The short-term and long-term stratospheric and tropospheric ozone variability available from zenith sky measurements.

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Abstract. This work evaluates the quality of stratospheric and tropospheric ozone information derived from ground-based Dobson and Brewer measurements. The updated and homogenized SBUV/2 V8 ozone profile time series is evaluated for internal consistency and potential drifts between different satellites. Long-term records from well-maintained Dobson Umkehr stations are used for assessment of the SBUV time series. Stratospheric ozone variability is analyzed as function of season, altitude and latitude. In addition, the short-term and long-term tropospheric ozone variability derived from two Umkehr data sets available from Boulder, CO, and Mauna Loa Observatory in Hawaii are validated against the reference dataset comprised of co-incident and co-located ozonesonde profiles. Analysis suggest that both the Dobson and Brewer Umkehr techniques are capable of monitoring short-term variability in tropospheric ozone. Dobson and Brewer retrieved data can explain about 50 % of the variability measured by ozone sondes. It was noticed that the 1-day co-incident data have higher correlation coefficients than the 2-day window for Boulder, but not for Mauna Loa. In addition, correlation coefficients calculated for co-incident Umkehr and ozonesonde data were found to be relatively large and statistically significant in the troposphere, although the highest correlation was in the lower stratosphere. Moreover, ozonesonde data smoothed with the corresponding Umkehr Averaging Kernel function showed larger correlation coefficients as compared to comparisons using layer-integrated ozonesonde data. Based on correlation analysis Dobson and Brewer data can capture tropospheric ozone variability. Therefore, the Umkehr method is capable of measuring long-term changes in tropospheric ozone.

Past issues

- UMK04 ozone profile retrieval algorithm was designed in 2004 to reduce effects of a priori on trends and inter-annual variability (Petropavlovskikh et al., 2005).
- All data at the WMO Ozone and UV Data Center had been processed with UMK04 algorithm and archived
- Natural and instrument variability in Umkehr data has been recently compared with SAGE, SBUV and sounding (Fioletov et al, JGR, 2006).

Remaining issues

- Studies of tropospheric ozone variability in Umkehr retrievals and comparisons with ozone sounding data.
- The impact of the retrieval algorithms (UMK04 vs. UMK92) on the derived trends.
- Brewer ozone retrievals (Martin Stanek, O3BUmkehr ozone RT algorithm).
- Comparisons with SBUV-type satellite profiles (V. Fioletov, SBUV combined data).

Validation of Brewer tropospheric ozone data against sonde, Boulder 2006-2008 time series

Sampling:

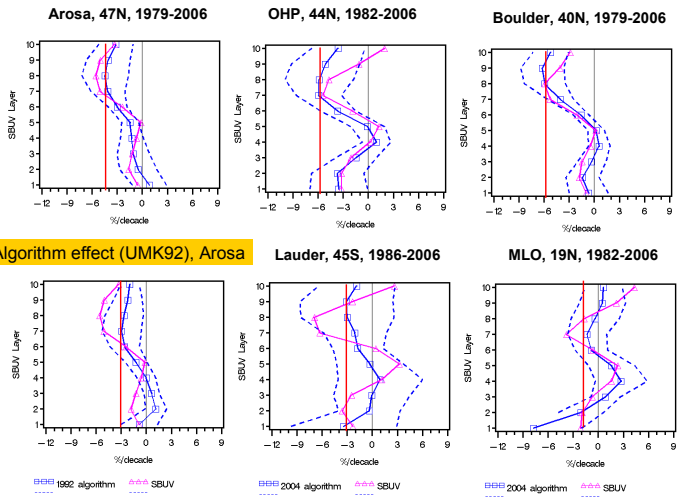
- Brewer – daily, multiple TO
- Sounding – weekly

Limitations:

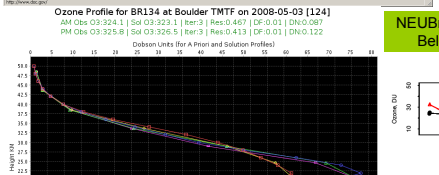
Brewer – clouds, vertical resolution

Sounding - sampling

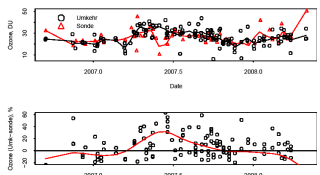
Trends in Umkehr (UMK04) and NOAA SBUV (V8, station overpass) time series



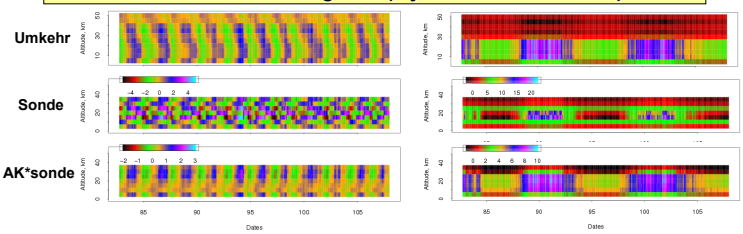
Algorithm effect (UMK92), Arosa



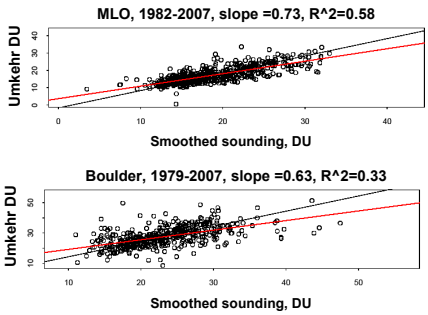
NEUBrew data and ozone sounding, Boulder, Below 250 hPa, Sept 2006 – May 2008



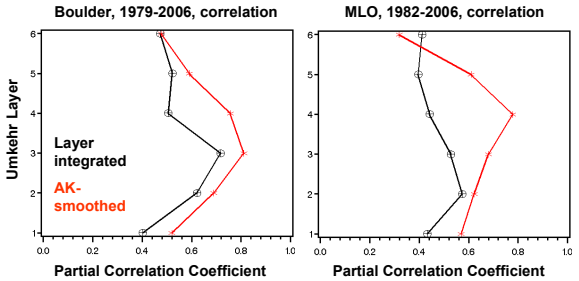
MLO, 1982-2007, QBO (left) and Solar (right) signals Umkehr and sounding data (layer and AK-smoothed)



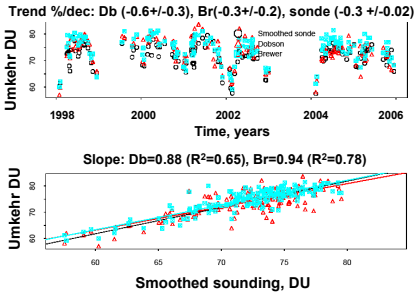
Tropospheric ozone below 250 hPs, Dobson vs. sonde



Dobson/sonde correlation, MLO and Boulder, coincidence < 2-day



MLO, Stratospheric ozone 16-32 hPs (25-30 km) Dobson, Brewer and sonde, 2-day coincidence



Summary of Results

- Umkehr retrieved ozone profile time series are valuable assets in determining ozone inter-annual variability and trends in both the stratosphere and troposphere.
- Quality assured Umkehr data show no significant differences in stratospheric ozone trends among stations in northern middle latitudes.
- Trend differences found in stratospheric ozone depletion over Lauder, NZ (southern hemisphere compared to the Northern hemisphere) are most likely related to the starting date of the record.
- Umkehr and sonde-derived QBO and Solar signals are similar after sonde smoothing.
- Long-term Umkehr data records provide ground-truth for homogenized SBUV and TOMS satellite data records

Continuing research

- Work on Brewer ozone profile retrieval: collaboration with Martin Stanek (*new PC software "O3BUmkehr", stanek@chmi.cz*), NASA/Goddard, NOAA/NESDIS, Ozone SAG and USA Environmental Protection Agency.
- New ozone profile data sets are available for 6 NEUBrew sites.
- Extended Brewer ozone profile data set will be available for future satellite mission validation (NPOESS) and ozone recovery analysis.

Poster by P. Kiedron et al. "NEUBrew - The NOAA/EPA Brewer Spectrophotometer UV Monitoring Network".

Poster by K. Miyagawa et al. "Vertical Profile of Ozone by Umkehr Measurements at Syowa Station".