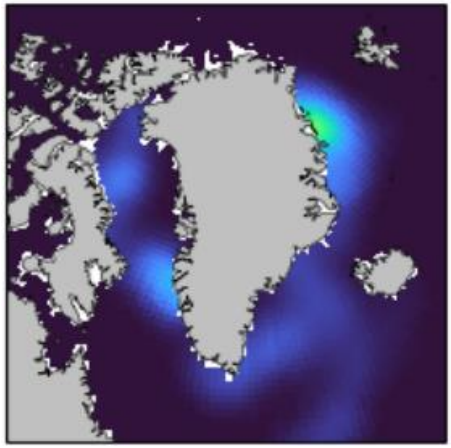


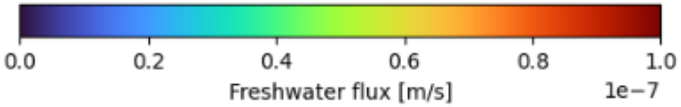


Small icebergs

Large icebergs







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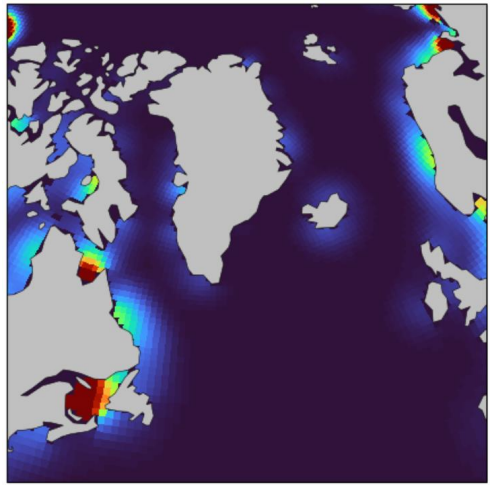
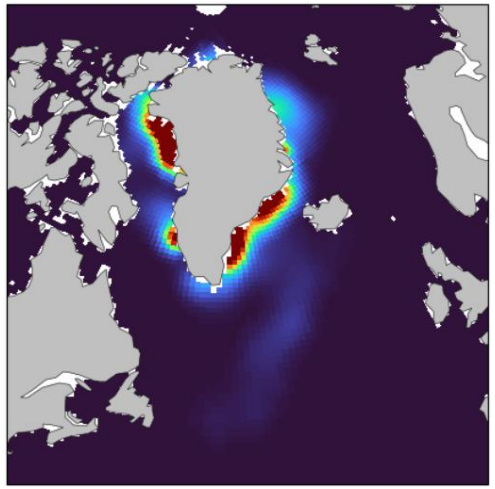
RESULTS

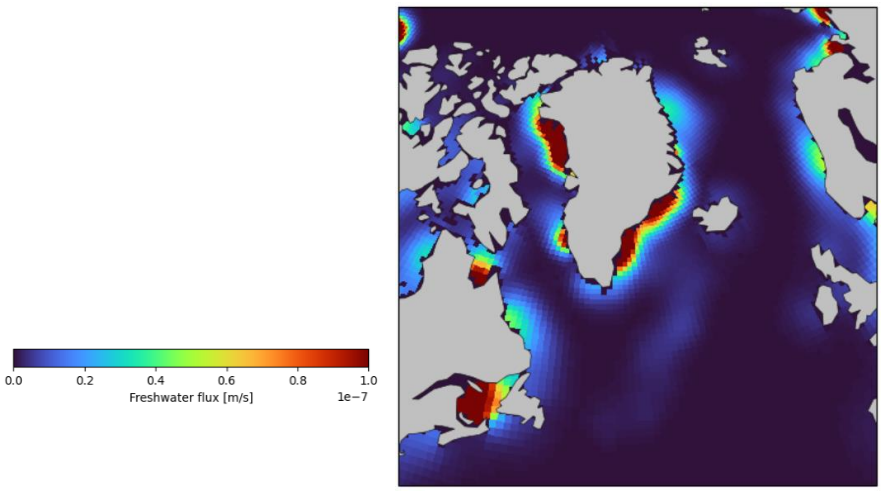


Old field



New field (Greenland only

```
FW_new2 = np.where((FW_new<0.01e-07)&(FW_old>0.01e-07),(FW_old+FW_new)/2,FW_new)
FW_new2 = np.where((FW_new<0.003e-07)&(FW_old>0.003e-07),FW_old,FW_new2)
```



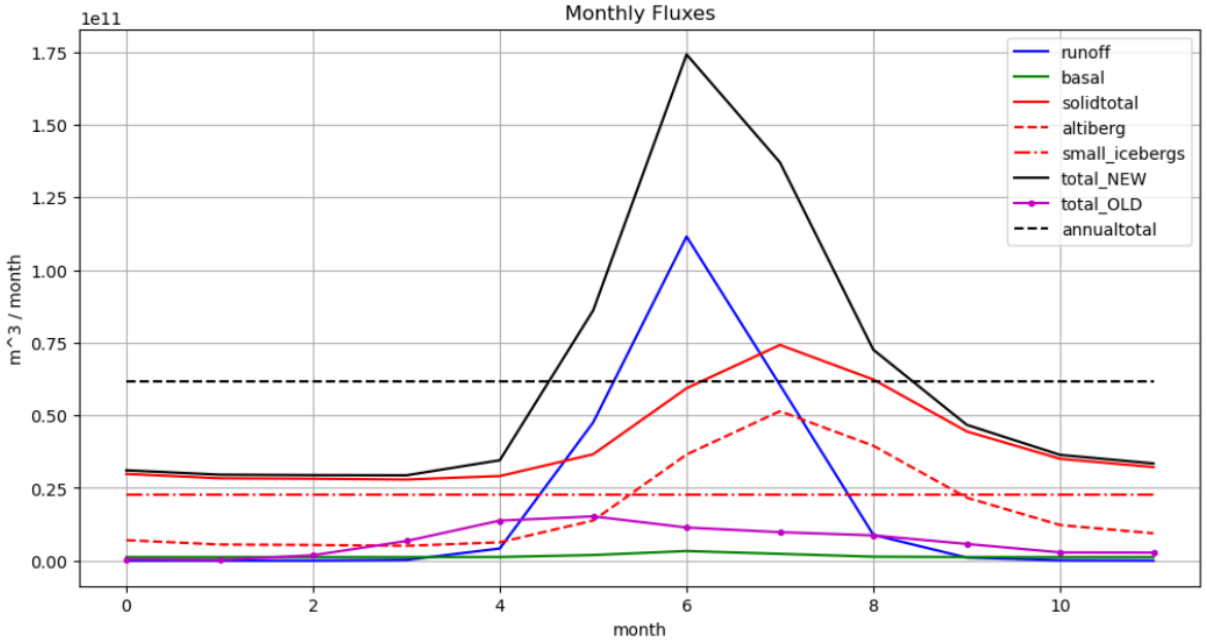
New field stitched together with old field

- My freshwater field have the same total annual flux (in m^3/year) as GEUS data
- The old field is off by an order of magnitude
- Icebergs delay of about 1 month

GEUS: $740.5 \cdot 10^9$ m3/year

New field: $735.5 \cdot 10^9$ m3/year

Old field: $79.6 \cdot 10^9$ m3/year



ICEUP

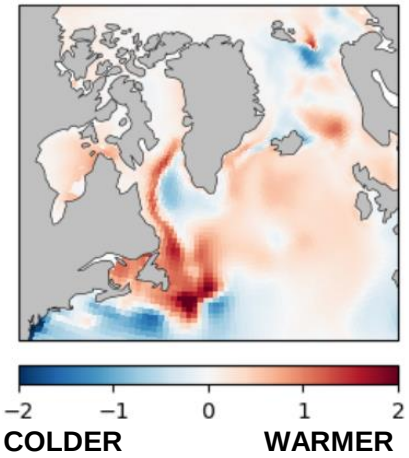
Iceberg **C**ontribution to **E**CCO **U**pgrade and **P**erformance

Sara Jensen, DTU Space

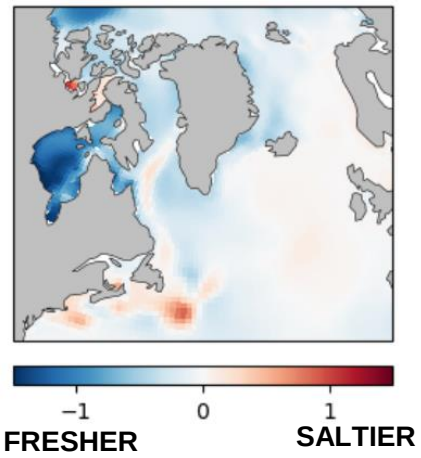
RESULTS

10 year (2003 – 2013) monthly average difference between ECCOv4r5 (old runoff) and ECCOv4r4 (new runoff). **New minus old**

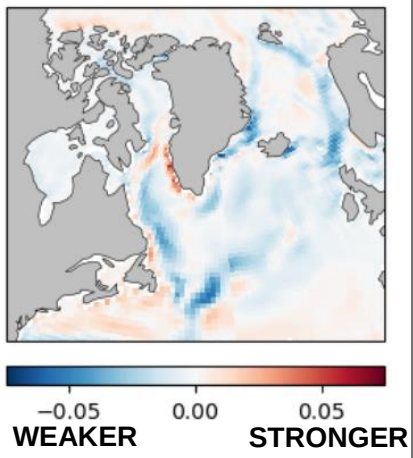
WINTER (february)



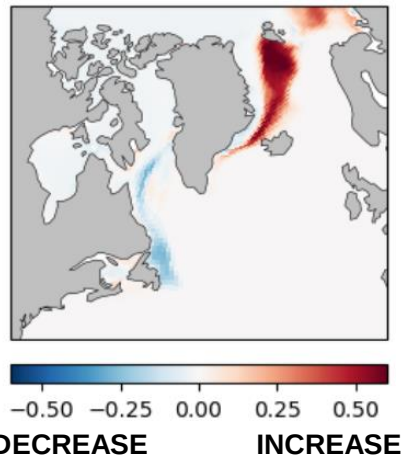
Temperature
(mean of upper 45 m)



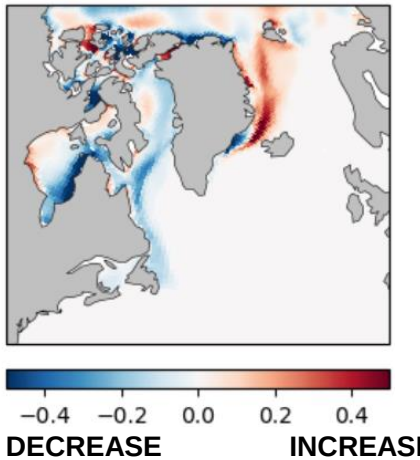
Salinity
(mean of upper 45 m)



Current speed
(mean of upper 45 m)



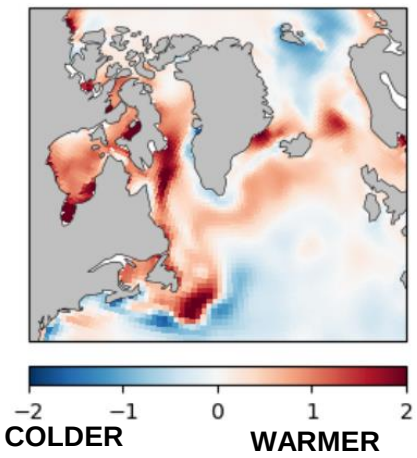
Sea ice area



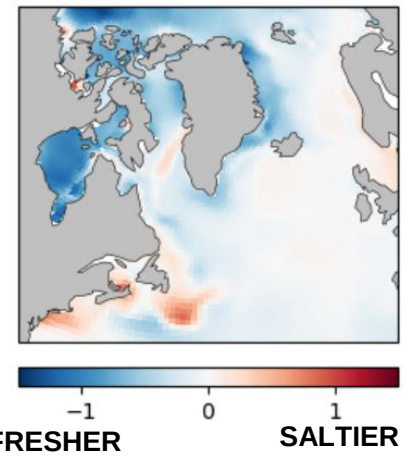
Sea ice height

Winter is **warmer**, **fresher** and has **more** sea ice.

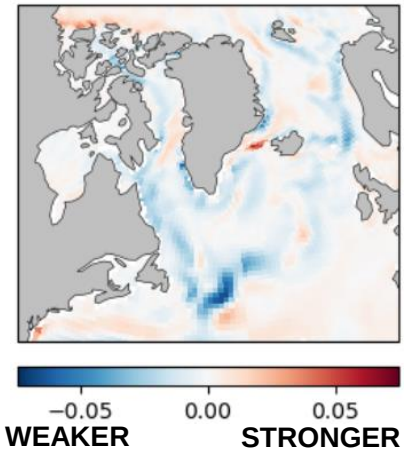
SUMMER (august)



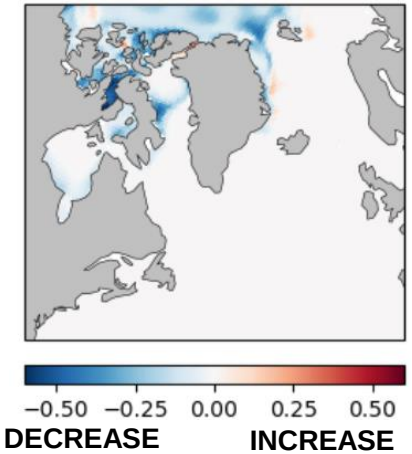
Temperature
(mean of upper 45 m)



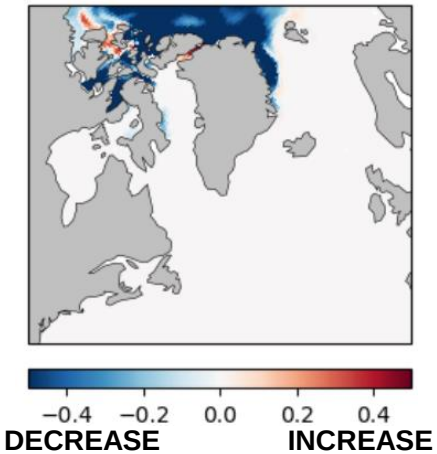
Salinity
(mean of upper 45 m)



Current speed
(mean of upper 45 m)



Sea ice area



Sea ice height

Summer is **warmer**, **fresher** and has **less** sea ice.

ICEUP

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REFLECTIONS

CHALLENGES

- I went through great struggles getting the total freshwater to add up
- Interpolation to LLC90 grid is done in a very suboptimal way
- I had little time to look at the results

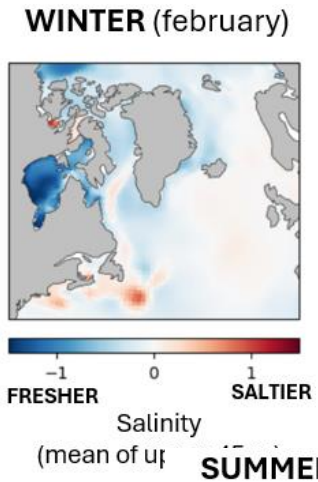
WHAT I LEARNED

- I have gotten familiar with the ECCO outputs
- Learned how to run ECCOV4r4 on the P-Cluster
- I learned a lot about how freshwater fluxes are computed

IF I HAD MORE TIME, I WOULD…

Look more into the results:

- Explain the loss of sea ice in summer
- Why do so much of the freshwater end up in Hudson bay?
- Why is the North Atlantic warming in summer?
- How do the time varying field look?



Improve the code used to create the runoff file

- Implement not just a climatology but a time-varying field that can represent **interannual variations** (ALTIBERG data from 1993-2022 and GEUS data from 2010-2020)
- Improve the part of the code that projects the fields to LLC grids
- Make the code able to handle other grids than LLC90