A spectral signature of sand in GOME-2 observations at 400 - 500 nm

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The GOME-2 instrument

- GOME-2:
  - launched on MetOp-A in October 2006
  - data since January 2007
  - 4 channel nadir viewing UV/visible spectrometer
  - first in a series of three identical instruments
  - 80 x 40 km² pixel size
  - global coverage in 1.5 days
  - 09:30 LT equator crossing

Verification with ground-based data

- Sand from the Sahara
- University of Bremen MAX-DOAS instrument alternately pointing to zenith-sky and sand covered surface for all of February 9, 2011
- Ratios taken between surface and zenith-sky measurements, high-pass filter applied
- high-pass filtered results are very similar to empirical satellite spectrum
- peak at 480 nm is less pronounced
- low frequency contribution is different
- need for more measurements under better conditions

Sand signal and aerosols

- Observations:
  - on some days, clear enhancements of the GOME-2 sand signal are also observed over the ocean
  - these signals are linked to desert dust export events as observed in MODIS AOD data

Conclusions

- at wavelengths larger than 450 nm, surface spectral reflectance cannot be assumed to be smooth for DOAS type trace gas retrievals
- there is a clear sand signal in GOME-2 NO² fits at 425 - 497 nm which could tentatively be confirmed in ground-based measurements
- the sand signal has the potential of providing additional information on desert dust aerosol over the oceans

Selected References


see also: www.iup.uni-bremen.de/doi

A surface signal in nadir observations

- Observations:
  - usually, surface spectral reflectance is assumed to be smooth with wavelength in satellite UV/vis trace gas retrievals
  - signatures from liquid water absorption and different vegetation types have been reported previously in satellite retrievals at wavelengths > 450 nm
  - in a new fitting window for NO² covering 425 - 497 nm, unexpected large fitting residuals were found over deserts

Approach:

- two very closely co-located earth-shine spectra were selected, one with a large fitting residual, the other one with a small one
- the ratio shows a pronounced spectral shape, in particular around 480 nm
- this strong spectral signature is systematically found in ratios from different deserts and different seasons
- the empirical signature is added in the retrieval as new parameter

Possible interferences

As this is a signal so far not detected, and high frequency spectral features in sand spectra have not been reported before, interference by other parameters needs to be excluded:

Oxygen dimer (O²)
- there is a similarity between the cross-sections of O² and the empirical sand signal around 480 nm
- over deserts, O² columns are larger
- changing O² cross-section doesn’t change the signal
- over snow ice, O² is large but the sand signal is small
- not an O² interference!

Brightness
- desert areas are bright and the sand signal is found over bright surfaces
- no sand signal is found over clouds or snow and ice
- not a brightness effect!

Liquid water absorption
- over regions where neither liquid water, nor sand signal are large, these two parameters are sometimes highly anti-correlated
- globally, the two parameters are not more anti-correlated than expected from their sources
- regions exist where only one of both is O, as well as other areas, where both are close to 0
- not a liquid water interference!

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