An Effective Approach to Remap Runoff onto an Ocean Model Grid

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49th CMOS Congress & 13th AMS Conference on Polar Meteorology and Oceanography, Whistler, BC, Canada

Objective

- remap runoff data onto ocean model grid
  - volume conserving
  - resolution (either the source and target grid) independent
  - "directionally" distribute runoff to proper regions
- study its impact on ocean numerical simulation
  - hydrography and circulation
  - NEMO based 1/4^o regional model confiugration covering Arctic and Northern Hemisphere Atlantic (ANHA4) website: http://knossos.eas.ualberta.ca/xianmin/anha

What is the problem?

- regional coastline varies with spatial resolutions
- many 1^ox1^o gridded runoff data points fall on land (see red dots in figure 1, right) or open ocean on higher resolution model grid which provides more accurate coastline
- direct interpolation can NOT guarantee all runoff entering the "ocean" in the model and in the proper locations

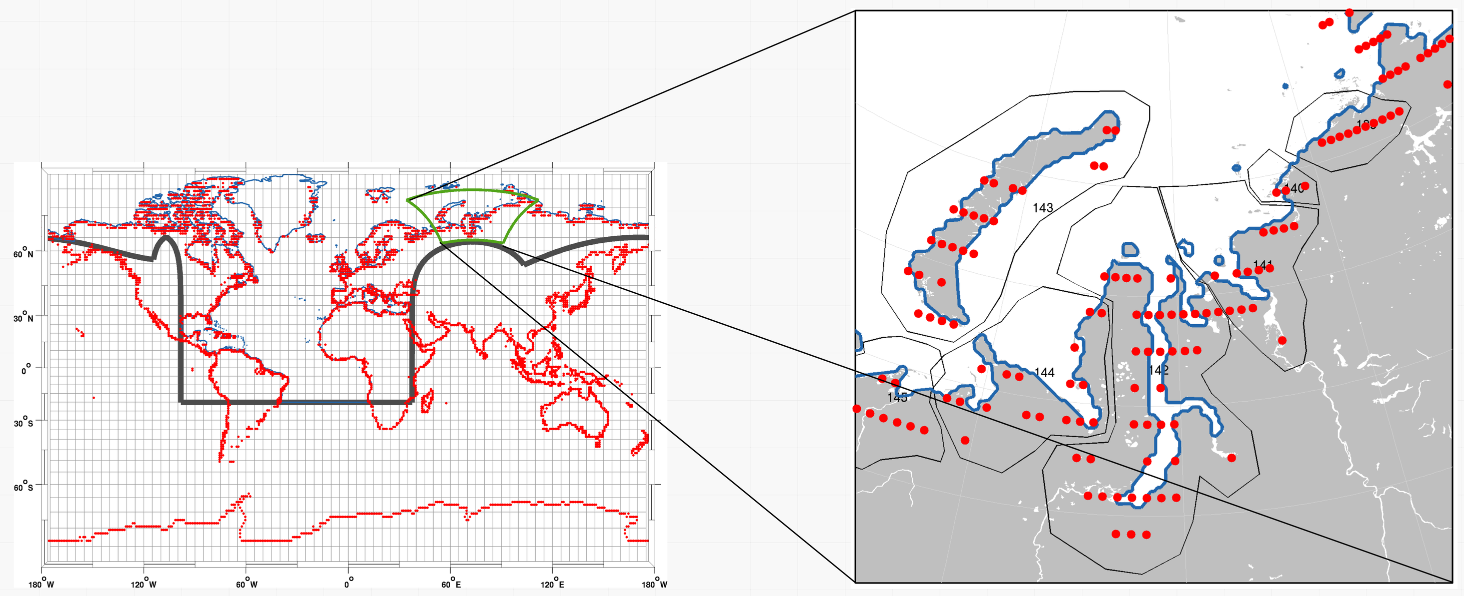


Figure 1 Left: non-zero runoff locations (red dots) in 1^ox1^o gridded Dai and Trenberth[1] global river flow and continental discharge dataset and model configuration domain (black thick line). Light blue line shows the coastline represented in ANHA4. Right: similar to the right but zoomed into Kara Sea region (green box in the left figure). black polygons are the buffer-zone-like polygons mentioned in next section.

How to solve the problem?

- buffer-zone-like polygon
  - covers part of land and part of ocean along the coast (figure1, right)
  - includes one or many "similar" source data points (e.g., these flowing into the same bay)
  - covers enough potential water points in numerical model
- if necessary, convert the runoff source data to volume flux (m^3s^{-1})

$$\frac{kg}{m^2\ s} \cdot \underbrace{\overbrace{\frac{m^2}{kg \cdot m^{-3}}}^{\text{area}}}_{\text{pure water density}} = \frac{m^3}{s}$$

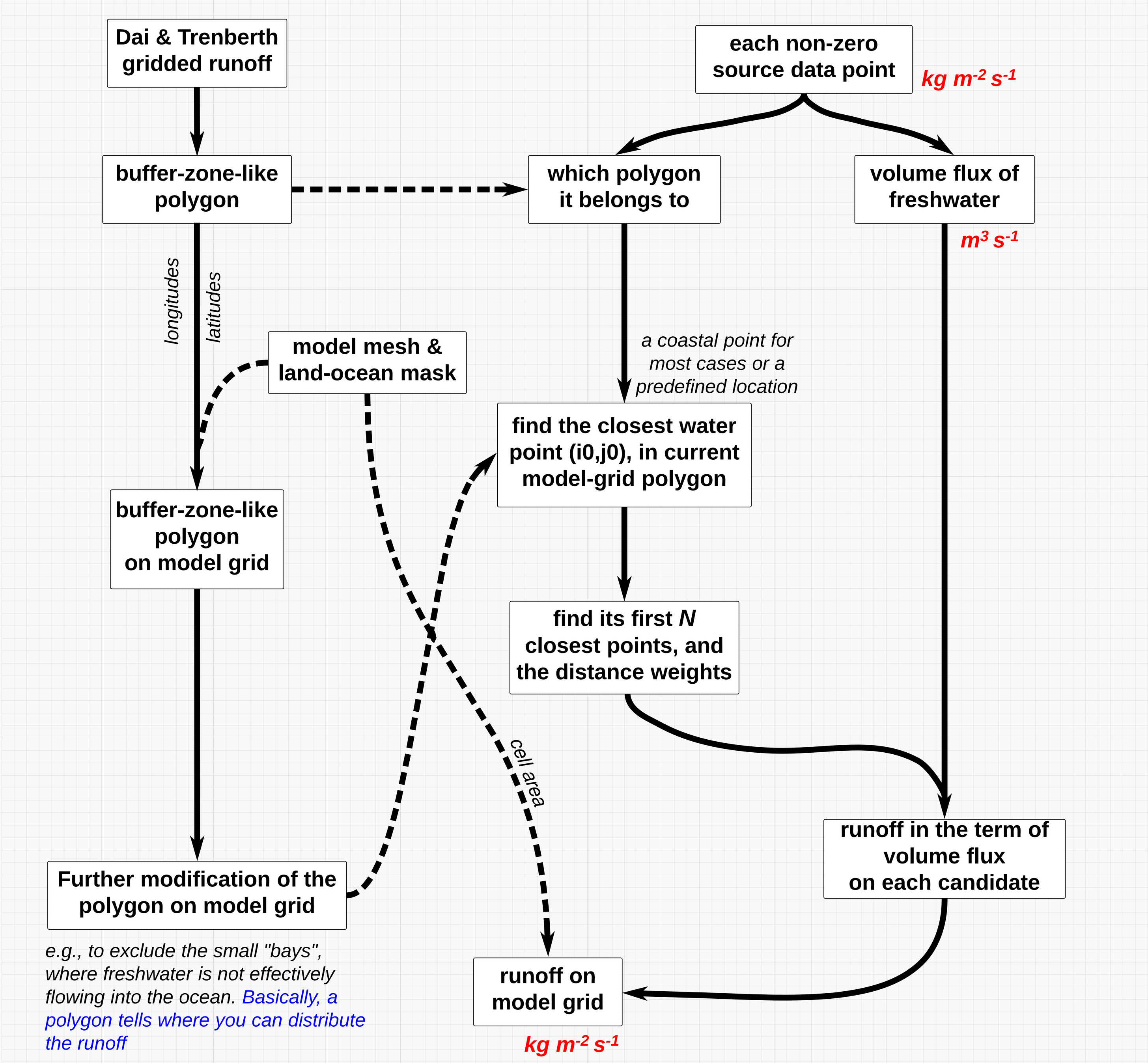
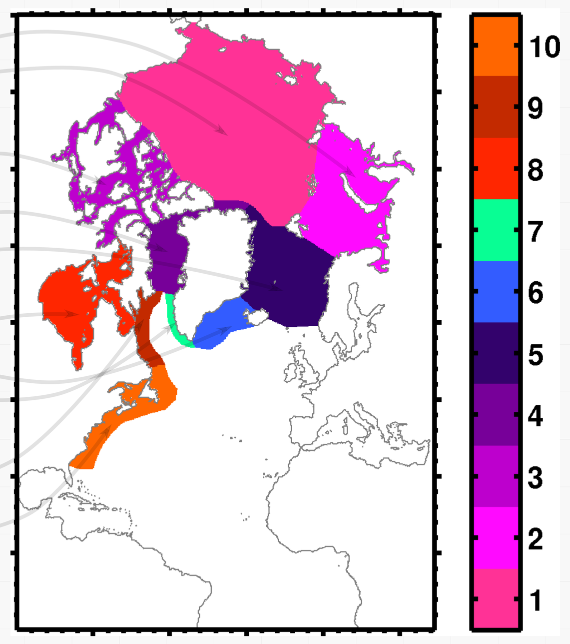


Figure 2 Runoff remappling flowchart

What is the result?

Table 1 Total runoff (unit: km^3 yr^{-1}) into different regions via "direct" interpolation and remapping method

	on-the-fly[a]	remap-I[b]	remap-II[c]
1	50	1652	1652
2	127	1855	1855
3	133	414	414
4	21	73	**181**
5	19	81	**122**
6	15	28	**143**
7	5.5	5.9	**80**
8	312	1016	1016
9	0.7	112	112
10	212	1071	1071
domain	2926	**22171**	**22510**



on-the-fly should NOT be used for runoff

a: NEMO online interpolation technique (bilinear interpolation is used here) Dai and Trenberth 1°x1° gridded monthly climatology is used here

b: same data source as the first column but with the remapping method

c: similar to b but includes Greenland meltwater (averaged over 1961 to 1990) from Jonathan Bamber[2]

What is the impact?

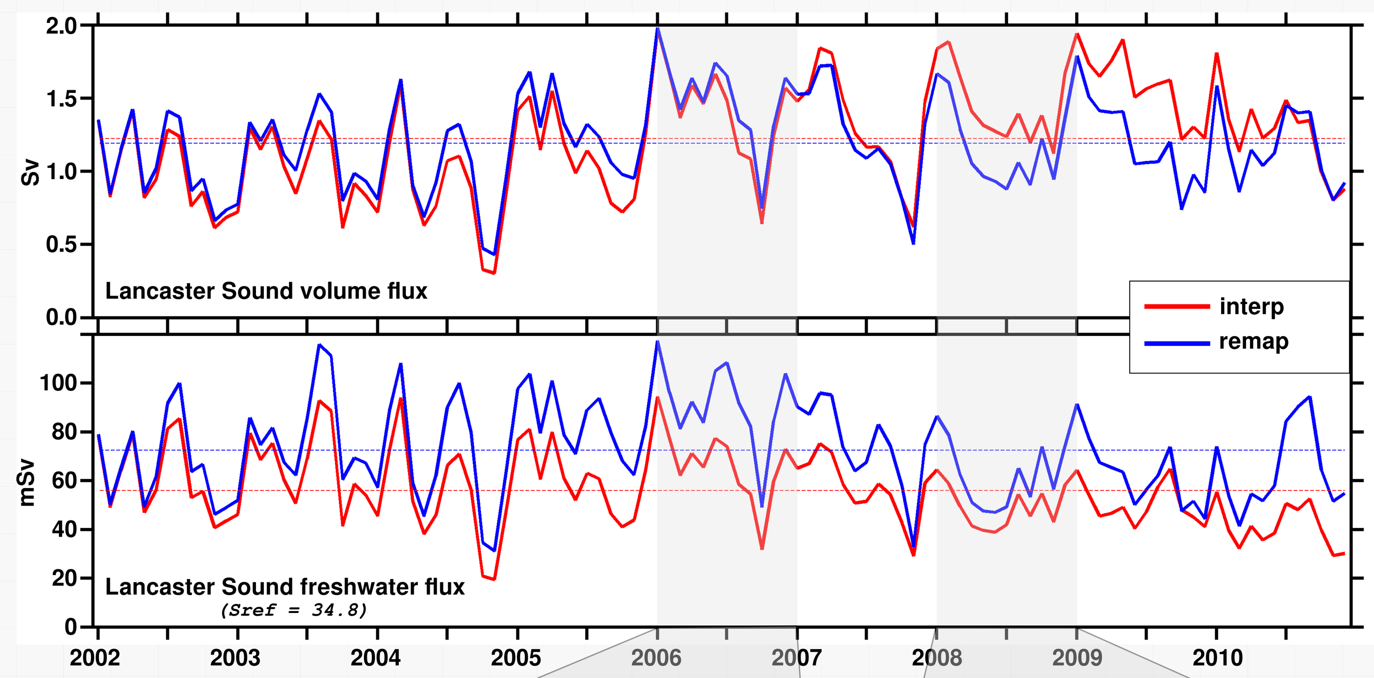
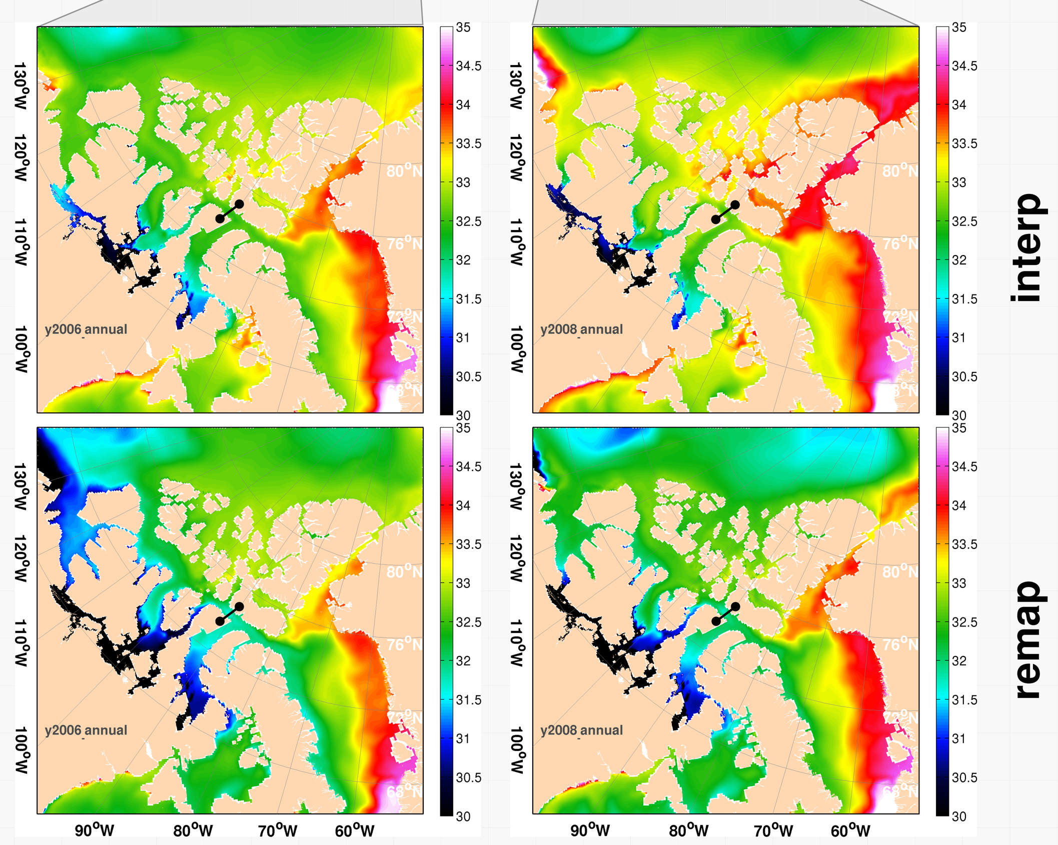


Figure 3 Simulated monthly volume and freshwater flux through Lancaster Sound in ANHA4 with the on-the-fly interpolated runoff (red) and remapped (blue). Both the simulation starts from the same initial conditions in Jan 2002 and are driven with same forcings except runoff. Annual mean of the top 50-m averaged ocean salinity in 2006 and 2008 from the two runs are shown on the right.



More impacts?

Yarisbel Garcia's talk (16:00 on June 3rd, 2015):
Title: Influence of runoff on the Labrador Sea Water formation and Meridional Overturning Circulation, from a numerical model
Session: The Labrador Sea as a vital element of the climate system-Part 2 (No. 50902)

Conclusion & Discussion

- this method significantly improves the amount of freshwater (runoff) received by the ocean in the numerical model (compared to simple interpolation)
- more accurate runoff input helps to reduce the salinity drift in ocean simulations
- volume conserving allows for relatively easier model simualtion comparison
- this method is actually a point-to-grid remapping method, thus it is convenient for including multiple data sources

Reference

1 Dai, A., T. Qian, K. E. Trenberth, and J. D Milliman (2009): Changes in continental freshwater discharge from 1948-2004. Journal of Climate, 22, 2773-2791

2 Bamber, J., van den Broeke, M., Ettema, J., Lenaerts, J., and Rignot, E. (2012): Recent large increases in freshwater fluxes from Greenland into the North Atlantic. Geophysical Research Letters, 39, doi:10.1029/2012GL052552

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