Impact of Greenland Melt on the East and West Greenland Currents and the North-West Labrador Sea

Xianmin Hu and Paul G. Myers

Department of Earth and Atmosphere Sciences
University of Alberta

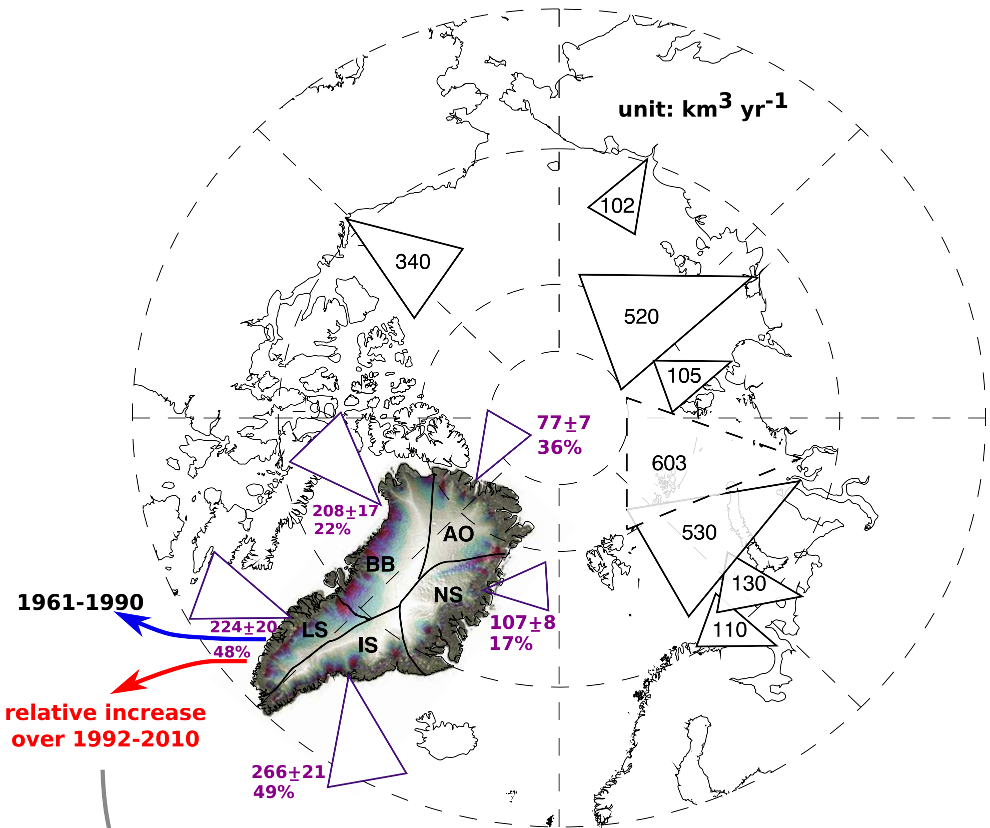
CMOS2015 Whistler, BC, June 3rd, 2015

NSERC CRSNG People. Discovery. Innovation.

Outline

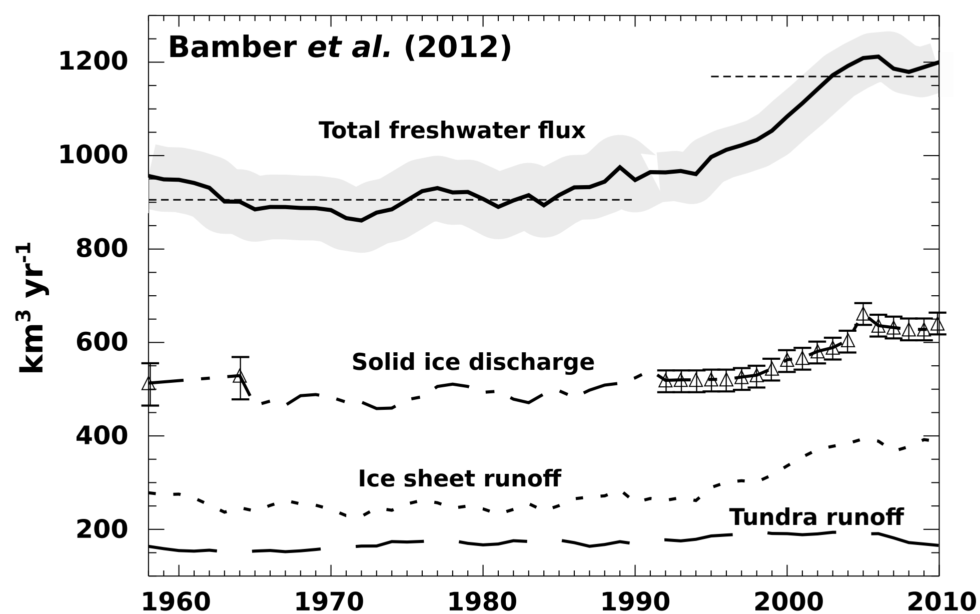
- **Background**
- **Model configuration and experiment setup**
- **Results**
  - evolution of passive tracer content
  - travel time to the north-west Labrador Sea
  - impact on the East and West Greenland Current
- **Summary and future work**

Increasing Greenland Melt



Bamber *et al.* (2012)

"Mackenzie River"

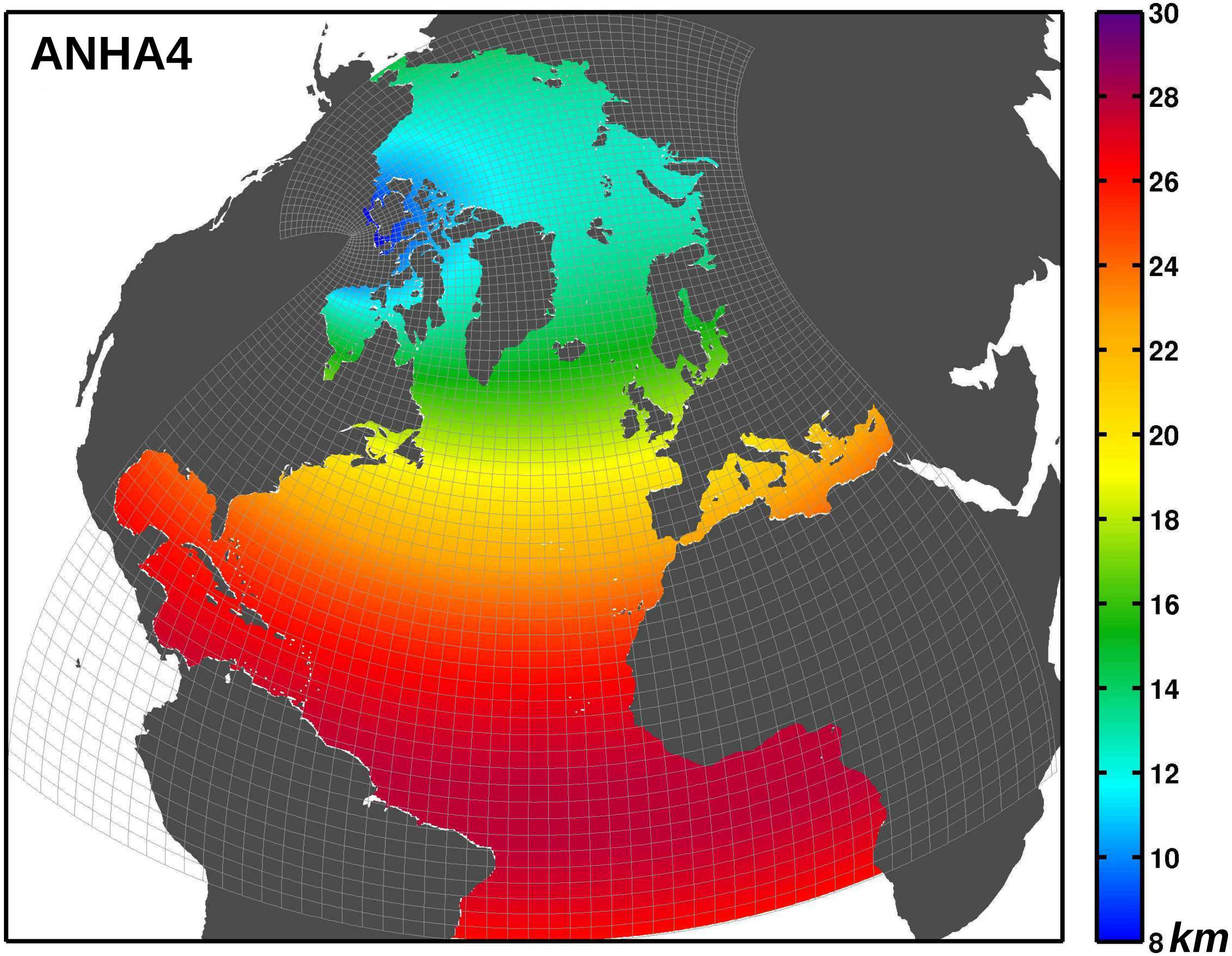


- NOT negligible
- increased quickly since the early 1990s
- surface runoff: ~46%

Outline

- Background
- **Model configuration and experiment setup**
- Results
  - evolution of passive tracer content
  - travel time to the north-west Labrador Sea
  - impact on the East and West Greenland Current
- Summary and future work

Model Configuration



Model : NEMO 3.4
LIM2 + EVP

Resolution : 1/4 degree

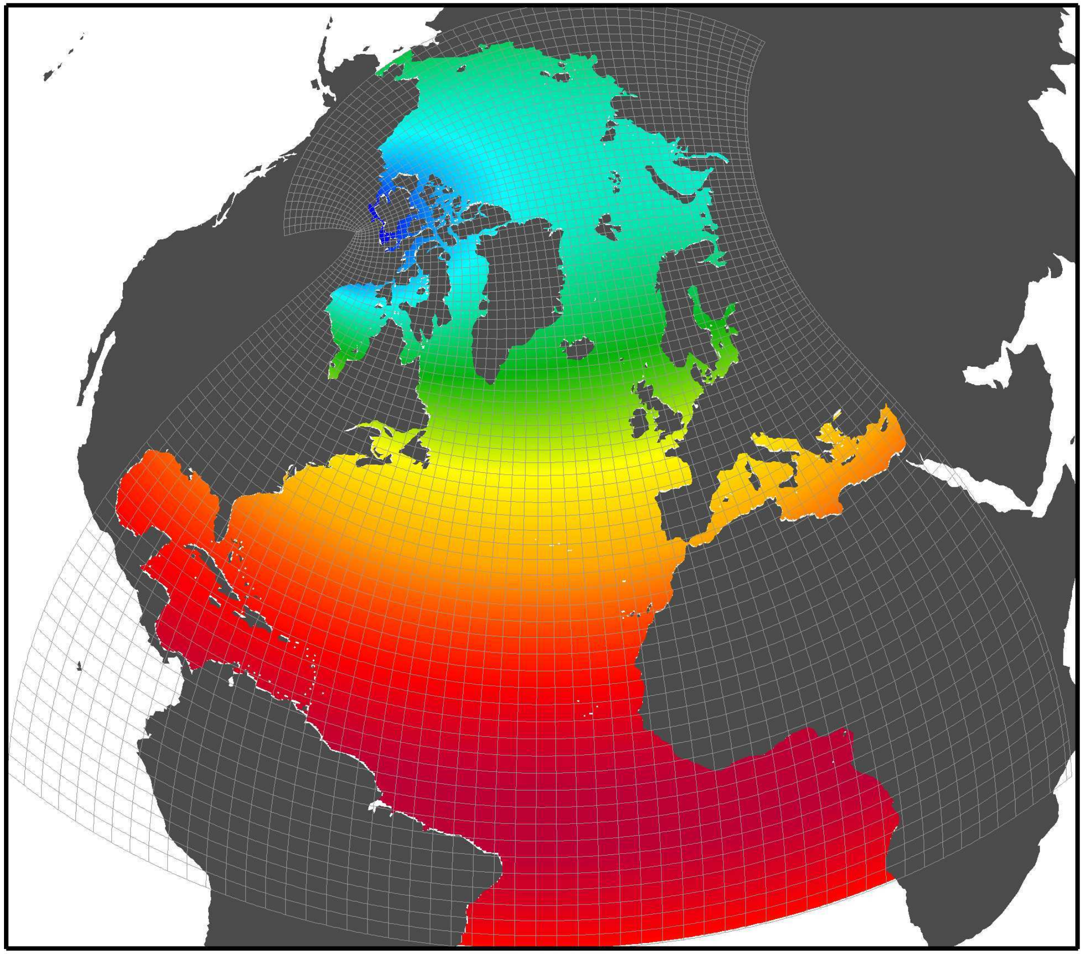
Mesh : 544 x 800

50 levels

ANHA12 is still in the job queue :(

ANHA: Arctic and **N**orthern **H**emisphere **A**tlantic

Experiment Setup



Initialization:

3D T, S, U and V (GLORYS2v3, Jan02)
SSH and Sea Ice

Atmospheric forcing (CGRF, hourly):

T2, Q2, U10, V10
Precipitation
Radiation (SW & LW)

Runoff:

Inter-annual Dai and Trenberth's runoff
+ Jonathan Bamber's Greenland melt

OBC:

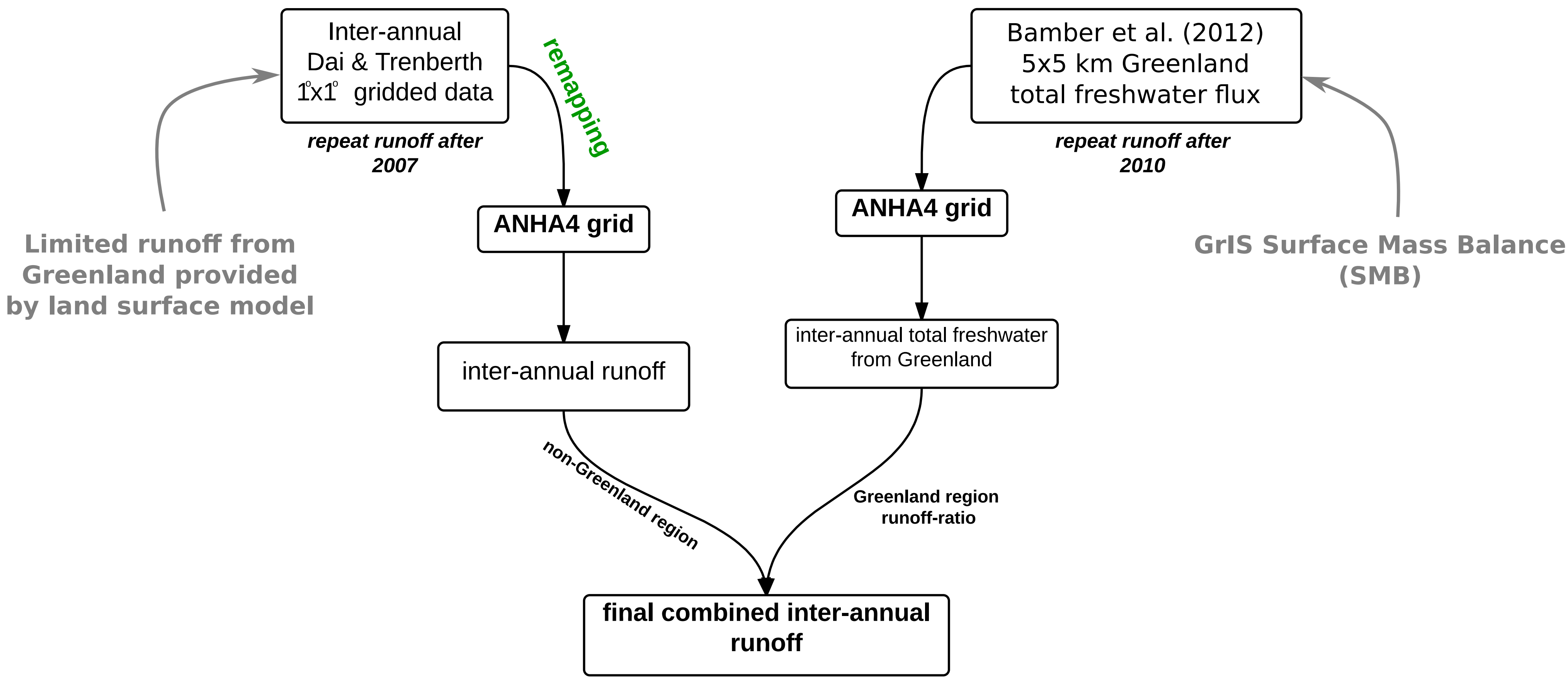
U, V, T and S (GLORYS2v3)

NO temperature & salinity restoring

Jan 2002 – Dec 2011

CGRF: CMC GDPS reforecasts
GDPS: Global Deterministic Prediction System
CMC: Canadian Meteorological Centre
GLORYS: GLobal Ocean ReanalYses and Simulations

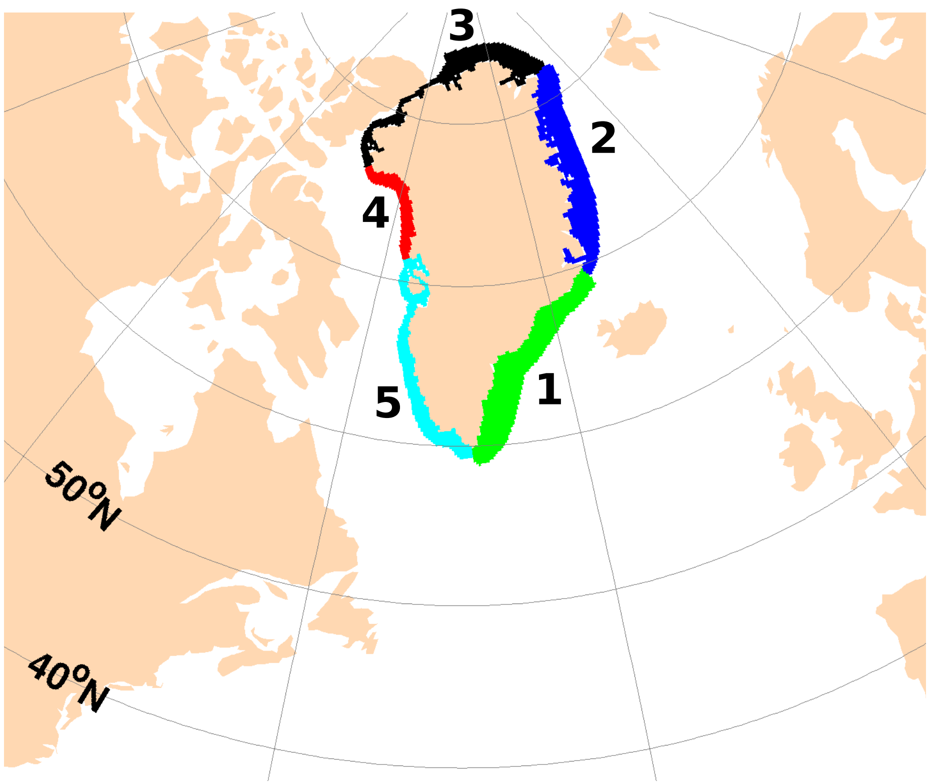
How to Create the Runoff Data



remapping details: **#502P01**

An Effective Approach to Remap Runoff onto an Ocean Model Grid

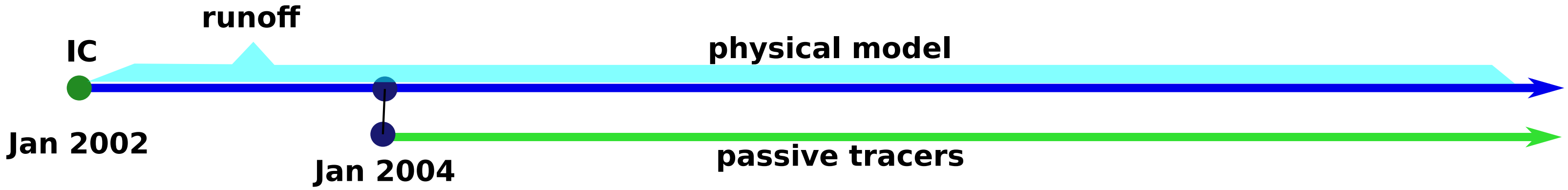
How to Add the Passive Tracers



- five passive tracers
- proportional to the amount of runoff
- start adding tracers from Jan 2004

$$\Delta_C = \frac{\Delta t}{\rho_o \cdot e3t_1} \cdot rnf$$

$$\frac{s}{\frac{kg}{m^3} \cdot m} \cdot \frac{kg}{m^2 \cdot s} = unitless$$



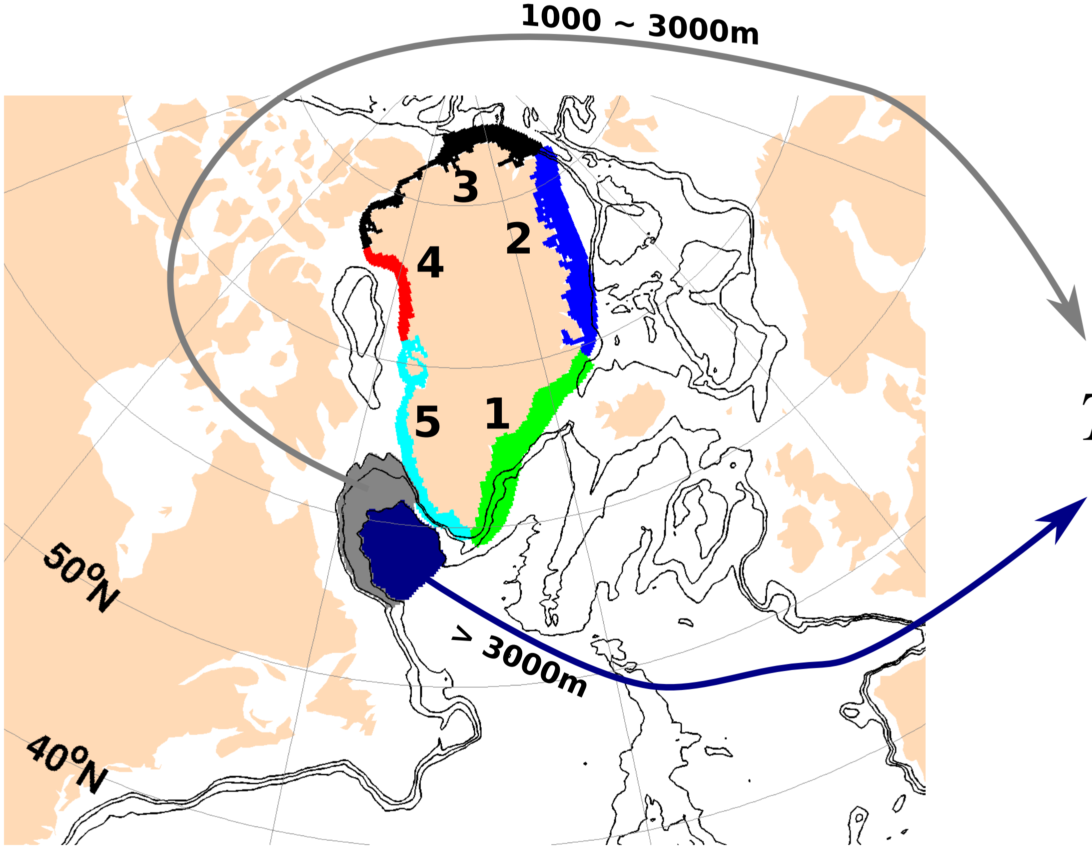
Outline

- **Background**
- **Model configuration and experiment setup**
- **Results**
  - evolution of passive tracer content
  - travel time to the north-west Labrador Sea
  - impact on the East and West Greenland Current
- **Summary and future work**

Evolution of Total Passive Tracer Content

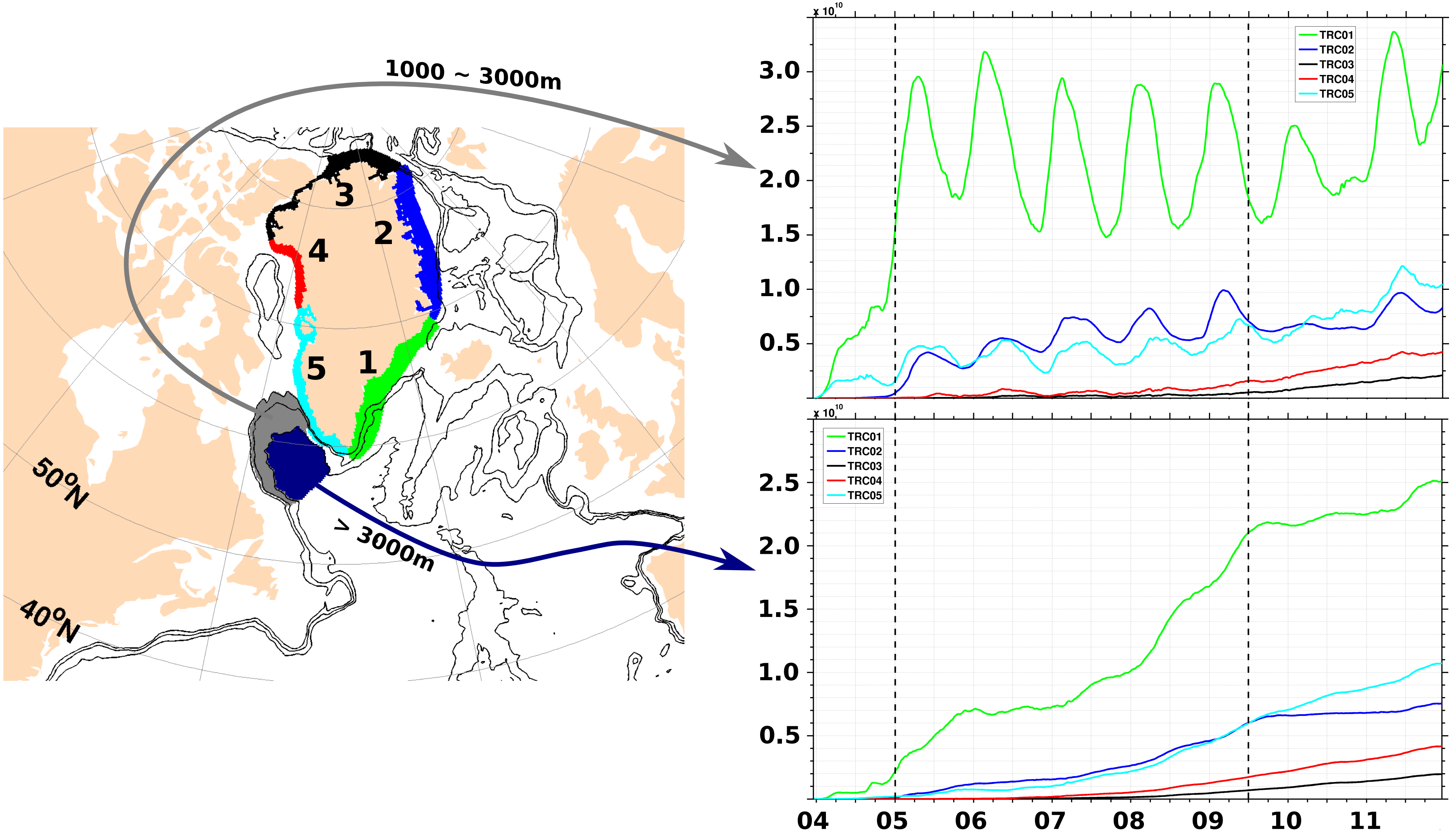
$$TC(x, y, t) = \int c(x, y, z, t)\, dz$$

Travel Time to Reach the North-West Labrador Sea

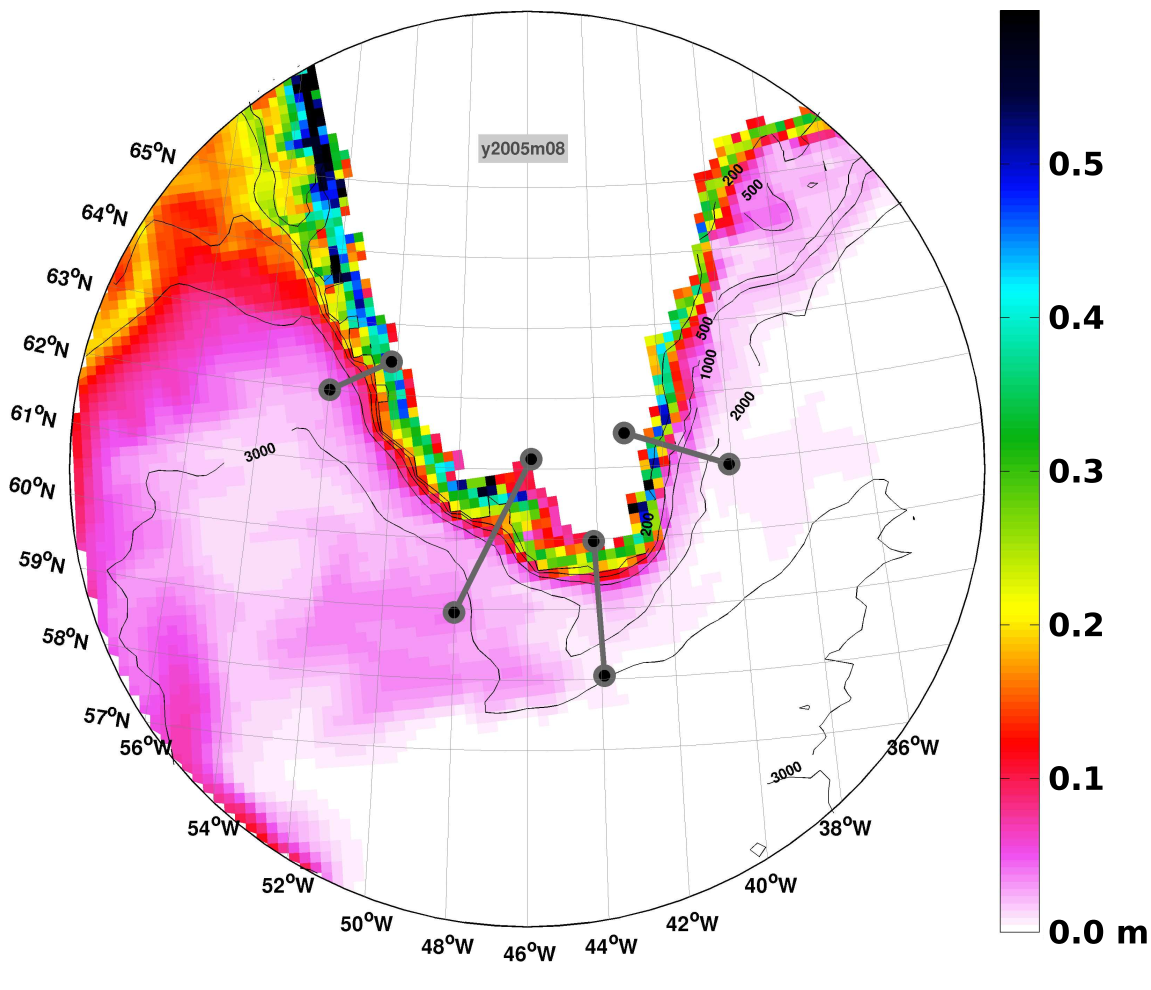


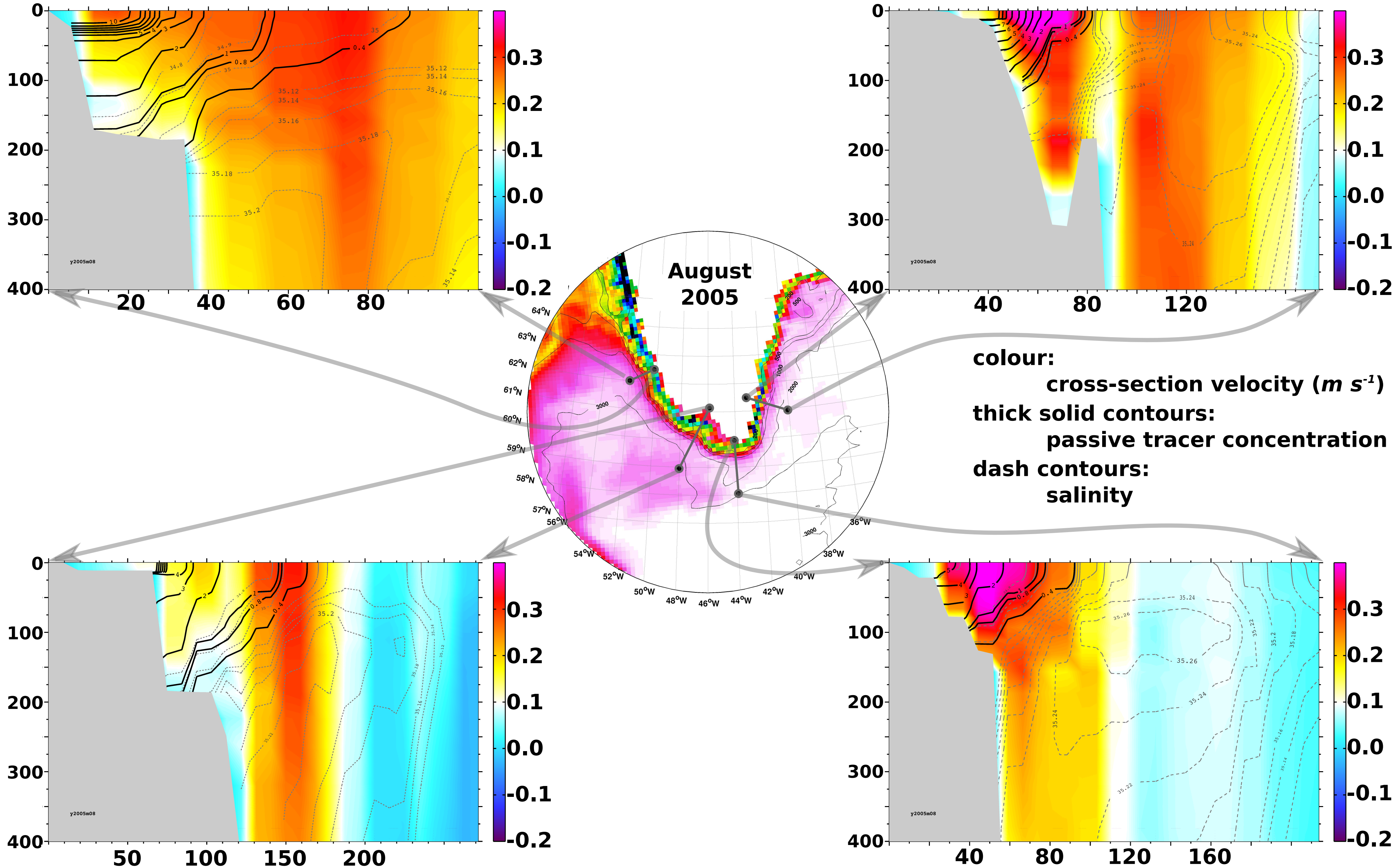
$$TS(t) = \iiint c(x,y,z,t)\,dz\,dy\,dx$$

Travel Time to Reach the North-West Labrador Sea

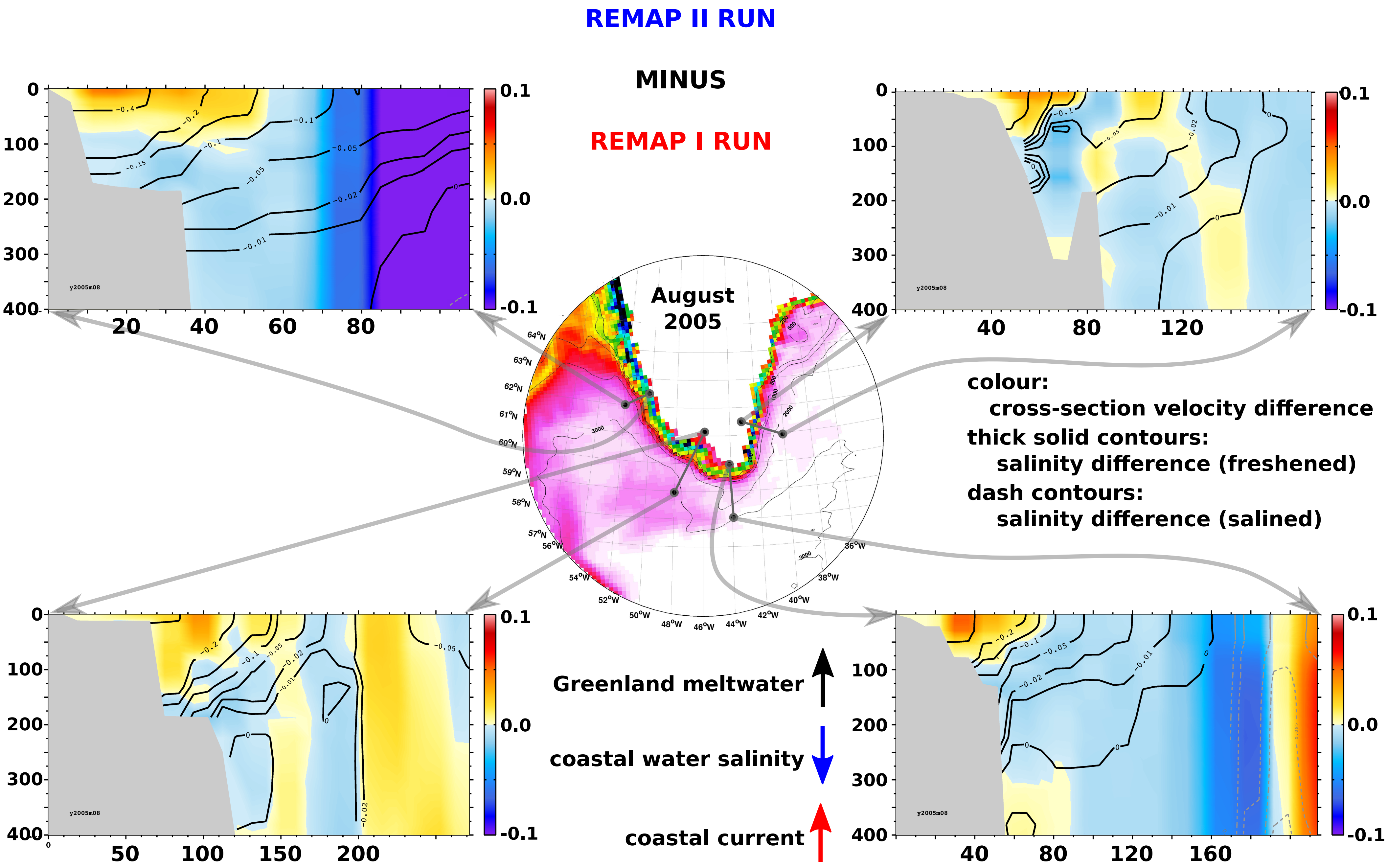


Impact on Greenland Coastal Currents





August
2005
colour:
cross-section velocity ($m\ s^{-1}$)
thick solid contours:
passive tracer concentration
dash contours:
salinity


REMAP II RUN
MINUS
REMAP I RUN
August
2005
colour:
cross-section velocity difference
thick solid contours:
salinity difference (freshened)
dash contours:
salinity difference (salined)
Greenland meltwater
coastal water salinity
coastal current
0.1
0.0
-0.1
y2005m08

Outline

- **Background**

- **Model configuration and experiment setup**

- **Results**
  - evolution of passive tracer content
  - travel time to the north-west Labrador Sea
  - impact on the East and West Greenland Current

- **Summary and future work**

Summary & Future Work

- Passive tracers successfully show where the Greenland meltwater goes and where it may stay

- Meltwater from SE, NE and SW Greenland can reach and pass the north and west Labrador Sea shelf (1000~3000m) very quickly, showing a clear seasonal cycle

  Meltwater from West and North Greenland takes about 5 years to reach this region, and basically accumulates there after

  In the Labrador Sea interior basin, the meltwater from all Greenland regions, particular the SE (NE and SW follows), accumulates there over years, increasing quickly in the first 5 years

- Qualtatively, the cross-coast distribution of passive tracers matches well the East and West Greenland coastal current structure. Sensitivity experiments show Greenland meltwater strengthens the coastal currents. Further quantitative analysis is required.

- Expecting to see more interesting results from ANHA12 simulation

Question?