Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2020-64-AC1, 2020


Ocean Science
Discussions

# *Interactive comment on* "Effect of mesoscale eddy on thermocline depth over the global ocean: deepen and uplift" *by* Xiaoyan Chen and Ge Chen

**Xiaoyan Chen and Ge Chen**

gechen@ouc.edu.cn

Received and published: 24 August 2020

Dear referee: We would like to express our sincere appreciation for your careful reading and invaluable comments. In response to your suggestions, I have some of my point of views as follows. Thermocline and geostrophic vorticity are closely related to each other and mesoscale eddy plays an important role in modifying the thermocline structure for their ability of transporting heat, salt and other chemical substances, and changing dynamic conditions of the ocean. The effect of mesoscale eddies on the thermocline that we emphasize is the uplifting and deepening of eddies on the thermocline. It is closely related to eddies' structure. The horizontal scale that a single eddy can affect is on the order of hundreds of kilometers, and the vertical scale is thousands of kilometers. Oceanic eddies are omnipresent in the ocean, accompanied by the slowly



migration process of eddies ($\sim$10km/day), the background stratification of the ocean is re-adjusted. Our job is to select a standard stratification to measure the influence of this adjustment. It is undeniable that the mesoscale eddy has a modulating effect on both the thermocline and the mixed layer. But thermocline defined by maximum temperature gradient is a more stable stratification structure, so the displacement of the thermocline is less interfered by other factors such as air-sea interface interaction while is mainly captured by mesoscale dynamics. There are many corresponding researches about the effect of mesoscale eddy on the structure of thermocline. Except as mentioned in the manuscript, Liu et al. (2001) pointed out that the thermocline changes when an eddy passes by. Cessi and Fantini (2004) indicated that baroclinic eddies on scales from 50 to 100 km could maintain a thermocline against diapycnal diffusion. Zhang et al. (2010) found that the eddy had a great influence on the thermohaline structure pattern in the local upper ocean, that is, when the eddy was strong, the thermocline depth shoaled greatly, and the subsurface high salinity water decreased largely. However, most of the existing related researches are based on a specific sea area. With the abundance of Argo data, we expand the research area to the entire global sea area, so that the thermocline displacement caused by eddies can be seen from a global perspective and long-term series. The spatial distribution feature of eddy-induced thermocline displacement is also one of the highlights of this article. We will be more inclined to dig out information and characteristics based on the ocean big data and display them quantitatively to reveal an actual ocean phenomenon. In addition, we obtain the position of the thermocline by calculating the maximum gradient of the temperature profile data obtained by each Argo float, as shown in Figure 1. When studying the displacement of the thermocline, the conclusion that the displacement of the thermocline caused by the eddy is based on the comparison between the thermocline depth of the inner eddy and the depth of the outer eddy. In other words, the changes in the thermocline itself are considered when calculating anomalies and it is reasonable to use the thermocline stratification with the fastest sea temperature change as a representative. What's more, you mentioned that we did not consider regional differences

in our research. In fact, you can see obvious regional characteristics in Figure 4-5 in the manuscript that remarkable thermocline displacements appeared along the western boundaries of strong current systems such as the Kuroshio extension, Gulf Stream, North Atlantic warm current, East Austrian warm current, Brazil warm current, Agulas current. But we indeed did not expand the areas with these characteristics for further research which is also worth doing later. The effect of eddy on the thermocline we have calculated is based on the identified eddy data set. Therefore, the study of the spatial distribution of the eddy-induced thermocline displacement could be restricted by the spatial distribution of eddies. And for the regional where lack thermocline, the effect of eddy on the thermocline is naturally small or even non-existent. However, many recent studies have shown that eddies also have uplifting and sinking effects on the halocline, which further shows that the phenomenon of ocean stratification displacement caused by such eddies is ubiquitous. The effects of eddies on halocline and pycnocline, and the differences in these effects are also our future research directions.

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2020-64, 2020.



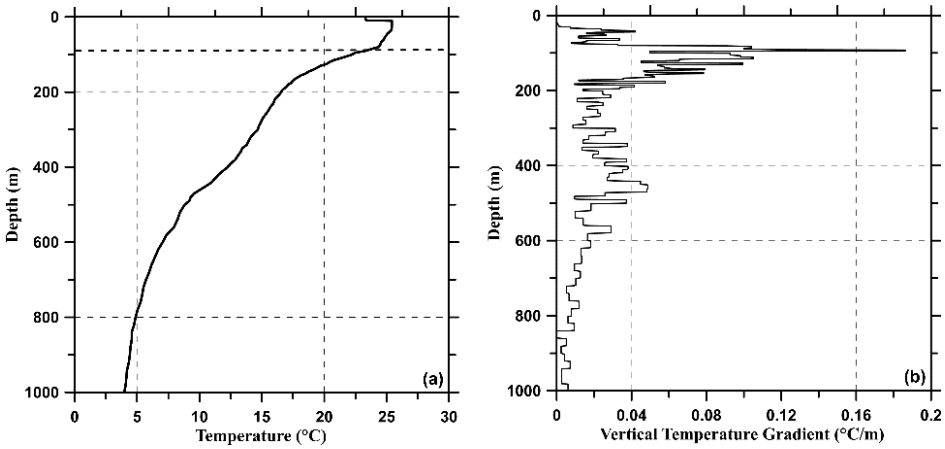


**Fig. 1.** Procedure for determining the thermocline depth a. Argo temperature profile; b. vertical temperature gradient of the Argo temperature profile.