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Intercomparison of in situ and remote sensing aerosol measurements in the lowermost stratosphere during varying volcanic influence

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In this study two aerosol measurement platforms have been compared. Aerosol optical depth (AOD) per meter in the lowermost stratosphere was obtained with the “In-service Aircraft for a Global Observing System - Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container” (IAGOS-CARIBIC) platform and with the “Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation” (CALIPSO) satellite. The in situ measurements were taken from the IAGOS-CARIBIC platform, where sampling of aerosol and trace gases was undertaken in the altitude range 9 – 12 km from a passenger aircraft, usually on four intercontinental flights a month (Brenninkmeijer et al., 2007). Here we use impactor samples that were analyzed for elemental concentrations with Particle-Induced X-ray Emission (PIXE) and Particle Elastic Scattering Analysis (PESA) (Nguyen et al., 2006; Martinsson et al., 2014). The comparison was based on the sulfurous aerosol, which is the main component of the aerosol in the stratosphere. From the amount of sulfur, the AOD per meter could be estimated, assuming standard stratospheric aerosol composition (75% sulfuric acid and 25% water) and stratospheric background particle size distribution (Jäger and Deshler, 2002). The CALIPSO measurements were taken with a polarization-sensitive lidar with a high vertical resolution, of 30 m at most, using laser wavelengths of 532 nm and 1064 nm. In this study level 1b data was used to calculate AOD per meter. Clouds were removed based on depolarization ratio (Vernier et al., 2009). The results from the two measurement platforms were compared with each other for time periods after the volcanic eruptions of Sarychev (2009) and Nabro (2011) as well as the period from autumn 2013 to early spring of 2014 which had small volcanic influence. The measurements in this study were taken between 40°N and 75°N. Vertical profiles of AOD per meter were created for data above the tropopause. In this study the dynamical tropopause at 1.5 PVU was used (Gettelman et al. 2011). The increase of the AOD per meter with height above the tropopause reflected that the concentration of volcanic aerosols was denser at higher altitudes. After volcanic eruptions the agreement between the two measurement platforms is good except during spring, where substantial differences between the two measurement platforms were observed. These differences could have been caused by a presence of soil dust above the tropopause. For the period of small volcanic influence CALIPSO systematically reported higher AOD per meter values than IAGOS-CARIBIC, thus indicating that aerosol components other than particulate sulfur were contributing to the CALIPSO measurements.

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