Vertical Redistributions of the Global Oceanic Heat and Salt Contents

Ocean observations are essential for describing and understanding climate change and climate variability. The existing ocean observations, however, are primarily limited to the upper ocean and recently down to about 2000m (thanks to the Argo program). It is frequently overlooked when interpreting ocean observations that the global ocean is a dynamically active system and has a memory of thousands of years. Not only the exchanges between ocean and atmosphere but the vertical redistributions inside the ocean also contribute to changes in the relatively well-observed upper ocean. Here, I will present the global oceanic vertical heat and salt fluxes as well as the related physical processes from a dynamically consistent and data-constrained ocean state estimate – ECCO (Estimating the Circulation and Climate of the Ocean) version 4. The results confirm that the vertical redistributions of heat and salt contents contribute significantly to the upper ocean temperature and salinity changes. We should, therefore, consider the vertical exchanges inside the ocean when inferring climate change and climate variability from the upper ocean observations. In the end, I will also present our recent finding of intense upwelling systems associated with the major western boundary currents, which are neglected branches of the global ocean circulation and are important for the vertical redistributions of ocean properties and materials.