Supplementary Materials for

A continuous pathway for fresh water along the East Greenland shelf

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Figs. S1 and S2
1. Hydrographic section at the mouth of Kangerdlugssuaq Trough (OC395)

[Image: Figure S1. Observed hydrography at the mouth of the Kangerdlugssuaq Trough. Salinity (a) and absolute geostrophic velocity (b) from the XCTD section across the mouth of Kangerdlugssuaq Trough in 2003 (red section in Fig. 1b). The viewer is looking northward (the western side of the trough is on the left). Isopycnals are overlaid in black (kg/m$^3$). The XCTD stations (black triangles) and their numbers are provided for reference. Positive velocities in b indicate flow out of the trough and the white contour in b marks the 34 isohaline. Bathymetry is shaded gray.]

2. Coherence of along-section winds and onshore flow of fresh water

The onshore transport variability across section 3 in the numerical model (Fig. 4) is found to be largely a function of variability in the along-section winds (60% variance explained). To arrive at this conclusion, we first calculated the Ekman transport using the following equation:
\[ \text{Ekman transport (Sv)} = \frac{1}{\rho_0 f} \int \tau \, dl \]

where \( \rho_0 \) is reference density (1025 kg/m\(^3\)), \( f \) is the Coriolis parameter (1.34*10\(^{-4}\) 1/s), \( \tau \) is the along-section surface stress induced by wind and ice (N/m\(^2\)). The integration is done spatially along the section (denoted by \( l \)). To compare this theoretical transport induced by the surface stress (wind + ice), we also sum the model’s velocity field over the Ekman layer (upper 40 m) and along the section to derive a directly-calculated, cross-section transport.

From these two time series we calculated how much variance in the calculated flow is explained by the theoretical flow using the following equation:

\[
\text{Variance of } X \text{ explained by } Y (\%) = 100 \times \left[ 1 - \left( \frac{\sigma^2(X - Y)}{\sigma^2(X)} \right) \right]
\]

where \( X \) is the cross-section flow calculated from the model’s velocity field, \( Y \) is the theoretical Ekman transport from the along-section winds, and \( \sigma^2 \) is the variance of the time series. This metric summarizes both the temporal correlation and the magnitude of the covariance in the two time series.

3. **Geostrophic onshore flow upstream of Denmark Strait**

To determine what drives the full-depth onshore flow across section 3, we decomposed the total model velocity into its geostrophic and ageostrophic components. To calculate the geostrophic velocity, we vertically integrated the density and sea-surface height (SSH) fields from the model to determine the pressure field using the hydrostatic balance. The along-section horizontal pressure gradient was then incorporated into the geostrophic equation to calculate the model’s across-section geostrophic velocity.

The ageostrophic velocity was then defined as the difference between the total velocity and the geostrophic velocity (Fig. S2). The Ekman circulation is apparent in the ageostrophic field, with onshore flow in the upper 40 m and offshore at depth. When integrated over the entire section, the ageostrophic velocity induces a net offshore flow of 0.29 Sv, opposing the onshore flow in the total. The geostrophic velocity compensates with a flow of 1.17 Sv directed onto the shelf. This geostrophic flow is driven by a wind-driven SSH gradient (Fig. S2a) that results from denser water at the southern end of the section at Dohrn Bank (left-hand side of Fig. S2) than at the northern end at the Kögur line (right-hand side of Fig. S2).
Figure S2. Decomposition of the modeled velocity field between Dohrn Bank and the Kögur section. The viewer is looking west with the southern end of the section to the left and the northern end of the section to the right. (a) The model mean SSH is higher on the northern end than on the southern end. (b) Total velocity (color) with positive flow directed out of the page (i.e. offshore). (c) Geostrophic velocity calculated from the SSH, pressure, and density fields. (d) Ageostrophic velocity calculated as the difference between the total velocity and the geostrophic velocity. Isopycnals (black; kg/m³) are identical in the three panels.