Atmospheric ozone monitoring in the frame of WMO/Global Atmospheric Watch programme

Johanna Tamminen, Finnish Meteorological Institute
on behalf of A.F. Bais and WMO-GAW SAG-ozone

GCOS Science Conference, Amsterdam March 2-4, 2016
Global Atmospheric Watch programme: Six focal areas

- Stratospheric Ozone
- Greenhouse Gases
- Aerosols
- Reactive Gases
- Solar UV Radiation
- Precipitation Chemistry

- CH₄
- CO₂
- N₂O
- SF₆
- NOx
- CO
- O₃
- NH₄⁺
- H⁺
- K⁺
- Mg²⁺
- SO₂
- VOC
- SO₄²⁻
- Ca²⁺
- C₂⁺
- Cl⁻

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The importance of long time series

Total ozone, Arosa, Switzerland

Annual averages
11 year running mean
1927-2013 average

Total ozone [DU]
Ensuring high quality of observations

Intercomparison campaign of the regional Brewer calibration center - Europe & Cost action ES1207 UEBREWNET campaign

“El Arenosillo” Atmospheric Sounding Station, INTA (Huelva, Spain), May 27 - June 05, 2015
Regular intercomparisons since the late 1960s have resulted in a substantial improvement of the homogeneity of the global network of Dobson spectrophotometers.
Understanding differences between instruments

Campaigns arranged to:

• Understand differences in observations to allow homogenization of data records.
• Create reliable data records for trend studies.
• Support development of new instruments.

Double and Single Brewer comparison, Sodankylä and Izana, CEOS 2011

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Homogenization of long term data records of ozone soundings

- On-going action “Ozone Sonde Data Quality Assessment (O3S-DQA) aims for creating homogenized data records.
- Due to changes of instruments or operating procedures there are inhomogenities in the long term ozone sounding records.
- Planned outcome: well documented homogenization process, data sets with careful uncertainty quantification.

**Goal:** study, evaluate, and recommend the most suitable ozone absorption cross-section laboratory data to be used in the data processing of atmospheric ozone measurements.

**Strong commitment from the ozone community including satellite, ground based observations and laboratory groups.**
ACSO - a detailed study on differences and uncertainties

- Status report with recommendations published in 2015.
- Uncertainty quantifications of observations and understanding differences between instruments.
- Highlighted the need for accurate laboratory measurements and their temperature dependency to achieve accurate ozone observations.
- Lessons learned from ACSO activity could be expanded to other gases and wavelength regions.

Ozone absorption cross sections in the Huggins band (Serdyuchenko et al. 2014)

GAW report 218
www.wmo.int/pages/prog/arep/gaw/gaw-reports.html
SI2N initiative on ozone profiles

- Joint effort by: SPARC-project, IGACO-O3/UV, IO3C, NDACC-network

- Goal to improve our knowledge and understanding of the past changes in the vertical distribution of ozone by studying
  - Satellite and ground based measurements, data processing and data quality.
  - Procedures for merging ozone measurements from different sources.
  - Time series and trend analysis.

- 53 peer reviewed papers published in joint special Issue in ACP & AMT & ESSD.

3rd workshop 2013 in Helsinki, FMI
Ozone trends for the period for 1998–2012 derived from satellite data sets. The hatched lines indicate that the trends are not statistically significant at the 95% confidence level.

From Harris et al 2015, ACP
Number of active ozone stations declining

- Number of active ozone stations decreased dramatically since 1990 (50-80%).
- Funding of stations is becoming critical in many countries.
- Difficulties in data submission or in the worst case closing stations.

Number of ozone stations that have submitted data. From WOUDC.
Summary

- The commitment of the ozone community on GAW-related activities has been exceptionally good and facilitated the success stories.

- Important to ensure continuity of high quality ozone observations:
  - Continuity of high quality ground-based total ozone and ozone profile observations and networks are very important.
  - Continuity of satellite observations of high vertical resolution measurements.
  - Maintain and enhance capabilities to analyze historical data.
Characterization of uncertainties are crucial for reliable data records useful for climate and trend studies.

Advances have been made in methodologies for data homogenization and merging of different data sets but still work needed, e.g., to characterize and take into account the uncertainties.

Methodologies and lessons learned from activities within GAW ozone could benefit other constituents.
Ozone sounding at Sodankylä, February 26, 2016

OMI Total ozone March 2\textsuperscript{nd}, 2016 (direct readout)
Arctic ozone in spring 2016

Ozone sounding at Sodankylä, February 26, 2016

OMI Total ozone (direct readout)

Sodankylä (67.4° N, 26.7° E) ozone sounding

Total ozone: 275 DU

G O

OMI

OMI O3 Column
1 day composite
Latest: 26.02.2016 14:32 UTC

PMI-RMMI-NASA-NSO

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IGACO-O$_3$/UV framework to support combined use of observations and modeling

- “Integrated Global Atmospheric Chemistry Observations” Theme Report, published in 2004 highlighted the need to consider various observing systems, modeling and assimilation together.

- This has been the focus of IGACO-O$_3$/UV secretariat, hosted by Finnish Meteorological Institute, in supporting GAW ozone.

- Originally 30 specific activities were identified.