The Distribution of Supercooled Water Clouds from Himawari-8 Measurements and Optical Properties of Its Particles

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Abstract: The distribution of supercooled water clouds (SWCs) is an essential factor for artificial rainfall, aircraft icing and radiative energy balance of climate model simulation. However, it is challenging to detect SWCs using only passive satellite measurements. Based on the characteristic that the distribution of SWCs is sensitive to cloud effective radius (CER) values, and SWCs may appear in mixed-phase clouds identified by satellites, we introduce CER and cloud phase (CPH) information, combined with cloud top temperature (CTT) and cloud optical thickness (COT) properties existed in the previous SWCs detection method, to develop a high accuracy algorithm. It is applied to Himawari-8 full-disk observations, and the hit rate (HR) and false alarm rate (FAR) validated against lidar measurements are 93.52% and 25.27%, respectively. Furthermore, we use algorithm results to analyze SWCs occurrence frequency. SWCs mostly appear over ocean near storm tracks and higher latitude regions. Fewer SWCs over land are mainly observed in East Asia and between 60°S and 30°S. In China and northern hemispheric storm tracks, more SWCs occur during winter and spring. The seasonal distribution feature is opposite for oceans in southern hemisphere.

In order to retrieve optical properties of SWCs, we choose the droxtal habit as a cold cloud particle to investigate its single scattering properties. We compare the single scattering properties (e.g., phase functions) between droxtals and sphere particles at different wavelengths. Furthermore, the droxtal habit model is installed in RSTAR7 radiative transfer model to simulate the satellite observed radiance reflected by SWCs. As a future work, we plan to develop a look-up table for estimating optical properties of SWCs.

Keywords: Himawari-8, supercooled water clouds, distribution, droxtals, optical properties