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Mechanisms of volumetric change over the North Atlantic on interdecadal timescales

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Observations have shown that over the last half century there has been an increase in the volume of the coldest and warmest isothermal layers of the North Atlantic Ocean. This has been accompanied by a decrease in the volume of waters of intermediate temperature.

The changes in the water mass inventory were recreated in an isopycnic model by forcing the surface with realistic atmospheric forcing fields for 50 years. It was then possible to use a variety of diagnostics tools to reveal the mechanisms underlying the volumetric changes.

Firstly changes in the heat content of the surface layer were compared to changes in surface heat input and surface Ekman heating. The results of these diagnostics showed that whilst changes in surface heat input are important over the subtropical and subpolar region, changes in the surface heat content of the tropics are dominated by changes in Ekman transfer of heat.

In the interior temperature changes were examined by decomposing the changes into those due to the displacement of isopycnals and those due to watermass changes. Over the subtropics there was an increase in the heat content due to the downward displacement of isopycnals over the upper $500m$. This occurred as a results of increased wind strength over the region. Conversely watermass changes led to an enhanced advection of colder Labrador Sea water leading to a cooling of $\sim 0.1°C$ at depths of $2000 - 4000m$.

The model is able to simulate some but not all of the recent changes in North Atlantic heat content; although it is noted that as the boundary conditions are fixed, the influence of climate changes outside the model domain are excluded from the experiment.