Time Series of Freshwater Flux at 26°N in the Atlantic Ocean

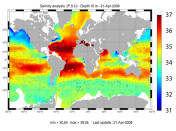
Elaine McDonagh[1] (elaine.mcdonagh@noc.ac.uk)• Brian King[1] • Harry Bryden[1] • Peggy Courtois[1] • Stuart Cunningham[2] • Zoltan Szuts[3] • Chris Atkinson[4]

1. National Oceanography Centre, Southampton • 2. Scottish Association for Marine Science • 3. MPI Meteorology • 4. UK Met Office

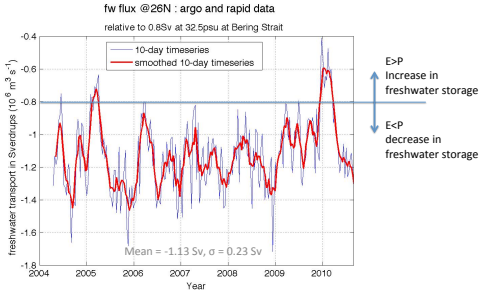
Oceanic Freshwater Flux at 26°N April 2004 to August 2010

Rationale

- We have generated a continuous time series of oceanic freshwater flux across 26°N. This time series gives the integrated freshwater exchange (with atmosphere, cryosphere and terrestrial hydrosphere) and changes in oceanic freshwater storage over a region including the Arctic and the deep water formation sites of the North Atlantic.



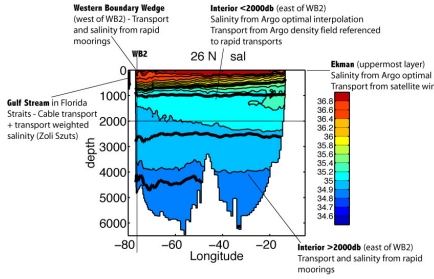
The Atlantic is the most saline ocean, this high salinity is thought to result in the formation of deep water in the North Atlantic. Further the formation of North Atlantic Deep water is thought to be sensitive to changes in freshwater inputs to the North Atlantic.



What is it?

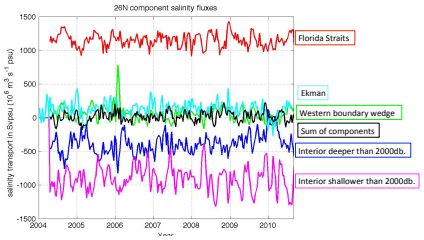
- Mass flux across the section.
- Based on salinity conservation between Bering Strait and 26°N. Uses Bering Strait salinity flux of 26 Svpsu. Pacific to Arctic flux of 0.8 Sv at 32.5 psu.
- Difference between -0.8 Sv and freshwater flux represents integrated surface freshwater fluxes and change in the oceanic freshwater storage between Bering Strait and 26°N.
- Mean divergence implies 0.33 Sv of freshwater added to the ocean between Bering Strait and 26°N (or decreased oceanic freshwater storage).

The Calculation



At each time step (every ten days) calculate a salinity flux for each segment of the 26°N section (shown above) using

- salinity and transports from the 26°N mooring array
- salinity and density (for geostrophic calculation) from Argo data optimally interpolated on density using Hydrobase climatology.



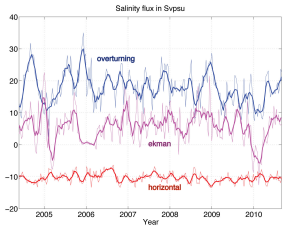
- Constrain the salinity flux at each time step to be -26 Svpsu (the salinity flux at Bering Strait) by adding a volume flux at the section average salinity.
- The net volume flux across the section is the freshwater flux.

	Uncertainty (Sv psu)
Florida Straits	2.6
Interior Upper	1.01
Wedge	0.72
Ekman	0.57
Bering Strait	0.54
Interior Deep	0.30
Barotropic compensation	0.21
TOTAL	**3.01**

Uncertainty is estimated by considering the transport and salinity uncertainty in each element of the calculation. **TOTAL** uncertainty = **3.01 Sv psu** in salinity flux or **0.09 Sv** in equivalent freshwater for each ten day estimate. The uncertainty is dominated by uncertainty in the volume flux through Florida Straits.

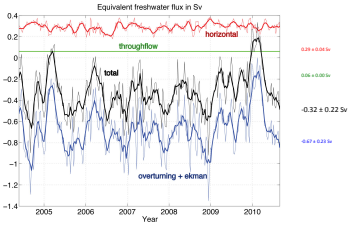
Components of the Freshwater Flux

The salinity flux across 26°N is split into overturning and horizontal components. Each component is associated with zero net mass flux. The Ekman flux is separated from the overturning flux by compensating it with the section average salinity.

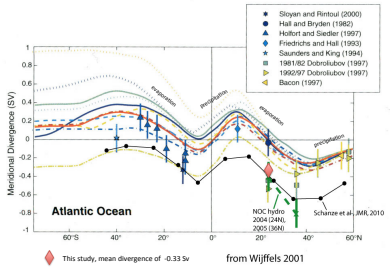


The overturning and Ekman fluxes both transport salinity northwards (the upper level northward flow is more saline than the lower level southward flow). The horizontal circulation transports salinity southwards (the northward flow in the Florida Straits is less saline that the southward flow in the subtropical gyre interior).

Salinity fluxes are converted to equivalent freshwater fluxes by dividing by the section average salinity. These equivalent freshwater flux components sum to the freshwater divergence between 26°N and Bering Strait. The throughflow component represents the change in the section average salinity between Bering Strait and 26°N.



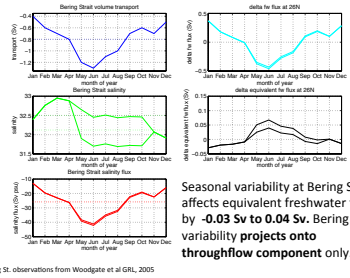
Comparison with other estimates



The mean from our estimate of the freshwater divergence (-0.33 Sv) is compared to integrated surface flux climatologies and reanalyses (continuous lines) and estimates from hydrographic sections (symbols).

Bering Strait Considerations

We use the mean transport through Bering Strait as our constraint. What effect does the seasonal variability in the Bering Strait flow have?



Seasonal variability at Bering Strait affects equivalent freshwater flux by **-0.03 Sv to 0.04 Sv.** Bering Strait variability **projects onto throughflow component** only.

Bering St. observations from Woodgate et al GRL, 2005

Acknowledgements This work was funded by MONACO, a NERC RAPID-WATCH project. Data from the RAPID-WATCH/MOCHA project are funded by the Natural Environment Research Council (NERC) and National Science Foundation (NSF) and are freely available from www.noc.soton.ac.uk/rapidmoc. Florida Current transports estimates are funded by the National Oceanic and Atmospheric Administration (NOAA), and are available from www.aoml.noaa.gov/phod/floridacurrent. Argo data were collected and made freely available by the International Argo Project and the national programmes that contribute to it (**http://www.argo.ucsd.edu**, http://argo.jcommops.org). The HydroBase climatology, funded by NSF, is made available by Ruth Curry, WHOI.