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Response of atmospheric pressure to sea surface temperature over the Kuroshio Extention

KAWAI, Yoshimi[1*], Hiroyuki Tomita[1]

[1]Japan Agency for Marine-Earth Science and Technology

The western boundary currents transport warm water from the tropics to the mid-latitudes, and forms sharp surface temperature fronts in the west of the oceans. The annual mean climatology of surface heat flux is the largest over the Gulf Stream and the Kuroshio and its extensions. The effects of the large heat flux over these regions on the mid-latitude atmosphere have attracted much attention. For example, some researchers showed from in situ data that seasonal mean sea level pressure (SLP) was locally minimum (trough) and the surface wind converges except summer on the southern flank of the Kuroshio Extention (KE) front, where sea surface temperature (SST) and surface turbulent heat flux are the maximum (Tokinaga et al., 2009; Tanimoto et al., 2011). However, they showed only climatological features and the spatial resolution of the historical in situ dataset they used was coarse. We need to clarify the response of the lower atmosphere to SST fronts on a finer scale to fully understand the mid-latitude air-sea interaction.

Two surface buoys have been moored north and south of the KE front (about 38.1N, 146.4E, and about 32.4N, 144.6E). Both the buoys measure SST, SLP, and some other meteorological factors. We performed meteorological observations across the KE front between the two buoys to investigate atmospheric responses to SST. Surface meteorology and SST were continuously observed on the moving research vessels, and the radiosondes were also launched at intervals of 0.25-0.5 degree in latitude from the vessels. Spatial SLP distribution was extracted by subtracting fixed-point SLP observations at the moored buoys from that observed at a moving ship at the same time.

The spatial SLP anomaly tended to be larger (smaller) where SST was lower (higher) on a scale of about 100 km, although they did not always clearly correspond to each other. The radiosonde observations showed that the atmospheric mixed layer became higher over the warmer SST, which is consistent with the former studies. Furthermore, it appears that the low-level air converged over the warmer SST, although the zonal wind component could not be considered in this study. This means that local circulations similar to the sea breeze circulation might have been formed over the SST fronts. The spatial scale of this circulation was 100 km or more, which is larger than the typical sea breeze circulation. High-resolution SST is necessary to simulate such phenomena in atmospheric numerical models. However, we found that there can be large discrepancies between in situ and satellite microwave SSTs around the fronts.

Keywords: air-sea interaction, mid-latitudes, Kuroshio Extention, sea level pressure, sea surface temperature, local circulation