



## **Observed seasonal variability of barrier layer in the South China Sea, from meso to regional scales**

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Based on combined observational dataset, WOD01+SCSIO+ARGO, the collection of 17,898 instantaneous temperature and salinity profiles, the formation mechanisms of the barrier layer (BL) and its seasonal variability in the South China Sea (SCS) are examined. The BL is considerably thicker and more frequent between July and November than in the rest of the year. The BL exceeding 5 m is found in 33.74% of all profiles, with most of those exceeding 25m locates in the southeastern and northern regions. The seasonal variability of BLT is closely related to the processes that occur during summer and winter monsoons. During spring, due to weak wind-driven mixing, little rainfall and surface warming throughout the basin, the MLD and ILD are found to be thinnest and BL is weakest. During summer, the Vietnam offshore current carries a wide band of low-salinity water from the Mekong River mouth and dumps it in the convergence zone among the South Vietnam Anti-cyclonic Eddy. Shallow MLD due to strong haline stratification and deep ILD due to downward convergence develop the thick BL off the southeast of Vietnam. In the Luzon Strait, the SCS water and western Pacific water carried by surface Ekman drift and geostrophic current separately, encounters and forms sharp salinity gradient forms upon the well-mixed high temperature Kuroshio intrusion water, and maintains thick BL. During winter, the BL is weakened due to rapidly rising MLD. Especially in the northern basin, the Ekman pumping in the convergence zone promotes the MLD and ILD deepening along with the effect of turbulent mixing by strong monsoon winds and surface cooling. Along the eastern boundary and in the southwestern basin, the effect of turbulent mixing by strong monsoon winds in deepening the upper layer is opposed by the shoaling caused by Ekman divergence and no BL forms.