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Effective cloud fractions of GOME-2 measurements using an enhanced HICRU implementation

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The physics of clouds is one of the most important drivers of meteorology and the climate system. Apart from this, the distribution of clouds interferes with the majority of satellite measurement techniques. Tropospheric trace gas retrievals are particularly sensitivity to the distribution of clouds within the field-of-view of the instrument, because already small cloud fractions have the potential to alter the measurement error and significantly increase the uncertainty of the measurement. Hence, the accuracy of tropospheric trace gas retrievals depends on the accuracy of the cloud fraction, particularly for small cloud fractions.

The original HICRU Iterative Cloud Retrieval Utilities (HICRU) algorithm has been specifically developed for the retrieval of small cloud fractions at high accuracy. This is achieved by inferring a clear sky top of atmosphere reflectance map from the dataset itself, minimising the influence of instrument degradation and/or insufficient calibration. HICRU thus requires a minimum of a-priori knowledge. So far, this approach was limited to measurements at sufficiently small viewing angles, such as GOME and SCIAMACHY, for which the use of a single, viewing-angle independent background albedo map is justified.

Here, we demonstrate how this empirical approach may be enhanced by parametrising the viewing angle dependence of the TOA reflectance. It then becomes applicable to satellite instruments like GOME-2, OMI, and the upcoming TROPOMI/S5P with viewing angles up to 45 or even 70 degrees, by parametrising the viewing angle dependence of the TOA reflectance. Furthermore, the enhanced HICRU algorithm comprises an advanced treatment of the temporal evolution using a spatially averaged Fourier series fit. The enhanced HICRU has the potential to be applied also to instruments with moderate spectral resolution like MERIS, MODIS, or AVHRR as well.