Meteoritic material in aerosol particles observed in the lowermost stratosphere over western Europe

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Airborne measurements of aerosol composition using the bipolar single particle mass spectrometer ALABAMA (Aircraft-based Laser ABlation Aerosol MAss spectrometer, Brands *et al.* (2011)) were conducted during the HALO ML-CIRRUS mission in March/April 2014. The mission included 13 measurement flights over western Europe, focusing on altitudes between 7 and 14 km.

During these 13 flights, more than 22000 ambient aerosol particles which were sampled through the HALO Aerosol Standard Inlet (HASI) were analysed by ALABAMA (size range 150 – 900 nm). In parallel, an optical particle counter (Grimm 1.129) measured the total particle size distribution (d > 250 nm).

The data evaluation of the single particle mass spectra was done with the software tool CRISP (Klimach et al., 2010) using fuzzy c-means clustering. The analysis revealed the abundance of a distinct particle type occurring almost exclusively in the lowermost stratosphere (LMS) but not in the upper troposphere. The positive ion mass spectrum of this particle type is characterised by Mg (24^+) and Fe (56^+), see Figure 1. The isotopic ratios (^{24}Mg, ^{25}Mg, ^{26}Mg; ^{54}Fe, ^{56}Fe) unambiguously identify magnesium and iron. The corresponding negative mass spectrum shows only the HSO_4^- peak at m/z 97^-.

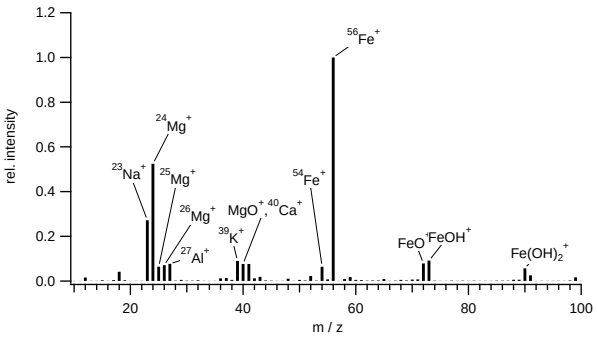

Figure 1. Mean mass spectrum (683 particles) of the particle type observed in the LMS only (2014-04-01).

The mass spectrum shown in Figure 1 corresponds very well to those mass spectra reported by Cziczo *et al* (2001) and Murphy *et al* (2014), describing a type of stratospheric aerosol that consists of sulphuric acid with metals from ablation of meteoroids. We therefore conclude that the particles we observed represent the same particle type.

Observations of non-volatile particles in the stratosphere in the region of the polar vortex have been reported by Curtius *et al* (2005) and Weigel *et al* (2014). The authors assumed meteoritic material as the non-volatile particle component, but their measurements did not include chemical analyses, such that the origin and nature of the particles could not be positively identified. Our data suggest that the existence of meteoritic material in the LMS is frequent and also occurs in mid-latitudes. The fraction of the particles containing meteoritic material measured during two flights (2014-04-01, 2014-04-07) is shown in Figure 2. It appears that these particles contribute to a large fraction to the LMS aerosol.

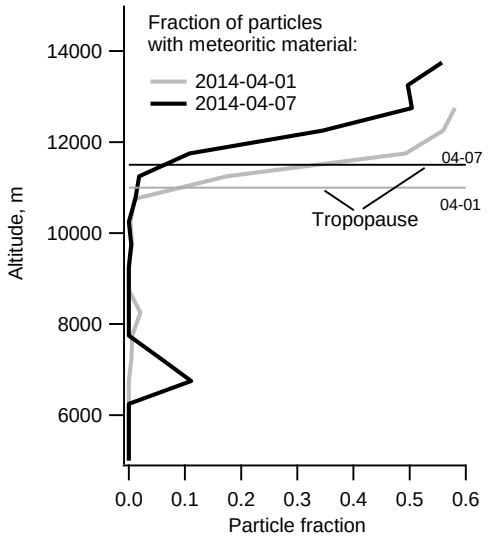

Figure 2. Vertical profiles of the abundance of the meteoritic aerosol particles, relative to the total number of particles analysed by ALABAMA.

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Brands, M., et al. (2011) *Aerosol Sci. Technol.* **45**, 46–64.

Curtius, J., et al. (2005) *Atmos. Chem. Phys.* **5**, 3053–3069.

Cziczo, D.J., Thomson, D.S, and Murphy, D.M. (2001) *Science* **219**, 1772-1775.

Klimach, T., Drewnick, F., and Borrmann, S. (2010) *International Aerosol Conference, Helsinki.*

Murphy, D.M., Froyd, K.D., Schwarz, J.P, and Wilson, J.C. (2014) *Q. J. R. Meteorol. Soc.* **140**, 1269–1278.

Weigel, R., et al. (2014) *Atmos. Chem. Phys.* **14**, 12319–12342.