→ CLIMATE CHANGE INITIATIVE

Ozone_cci Newsletter

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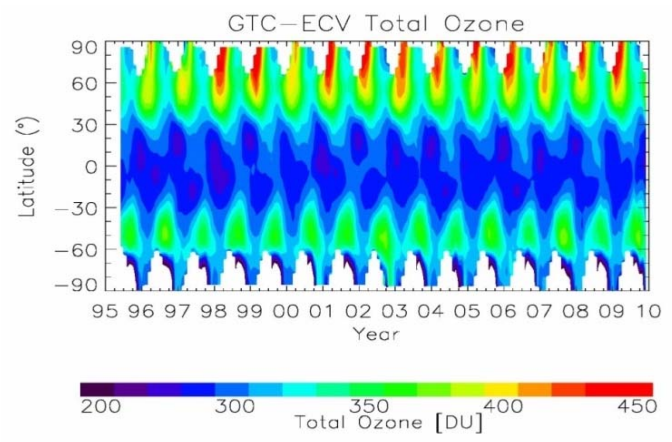


Time-series of merged zonal-mean total ozone columns from GOME, SCIAMACHY, and GOME-2 covering the period from July 1995 until December 2010.

In this issue:

Towards the 2014 Ozone Assessment: Monitoring and modelling ozone in a changing atmosphere

The evolution of the ozone layer, which protects life on Earth from ultraviolet solar radiation, is a key environmental issue with strong links to climate change.

Man made halogen containing compounds caused a dramatic thinning of the so-called ozone layer in the stratosphere during the 80s and 90s. Most notable is the Antarctic ozone hole – the near total depletion of stratospheric ozone over Antarctica.

The discovery of the ozone hole and its attribution to man made halogen containing compounds lead to the Montreal Protocol and its amendments regulating them.

To monitor the success of the protocol Scientific Assessments of Ozone Depletion were initiated. The most recent was published by WMO/UNEP in 2011 summarising the state of affairs up-to 2010.

Now, the community is slowly gearing up to support the next assessment for 2014 with different initiatives and workshops:

- Activity on Past Changes in the Vertical Distribution of Ozone (SI^{2}N, igaco-o3.fmi.fi/VDO/index.html)
- IGAC/SPARC Global Chemistry-Climate Modelling and Evaluation Workshop projects.pmodwrc.ch/ccval
- Quadrennial Ozone Symposium 2012 (www.cmos.ca/QOS2012/)

16 years of harmonised total ozone data records from GOME, SCIAMACHY and GOME-2 sensors

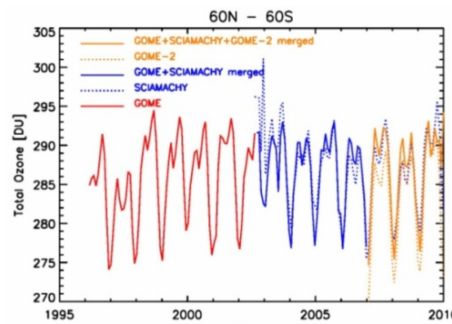
Demonstrated on the GOME GDP v5.0 (Van Roozendael et al., 2012), direct fitting has been selected by ESA as the baseline algorithm to generate the total ozone essential climate variable.

As part of the Ozone_CCI project, an improved version of the direct-fitting algorithm is being developed and applied to GOME, SCIAMACHY and GOME-2 to generate a prototype data set that will cover the full period from 1996 until 2011.

In addition to improved corrections for the Ring effect and polarisation dependencies, as well as the implementation of a new acceleration scheme for the radiative transport calculations, the algorithm also features a new soft-calibration scheme, that accounts for both broadband and spectral features errors in the measured reflectance spectra.

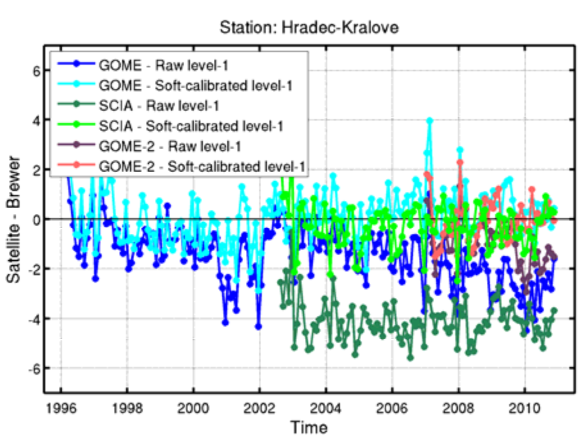
Consistently applied to the different sensors, the correction scheme allows to bring the level-2 data sets in much better agreement (see figure) and reduces the need for additional adjustments.

This forms the basis for the creation of a global total ozone data set obtained by merging GOME, SCIAMACHY and GOME-2 into one single consistent multi-year data record. Similar instrument properties and measurement conditions as well as long overlap periods are advantageous for this task. Remaining small differences among the individual observations are carefully characterised and accounted for using a newly developed stacked neural network approach (Loyola and Coldewey-Egbers, 2012).



Monthly mean ozone values averaged over 60°N to 60°S for the merged total ozone data set (solid red, blue, and yellow lines), in comparison to original SCIAMACHY and GOME-2 data (dotted blue and yellow lines).

Owing to its long-term stability and the length of the available time series (1995-2011), the GOME instrument has been selected as the reference data set. SCIAMACHY and GOME-2 are adjusted accordingly. After corrections depending on latitude, season and time, all data sets are smoothly merged, and a first demonstration long-term time series has been produced as illustrated in the figure above (Loyola et al. 2009).



Time series of total ozone differences between satellite and reference ground-based measurements at the Brewer station of Hradec-Kralove. GOME, SCIAMACHY and GOME-2 direct-fitting results are in much better agreement with the Brewer data after application of the new soft-calibration scheme.

Loyola, D.G., et al. Global long-term monitoring of the ozone layer - a prerequisite for predictions, Int J Remote Sens, 30:15, 4295-4318, 2009.

Loyola, D.G. and M. Coldewey-Egbers, Multi-sensor data merging with stacked neural networks for the creation of satellite long-term climate data records, EURASIP J. Adv. Sig. Pr., 2012, 2012:91, doi:10.1186/1687-6180-2012-91, 2012.

Van Roozendael, M., et al., Fifteen years of GOME/ERS2 total ozone data: the new direct-fitting GOME Data Processor (GDP) Version 5: I. Algorithm Description, J. Geophys. Res., 117, D3, doi:10.1029/2011JD016471, 2012.

Understanding the distribution, natural variability and trends in total ozone – a modelling perspective

Continuous model development and validation is required to advance our understanding of ozone variability and trends. We discuss some recent changes in our models.

The Ozone_CCI climate research group (CRG) has access to a number of chemistry-climate models. Since the publication of the recent Scientific Assessment of Ozone Depletion these CCMs have undergone numerous changes and updates. A small summary of changes for the DLR and Cambridge models is summarised here.

DLR Model (E39CA)

The coupled chemistry-climate model E39CA is an upgraded version of E39C (Dameris et al., 2005). The model top is centred at 10 hPa, with 39 levels between Earth surface and the model top; the horizontal resolution, on which the tracer transport, model physics and chemistry are calculated, is approximately 3.75°×3.75°. The chosen time step is 24 min.

Dameris, M., et al., Long-term changes and variability in a transient simulation with a chemistry-climate model employing realistic forcing, Atmos. Chem. Phys., 5, 2121–2145, 2005.

Cambridge Model (UMUKCA)

The following changes have been recently implemented:

- A Unified Model (the underlying climate model) version update from 6.1 to 7.3
- Inclusion of a module providing fully interactive photolysis rates (previously pre-computed look-up tables were used)
- Updated rates for some reactions
- Inclusion of new diagnostics tracers to characterise modelled transport better
- Option to run with interactive ocean and sea ice

Example of a standard UMUKCA validation against GOME satellite observations: Probability density functions (PDFs) of total ozone are computed for different areas of the world. The model is run for 20 years in a so-called time slice integration. In this example boundary conditions for the 1990s are prescribed periodically; the first 10 years of the integration are discarded as spin-up and the final 10 years are analysed. Overall agreement is generally good. Part of the underestimate in modelled standard deviations and range can be attributed to the periodic boundary condition.