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IPY's Lancaster Sound mooring, regression analysis and numerical modeling

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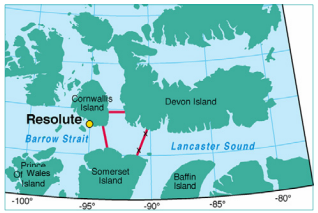
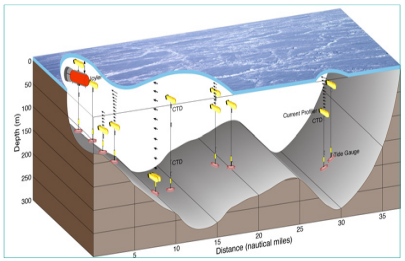
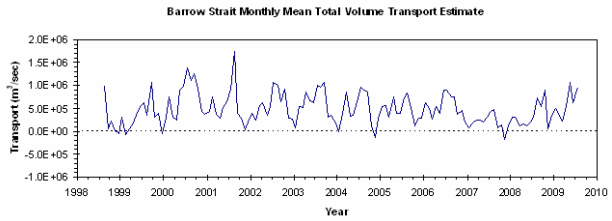
The IPY mooring and modeling effort of the Canadian Archipelago Through-Flow Study (CATS) for Lancaster Sound extended the mooring time series 3 years, so processed data now extend from August 1998 to August 2009. The mooring array has been reduced in complexity, and now consists of two sites along the southern shore of eastern Barrow Strait where the Arctic Surface Water outflow is concentrated. The figures below show the location of the mooring array site within the Canadian Archipelago, the instrumentation of mooring array, and estimated volume fluxes that have been processed to date. The third figure shows the large interannual variability of the volume flux passing through eastern Barrow Strait and Lancaster Sound.



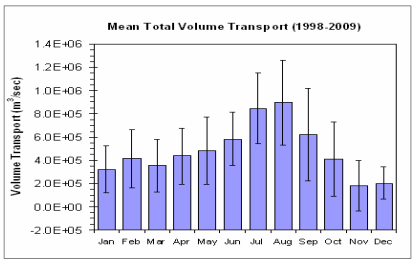
Map of Canadian Arctic Archipelago showing the mooring transect (with crosses) and the Salinity-Temperature transects (red lines).



Instrumentation of mooring array in eastern Barrow Strait from south (left) to north (right).

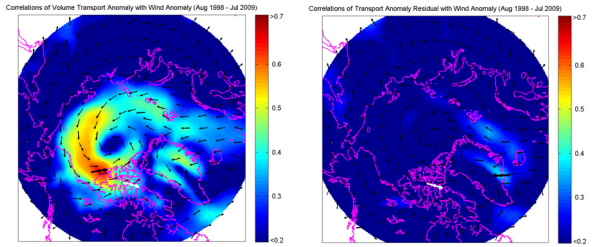


Monthly mean volume transport through Barrow Strait, estimated from processed mooring data.

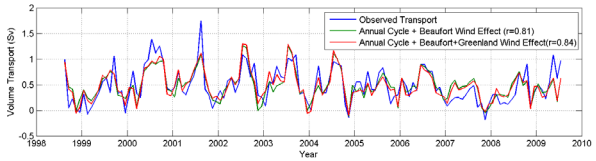


Annual cycle of volume transport through Barrow Strait based on 1998-2009 observation period.

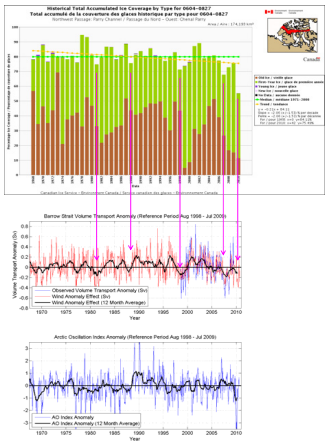
A regression analysis of the monthly transport anomaly through Lancaster Sound with NCEP/NCAR Reanalysis wind anomalies (55-90°N) shows that the transport anomaly is significantly correlated with far-field wind forcing in the Beaufort Sea. Northeastward wind anomalies in the Beaufort Sea, parallel to the western side of the Canadian Arctic Archipelago, show the highest correlation with the monthly volume transport anomaly, explaining 42% of the variance. Northwestward wind anomalies east of Greenland have a weaker effect, explaining an additional 8% of the variance.
The response to winds in the Beaufort Sea represents transport being driven by the sea level difference between opposite ends of the NW Passage, and the sea level difference being determined mainly by the setup caused by alongshore winds in the Beaufort Sea. Northwestward winds east of Greenland would help define the large-scale cyclonic wind and ice drift anomalies, which would increase the setup along Arctic coastlines over a long distance, and increase transport through the Northwest Passage.



Correlations of transport anomaly with wind anomaly: maximum r = 0.65 ($p<0.01$) at 75°N 127.5°W (left) and correlations of residual with wind anomaly: maximum r = 0.37 ($p<0.05$) at 67.5°N, 35.0°W (right).

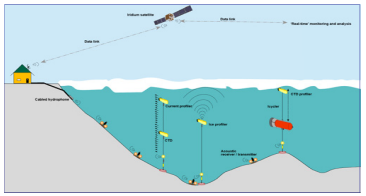


Volume transport estimated from mooring observations, and simulated transport from regression model based on surface wind.



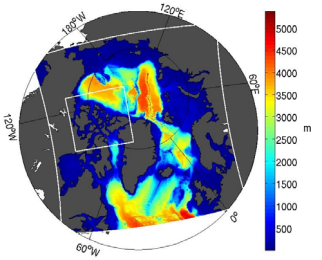
Regular observations of sea-ice area in the NW Passage by the Canadian Ice Service extend back to the late 1960's. The volume transport anomaly in the NW Passage over the same period can be estimated from the regression model and the NCEP/NCAR R1 wind dataset, which extends back to 1948. The summer sea-ice area shows a similar interannual pattern to that of the volume transport anomaly, as well as a long-term decreasing trend. The correlation coefficient of the monthly Arctic Oscillation Index anomaly (bottom panel) with the observed volume transport anomaly (1998-2009) is 0.15.

The mooring is strategically located where nearly all marine shipping in the NW Passage passes by. This area has been the main focus of the Department of National Defence to monitor ship traffic through the NW Passage, and continue with a renewed effort under their Northern Watch program to address national security and sovereignty issues.
DFO is taken advantage of DND's effort and is using the ice-resistant "Tube" to bring oceanographic and ice mooring data to shore via a cable. The data will become available in real-time through an Iridium satellite link, and assimilated into ice-ocean and weather forecast models.



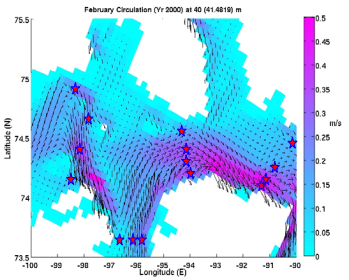
Schematic of the real-time mooring data system using DND base camp at Gascoyne Inlet on the southwest corner of Devon Island.

Arctic Ocean and CAA ice-ocean model development was partly funded under the IPY program, and is continuing under the ESRF and PERD programs. The models are based on the NEMO ocean and LIN ice models and have an 18km grid for the Arctic basin and a 6km sub-grid for the CAA-Beaufort Sea region.



Configuration of the pan-Arctic model (outer box) and the embedded CAA sub-model (inner box). Colour shading is water depth (in m).

The model simulations are being validated with available DFO and ArcticNet mooring observations, some of them shown in the figure below for the winter near the centre of the NW Passage. The model will become the main ice-ocean model to be used by the Canadian Ice Service and the Canadian Meteorological Centre to enhance their ice and weather forecast products, and thus the safety of northerners using and relying on these forecasts. In addition, it will be the basic physical model for driving biological models that will investigate the potential impacts of the changing ice regime and vertical and horizontal circulation on biological production and the total ecosystem.



Simulated winter climatic surface current distribution of the Barrow Strait region and current observation sites (stars). The transect on the right is the present mooring array site shown in the left panel.

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