Recent Mediterranean Outflow Water and Atlantic Meridional Overturning Circulation correlations

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Introduction and methodology

The Atlantic Meridional Overturning Circulation (AMOC) is the main contributor to the heat interchange in the North Atlantic. Any slowdown in its transport would produce a significant decrease of the temperature around the world. An input of fresh water would produce a reduction in the transport of the AMOC, while a supply of salty water, such as the Mediterranean Outflow Water (MOW), would strengthen it. To determine if the variation of the volume of the MOW is affecting the transport of the AMOC, we estimated the correlation between the MOW distribution in the eastern Atlantic and the AMOC using data from the RAPID array and the Argo observing system.

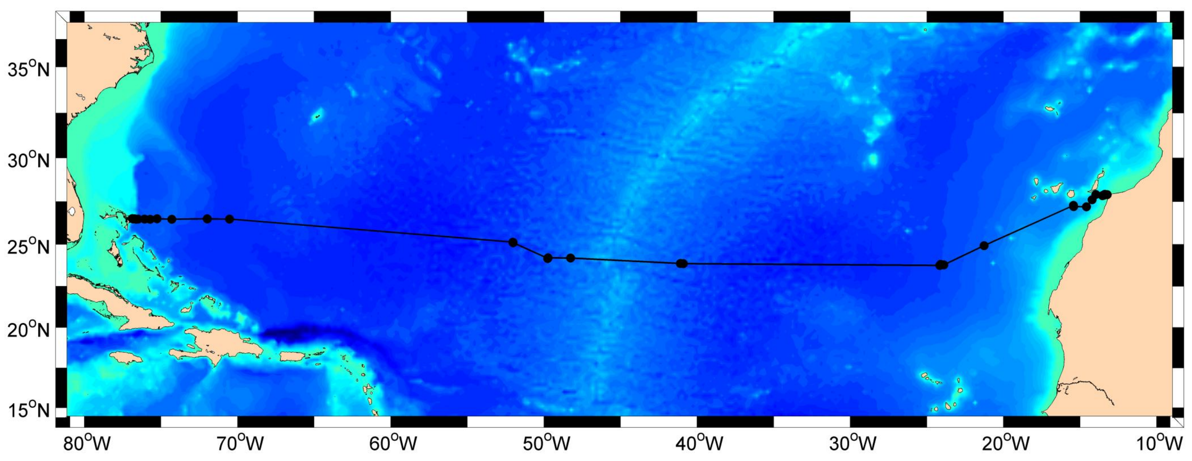

Figure 1. RAPID array position.

Under the RAPID programme an array of instruments was deployed across the Atlantic at 26°N (Figure 1), which measure the temperature, salinity and current velocities from the near surface to the sea floor. These data have been used to determine the overturning circulation in the North Atlantic. The RAPID estimates the AMOC as the sum of three components and it also retrieves the transport for the different layers of the water column (Figure 2).

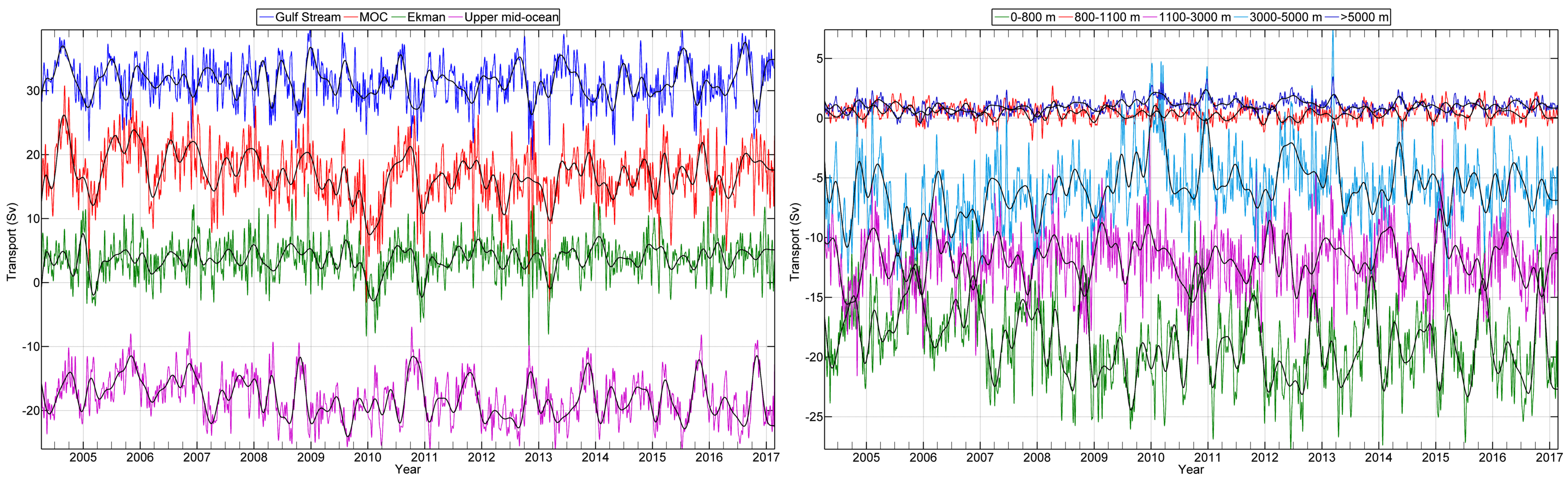

Figure 2. AMOC components (left) and layers (right) transport corresponding to 10-day (coloured lines) 90-day (black lines) filtered data.

The Argo observing system is an array of around 3800 free-drifting profiling floats distributed globally, which measure the pressure, temperature and salinity of the first 2000 m of the water column.

Results

The MOW is characterized by a salinity maximum, at intermediate depths, associated to relatively high temperatures (Figure 3) and can be easily identified in a TS diagram (Figure 4).

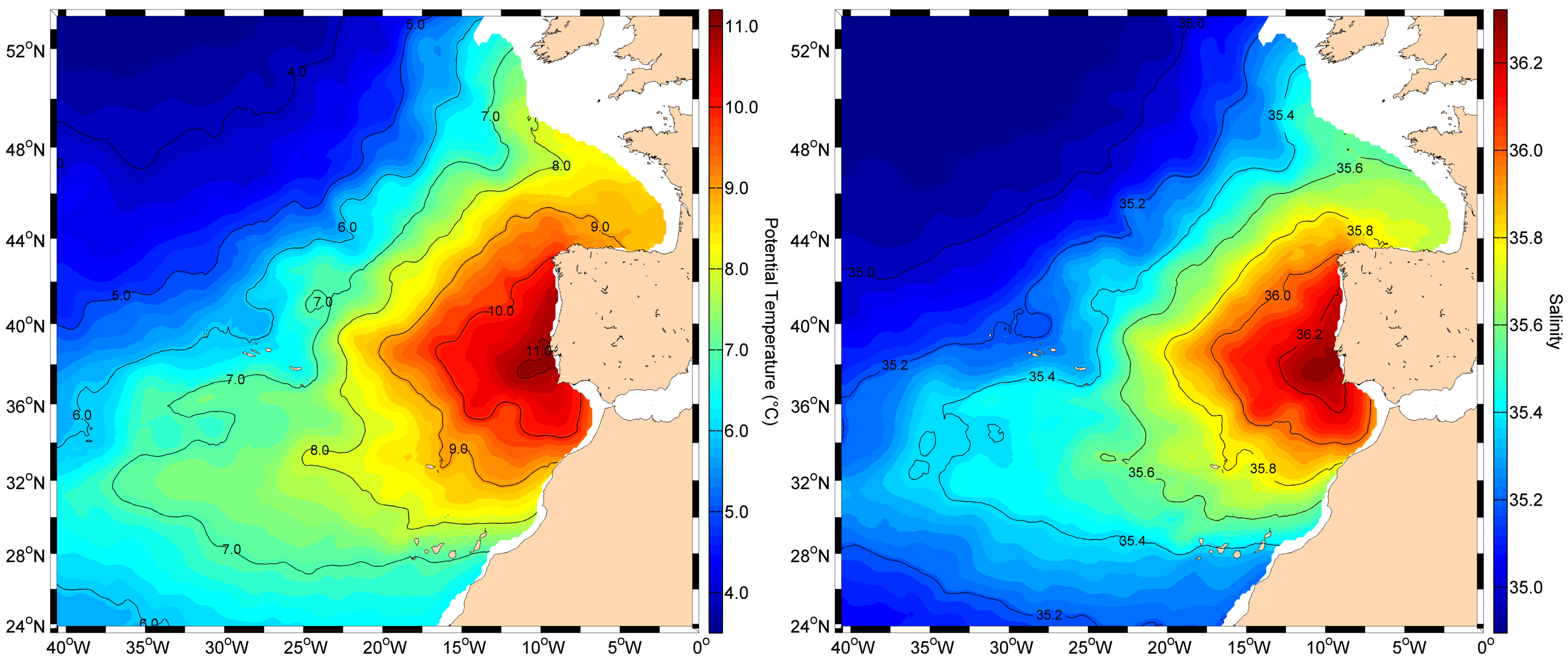

Figure 3. Mean annual salinity and potential temperature at 1200 db (data from Roemminch-Gilson Argo Climatology for the period 2004-2016).

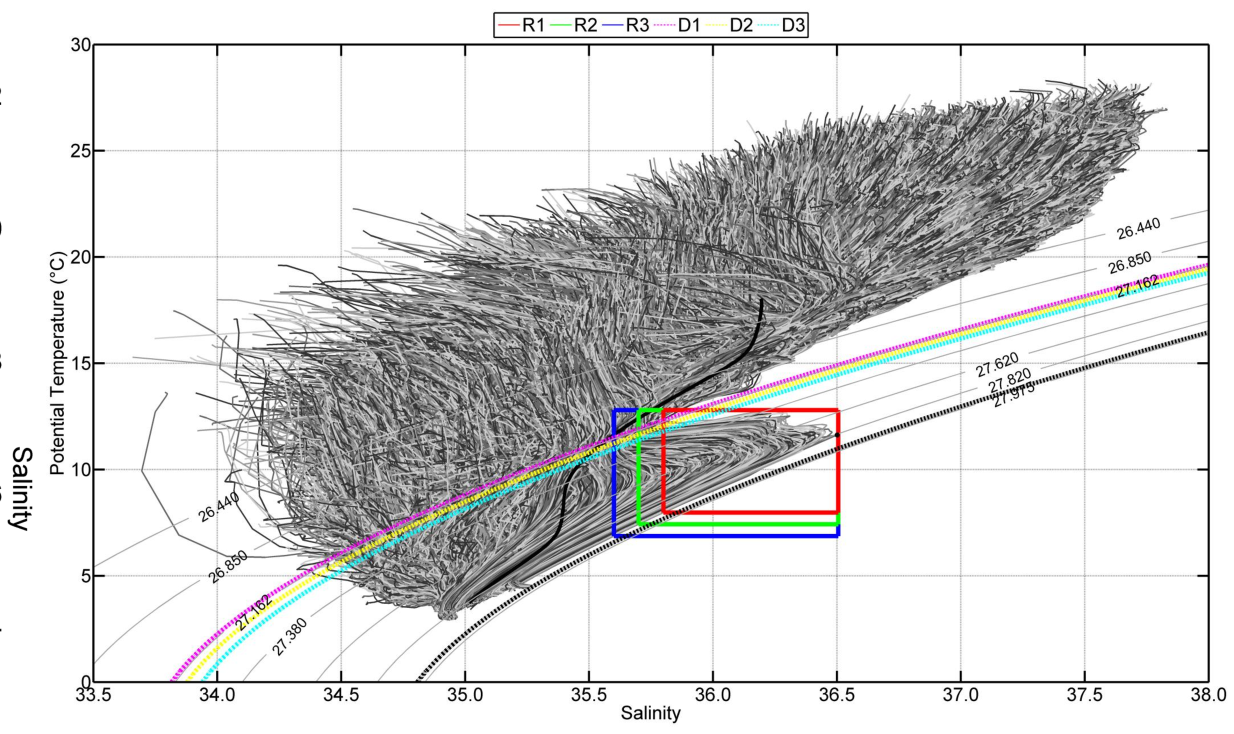

Figure 4. θ/S diagram. The grey lines correspond with the values of temperature and salinity in each point of the grid, while the black line is the mean value. A black dot is located at the maximum of salinity (at 1200 db). The rectangles indicate the ranges of salinity and temperature selected, the black lines are the density lines and the dotted and coloured ones correspond with the density values set as limits.

Using the Roemminch-Gilson Argo Climatology , we determined the geographical distribution that met established conditions of temperature, salinity and density. In this way we estimate the monthly temporal variation of the MOW volume. To get a robust estimation, we selected the volume of the MOW at the core (Figure 5), as it contains water less mixed.

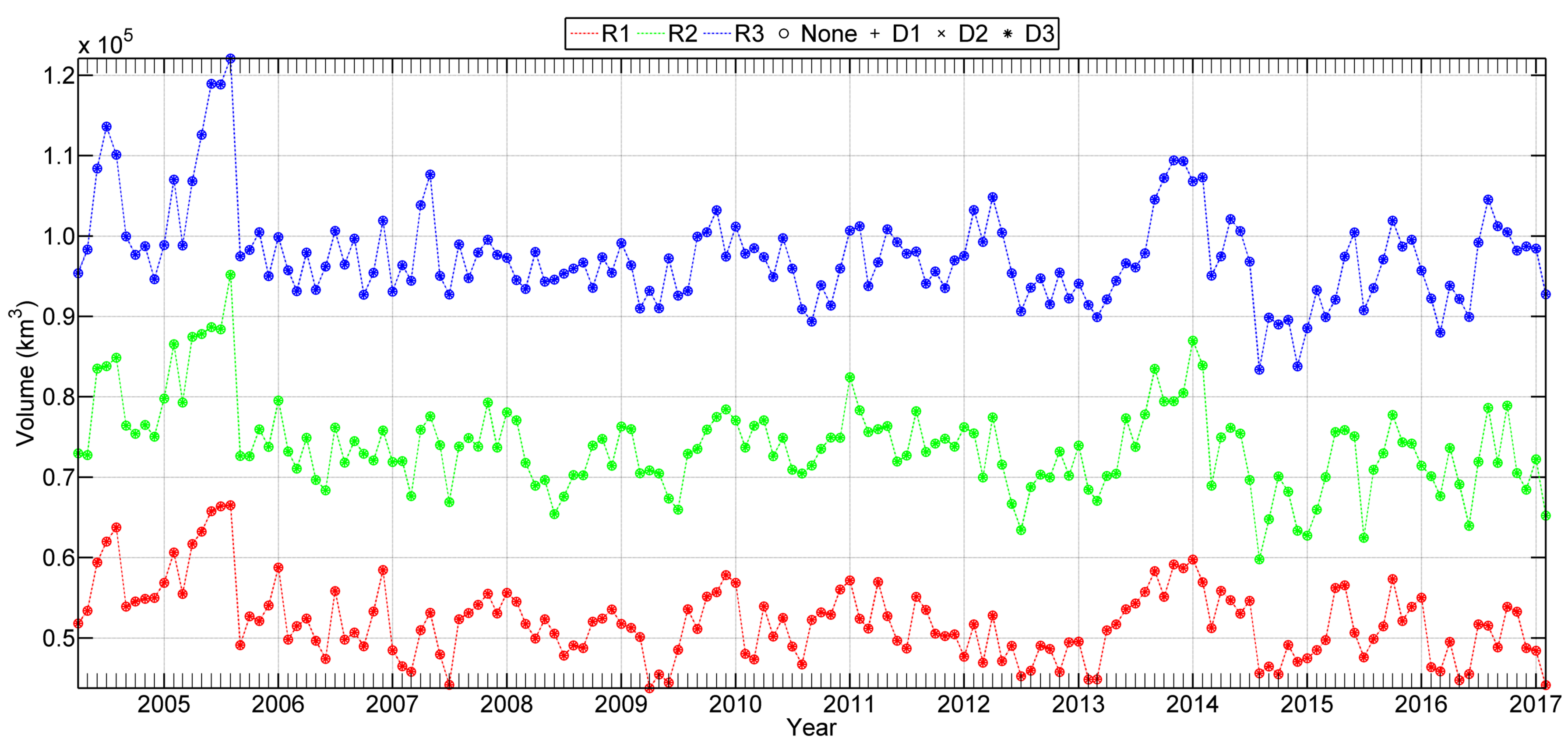

Figure 5. Time series of the volume of the MOW at 1200 db. The colour of the lines indicates the range of temperature and salinity used and the markers the limits of density being applied.

The time series of the volume of the MOW were compared it with the transport time series of the MOC components and layers. The highest similarities were found between the Upper mid-ocean and the Thermocline recirculation (the circulation in the first 800 m) transports, and the range R1, especially for the period between 2012 and 2017 (Figure 6).

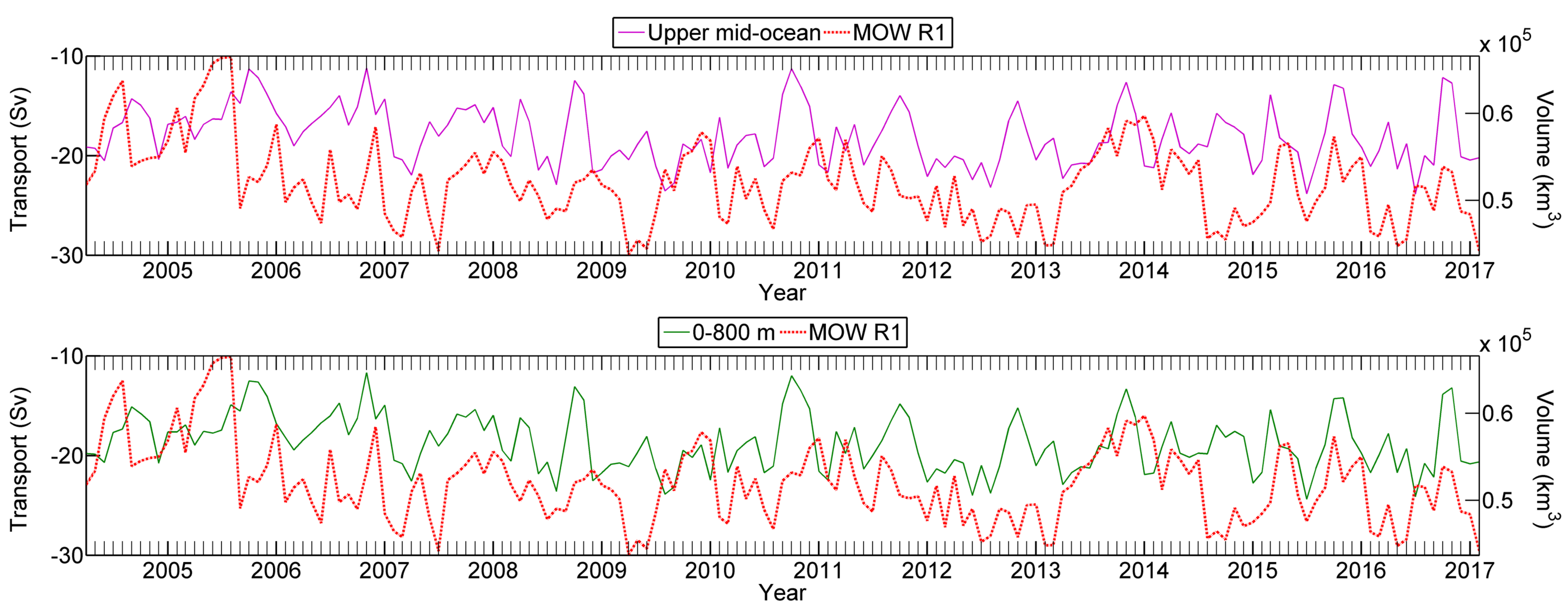

Figure 6. Upper mid-ocean transport (top) and transport in the first 800 m of the water column (bottom) compared with the MOW volume at 1200 db for range R1.

In spite of the similarities, in both cases the results of applying a linear fit give very low correlation coefficients.

Discussion and conclusions

Although the extremely low correlation coefficients suggest that the MOW is not having any effect in the AMOC, the high resemblance of both time series, especially during the period 2012-2017, make us think that a connection might exits between the MOW and the AMOC. To explain this similarity, the hypothesis we proposed is that the changes that occur in all the Atlantic, observed by the RAPID array, also affect the exchange between to the Atlantic and the Mediterranean, and therefore to the volume of MOW in the Atlantic.

Acknowledgments

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