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The Lagrangian divergence of heat and salt: A new method to determine water mass transformations

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Water mass transformation is an important part of the Ocean circulation. Lagrangian trajectories can be used to connect pathways with water mass properties such as temperature and salinity. Here, we will introduce the Lagrangian divergence of heat and salt that can be computed using Lagrangian trajectories. This is a new method that can be used to determine where water masses are changing temperature or salinity geographically.
Further, the following two examples on how to use the Lagrangian divergence will be given:

(1) In the Atlantic Ocean water flows northward and transform from warm and saline to cold and fresh. The Lagrangian divergence has been used to show that this cooling and freshening is confined to the North Atlantic Subtropical Gyre.

(2) Waters in the upper limb of the Southern Hemisphere Conveyor Belt circulation converts from cold and fresh to warm and saline as it travels from the Southern Ocean to the tropics. The Lagrangian divergence shows that this warming and salinification are confined to the Antarctic Circumpolar Current, the southern subtropical gyres, and the equator. In this study, the Lagrangian divergence are separated by the mixed layer depth, which distinguishes if a change in heat and salt is driven by internal mixing or air--sea interactions.