Monitoring the Meridional Heat Transport in the North Atlantic

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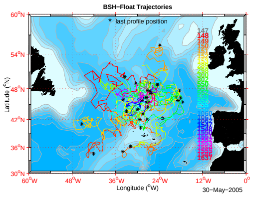
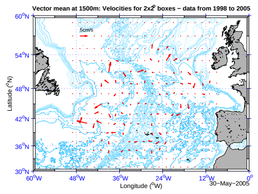
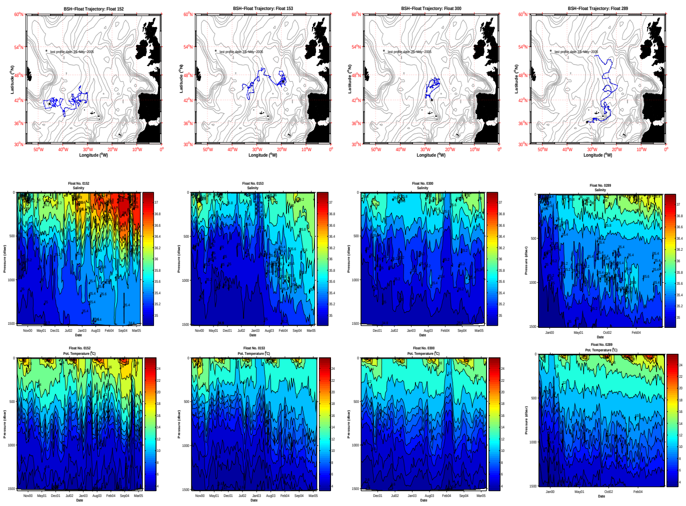
Since 1993 the meridional heat transport across 48°N (WOCE-A2) in the North Atlantic has been estimated almost annually by working an ocean-wide high-resolution, full-depth hydrographic section. With 0.52 PW +- 30% the heat transport shows considerable variations on interannual time scales. Baroclinic transports contribute 80-90% of the absolute transports, the eddy and Ekman components some 10-20%, so the mesoscale variability accounts for +- 0.13 PW. To estimate the baroclinic changes on monthly time scales for the top 1500 m, XBTs have been deployed along AX3 since 1988. In addition since 1995 re-seedings of TS-floats across the Mid-Atlantic Ridge have contributed, particularly important during the winters, T/S-profiles at virtual time series stations on critical sites of the hydrographic section. The determination of the required velocity information for the heat transport estimates has been difficult. Attempts to use satellite altimetry have been useful, although still await better information about the geoid. The heat and freshwater transport estimates and the rates of meridional overturning circulation have been helpful to understand the impact of changes of largescale atmospheric pattern on the oceanic circulation in the North Atlantic. To provide a sustainable component of an observing system this work needs to be optimised. We envisage a combination of altimetric sea level heights, quarterly surveys of the thermohaline structure of the top 1000 m and full-depth hydrographic sections at larger time intervals.





Mean Flow Field at 1500 m Depth:

Velocities of all floats operating between 1998 and 2005 at depths of 1500 m were averaged on a 2x2° grid. The flow field shows a strong topographic steering along the eastern side of the MAR. Floats cross the MAR from the Western to the Eastern Basin preferably at the fracture zones between 42°N and 48°N. Highest velocities appear on the western side of the North Atlantic, with floats caught in the Deep Western Boundary Current and its recirculation. Low velocities appear above the central MAR. A pronounced westerly flow is observed south of the Azores.



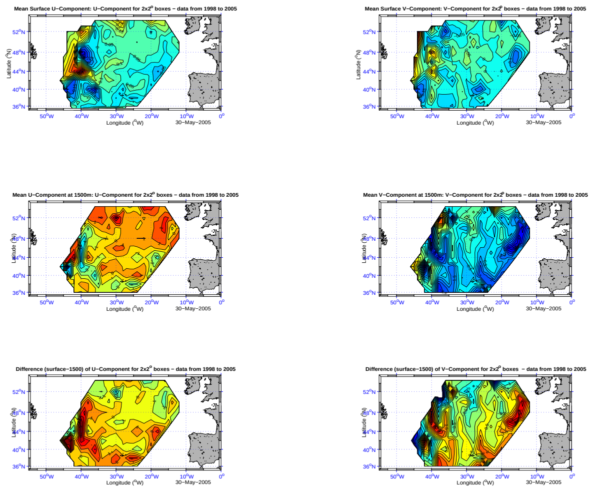
Regional Float Examples:

Trajectories, salinity and potential temperature isopleths of four different Apex floats (Float 152, 153, 300 and 289) are constructed from uncorrected data. Only for the salinity sensor of float 152 preliminary checks indicate a drift.

Float 152 deployed in May 2000 west of the MAR runs in a westward direction. Float 153 started also in May 2000 in the western basin of the North Atlantic running eastward, crossing the MAR. The track of float 300 is quasi-stationary above the MAR, starting in May 2001. The longest living float 289 started in June 1999 on the eastern side of the MAR and moves along the isobaths from north to south.

The seasonal cycle reaches to a depth between 500 and 800 m. Winter deep convection is absent in January/ February in the southeast sector of the area, south of 45°N and east of 30°W. Deep convection down to 1500 m in winter either appears in the subpolar gyre (float 289) or when the floats are above the MAR. Float 300 has deep convection in February 2004 and float 153 in January 2003.

The salinity isopleths of float 289 show the propagation from the subpolar gyre with relatively low salinities to the subtropical gyre with higher salinities.

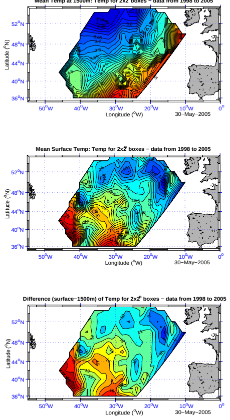


Mean U- and V- Velocity Components at 10 m and 1500 m Depth:

The velocity field is decomposed into its u- and v-components for the "surface" at 10 m and the 1500 m depth. Highest u-values appear at the boundaries of the basins and flow is weaker over the Mid Atlantic Ridge. North of 46°N eastward flow prevails, south of 40°N we observe westward flow.

At 1500 m depth, strong northward flow is only observed at the westernmost boundary and west of the MAR. In the eastern basin the southward flow is slightly intensified along the eastern flank of the MAR. Further east towards the eastern side of the investigation area it increases up to 1.5 cm/s.

The bottom panels show the vertical differences of the u- and v-components between the "surface" and the 1500 m depth level. The meridional v-component largely follows the alignment of the bottom topography.

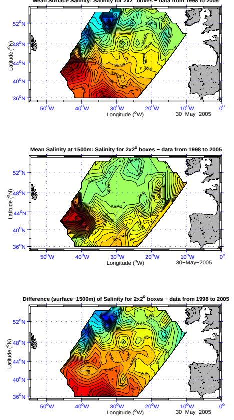


Mean Temperature Field at 10 m and 1500 m Depth:

Temperatures from float data collected between 1998 and 2005 were averaged on a 2x2° grid, representing a 7 year mean. At 1500 m depth the front of the subpolar and subtropical gyres is clearly lined out in the salinity field and crosses the MAR at 42°N. From 36°N to 42°N influences from Mediterranean Water are visible. Less saline waters of the subpolar gyre occupy the area to the north.

The sharp "surface" temperature front between the subpolar gyre and the subtropical gyre crosses the MAR at 40°N and is displaced southward of the salinity front by some 2° in latitude. The northward edge of the subtropical gyre is strongly influenced by the Mediterranean Water tongue. At 1500 m the subpolar domain extends further to the SE. At the "Mann Eddy" at 40°N and 40°W is cleary visible.

The bottom panel shows the vertical temperature difference at each grid point between the "surface" and the 1500 m depth level.



Mean Salinity Field at 10 m and 1500 m Depth:

Salinities from float data collected between 1998 and 2005 were averaged on a 2x2° grid for two depth levels. The front of the subpolar and subtropical gyres is clearly lined out in the salinity field and crosses the MAR at 42°N. From 36°N to 42°N influences from Mediterranean Water are visible. Less saline waters of the subpolar gyre occupy the area to the north.

The sharp salinity front between the subpolar gyre and the subtropical gyre crosses the MAR at 40°N and is displaced northward of the temperature front by some 2° in latitude. The northward edge of the subtropical gyre is strongly marked by the Mediterranean Water tongue.

The bottom panel shows the vertical salinity difference at each grid point between the "surface" and the 1500 m depth level. The southwestern quadrant shows the largest vertical salinity differences of more than 1 psu.

These fields will be compared in the near future with the WOCE Global Hydrographic Climatology (WGHC) to obtain anomalies.

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