Homogenization of the European ozonesonde time series

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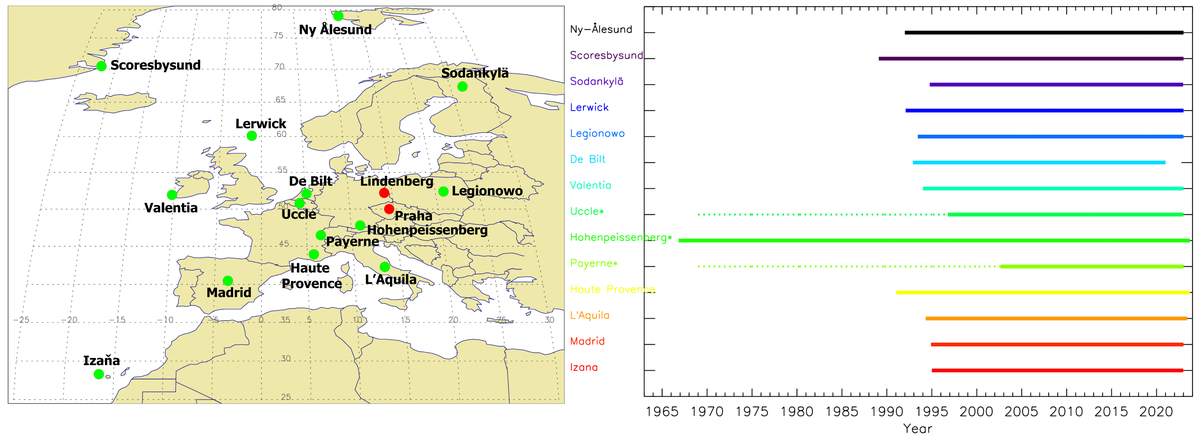
Motivation

- Ozonesondes, launched with weather balloons, measure the ozoneconcentration through an electric current generated in the external circuit of an electrochemical cell. This current is directly related to the uptake rate of ozone in the sensing solution in the cells.
- each launch = unique instrument, that has to be thoroughly prepared, checked, and characterized before launch
- risk/origin of inconsistencies in preparation procedures, hardware, data processing in a time series at one site and/or between different sites
- ➔ (inherent) need for homogenization of ozonesonde data

The homogenization of 14 out of 16 European ozonesonde time records improves the agreement with (co-located or satellite overpass) total column ozone measurements and MLS stratospheric ozone profiles, enabling a regional assessment of vertical ozone climatology and trends in Europe.



Principles of homogenization

1. Correcting for biases due to changes in ozonesonde type (SPC, EN-SCI), sensing solution type (SST) and volume, pump temperature location (SPC 5A vs. SPC 6A), applied correction steps, preparation, etc.

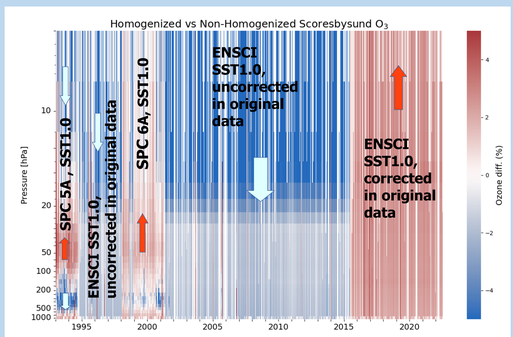


Fig. 1: Relative differences in the vertical ozone concentrations between the homogenized and (minus) non-homogenized ozonesonde time record at Scoresbysund, Greenland. Marked are the used ozonesonde types (SPC 5A, SPC 6A & EN-SCI), and sensing solution type (SST1.0). Note that the recommended combinations are SPC SST1.0 and EN-SCI SST0.5, so that a conversion is needed from the used EN-SCI SST1.0.

2. estimation of uncertainties for each ozone partial pressure measurement

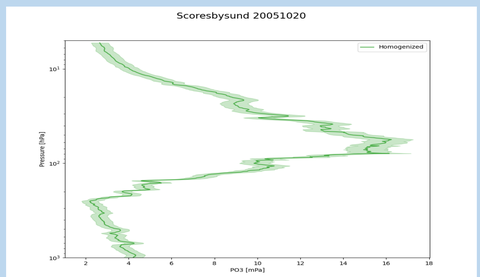


Fig. 2: Ozone sounding at Scoresbysund on 20 October 2005 (green line). The shaded area denotes the estimated uncertainties.

3. providing raw observations ("currents"), needed for (future) re-processing of the data

Evaluation of homogenization

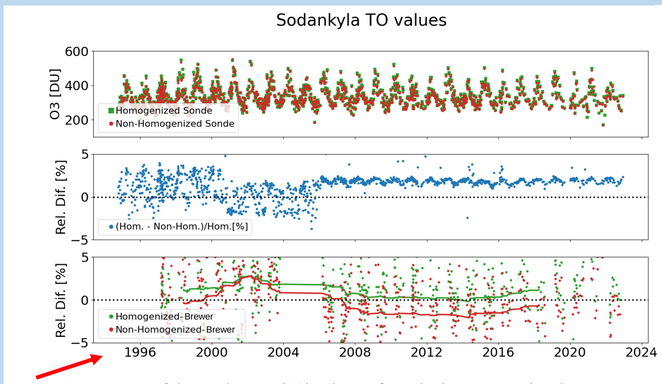


Fig. 3: Comparisons of the total ozone (TO) columns from the homogenized and non-homogenized Sodankylä ozonesonde time series (upper panel), their relative differences (middle panel), and relative to the total ozone column measured with the co-located Brewer spectrophotometer (lower panel).

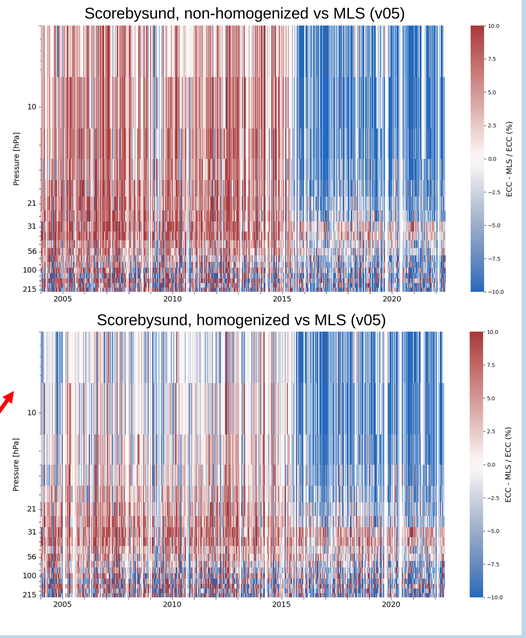


Fig. 4: Time series of coincident Scoresbysund ozonesonde and Microwave Limb Sounder (MLS) satellite O_3 profile relative differences ([ozonesonde-MLS/ozonesonde]). Red or blue colors indicate where the ozonesonde ozone is greater or smaller than MLS, respectively. Upper plot for the non-homogenized ozonesonde time series, lower plot for the homogenized.

We evaluate the ozonesonde data homogenization by comparing

- ✓ vertical stratospheric ozone profiles with MLS
- ✓ total ozone columns with co-located Brewer/Dobson or satellite overpass measurements

- Most of the EU stations already had rather homogeneous ozonesonde time records, without major inconsistencies.
- For most of those stations (e.g. Sodankylä, Fig. 3), the homogenization leads to higher ozone concentrations (additional pump temperature correction), resulting in closer agreement with the external ozone measurements (Fig. 3).
- However, homogenization is sometimes not a "silver bullet", leaving some uncorrected biases (e.g. underestimation of stratospheric ozone levels with respect to MLS from about 2016 onwards, still present in homogenized Scoresbysund time series in Fig. 4)

Homogenized ozonesonde data available at https://hegiftom.meteo.be/datasets/ozonesondes

Trends

Vertical ozone trends from 2000 are calculated using the LOTUS (Long-term Ozone Trends and Uncertainties in the Stratosphere) Multiple Linear Regression with the QBO, solar radio flux, ENSO, and stratospheric aerosols as proxies (SPARC/IO3C/GAW, 2019).

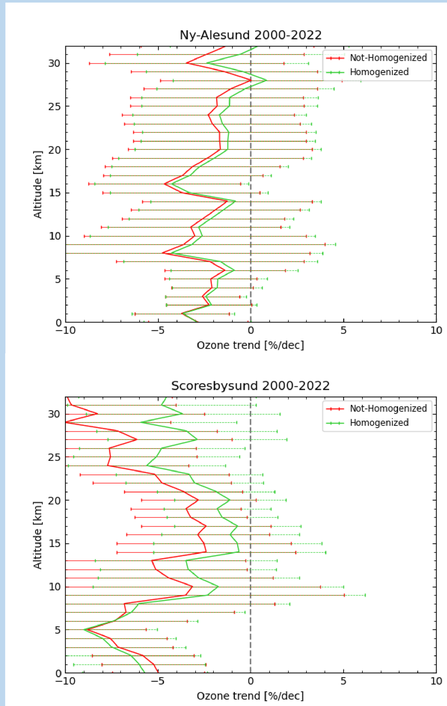


Fig. 5: Post 2000 vertical ozone relative trends [%/dec] estimated with the LOTUS MLR trend model for the Homogenized and Non-Homogenized time series for the Arctic stations Ny Ålesund (upper panel) and Scoresbysund (lower panel).

- The vertical ozone trends of the European ozonesonde time records are mostly not significantly impacted by the homogenization (Fig. 5, upper panel), except for Scoresbysund (Fig. 5, lower panel, possible reason: see poster session A21H, board number 2366)
- Homogenization brings the vertical ozone trends from the European Arctic sites in closer agreement with each other.

Future work & further information

- Does the ozonesonde homogenization improve the spatial and temporal consistency of the (vertical) ozone amounts above Europe?
- Apply the new Time Responses Correction & Calibration method (see poster session A21H, board number 2374) on the EU ozonesonde data.

FOR MORE INFORMATION: