

Description of Homogenized Dobson Umkehr Profiles.

Contact

Dr. Irina Petropavlovskikh

Irina.petro@noaa.gov

Senior Research Scientist

Peter Effertz

Peter.effertz@noaa.gov

Professional Research Assistant

NOAA GML Ozone and Water Vapor Division.
325 Broadway GML/1
Boulder, Colorado 80305

Data Description

The files in this directory are the Umkehr profiles retrieved from the Dobson instrument at five locations. The Umkehr profiles have been homogenized. These files are in the NetCDF-4 format. (<https://www.unidata.ucar.edu/software/netcdf/>). Each file represents one year of data at each station.

Station information:

Station ID	WMO Code	Location
ARO	035	LichtKlimatisches Observatorium - Arosa, Switzerland
BDR	067	NOAA ESRL David Skaggs Research Center - Boulder, Colorado, USA
LDR	256	National Institute of Water & Atmospheric Research- Lauder, New Zealand
MLO	031	Mauna Loa, Hawaii, USA
OHP	040	Observatoire de Haute-Provence, Marseille-Provence Astronomical Observatory Federation - Haute Provence, France

In each file, you will find the following variables related to the retrieval:

- A priori Ozone profile
- Averaging Kernel
- Retrieved Ozone Profile in 16 layers
- Retrieved Ozone Profile in 10 layers

Also in each file, you will find the following variables related to the structure of the profile:

- Averaging Kernel number (1-16):
- Measurement Code where "00" is clear sky
- Pressure 10: These are the pressure (mbar) of the bottom of each layer (for the ozone profile in 10 layers). Note that for layer 0, this is the average station surface pressure of each site.
- Pressure 16: These are the pressure (mbar) of the bottom of each layer (for the ozone profile in 10 layers). Note that for layer 0, this is the average station pressure of each site.

- Time: Number of hours since epoch (1900-01-01 00:00). Please see this discussion for the NetCDF time convention: <https://www.unidata.ucar.edu/software/netcdf/time/recs.html>
Also note, that the hour on the timestamp is only meant to represent whether the profile took place in the morning (6:00) or afternoon (18:00). It does not represent the exact time the Umkehr observation started or stopped.
- Time of day: The old method of distinguishing between morning and evening profiles (1 is morning or am and 2 is afternoon or pm).
- Total Column Ozone Integrated: Integrated from the Umkehr profile.
- Total Column Ozone Observed: Closest total ozone column observation.
- Wavelength: 3 refers to the Umkehr C-pair, 5 refers to the cloud-corrected Umkehr C-pair

Homogenization Procedure:

Umkehr ozone profile records are homogenized using simulated ozone record over the station (i.e. M2GMI model) as a reference to remove step changes in observations (N-values) when caused by changes in the stray light contribution or from other instrumental artifacts, or in association with data re-processing before and after instrument calibrations. The reference paper is in the reviews. <https://amt.copernicus.org/preprints/amt-2021-203/#discussion>

Data Management

- Only good data are provided in the output (i.e. less than 4 iterations, RMSD less than 100, no negative ozone, no missing observations between 70 and 90 degrees SZA).

Uncertainties and Consistency:

- Equations for measurement and smoothing errors from Rodgers (2000) are used for uncertainties, similar to calculations discussed in Bhartia et al, 2013 paper.

Bhartia, P. K., McPeters, R. D., Flynn, L. E., Taylor, S., Kramarova, N. A., Frith, S., Fisher, B., and DeLand, M.: Solar Backscatter UV (SBUV) total ozone and profile algorithm, Atmos. Meas. Tech., 6, 2533–2548, <https://doi.org/10.5194/amt-6-2533-2013>, 2013.
- GAW Report, 180. Towards a Better Knowledge of Umkehr Measurements: a Detailed Study of Data from Thirteen Dobson Intercomparisons. Conclusion: individual instruments have different out-of-band light rejection (aka stray light), which can result in relative biases (up to 6 % or larger) between Umkehr retrieved profiles measured simultaneously by several instruments.
- Petropavlovskikh et al (2021) shows that homogenized Umkehr profiles have less than +/- 5 % biases from other techniques (i.e. COH, MLS, SAGE III and ozonesonde) in the

stratosphere. The biases increase in the lower stratosphere and troposphere depending on station: -5 % at Lauder, near zero at Boulder and MLO, 5% at OHP

- World Meteorological Organization (WMO) - WMO, 2008 (WMO/TD-No. 1456) How much inconsistency is left over after homogenization: details in Annex or referencing.

Traceability:

All Umkehr observations are traceable to Dobson 083 instrument, the WMO GAW world standard instrument. During intercomparisons, Umkehr observations are compared between the station and standard instrument and results are included in the report. The optical wedge calibration is done with standard lamps (NIST traceable).

History:

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