Validation of the Limb-Nadir-Matching Method for the Determination of Tropospheric Ozone in the Subtropics and Middle Latitudes

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Introduction

SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric ChartographY) launched in March 2002 measures sunlight, transmitted, reflected and scattered by the earth atmosphere or surface (240 nm - 2380 nm) [Bovensmann et al. 1999, Gottwald et al. 2006]. SCIAMACHY Ozone (O_3) Limb and Nadir measurements can be used to retrieve the tropospheric O_3 column through Limb-Nadir-Matching [Sierk et al. 2006].The thus retrieved results will be compared here with results determined by 6 Ozonesondes, which are part of the WOUDC Database (http://www.woudc.org), between the latitudes 20°N and 40°N. The positions of these Ozonesondes are shown in Figure 1.

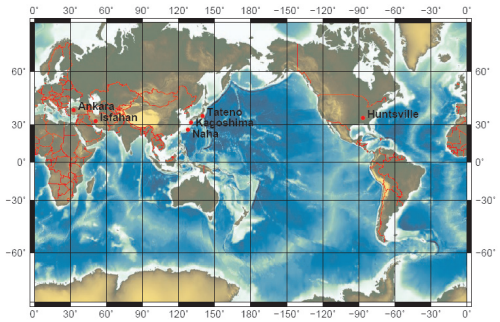

Fig. 1: Map of the Location of the Ozonesondes

Limb-Nadir-Matching

The main idea of Limb-Nadir-Matching is to subtract the stratospheric ozone column from the total ozone column to determine the tropospheric ozone column (Fig. 2). The stratospheric profile is determined from Limb-measurements and the total column through Nadir-measurements. In order to determine the tropospheric column it is necessary to first determine the tropopause height. In this case the tropopause height was determined from ECMWF data using the WMO criterion (the method was validated with temperature profiles profiles from sondes). Using this tropopause height the stratospheric profile is integrated to determine the **stratospheric column**.This stratospheric column can then be subtracted from the **total column** to yield the **tropspheric column**.

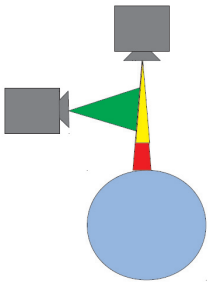

Fig. 2: Limb-Nadir-Matching approach

Clouds

Clouds make it very difficult to determine the total column O_3 directly as the view to the surface is obscured. In order to retrieve the total column O_3 a ghost column [Lerot et al. 2009] signifying the amount of O_3 under the clouds, is often added. For Limb-Nadir-Matching this would mean that significant part of the retrieved tropospheric column will be made up by ghost column. As this can significantly increase the errors in the tropospheric column, retrieved through Limb-Nadir-Matching, only Limb and Nadir pixels that are completely cloud free were used.

Results

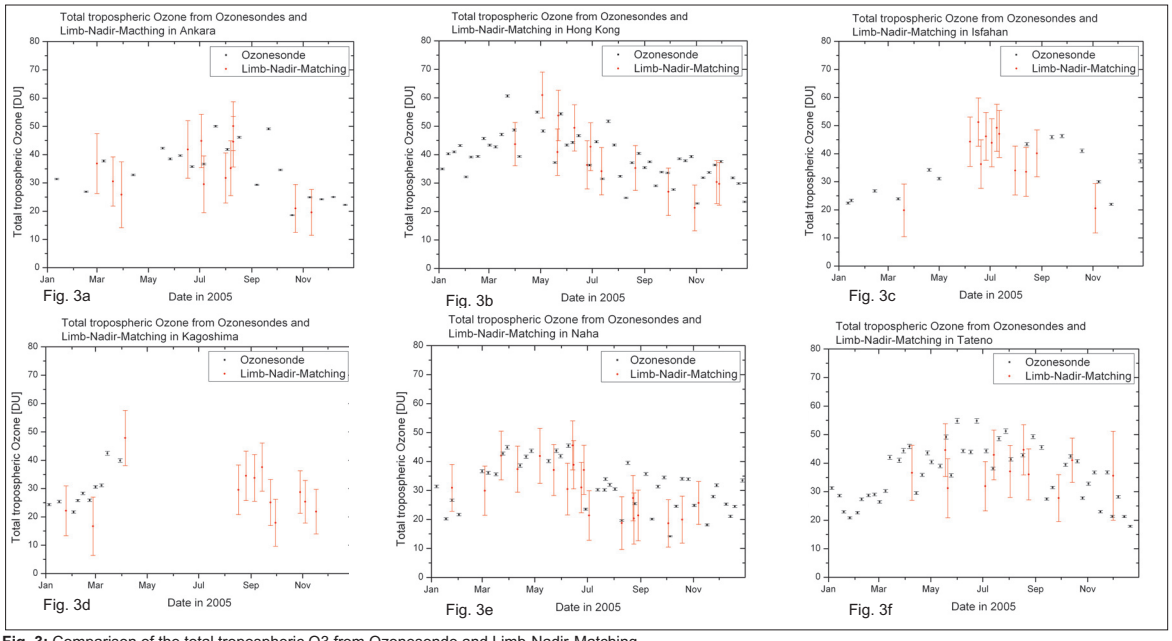

Fig. 3: Comparison of the total tropospheric O3 from Ozonesonde and Limb-Nadir-Matching

Figures 3a-f all show a good match between the tropospheric column determined from Limb-Nadir-Matching and Ozonesondes in 2005. However the focus on only completely cloud free pixels severely limits the number of measurements from Limb-Nadir-Matching. This features prominently in Figure 3c-d. Figures 3c-d show a very limited temporal overlap between Limb-Nadir-Matching and Ozonesondes.

Conclusions

These first results indicate that Limb-Nadir-Matching has the potential to retrieve tropospheric O_3 globally outside the tropics, where the height of the tropopause is more or less constant. In order to use this method on a global scale further validation, in the tropics, subtropics and higher latitudes, has to be conducted using additional Ozonesondes, longer time series as well as other satellite instruments. Additionally the effect of clouds on the retrieval has to be determined in order to get a better coverage.

References

Bovensmann, H., J. P. Burrows, M. Buchwitz, J. Frerick, S. Noel, V. V. Rozanov, K. V. Chance, and A. H. P. Goede, SCIAMACHY - Missionobjectives and measurement modes, J. Atmos. Sci., 56, (2), 127-150, 1999.

Gottwald M., H. Bovensmann, G. Lichtenberg, S. Noel, A. von Bargen, S. Slijkhuis, A. Piters, R. Hoogeveen, C. von Savigny, M. Buchwitz, A. Kokhanovsky, A. Richter, A. Rozanov, T. Holzer-Popp, K. Bramstedt, J.-C. Lambert, J. Skupin, F. Wittrock, H. Schrijver, J.P. Burrows: SCIAMACHY, Monitoring the Changing Earth's Atmosphere; DLR, Oberpfaffenhoffen, 2006.

Sierk, B., Richter, A., Rozanov, A., v. Savigny, C., Schmoltner, A.M., Buchwitz, M., Bovensmann, H., and J. P. Burrows, Retrieval and Monitoring of Atmospheric Trace Gas Concentrations in Nadir and Limb Geometry using the Space-Borne SCIAMACHY Instrument, Environmental Monitoring and Assessment, DOI: 10.1007/s10661-005-9049-9.2006.

Lerot C., Van Roozendael M., van Geffen J., van Gent J., Fayt C., Spurr R., Lichtenberg G., and A. von Bargen, Six years of total ozone column measurements from SCIAMACHY nadir observation, Atmos. Meas. Tech., 2, 87?98, 2009.

CAMS-IAC, & CAS-IAP, & EMA, & HKO, & HKPU, & HSSRV, & IGUT, & IMD, & INME-MU, & INTA, & JMA, & KMA, & MDI, & NASA-TOMS, & NASA-WFF, & NOAA-CMDL, & NSF, & PMD, & RMDA, & TSMS, & U_Aleppo, & U_Athens, & UAH, & USDA_CSU, & Yonsei_U. World Ozone and Ultraviolet Radiation Data Centre (WOUDC) [Data]. Retrieved February 24, 2010, from http://www.woudc.org.

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