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Water-mass transformation in the Atlantic Ocean in a Lagrangian frame work

Sara Berglund, Kristofer Döös, and Jonas Nycander
Department of Meteorology, Stockholm University,Sweden (Sara.berglund@misu.su.se)

The world ocean is constantly moving, mostly due to density differences and atmospheric winds. This circulation is commonly refereed to as the Conveyor Belt circulation. In the Southern parts of the Atlantic, around the tip of South Africa, warm and saline water is entering. The water travels northward towards the equator where it increases in salinity. After passing the equator and reaching the North Atlantic, the water becomes cold and fresh, due to heat release to the atmosphere. Previous studies has introduced and computed the thermohaline stream function to connect water-mass transformations to the Conveyor Belt circulation in a temperature and salinity space. It has been suggested that the northward flowing water mass in the Atlantic Ocean can be shown in the stream function as water that converts from warm and saline to cold and fresh, and that the conversion is due to air–sea interactions. In the present study, Lagrangian trajectories are used to quantify the northward flowing water masses in the Atlantic Oceans contribution to the Conveyor Belt circulation in TS-space by introducing the Lagrangian thermohaline stream function. The stream function shows the Atlantic water-mass transformation, where warm and saline water is converted to cold and fresh, as the water flows from $17^{\circ}S$ to $58^{\circ}N$. This conversion is found to be both isopycnal and diapycnal. To connect the water-mass transformation to a geographical position in the Atlantic Ocean, the Lagrangian divergence of heat and salt flux is introduced. Conversions of temperature and salinity shown by the Lagrangian thermohaline stream function are found to occur in the same region of the domain, however, with a different spread. The conversion of temperature is found to take place in the Gulf Stream, the upper flank of the North Atlantic subtropical gyre, and in the North Atlantic Drift, whereas the conversion of salinity occurs over a narrower band in the same regions. To be able to study the processes giving rise to the water-mass transformation, a specific, representative trajectory is used. It shows that in the absence of air-sea interactions, a mixing process leads to the conversion of temperature and salinity shown by the Lagrangian thermohaline stream function. This process, is confined to the North Atlantic subtropical gyre, however, to define and understand the process, further analysis is needed.