Study on dependence of atmospheric responses on wind directions over the Kuroshio front

笠毛, 健生

https://doi.org/10.15017/1500768

氏　　名：　笠毛　健生

論文題名：Study on dependence of atmospheric responses on wind directions over the Kuroshio front
（黒潮前線上の風向に対する大気応答の依存性に関する研究）

区　　分：甲

論　文　内　容　の　要　旨

To understand regional scale air-sea interactions over the Kuroshio front in the East China Sea, we focus on the wind directions over the Kuroshio front. This is because the dependency of the air-sea interactions on wind directions is likely to occur due to the horizontal variation (hence, divergence/convergence) of wind speed over the spatially variable oceanic fronts, although it has not been well investigated yet in the East China Sea. In investigating the dependency of wind direction, we separate this study into two parts with different timescales; the first one is the case with timescale shorter than a week, and the other deals with the phenomena with a timescale much longer than the former case.

In the first half of this thesis, a field measurement was conducted using both expendable bathythermographs and Global Positioning System sondes released concurrently across the Kuroshio front in the East China Sea in December 2010 to confirm whether surface winds strengthen above warm waters around oceanic fronts using in-situ data. In contrast to previous studies mainly based on satellite observations, the local weakening of surface winds is found to the present field survey at the northern flank of the Kuroshio front. From the above field observation in conjunction with a regional numerical model experiment, it is suggested that the cold and dry northwesterly winds crossing the Kuroshio first weaken at the northern flank of the front because of the onset of upward transfer of the “nonslip” condition at the sea surface. Thereafter, as the atmospheric mixed layer with warm and humid air mass develops gradually downwind over the Kuroshio region, the surface winds are gradually accelerated by the momentum mixing with strong winds aloft. The surface winds remain strong over the cool East China Sea shelf, and it is thus considered that the surface winds only weaken at the northern flank of the Kuroshio front. However, numerical modeling indicates that this local weakening of the surface winds occurs as a transient state with a short duration and such a structure has thus rarely been detected in the long-term averaged wind fields observed by satellites.

In the latter half of this study, to investigate atmospheric responses to different surface-wind directions over the Kuroshio front in the East China Sea, composite maps of sea surface temperature (SST), wind speed, precipitation, turbulent heat flux, surface wind divergence, and surface wind curl are depicted by sorting out the periods with intense northeasterly (along the Kuroshio front) and northwesterly (across the front) winds over the East China Sea using satellite-derived datasets in winter, because as above study, the wind directions over the Kuroshio front are suggested to important factor of the air-sea interaction in the East China Sea. In the period when northeasterly winds prevail, large precipitation occurs on the offshore side of the Kuroshio front than the period with prevailing northwesterly winds. First, the northeasterly winds strengthen above the Kuroshio by the downward momentum transfer from the fast-moving air at higher levels. Second, a cyclonic vortex forms on the offshore side of the Kuroshio, and thereafter, the surface-wind convergence via the Ekman suction (hence, high precipitation) occurs over the East China Sea shelf breaks. The northeasterly winds blow over the East China Sea when the Aleutian Low retreats to the east, and when high sea-level pressure (SLP) occupies in the northern Japan Sea. On the other hand, the northwesterly winds prevail over the East China Sea when extratropical cyclones develop over the Japan Sea. Thus, the suggestion is a regional teleconnection between the precipitation in East China Sea and the SLP (also, precipitation) in northern Japan Sea, and the teleconnection is mediated by the Kuroshio front along the East China Sea shelf break.