

Global distribution of 10-day differences of temperature and salinity around 2000 m depth observed with Argo floats

*Yoshimi Kawai¹

1. Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology

It has been indicated from repeat hydrographic observations up to the bottom that the warming of the oceans already spread to the global abyssal waters, not only near the surface. Investigating processes of energy and material transport and their variations is essentially important for global climate changes. It had been difficult to do that globally due to lack of observation, but now the observation system by the Argo floats covers almost the whole world. Previous studies have utilized the Argo data to investigate absolute geostrophic velocity, vertical diffusivity, warming trend, and intraseasonal oscillations globally around 1000-m depth or deeper, for example. Short-term variations induced by atmospheric cyclones and internal tides in the intermediate and deep layers are, however, not examined enough. In this study, the authors examine the variability of the layer around 2000 m depth, which is the “bottom” of the present, dense Argo observation system, using all of available Argo float data. In particular, this study focuses on the difference between two successive observations, that is, nearly 10-day variation, aiming to detect rapid changes, mainly due to developed cyclones or internal tides. Even 1-day sampling is too coarse to resolve the Ekman suction or near-inertial oscillations, but a large number of samples will highlight areas where the frequency of large changes in a short period is high.

All delayed quality controlled float data that were available as of 20 September 2020 were downloaded from the ftp site of Argo Global Data Assembly Center and analyzed only the measurements flagged as good. Each profile was vertically interpolated on a 10-dbar grid using the Akima spline. Then the author obtained differences in properties between two successive observations for each individual float at an isobaric or isopycnal surface. The differences with an observation interval of 9-12 days, $\Delta T_i = T_i - T_{i-1}$ for temperature, and $\Delta S_i = S_i - S_{i-1}$ for salinity, were selected and averaged on $2^\circ \times 2^\circ$ grids. T and S are temperature and salinity, and subscript i denotes observation cycle. The average of the absolute value of ΔT or ΔS at 1000 dbar or 1950 dbar are mainly examined in this study.

Mean ΔT at 1000 dbar is large in the western boundary currents: the Gulf Stream, the North Atlantic Current, the Agulhas and Agulhas Return Currents, the East Australian Current, and the Kuroshio Extension. At 1950 dbar, ΔT is remarkable in the eastern North Atlantic Ocean west of Europe, the Argentine basin, and the northwestern Indian Ocean. Large ΔT is localized in some areas in the Southern Ocean: around 30°E , 85°E , 155°E , 135°W , and the Scotia Sea. For salinity, the spatial patterns are similar to those of temperature, but ΔS at 1000 dbar is also large in the east North Atlantic. There is no clear seasonality in the 10-day variations at 1000 dbar or deeper. The ΔT distribution at 1950 dbar shown by this simple procedure appears to reflect internal waves related with bottom topography, rather than atmospheric turbulence. The locally enhanced ΔT in the Southern Ocean are located over the ridges or leeward of the plateau, and may be caused by internal lee waves from geostrophic flows. On the other hand, the spatial distribution of ΔT in the North Atlantic Ocean is similar to that of the Mediterranean Outflow Water, which is a saline and warm water mass produced as a result of mixing the Mediterranean Sea Water and the ambient North Atlantic Central Water. The large ΔT in the North Atlantic Ocean would reflect the mixing and spreading processes of the saline water. The results of this study does not directly indicate the strength of ocean mixing, but is useful to infer where the mixing is vigorous in the intermediate layer, and will contribute to designing the observation system of the deep Argo float.

Keywords: Argo float, intermediate layer, 10-day change