HOMOGENIZATION OF THE LONG-TERM GLOBAL OZONESONDE RECORDS

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Introduction: ozonesondes

- small balloon-borne instruments consisting of pump and electrochemical cells, coupled to radiosondes with electronic interface
- measuring vertical profile of ozone concentrations by reaction of O_3 with KI solutions in cells
- pump and cells have to be thoroughly prepared and checked before launch
- around 60 active stations, longest time series > 50 years

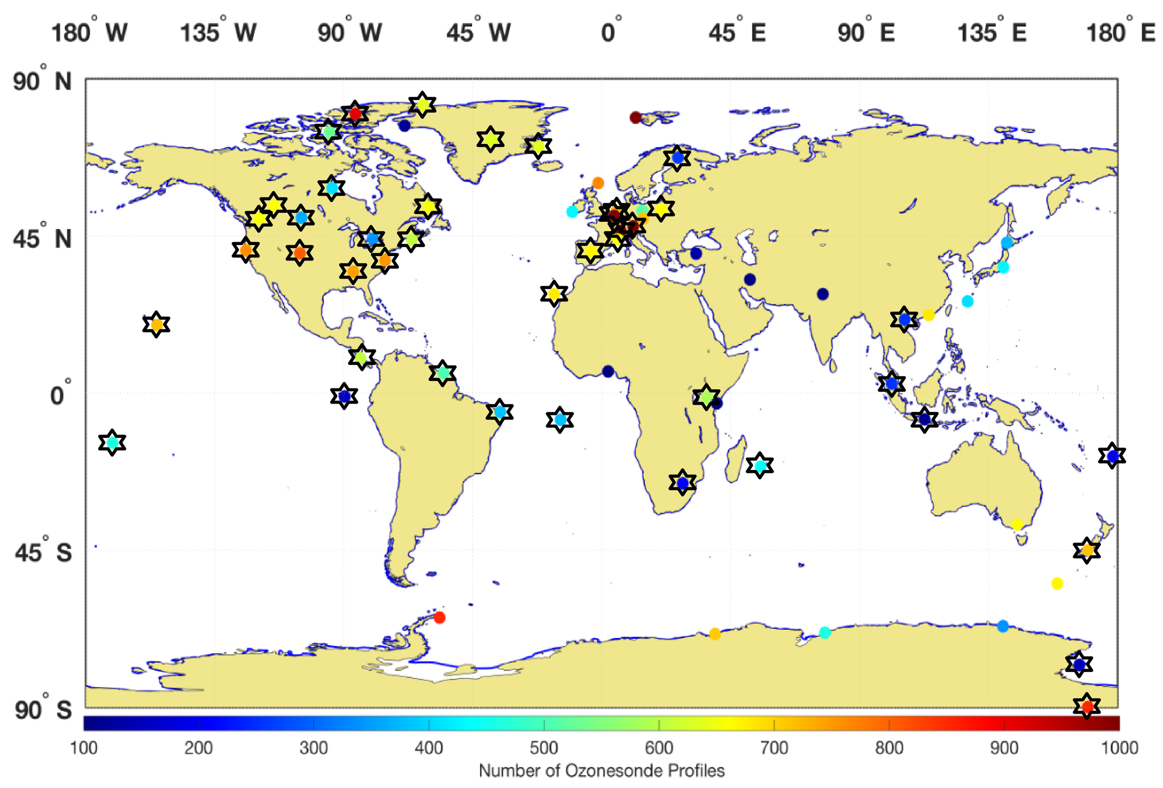


Fig 1 : Global ECC ozonesonde station loations with the number of ozonesonde profiles from 2005-2019 indicated by the colormap (from Smit et al., 2021).

Principles of homogenization

1. correcting for changes in ...
   - ECC ozonesonde type (SPC, EN-SCI)
   - sensing solution strength/volume
   - "pump" temperature measurements
   - pre-flight procedures (background current, pump flow rate)
   - post-processing (pump efficiency correction tables, total ozone normalization, etc.)

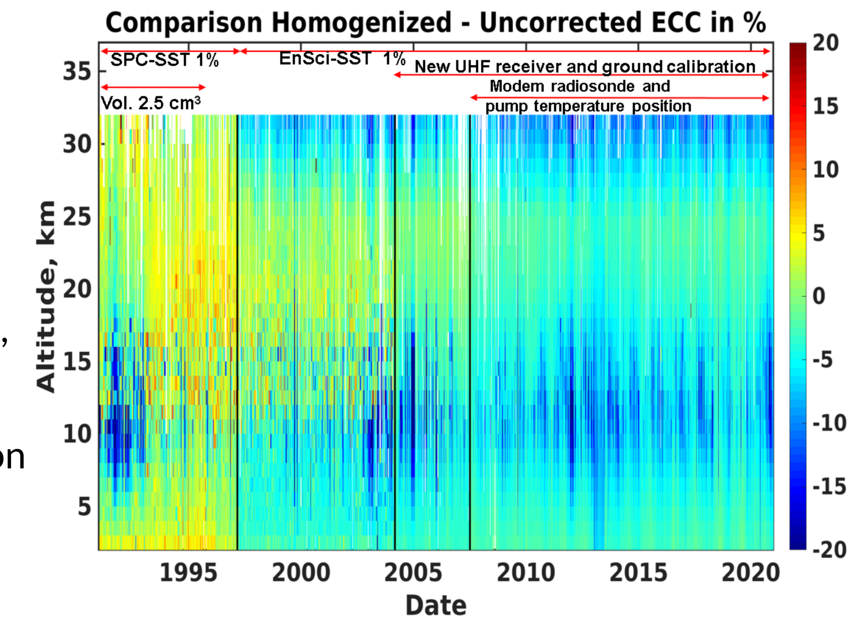


Fig 2 : Time evolution of the relative difference between homogenized and uncorrected ozone concentrations at Observatoire Haute Provence as a function of altitude (Ancellet et al. 2022).

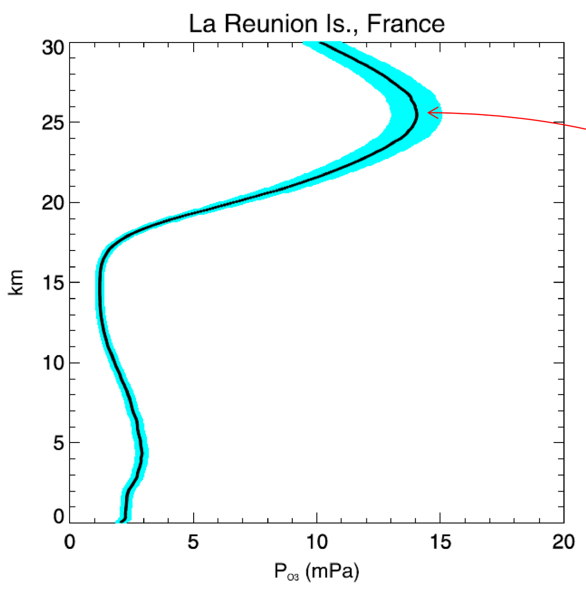


Fig 3: Average profile of O3 partial pressure (PO3) in mPa (black) and ±uncertainty estimates (cyan) at La Reunion Is.. (from Witte et al. 2018)

2. estimation of uncertainties for every ozone partial pressure measurement
3. providing raw observations ("currents"), needed for re-processing
   - ULTIMATE GOAL: reduce uncertainty from 10-20% to 5-10%
   - about 40 stations have already been homogenized (stars in *Fig. 1*).

Validation of homogenization

- comparison with **vertical ozone profiles**
  - in stratosphere: satellite (Microwave Limb Sounder, MLS)
    → **red/blue color contour plots hereafter**
  - in troposphere: aircraft, Lidar
- comparison of **total column ozone (TCO)** from ozonesonde profile with
  - co-located spectrophotometer (Brewer/Dobson/SAOZ) TCO ("normalization factor")
  - nadir satellite (OMI, OMPS, GOME2A, GOME2B) overpass TCO measurements
    → **plots with colored dots and 500 pt. moving average lines hereafter**

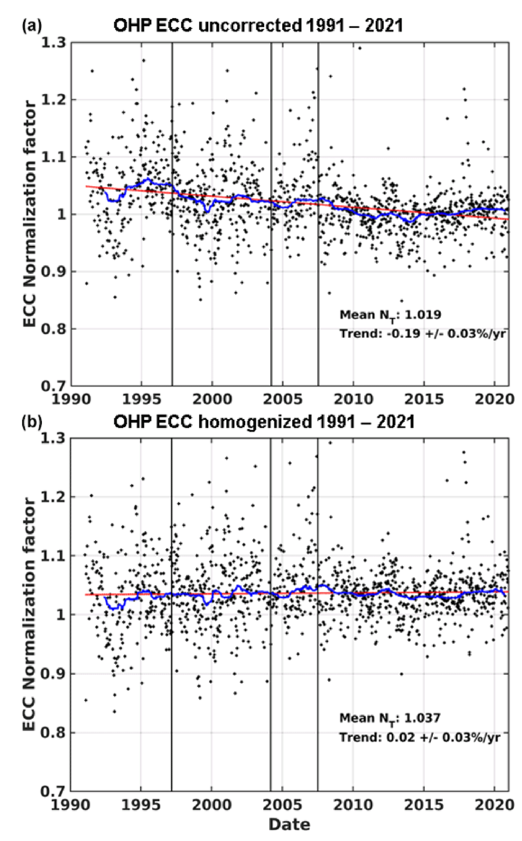
Fig 4: Illustration of the MLS instrument on board the AURA satellite platform.

Fig 5: A Brewer spectrophotometer measuring the total ozone column from the ground, based on solar UV.

Examples: success stories

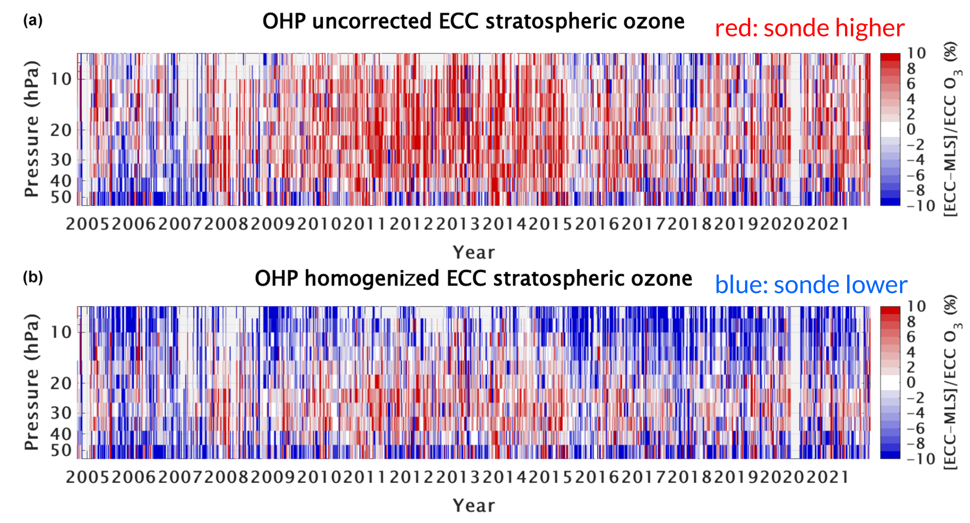
Observatoire Haute Provence (OHP), France

Total ozone amount
(co-located ground-based spectrophotometer)

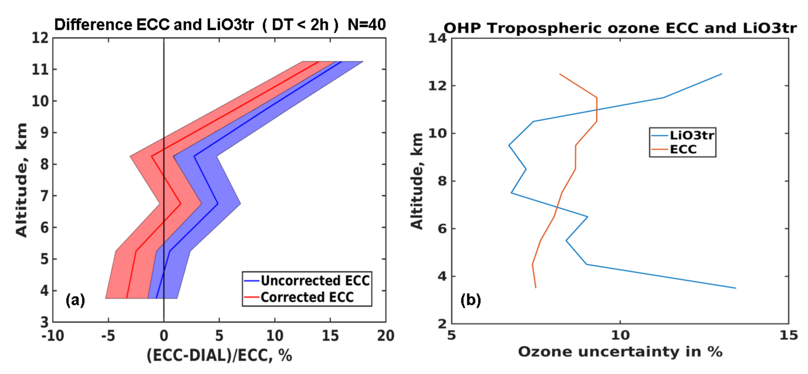


Figures taken from Ancellet et al. (2022)

Stratospheric ozone profile
(MLS satellite instrument)



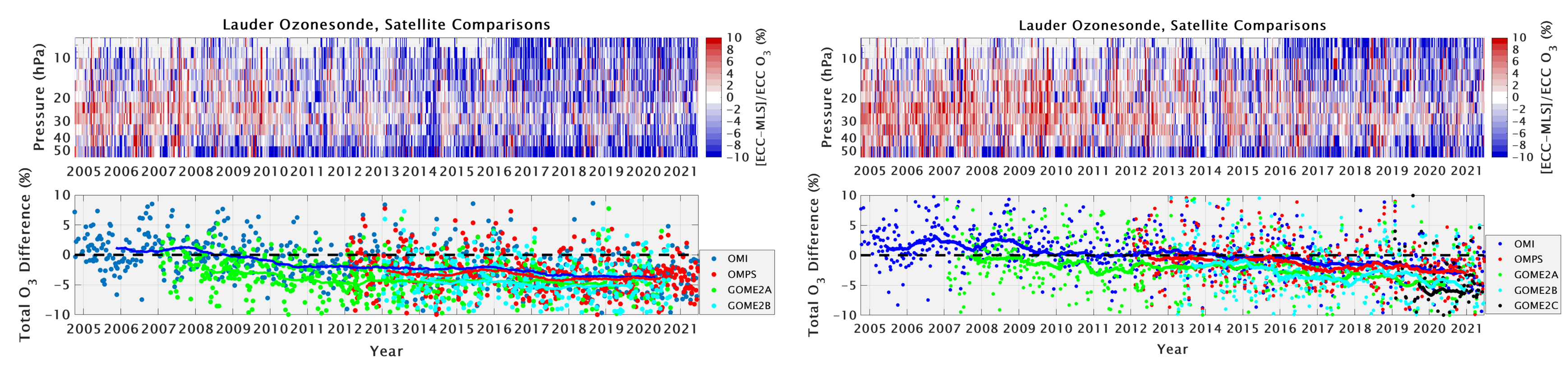
Tropospheric ozone profile
(co-located ground-based Lidar)



- major improvement of homogenized vs. uncorrected when compared to 3 independent instruments:
  - smaller relative biases
  - smaller drift

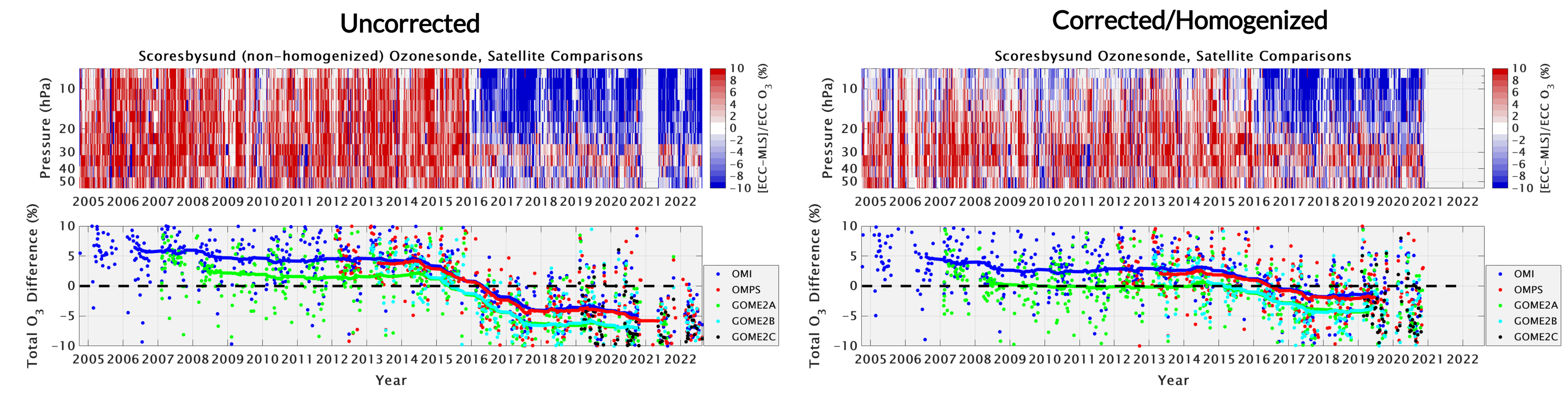
Examples: remaining issues

Lauder, New Zealand



- overall underestimation of ozone in stratosphere (*upper panels*) and entire vertical column (*lower panels*) disappears after homogenization
- remaining drift in ozonesonde time series vs. MLS & satellite overpass total ozone retrievals

Scoresbysund, Greenland (Denmark)



- **Uncorrected:** large discontinuity in 2016 due to reprocessing from 2016 onwards (hereby correcting for 3-4% bias from ozonesonde network standard)
- **Homogenized:** amplitude of discontinuity decreased, but still present.
- **Around 2016**, many changes: radiosonde type, pressure measurement (pressure sensor → from GPS), battery type for ozonesonde pump, active heating system in the Styrofoam box, etc.
- **NEED FOR CONTINUOUS QUALITY MONITORING!**

Conclusions

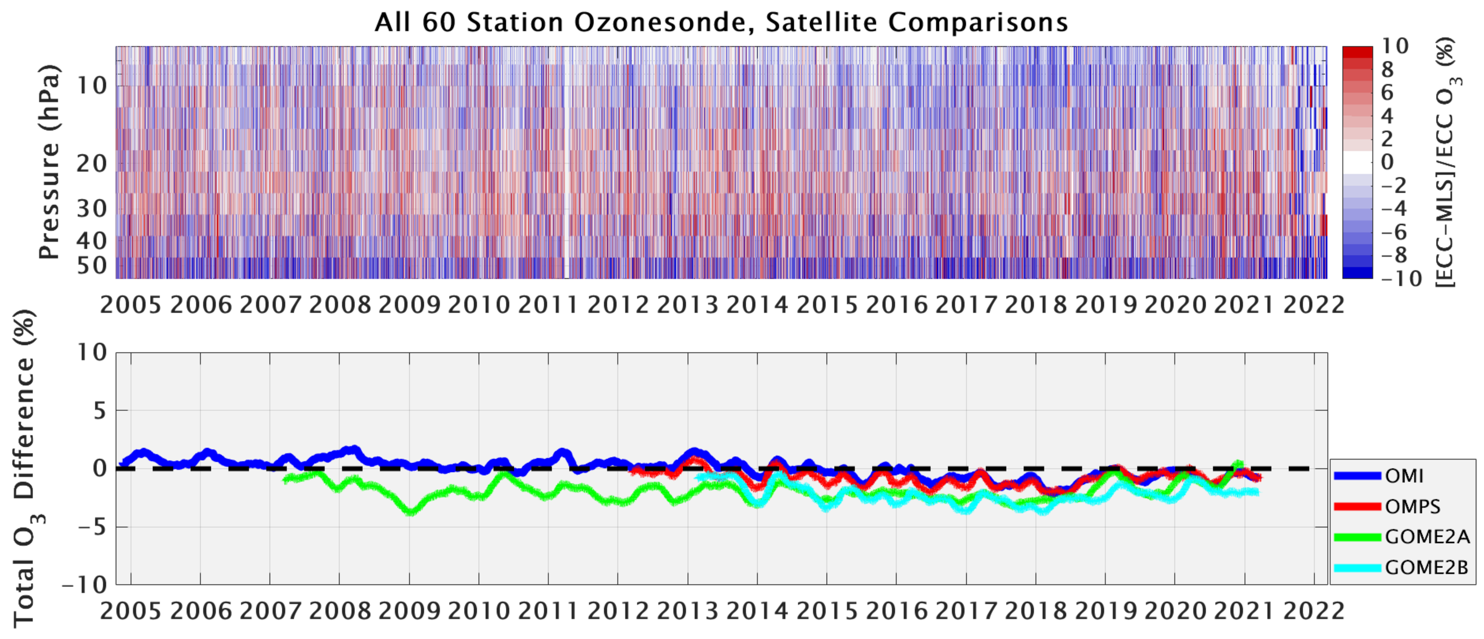


Figure from Stauffer et al. (2022)

- When averaged across the global ozonesonde network, the ozonesonde data are stable within about ±2% total column ozone relative to satellites, and show no noticeable drift/bias in the stratospheric ozone profiles.
- Homogenization has greatly enhanced the accuracy and stability of global ozonesonde network data.
- However, homogenization is sometimes not a "silver bullet".

References

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