

Observation of Structure of Marine Atmospheric Boundary Layer by Ceilometer over the Kuroshio current

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We have employed shipborne ceilometer for observing cloud and aerosols over the ocean for the last decade. These data have been widely used for the study of the interaction between atmosphere and ocean. In addition, the heights of marine atmospheric boundary layer (MABL) are also automatically derived with Vaisala BL-View (Boundary Layer View Software), which attribute to integrating study with the radiosonde and comprehensive cruise data on the research vessel.

In May 24-31, 2021, the research vessel “Shinseimaru” (66 m, 1635 ton) of Japan Agency for Marine-Earth Science Technology (JAMSTEC) was conducted for Kuroshio (warm current from southern Japan) and its causal effects study. This study is involved in “Mid-latitude ocean-atmosphere interactions hotspots under the changing climate” of Granted-in-Aid for Scientific Research on Innovative Areas, Minister of Education, Culture, Science and Technology. We installed a CL31 ceilometer on the compass deck and continuously operated. The research vessel cruises over the large meandering Kuroshio and its associated cold eddy. Therefore, the large gradient in SST across the Kuroshio would cause large influences on the lower atmosphere.

In this study, we applied BL-View after the cruise. Here we present the results from BL-View 1.0 with the default parameters. During the cruise, the radiosonde observations were performed for 31 times extensively. A reasonable agreement of the MABL structure was obtained between the radiosonde and the ceilometer. The lowest ABL is often defined as the height where the virtual potential temperature increases by 1 degree C from the surface (Tokinaga et al., 2006). Thus determined ABL agree with the lowest Boundary Layer Height (BLH) by the BL-View more than 70 %. In addition, elevated 2nd and 3rd BLH often supported by the inversion observed by radiosonde.

During the cruise, interesting transitional phenomena was observed when across the Kuroshio to the cold eddy. $S=SST-SAT$ (surface air temperature) is considered as the parameter of atmospheric stability near the surface. Over the warm Kuroshio, the BLH is enough high as 500 to 800 m, continuously with the high S of up 2.5 deg. C was observed. At the boundary between the Kuroshio and the cold eddy, fluctuated S oscillation was observed and the ABL follows with S behavior well. After entering the cold eddy, the shallow ABL arose from the surface and developed up to 300 m in noon. Even over this cold eddy, the afloat BLH have been still observed. Thus, it seems that there are two major ABL components in this region; continuously existing relatively higher ABL / residual layer associated with the Kuroshio warm current, and diurnally developing shallow surface layer on the cold eddy near the land.