Transport Variability in the West Greenland Current

Paul G. Myers[1], Chris Donnelly[1] and Mads H Ribergaard[2]

[1] Department of Earth and Atmospheric Sciences, University of Alberta, Canada

[2] Danish Meteorological Institute, Copenhagen, Denmark

1. Background

- Significant freshening observed in the Labrador Sea between the 1960s and present
- Questions on the relative importance of the West Greenland Current versus the Labrador Current for supplying the observed freshwater (FW) to the interior of the Labrador Sea
  - Mainly linked to enhanced export of FW from the Arctic
  - Atmospheric excess precipitation and changes in melt from the Greenland Ice Cap may also play a role and must be considered
- No detailed study of FW transport in the West Greenland Current has been carried out to our knowledge
  - Thus, here we examine the transports (volume, heat and freshwater) in the West Greenland Current across 6 lines regularly occupied by the Danish (Fig. 1)

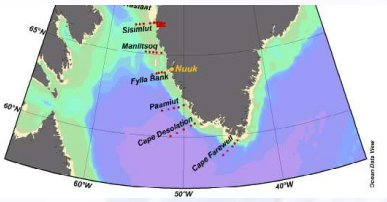
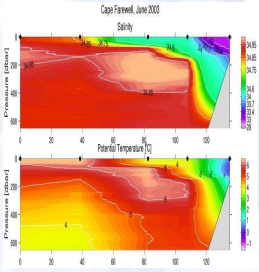


Fig. 1: Position of oceanographic sections off West Greenland used in this study. Taken from Ribergaard and Buch (2004).

2. Data and Methods

- Temperature and Salinity measurements taken from The International Council for the Exploration of the Sea (ICES) database
- Sample sections of temperature and salinity (Cape Farewell, 2003) are shown in figure 2 (taken from Ribergaard and Buch, 2004).



- Calculations limited to 700 db where the bottom is deeper as this is the deepest common level for all stations each year
- Mixed layer assumed deeper than top most measurement in each profile (normally 4-14 m deep) and thus a constant profile is assumed upwards from the top measurement
- Densities determined using the UNESCO equation of state
- Baroclinic velocities geostrophically determined between each station on all sections
- Barotropic reference velocity taken from diagnostic model based upon summer climatological analysis of Kulan and Myers (2006) – see panel to right for more detail
- Additional issues in determining FW transports
  - Timing of stations – taken over ~1 month in June/July and not always at the exact same time each year
  - Transport between the inner station and the coast
  - Linear interpolation of T and S values to velocity points does not capture observed frontal structure of observations (Fig. 2)
  - Attempted Solutions
    - Copy the innermost station to the coast, but use the velocity profile from between stations 1 and 2 for the region between station 1 and the coast
    - Develop a frontal model to allow T and S to be estimated at intermediate points, including between the inner station and the coast (still under development)

3. Climatological Analysis of Kulan and Myers (2006)

- Region: 45-70N; 40-70W (1/3 degree resolution)
- Based on data in MEDS database / 1910-present / Temperature (T) and Salinity (S)
  - Objective analysis using iterative difference-correction scheme with depth dependence
  - Modified by polynomial weighting based on bottom depth
- Vertical Binning
  - Geopotential Coordinates (44 levels)
  - Isopycnal Coordinates (44 isopycnal surfaces)
- Annual and Seasonal versions produced
- Time varying triads based on overlapping running means
- Climatological data merged with Levitus and/or Lozier climatologies for rest of sub-polar gyre
- An OGCM (Myers, 2002) then run in diagnostic mode to produce an estimate of velocities associated with T and S fields

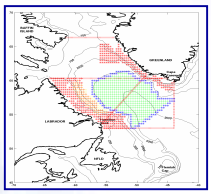


Figure 3: A map of the study area. Red is the boundary Currents (West Greenland - WGC and Labrador Current – LC), green is the interior, and the blue broken line denotes the boundary we use for computing transports between the boundary currents and the interior Labrador Sea.

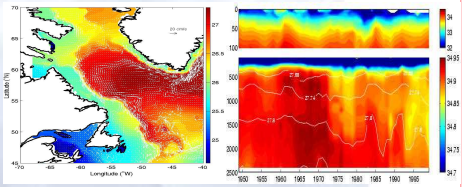


Figure 4: Sample plots from climatology: left) density field and diagnostic currents at 30 m, and right) time varying salinity in the West Greenland Current interior.

4. Preliminary Results – Mean Transports

Section	Mean (95-05) Volume Transport (Sv)	Mean (84-05) Volume Transport (Sv)
Cape Farewell	12.41	11.79
Cape Desolation	11.06	10.27
Paamiut	3.90	4.29
Fylla Bank	4.73	
Maniitsoq	0.24	
Sisimiut	0.11	

Section	Mean (95-05) Heat Transport (10^{14} J s^{-1})	Mean (84-05) Heat Transport (10^{14} J s^{-1})
Cape Farewell	2.17	1.94
Cape Desolation	1.83	1.55
Paamiut	0.66	0.64
Fylla Bank	0.82	
Maniitsoq	0.26	
Sisimiut	0.05	

Section	Mean (95-05) Freshwater Transport (mSv)	Mean (84-05) Freshwater Transport (mSv)
Cape Farewell	81.33	69.79
Cape Desolation	72.23	65.58
Paamiut	35.72	34.83
Fylla Bank	23.36	
Maniitsoq	8.00	
Sisimiut	3.31	

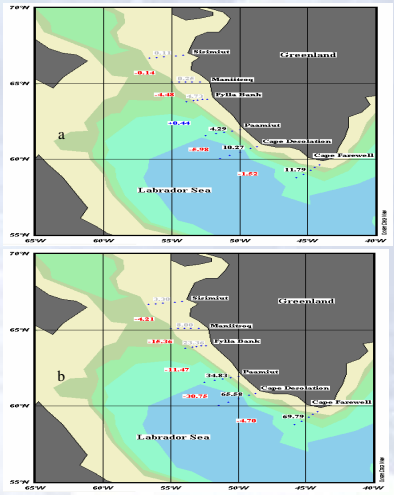


Figure 5: Schematic showing mean a) volume and b) freshwater transport across each section (black numbers are averages over 84-05 while grey numbers are averages over 95-05). To the right are estimates of the transport into the Labrador Sea needed to balance the changes in transport along the West Greenland Current assuming no exchange with the atmosphere or at the coast (which is not realistic for freshwater). Red numbers indicate transport into the Labrador Sea while blue numbers are for transport in to the WGC.

5. Preliminary Results – Transport Variability

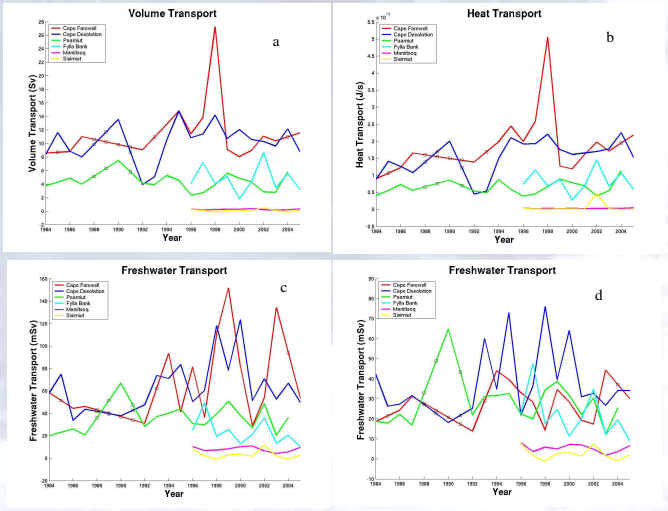


Figure 6: Timeseries of transports across each of the 6 sections over the periods (84-05 or 95-05 for the northernmost 3 sections). Square boxes indicate that there is no data for that given section and year and the value is determined purely by linear interpolation. For the freshwater, figure c considers the transport between the coast and the outermost stations (using the assumptions discussed in section 2) while figure d shows the actual freshwater transport between the innermost and outermost stations.

References:

Kulan, N. and P.G. Myers, 2006: Comparing two climatologies of the Labrador Sea: Geopotential vs isopyncal, Atmosphere-Ocean, submitted

Myers, P.G., 2002: SPOM: A regional model of the sub-polar North Atlantic, Atmosphere-Ocean, 40, 445-463

Ribergaard, M.H. and Buch, E., 2004: Oceanographic Investigations off West Greenland 2003, NAFO Scientific Council Documents, *04/001*

Funding Acknowledgements:

This work is supported by **NSERC**,and by the Nordic Council of Ministers ("West Nordic Ocean Climate" programme)

Author Address:

Paul Myers, Dept. of Earth and Atmospheric Sciences, University of Alberta, Edmonton,

Alberta, Canada T6G 2E3

Email: pmyers@ualberta.ca