New OMI total ozone data set developed as part of CCI activities

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Outline

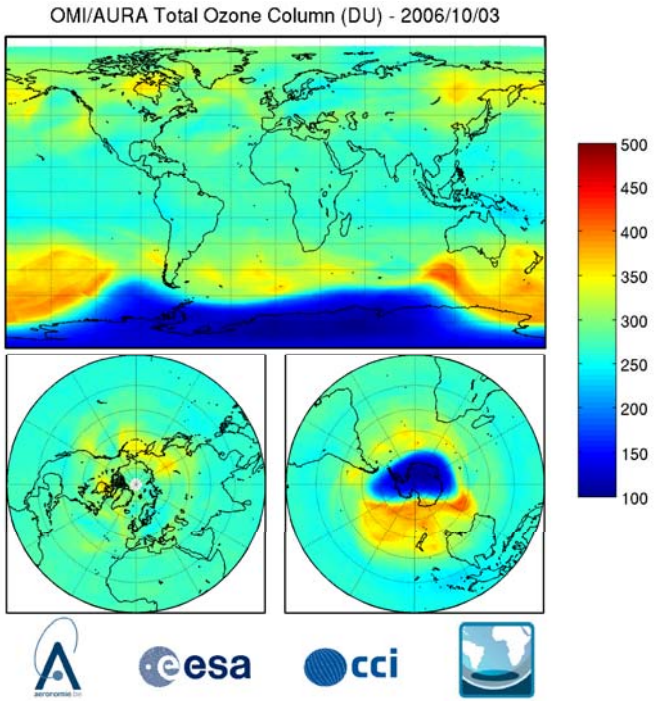
- The GODFIT algorithm and OMI specificities.
- Comparison with OMI-TOMS and OMI-DOAS products.
- Consistency with other CCI data sets and SBUV v8.6.
- First validation results.
- Impact of the cloud algorithm.
- Summary.

The total ozone algorithm GODFIT (1)

- Algorithm developed for nadir hyperspectral instruments.
- **Direct fitting** of reflectances simulated with LIDORT in the Huggins bands (**325-335 nm**).
- *A-priori O_3 profiles*:
  - Stratosphere: Total column classified climatology **TOMSv8**
  - Troposphere: **OMI / MLS** climatology.
- *O_3 cross-sections:* **Brion, Daumont and Malicet**.

- Reflectance simulated for a single effective scene: An **effective albedo** is retrieved simultaneously to ozone.
- **State vector**: Total O_3, T-shift, Ring scale factor, effective albedo.

- Baseline Algorithm for generating the **CCI** total O3 data sets.



Lerot et al., JGR, 2014.
Van Roozendael et al., JGR, 2012.

The total ozone algorithm GODFIT (2)

- Limitations in level-1 data calibration may introduce systematic biases.

➔ Brewer-based soft-calibration of the level-1 reflectances.

➔ Significant enhancement of the inter-sensor consistency.

CCI Reprocessed level-2 data sets

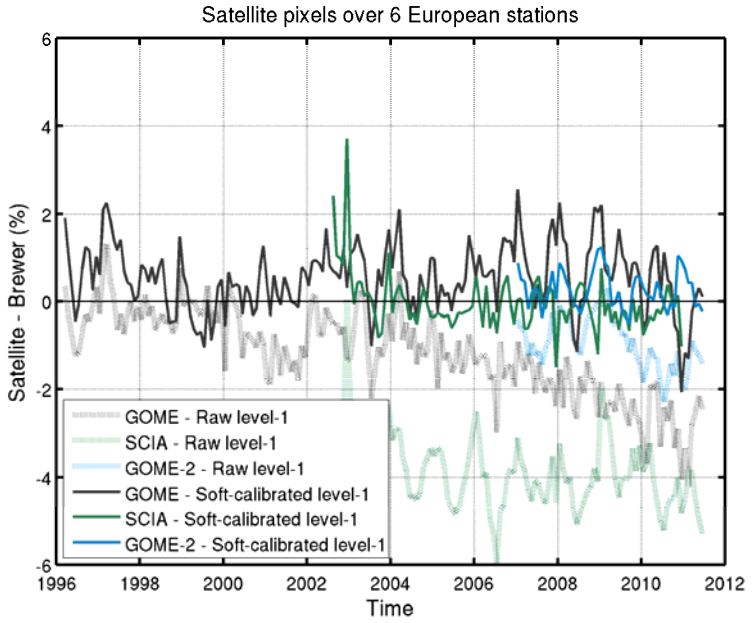
GOME/ERS-2	Mar 96 – Jun 11
SCIAMACHY/Envisat	Aug 02 – Mar 12
GOME-2/Metop-A	Jan 07 – Dec 12

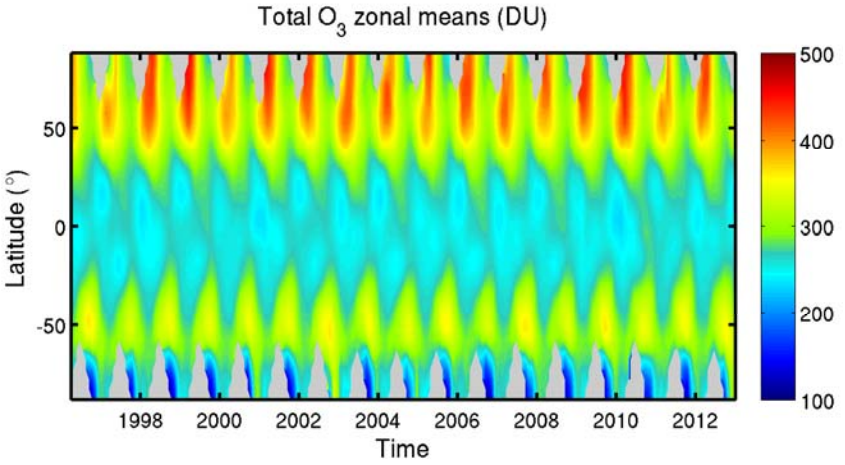
Output available (www.esa-ozone-cci.org)

- Orbit files + Overpass files
- Gridded daily data + zonal means

+ Level-3 merged data GTO-ECV v2

Lerot et al., JGR, 2014.
Van Roozendael et al., JGR, 2012.

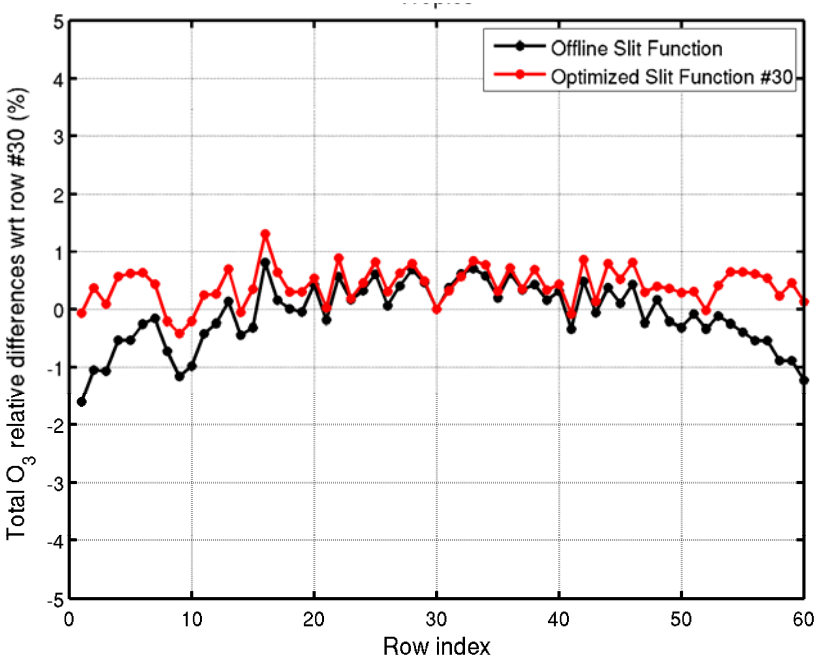




Transfer of the algorithm to OMI

- Subroutines to ingest OMI L1 data implemented.
- **O2-O2 cloud product** is used. Conceptually closer to FRESCOv6 used for other sensors.
- The **OMI slit function** may be **row-dependent**. When using the key data slit functions, a row-dependence remains in the OMI total ozone product.
- Tools available at BIRA to optimize slit functions in specified fit interval.
- In the O3 fit interval (325-335 nm), the **optimized slit functions** for extreme rows are slightly broader and more asymmetric.
- The row dependence in the GODFIT OMI product disappears when using optimized slit functions.
- The fit residuals are also reduced with those slit functions, especially at large viewing angles.

Nadir-normalized ozone differences

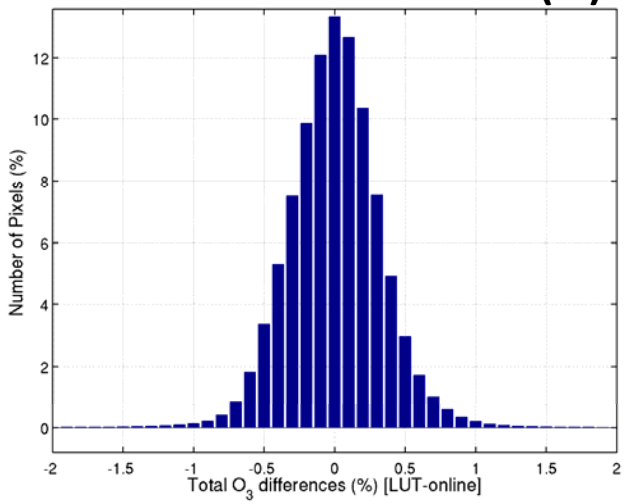


Transfer of the algorithm to OMI

Look-up table version of GODFIT

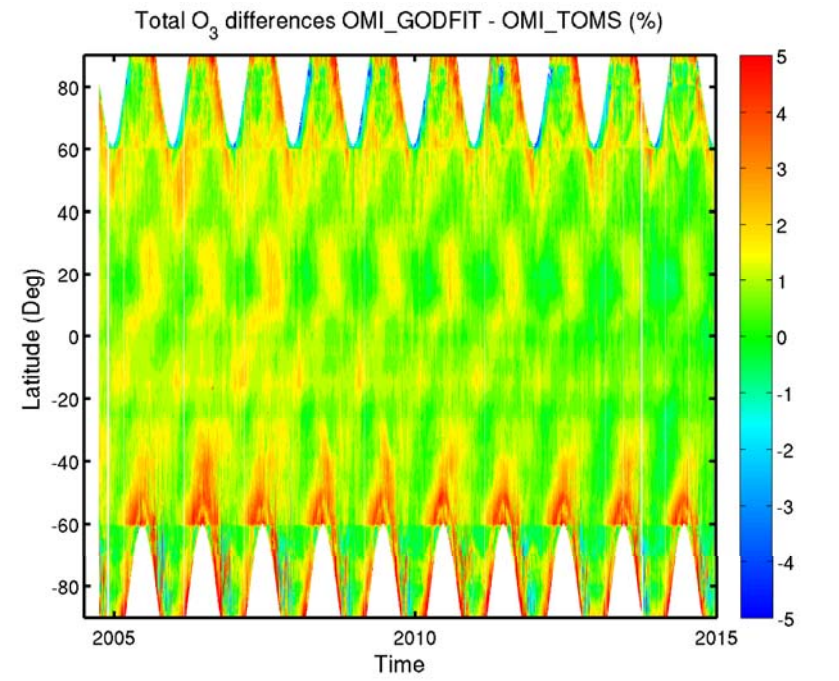
- **Motivation**: Full reprocessing of the OMI L1 data set at the end of year 1.
- **Concept**: All online RT calculations are replaced by interpolation through pre-calculated tables of radiances.
- **Specs:**
  - 9 dimensions: 3 angles, T°, Scene altitude and albedo, month, latitude, total O_3
  - Jacobians computed from the radiance LUT itself.
  - Final size: ~370 Gbytes.
  - Has been generated in 20 days using 32 cores (2.66GHz)
- No systematic dependence introduced by the method.
- The full reprocessing has been achieved within 3 weeks (the processing is more than 10 times faster compared to the online algorithm).
- **No Soft calibration applied for OMI!!**

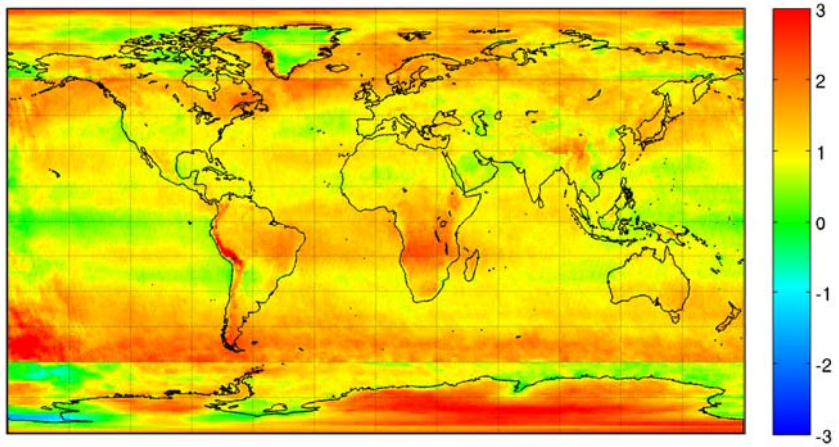
LUT – online difference (%)



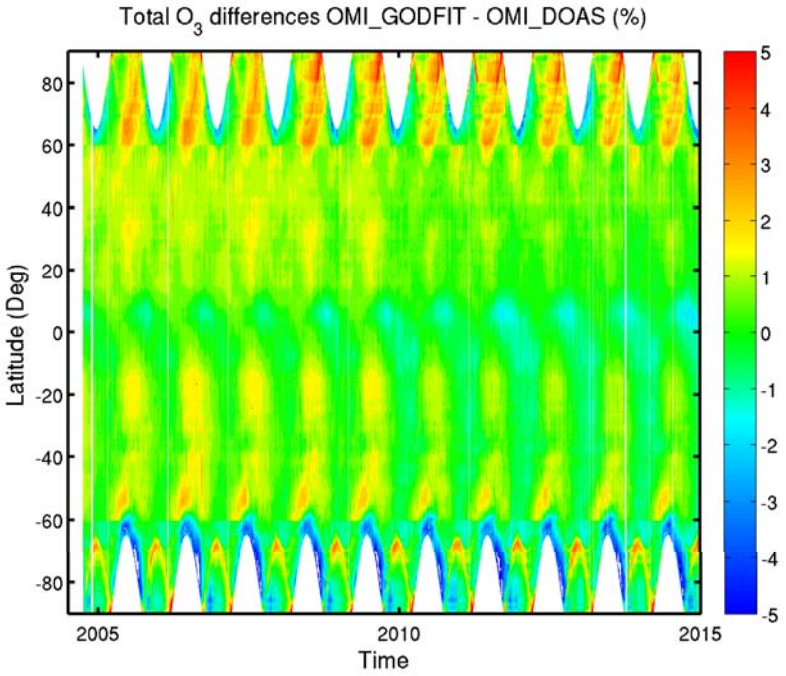
Comparison with OMI-TOMS and OMI-DOAS

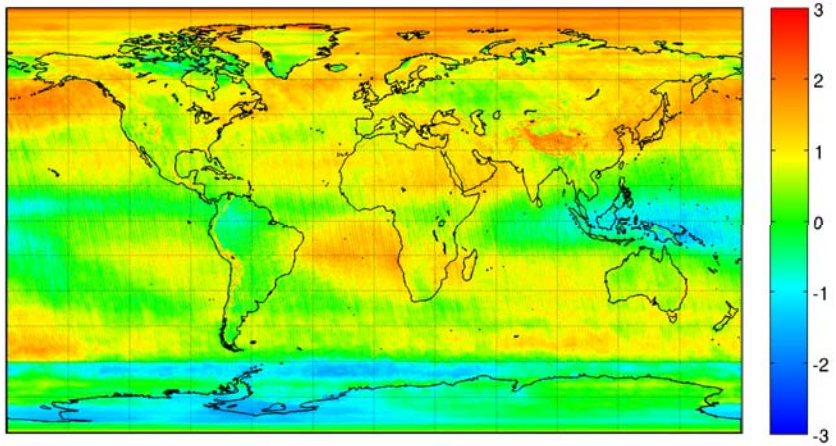
OMI_GODFIT - OMI_TOMS





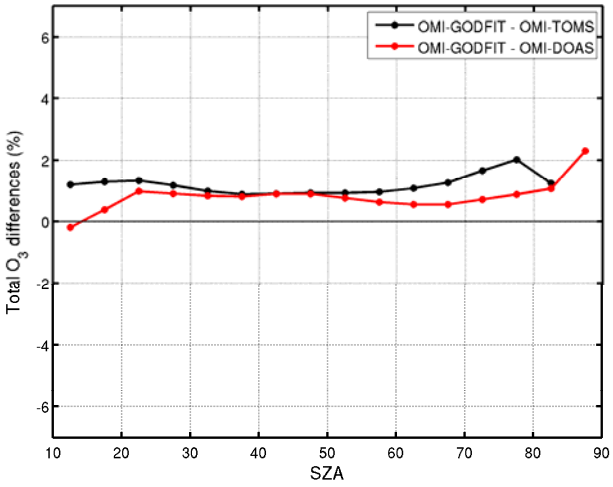
OMI_GODFIT - OMI_DOAS



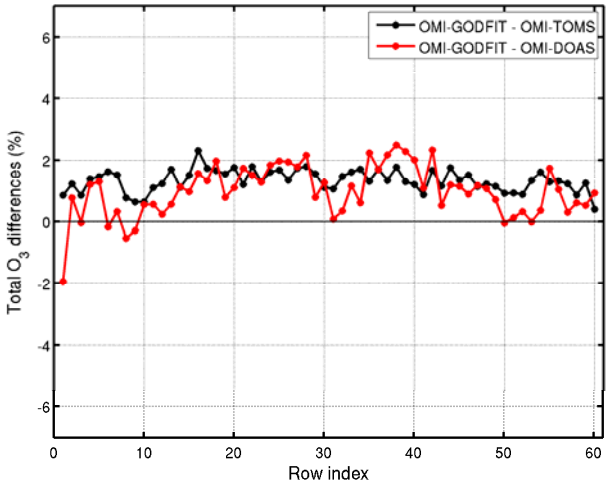


Comparison with OMI-TOMS and OMI-DOAS

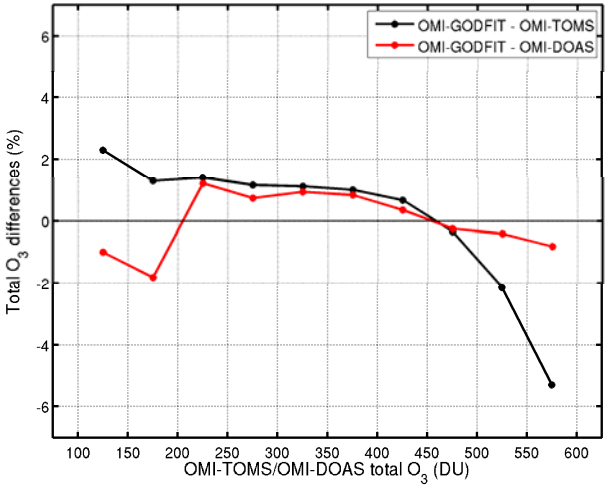
SZA dependence



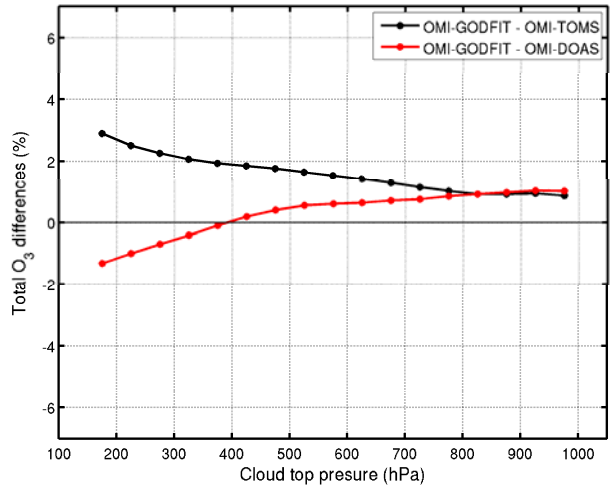
Row dependence



Total O3 dependence

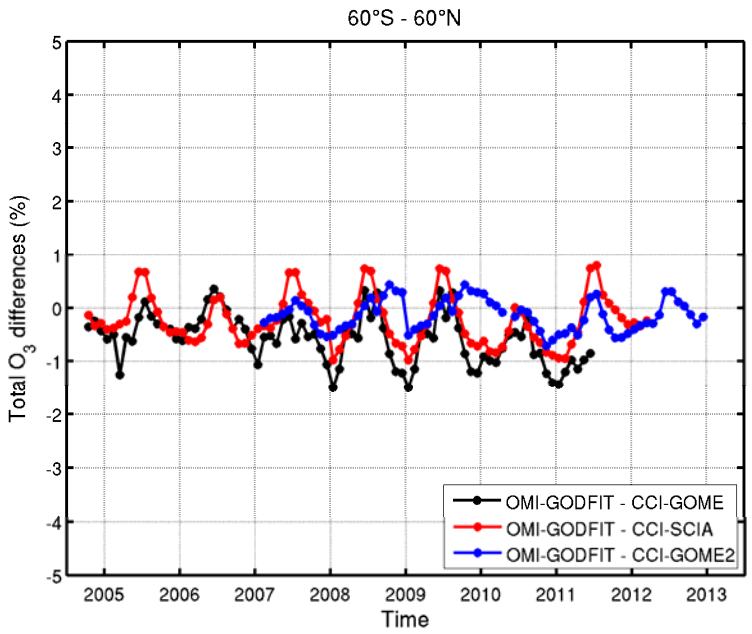


Cloud top pressure dependence

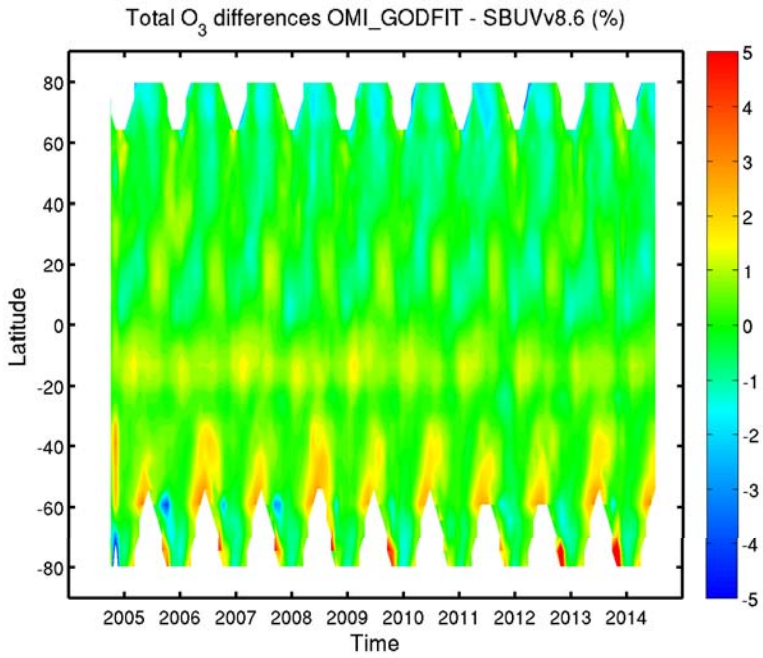


Comparison with other CCI data sets and SBUV v8.6

CCI L2 data sets intercomparison

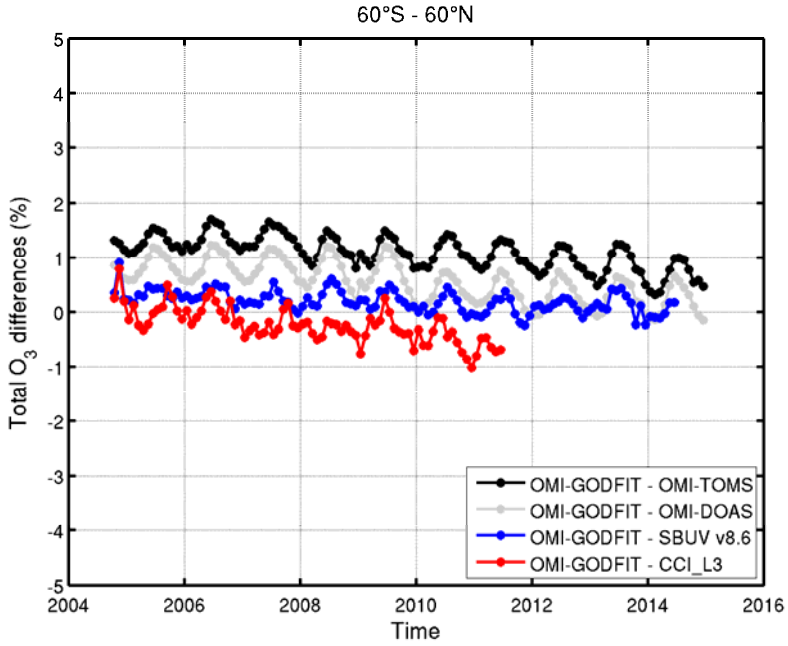


OMI-GODFIT - SBUV



Comparison with other CCI data sets and SBUV v8.6

Time dependence

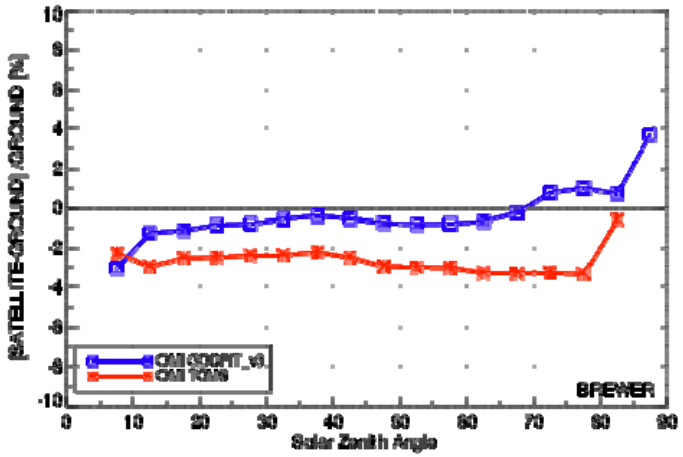


- Very small drift compared to OMI-TOMS (< -0.5%/decade)
- Drift slightly larger with respect to OMI-DOAS and CCI_L3.
- No drift compared to SBUV v8.6.
- Time stability meets user requirements.
- The OMI-GODFIT product will be used as long-term reference in future CCI activities.

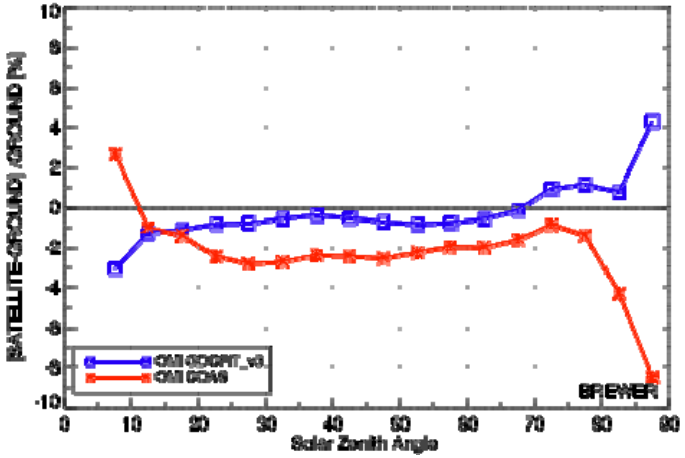
First validation results

Solar zenith angle dependence

OMI-GODFIT and OMI_TOMS



OMI-GODFIT and OMI_DOAS

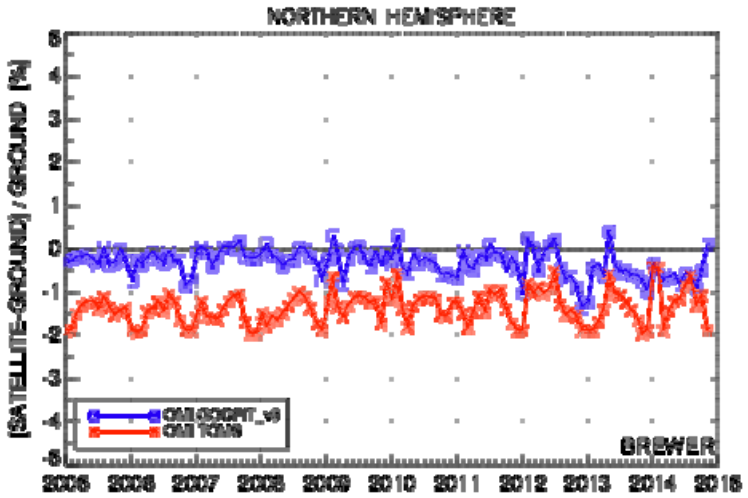


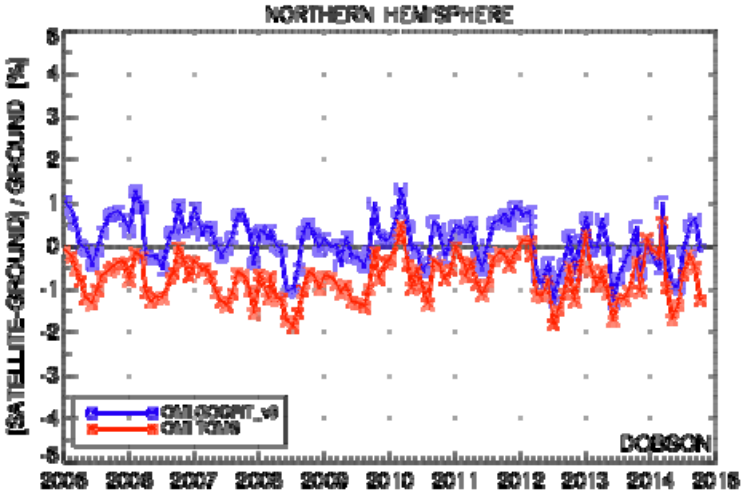
- All products have issues in the lowest bin. Statistically significant?
- OMI_GODFIT very stable up to 70°, differences slightly increase at higher SZAs.
- OMI-TOMS very stable too. The differences are slightly larger above 50°.
- OMI-DOAS has a larger SZA dependence, especially at low and high SZAs.

First validation results

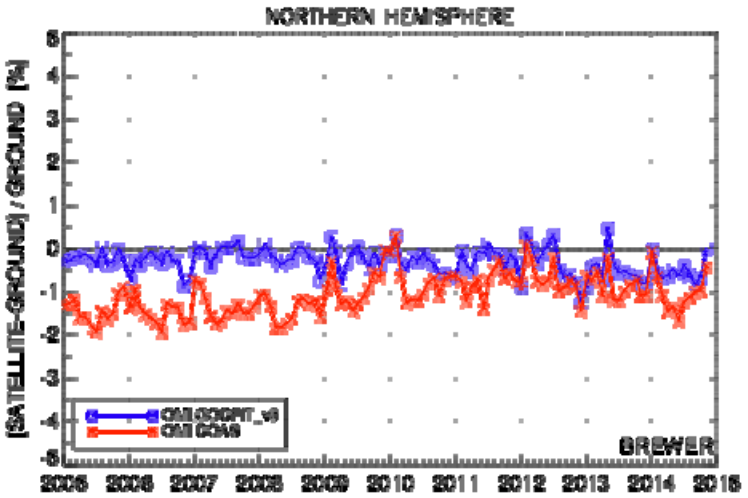
Time dependence

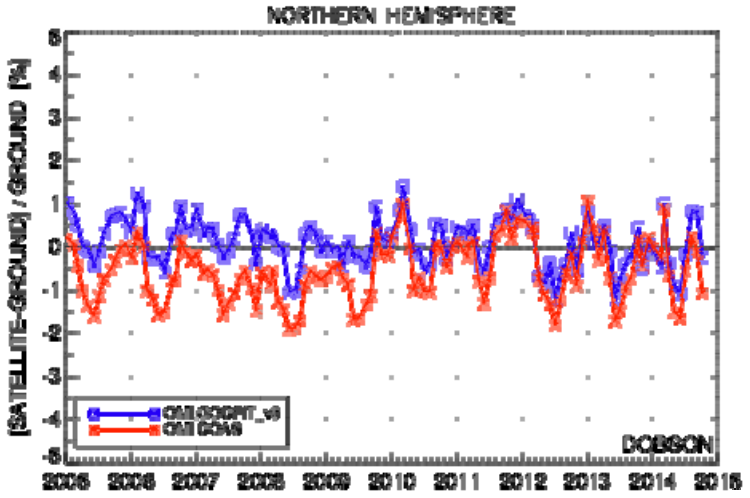
OMI-GODFIT and OMI_TOMS





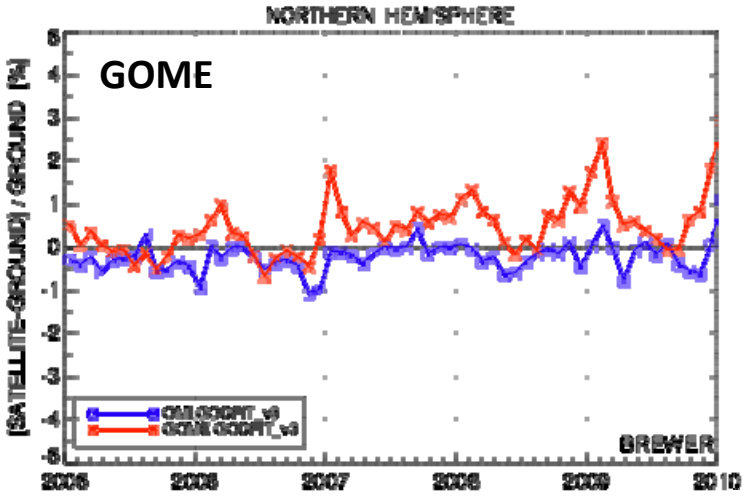
OMI-GODFIT and OMI_DOAS

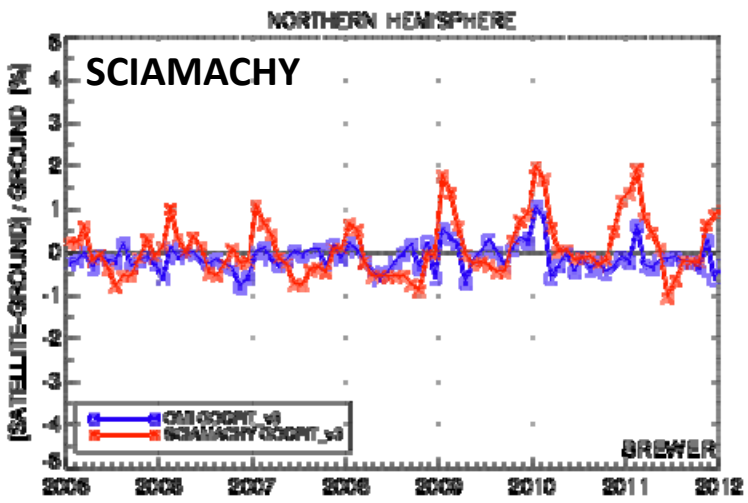


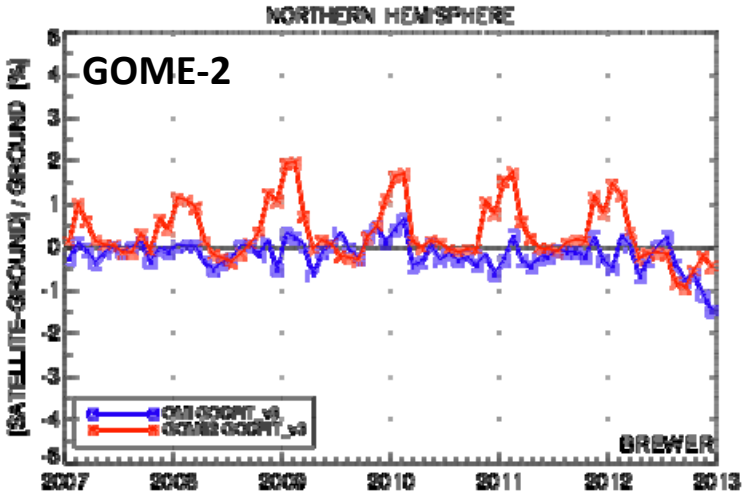


First validation results

Time dependence (comparison with CCI data sets)





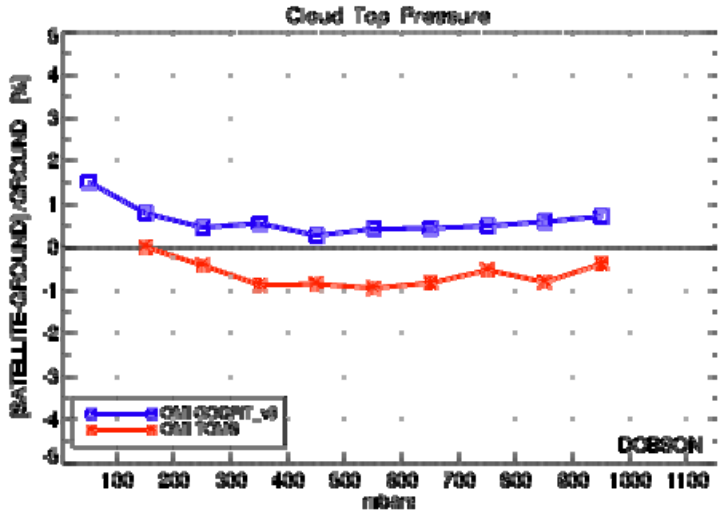


- Excellent consistency with the other CCI data sets.
- Without soft-calibration, OMI_GODFIT agrees better with the Brewer than the soft-calibrated CCI data sets.

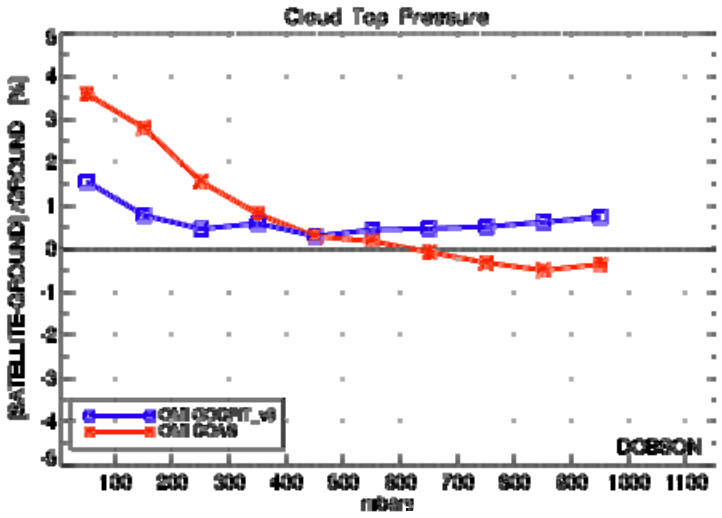
First validation results

Cloud top pressure dependences

OMI-GODFIT and OMI_TOMS



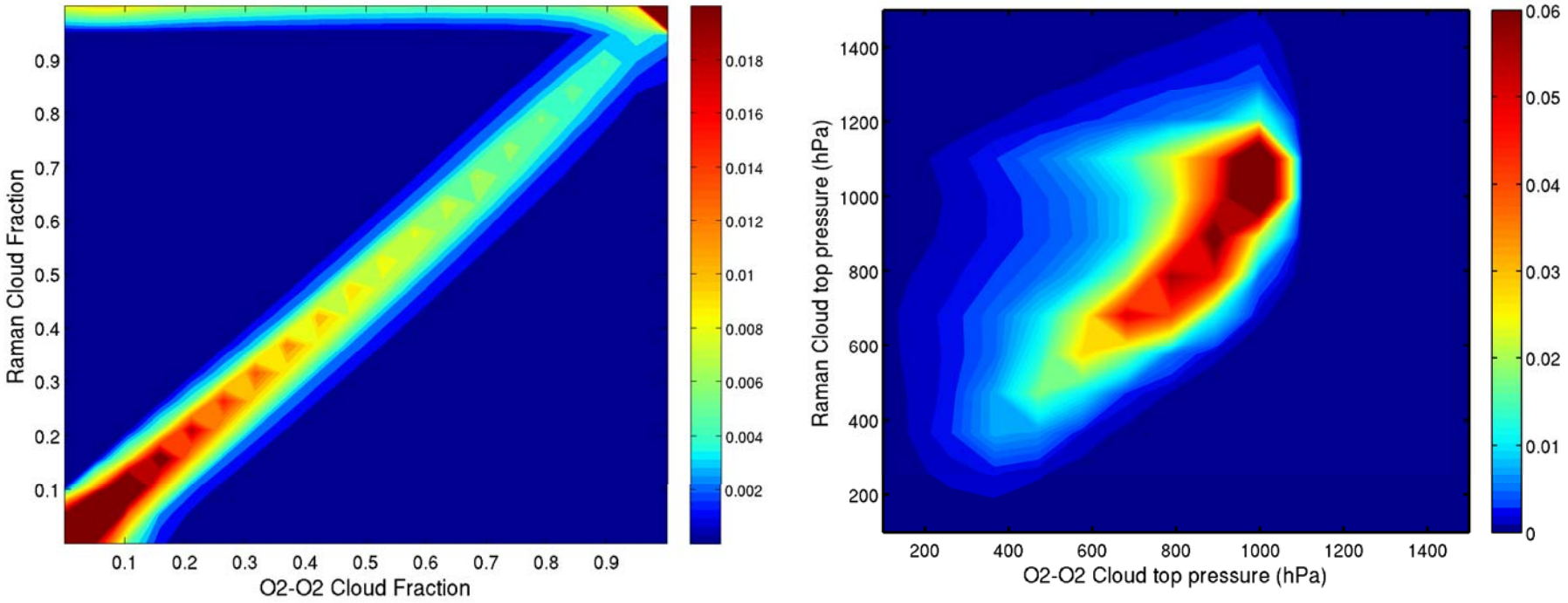
OMI-GODFIT and OMI_DOAS



Impact of the cloud algorithm

Use of RR product instead of O2-O2

Cloud parameter comparison

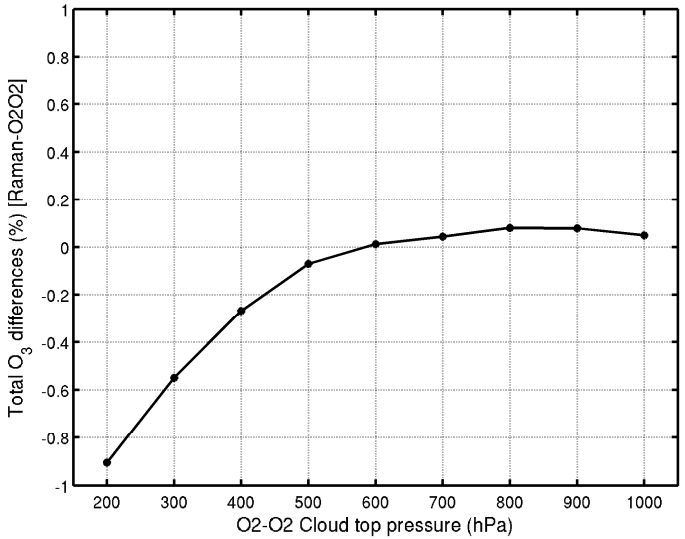


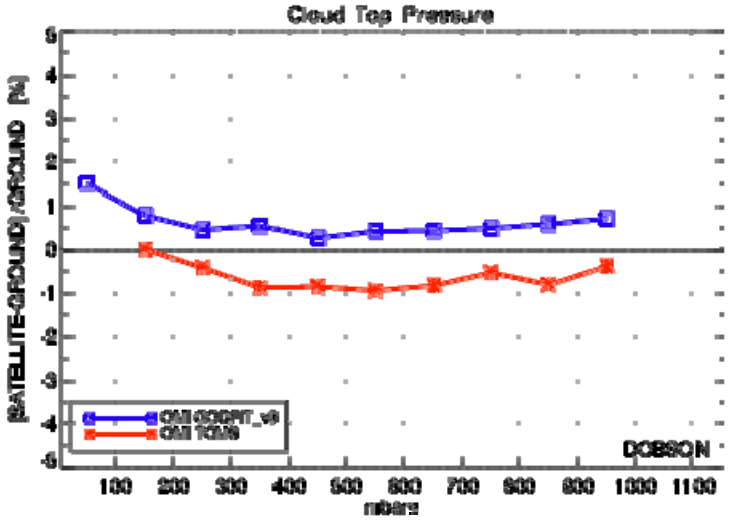
- Much more fully cloudy pixels in the Raman algorithm.
- Cloud generally lower in the Raman algorithm than in the O2-O2 product. A lot of pixels with the cloud below the surface.

Impact of the cloud algorithm

Use of RR product instead of O2-O2

Impact on total ozone





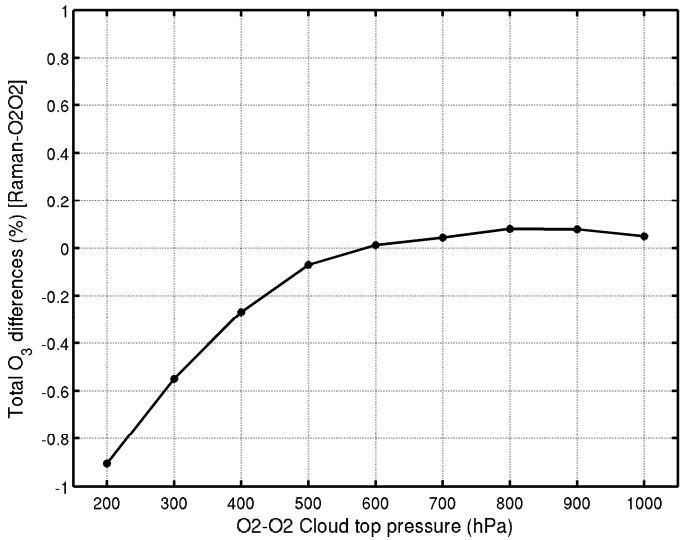
Summary and Next steps

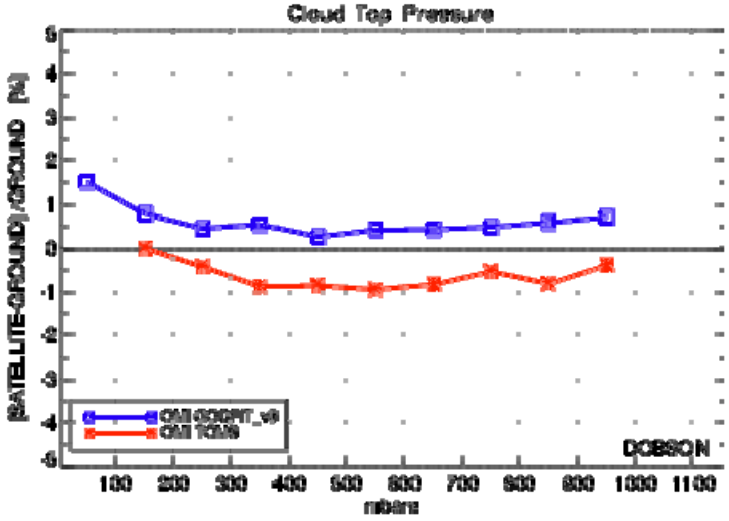
- The full OMI mission has been reprocessed with a fast look-up table version of GODFITv3.
- The three products OMI_GODFIT, OMI-TOMS and OMI-DOAS are very consistent. Larger differences appear in extreme conditions (high SZAs, extreme O3 columns, high clouds, …). OMI-DOAS appears to be affected by slightly larger dependences.
- Use of optimized slit functions in the 325-335 nm interval significantly reduces the row dependence in the OMI-GODFIT product.
- Despite a limited impact on the total ozone retrievals, using the Raman cloud product instead of O2-O2 would slightly degrade the OMI-GODFIT product on average.
- OMI-GODFIT agrees very well with the other CCI data sets and with SBUV V8.6.
- Despite a small discontinuity in 2012, 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.

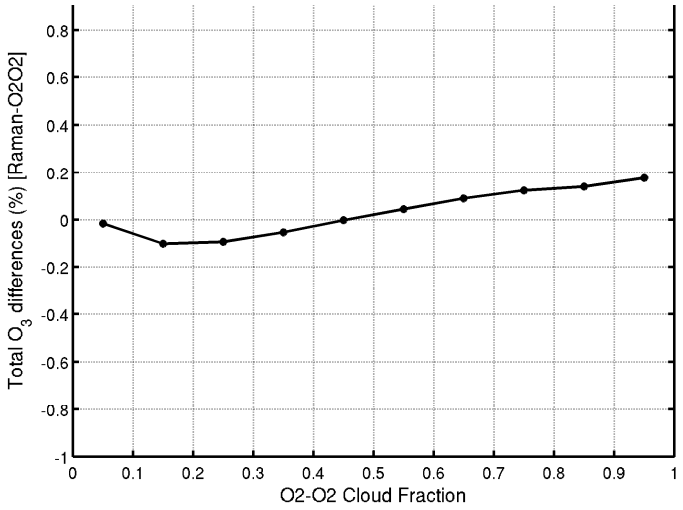
Impact of the cloud algorithm

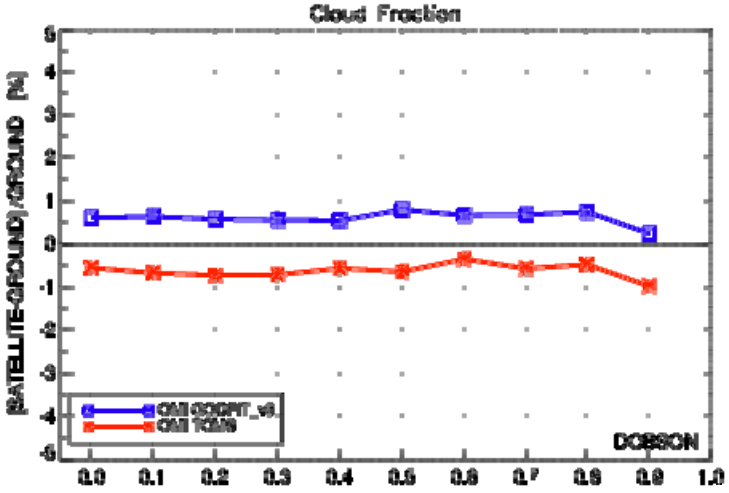
Use of RR product instead of O2-O2

Impact on total ozone



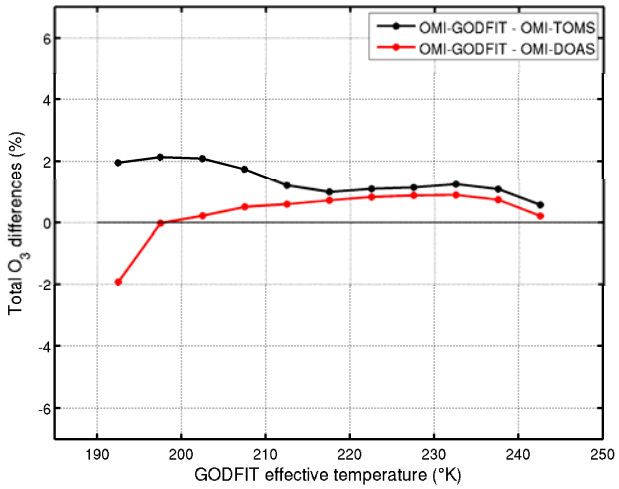




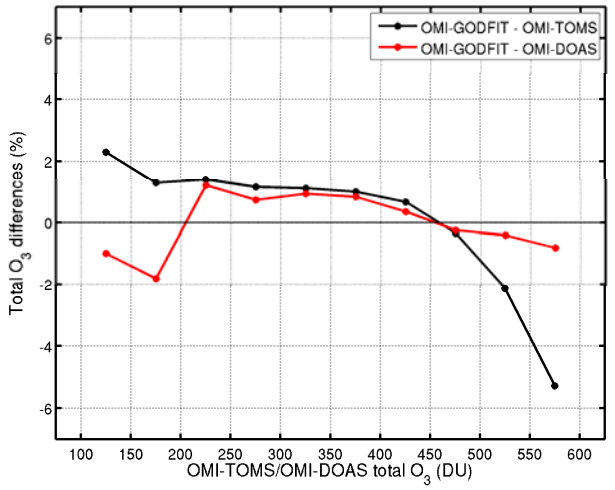


Comparison with OMI-TOMS and OMI-DOAS

Effective temperature dependence



Total O3 dependence



- In general, excellent consistency between the three OMI total ozone products.
- Nevertheless, some systematic differences are visible in extreme conditions, i.e. very low or very high SZAs, extreme ozone columns, low temperatures.