Visualisation of long-term atmospheric composition datasets from the RAL Space Infrared and Microwave Sounder (IMS) extended retrieval scheme.

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ABSTRACT

The RAL Infrared and Microwave Sounder (IMS) scheme is an optimal estimation scheme (based on the Eumetsat operational scheme) initially created to combine measurements from the Metop sounding instruments - IASI, AMSU, and MHS, in a joint retrieval of water vapour, temperature, and ozone. The algorithm has also been modified to use with CrIS and ATMS, the TIR and microwave sounders onboard Suomi-NPP and NOAA-20, due to the increased near-surface sensitivity that can be achieved due to a combination of its signal-to-noise, viewing geometry and observation time which is crucial for the detection of certain trace pollutants.

The scheme has been developed to produce high-quality long-term datasets from both MetOp and NOAA platforms and the data are currently contributing to the ESA-CCI Water vapour project. The *extended* version of the IMS scheme additionally includes retrievals of carbon monoxide, cloud parameters, two types of aerosol (dust and volcanic sulphate), and column retrievals of several minor species including ammonia, isoprene (CrIS only), other VOCs, and sulphur dioxide. Complete datasets exist for the full lifetime of the IASI and CrIS instruments for all retrieval parameters and will be illustrated in this paper. The algorithm is also run in near-real time, with the output available to view (alongside other datasets produced within RAL Space Remote Sensing Group) through the data visualisation portal at http://rsg.rl.ac.uk/vistool.

Data from the *extended* scheme have been exploited in a number of scientific studies, covering a variety of species, such as, the nocturnal survival of isoprene (Palmer et. al. 2022, https://doi.org/10.1126/science.abg4506); the global OH radical distribution (Pimlott et. al. 2022, https://doi.org/10.5194/acp-22-10467-2022); the unexpected radiative impact of the Hunga Tonga eruption (Selitto et. al. 2022, https://doi.org/10.1038/s43247-022-00618-z); methanol and CO enhancements from Australian wildfires (Pope et. al. 2021, https://doi.org/10.1029/2021JD034892); and the tropospheric ozone radiative effect (Pope et. al. 2024, https://doi.org/10.5194/acp-24-3613-2024).

Additionally, the IMS extended scheme is now being further optimised for the retrieval of each individual minor gas. For this purpose, a new module has been developed to carry out linear retrievals of the weakly-absorbing minor species post IMS processing, using the IMS retrieved atmospheric and surface state as the linearisation point. The linear retrieval is used to detect departures in the atmospheric state from a generalised background covariance matrix created using IMS spectral residuals for scenes that do not contain detectable amounts of the gas in question. Similar methods are well established (e.g. Walker 2012, https://doi.org/10.1029/2011JD016810), and it has been implemented here to improve the precision of the minor gas retrievals, whilst also mitigating spectral interference from other species/contaminants to reduce systematic errors. The latter is important for isoprene, for example, as the current version is affected by dust contamination. Some results of implementing the improved algorithm are demonstrated.