Particulate Carbon and Sulfur in the Lower Stratosphere

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Introduction

Previous measurements in the upper troposphere (UT) and the lowermost stratosphere (LS) have indicated the presence of a carbonaceous component in the aerosol (Murphy et al.,1998, Nguyen et al. 2008, Martinsson et al. 2009). Here the occurrence of carbonaceous and sulfurous particles around the tropopause is investigated. The data were taken from the CARIBIC (Civil Aircraft for Regular Investigation of the atmosphere Based on an Instrument Container) platform, where instruments onboard a Lufthansa passenger aircraft on inter-continental flights are implemented for examination of the atmospheric composition in the UT/LS at 8-12 km altitude (Brenninkmeijer et al. 2007). CARIBIC undertakes aerosol sampling for chemical characterization, as well as measurements of particle number concentrations and mixing ratios of a large number of trace gases including O_3, CO, NO/NO_y, Hg, water (gaseous and condensed), acetone, acetonitrile, greenhouse gases and halogenated hydrocarbons. The CARIBIC dataset also contains data on meteorological conditions.

Methods

900 aerosol samples were collected during 200 flights with a typical sampling time of 100 minutes by an impaction technique (Nguyen et al., 2006). Specimen are then analyzed by quantitative multi-elemental analysis by PIXE (Particle-Induced X-ray Emission) and PESA (Particle Elastic Scattering Analysis) to obtain elemental concentrations for sulfur, iron, titanium, potassium, hydrogen, carbon, nitrogen and oxygen among others (Nguyen and Martinsson, 2007).

Results and Conclusions

The concentrations of particulate carbon and sulfur shows an increase from the tropopause into the LS, with a strong dependence on potential vorticity (PV). A seasonal cycle in the concentration to PV ratios is observed in the LS for ozone, carbon and sulfur (Fig.1).

The peak of the oscillations is found in the end of April to the beginning of May for carbon and ozone. The sulfur peak is shifted more than a month in respect to ozone and carbon, indicating different formation patterns for carbonaceous and sulfurous aerosol in the stratospheric circulation.

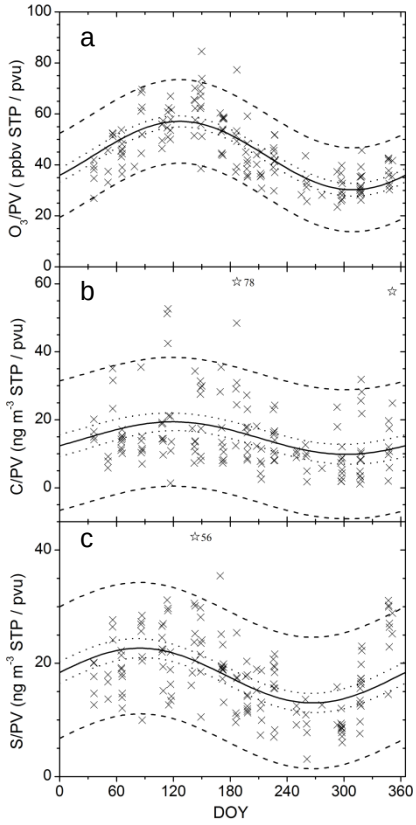

Figure 1. Concentration to potential vorticity ratios vs. day-of-year for a) ozone, b) particulate carbon and c) particulate sulfur, from stratospheric measurements. Solid lines shows regressions. Dotted lines shows 95% confidence interval for model. Dashed lines 95% prediction interval for data. Stars represents outliers not included in the model.

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