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1) Motivation – iodine species in the troposphere

Why is iodine important for tropospheric composition?
• Strong ozone depletion potential via catalytic cycles
• Change of oxidation pathways
• Nucleation of higher iodine oxides I₂O₅ (e.g. I₂O₃, I₂O₇)
• Possible growth to cloud condensation nuclei
  Impact on radiation balance

Sources of atmospheric iodine
• Mainly maritime sources identified, release pathways not yet fully understood
• Biogenic release by certain types of algae/phytoplankton: I₂, CH₂I₂, CHICl, etc.
• Inorganic release: e.g. surface reactions of O₃ with I, yet unknown pathways

2) The SCIAMACHY instrument

SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY
• UV-VIS-NIR-spectrometer onboard ENVISAT
• Spectral range within 214 – 2400 nm
• Sun-synchronous orbit at 800 km altitude
• Observation geometries nadir, limb, occultation
• Ground pixel size typically 30 x 60 km²
• Launch in 2002, mission assured until 2014
• Mission might be further extended

3) The IO retrieval by DOAS

DOAS retrieval settings for IO
Fitting window: 416 to 430 nm (2 absorption bands)
Trace gases: NO₂ (223K), O₃ (221K), IO (298K)
Other features: Ring effect, stray light, 2nd ord. polynomial
Result: Slant column amounts (SC) of the trace gases

Relevant definitions
SC (slant column): Trace gas amount integrated along the individual light path and then averaged over all occurring light paths.
VC (vertical column): Trace gas amount integrated over all altitudes vertically above a ground area of 1 km².
AMF (air mass factor): Light path enhancement/reduction within the absorber layer, i.e. also equivalent to the ratio between SC and VC.
BAMF (block air mass factor): Discrete change in the retrieval quantity (here SC), if the actual vertical column changes by a discrete amount at a certain altitude interval of the discrete altitude grid, hence representing the altitude sensitivity of the retrieval.

4) AMF considerations

Radiative transfer: Applied code: SCIATRAN (Rozanov et al. 2005)

Strong variation in space & time: enhanced IO is observed in different areas at individual times
• Areas affected include sea ice, coast lines, parts of the continent and ice shelves
• Assuming box profiles of IO, vertical column amounts can be directly converted to mixing ratios

5) IO vertical columns above Antarctica

Time series of IO vertical columns above Antarctica from SCIAMACHY observations:
Monthly means within 2004-2009

• Retrieval of IO above dark ocean scenes depends more on the retrieval settings than above the Antarctic, caution is necessary.
• Occurrence of positive IO amounts in Eastern Pacific possibly linked to biological productivity
• No general, clear correlation of IO and Chi-a, but some relation seems to be present.

6) IO vertical columns over the ocean

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7) Challenge: retrieving "small" absorbers

Standard retrieval: actual IO amounts are below this colour scale.

8) Summary and conclusions

• Retrievals of absorbers with small optical depth such as IO need to be treated with great care.
• IO vertical columns are deduced from SCIAMACHY satellite measurements by using a DOAS retrieval and by applying a Rayleigh atmosphere AMF for a box shaped IO profile.
• Radiative transfer calculations show that the satellite sensitivity for IO is largest above bright surfaces such as snow and ice. In this case, the AMF depends only weakly on the IO profile.
• Six years of IO observations show many details of spatial and temporal variation above the Antarctic.
• Occurrence of IO above sea ice in late spring may be linked to biogenic emissions from below the ice.
• Observations of IO above the tropical oceans are subject to larger noise and uncertainties than over snow and ice.
• Enhancements of tropical IO might be linked to biological activity in upwelling regions of the ocean.

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Selected References


see also: www.iup.physik.uni-bremen.de/doas