Impact of Runoff Forcing on Ocean Model Simulations in the Pan-Arctic Region

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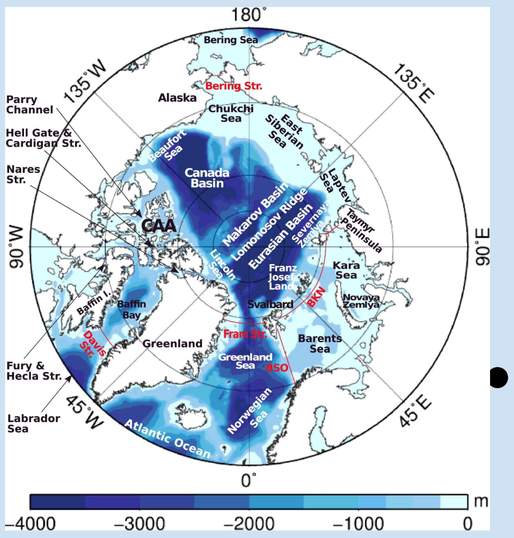
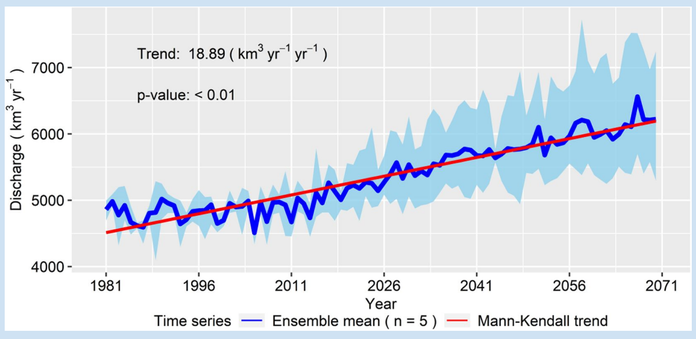
Background



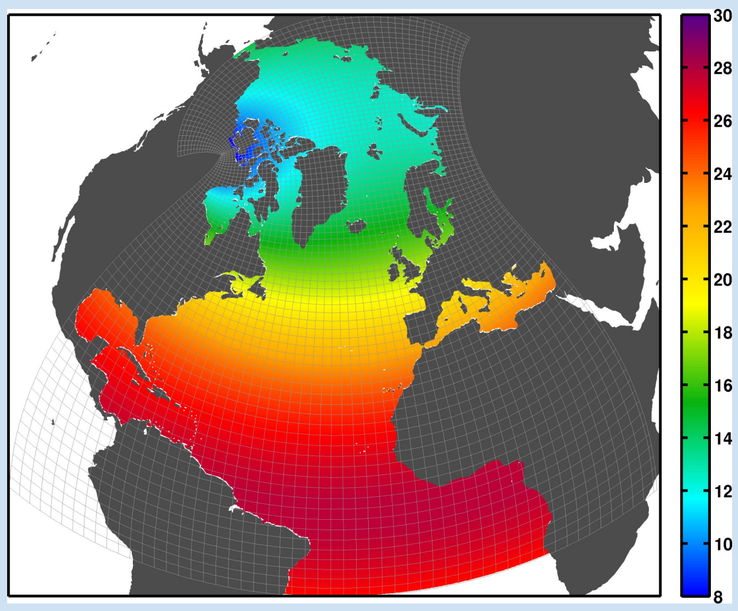
Map of the Arctic ocean with its topography, including major features and gateways labelled (Wang et al. 2016)

- Freshwater plays an important role in the Pan-Arctic region.
- With climate change, source of freshwater are expected to increase.
- Understanding the impact of freshwater sources is an important question to examine in ocean general circulation models.



Expected annual discharge in the Pan-Arctic watershed, which is expected to continue increasing (Stadnyk et al. 2021)

Model Configuration

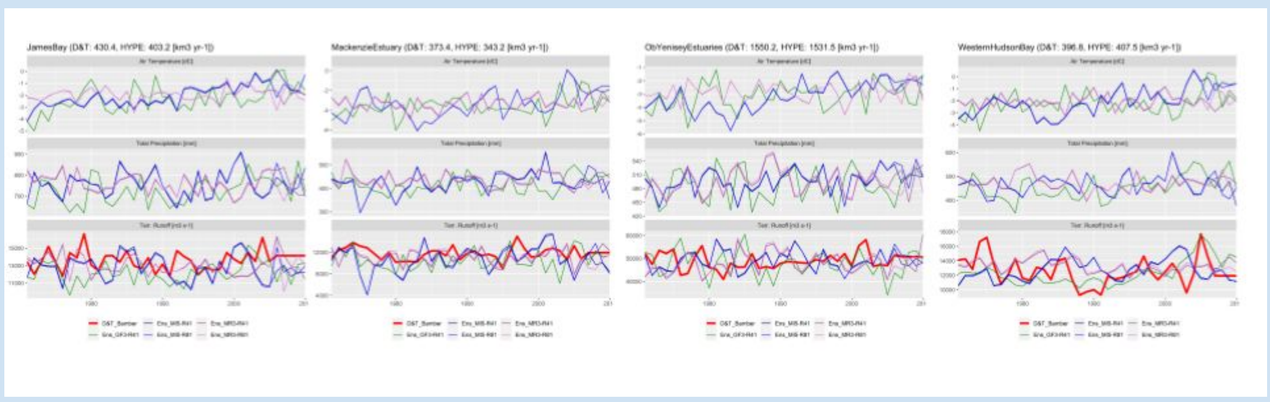


The ANHA4 domain, colours show model resolution in km (http://knossos.eas.ualberta.ca/anha/model_configuration.php#anha4)

- We used a ¼ degree resolution configuration of the NEMO ocean model, ANHA4 (Arctic and Northern Hemisphere Atlantic).
- We used two different atmospheric forcing datasets in order to separate out the effects of runoff inputs versus atmospheric forcing.
- The model was run from 2002 to 2019, with 5 day average output

Setup

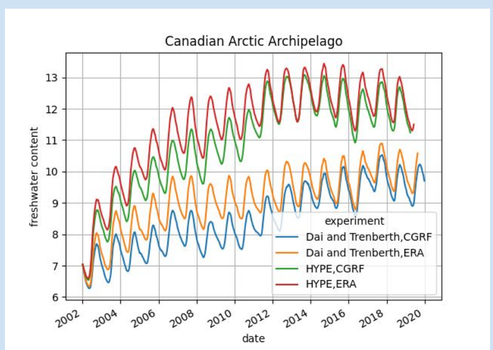
- River runoff is a major source of freshwater input into the Arctic ocean, yet traditionally runoff inputs based of climatological data from Dai and Trenberth have been used.
- This dataset has large limitations in the Arctic, and lacks recent runoff changes.
- Here we collaborate with the Hydrological Analysis Lab at the University of Calgary who have produced runoff scenarios for the Arctic Ocean using the Swedish Hydrological Predictions for the Environment (HYPE) hydrological model that now extend to the present day.
- The HYPE model is a semi-distributed catchment model, which simulates water flow through different storage areas to the ocean.

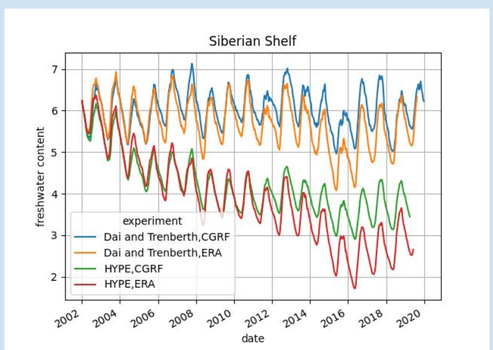


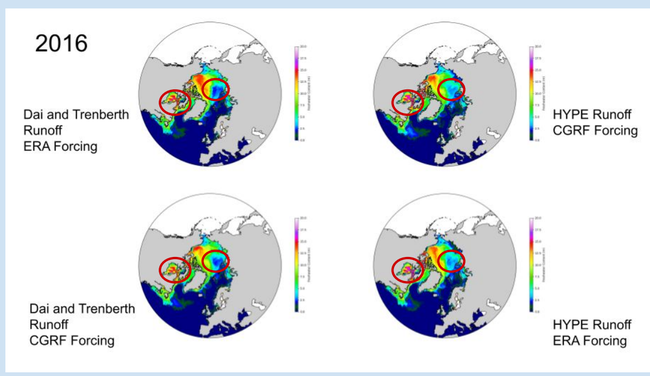
Shows the two runoff datasets, with the older Dai and Trenberth in red, and the ensemble members used for HYPE in the purple/blues. Compares the runoff for different, major sources in the Arctic. .

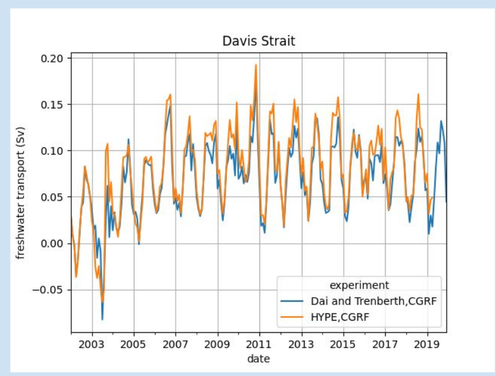
Preliminary Results

- We see large differences in freshwater content, both temporally and spatially.
- Some notable regions include the Canadian Arctic Archipelago, and the Siberian shelf region, where there are very clear differences between runoff forcing
- There are also differences in the freshwater export through the Labrador current, and into lower latitudes









Top row: Plots of the freshwater content in the Canadian Arctic Archipelago, and Siberian shelf, where large differences can be seen between the models using difference runoff forcing
Bottom left: Spatial variation of the freshwater content between model runs
Bottom right: Freshwater transport out of Davis strait. In the model runs with the new runoff, we can see increased freshwater transport

References:
Wang, Qiang et al. (2016a). “An assessment of the Arctic Ocean in a suite of1239 interannual CORE-II simulations. Part I. Sea ice and solid fresh, Stadnyk, Tricia A., et al. "Changing freshwater contributions to the Arctic: A 90-year trend analysis (1981–2070)." *Elem Sci Anth* 9.1 (2021): 00098. Aiguo Dai et al. “Changes in continental freshwater discharge from 1948 to 2004". In: Journal of climate 22.10 (2009), pp. 2773{2792. G□oran Lindstr□om et al. “Development and testing of the HYPE (Hydrological Predictions for the Environment) water quality model for different spatial scales". In: Hydrology research 41.3-4 (2010), pp. 295{319.