Salt-Stratified Barrier Layers in the Eastern Tropical North Pacific

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A knowledge of the role of salinity in setting the stratification within the upper ocean is important for understanding climate variability, air-sea interaction and biogeochemical processes. For example, salinity stratified barrier layers (BLs) impede heat and momentum exchange between surface and subsurface layers that can significantly affect sea surface temperature and thus impact air-sea interaction. In the north-eastern tropical Pacific Ocean BLs are thought to influence ENSO variability but we know little about the mechanisms that result in their formation in this region. Seasonality and formation of BLs and associated temperature inversions (TIs) in the eastern tropical North Pacific were investigated using Argo profiling float data, satellite data and various sea surface flux data sets. BLs were observed frequently in boreal summer and autumn along the sea surface salinity (SSS) front south of the eastern Pacific fresh pool. TIs were found within the gap between the western and eastern Pacific warm pools in autumn when BLs were thickest. A mixed layer salinity budget revealed that Ekman advection works to freshen the eastern tropical North Pacific in autumn and contributes to the formation of the thickest BLs. Cooler water is also advected by Ekman flows in the gap between the warm pools in autumn contributing to TI formation. Collectively, this suggests the formation of autumn BLs and TIs through the tilting of the SSS front caused by Ekman advection. Since the largest rainfall associated with the Intertropical Convergence Zone (ITCZ) mostly occurred north of the band of thickest BLs in autumn, precipitation is a secondary contributor to BL formation. The idea that Ekman advection contributes most to the formation of the thickest BLs with warm TIs was further corroborated as the horizontal salinity gradient was the dominant contributor to the density gradient, and so favorable for BL and TI formation. BLs are also prevalent during summer but are thinner and without associated TIs and are primary formed through precipitation. The geostrophic advection of salinity did not coherently contribute to the formation of BLs or TIs. In our study, we find that the seasonality of BLs and TIs reflects the wind direction and the intensity of the SSS front. Thus, BLs and TIs may be closely coupled to the trade wind, that is, their presence and thickness are not only affected by the trade wind but in turn can also affect the wind field by modifying the SST.

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