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ATMOSPHERIC COMPOSITION VALIDATION AND EVOLUTION

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Validating the NRT Total Ozone Retrieval Algorithm for TROPOMI/S5P based on GOME-2/Metop-A observations

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Historical perspective

“If I have seen further it is by standing on the shoulders of giants.”
- Isaac Newton, Letter to Robert Hooke, English Scientist, February 5th, 1676

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Historical perspective


Historical perspective


Historical perspective


“Would it save you a lot of time if I just gave up and went mad now?”

- Douglas Adams, The Hitchhiker’s Guide to the Galaxy

Or else, going from the GOME2 algorithm version GDP4.7 … to GDP4.8 … to UPAS2-CAL
The current status of the GDP4.7 algorithm

From GDP4.7 to GDP4.8 - I

**DOAS algorithms**

Improved Kurucz Solar reference spectrum (SAO2010) for wavelength calibration. Improved Ozone (I0 effect) and Ring Cross sections (using new high resolution solar spectra, SAO2010)

**Iterative AMF/VCD**

Updated scan angle correction. In GDP4.8, the correction factors were calculated using 7 years GOME-2A data for GOME-2A and 2 years GOME-2B data for GOME-2B respectively.

From GDP4.7 to GDP4.8 - II

Cloud treatment:
Using new cloud (version 3.0) algorithms:

**OCRA**: PMD degradation correction + new cloud-free map based on GOME-2A data

**ROCINN**: New Tikhonov inversion + updated RTM (spectroscopy, a-priori surface albedo, etc)

The current status of the GDP4.8 algorithm

From GDP4.8 to UPAS2-CAL

Optimal wavelength for AMF
From 325.5 nm to 328.125 nm
The typical GDP4.x errors increasing as function of SZA should be reduced significantly

Polarization correction for AMF instead of normalizing $O_3$
This correction should improve the viewing angle dependency (removed in GDP 4.x by normalizing the $O_3$).

TOMS V8 + OMI/MLS a priori
That is the same combined climatology as the one used in ESA $O_3$-CCI GODFIT algorithm and therefore we expect the same kind of improvements in Tropical Regions.
Cloud treatment:
CAL instead of CRB

**CRB** (cloud as reflecting boundary or MLER) is the old cloud model used in previous missions.

Requires ad-hoc semi-empirical corrections for ghost column \((G)\) and intra-cloud \((v)\) effects with two calls to RTM.

The smaller pixel size of the atmospheric missions Sentinel-5P/4/5 requires a more precise treatment of clouds: **CAL** (clouds as layers)

No corrections needed, one single call to RTM.
VALIDATING THE UPAS2-CAL ALGORITHM
GOME2A TOCS USING BREWER & DOBSON SPECTROPHOTOMETERS
BREWER & DOBSON STATIONS

http://woudc.org/home.php
Global validation on the Dobson network
Monthly mean time series - the Dobson network
Monthly mean time series - the Brewer network
SZA dependency

- Optimal wavelength for AMF
Scan angle dependency

- Polarization correction for AMF instead of normalizing $O_3$
Cloud parameters dependency

- Using new cloud (version 3.0) algorithms:
Concluding...

- The aim of this work was to ascertain that the new UPAS₂-CAL algorithm performs to high standards and is equally stable as the current operational UPAS₁-GDP₄.₈ algorithm.

- The comparisons with the Dobson and Brewer spectrophotometer TOCs for the two years of GOME₂/MetopA TOCs provided showed that:
  - **In the NH**, the comparisons with the Dobsons provide a mean difference of 1.23±1.40% to UPAS₁-GDP₄.₈ and 1.50±0.97% to UPAS₂-CAL.
  - **In the SH**, the comparisons with the Dobsons provide a mean difference of 1.82±1.12% to UPAS₁-GDP₄.₈ and 2.640±1.27% to UPAS₂-CAL.
  - Between 60°S and 60°N, UPAS₂-CAL introduces an extra 0.5 to 1% overestimation to the ground compared to UPAS₁-GDP₄.₈.
  - **In the Poles**, however, UPAS₂-CAL appears to **reduce** the current over-estimations, from 1.25% to 0.57%.
  - The comparisons to the Brewer NH network are **stable at +2% up to 75° in SZA**, whereas the GDP₄.₈ comparisons show a dependency from 40° onwards.
“Well, I must endure the presence of a few caterpillars if I wish to become acquainted with the butterflies.”

— Antoine de Saint-Exupéry, The Little Prince
S5P Total Ozone – Heritage

- **NRT: DOAS**
  - **DOAS fit** for ozone slant column and effective temperature
  - **Iterative AMF/VCD** computation using a single wavelength
  - **Molecular Ring correction** (Van Roozendael et al., JGR 2006)
  - On-the-fly **RTM simulations** LIDORT v3.x (Spurr, 2003)
  - Cloud using **OCRA&ROCINN v3.0** (Loyola et al., TGRS 2007)
  - Adaption to SCIAMACHY (Lerot et al., AMT 2009)
  - **Intra-cloud, sun-glint and scan angle** (Loyola et al., JGR 2011)
  - Adaptation to GOME-2 (Hao et al., 2014)

- **OFL: GODFIT**
  - **Direct-Fitting algorithm** retrieval total ozone, effective temperature, effective albedo, and Ring
  - Baseline Algorithm for generating the **CCI total O3 data sets**
  - Successfully applied to GOME, SCIAMACHY, GOME-2A/B and OMI (Lerot et al., JGR, 2014, Koukouli et al., JGR, 2015)