Supplemental Material

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Freshwater Input and Vertical Mixing in the Canada Basin's Seasonal Halocline: 1975 versus 2006–12
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Supplemental Material for "Freshwater input and vertical mixing in the Canada Basin's seasonal halocline: 1975 versus 2006-2012"

1. Isolating $\Delta\Phi$ and ΔD

Here we provide the algabraic derivation of the equations 20-21, using the definitions provided in Section 3a. First, the mixed-layer freshening ($\mathbb{S}$):

$$\begin{aligned}
\delta S_{surf,ITP} &= \frac{\Phi_{ITP}}{D_{ITP}} \\
&= \frac{\Phi_{AJX}+\Delta\Phi}{D_{AJX}+\Delta D} \\
&= \delta S_{surf,AJX}\left(\frac{1+\Delta\Phi/\Phi_{AJX}}{1+\Delta D/D_{AJX}}\right) \\
&= \delta S_{surf,AJX}(1+\Delta\Phi/\Phi_{AJX})(1-\Delta D/D_{ITP}) \\
&= \delta S_{surf,AJX}+\frac{\Phi_{AJX}}{D_{AJX}}\left(\frac{\Delta\Phi}{\Phi_{AJX}}-\frac{\Delta D}{D_{ITP}}-\frac{\Delta\Phi\Delta D}{\Phi_{AJX}D_{ITP}}\right) \\
\Delta(\delta S_{surf}) &= \frac{\Delta\Phi}{D_{AJX}}-\frac{\Phi_{AJX}\Delta D}{D_{AJX}D_{ITP}}-\frac{\Delta\Phi\Delta D}{D_{AJX}D_{ITP}}.
\end{aligned}$$

Second, the stratification (S_z):

$$\begin{aligned}
S_{z,ITP} &= \frac{\Phi_{ITP}}{D_{ITP}^2} \\
&= \frac{\Phi_{AJX}+\Delta\Phi}{(D_{AJX}+\Delta D)^2} \\
&= S_{z,AJX}\left(\frac{1+\Delta\Phi/\Phi_{AJX}}{(1+\Delta D/D_{AJX})^2}\right) \\
&= S_{z,AJX}(1+\Delta\Phi/\Phi_{AJX})(1-\Delta D/D_{ITP})^2 \\
&= S_{z,AJX}\left(1-\frac{2\Delta D}{D_{ITP}}+\left(\frac{\Delta D}{D_{ITP}}\right)^2+\frac{\Delta\Phi}{\Phi_{AJX}}+\frac{\Delta\Phi\Delta D}{\Phi_{AJX}D_{ITP}}\left(\frac{\Delta D}{D_{ITP}}-2\right)\right) \\
&= S_{z,AJX}+\frac{\Delta\Phi}{D_{AJX}^2}+\frac{\Phi_{AJX}\Delta D}{D_{AJX}^2D_{ITP}}\left(\frac{\Delta D}{D_{ITP}}-2\right)+\frac{\Delta\Phi\Delta D}{D_{AJX}^2D_{ITP}}\left(\frac{\Delta D}{D_{ITP}}-2\right) \\
\Delta S_z &= \frac{\Delta\Phi}{D_{AJX}^2}-\Phi_{AJX}\Delta D\left(\frac{D_{ITP}+D_{AJX}}{D_{AJX}^2D_{ITP}^2}\right)-\Delta\Phi\Delta D\left(\frac{D_{ITP}+D_{AJX}}{D_{AJX}^2D_{ITP}^2}\right)
\end{aligned}$$

2. Uncertainties in Φ

Here we roughly estimate uncertainties in Φ due to a lack of near-surface measurements. First, we consider the thin, fresh surface layer that can emerge in during the summer months. Proshutinsky et al. (2009) estimated that this bias causes the freshwater content (referenced to 34.8 psu) to be underestimated by 0.15-0.20m in the top 8m of the ITPs during June-August. If we consider the ITP-average $S_0 = 27.78$ g/kg, this bias would correspond to an underestimate of 5.22-6.96 m·g/kg in Φ (multiply 0.15-0.20 m by 34.8).

References

Proshutinsky, A., and Coauthors, 2009: Beaufort Gyre freshwater reservoir: State and variability from observations. *Journal of Geophysical Research*, **114**, C00A10, doi:10.1029/2008JC005104, URL http://doi.wiley.com/10.1029/2008JC005104.

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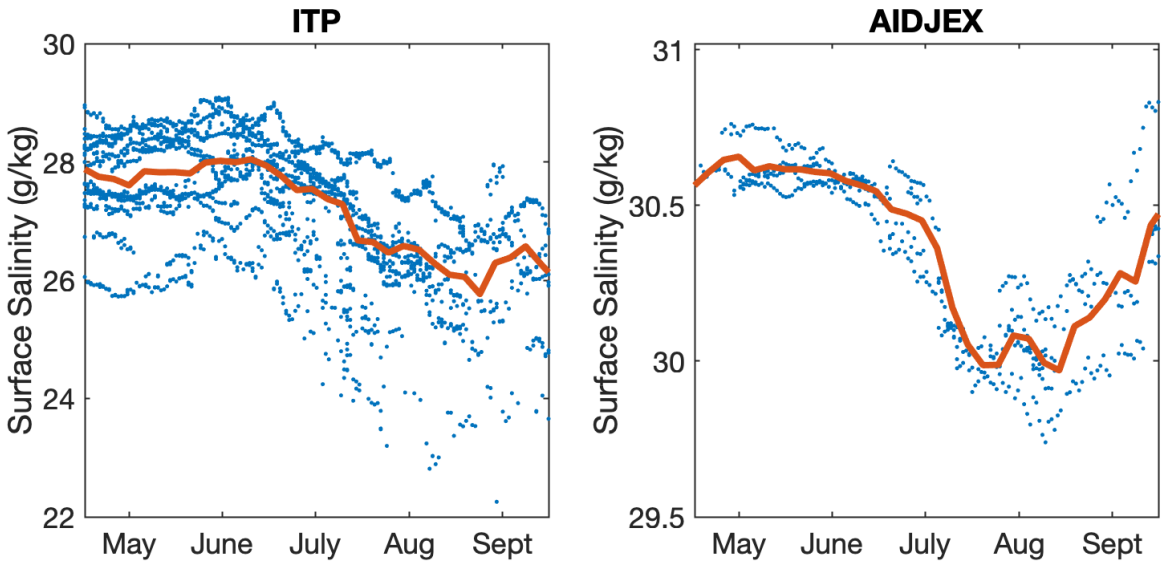

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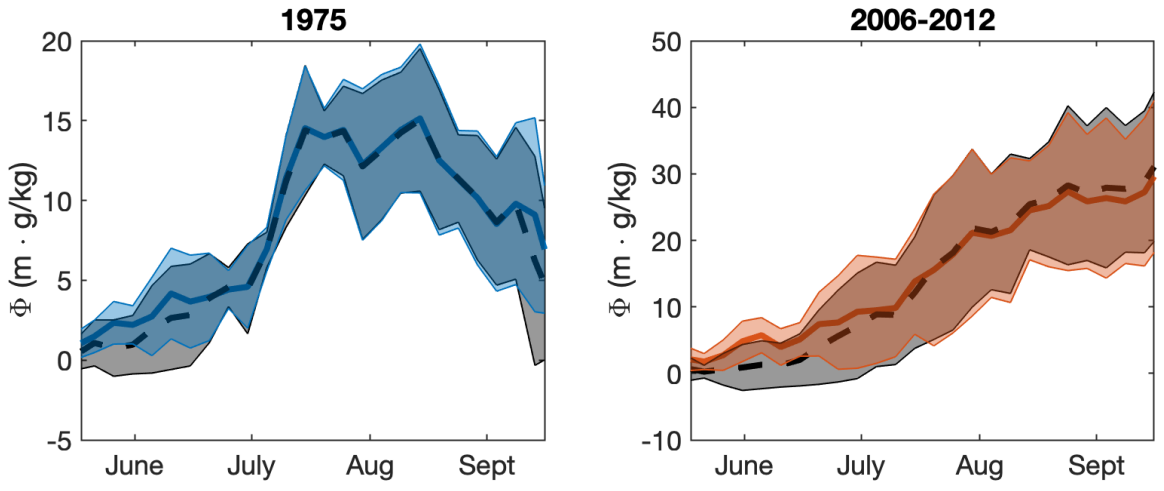

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