GOME-2 on MetOp-A
Support for Analysis of GOME-2 In-Orbit Degradation and Impacts on Level 2 Data Products

Executive Summary

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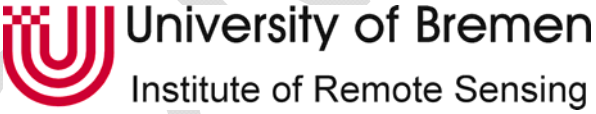

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1. What is the effect of GOME-2 degradation on the fit quality of level 2 products?

The quality of the fit is expressed in terms of χ^2, i.e. the scatter of fit residuals over the wavelength region on which the trace gas retrieval is being performed. This has an impact on the precision of individual retrievals, but should (ideally) not lead to systematic biases in the averages of the derived columns. Results show a significant increase in χ^2 over the whole observation period of GOME-2. Trace gases retrieved in channel 2 (BrO and HCHO, but also SO_2) in particular suffer from the high loss of throughput known to be present in this wavelength region. Values for χ^2 have risen up to five times its original value (c.f. January 2007).Comparisons to SCIAMACHY data show a clear difference. In the same observation period (2007-2011) and during its first mission years (2003-2006), SCIAMACHY has a by far smaller increase in χ^2.

2. What is the effect of GOME-2 degradation on the precision (scatter) of level 2 products?

The precision of level 2 products has been investigated by calculating the standard deviation (RMS) of all vertical columns within a chosen geo-location box. Results indicate that the loss of throughput leads to a systematic increase in the scatter of retrieved vertical columns. This increase is most pronounced for BrO. When compared to results from SCIAMACHY data, the increase in RMS for HCHO, O_3, and H_2O is roughly in the same order of magnitude, larger for NO_2 and much larger for BrO. After the 2nd throughput test, the increase in RMS has slowed down or even stopped, stabilizing the results.

3. Is the degradation dominated by throughput loss or are there also systematic spectral structures linked to instrument changes or degradation related calibration deficiencies?

The loss of throughput has a very significant impact on the retrieval of trace gases. The retrieval of trace gases with minor absorption features such as BrO and HCHO is heavily reliant on strong earth-shine signals to minimize the effect of shot noise and these products are therefore especially affected by loss of throughput. Comparisons with SCIAMACHY data of the fit window intensity show a much more rapid loss of throughput for GOME-2 in particular in channel 2. This explains most of the observed reduction in fitting quality (χ^2). However in addition, a year to-year increase in χ^2 for the same fit window intensity and a comparison with retrievals made using earthshine reference spectra (as opposed to solar spectra) indicate that an additional systematic error component is present, probably originating in changes in the solar measurements, in part linked to the 2nd throughput test.

4. Are there possibilities to correct for degradation effects on GOME-2 level 2 products?

Throughput loss cannot be remedied by calibration. Therefore level 2 data products from channel 2 need to be carefully monitored as to their fit quality and precision. GOME-2 FM2 on Metop-B is planned to be launched in May 2012 and will hopefully become operational before the quality of trace gas products such as HCHO and BrO have reached an unacceptable level. The most practical correction scheme available at this point is to use a normalization of the data over a clean Pacific region as already applied to GOME, and in some cases also SCIAMACHY data, and tested for GOME-2 BrO and NO_2.

5. What happened with GOME-2 level 2 products during the 2nd throughput test, and what can we learn from these results?

A short-term improvement (i.e. throughput gain) could be linked to either a gain in quantum efficiency of the detector at higher temperatures or alternatively the evaporation of an absorbing layer from an optical component, the latter being more convincing. For upcoming flight models, contaminants once evaporated, need to have the possibility to escape the optical bench and or detector enclosure into space.