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Lagrangian tracing of water mass transformation in the Atlantic Ocean

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The northward flowing water masses in the Atlantic Ocean are expected to convert from warm and saline to cold and fresh as they travel through the basin. The thermohaline stream function, which captures the ocean circulation in temperature and salinity space, has in previous studies been used to describe and analyse the water mass transformation of the World Ocean. In the present study, a Lagrangian framework is used to compute the Lagrangian thermohaline stream function for northward flowing water masses in the Atlantic Ocean. The result shows a water mass transformation from warm and saline to cold and fresh as water flows from 17°S to 58°N. Moreover, the Lagrangian thermohaline stream function for the northward flowing water masses of the Atlantic Ocean reflects the cooling and freshening shown by the World Ocean thermohaline stream function.

Although the water mass transformation can be shown with the thermohaline stream function, there is no information of where geographically the conversion takes place. By introducing a Lagrangian divergence of heat and salt it is found that changes in temperature are confined to the Gulf Stream, the upper flank of the North Atlantic Subtropical Gyre and the North Atlantic Drift. Changes in salinity occur in the same regions but in a narrower band.

Furthermore, the study of a specific, representative trajectory shows that, in the absence of air-sea interactions, the conversion of temperature and salinity from warm and saline to cold and fresh is achieved by sub-surface mixing processes. It is suggested that this mixing is confined to the North Atlantic Subtropical Gyre, where warm and saline water meet cold and fresh water from the Labrador Sea.