ESA Ozone Climate Change Initiative: combined use of satellite ozone profile measurements

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Ozone_cci limb profile instruments

Vertical resolution 2-4 km

MIPAS
4.15 - 14.6 µm

GOMOS

SCIAMACHY

SMR
501.8GHz, ~0.6 mm

Odin

SCISAT-1

Scattered solar light

Emission spectra

ACE-FTS
2.2-13.3 µm

occultation
Harmonized dataset (HARMOZ), Level 2

- Level 2 ozone profiles in the same vertical grid
- User-friendly: only valid data
- Data are in the same netcdf format
  - Mandatory parameters, the same for all instruments
    - Ozone, uncertainties, vertical resolution, parameters for different representations
  - Optional parameters, specific for each instrument
    - Related to data quality and its characterization
- Currently: on pressure grid
- Nearest future: also on altitude grid
- New datasets included
  - GOMOS bright limb data
  - SMR 544 GHz
  - NASA& NOAA sensors: SAGE-II, HALOE, MLS, SABER
- Relative biases and drifts, Rahpoe et al., 2015, AMT
Level 3 data

- Monthly zonal mean from individual sensors
  - Uncertainty characterization including sampling uncertainty (Sofieva et al., 2014, AMT)
- Merged monthly zonal mean
- Level 3 data with resolved longitudinal structure
  - From individual sensors and merged
- Mesospheric datasets
- Tropospheric ozone column from matched nadir-limb measurements
**Data availability:**

http://www.esa-ozone-cci.org

Open access:  
No password  
No registration
Usefulness of intercomparisons

- The data with strong drifts can be removed from the ensemble
- Even in the very problematic case in the illustration, the merged time series follows the majority of the data
- Negative trend ~35 km is observed in several datasets

Strong SCIAMACHY bias and drift: local feature → will be improved in the next data version (processing)
New data versions

- **ACE-FTS v.3.5**
- **GOMOS ALGOM 2s:**
  - improved UTLS ozone
  - More accurate filtering of invalid data
- **MIPAS IMK v7**
  - time-dependent non-linearity correction: removed drift
- **SCIAMACHY v3.5**
  - Inversion using continuous spectrum in VIS
  - More accurate reference and advanced aerosol modelling
- **OSIRIS**
  - Altitude registration correction (better stability at upper altitudes)
- **SMR**
  - correction of corrupted data

Eckert et al, ACP, 2014
Good agreement: the Arctic stratosphere

Strong SSW in 2009

Arctic ozone hole 2011
Ozone seasonal cycle in the extra-tropical UTLS

Hegglin et al., 2010

Ozone _cci limb instruments

Climate models

Hegglin et al., 2010

Hegglin et al., 2010

100 hPa

Ozone (ppmv)

Month

100 hPa

Ozone (ppmv)

Month

Hegglin et al., 2010

Hegglin et al., 2010
Trends in vertical ozone distribution

Trends in qualitative good agreement but there are differences between datasets

Bourassa et al., 2014

SAGE II / OSIRIS Post-1997 Trend (%/Decade)

O$_3$ trend %/dec

HARMOZ 2000 to 2012

WMO ozone assessment 2014

SCIAMACHY (2002-2011)

Gebhardt et al., 2014

Kyrölä et al., 2013

Kyrölä et al., 2013

Gebhardt et al., 2014

SCIAMACHY (2002-2011)

WMO ozone assessment 2014
From individual time series
through individual deseasonalized anomalies

Deseasonalized ozone anomalies in %
....to merged dataset

Ozone_cci merged anomalies, %

ECMWF temperature anomalies (K)
Examples of time series in the equatorial LS

z = 18 km

OSIRIS
ACE-FTS
MIPAS
GOMOS
SCIAMACHY
- - merged
Combination with SAGE II

Graphs showing ozone anomaly percentages at different altitudes (z=19 km and z=22 km) over a period from 1984 to 2013. The graphs compare data from SAGE II, Ozone CCI, and a combined dataset.
Preliminary assessment of ozone trends

Merged SAGE II & Ozone_cci data set 1984 – 2012

Ozone_cci:
- ACE-FTS v 3.5, OSIRIS V5.07R, MIPAS IMK V7, GOMOS ALGOM2s, SCIAMACHY v 2.9
- Removing anomalies with drifts or with excessive variability

Piece-wise linear trend, solar flux, QBO, ENSO
On-going work, nearest plans

- Creating Level 3 datasets (after new versions are ready)
- Revised ozone trend analyses (together with historical datasets), SAGE II- Ozone_cci-(OMPS)
- Contribution to Obs4MIPs
- Contribution to next WMO ozone assessment and related SPARC activity (Long-term Ozone Trends and Uncertainties in the Stratosphere, LOTUS)
Further extension

- Currently operating: OMPS
- Future: SAGE III/ISS, ALTIUS (occultation ja limb measurements)
- All these instruments use UV-VIS wavelength range for ozone retrievals (number density on altitude grid)
- Climate data record can be continued
- Furthermore, it can be made even more consistent (e.g., all limb-scatter data processed with one processor, occultation data etc)
- Important to have more than one dataset
  - For quality assessment
  - For confidence in observed phenomena