

Breakout Session #1

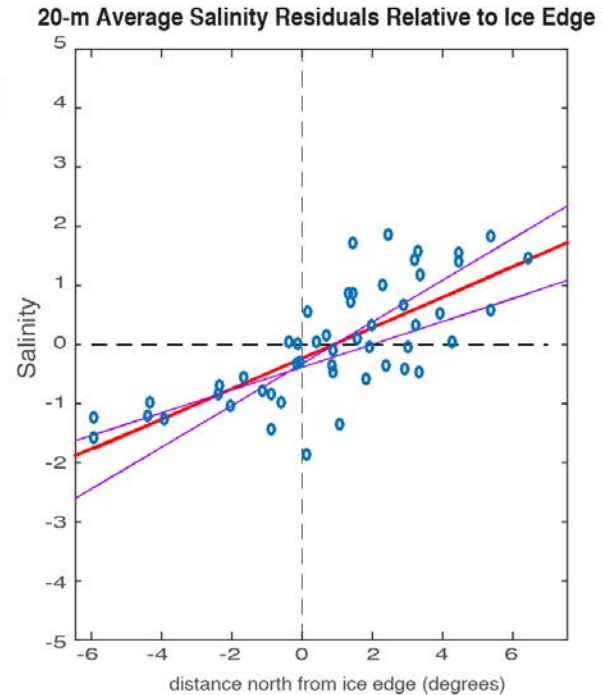
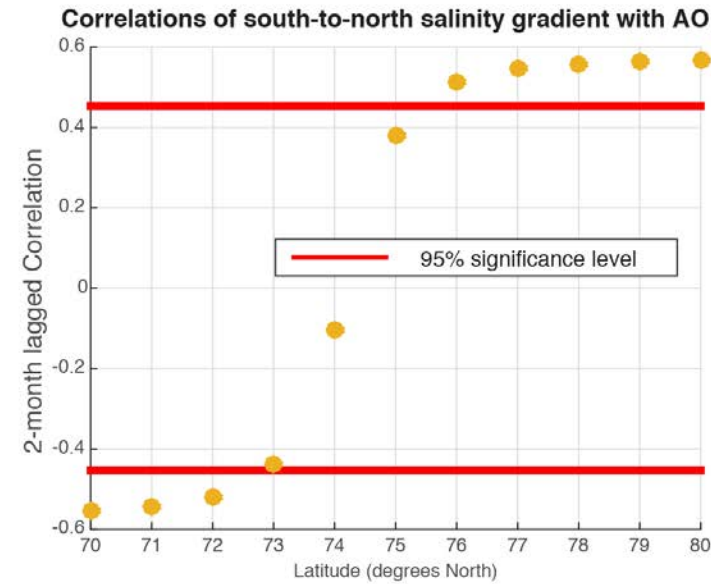
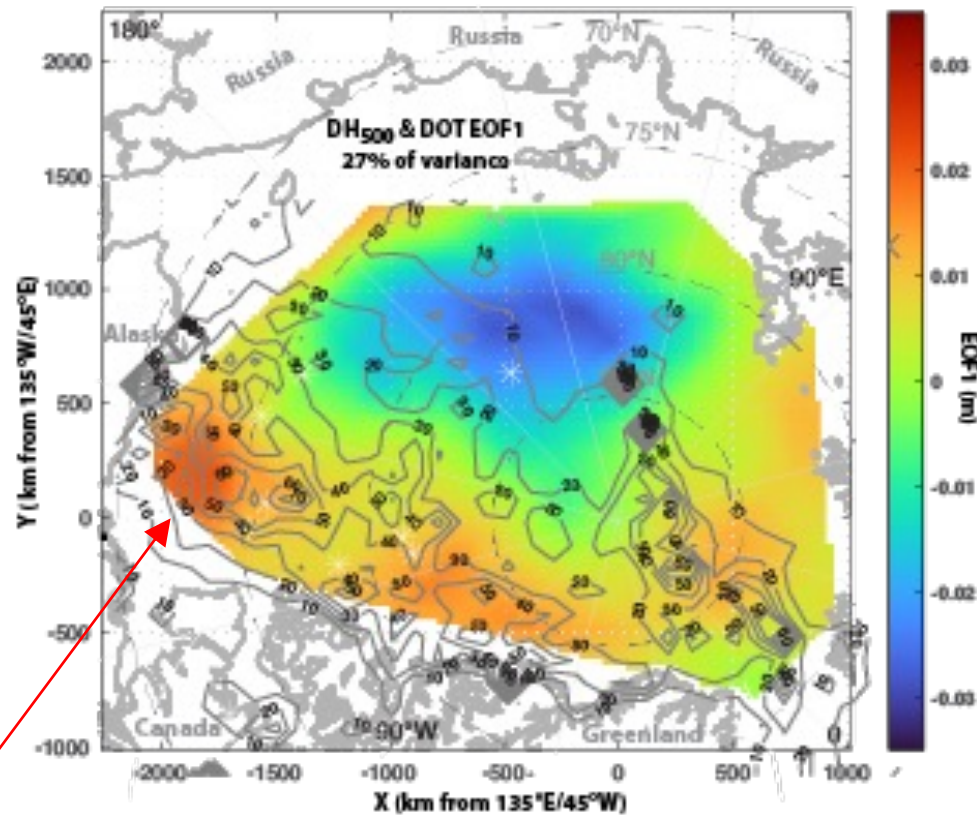
Surface circulation

Discussed 6/27/22

- “Local vs External Forcing of Arctic Ocean Circulation” of the Arctic Ocean morphed into agreement that Arctic Ocean circulation has 2 components
 - 1) an estuary or fjord component driven inherently by the height difference between the relatively fresh Pacific (river) relatively the salty Atlantic (ocean) that generally underlies
 - 2) the Arctic Ocean and Sub-Arctic Seas wind-driven circulation that has in addition to other characteristics, anticyclonic and cyclonic modes of circulation.

How are these coupled / interact?

- Cyclonic vs Anticyclonic surface circulation: two sides of the same coin following the paradigm of Sokolov (1962), but a key realization is that the cyclonic mode can act to increase the intensity (i.e., dh/dr) of the Beaufort Gyre

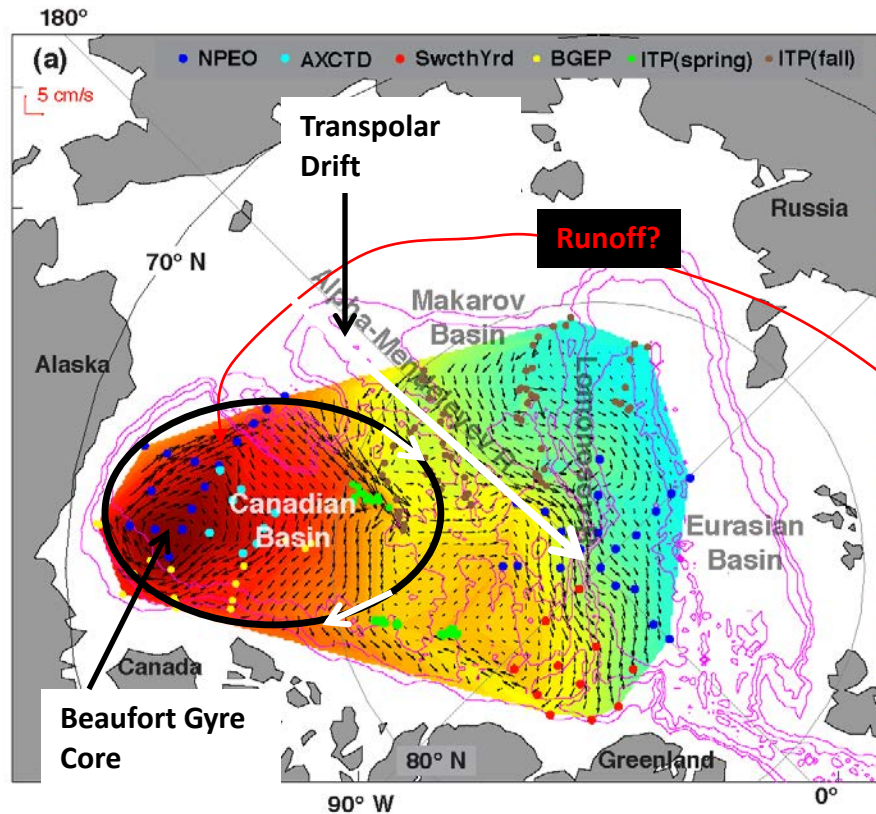


In trying to separate the ice-edge linked salinity signature in the SIZ from doming in the Beaufort Gyre, we find the degree of doming expressed as salinity gradient is positively correlated at 2-month lag with the AO

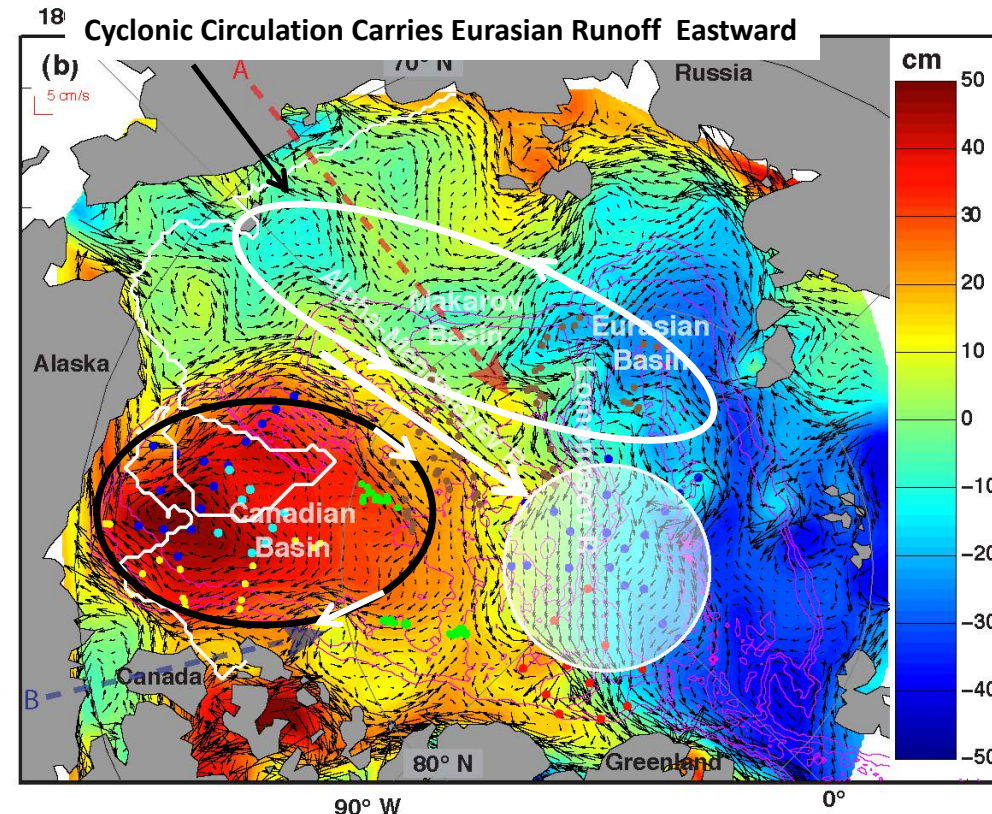
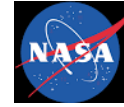
- Better yet ☺ the EOF1 is such that intensity of the BG increases under the Cyclonic even if BG size decreases.

Expanding our View to See the Whole Arctic Ocean After 2007 AO Increase

Spring 2008 dynamic height and surface geostrophic current relative to 500 dbar from available hydrographic profiles only show the Beaufort Gyre and Transpolar Drift



ICESat dynamic ocean topography (DOT) and surface geostrophic current reveal DOT trough and cyclonic circulation on the Russian side of the Arctic Ocean invisible to in situ obs.



- Agreement between dynamic height and DOT ($r = 0.92$) => mostly baroclinic

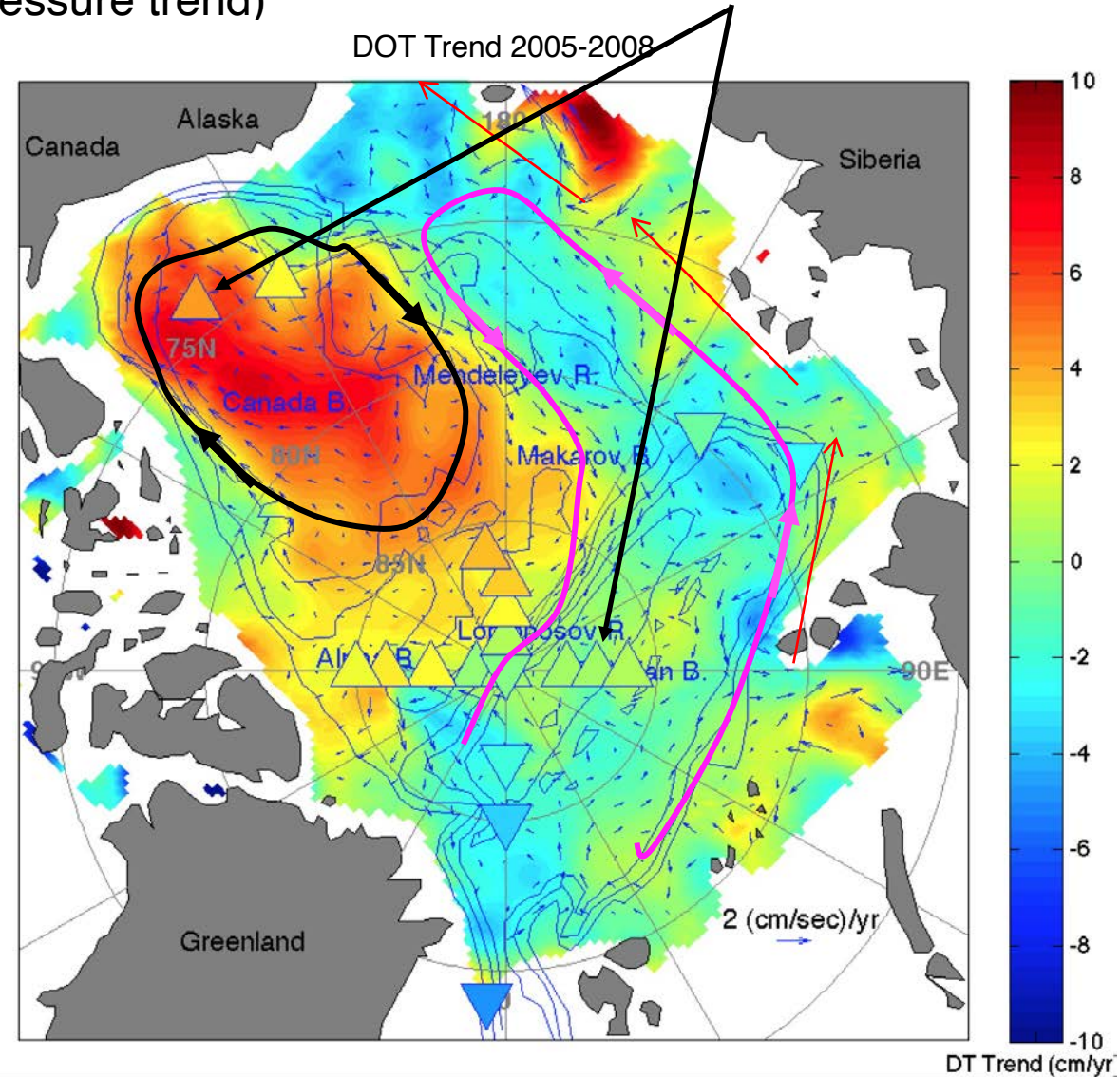
Kwok, R., and J. Morison (2011), Dynamic topography of the ice-covered Arctic Ocean from ICESat, *Geophysical Research Letters*, 38(L02501), L02501.

DOT Trend 2005-08 From ICESat Altimetry And From GRACE Bottom Pressure - CTD Steric Pressure (triangles) (DH trend adjusted for bottom pressure trend)

Color contours of DOT and velocity trends 2005-2008 => shift to cyclonic mode. Beaufort Gyre tightens becomes more intense with an increase in freshwater.

Developing DOT trough aligned with the Russian shelf break produces cyclonic circulation.

Which carries more Eurasian runoff eastward to enter Beaufort Gyre.

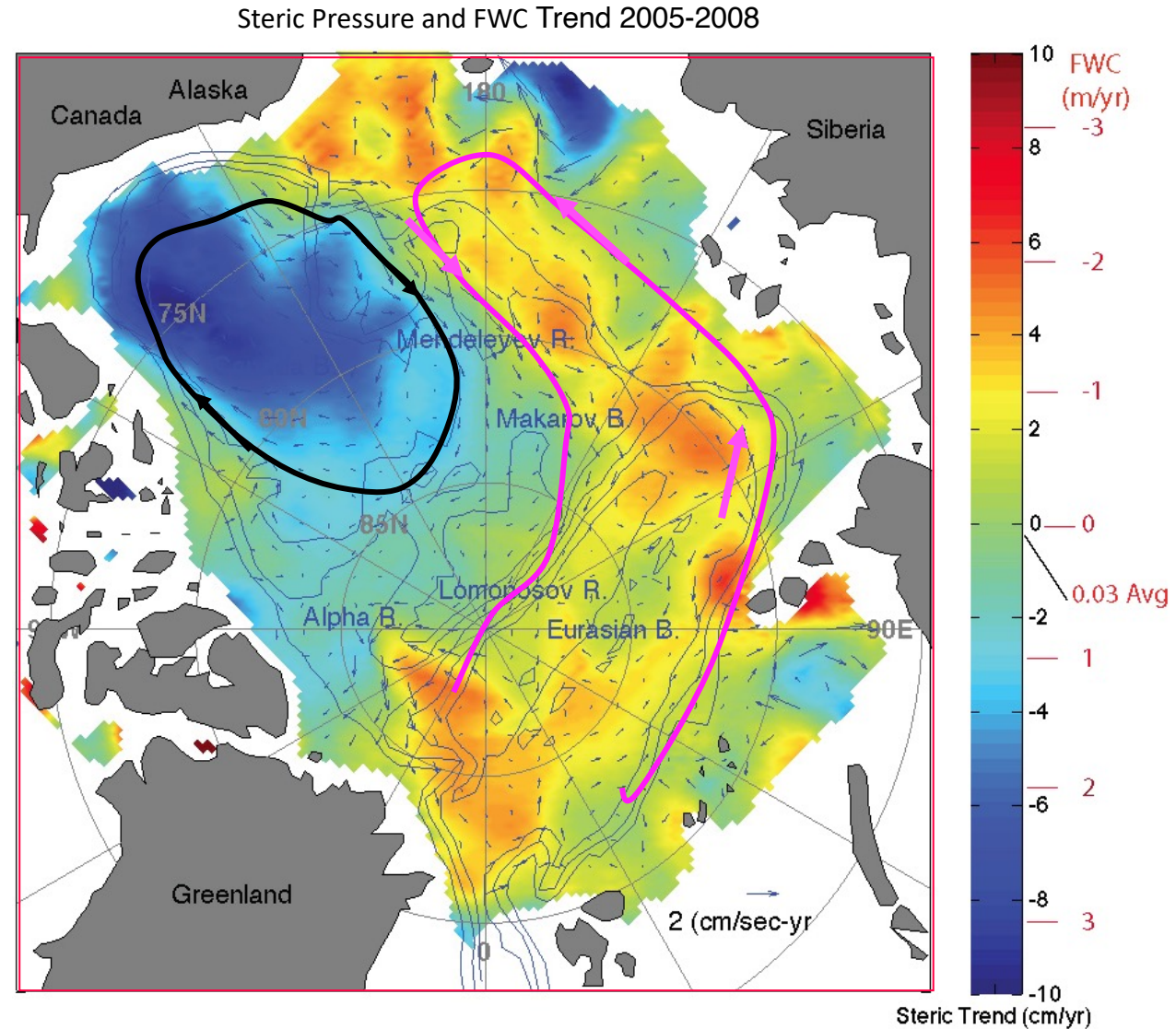


Morison, J., R. Kwok, C. Peralta-Ferriz, M. Alkire, I. Rigor, R. Andersen, and M. Steele (2012), Changing Arctic Ocean freshwater pathways, *Nature*, 481(7379), 66-70.

Steric Pressure ~ Freshwater Trend 2005-08 ~ -36 x (GRACE Bottom Pressure - ICESat DOT)

FWC increase in the Beaufort Sea is balanced by decreases almost everywhere else.

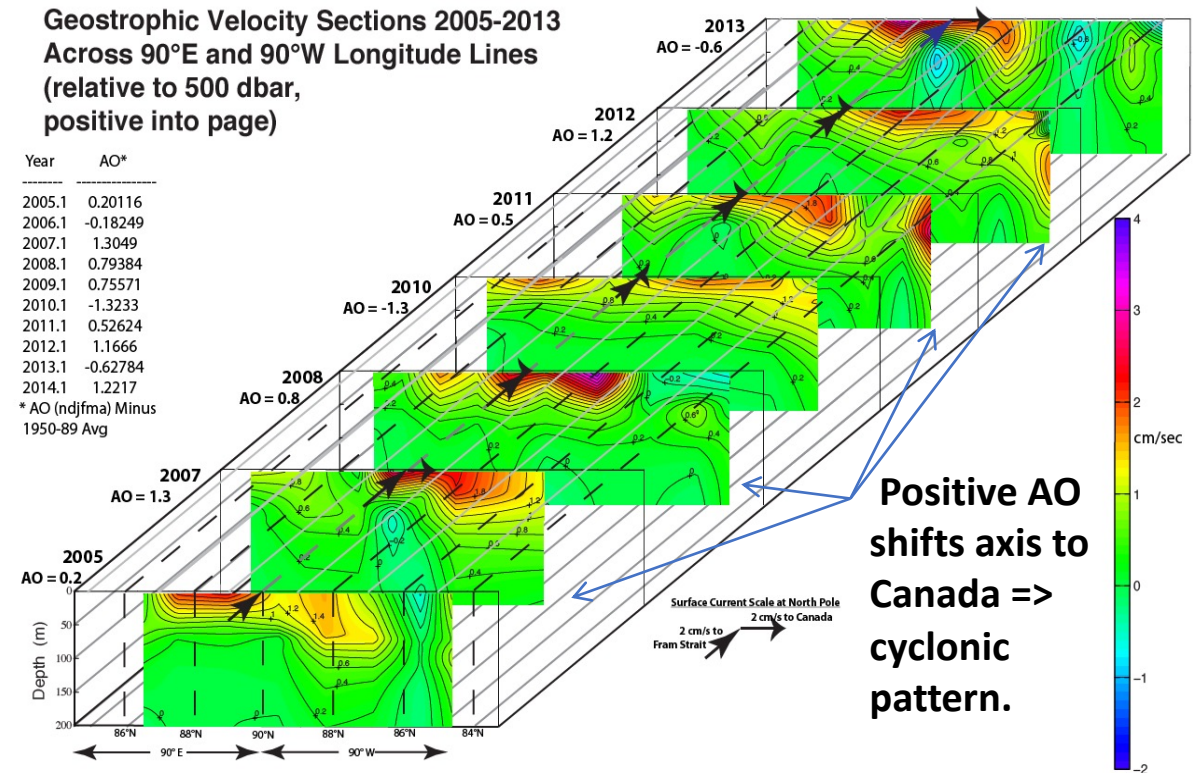
Average change in FWC in deep basin (> 500m) inferred from GRACE OBP and ICESat DOT is small, (0.18 m yr^{-1}) compared to the inter-basin changes due to a shift in freshwater trajectory but similar to *Rabe et al.* [2011] (0.18 m yr^{-1}) and to reduction in average resident sea ice mass (0.17 m yr^{-1}).



[Morison, J., R. Kwok, C. Peralta-Ferriz, M. Alkire, I. Rigor, R. Andersen, and M. Steele (2012), Changing Arctic Ocean freshwater pathways, *Nature*, 481(7379), 66-70.

- Transpolar Drift, how to define it and how it varies and mixing: Transpolar Drift is largely determined by its geostrophic velocity parallel Transpolar Front between Pacific and Atlantic-derived upper ocean waters as observed in hydrographic cross-sections or zero-vorticity geostrophic surface velocity.

- Key question is how water properties are exchange across the Transpolar Front/Drift?
Must be ageostrophic processes?



Hydrographic sections along 90°W and 90°E cross the front that defines the Transpolar Drift. Thus, they tell us the position, velocity and transport properties of the dominant current of the Arctic Ocean, an indicator of circulation change.

- Modes of variability in sea ice: temporal change? Revisit Rigor et al. (2002) for earlier and more recent periods.
- Effect of “episodicity” of temporal and heterogeneity of spatial scales of forcing and how they effect longer term variability. For example, forcing by storms or mean wind. Surface forcing by a discontinuous ice cover with buoyancy flux in narrow leads and surface stress over individual flows. How do we aggregate events and “mosaic” these to make grid cell forcing versus time?



"Mr. Osborne, may I be excused?
My brain is full."