Multilayer Cloud Characteristics over the North Pacific Ocean Obtained from CloudSat/CALIPSO Combined Data

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Clouds have a large impact on the hydrological system and Earth’ s energy budget. Many previous studies identified clouds as an important source of uncertainty when attempting to understand and predict global climate change (*e.g.*, *Stephens,* 2005; *Dufresne and Bony,* 2008). Cloud effects are strongly regulated by their microphysical (particle size, number concentration, and mass density of water or ice particulates) and macrophysical (temporal frequency, height, geometrical thickness, and rainfall intensity) structures. For example, *Kawamoto and Hayasaka* (2008) reported that surface radiative flux was dominated by cloud optical thickness and cloud cover. However, in the case of a structure where the upper cloud and the lower cloud vertically overlap, the influence of the upper cloud on the lower cloud is not known in detail.

In this study, we investigated the difference in the cloud geometrical thickness and maximum radar reflectivity between single and double layered-clouds. As a result, we found that lower cloud of the double layered-clouds were geometrically thinner than the single layer clouds, and those radar reflectivity decreased. Significant differences were observed when the upper clouds were geometrically thick. Altostratus clouds were dominated in the upper clouds over the northern part of the North Pacific Ocean, and upper clouds were geometrically and optically thicker than in other regions. Therefore, we concluded that growth suppression effect was strongly observed in this region.

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