The Cloud Top Heights of Marine Low Clouds and the Frequency of Marine Fog over Mid-Latitudes, and their Controlling Environment

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While cloud amount of marine low-clouds is mainly controlled by a stability of a lower troposphere, which is substantially determined by the difference between SST and temperature of a mid-troposphere, low-cloud amount has a significant influence on SST through an interruption of solar insolation. It means that there is a strong interaction between marine low-clouds and the ocean.

Though marine low clouds over subtropics have been studied extensively, those in the mid-latitudes have received less attention than subtropical ones. Studies associated with cloud top height is very few, although we can find several studies related to low-cloud amount over the mid-latitudes. Therefore, the cloud top height of marine low-clouds in the mid-latitudes is investigated here in detail using cloud mask data, which are based on observations from the CALIPSO satellite. It became possible to reveal cloud top heights globally only after CALIPSO satellite was launched.

This study provides a comprehensive overview of the observational characteristics of variations in cloud top height of marine low-clouds and fog frequency over the mid-latitudes. Seasonal variations in the cloud top height of mid-latitude marine low-clouds were determined, as well as the differences in these seasonal variations between the Northern and Southern hemispheres. While clear seasonal variations in the frequency of fog occurrence are found over the North Pacific and the northwest Atlantic, the fog frequency over the Southern Ocean is almost constant irrespective of the season. Furthermore, controlling meteorological fields, including SST, which cause these characteristics and variations, were investigated. High correlations were found between the low-cloud top height and stability indexes, and between the fog frequency and some surface parameters including temperature difference between the surface air and the sea surface (Fig. 1).

Keywords: mid latitude, marine low clouds, marine fog

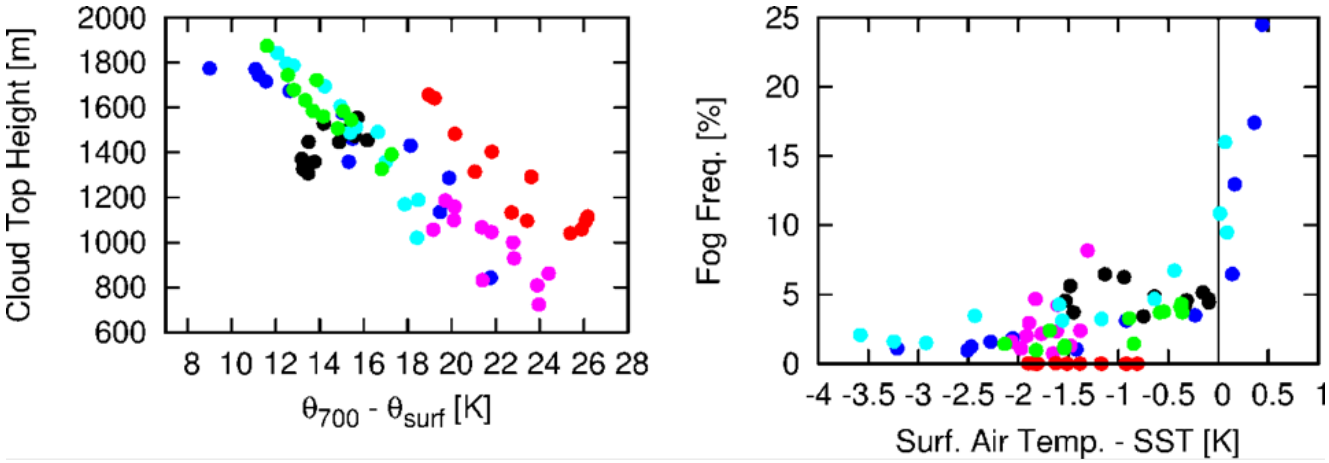

Fig. 1. The relationship between cloud top height and a potential temperature difference $\theta_{700}-\theta_{surf}$ (left), and the relationship between fog frequency and temperature difference between the surface air and the sea surface (right). Areas investigated in the present study: the North Pacific (blue), the Southern Ocean (black), the northwest Atlantic (light blue), the northeast Atlantic (green), off California (pink), and off Peru (orange).