

Activities of the Polar Energy Budget Group

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b·geos

FWF

Der Wissenschaftsfonds.



CECMWF



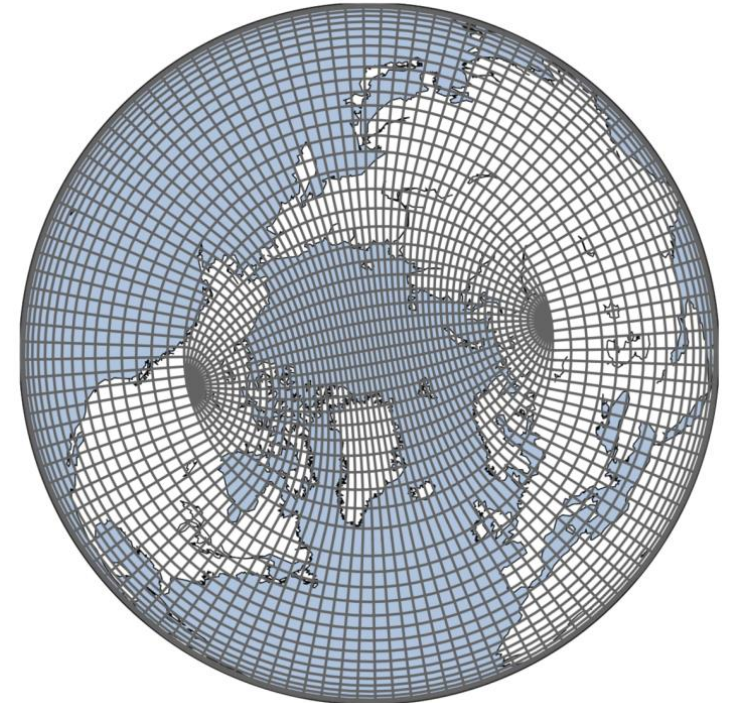
Overview of recent activities

- FWF project “A consistent framework for quantifying global energy budgets”
 - coupled energy and water budgets, focus on Arctic
 - Validation of Arctic energy and water budgets in CMIP6 models
- CMEMS-funded “Validation and Intercomparison of Global Reanalyses for Ocean Currents and Transports” hosted by b.geos
 - Michael Mayer lead author of section 4.2 “Recent variations in oceanic transports across the Greenland–Scotland Ridge” in OSR7
- Community service: Michael Mayer Austrian member of IASC atmospheric working group
 - call for IASC Cross-Cutting and Working Group proposals open until January 2024
(<https://iasc.info/our-work/working-groups/call-for-proposals>)
- Susanna W. member of new Fresh Eyes on CMIP working group

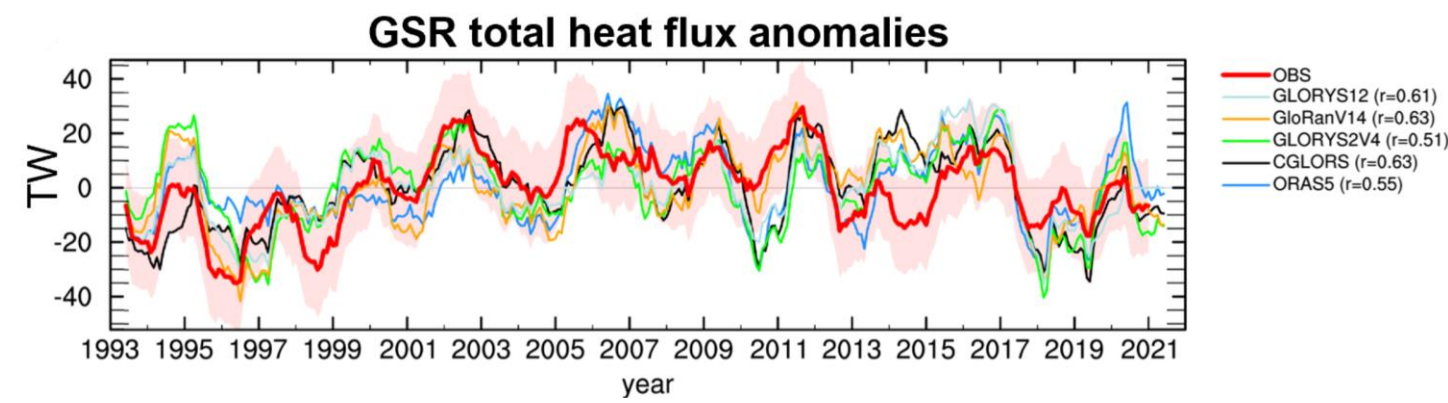
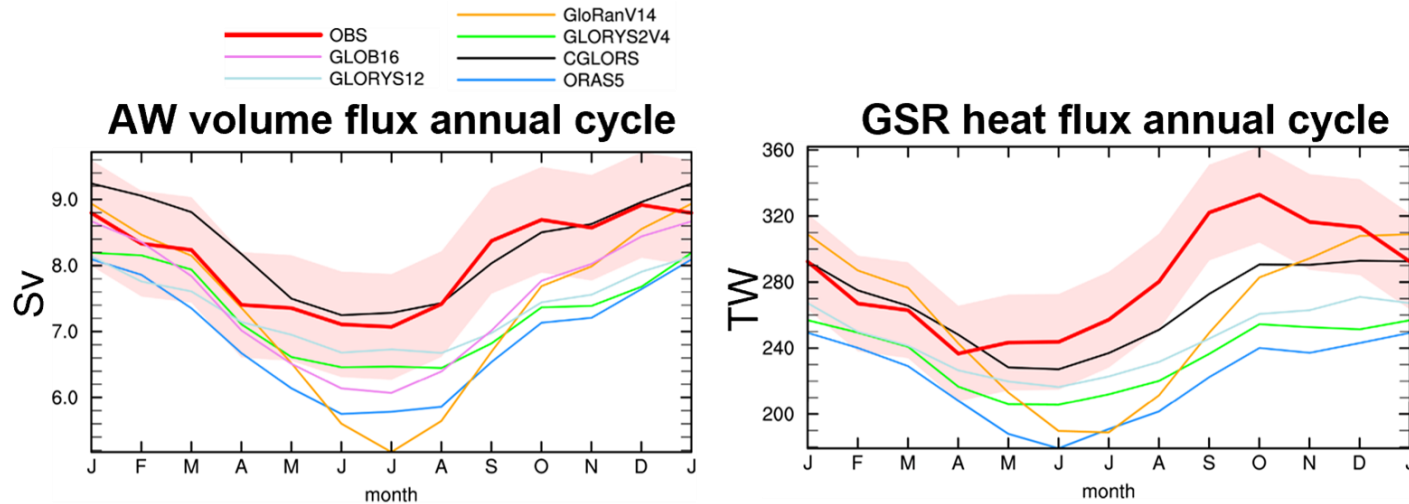


StraitFlux (Winkelbauer et al., in preparation)

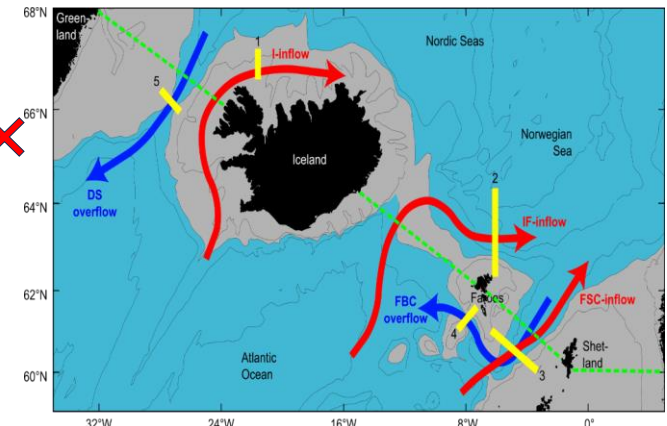
- Development of new tools that enable:
 - Precise calculation of oceanic transports of volume, heat, salinity and ice
 - Calculation of Cross-sections of the vertical plane to assess profiles of e.g. currents
- Works on various ocean model grids (tested for > 30 CMIP6 models and various reanalyses) and for any desired straits
- Available via github and zenodo (and pypi) (<https://doi.org/10.5281/zenodo.10053555>)



Recent variations in oceanic transports across the Greenland–Scotland Ridge (Mayer et al. 2023, in OSR7)



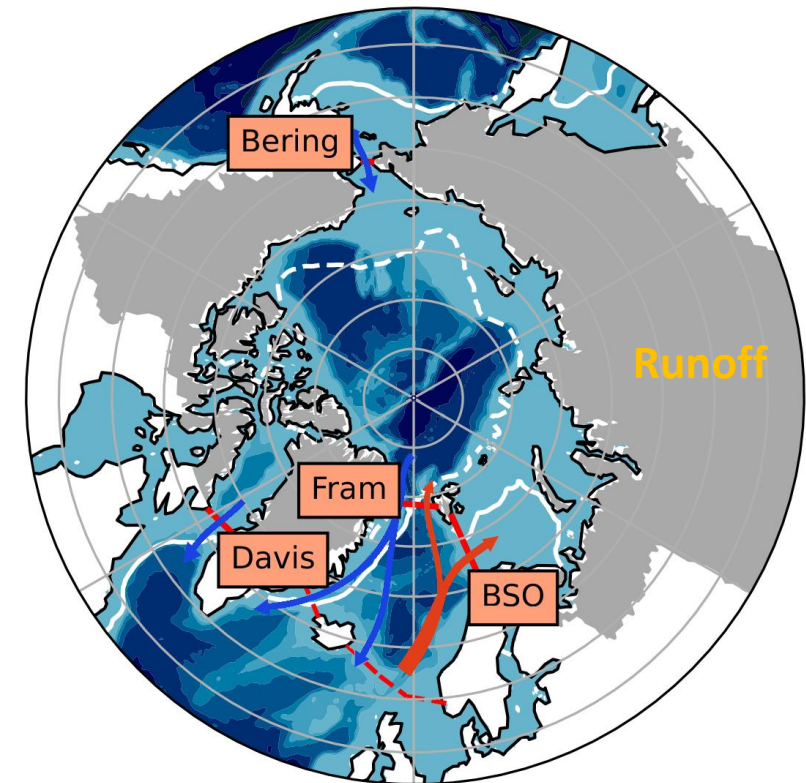
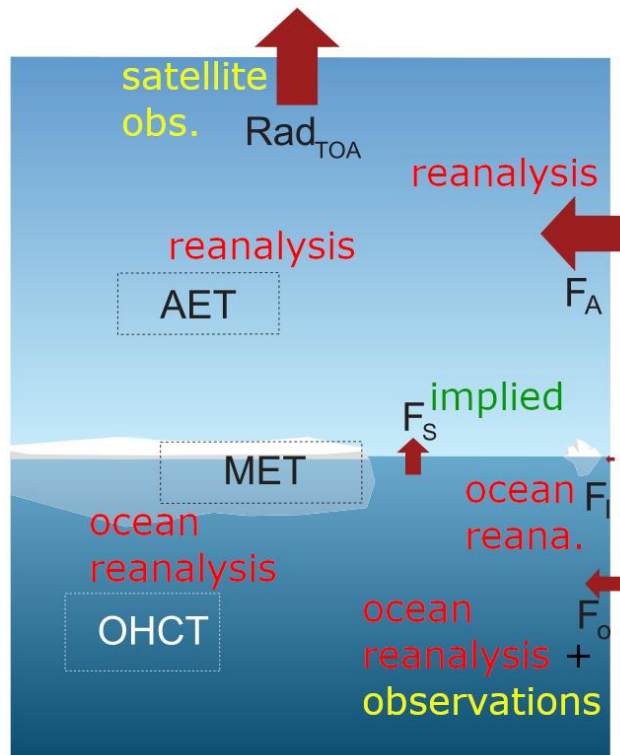
Sermilik X



- Typical decomposition into Atlantic (AW), Overflow (OW), and Polar outflow (PW) waters shows that most ORAs underestimate the inflow of warm and saline AW
- As a result, heat flux across GSR is underestimated by all ORAs
- Pronounced anomaly during 2017-2019 caused by a reduction in AW inflow through the Faroe–Shetland branch + cooler waters due to SPG strengthening

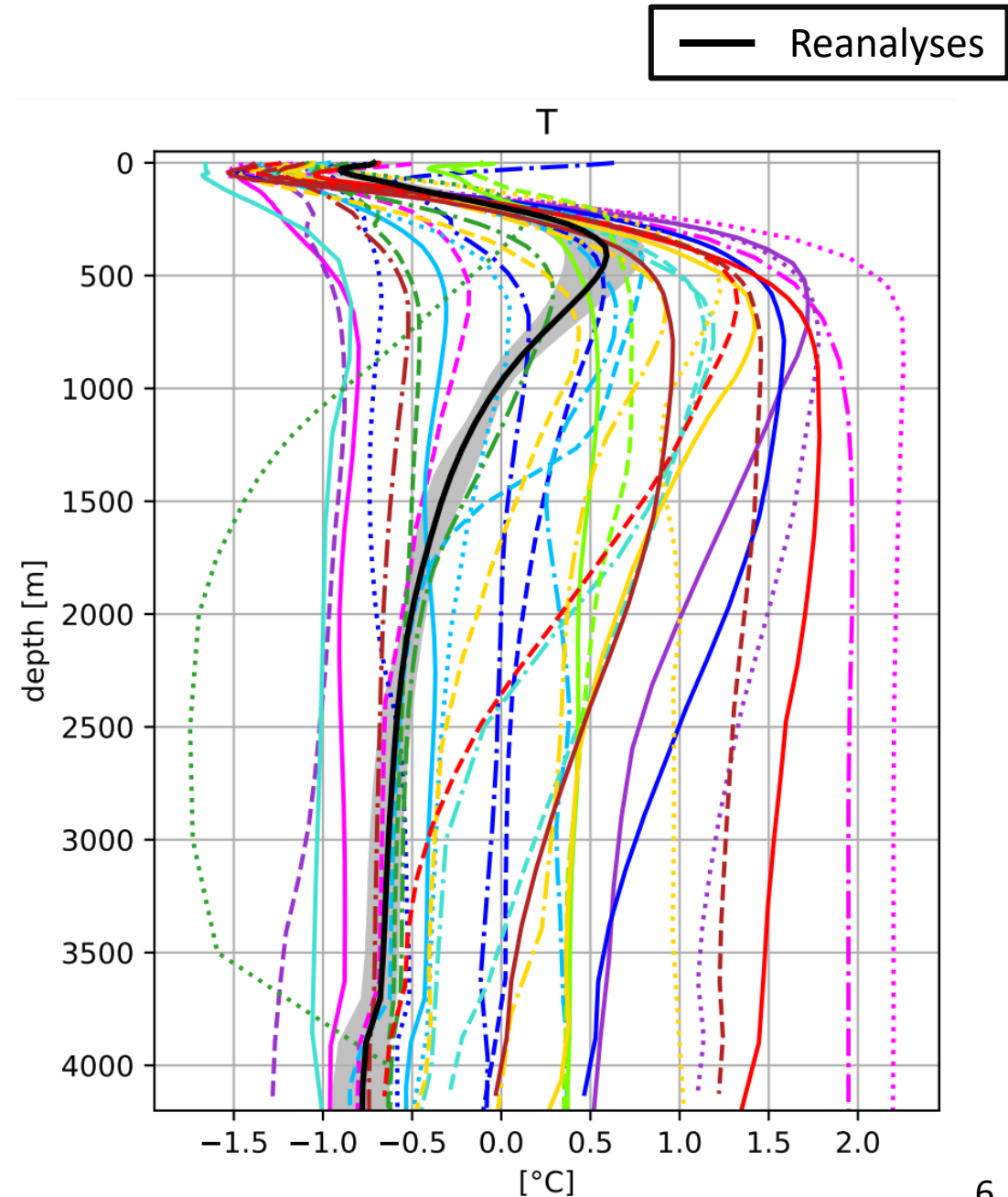
Coupled energy (and water) budgets in CMIP6 (Winkelbauer et al., in review)

- Assess historical simulations of relevant components of the Arctic energy and water budgets for 39 Coupled Model Intercomparison Project Phase 6 (CMIP6) models
- Use observationally constrained budgets for validation
Mayer et al., 2019 (10.1175/JCLI-D-19-0233.1)



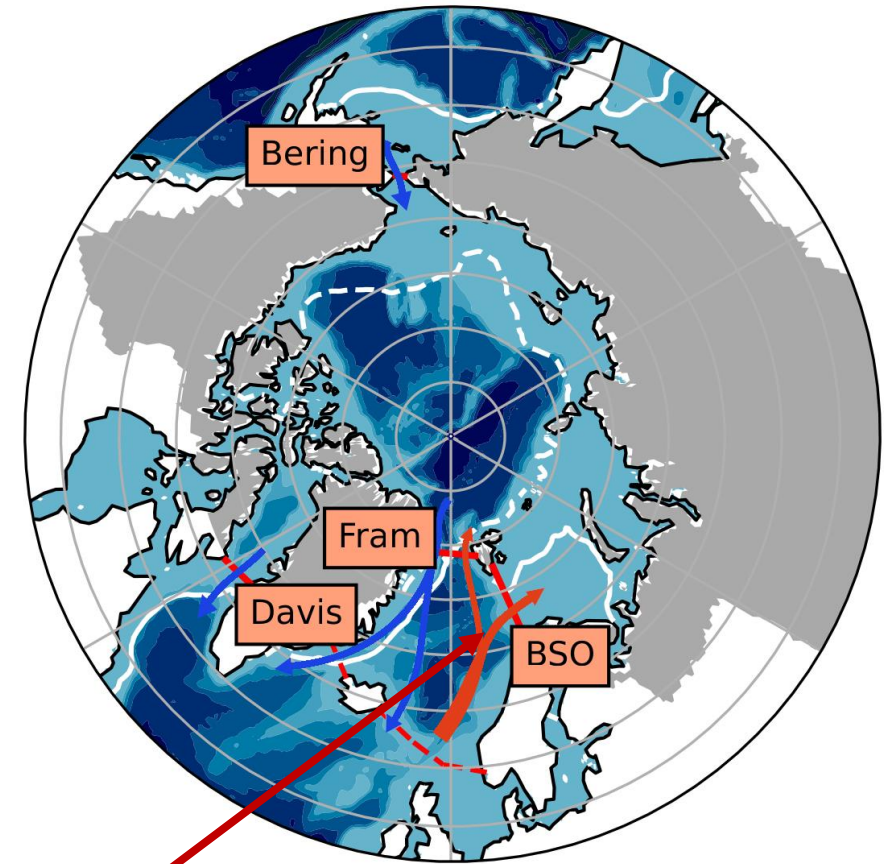
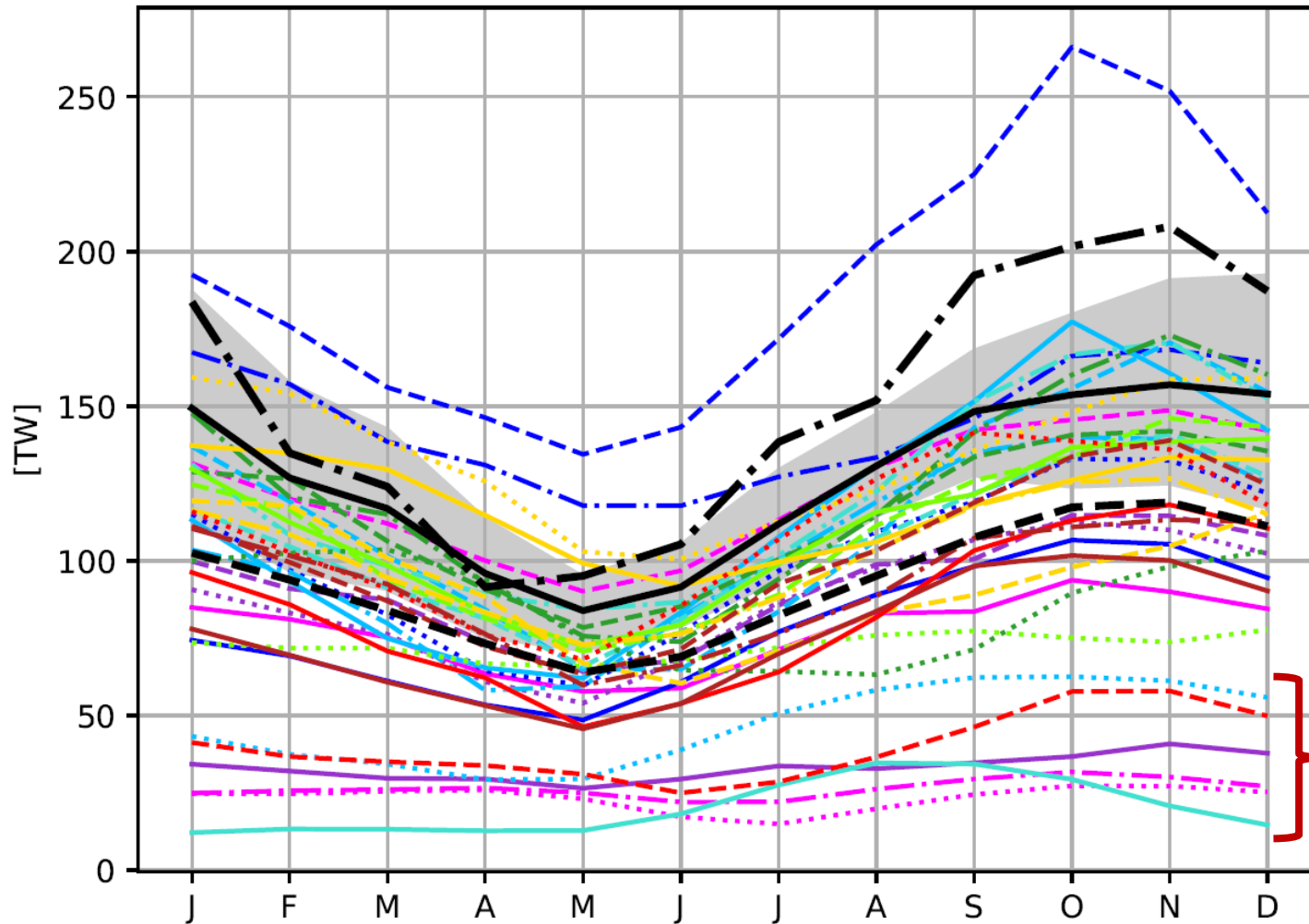
State of Arctic Ocean in CMIP6

- Large inter-model spreads for salinity and temperature
- Halocline mostly too fresh (not shown) and too cold
- Atlantic Water layer is too deep and too thick
- Biases caused by processes both within and outside the Arctic:
 - lack of shelf overflows / ventilation
 - inaccurate oceanic transports (correlations with SPG and AMOC)



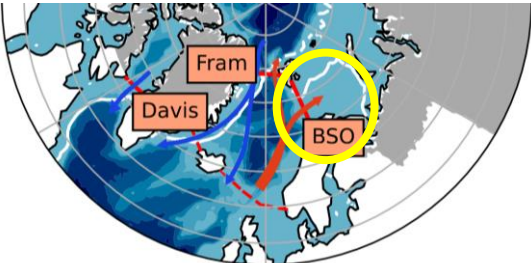
Net Arctic ocean heat transport

OHT 1993-2014, n=34



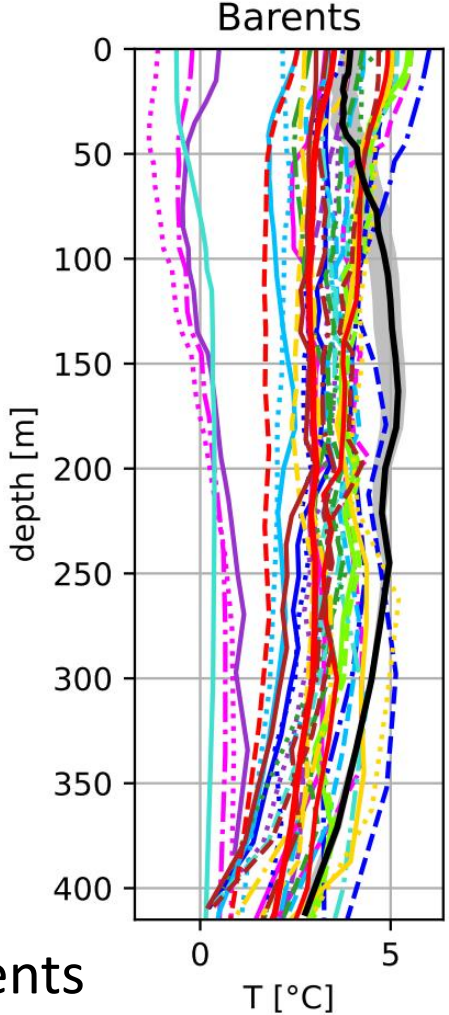
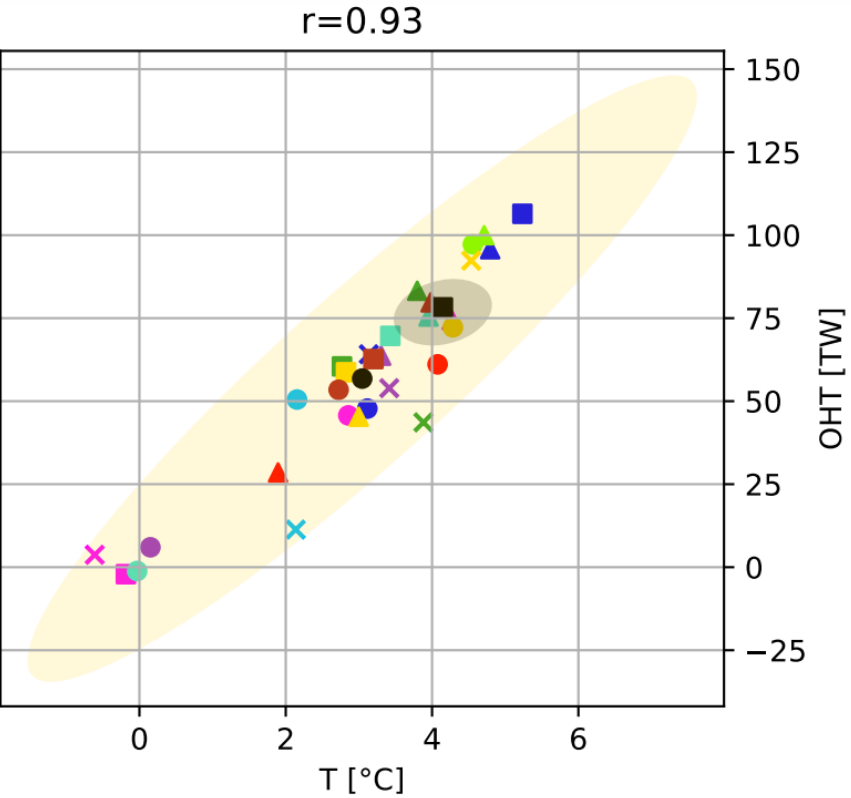
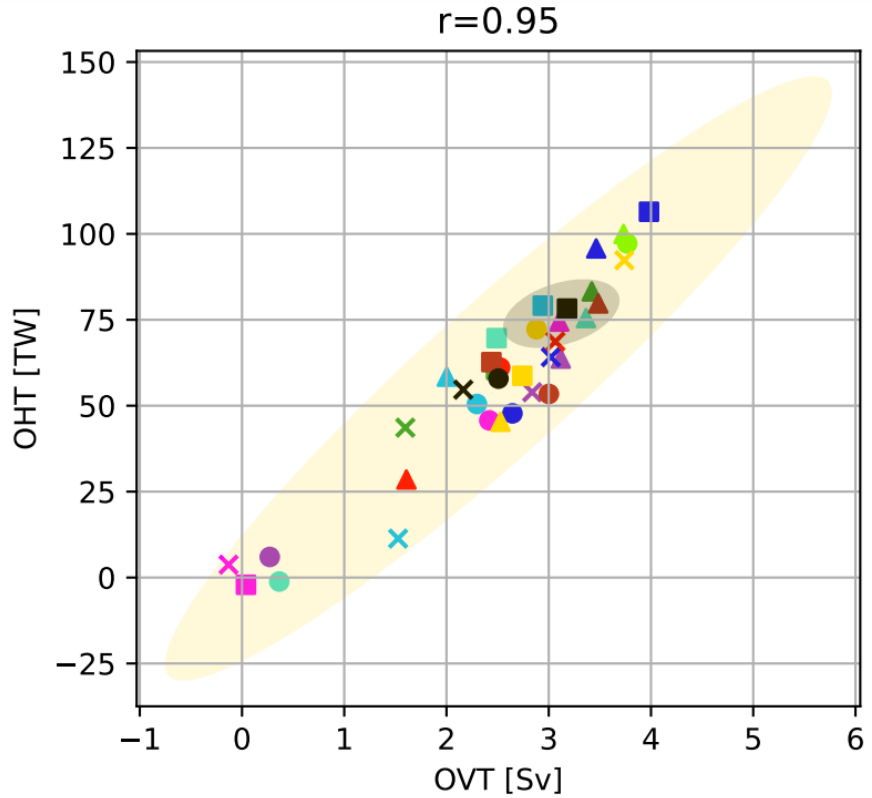
- - CMIP6 mean
- Reanalysis
- · Observations

Barents Sea Opening heat transport



● CMIP6 mean
■ Reanalysis ensemble

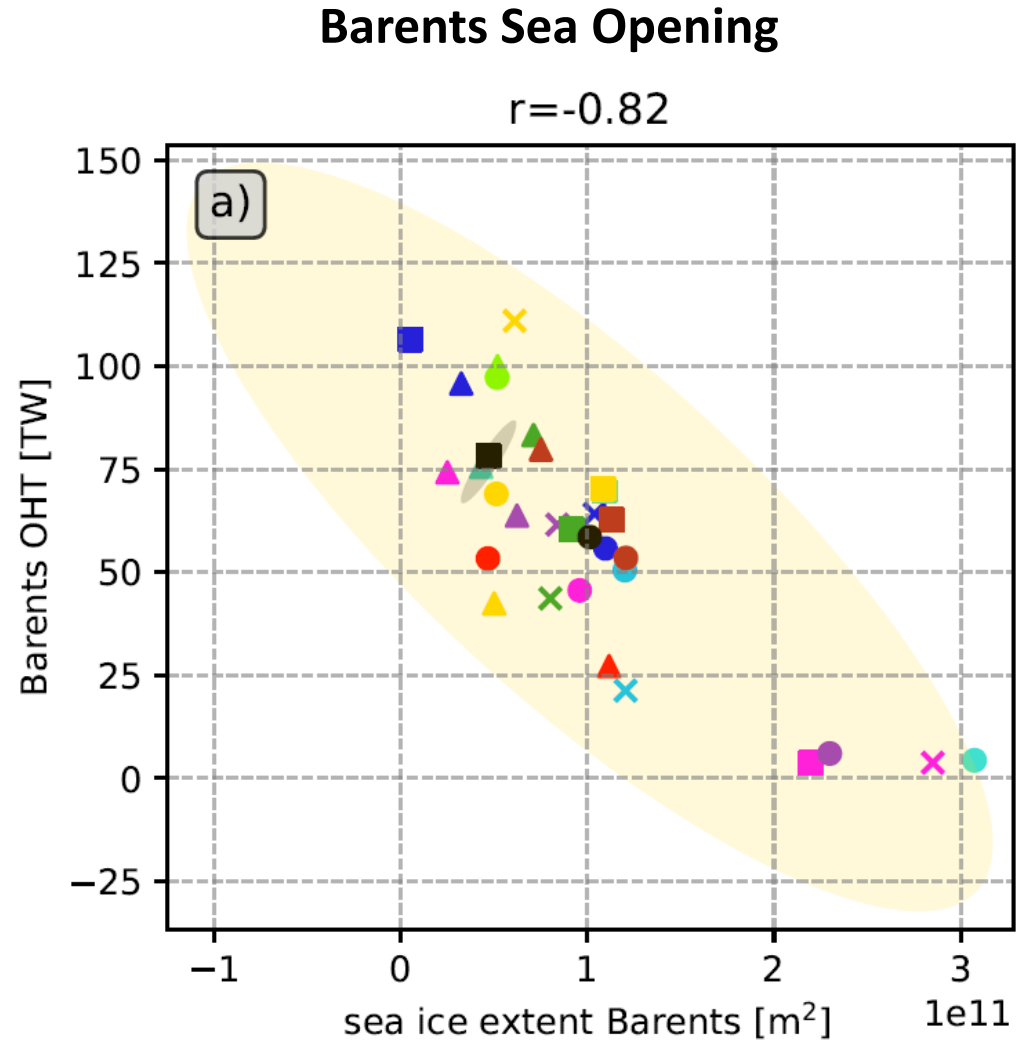
— CMIP6 mean
— Reanalysis



→ BSO OHT biases result of temperature biases and biases in the simulated currents

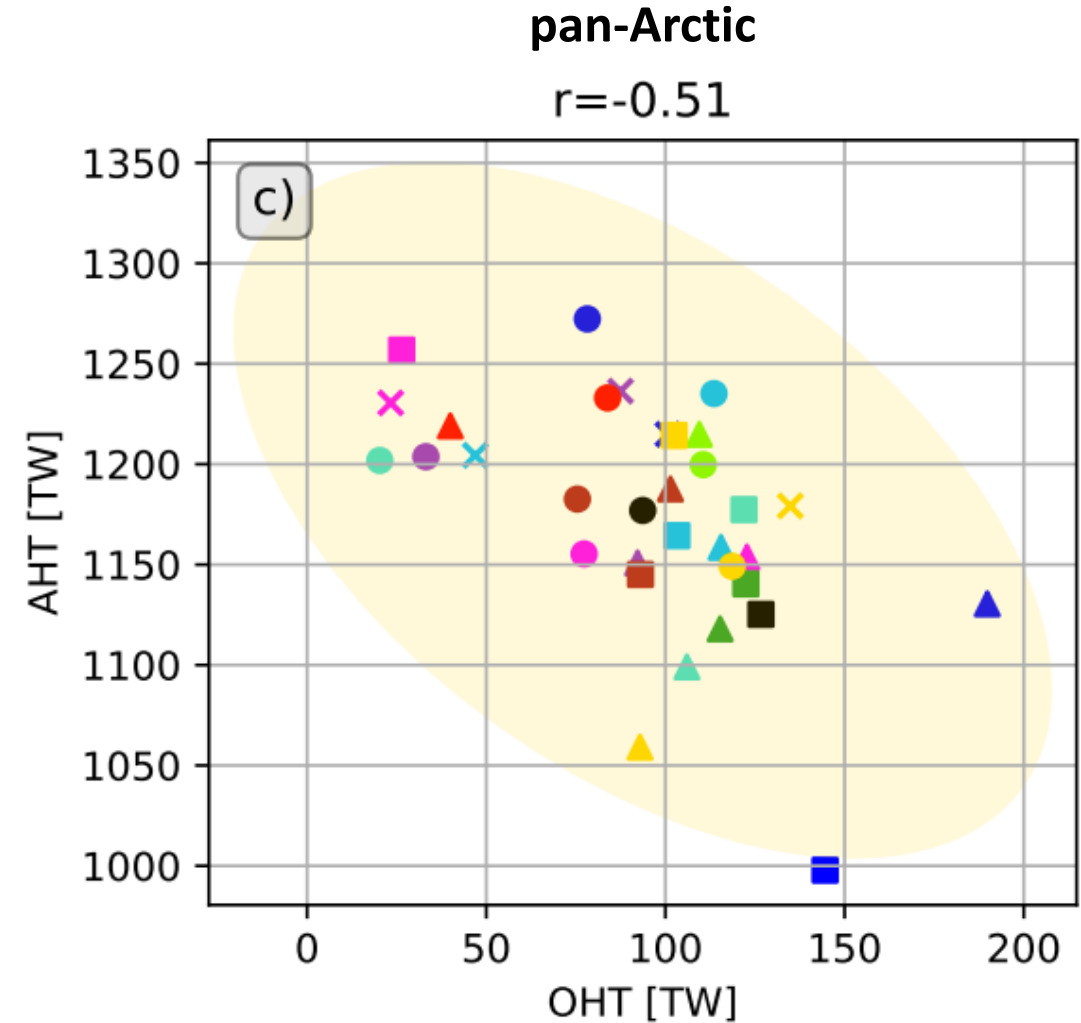
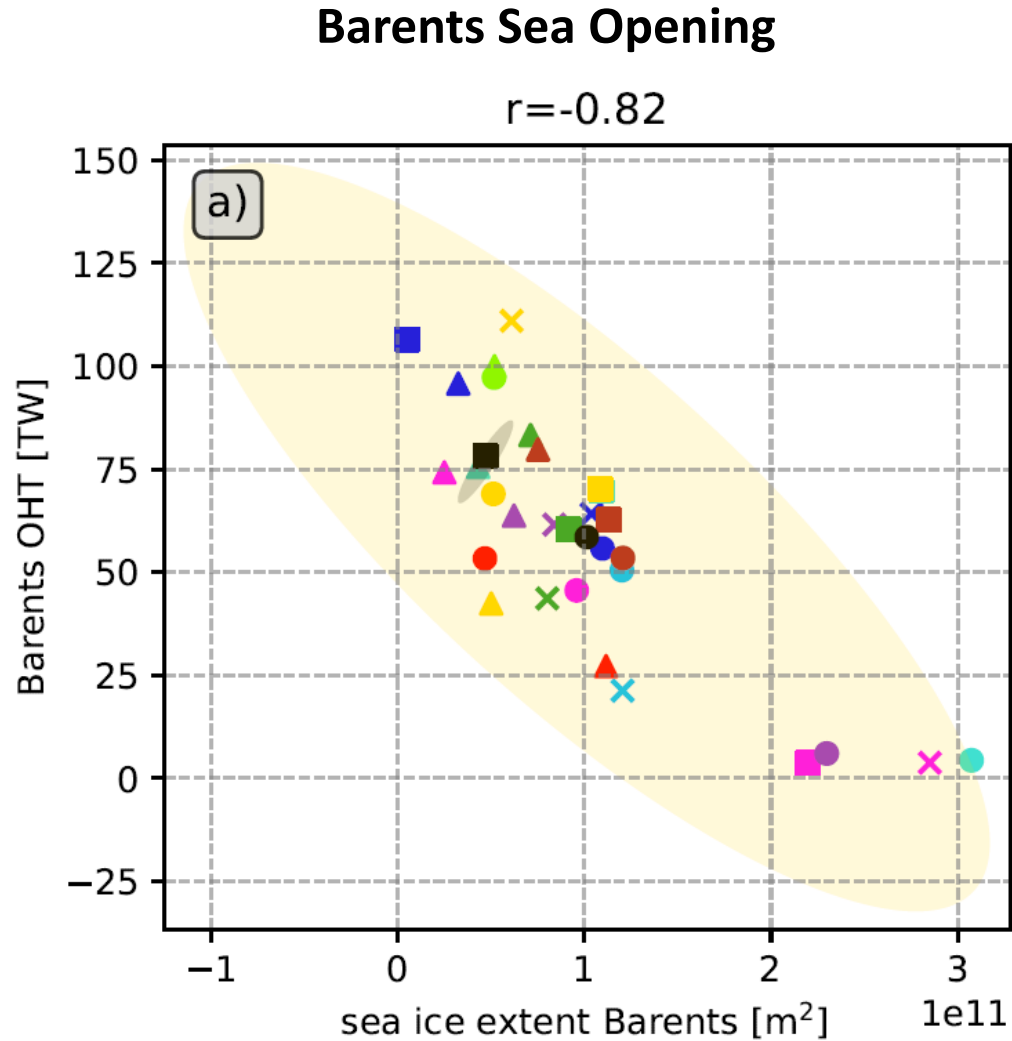
Impacts on state and change of the Arctic

- CMIP6 mean
- Reanalysis ensemble

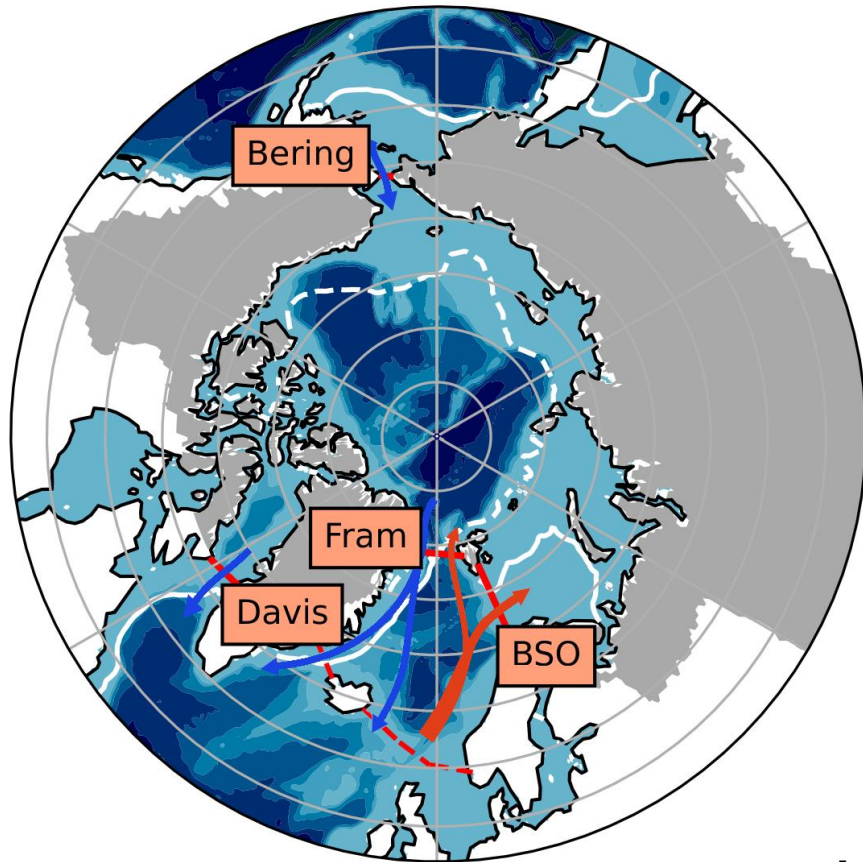


Impacts on state and change of the Arctic

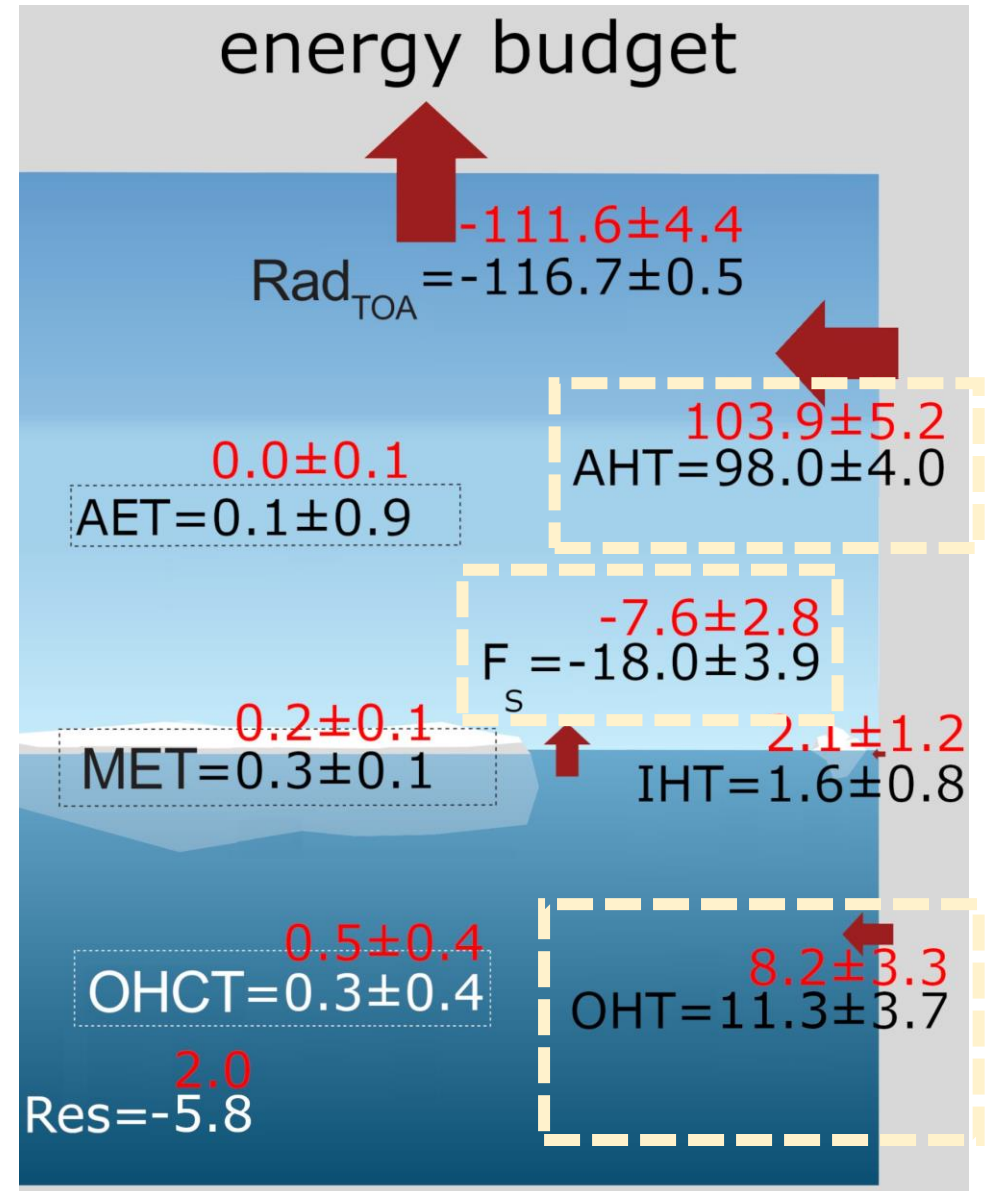
- CMIP6 mean
- Reanalysis ensemble



Mean Arctic Energy budget



black: reference
red: CMIP6



Key points and Outlook

- StraitFlux enables precise calculations of oceanic transports (<https://doi.org/10.5281/zenodo.10053555>)
- Coupled budgets in CMIP6 (Winkelbauer et al., in review):
 - Large spread in CMIP6 Multi-Model Ensemble
 - Systematic biases in major energy (e.g., OHT, Fs) and water budget components (not shown)
- Use results to generate physically based metrics to detect outliers from the model ensemble → reduce the spread of future projections of Arctic change
- Calculation of transports and other budget components for CMIP7
- Regional study between glacier retreat in east Greenland and atmospheric and oceanic transports