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The Transition region Mode Water of the North Pacific and its rapid modification

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The subtropical-subarctic transition region in the North Pacific is the basin-scale boundary region between subtropical and subarctic waters, where the upper region forms a transition from warm and saline subtropical water to cold and fresh subarctic water. The transition region is known to have large signals of decadal and multi-decadal variability of sea surface temperature (SST). Formation and modification processes of water masses in this region need to be understood to clarify how those signals are propagated into ocean interior. Using Argo float data, this study examined the formation region, spatial distribution and modification of Transition Region Mode Water (TRMW), which is a recently identified pycnostad in this region. Analyses of the formation fields of water masses within and around the transition region reveal that TRMW forms in a wide area from the western to central transition region and is separated from the denser variety of Central Mode Water (D-CMW) to the south by a temperature and salinity (T-S) front. TRMW has temperatures of 4-degree to 9-degree-C and salinities of 33.3-34.0, making it colder and fresher than D-CMW. TRMW has a density range of 26.3-26.6 sigma-theta, and thick TRMW is widely distributed in the transition region. However, the range of the T-S properties at TRMW cores is substantially reduced downstream within 10-degree to 20-degree longitude from the formation region by gradually losing its fresh and cold side. It is also demonstrated that major part of TRMW of 26.4-26.6 sigma-theta is entrained into the mixed layer in the following winter. Quasi-Lagrangian observation by an isopycnal-following Argo float demonstrates that the double-diffusive salt-finger convection plausibly causes not only rapid erosion of the TRMW pycnostads but also increase of salinity and temperature at the TRMW cores at least to some degree. It is demonstrated that strong salt fingering within TRMW is probably caused by geostrophic currents with vertical shear crossing the density-compensating T-S front that brings warm and saline water to the upper TRMW and creates instability in the salinity stratification. This modification process could explain why water that is subducted from the transition region and constitutes the pycnocline of the subtropical gyre in the North Pacific has different T-S properties from the winter mixed layer of the transition region. This knowledge about the modification process of the subducted water in the transition region would help to model the permanent pycnocline structure more realistically and to clarify how the large signals of decadal and multi-decadal SST variability in this region are propagated into the permanent pycnocline.