ASOF2011: Variability in 12-years of transports through Lancaster Sound of the Canadian Arctic Archipelago

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Presentation

- Early data from 1981-82 Barrow Strait mooring
- Mooring data from 1998-present from Lancaster Sound
- Far-field wind forcing of the transport variability
- Work underway and conclusions

Map of Canadian Arctic Archipelago

Northward moving Magnetic Pole 1994

1979-83 winter surveys 1998-2011 mooring array
1969 ESSO Manhattan in McClure Strait of the NW Passage helped by CCGS MacDonald

Sovereignty issue – Can. Government research redirected to Canadian Arctic
1979-83 winter surveys

- **Current meter mooring**
- **Current meter transect**
Barrow Strait transects looking towards the Arctic Ocean

Salinity and current plots
Year-long mooring 1981

What we learned for the mooring work in Lancaster Sound

Summer and winter CTD sections

Estimate yearly transport ~0.5Sv for 1981-82 for Barrow Strait
- Summer maximum
- along channel SLP

Southern Beaufort Sea – Resolute Bay
1998-2012 survey

North Magnetic Pole Problem

ADCP in a streamlined float and Watson compass
1999-2000 annual mean currents

Northern site

southern site
Fluxes through Lancaster Sound 1998-2012

Cross-section of Lancaster Sound with year-long full mooring array

- Cold, low salinity Arctic surface water
- Warm, high salinity Baffin Bay water
Weekly along-strait velocities of 0 to 60m surface layers for Sept., 2001-Aug. 2002.

Top: surface layer means for the southern and $\frac{1}{4}$ and $\frac{1}{2}$ across the Sound.

Bottom: surface layer means of the southern and the three moorings’ average.
Other results after 6 years:

- ULS data: small solid freshwater signal due ice plug to the west of mooring. (In AO paper)

- ICYCLER profiler: 3-5% additional surface freshwater is not available fluorescence data more for phytoplankton production.

- ADCP data: backscatter intensity used as zooplankton index

- CTD data: late summer data used to predict the onset of ice cover similar as done in Gulf of St. Lawrence,

To be published in JGR by Jim Hamilton.
12-years of 6-hourly filtered Flux estimates passing through Western Lancaster Sound

1998-2006 results In Liege “Climate Change” book by Nihoul-Kostianov
1998-2009 IPY highlight results
1998-2010 results in JGR 2011 being corrected

Analysis results: Ingrid.Peterson@dfo-mpo.gc.ca
Data files: Roger.Pettipas@dfo-mpo.gc.ca
12-years of Monthly Flux estimates passing through Western Lancaster Sound

- High coherence between Freshwater Flux and Volume Flux
Monthly Volume Flux Estimates

Transport (m$^3$/sec)


Summer Arctic Ice extent

Extent (million square kilometers)


National Snow and Ice Data Center
Analysis of 1998-2004 (6yr) to 1998-2010 (12y)

1) Reduced transport estimate from 0.7Sv to 0.5Sv
2) Summer peak delayed from July to August
   Weak winter peak earlier
Wind Stress inferred from sea level pressure gradients have been used by Ingrid Peterson to explain seasonal variability of the sea level on the Beaufort Sea Shelf and observed transport variability at the Lancaster Sound mooring array.

Maximum wind stress correlation found by Peterson

NCEP winds
Monthly transport anomaly through Lancaster Sound regressed with NCEP/NCAR reanalysis wind anomalies shows

- transport anomaly is significantly correlated ($r= 0.65$) with far-field wind forcing in the Beaufort Sea
- Residual transport anomaly also correlated ($r= 0.37$) with far-field wind forcing east of Greenland
Comparison of wind regression transport estimates and observed estimates

- blue observed transports
- green annual + Beaufort Sea wind $r=0.81$
- red annual + Beaufort Sea and Greenland winds $r=0.84$
Physical Process: NW Passage fluxes show a max in the summer when winds off the western CAA are northwards increasing the Sea level in the eastern Beaufort Sea and the SL slope along the NW Passage.
- Weather and Ice forecasts
- Onset of ice cover
- Biological production

Data assimilation

- CSA RADARSAT-2 imagery, Amundsen Gulf
- DND-DFO Iridium Stn. Gascoigne Inlet
- DFO-CCG Ice drift and draft data

Presently real-time CTD data

Ice-ocean model
Work underway and conclusions

- Mooring came out this August (one more year of data)
- Shift in seasonal peaks (annual and semi-annual)
- Internal ice pressure and regression analysis
- Validation of climate ice-ocean models (next slide)
- Is the water passing through the CAA freshening??
- Real-time mooring and ice-ocean forecasting
- Onset of ice cover from late summer CTD data
- Biological production evolution
Conclusion

- Continue to do data analysis
  - Numerical modelling
  - Real-time ice drift and draft data
  - Ice cover onset and biological production
  - Climate mooring ???

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