Labrador Sea freshening linked to Beaufort Gyre freshwater release

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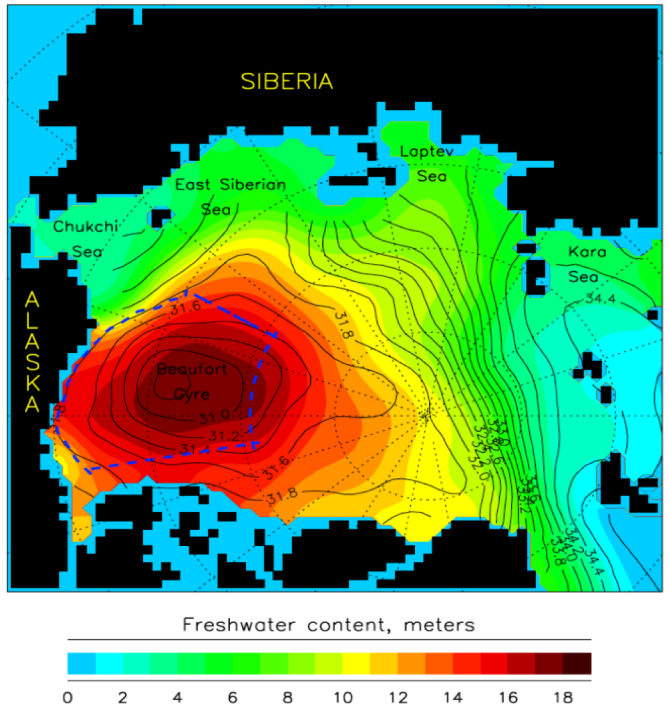
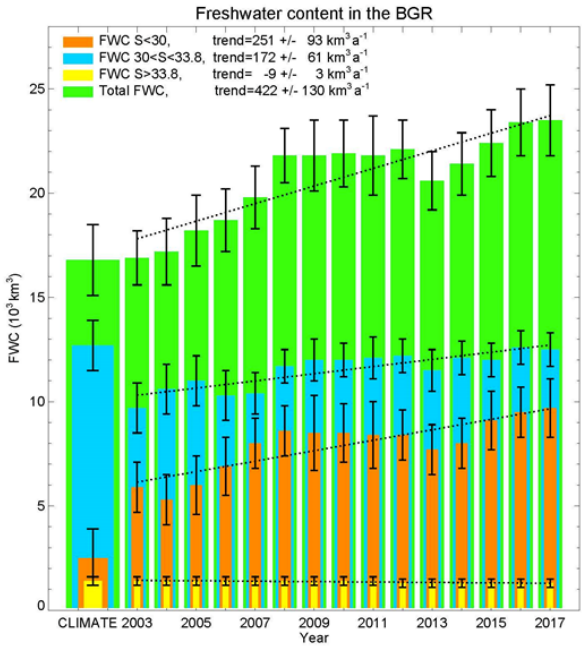
Unprecedented increase of Beaufort Gyre freshwater

Arctic Freshwater Content



(Proshutinsky et al., 2009)

Time series of BG FWC (10^3 km^3)



(Proshutinsky et al., 2020)

- By 2017, BG freshwater is 40% above its climatology
- Persistent anticyclonic wind + more available freshwater (sea ice melt, river runoff, Pacific Water inflow)
- If released, the excess freshwater would be transported to the subpolar North Atlantic and freshen its upper ocean salinity → the Atlantic Meridional Overturning Circulation (AMOC).

Focus and Tool

Existing studies

1) The sources of the BG freshwater, not much on its fate after it leaves the BG
2) The overall pan-Arctic freshwater budget, not the specific role of the BG region

Objective

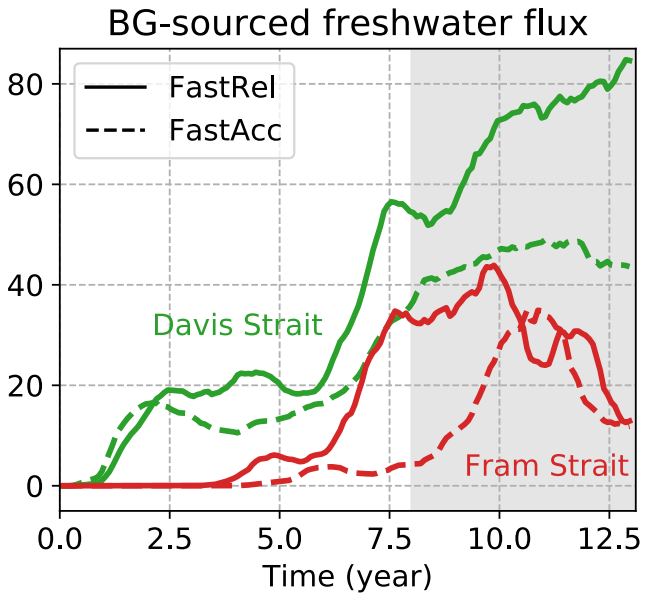
To explore the fate of the BG freshwater after it is released and to quantify its downstream impact on the subpolar North Atlantic salinity

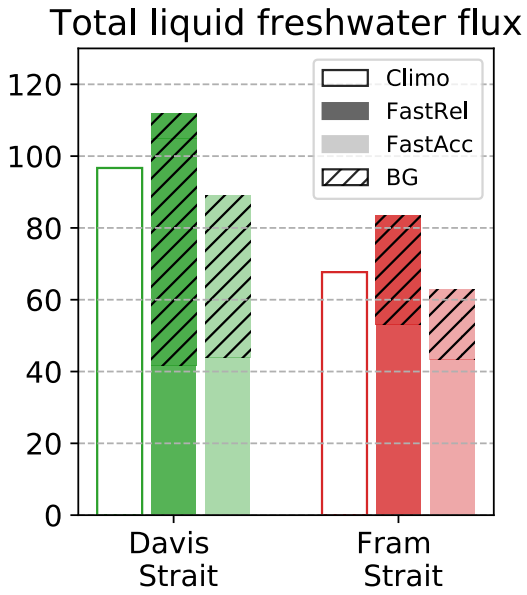
Tool

An ocean-sea ice hindcast simulation of 1948-2009

- DOE HiLAT03, global at 0.3° resolution
- New tracer diagnosis

Finding 1: Transport Route





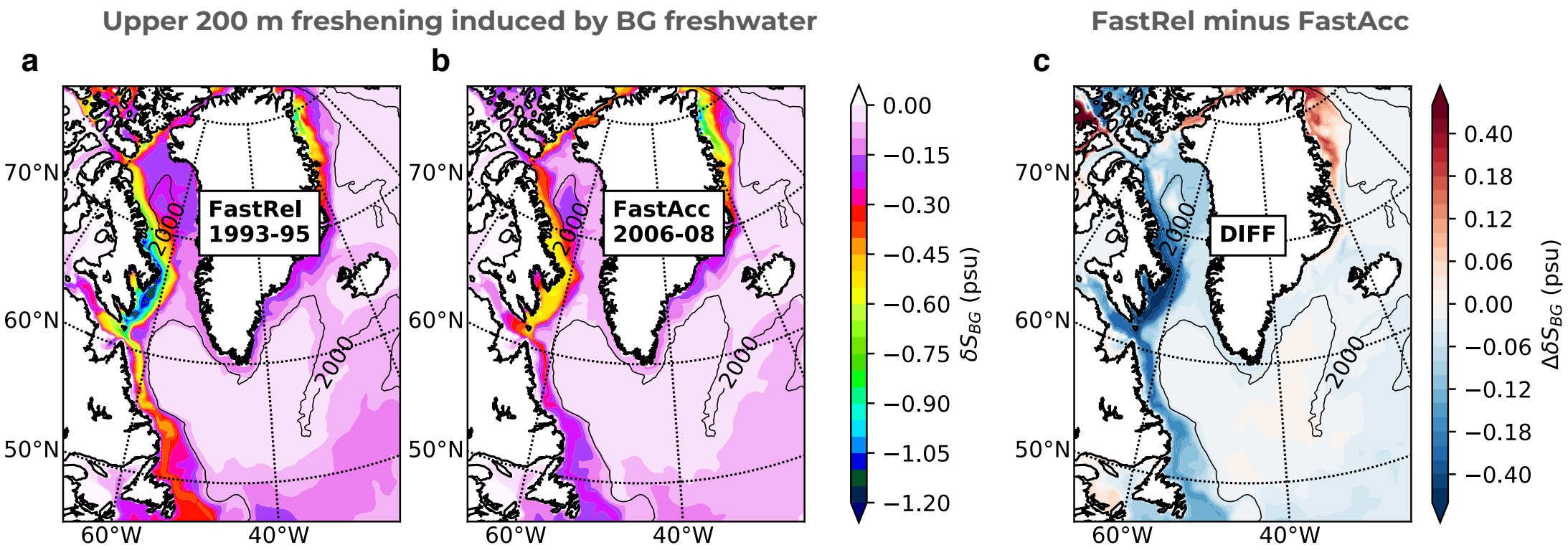
01 **Route**

The CAA and the downstream Davis Strait, rather than Fram Strait, are the main pathways through which BG freshwater exits the Arctic Ocean into the North Atlantic Ocean.

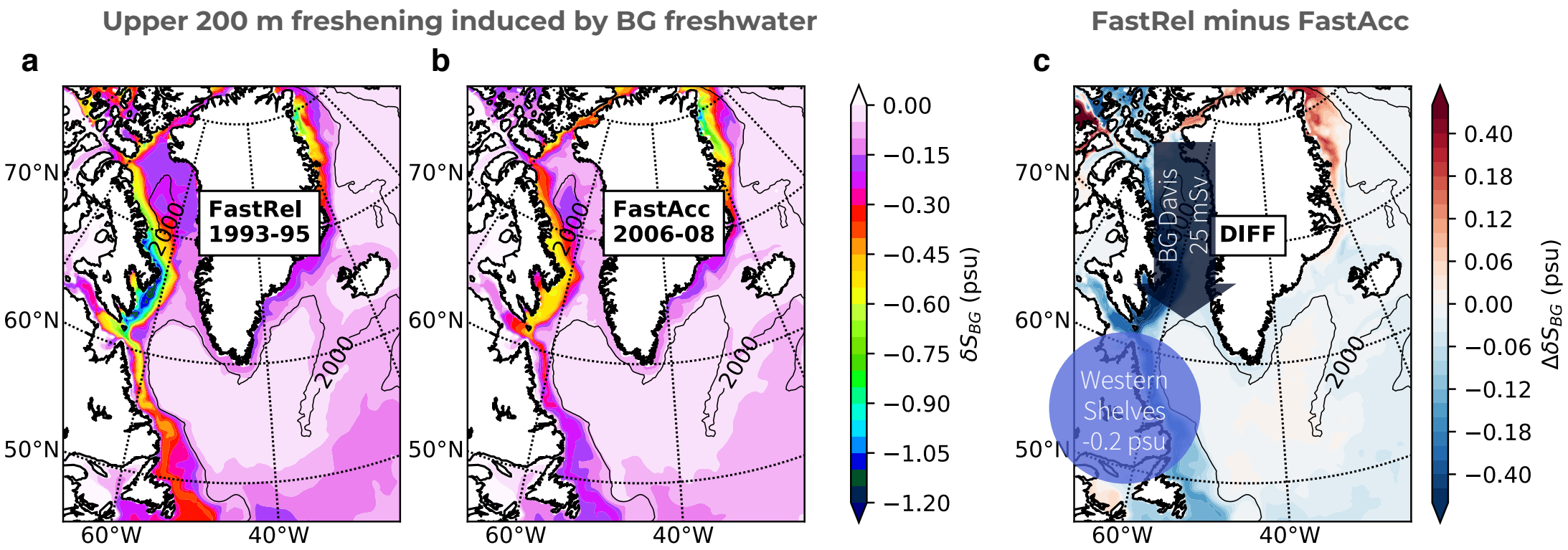
02 **Decomposition**

The increased Davis Strait freshwater transport is dominated by water from the BG region as compared to other regions of the Arctic.

Finding 2: Labrador Sea Freshening



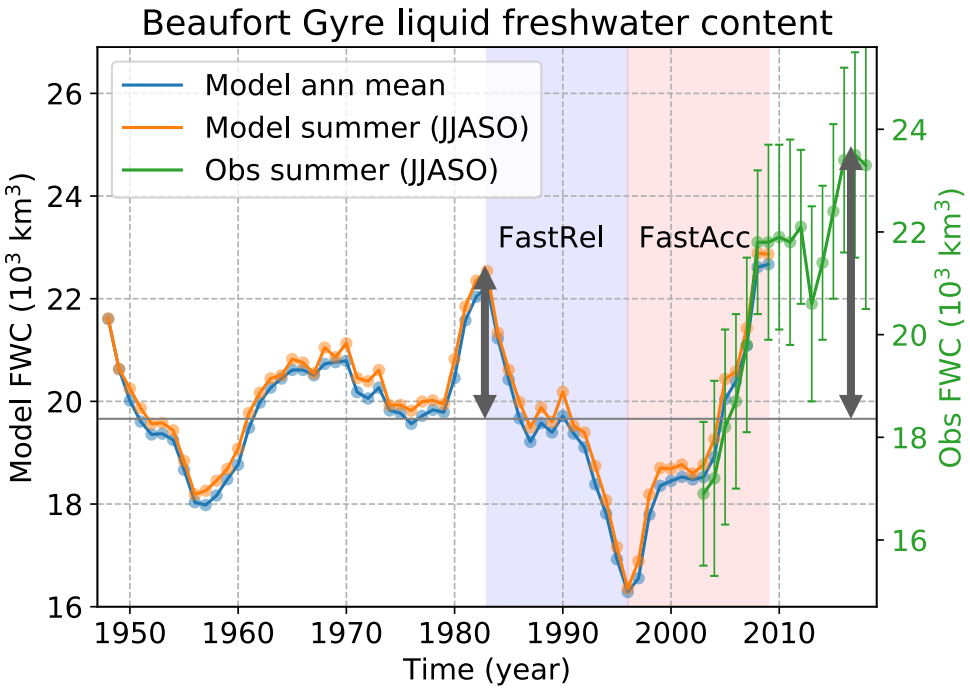
Finding 2: Labrador Sea Freshening



Finding 3: Comparable to Greenland meltwater

FW type	FWF anomaly	FW amount	SSS anomalies	Study
BG freshwater	O(25 mSv)	5,600 km3	-0.2 (western)	This study
Greenland meltwater	16.4 mSv	7,500 km3	-0.1 (interior)	Böning et al. (2016)
	9 mSv	⊗	-0.32 (interior)	Luo et al. (2016)

Summary



Objective

To explore the fate of the BG freshwater after it is released and to quantify its downstream impact on the subpolar North Atlantic salinity

Findings

1) BG freshwater exited the Arctic mostly through the Canadian Arctic Archipelago, rather than Fram Strait, during an historical release event.
2) The Labrador Sea is the most affected region in the subpolar North Atlantic, with a freshening of 0.2 psu on the western shelves and 0.4 psu in the Labrador Current.
3) Labrador Sea surface salinity anomalies induced by BG fluxes and Greenland ice melt are of comparable magnitudes.

Implications

- Potential impact on the AMOC
- The impact of a future rapid release on Labrador Sea salinity could be significant, easily exceeding similar fluxes from Greenland meltwater.