Supplementary Information for: Pollution trace gas distributions and their transport in the Asian monsoon UTLS during the StratoClim campaign

Sören Johansson¹, Michael Höpfner¹, Felix Friedl-Vallon¹, Jörn Ungermann², Gerald Wetzel¹, Norbert Glatthor¹, Erik Kretschmer¹, and Ingo Wohltmann³

¹Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany ²Institute of Energy and Climate Research - Stratosphere (IEK-7), Forschungszentrum Jülich, Jülich, Germany ³Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Potsdam, Germany

Correspondence: S. Johansson (soeren.johansson@kit.edu)

Introduction

In this document, supplementary information for retrieved GLORIA trace gases are shown in the following figures. This is followed by a map of total column HCOOH, measured by the Infrared Atmospheric Sounding Interferometer (IASI). In the end of this document, an exemplary analysis of the temporal evolution of the ATLAS trajectories is shown.



Supplementary Figure 1. Illustration of the error budget of the HNO_3 retrieval of StratoClim flight 03 on 31 July 2017 for a selected profile at 05:13:14 UTC. (a) retrieved vertical profile of HNO_3 with total estimated error (black) and initial-guess profile (gray). The retrieved profile has 10.8 degrees of freedom. (b) Total error contributions and estimated total error. (c) Vertical resolution of this retrieval result. The dotted line represents the flight altitude of the aircraft.



Supplementary Figure 2. HNO_3 from StratoClim flight 03 on 31 July 2017: cross section of (**a**) retrieved HNO_3 volume mixing ratio (the ECMWF potential vorticities of 2 and 4 PVU are marked with magenta dashed lines, and the ECMWF 380 K potential temperature level is marked with a green line). Cross sections of (**b**) total estimated error, and (**c**) vertical resolution.



Supplementary Figure 3. Same as Suppl. Fig. 1, but for O₃. The retrieved profile has 9.1 degrees of freedom.



Supplementary Figure 4. Same as Suppl. Fig. 2, but for O₃.



Supplementary Figure 5. Same as Suppl. Fig. 1, but for PAN. The retrieved profile has 13.3 degrees of freedom.



Supplementary Figure 6. Same as Suppl. Fig. 2, but for PAN.



Supplementary Figure 7. Same as Suppl. Fig. 1, but for C_2H_2 . The retrieved profile has 10.5 degrees of freedom.



Supplementary Figure 8. Same as Suppl. Fig. 2, but for C_2H_2 .



Supplementary Figure 9. Same as Suppl. Fig. 1, but for HCOOH. The retrieved profile has 9.9 degrees of freedom.



Supplementary Figure 10. Same as Suppl. Fig. 2, but for HCOOH.



Supplementary Figure 11. IASI HCOOH column measurements over India and southern Asia, averaged between 2017-07-25 and 2017-07-31. The IASI HCOOH Level-2 data was binned and averaged in $1^{\circ} \times 1^{\circ}$ (latitude × longitude) bins.



Supplementary Figure 12. a) Temporal evolution of the first 10 days of ATLAS backward trajectories starting at GLORIA tangentpoints of the region of interest (see Fig. 2 of the main paper) marked red with the first 5 days color coded according to the color bar. Isolines mark the same regions as in Fig. 6b of the main paper. All panels display a map centered at south east Asia and show the undisturbed backward trajectories. For b) and c) The dots mark the location of convective events and are color coded with b) the time difference between the convective event and the time of measurement, and c) the percentage of backward trajectories that already experienced convection until this specific point of a convective event.



Supplementary Figure 13. Same as Suppl. Fig. 12, but for the magenta marked region of interest.



Supplementary Figure 14. Same as Suppl. Fig. 12, but for the orange marked region of interest.



Supplementary Figure 15. Same as Suppl. Fig. 12, but for the blue marked region of interest.



Supplementary Figure 16. Same as Suppl. Fig. 12, but for the purple marked region of interest.



Supplementary Figure 17. Same as Suppl. Fig. 12, but for the cyan marked region of interest.