Cloud particle observation using Cloud Particle Sensor and its possibility of application to aircraft observation

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To understand microphysical processes in a precipitation system, it is necessary to grasp properties of particles; such as their size, phase (liquid or solid), shape, and number concentration, by direct (in situ) observations using aircraft or balloon. The Hydrometeor Videosonde (HYVIS) is a balloon-borne instrument. It can capture images of particles and transmits movie data by 1680 MHz band. In particular, it is useful to confirm the shape and size of ice crystal. The drop-type HYVIS (HYDROS) was developed and applied to aircraft observations (Murakami et al. 1994), however, there are several problems of HYDROS; such as the frequency of data transmit (1680 MHz band is not suitable to transmit data in long distance from the instruments to the receiver equipped on the aircraft), its weight and cost.
Recently, the Cloud Particle Sensor (CPS: Fujiwara et al. 2016) is developed. It is equipped with a diode laser at ~790 nm and two photo detectors with a polarization plate for one of the detectors. It can observe number of particles, their size ranging from 2 to 80 micrometers, and phase by degree of polarization. It transmits the particle information using 400 MHz band that is same as the GPS sounding observations. It has small (approximately 15 cm * 10 cm * 10 cm) size, light weight (~200 g), and relatively low cost with the HYVIS, thus we can expect to apply it to the aircraft observation. In the present study, we introduce the preliminary analysis using CPS soundings and discuss their possibility of application to the aircraft observation.
We conducted a filed observation at Okinawa in the Baiu season in 2016 and launched 4 CPSs combined with HYVISs and 2 CPSs with and without light shading tubes. All CPSs combined with GPS radiosondes, thus particle information can be obtained with altitude, temperature, and humidity simultaneously. The CPS is able to observe the particle information not only during the ascending period, but also during the descending one after the balloon bursts, therefore, it is possible to make the CPS dropping observation from the aircraft. The degree of polarization below the melting level is greater than 0.5 and is different from that above the melting level. This fact shows that the phase of particles can be clearly distinguished below the melting level by the CPS, however, supercooled waterdrops cannot be identified. The CPS sometimes observes noise that the detector receives direct or reflecting light from the sun or ground surface during the daytime. To reduce the noise, it attaches light shading tubes both at the upper and lower inlets. By attaching the tubes, we confirm that the obtained number of liquid particles with tubes is reduced over 10 times lesser than that without tubes. On the other hand, that of solid particles is reduced about 70-80%. Since the aircraft observation is expected to be conducted during the daytime, the noise in the thick cloud layer without tubes should be evaluated.

Keywords: Aircraft observation, Cloud microphysics, In situ observation, Cloud Particle Sensor (CPS), Hydrometeor Videosonde (HYVIS)