NO\textsubscript{2} is a key trace gas in the atmosphere. In the stratosphere, it is involved in catalytic ozone destruction, both directly in the NO\textsubscript{2} cycle and indirectly by forming reservoir species with the halogen oxides. In the troposphere, NO\textsubscript{2} columns can be determined, e.g., by combining nadir and limb measurements of the instrument.

Here, we investigate how large the impact of tropospheric NO\textsubscript{2} is on the limb measurements. This is relevant for a number of issues including the accuracy of limb profiles in the lower stratosphere, the potential to use limb measurements in the upper troposphere to study the emissions of lightening and aircraft and the accuracy of tropospheric NO\textsubscript{2} from limb nadir matching.

**Observation Geometry**

- **SCIAMACHY swath (30°)**
  - GOME-2 swath (50°)
  - OMI swath (57°)
  - lowest limb direction (63°)

**Sensitivity Study**

- The sensitivities of the nadir viewing directions increase with LOS but depend only slightly on wavelength above 6 km altitude
- The limb direction has much higher stratospheric sensitivity
- below 6 km, the sensitivity decreases systematically to the UV for the nadir directions
- this effect is even more pronounced for the limb direction
- only at 550 km, the limb direction should be sensitive to pollution NO\textsubscript{2} in the boundary layer

**SCIAMACHY Measurements Results**

**Observations**

- nadir slant columns show large tropospheric signals, in particular over China, Europe, the US, and South Africa
- integrated limb profiles are insensitive towards boundary layer NO\textsubscript{2}
- the lowest limb viewing direction does not show a clear tropospheric signal at 425 - 450 nm
- however, at 547.5 - 567 nm, some pollution hot spots are picked up
- there also are enhanced values over the Middle East that persist into higher layers (not shown), possibly indicating enhanced mid-tropospheric NO\textsubscript{2}

**Analysis**

- the results are in agreement with SCIATRAN model calculations (see box to the left)
- some sensitivity to boundary layer NO\textsubscript{2} could be demonstrated in the visible fit
- the results depend critically on clouds (not shown)

**Conclusions**

- the sensitivity of nadir measurements to boundary layer NO\textsubscript{2} depends systematically on wavelength with higher sensitivity at longer wavelengths
- below 6 km, the dependence on viewing angle is small, in particular in the UV
- even the lowest limb viewing direction (the tangent point just touching the surface) has much lower sensitivity to the boundary layer than to the stratosphere
- this is particularly true at UV wavelengths
- at 560 nm, the sensitivity to the boundary layer is comparable to that of nadir measurements, albeit on a large stratospheric background
- this could be confirmed in SCIAMACHY measurements
- the impact of boundary layer NO\textsubscript{2} on the standard limb retrieval can be neglected
- using retrievals at longer wavelengths, the sensitivity to tropospheric NO\textsubscript{2} can be much improved, making it a better choice for upper tropospheric retrievals
- detection of upper tropospheric NO\textsubscript{2} might then however be affected by some influence from the polluted boundary layer
- the effect of aerosols and clouds has been neglected here but can be substantial

**Selected References**


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