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Low cloud distributions around anticyclone observed by the CALIPSO satellite in the mid-latitude ocean

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Cloud cover is important to analyze the future climate change because variations of cloud cover largely affect the global radiation budget. Low cloud thickness is sometimes a few hundred meters so that most of global climate model cannot simulate correct features of low cloud with their poor vertical resolution. Therefore many previous studies have prospected the factor which controls the variation of low cloud cover. Wood and Bretherton (2006) reported that a strength of inversion above a marine boundary layer strongly governed seasonal variations of low cloud cover. This is because the strong inversion tends to catch water vapor from the sea surface, and then to make thick low cloud under the inversion.

Most of previous studies have focused on the subtropical west coastal ocean where low cloud is dominant all year around. In contrast, the analysis of low cloud in the mid-latitude ocean is still not sufficient partly because it is difficult to observe low cloud with a satellite due to high cloud cover. Moreover in the mid-latitude ocean, it is necessary to analyze shorter time scales than in the subtropical ocean due to prevailing moving cyclones and anticyclones. On such a time scale, we need to consider many factors such as a large scale descending motion, warm or cold advections near the sea surface, and ocean surface wind speed in addition to the strength of inversion. Therefore this study first investigated horizontal distributions of the inversion strength above marine boundary layer and moving cyclones and anticyclones in the mid-latitude ocean with every six hours reanalysis data. As a result, it was found that the inversion above marine boundary layer became strong around anticyclones and on the other hand weak around cyclones in the mid-latitude ocean.

Norris and Iacobellis (2005) reported that low clouds over the mid-latitude ocean had a particular distribution around cyclones and anticyclones as well as inversion strength. However in this report, the accuracy of height information is rough because the cloud top height is retrieved from the infrared brightness temperature observed by satellites. And the analysis region is limited in the northern Pacific region which has many ship passages because this study uses ship observations in order to distinguish low cloud types.

Low cloud height above the marine boundary layer is important to analyze low cloud cover variations because low cloud height affects a convective structure within the marine boundary layer. Therefore this study utilized the CALIPSO satellite which can observe vertical distributions of cloud fractions, and analyzed vertical structure of low cloud around cyclone and anticyclone in detail. As the result it was found the correspondence that low cloud height became low where a large scale descending motion was strong in the mid-latitude ocean. Another result is that low cloud around anticyclones in the northern Pacific ocean has somewhat different distributions from that in the southern Pacific ocean because in the northern Pacific ocean the structure of marine boundary layer may be affected by a strong subtropical anticyclone in summer and by a strong cold air from the Asian continent in winter. On that day we will present the result how do the difference of the factors, inversion strength, a large scale descending, warm or cold advection over the sea surface, affect low cloud cover and the visible optical thickness of low cloud respectively.

Instead of the CALIPSO vertical feature mask (VFM), we utilize new cloud mask data which are developed in Hagihara et al. (2010). This new cloud mask data overcome the problem which the CALIPSO VFM may mistake aerosol or noise for cloud, and as the result improve overestimation of low cloud cover (Rossow and Zhang., 2010). This work was supported by JSPS KAKENHI Grant number 22340133.

Keywords: low cloud, mid latitude, CALIPSO, anticyclone, inversion, marine boundary layer