Tropospheric Ozone from Limb Nadir Matching method between MIPAS and SCIAMACHY

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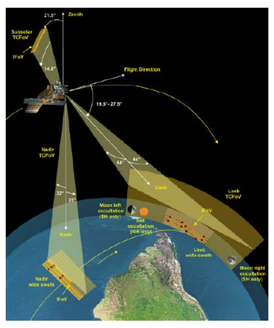
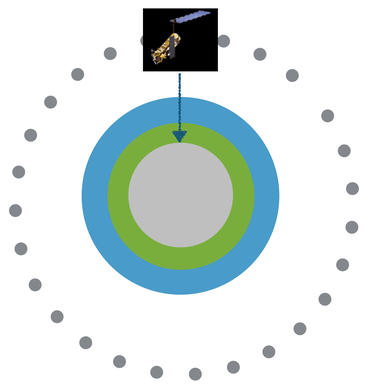
Abstract

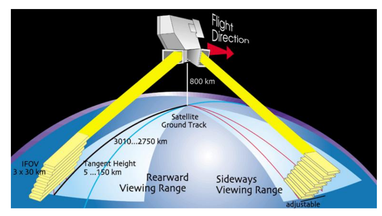
The tropospheric total ozone column (TTOC) is retrieved by applying the limb nadir matching algorithm (LIMONADE) for two different sensors on board the Envisat satellite. Each sensor provides independent information of the total ozone column (TOC, nadir) and stratospheric ozone column (SOC, limb). The latter is derived from the limb viewing geometry of MIPAS (Michelson Interferometer for Passive Atmospheric Sounding), while total ozone column (TOC) from the nadir viewing SCIAMACHY (SCanning Imaging spectrometer for AtMospheric CHartographY) measurements. The residual ozone column or tropospheric total ozone column (TTOC) is then derived by subtraction of the SOC from the collocated TOC. Although this method is straightforward, the underlying difficulties are the exact knowledge of the tropopause height, matching/collocation of the two measurements, and instrumental differences between two sensros (backward viewing). Our results from MIPAS – SCIAMACHY (MICHY) are compared with available tropospheric ozone columns derived from the SCIAMACHY – SCIAMACHY (CHYCHY) limb-nadir combination in order to understand the differences and the potential of limb nadir method (LIMONADE algorithm) for different sensor combination.

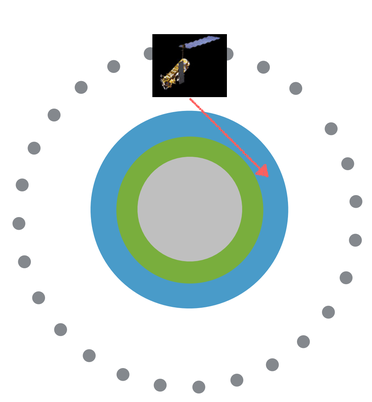
SCIAMACHY

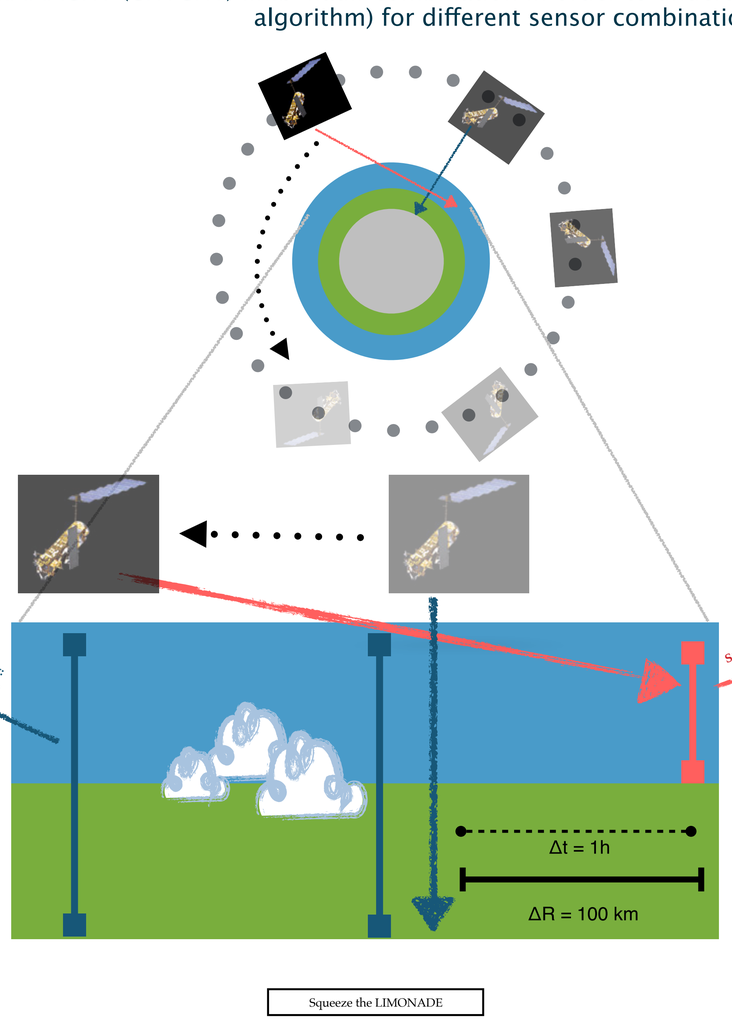




MIPAS







Observation with model as 1st guess by applying the Taylor method. Unknown fitting parameters derived by minimization

$$R_{obs} = R_{mod} + \frac{dR_{mod}}{dTOZ}(TOZ_{fit} - TOZ_{clim}) + \frac{dR_{mod}}{dT}(T_{fit} - T_{clim}) + .. + Polynomial$$

Total Column

Weighting function for total ozone

Weighting function for temperature

Coldewey-Egbers et al., 2005

Z_i

Z_i-1

Ozone (Z_i)

Ozone (Z_i-1)

Stratospheric Column

$$C = \sum_{i_{tph}}^{i=80} \left(\frac{N(z_{i-1}) + N(z_i)}{2} \right) (z_i - z_{i-1})$$

Ebojie et al., 2014, Jia et al., 2015

Squeeze the LIMONADE

Selection of time vector

Closest TPH (Tropopause Height) info selected

SCIA time 10:25

TPH 00 | TPH 06 | TPH 12 | TPH 18 | TPH 00

Stratospheric Column

TPH < 15.3 km Rejected

Only visibility free measurements!

Vis_free = 15.3 km

Total Column

Tropospheric Column

Tropospheric=Total-Stratospheric

Selection of TPH from closest time vector

TPH 12

A | B | C | D

Pixel

TPH: 12.0 km

TPH: 11.8 km

Minimum TPH

TPH: 11.6 km

TPH: 12.9 km

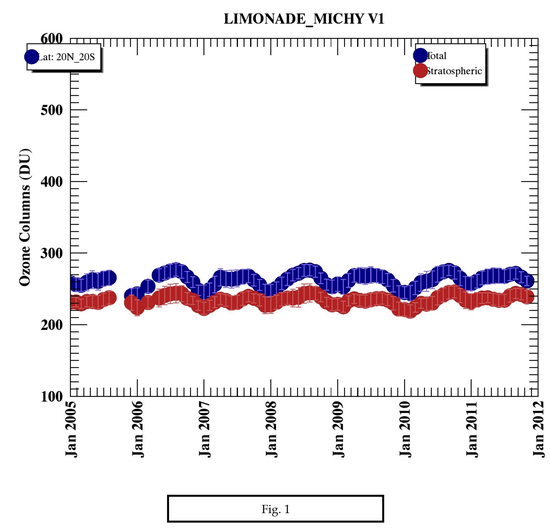


Fig. 1

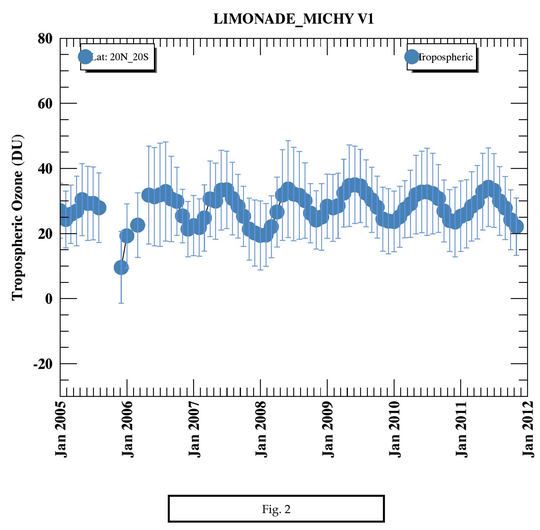


Fig. 2

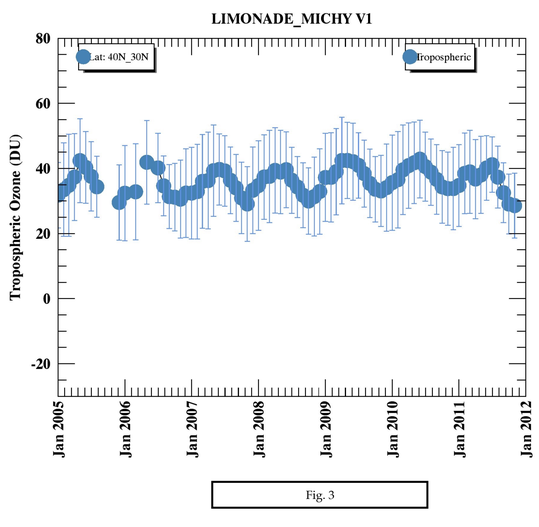


Fig. 3

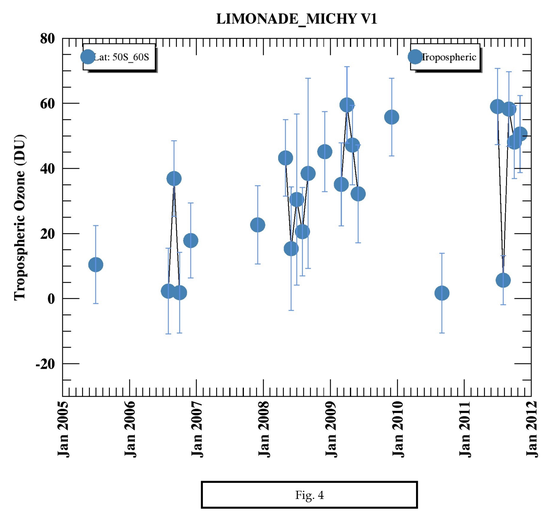


Fig. 4

Summary

The method applied on two different sensors gives solid results in terms of reproducing the tropospheric ozone columns and seasonal variability in the Northern Hemisphere as can be observed in Figs. 2-3 from total and stratospheric ozone columns (Fig. 1). For mid-latitudes in Southern Hemisphere (Fig. 4) this method can not deliver reliable results. The reason is essentially the viewing geometry of the MIPAS sensor, which has limb viewing backwards to the flight direction, and this can lead to forward scattering. Further reasons are mismatching between nadir and limb pixels in Southern Hemisphere due to orbital track over South Pole and backward viewing of limb pixel to match the nadir pixel. This can be solved by optimization of the collocation criterion between the different sensors.

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References

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