Using GEOS-Chem vertical profiles for an improved IASI-NH_3 product

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ABSTRACT

The discovery over a decade ago that satellites were able to measure atmospheric ammonia (NH_3) led to major advances in our understanding of its emission sources, transport, and atmospheric pathways. The Infrared Atmospheric Sounding Interferometer (IASI) onboard the Metop series of satellites has been especially impactful and currently holds over a 15-year record of measurements, allowing for a detailed assessment of local sources and long-term trends. Since the first global distribution acquired in 2008, IASI-NH_3 data products have been continuously improved, with progressively better accuracy and consistency, and are now widely used by the scientific community.

Satellite NH_3 measurements retrieve integrated vertical column abundances of NH_3, as there is insufficient information in the observed spectrum to derive vertical profile information. Instead, the inverse models rely on a priori estimates on the shape of the vertical distribution of NH_3, leading to potentially large errors in the retrieved columns. While previous retrieval versions already allowed flexibility in the assumptions on the vertical distribution, the absence of averaging kernels (AVKs) has until recently hampered model comparison and assimilation.

Here we briefly describe version 4 of the retrieval framework called ANNI, which introduces the calculation of AVKs. We show how the reprocessing of the IASI-NH_3 dataset using vertical profile shapes from GEOS-Chem chemistry transport model provides much improved distributions in all seasons, with a strong reduction of land-sea discontinuities. It also leads to a major improvement of the IASI-NH_3 nighttime distributions, pointing to a misrepresentation of the NH_3 vertical profile in the current baseline ANNI retrieval. Based on an in-depth analysis of GEOS-Chem simulations, we also present an improved parametrization of the vertical profile shapes to be considered for the IASI baseline product. This work is based on model simulations for the year 2017 at global (2°×2.5°) and European (0.5°×0.625°) scales.