Advances in Detection of Volcanic Ash from Commercial Aircraft

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Volcanic ash remains a continuing problem for commercial aircraft operations, sometimes leading to significant flight delays, airport closures, course deviations and damage to airframes and gas turbine engines. The brute force solution when ash encounters are expected is to either delay or cancel a flight or to drastically reroute the aircraft if the ash layers can be accurately forecast, something that is a challenge for operational forecast models.

Commercial aircraft currently do not carry standard sensors to detect the presence of any type of airborne aerosol particles. Larger aircraft with weather radar will be able to detect clouds with hydrometeors larger than 100 µm, but ash or dust layers generally contain finer particles and are undetectable using these sensors. In addition, given that these layers are generally less than several hundred meters thick once they are more than several hours from their source region, they are visually undetectable by flight crews as they are challenging to discriminate from water clouds by eye.

The next generation backscatter cloud probe with polarization detection (BCPD, is now undergoing performance testing and can differentiate atmospheric particle types as shown by laboratory tests (Fig. 1). The BCPD is a single particle detectors, permitting high sensitivity to the smallest quantities and rapid detection (within seconds) to alert flight crews.

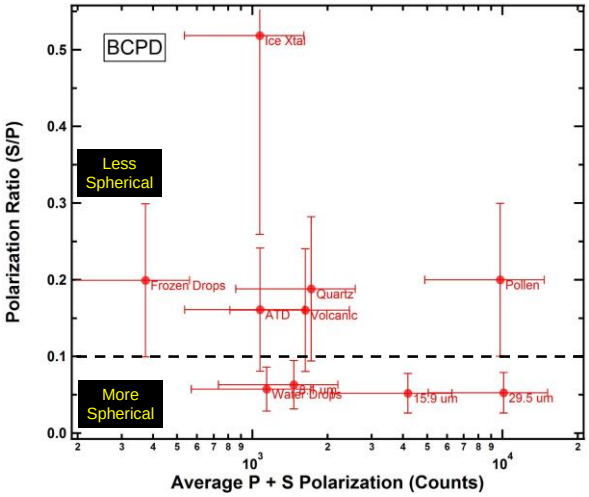

Figure 1. Laboratory results showing response of BCPD to different particle types.

The polarization ratio measured by the BCPD is used to discriminate spherical particles from aspherical particles and water droplets have ratios clearly less than frozen droplets, dust (ATD) or volcanic ash.

In the summer of 2015 the BCPD was flown on a light aircraft multiple times through the plume of the Sakurajima volcano (Fig. 2).

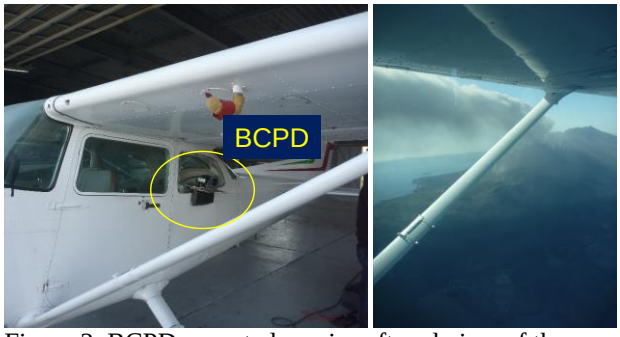

Figure 2 BCPD mounted on aircraft and view of the volcano plume prior to sampling.

The measurements were analyzed and plotted along with the laboratory results (Fig. 3), showing that the volcano plume, as expected so close to its source, was a mixture of ash particles and water droplets

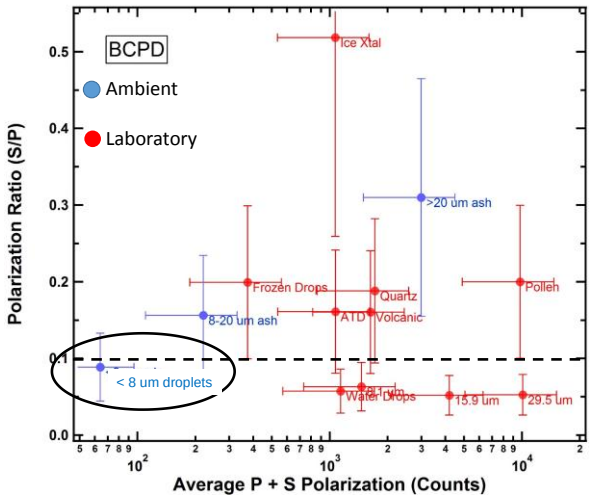

Figure 3. The measurements made in the ambient air, during volcano plume penetrations, are compared with the laboratory results.

These results, although very preliminary, demonstrate that the BCPD is capable of rapidly discriminating ash and dust particles that may be embedded in clouds and would be a useful tool for commercial aviation to avoid even low concentrations of ash or dust that might be hazardous to flight safety.