Overview of the Long-term Ozone Trends and Uncertainties in the Stratosphere (LOTUS) SPARC activity.

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LONG-TERM OZONE TRENDS AND UNCERTAINTIES IN THE STRATOSPHERE

LOTUS

The LOTUS project goals:

(a) Update and extend stratospheric ozone observations to recent years

(b) Improve or understanding of crucial yet poorly known sources of uncertainties in trend retrieval

(c) Investigate how uncertainties interact and propagate through the different stages of analysis chain

(d) Re-evaluate current best practice(s) and possibly establish more suitable alternatives.

SPARC website :
http://www.sparc-climate.org/activities/ozone-trends/

LOTUS workshop website
https://events.oma.be/indico/event/23/

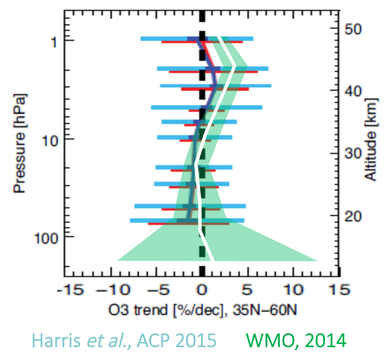


Figure 1: Trends by WMO/UNEP 2014 Ozone Assessment and by SI2N initiative.

Updates since 2014 Ozone assessment

- Newer versions of data sets & extend time series until recent years (2016+)
- Better understanding of impact from changing sampling pattern & merging methods
- Incorporate recent findings on decadal stability of satellites and ground-based records
- Influence of regression model on trend & uncertainty
- Revisit treatment of uncertainties in regression

MIDI Working group (V. Sofieva and R. Damadeo)

Objectives:

1. longer merged datasets
2. more accurate and more consistent datasets
3. better uncertainty characterization

Science questions: What is the impact of (changing) sampling patterns? What is the impact of instrument drift and biases between instruments? Can reliable estimates of corresponding uncertainty be obtained?

ROAST Working group (B. Hassler and R. Damadeo)

Objectives:

1. Understanding differences and similarities in most commonly used regression methods
2. Sensitivity in calculated trends and uncertainties to the regression method and basis functions
3. Development of a regression method

Science questions: Is there a preferred set-up for regression models? How to treat uncertainties? How robust are estimates of trends and trend uncertainties against alternative choices in the regression analysis?

Satellite datasets per measurement principle

Group 1. Ozone profiles from nadir sensors (partial columns on pressure grid)
SBUV MOD Release 6;
SBUV Merged Cohesive

Group 2. Ozone profiles from limb instruments in mixing ratio on pressure grid
HALOE – MLS

Group 3. Ozone profiles from limb instruments in number density on altitude grid
SAGE II – OSIRIS;
SAGE II – OSIRIS – OMPS;
SAGE II – Ozone_cci – OMPS

The dataset with converted ozone representation
Mixed coordinates converted to mixing ratio on pressure
GOZCARDS

Instrument	Station, period since
Lidar	OHP (1986), Hohenpeißenberg (1987), Table Mountain (1988), Mauna Loa (1993), Lauder (1994)
Microwave	Bern (1994), Payerne (2000), Mauna Loa(1995), Lauder (1992)
FTIR	Izana (1999), Lauder (2001), Jungfraujoch (1995), Wollongong (1996)
Umkehr	Mauna Loa (1984), Lauder (1987), Arosa (1956), OHP(1984), Boulder(1984), Fairbanks (1994), Perth (1984)
Ozonesondes	NOAA and SHADOZ datasets

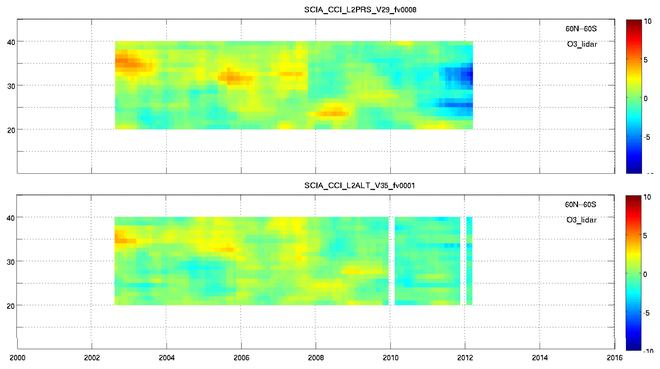


Figure 2. Validation of SCIAMACHI ozone 60S-60N against ozone lidar as function of altitude. SCIA v.3.5 ozone data seem more stable than previous version, but the interpretation of ground-based comparisons is not straightforward due to inhomogeneity in the reference records

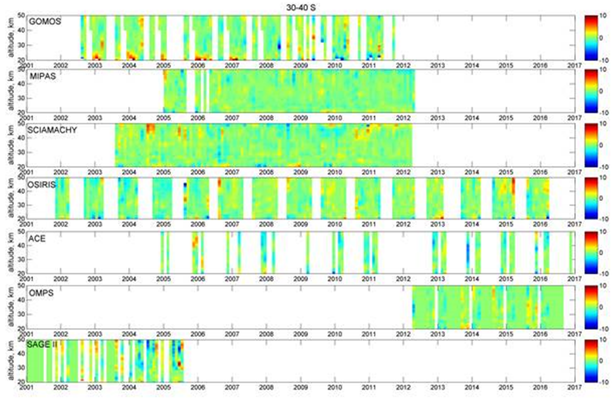


Figure 3. *. Deviations (in %, color) of deseasonalized anomalies for SAGE II, GOMOS, MIPAS, SCIAMACHY, OSIRIS, ACE-FTS and OMPS (indicated in the panels) from the median deseasonalized anomalies computed using these datasets. Latitude zone is 30-40°S, from (Sofieva et al., 2017).*

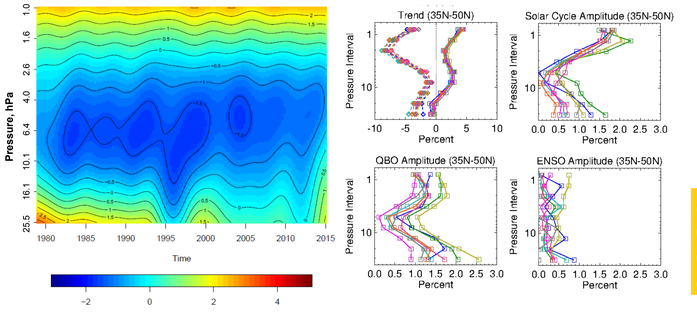


Figure 4. (far left). *Trends derived from SBUV MOD ozone profile data averaged over 35N-50N (GAMM model).*
(4 panels) *Common dataset test used in 8 regression models: Differences in derived Trends, Solar cycle, QBO and ENSO*

Example of SAGE data sampling issues:

MZM values are averages, but sparse sampling can introduce problems

•Sampling offset from center

•Unequal diurnal sampling

Simultaneous temporal and spatial (STS) regression can separate and characterize these effects (with limitations)

•Compute a diurnal correction (mean diurnal variability)

•Calculate difference between actual and representative sampling using only the seasonal cycle

Goal: Create sampling-bias corrected SAGE MZM data set

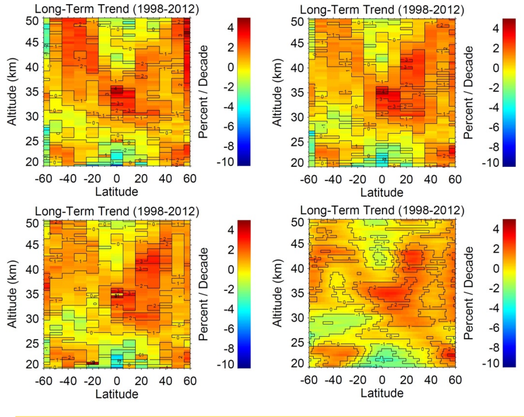
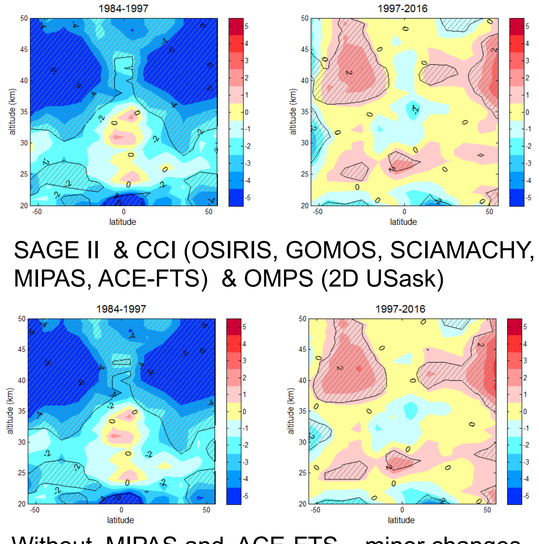


Figure 5. Trends derived from MZM using different corrections (raw=top left, diur. corr.=top right, diur. +seas. corr.=bottom left) and STS (raw=bottom right) regressions

Sensitivity study: how trends will change if exclude MIPAS and ACE-FTS data in the merged SAGE II-Ozone_cci –OMPS dataset



SAGE II & CCI (OSIRIS, GOMOS, SCIAMACHY, MIPAS, ACE-FTS) & OMPS (2D USask)

Without MIPAS and ACE-FTS – minor changes in trends after 1997.

Plans for future

- Provide results of trend analyses for Chapter 3 in the WMO Ozone assessment 2018
- Incorporate data uncertainties in trend estimates
- Write the Report on LOTUS findings