Tropospheric NO2 from SCIAMACHY limb/nadir matching

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Introduction

- NO2 is an important tropospheric pollutant: O3 smog, acid rain
- Global measurements are available from satellite instruments, e.g. SCIAMACHY
- When measuring tropospheric pollution, must account for stratospheric NO2 layer
- Traditionally, Pacific Ocean was defined as "clean" and taken as stratl. signal
- SCIAMACHY offers additional

Calculating strat. vertical columns

- Integrate limb profiles (12km - 40km)
- Consider each limb state individually
- For each limb state, interpolate one value per limb state, using latitude
- For each latitude, consider the limb state's line-of-sight
- For each nadir measurement, interpolate stratospheric column using the pixel's line-of-sight
- Limb columns differ from nadir columns over clean regions (Pacific Ocean)
- When assuming no tropospheric NO2 over Pacific, we need to apply linear offset to vertical limb columns

Error analysis

- Error in nadir slant columns: 2-4 10^14 molec. cm^-2
- Error in limb profiles from noise and smoothing: 15-20%
- Error from lightpath uncertainty: up to 20%
- Tropospheric reference sector not perfectly clean; need to add tropospheric background from model
- Stratospheric a priori for nadir zonally constant
- Nadir-columns not T-corrected (243K)
- No limb measurements lower than 12km and above 40km: need to account for missing and tropospheric parts of profile

These errors are partially accounted for by scaling limb columns to nadir columns over the Pacific Ocean. Only their zonal variability contributes to the total error.

Still, the resulting tropospheric data product looks remarkably good!

Summary

- Per-pixel calculation of stratospheric NO2 columns using the same instrument as for nadir columns
- Absolute difference between nadir and limb columns accounted for using latitude-dependent offset
- Absolute difference between nadir and scaled limb columns is still high
- Resulting tropospheric columns show almost no negative values

Selected References

- Behrens, S. et al., Retrieval of tropospheric NO2 columns from combined SCIAMACHY nadir/limb measurements, Atmos. Meas. Tech. 3, 283-299, 2010
- Boersma, K. F. et al., Error analysis for tropospheric NO2 retrieval from space, J. Geophys. Res. 109, D23S11, 2004
- Pajala, J. et al., The effect of horizontal gradients and spatial measurement resolution on the retrieval of global vertical NO2 distributions from SCIAMACHY measurements in limb-only mode, Atmos. Meas. Tech. 3, 1159-1174, 2010