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Analysing the retrieval quality and column densities of iodine monoxide from multiple satellite sensors

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Iodine compounds are emitted from the ocean and ice covered areas through organic and inorganic pathways involving macroalgae and microalgae as well as inorganic surface processes and volcanic eruptions. Iodine monoxide (IO) molecules are produced after photolysis of precursors and reaction with ozone. IO is thus an indicator of active iodine chemistry, and impacts on ozone levels, the NO/NO_2 ratio and particle formation. Rapid changes in Polar sea ice coverage and conditions may affect iodine levels in Polar Regions with respective consequences for tropospheric composition in the Arctic and Antarctic.

Remote sensing of IO faces the challenge that IO column densities are fairly small with a maximum absorption optical depth on the order of a few times 10^{-4}, which is close to the detection limit of satellite instruments. IO column densities are retrieved from several satellite sensors including SCIAMACHY (2002 to 2012), GOME-2 (since 2006) and TROPOMI (since 2017) by using Differential Optical Absorption Spectroscopy. Previous studies have shown slightly enhanced IO column densities above the Antarctic Region and in a strong volcanic plume, while IO column densities in the Arctic remain mostly below the detection limit. These areas are in the focus of iodine measurements from space. Retrieval quality and resulting IO column densities are investigated and compared between the different sensors with a focus on the recent instrument TROPOMI.

The small IO absorption signal complicates the identification of optimal retrieval settings, such as the choice of an adequate wavelength window. Aspects for quality control are discussed. In addition to the immediate retrieval RMS, also the IO standard deviation in (reference) areas with expected low IO absorption, consistency checks with other retrieval parameters as well as plausibility of IO column density results are considered. Finally, the idea of an ensemble retrieval strategy is discussed, which is based on the fact that for small trace gas quantities, the retrieval result depends unfavourably on the fit settings. After selection of reasonable quality criteria, the remaining fit parameter sets are all used for the retrieval of IO. The selected ensemble of parameter sets yields a result for IO as well as uncertainty estimates induced by the choice of fit settings. Due to computational effort, application of this strategy is restricted to case studies.