Net downwelling in the boundaries

Most of sinking occurs in the North Atlantic near the boundaries (Figure 1-top), due to buoyancy loss and sharp topography [1]. This sinking is proportional to the alongshore density gradient and eddies may play an important role in the densification of waters [2].

We use a high resolution model to answer the following questions:

a) What is the seasonal variation of sinking in the North Atlantic?

b) How sinking spreads over the different North Atlantic marginal seas?

Seasonal variability of net downwelling

- Time-mean maximum overturning (net downwelling/sinking), defined as $W(z)\Delta x \Delta y$, is found at a depth of 1130 m (Figure 2-left) with a mean value of $\sim -14$ Sv (negative sign denotes sinking), in good agreement with the max. overturning streamfunction at 45° (Figure 1-bottom).

- Stronger/weaker overturning occurs in summer/winter), which matches with a stronger/weaker overturning streamfunction (Figure 1-bottom, inset), with a seasonal variability of $\sim 10$ Sv.

Model configuration & dataset

- Parallel Ocean Program (POP) model. Curvilinear coordinates.

- Nominal horizontal resolution 0.1 deg. at the equator & $\pm 42$ z-levels.

- Normal (climatological) year forcing of wind and heat fluxes. Including river run-off.

- Results are based on 15 years monthly mean fields of 3D velocity fields and potential density. Employed fields (years 260 to 274) are part of a longer simulation [3]. The region of study is defined in Figure 1-bottom.

Regional variability of net downwelling

- Figure 2. (left) Total mean (black line) and monthly mean (color lines) overturning profiles (see legend Figure 2-right) for the whole study area (Figure 1-top). The horizontal line indicates the depth of maximum overturning. (right) Accumulated mean (black line) and monthly mean (color lines) net downwelling respect to the distance to the coast. The yellow shading highlights the accumulated sinking within the first 260 km (also indicated with a black triangle).

- Figure 3. Study area divided in 8 regions. DSO and ISO refer to Denmark Strait and Iceland-Scotland Ridge overflow regions respectively.

- Magnitude and depth of max. sinking is different for each region.

- 30% of sinking occurs in overflow regions (DSO and ISO).

A first-look at water-mass transformation

- Deepest mixed layer develops in late winter/early spring, with the greatest convection occurring in Labrador and Greenland Seas (Figure 5-top).

- All sub-regions of Figure 3 show a densification of waters in spring, which suggests the importance of diapycnal mixing (Figure 5-bottom).

- The highest relative changes in potential density occur in the Labrador Sea and in the Denmark Strait (Figure 5-bottom).

- The connection between the maximum overturning and the densification of waters during spring in the Labrador Sea is further discussed in the poster of [4].

References


