Extension of the ESA CCI total ozone climate data record with the application of the GODFITv3 algorithm to OMI observations

C. Lerot[1,✉], T. Danckaert[1], M. Van Roozendael[1], R. Spurr[2], D. Loyola[3], M. Coldewey-Egbers[3], M. Koukouli[4], I. Zyrichidou[4], D. Balis[4], J.-C. Lambert[1], J. Granville[1], F. Goutail[5], J.P. Pommereau[5], and C. Zehner[6]

(1) BIRA-IASB, (2) RT Solutions, Inc., (3) DLR-IMF, (4) AUTH, (5) LATMOS, (6) ESA/ESRIN, ✉: christl@oma.be

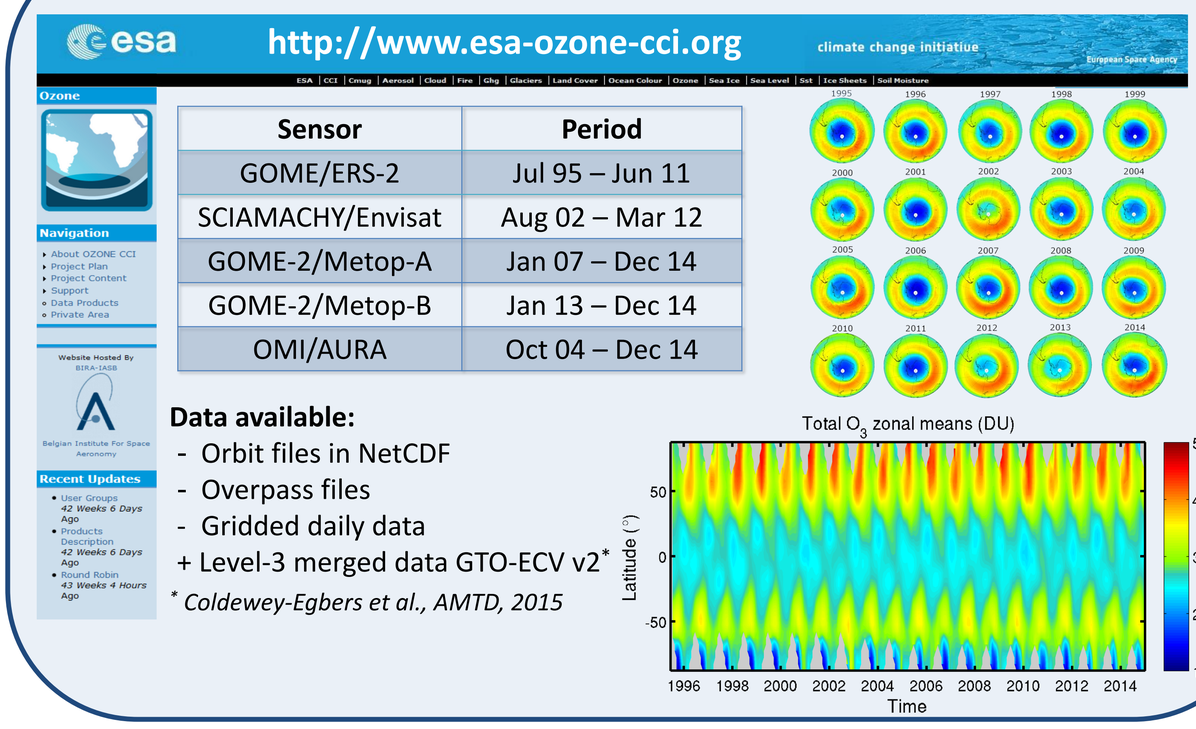
Abstract

One of the great achievements of the first phase of the ESA Ozone Climate Change Initiative has been the release of new level-2 total ozone data sets from GOME, SCIAMACHY and GOME-2/Metop-A reprocessed with the latest GODFIT-3 algorithm. These data sets are characterized by unprecedented standards of consistency, stability and accuracy.

Recently, GODFIT has been adapted in order to analyze backscattered light spectra measured by the Ozone Monitoring Instrument (OMI). In particular, a new look-up table version of GODFIT has been developed to process the massive OMI level-1 data set in a timely and fast manner. This approach maintains a level of accuracy similar to that of the on-line GODFIT version, in addition to providing accelerated performance by a factor of 10. This fast algorithm has been used to reprocess the entire OMI time series, thus extending the ESA CCI Climate data record for total ozone. Here, we compare the OMI GODFITv3 total ozone product to the two operational products OMI-TOMS and OMI-DOAS, and also to the historical multi-sensor CCI data set.

We show that an optimization of the pre-flight instrumental slit functions has been necessary in the ozone fitting window (325-335 nm) in order to completely eliminate any row dependence in the product. Such an optimization of the pre-flight slit functions has also the potential to enhance the consistency between total ozone data sets from different sensors as demonstrated here with GOME-2A and -2B.

ESA CCI total ozone data sets

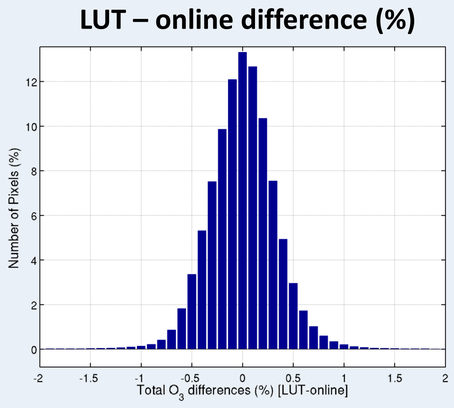


The GODFITv3 algorithm[1]

Main features

- Direct fitting of measured radiances in the Huggins bands (325-335 nm).
- State vector includes a.o. total ozone, effective temperature and albedo.
- O_3 cross-section: Brion, Malicet, Daumont et al.[2]
- A priori profiles: total column-classified climatology TOMSv8[3] combined with the tropospheric column climatology from OMI/MLS[4]
- Simulated spectra are computed on-the-fly with LIDORT or extracted from pre-calculated tables. The latter option is faster by a factor of 10, while maintaining a very high level of accuracy.
- Optional Brewer-based soft-calibration of level-1 reflectances to reduce the impact of calibration limitations. This procedure is not necessary for OMI.

LUT – online difference (%)



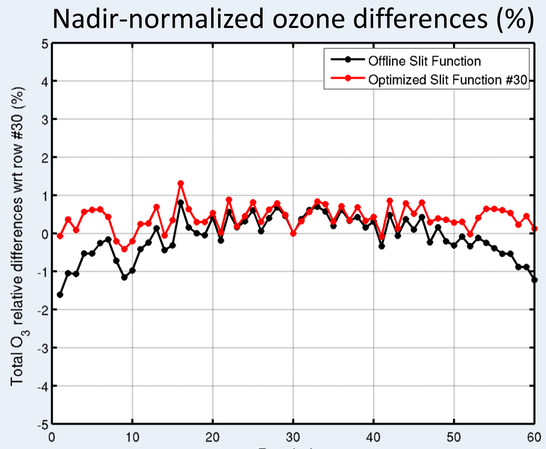
[1] Lerot et al., JGR, 2014; [2] Malicet et al, J. Atmos. Chem., 1995, [3] Mc Peters et al., JGR, 2007; [4] Ziemke et al., ACP, 2011;

Optimization of instrumental slit functions

GODFIT has the capability to optimize instrumental slit functions and to account for resolution change along the orbit. This may impact significantly the product quality.

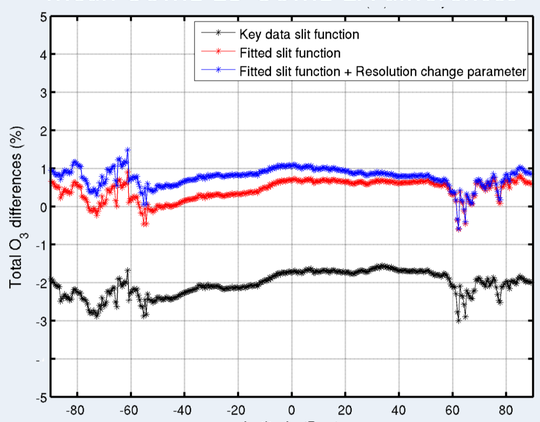
1. Row dependence of the OMI data set

Nadir-normalized ozone differences (%)



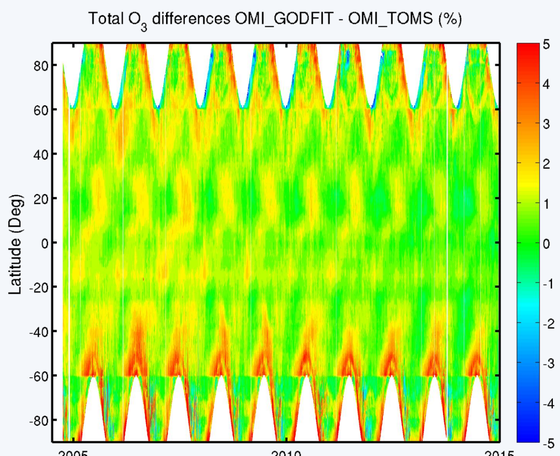
2. GOME-2B/-2A consistency

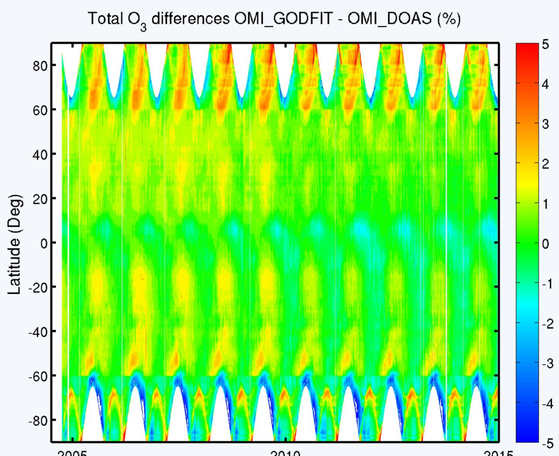
Mean GOME-2B-GOME-2A differences



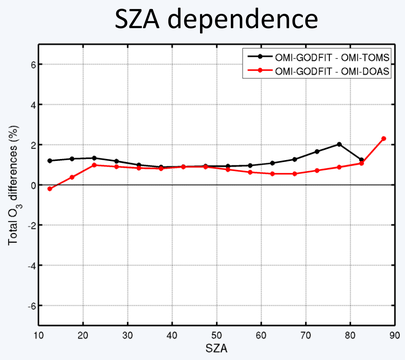
The OMI _GODFIT product: inter-sensor comparison

Comparison with OMI_TOMS and OMI_DOAS

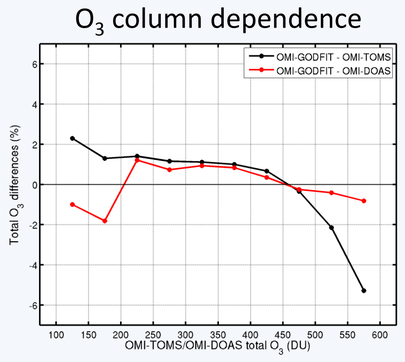




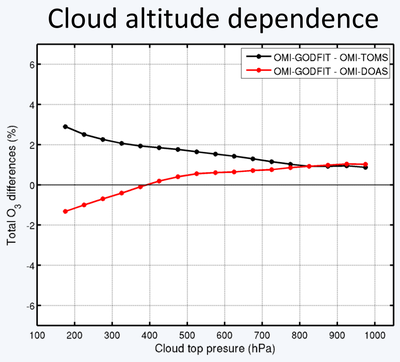
SZA dependence



O_3 column dependence

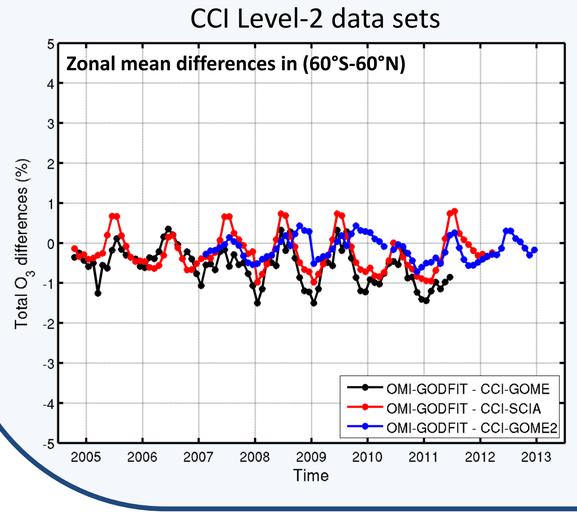


Cloud altitude dependence

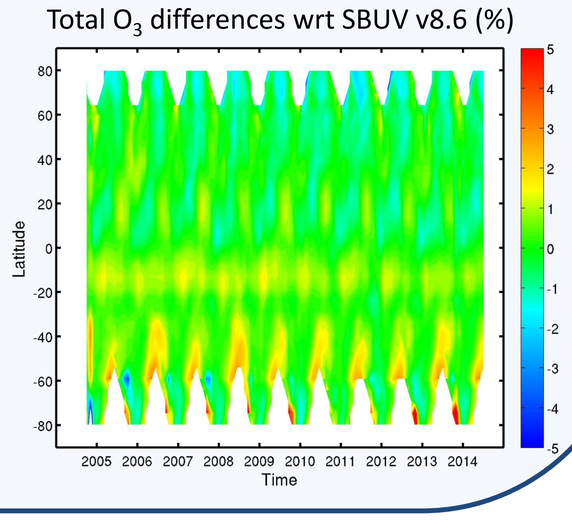


Comparison with standard climate total O_3 records

CCI Level-2 data sets

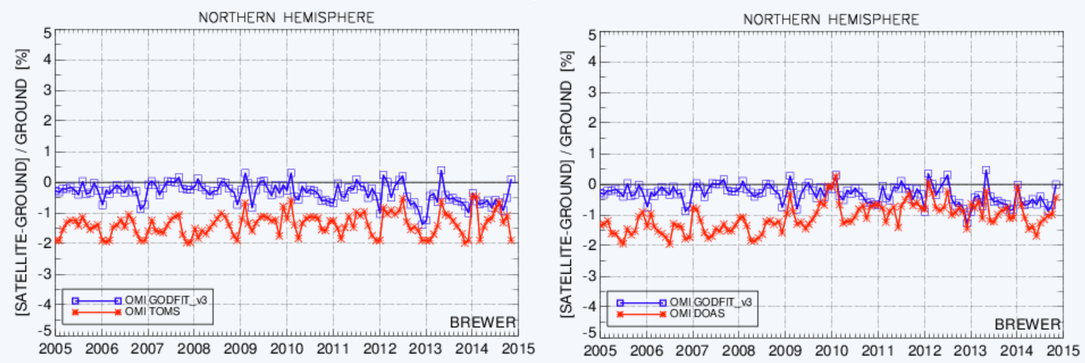


Total O_3 differences wrt SBUV v8.6 (%)

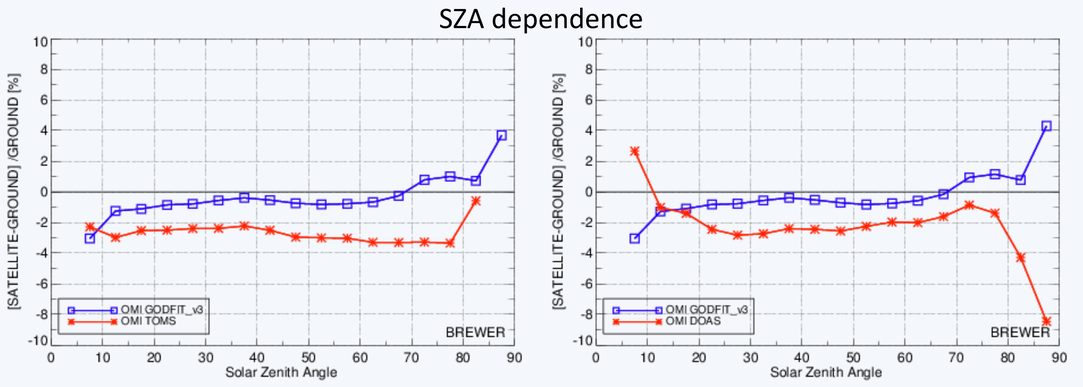


The OMI _GODFIT product: first validation results

Time dependence



SZA dependence



More details provided in Poster #89 by M. Koukouli et al.

Conclusions

- The algorithm GODFITv3, selected to generate the total ozone ECV as part of the Ozone_CCI project, has been adapted to handle the OMI data. The full mission has been recently reprocessed using a fast look-up table version of the algorithm and is available to the public on www.esa-ozone-cci.org, along with the other CCI data sets.
- A proper characterization of the instrumental slit functions is essential to have products of good quality and may help to enhance the inter-sensor consistency. In particular, using an optimized OMI slit function in the O_3 fitting window led to a significant reduction of the row dependence in the OMI_GODFIT product.
- In general, the three total ozone products OMI_GODFIT, OMI-TOMS and OMI-DOAS are very consistent. However, larger differences appear in extreme conditions (high SZAs, extreme O_3 columns, high clouds, …). Also, OMI_GODFIT agrees very well with the other CCI data sets as well as with the US golden standard long-term record SBUV v8.6.
- Validation shows that the time stability of GODFIT-OMI is excellent (<0.5%/decade) and meets the CCI user requirements. In future CCI activities, this product will be used as the long-term reference for soft-calibrating other sensors.