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## 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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1 Supplemental Material for “Freshwater input and vertical mixing in the Canada Basin’s  
 2 seasonal halocline: 1975 versus 2006-2012”

3 **1. Isolating  $\Delta\Phi$  and  $\Delta D$**

4 Here we provide the algebraic derivation of the equations 20-21, using the definitions provided  
 5 in Section 3a. First, the mixed-layer freshening ( $S$ ):

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

6 Second, the stratification ( $S_z$ ):

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

## 7 **2. Uncertainties in $\Phi$**

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

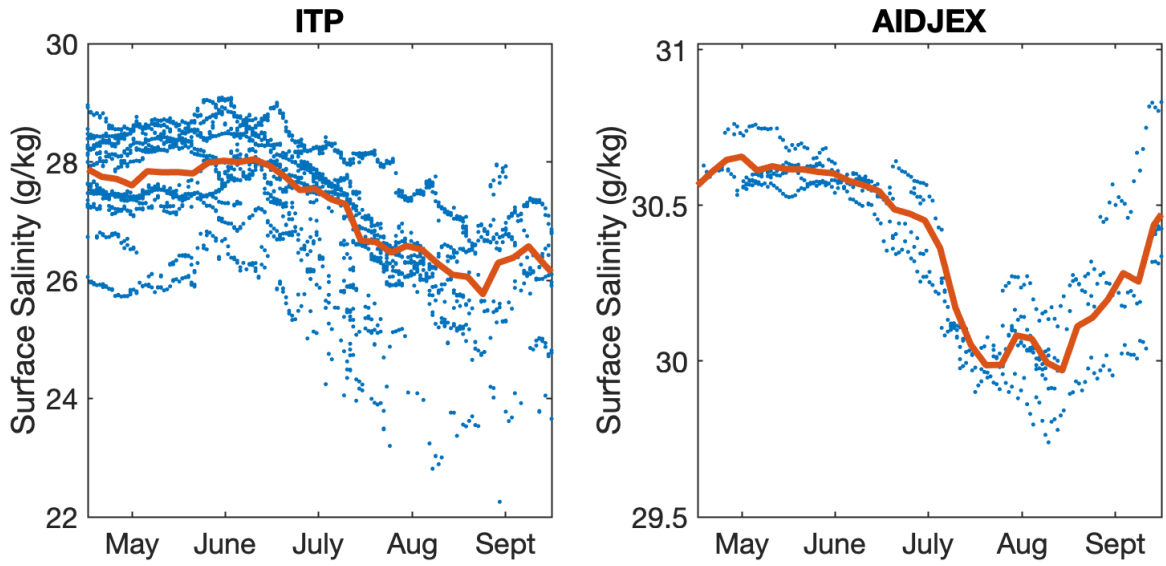
<sup>14</sup> **References**

<sup>15</sup> Proshutinsky, A., and Coauthors, 2009: Beaufort Gyre freshwater reservoir: State and vari-  
<sup>16</sup> ability from observations. *Journal of Geophysical Research*, **114**, C00A10, doi:10.1029/  
<sup>17</sup> 2008JC005104, URL <http://doi.wiley.com/10.1029/2008JC005104>.

18 **LIST OF FIGURES**

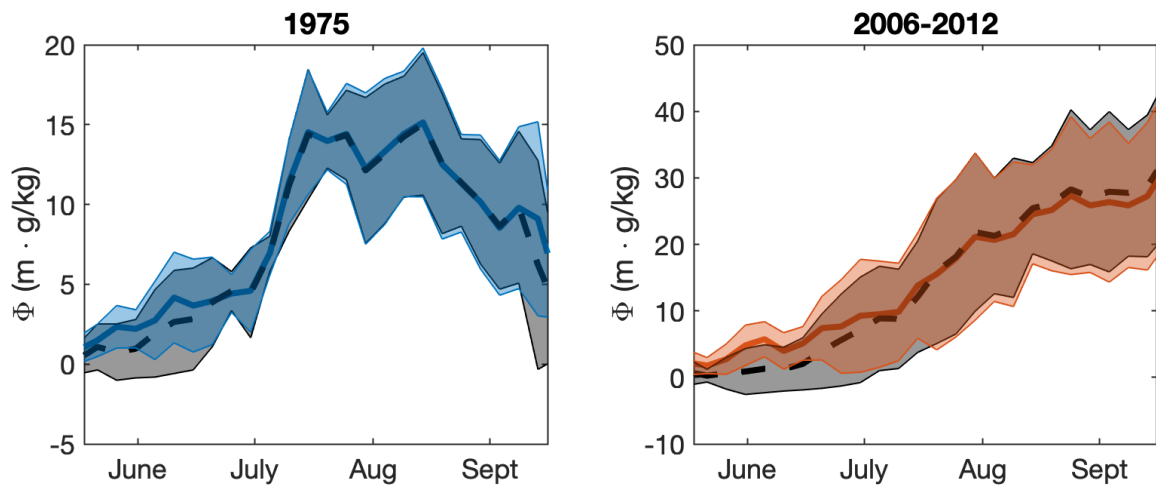
19 **Fig. S1.** Surface salinity evolution using (left) ITP and (right) AIDJEX data. Each dot indicates one  
20 profile. Red lines indicate 5-day averages. . . . . 5

21 **Fig. S2.** Salt deficit ( $\Phi$ ) using two different methods for computing  $S_0$  with (left) AIDJEX and (right)  
22 ITP data. Blue and red lines indicate results setting  $S_0$  to the average-May surface salinity for  
23 the same ITP or AIDJEX ice camp during the same year (as in the main text). Black dashed  
24 lines indicate results from setting  $S_0$  to the average surface salinity during May 16-22 (the  
25 earliest 7-day period with all AIDJEX ice camps collecting data). Solid lines indicate 5-day  
26 averages and shading indicates one standard deviation. . . . . 6



27 Fig. S1. Surface salinity evolution using (left) ITP and (right) AIDJEX data. Each dot indicates one profile.

28 Red lines indicate 5-day averages.



29 Fig. S2. Salt deficit ( $\Phi$ ) using two different methods for computing  $S_0$  with (left) AIDJEX and (right) ITP  
 30 data. Blue and red lines indicate results setting  $S_0$  to the average-May surface salinity for the same ITP or  
 31 AIDJEX ice camp during the same year (as in the main text). Black dashed lines indicate results from setting  $S_0$   
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 33 data). Solid lines indicate 5-day averages and shading indicates one standard deviation.