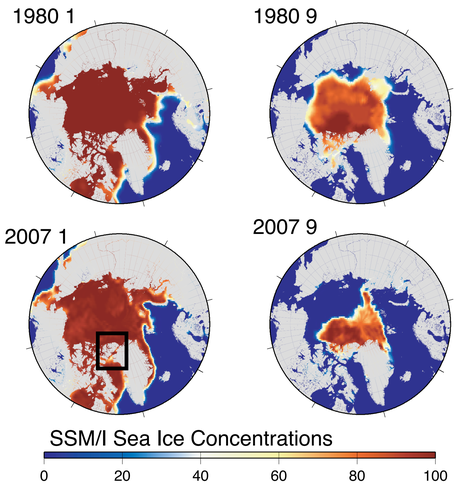
Coastal Circulation and Dynamics of Straits and Fjords of North Greenland

The Arctic Ocean is a rotating large estuary that discharges freshwater into the North-Atlantic Ocean. It transitions from a fully to a partially ice covered estuary at seasonal and interannual time scales. Summer ice cover may disappear within 5 years.

Coastal physics dominate.



Polar bear near Nares Strait mooring line as seen from aboard CCGS Henry Larsen on Aug.-12, 2012. [Credit: Kirk McNeil, Labrador]

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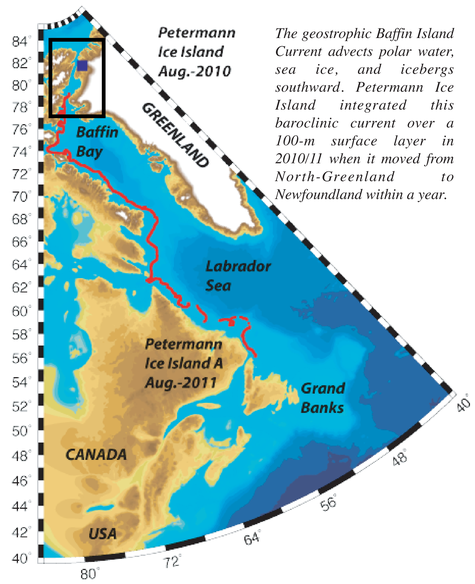
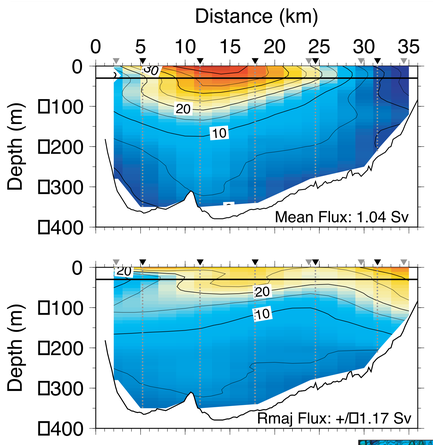


The geostrophic Baffin Island Current advects polar water, sea ice, and icebergs southward. Petermann Ice Island integrated this baroclinic current over a 100-m surface layer in 2010/11 when it moved from North-Greenland to Newfoundland within a year.

Nares Strait Ocean Moorings 2003-09

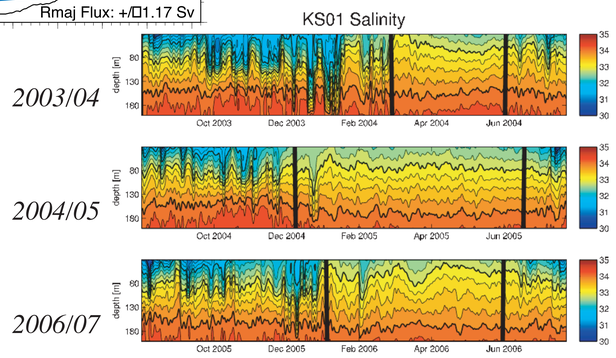
1. Mean Volume Flux 1.0 Sv (20% in top 30-m)
2. Strong Vertical Shear top 150-m



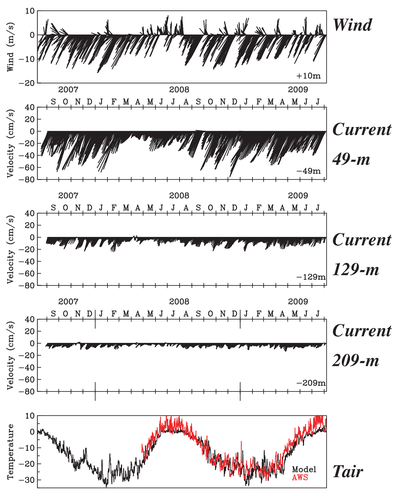
Mean Flow

Record mean flow (top) and variability (bottom) View is to the north with Greenland on the right and Canada on the left. Black and grey symbols indicate indicate mooring locations for 2007-09 and 2003-06 periods of observations, respectively. Flow above 30 meters is estimated via Ekman layer function fitting.

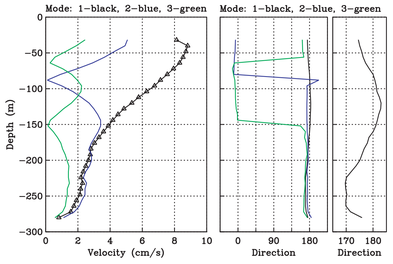
Salinity Variability:



Land-Fast Ice



Complex EOF



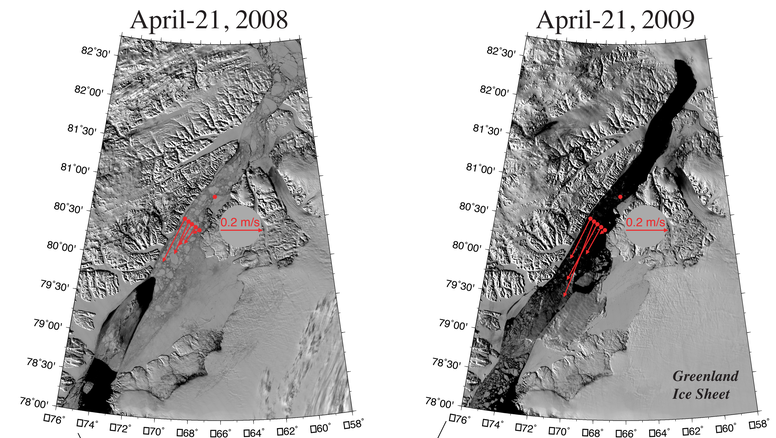
The first three complex (vector) empirical orthogonal functions for the 2003-06 period explaining 68%, 20%, and 5% of the total variance. Amplitudes are scaled such that the standard deviations of the temporal structure functions (not shown) are 1.

ACKNOWLEDGMENTS: The National Science Foundation, Government Canada, and the University of Delaware funded the work. Canadian and US Coast Guards gave enthusiastic and professional support.

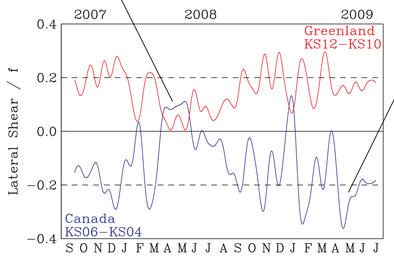
COLLABORATORS: Kelly Falkner, Helen Fricker, Helen Johnson, Humfrey Melling, Laurie Padman, Roger Samelson, Berit Rabe, Patricia Ryan.

Nares Strait Dynamics: 2003-2009

1. Along-channel Flow Almost Geostrophic
2. Along-channel Dynamics Almost Linear

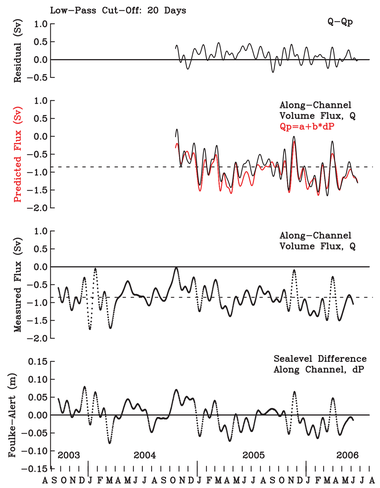


Nares Strait with southern (2008) and northern (2009) ice arch with low-pass filtered upper-layer (40-90 m) velocity profile (above).

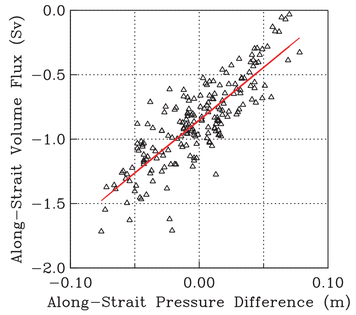


Relative Vorticity

Time series of lateral shear of along-strait velocity gives estimate of relative vorticity. (left).



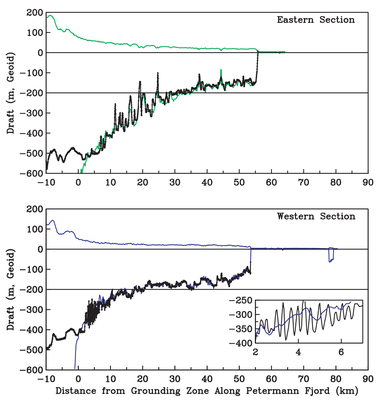
Regression of along-channel pressure difference with volume flux. The regression is derived from the 2003/04 data and applied to the 2005/06 data. The fit explains 70% of the flux variance.



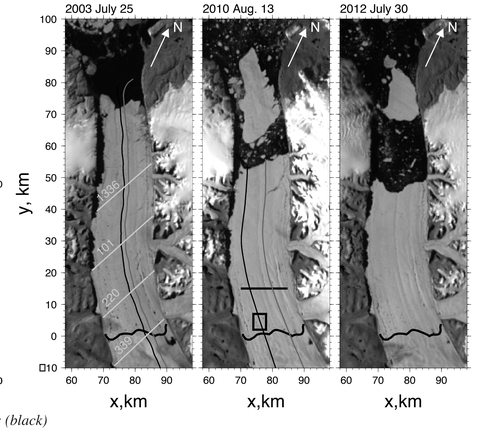
Predicting Flux via Along-Channel Pressure Gradient

Petermann Gletscher 2003-2012

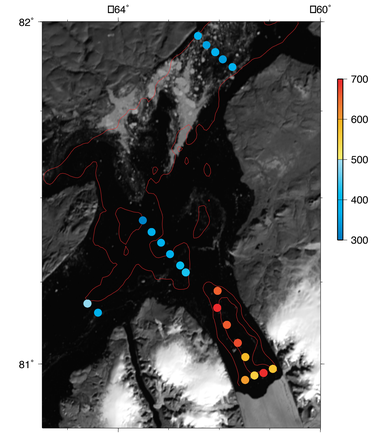
1. Glacier Retreat: Released 18 Gt of ice in both 2010 and 2012
2. Deep Ocean Warming causes Glacier Thinning



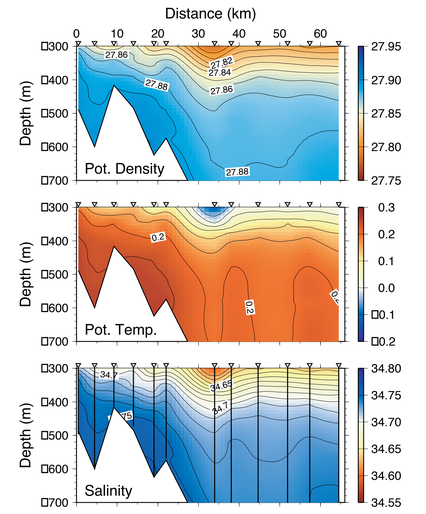
Ice shelf profile of Petermann Gletscher from NASA radar (black) and NASA's laser altimeter (blue, green) for May-7, 2011. Inset shows basal crevasses of 100 m vertical excursion embedded in 350 m thick floating ice. Colored lines are surface elevation and draft of a hydrostatically floating ice shelf.



Petermann Gletscher from MODIS Terra with NASA radar and laser flight tracks. White line are ICESat tracks. Thick black line across the glacier near y = 0 km is the grounding line.

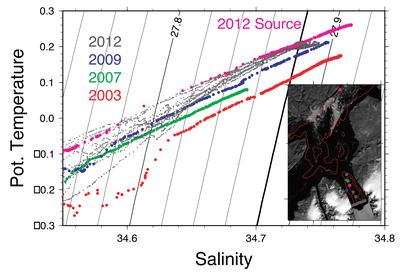


Depth of 27.88 kg/m^3 isopycnal on Aug. 9/10, 2012 in Nares Strait over 500-m and 1000-m isobath (above).



CTD data below 300-m along a section into Petermann Fjord shows the sill and plunging of warm, salty Atlantic waters into the fjord (right). Station gap near km-30 indicates position of the 180-m deep drafted ice island. (above).

The deep Atlantic waters inside the fjord have warmed along isopycnals from 2003-2012 (below).



Ice elevations from ICESat track 220. Dashed lines indicate significant linear trend (95%) of 0.33 +/-0.26 m/year, i.e., ice thickness reduces by 3.1 m/year. (below)