
The Arctic Subpolar gyre sTate Estimate(ASTE)

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(University of Texas, Austin)

Estimating the Circulation and Climate of the Ocean
Annual Meeting 20-22 Mar 2024



The University of Texas at Austin
Oden Institute for Computational
Engineering and Sciences



○ ASTE updates

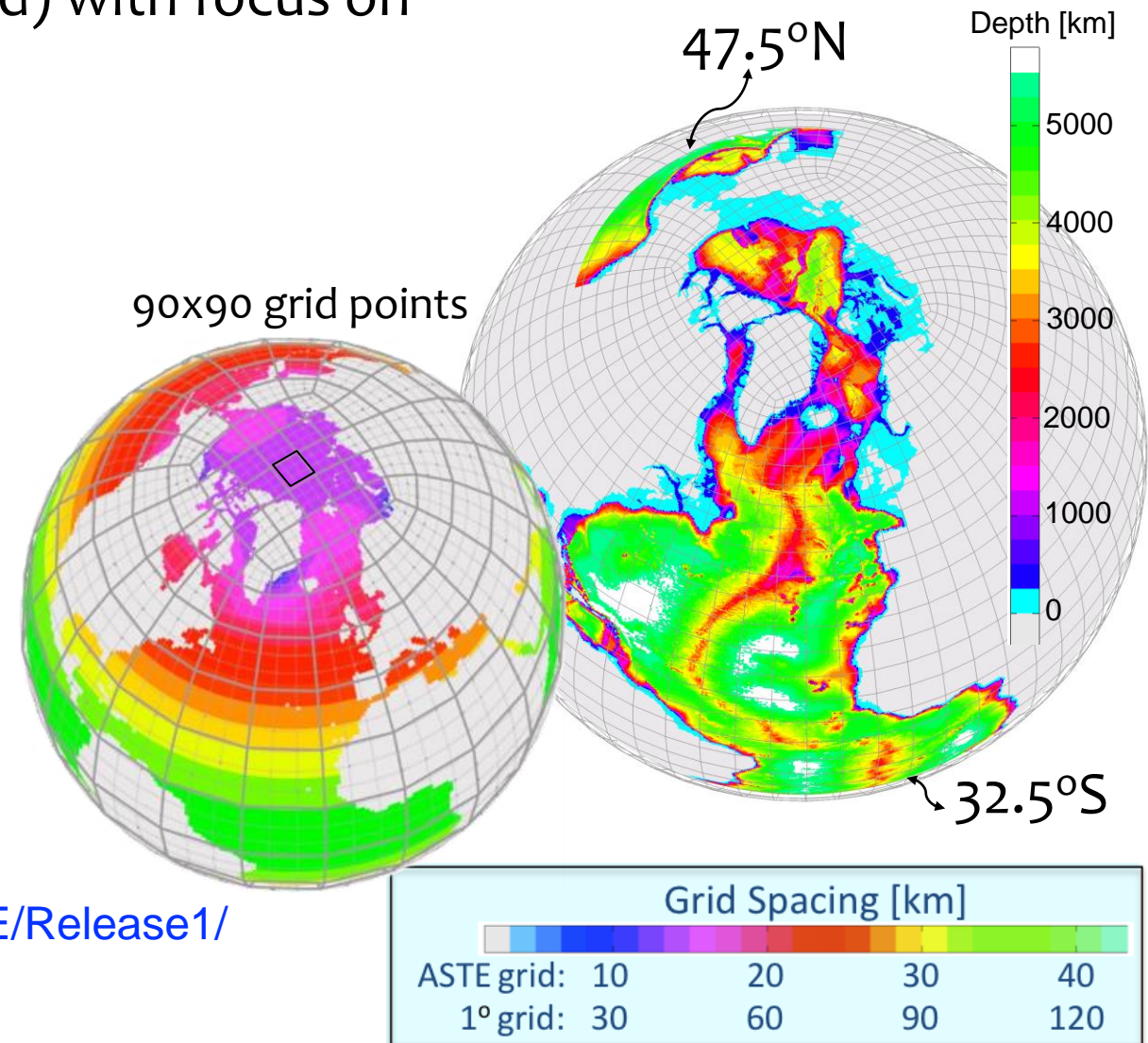
- Extension
 - Inputs update
 - forcing
 - **River runoff**
 - Data updates
 - Watermass transformation framework
 - Toward highres ASTE
- Feedbacks with ECCO central production

Arctic Subpolar gyre sTate Estimate (ASTE)

[Nguyen et al., 2021]

- Higher resolution than ECCOv4 (llc270 based) with focus on Arctic and subpolar North Atlantic
- 14km in Arctic, 17km in Nordic Seas
- OBCs: ECCO 1° global state estimate (ECCOv4R*)
- **Adjusted parameters:**
 - T/S initial conditions
 - time-varying atmospheric forcings,
 - 3-D ocean mixing parameters
- Data at Arctic Data Portal (arcticdata.io) & UT ECCO-mirror site

<https://web.corral.tacc.utexas.edu/OceanProjects/ASTE/Release1/>



ASTE Release 1 2002–2017 [Nguyen et al., 2021]

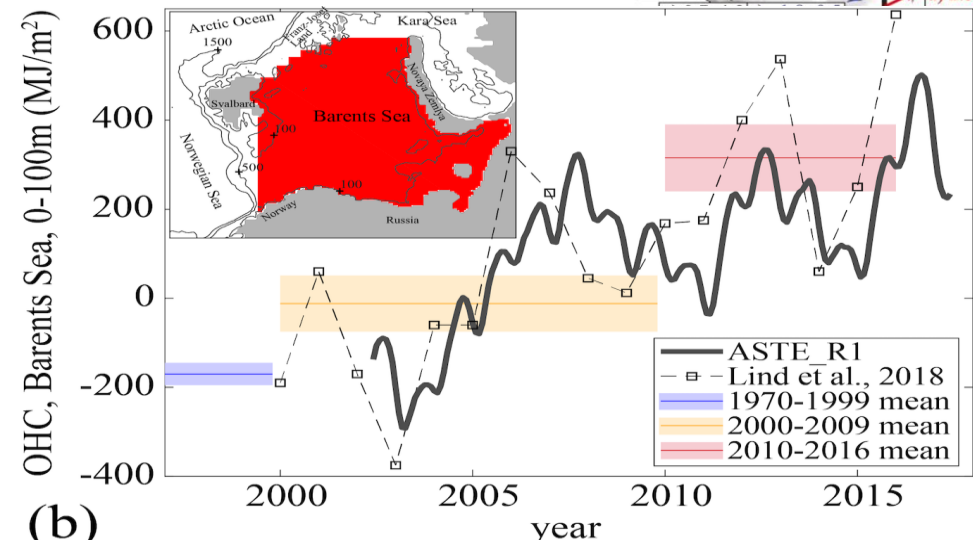
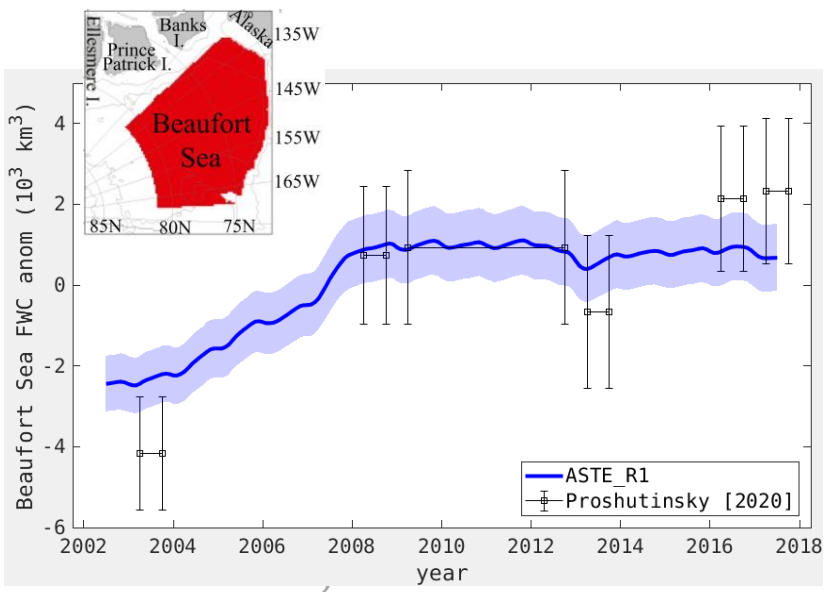
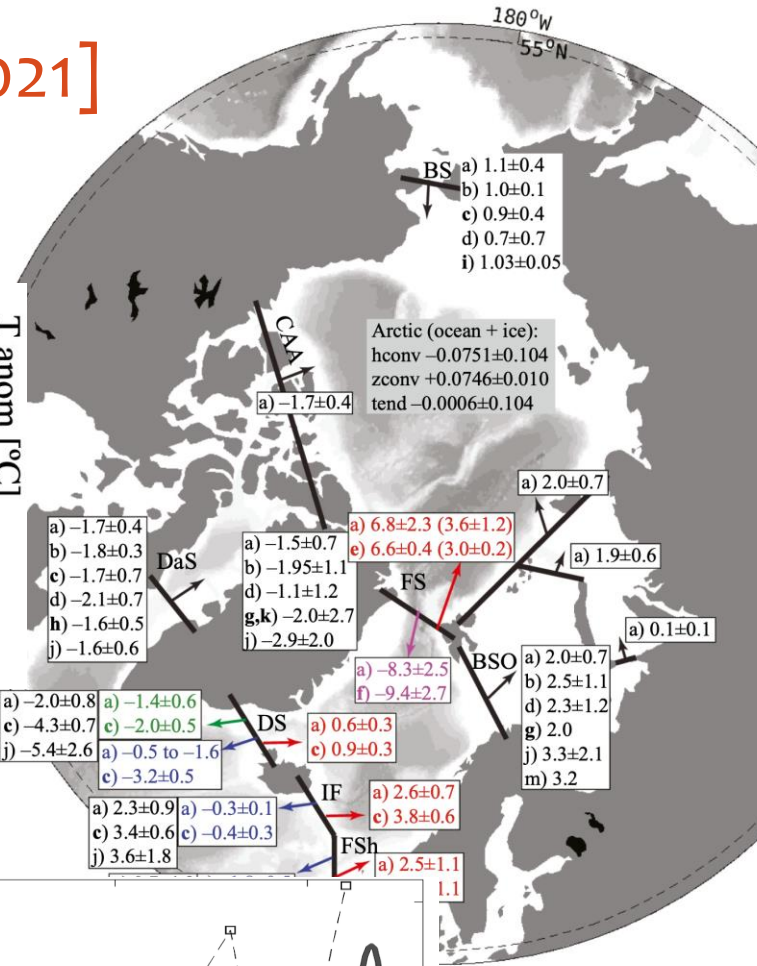
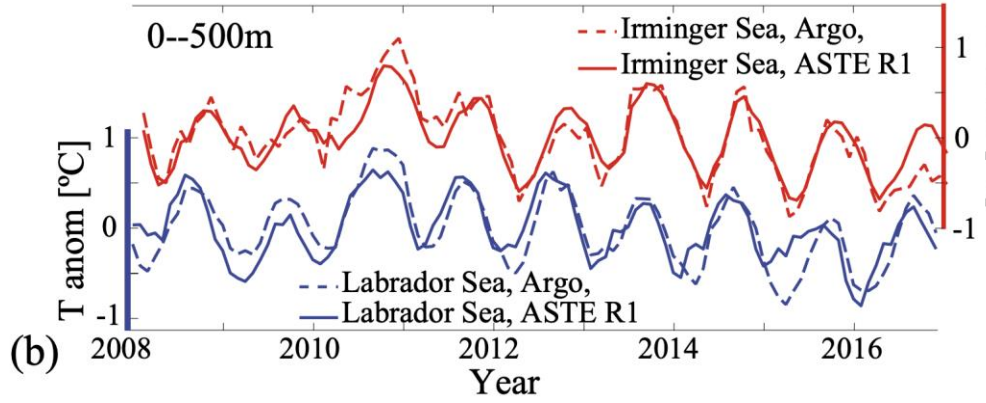
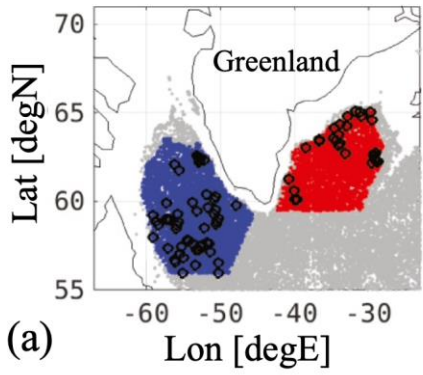
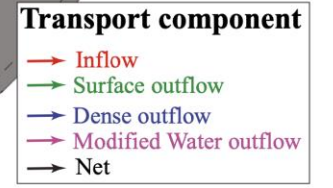
Extensive analyses on misfits, bias, budgets

Reference

- a: ASTE R1 (2006-2017)
- b: Iliak 2016 (1978-2007)
- c: Østerhus 2019 (1993-2015)
- d: Tsubouchi 2018 (09/2005-08/2006)
- e: Beszczynska 2012 (1997-2010)
- f: deSteur 2014 (1997-2009)
- g: Schauer 2008 (1997-2007)
- h: Curry 2014 (2004-2010)
- i: Woodgate 2018 (2003-2015)
- j: Tesdal 2020 (1992-2015)
- k: Marnela 2016 (1999-2010)
- l: Rossby 2018 (2009-2016)
- m: Smedsrud 2010 (1997-2007)

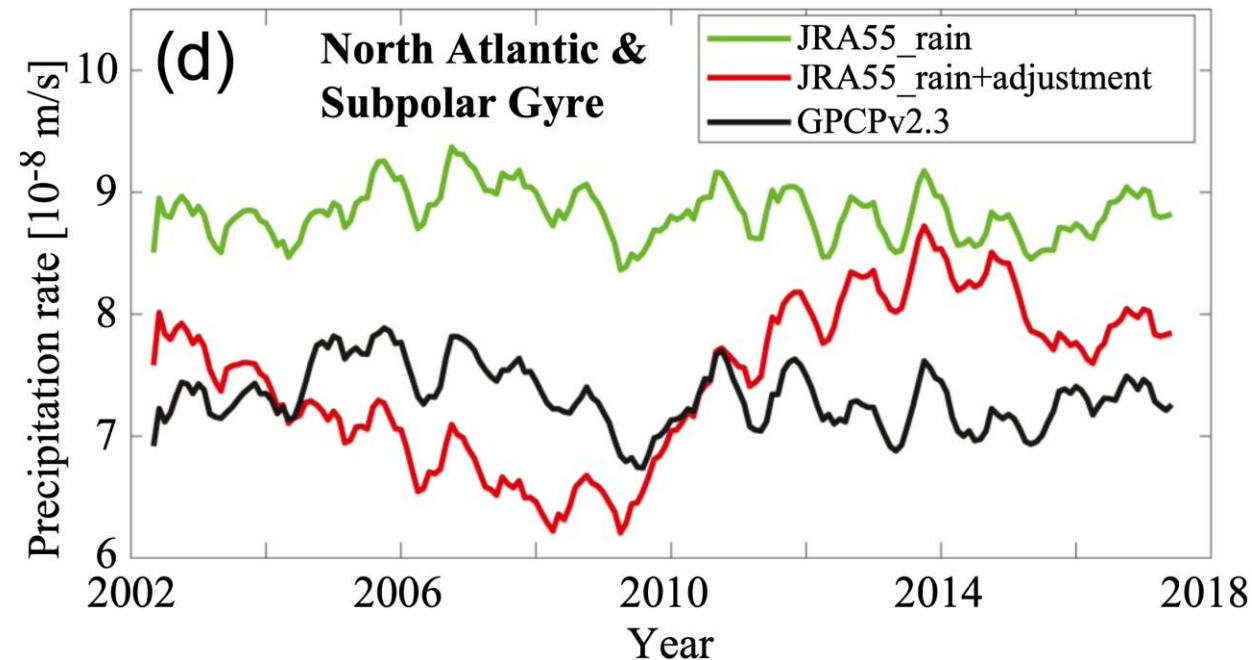
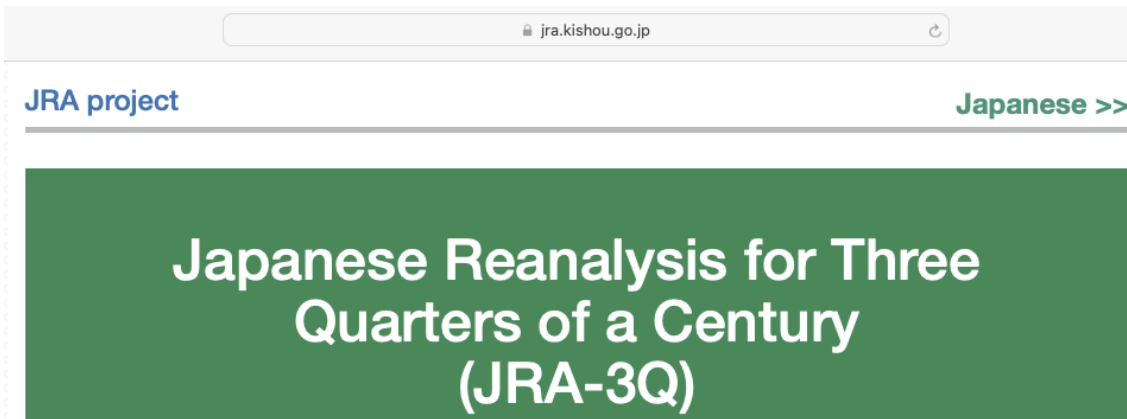
Gateway

- BS: Bering Strait
- FS: Fram Strait
- CAA: Canada Arctic Archipelago
- BSO: Barents Sea Opening
- DaS: Davis Strait
- DS: Denmark Strait
- IF: Iceland-Faroe
- FSh: Faroe-Shetland



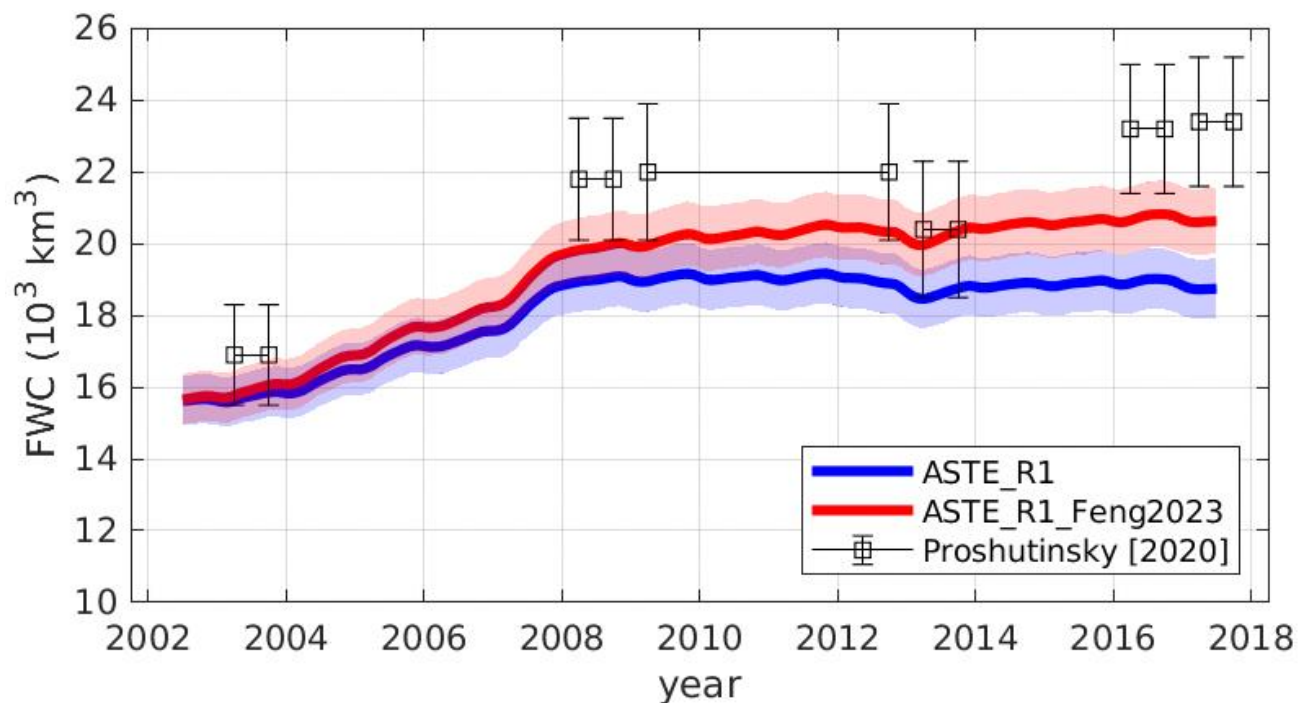
ASTE Extension

- Aim: to end of 2023
- parameterization of fjord-modified submarine melt and subglacial discharge through using Schulz et al. [2022] in fjord-resolving models of Wood et al., [2024] (side note: need help closing budget with “addmass”)
- Updating precipitation
- Update to forcing: JRA-3Q
https://jra.kishou.go.jp/JRA-3Q/index_en.html



ASTE Extension – river runoff (with help from Wenli Zhong)

- Updating river runoff: [Feng et al. 2021]
- pan-Arctic Remotely-sensed Arctic Discharge Reanalysis (RADR) for 1984-2018
- Assimilated product, of 9.18mil discharge obs from 227 mil river width measurements from Landsat images



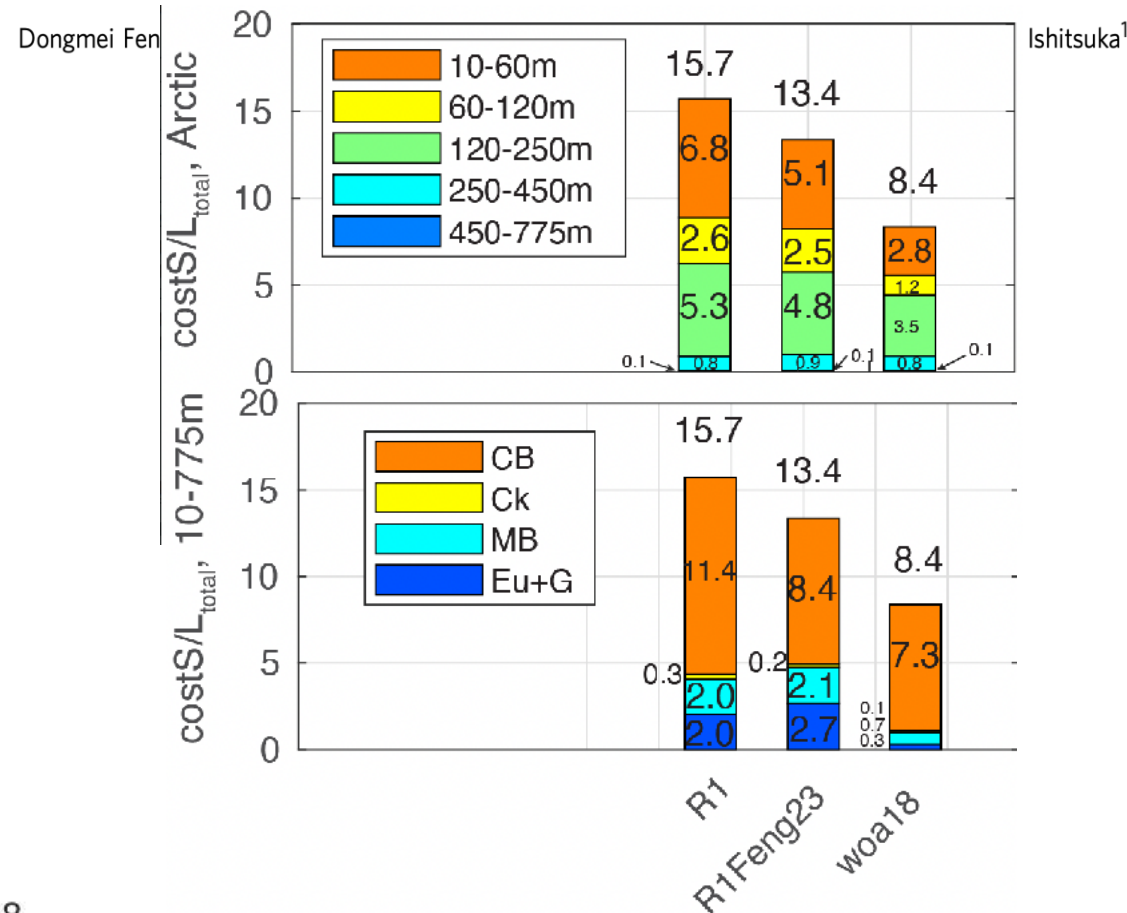
ARTICLE

<https://doi.org/10.1038/s41467-021-27228-1>

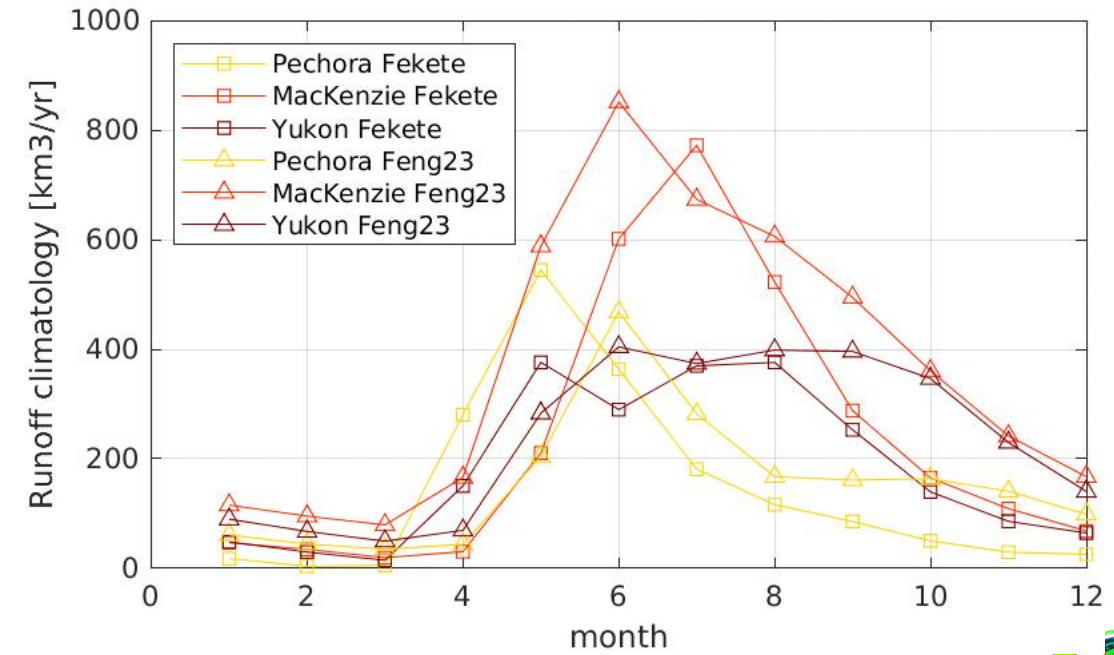
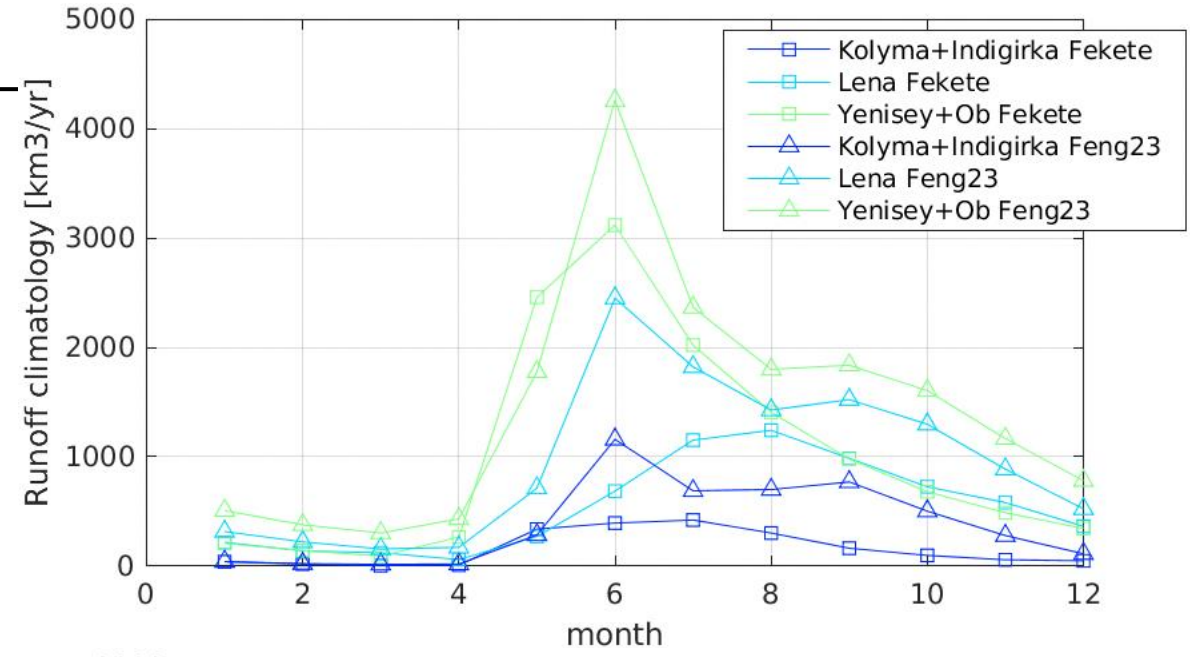
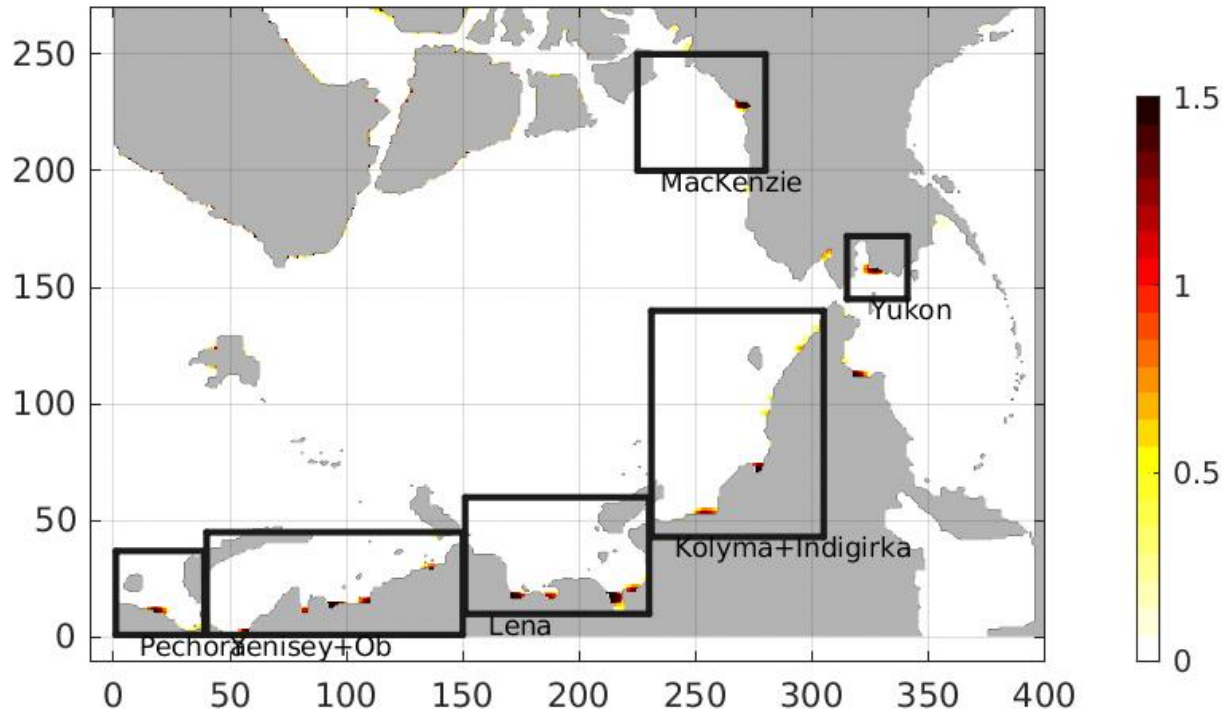
OPEN



Recent changes to Arctic river discharge



ASTE Extension – river runoff



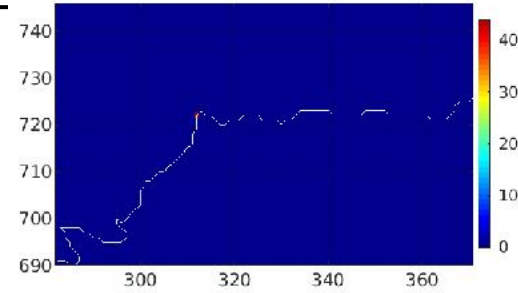
Note: change in seasonal cycle

ASTE Extension – river runoff

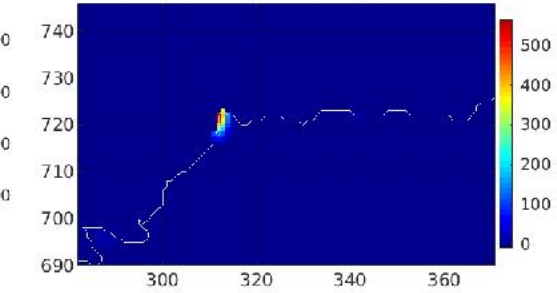
Improved representation of river runoff in Estimating the Circulation and Climate of the Ocean Version 4 (ECCOv4) simulations: implementation, evaluation, and impacts to coastal plume regions

Yang Feng^{1,2,3}, Dimitris Menemenlis⁴, Huijie Xue^{1,2}, Hong Zhang⁴, Dustin Carroll^{4,5}, Yan Du^{1,2,6}, and Hui Wu⁷

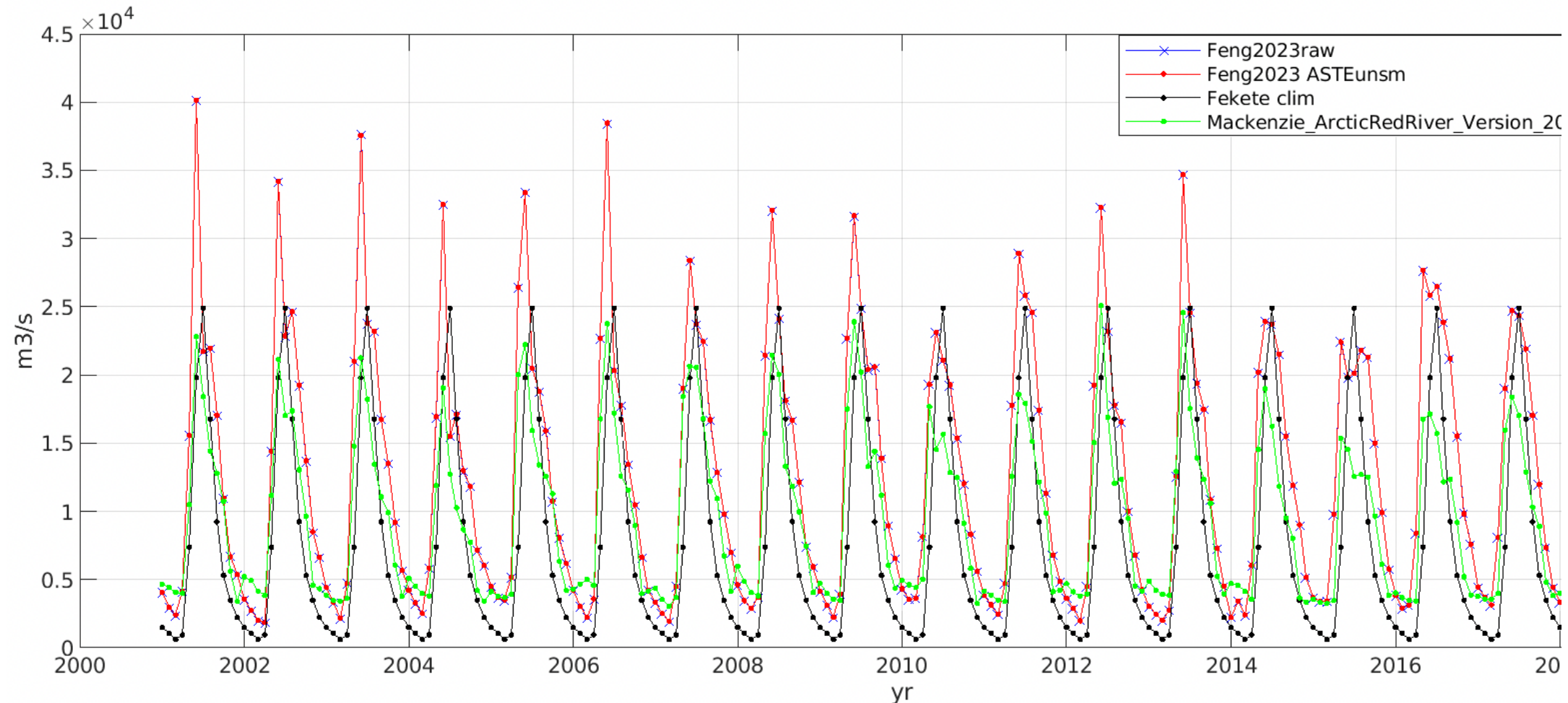
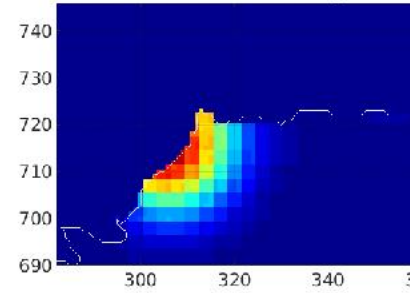
Feng2023 ASTE270 unsm, mo=420
sum(sum(aste_runoff_Feng23(ixq,iyq,420)))=
4905.2277 m3/s



Feng2023 ASTE270 sm, mo=420
sum(sum(aste_runoff_Feng23sm(ixq,iyq,420)))=
4905.7694 m3/s



Fekete ASTE270 sm, mo=12
sum(sum(feketeq(ixr,iyr,12)))=
2205.0386 m3/s



ASTE Extension – river runoff

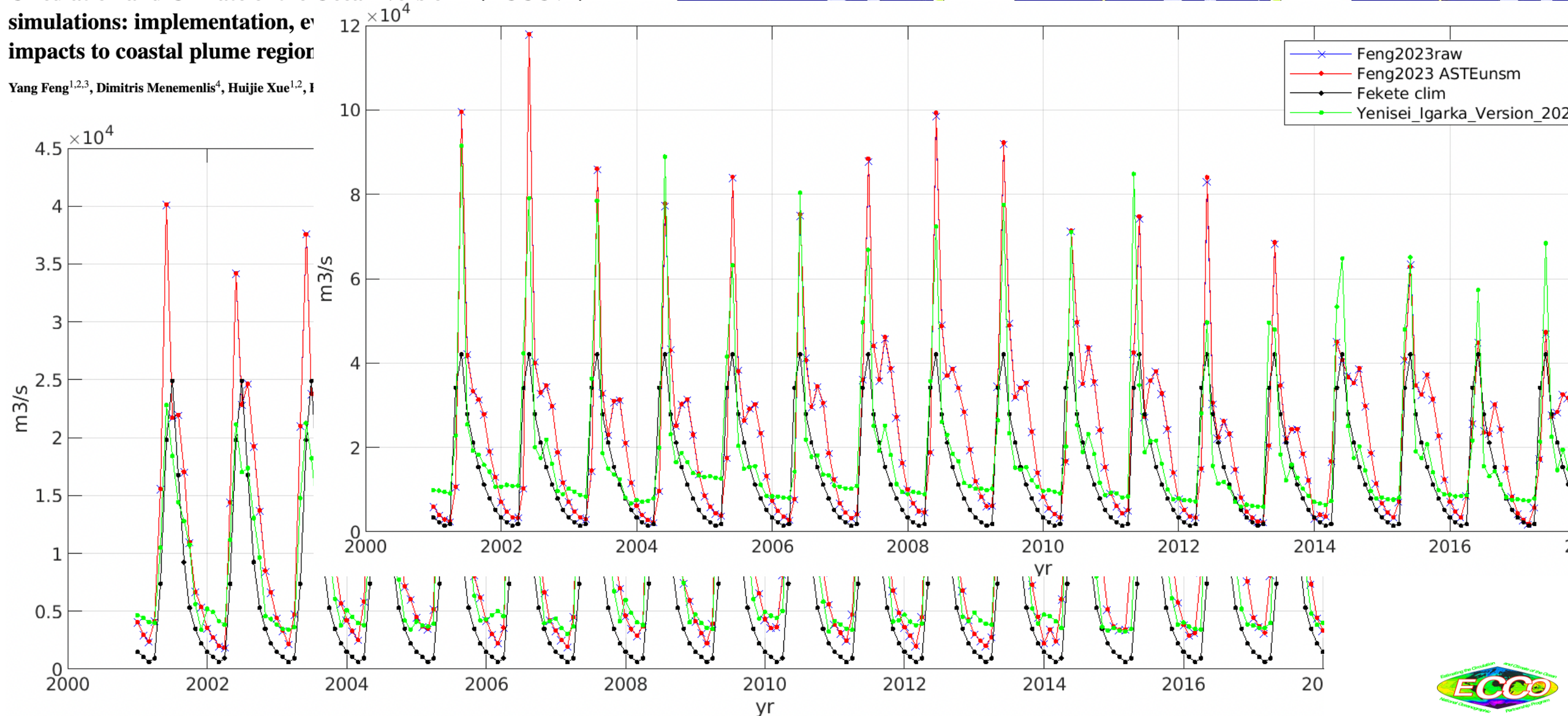
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Feng2023 ASTE270 unsm, mo=420
 $\text{sum}(\text{sum}(\text{aste_runoff_Feng23}(\text{ixq}, \text{iyq}, 420))) = 4905.2277 \text{ m}^3/\text{s}$

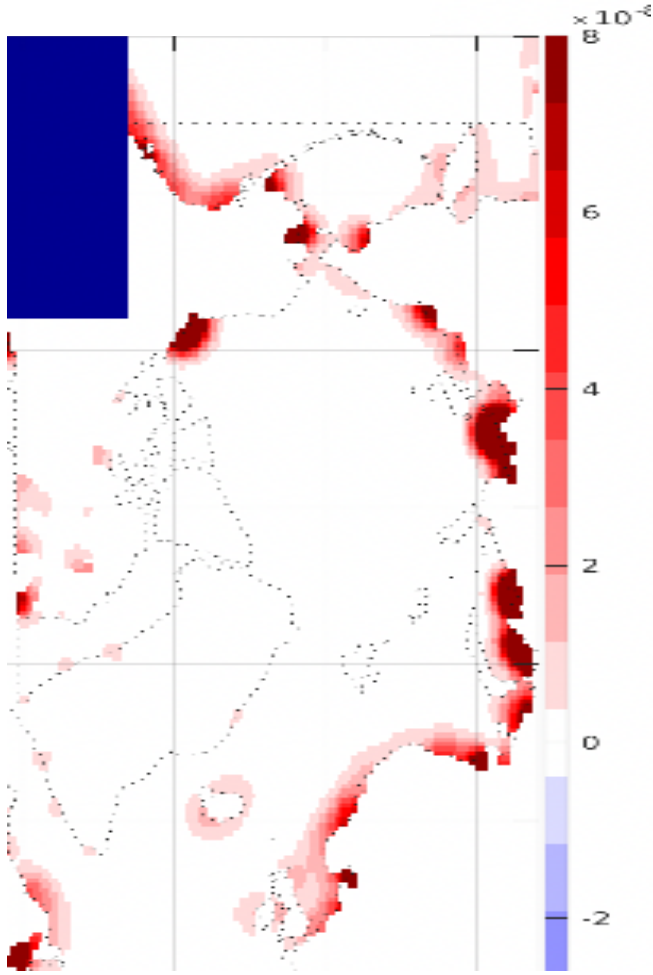
Feng2023 ASTE270 sm, mo=420
 $\text{sum}(\text{sum}(\text{aste_runoff_Feng23sm}(\text{ixq}, \text{iyq}, 420))) = 4905.7694 \text{ m}^3/\text{s}$

Fekete ASTE270 sm, mo=12
 $\text{sum}(\text{sum}(\text{feketeq}(\text{ixr}, \text{lyr}, 12))) = 2205.0386 \text{ m}^3/\text{s}$



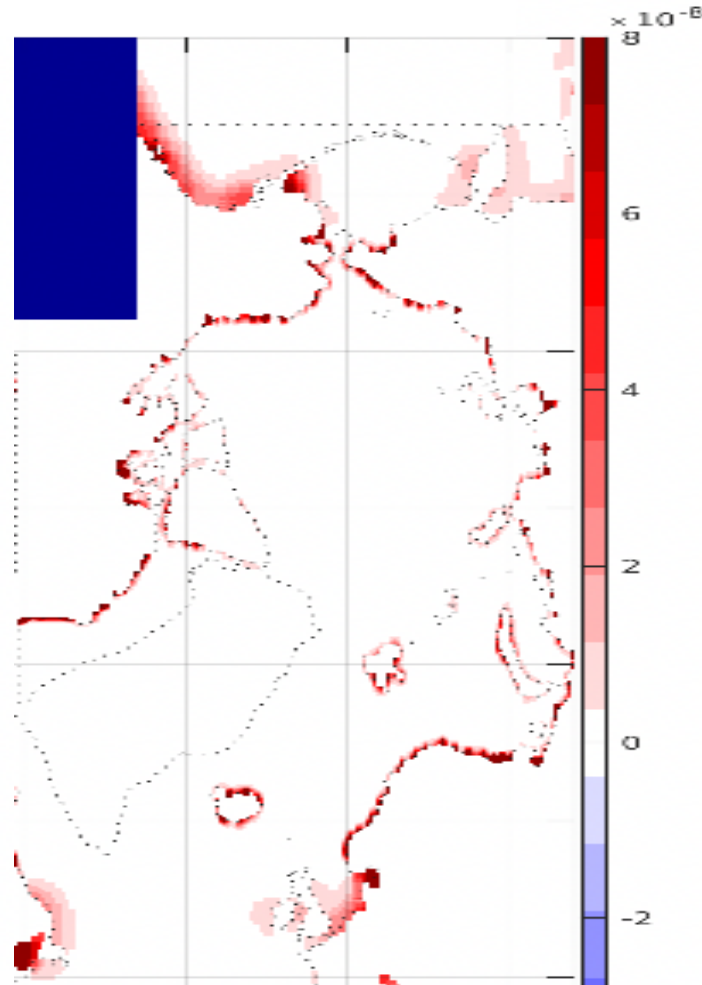
ASTE Extension – river runoff

(Sep) Fekete
climatology



3

(Sep 2012)
Fekete+Feng21

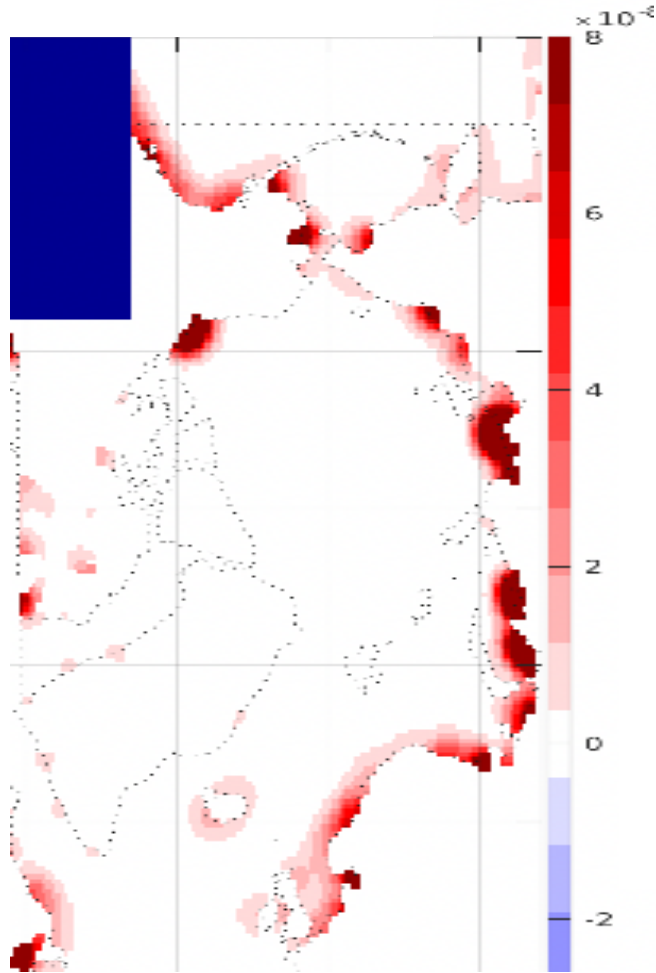


Merged into ASTE's grid
In progress: add Mankoff 2020
& Bamber 2018

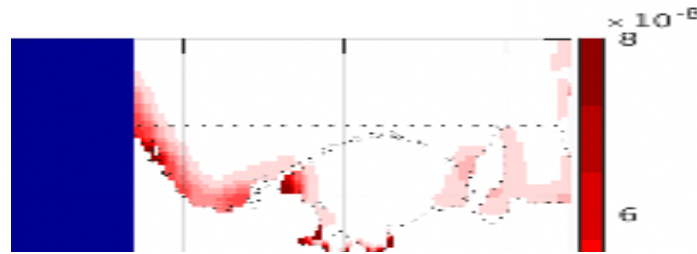
→ Subglacial vs surface discharge

ASTE Extension – river runoff

(Sep) Fekete
climatology



(Sep 2012)
Fekete+Feng21



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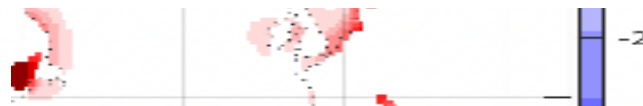
Water Resources Research

Research Article | Open Access | CC BY-NC-ND

A Framework for Estimating Global River Discharge From the Surface Water and Ocean Topography Satellite Mission

Michael Durand, Colin J. Gleason, Tamlin M. Pavelsky, Renato Prata de Moraes Frasson, Michael Turmon, Cédric H. David, Elizabeth H. Altenau, Nikki Tebaldi, Kevin Larnier, Jerome Monnier ... [See all authors](#) ▾

First published: 27 March 2023 | <https://doi.org/10.1029/2021WR031614> | Citations: 1



SWOT-based river
discharge database

ASTE Extension – data sets

Thanks Ian for satellite obs, Matt for Argo

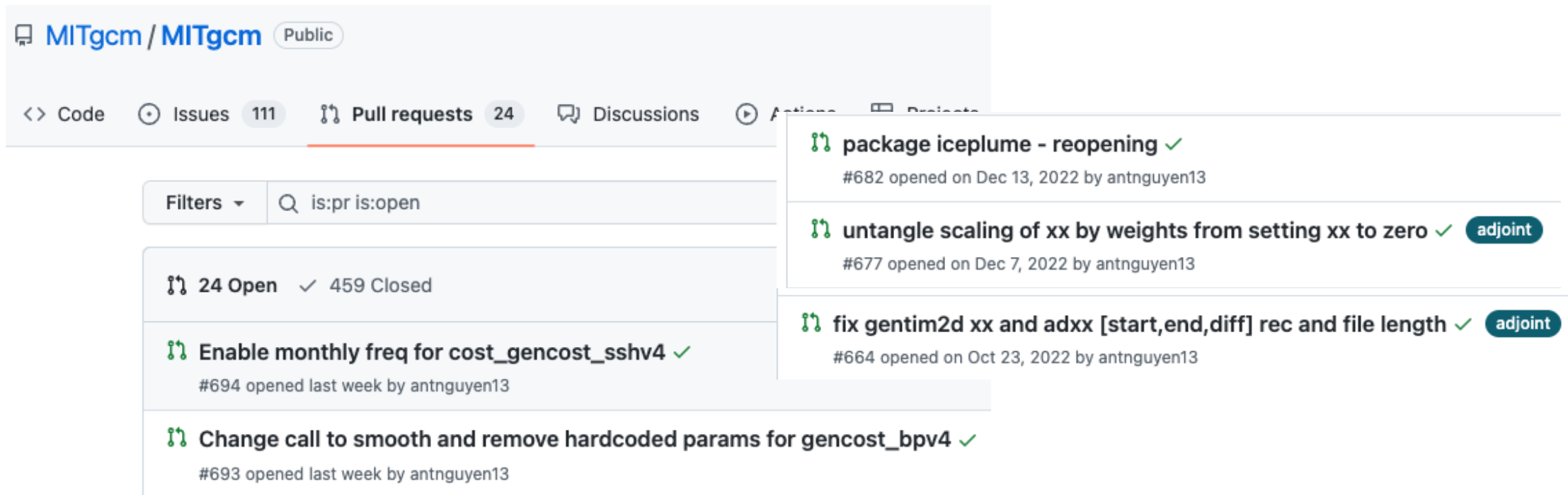
- MOSAic
- Mooring arrays across GSR: <http://www.oceansites.org/tma/gsr.html>
- A-Twain data: [Våge16,PerezHernandez17,Renner18]
<https://data.npolar.no/dataset?page=1&q=A%20Twain&location=arcticOcea>
<https://openpolar.no/Record/npolardata:oai:npolar.no:dataset%2Fd3a5adc2-aa97-4934-893d-83427f7134ad>
- Davis Strait data: not avail after 2015, already sent email to C. Lee to ask.
- GIS ridge: <http://kogur.who.edu/php/index.php>, http://kogur.who.edu/Historical_Data/ [Våge13, 18]
- Iceland Greenland Project (IGP, Huang21): <https://web.who.edu/all0118/> , (only ctd, not underway vel)
- UDASH: [Behrendt17, Behrendt18], 1980--2015, <https://doi.pangaea.de/10.1594/PANGAEA.872931>
- International Council for the Exploration of the Seas (ICES): <https://data.ices.dk/>
- Faroe-Island data: <http://www.envofar.fo>
- GreenlandScotlandRidge: <http://www.oceansites.org/tma/gsr.html> (transp avail, contact people for indiv)
- FramStrait [in/out]flow (start here, already downloaded publication from year 2023)
<https://www.pangaea.de/?q=von+Appen%2C+Wilken-Jon&f.pubyear%5B%5D=2022&f.project%5B%5D=FRAM>
<https://www.npolar.no/en/projects/fram-strait-arctic-outflow-observatory/#toggle-project-dataset;>
<https://data.npolar.no/dataset/c4d80b64-25f6-4afd-b392-696430c3fd14>
- NABOS (Igor Polyakov)

ASTE Extension / Devel

- Sea ice adjoint (bug fix of flooding)
- Toward higher res: Ilc1080-based ASTE (exists in forward mode)
 - Multigrid
 - following ECCO efforts, also testing tape saving capability (Matt Mazloff's code)

ASTE – ECCO central production

- Sea-ice data & Sea-ice parameters as controls
- **Improved physics , e.g., subglacial discharge / submarine melt representation / parameterization**
- Code development relevant to ASTE/ECCO production
- Multi-grid code and implementation



The screenshot shows the GitHub interface for the MITgcm/MITgcm repository. The 'Pull requests' tab is selected, showing a list of 24 open pull requests. The search filter is set to 'is:pr is:open'. The pull requests listed are:

- package iceplume - reopening** ✓ #682 opened on Dec 13, 2022 by antnguyen13
- untangle scaling of xx by weights from setting xx to zero** ✓ **adjoint** #677 opened on Dec 7, 2022 by antnguyen13
- fix gentim2d xx and adxx [start,end,diff] rec and file length** ✓ **adjoint** #664 opened on Oct 23, 2022 by antnguyen13

Summary statistics: 24 Open, 459 Closed.

Additional pull requests visible in the list:

- Enable monthly freq for cost_gencost_sshv4** ✓ #694 opened last week by antnguyen13
- Change call to smooth and remove hardcoded params for gencost_bpv4** ✓ #693 opened last week by antnguyen13