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航空機搭載 CVI を用いた大気エアロゾルおよび雲残渣粒子の直接観測
Direct measurement of aerosols and cloud residues using airborne CVI

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The POLARCAT (POLar study using Aircraft, Remote sensing, surface measurements and modelling of Climate, chemistry, Aerosols and Transport), is an international program endorsed as part of the 4th International Polar Year (IPY) in 2007 and 2008 (co-sponsored by ICSU/WMO), which aims to quantify the impact of trace gases, particulate aerosols and heavy metals transported to the Arctic and their contribution to pollutant deposition and climate change in the region. The contribution from the POLCARCAT-France team (http://www.polarcat.no/activities/polarcat-cnrs) involved in-situ aircraft measurements to better quantify the impact of aerosol particle properties on the cloud characteristics in the Arctic during the spring 2008 campaign. The focus of this particular study is to conduct detailed characterization of individual cloud residual and interstitial aerosol particles collected using an airborne CVI (Counterflow Virtual Impactor), and provide insights into the cloud nucleating properties of the Arctic aerosols.

The ATR-42 research aircraft was stationed at Kiruna airport (67^{o}50'N, 20^{o}20'E, 460m a.m.s.l.) in the north of Sweden, from 30 March to 11 April 2008 during the POLARCAT-France spring measurement campaign. The aircraft made multiple level flights in the presence of cloud layers and pollution plumes in the low-mid troposphere (0.3-6 km). Tropospheric aerosol particles as well as residues from various clouds (ice, liquid or mixed phase) extracted by the CVI were analyzed later in the laboratory on individual particles basis under both Scanning and Transmission Electron Microscopes coupled to Energy Dispersive X-ray detectors (SEM- and TEM-EDX).

Submicron Biomass Burning (BB) particles (enriched in K, S and often internally mixed with soot) were characteristically found in polluted air-mass in the Arctic troposphere. Such BB particles were also extracted especially from liquid phase clouds but not as frequently from ice phase clouds. On the other hand, mineral dust, bare soot, flyash and marine (sea salt often enriched in K) particles dominated the submicron ice cloud residues.

The enrichment of marine particles in ice and mixed phase residues and abundance of BB particles as interstitial aerosols found in our study is surprisingly consistent with the results during CRYSTAL-FACE experiments (Cziczo et al., 2004). They also reported high abundance of sea salt found in the ice residue versus a low quantity found in the interstitial aerosol. BB related particles (those with mass spectral features owing to Sulfates, K+, Organics, and NO+), conversely, represents the vast majority of interstitial aerosol particles but with lower representation as ice residue. This similarity is striking considering the different analytical methods involved and geographical settings (i.e. cirrus clouds over Florida in 13km).

Reference:
Cziczo, D. J., Murphy, D. M., Hudson, P. K., & Thomson, D. S., Single particle measurements of the chemical composition of cirrus ice residue during CRYSTAL-FACE., J. Geophys. Res., 109, D04201, 2004.

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