Using SCIAMACHY and Sonde Data to Observe the Transport of Tropospheric Ozone Over the Tropics

A. Ladstätter-Weißenmayer, S. Bötel, C. v. Savigny and J. P. Burrows

Institute of Environmental Physics, University of Bremen, P.O.Box 330440, D-28334, Bremen, Germany,
(E-mail: lad@iup.physik.uni-bremen.de)

Introduction

Ozone (O_3) measurements from SCIAMACHY(Scanning Imaging Absorption Spectrometer for Atmospheric ChartographY, launched in March 2002, measuring sunlight, transmitted, reflected and scattered by the earth atmosphere or surface (240 nm - 2380 nm) [Bovensmann et al.1999, Gottwald et al., 2006]) are used to characterize the effects of biomass burning at two SHADOZ (Southern Hemisphere Additional Ozonesondes, [Thomson et al., 2003]) ozonesonde stations in the tropics, namely La Réunion (21.06S, 55.48E) and Irene (25.90S, 28.22E). The analysis of tropospheric O_3 was carried out with the Reference-Sector- [Ladstätter-Weissenmayer et al., 2004, Richter & Burrows, 2002] and with Limb-Nadir-Matching method [Sierk et al., 2006]. The validation of both retrieval methods with respect to tropospheric O_3 from the satellite-based SCIAMACHY measurements was carried out with O_3-sonde SHADOZ data whereas the transport of air masses was analysed using the results of the trajectory calculation (backward) for the time period of 2002 to 2006 for La Réunion and 2002 to 2008 for Irene.

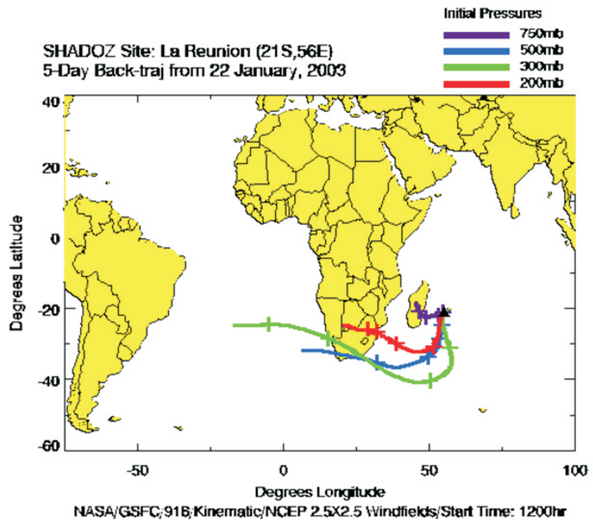
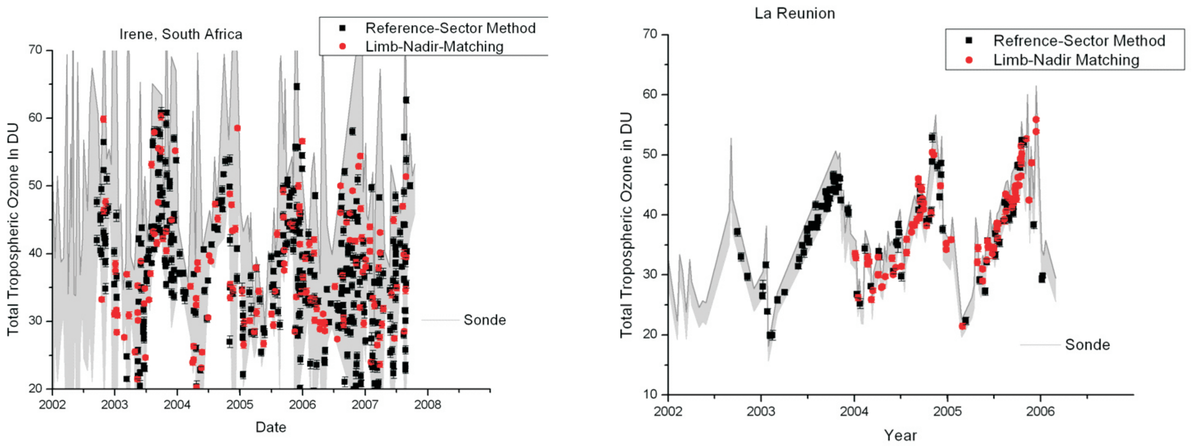


Fig. 4. 5-days back trajectory calculation starting over Irene for the 22nd of January 2003 as an example.

Results

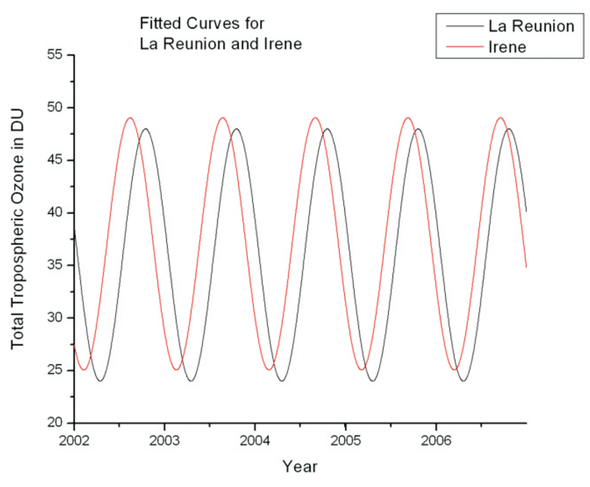
Distinct seasonal patterns of O_3 at each station indicate the strong influence of the African biomass burning [Meyer-Arnek et al., 2005]. A variability of 15-60 DU of tropospheric O_3 including an error of 1 DU and of 5 DU respectively can be seen from satellite based SCIAMACHY as well from sonde data. The results of SCIAMACHY retrieved with the Reference-Sector-Method (coloured black) and with Limb-Nadir-Matching (coloured red) agree with the results of sonde measurements (coloured grey) within their errors (± 1.2 DU for the Reference-Sector-Method and ± 1.0 DU for the Limb-Nadir-Matching-Method) (see Figs. 1 and 2).



Figs. 1 and 2. Timeseries of tropospheric ozone Irene (2002-2008, left hand) and La Réunion (2002-2006, right hand) including the results including error bars of SCIAMACHY (coloured black (Reference-Sector-Method) and red (Limb-Nadir-Matching-Method)) and sonde measuremements (coloured grey).

Comparing the results of La Réunion and Irene (meanvalue of Reference-Sector-Method as well as Limb-Nadir-Matching) a phaseshift of 5.3 days can be seen (see Fig. 3). The 5-days-backward trajectory calculation shows the transport of air masses form Irene towards La Réunion over a distance of ~8000km (see Fig. 4). Assuming a mean wind speed of ~20 m/s an influence of polluted air masses (with respect to tropospheric O_3) from Irene can be observed over La Réunion. In addition to that the influence of the fires over Madagascar should not be neglected.
Additionally an agreement within the margin of error can be seen between the Reference-Sector-, which is the only viable in the tropics, and the Limb-Nadir-Matching method.

Fig. 3. Timeseries of the meanvalues of tropospheric ozone of both stations (La Réunion and Irene) phaseshifted of 5.3 days.



Conclusions

In this study the results of two different retrieval methods (Reference-Sector- and Limb-Nadir-Matching-Method) for the analysis of tropospheric O_3 is shown. The validation with sonde data showed differences of about 5% (agree within the errors of both methods).
Using satellite based SCIAMACHY measurements the increase of tropospheic O_3 caused by the biomass burning events, occurring every year over South Africa can be seen. The trajectory calculation showed that additional input of tropospheric O_3 over La Réunion is caused by the transport of polluted air masses from Irene and Madagascar. The input of the different source regions will be calculated in a next step with a box model. Furthermore the viability of the Limb-Nadir-Matching method outside the tropics will be investigated.

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