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Update of the Homogenization of the Long-Term Global Ozonesonde Records

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Current “homogenization” activities within O3S

- harmonizing Standard Operating Procedures by new WMO-GAW report No. 268 in https://library.wmo.int/doc_num.php?explnum_id=10884
- continuation of O3S-DQA (Ozone Sonde Data Quality Assessment) activity (°2011)
- Harmonization and Evaluation of Ground-based Instruments for Free Tropospheric Ozone Measurements within the TOAR-II Focus Working Group “HEGIFTOM”
- TCO dropoff

- ✓ Introduction
- ✓ Status
- ✓ Success Stories
- ✓ Unsolved Issues
- ✓ Outlook

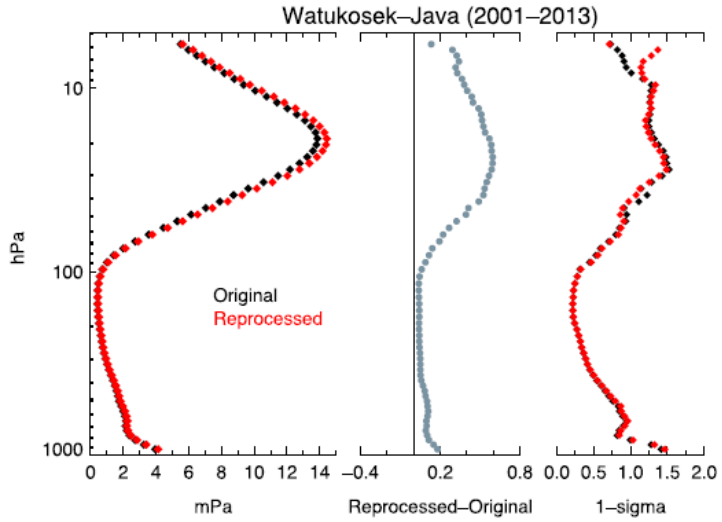
O3S-DQA: principles

- **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, tot ozone normalization, etc.)
- **estimation of uncertainties for every ozone partial pressure measurement**

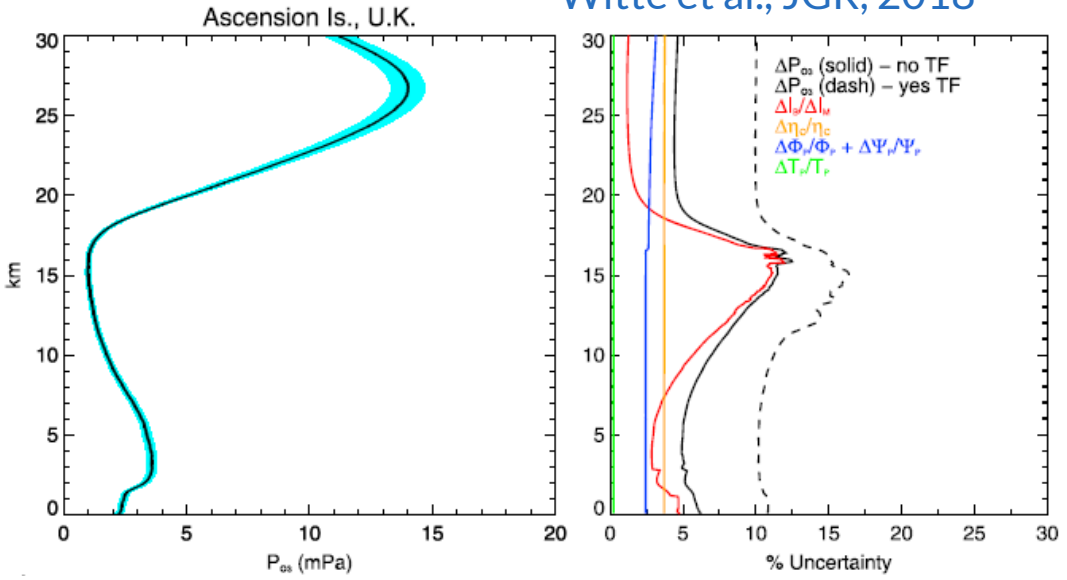
➔ **reduce uncertainty from 10-20% to 5-10%**

WMO-GAW report No. 268 (Annex-C & D in https://library.wmo.int)

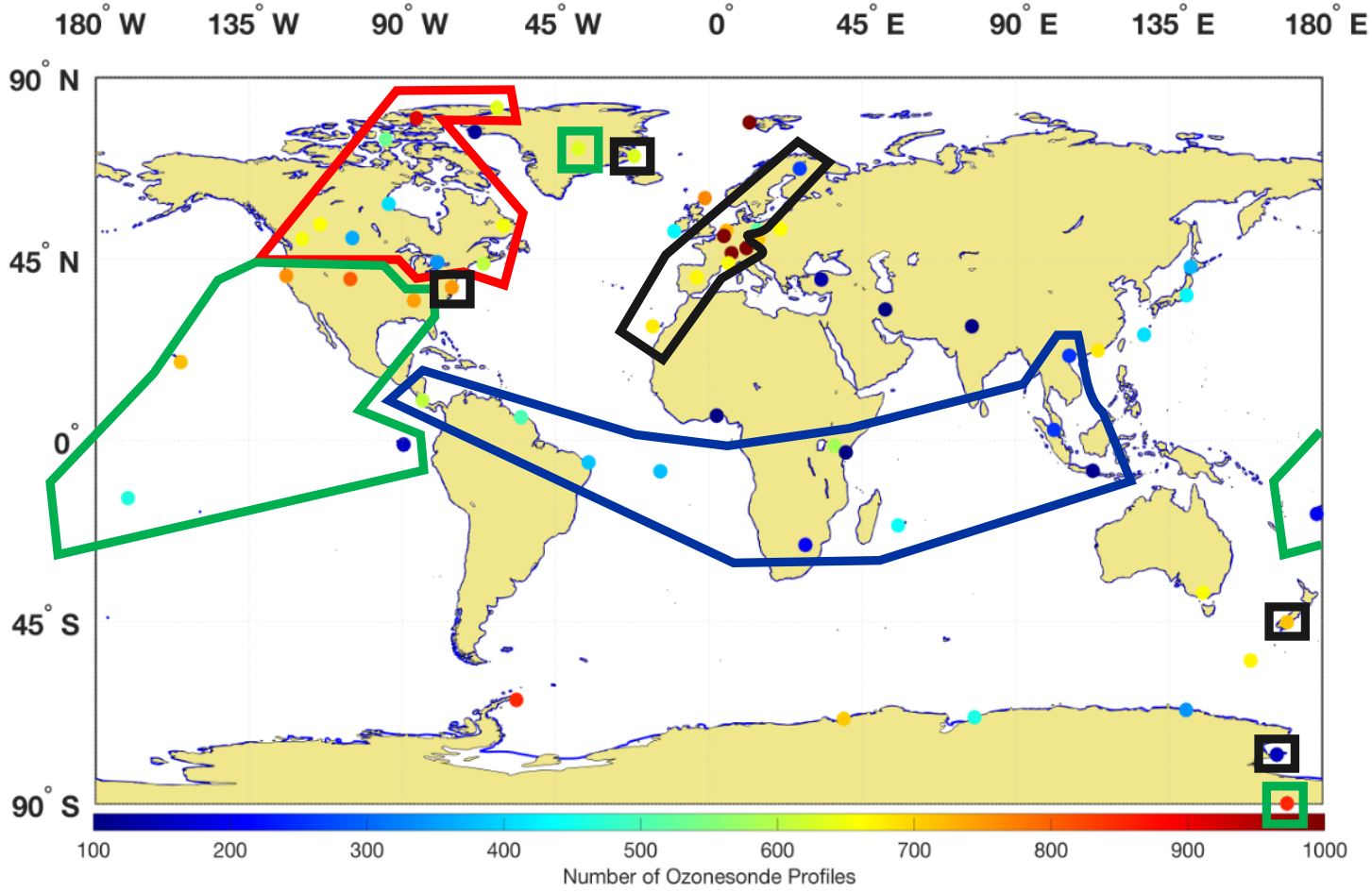
Witte et al., JGR, 2017



Witte et al., JGR, 2018



O3S-DQA: status



- **Canadian network (10 sites)**
  Tarasick et al., AMT, 2016
- **SHADOZ network (10 sites)**
  Witte et al., JGR, 2017, 2018, Thompson et al., JGR, 2017
- **NOAA network (9 sites)**
  Sterling et al., AMT, 2018
- **Individual sites (13)**: Uccle & De Bilt *(Van Malderen et al. , AMT, 2016)*, Wallops Island *(Witte et al., JGR, 2019)*, Mc Murdo, Payerne, OHP *(Ancellet et al., AMT, 2022)*, Izaña, Madrid, Sodankylä, Lauder, Hohenpeissenberg, Legionowo, Scoresbysund
- ➔ **42 homogenized sites**

Figure 1-2: Global ECC ozonesonde station locations with the number of ozonesonde profiles from 2005-2019 (Aura satellite era) indicated by the colormap.

Fig. taken from the new WMO-GAW Report No. 268

O3S-DQA: status

All homogenized data (and **only** homogenized data!) are available on a ftp-server, together with general description and link to github Python code on HEGIFTOM website:

http://hegiftom.meteo.be/datasets

IAGOS


Ozonesondes

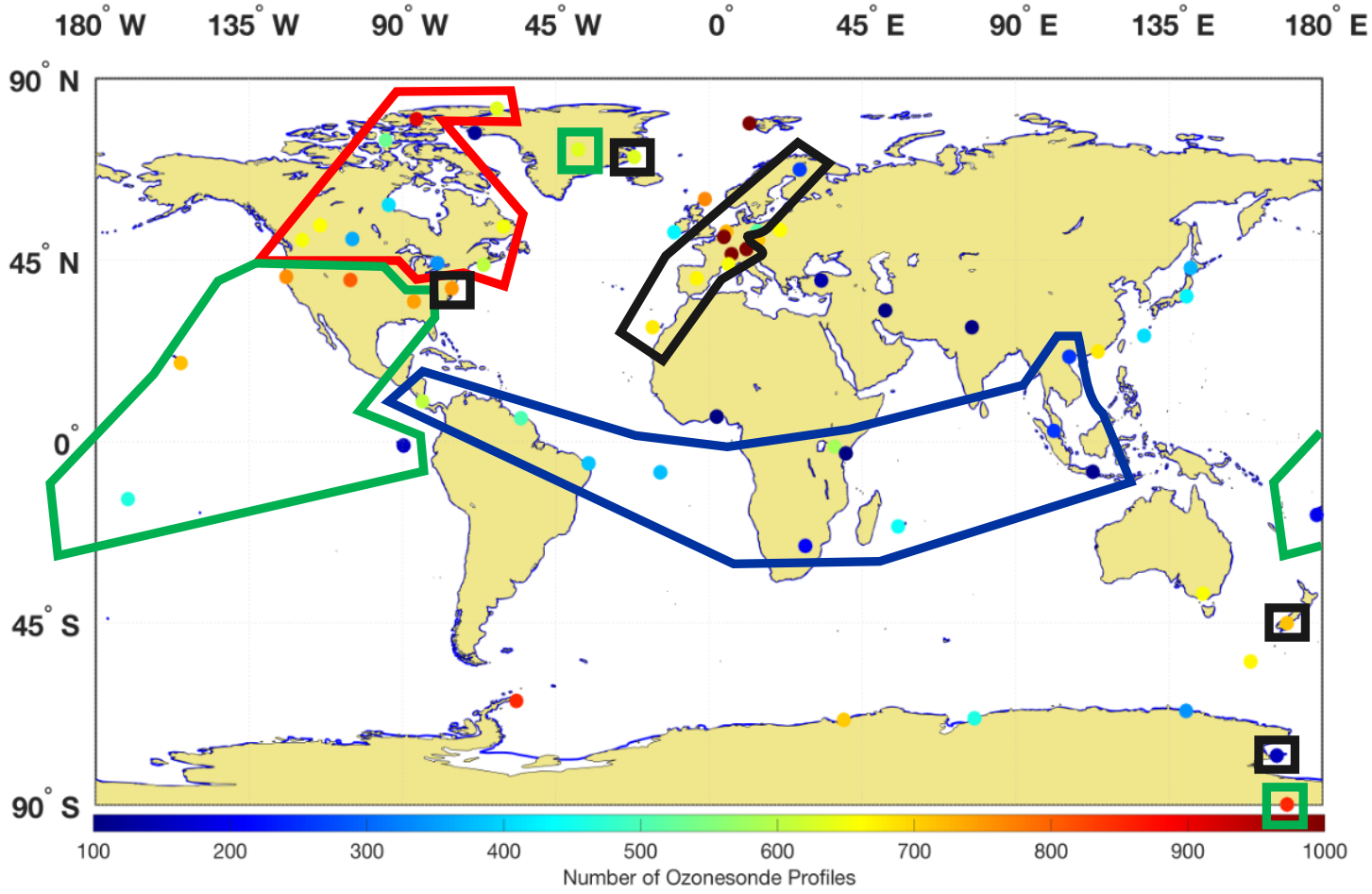

Brewer/Dobson Umkehr


FTIR


Lidar


MAX-DOAS & Pandora

O3S-DQA: status



- **Missing sites:**
  - ✓ Japanese (2023)
  - ✓ Australian
  - ✓ EU (Ny Alesund, Lerwick, Valentia, Praha)
  - ✓ Antarctic (Marambio, Neumayer, Durmont d'Urville, Davis, Syowa, Belgrano)
  - ✓ Asian: Chinese (Beijing!) + Hong Kong + Indian

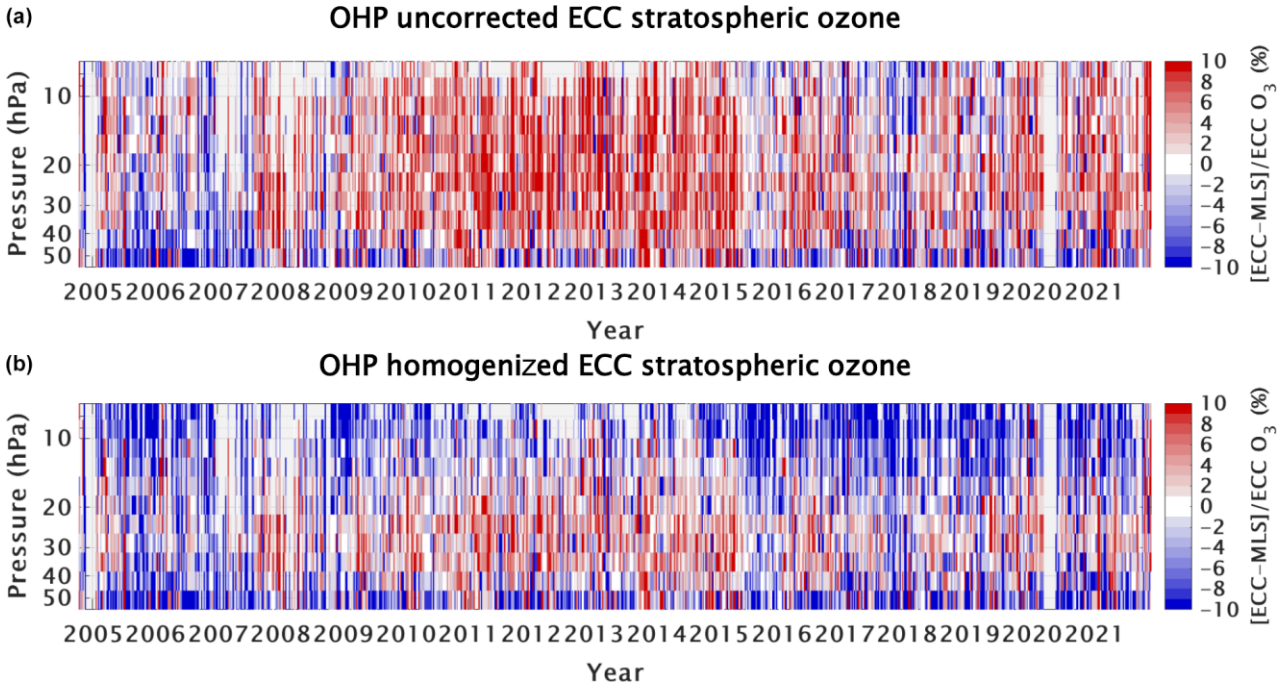
Figure 1-2: Global ECC ozonesonde station locations with the number of ozonesonde profiles from 2005-2019 (Aura satellite era) indicated by the colormap.

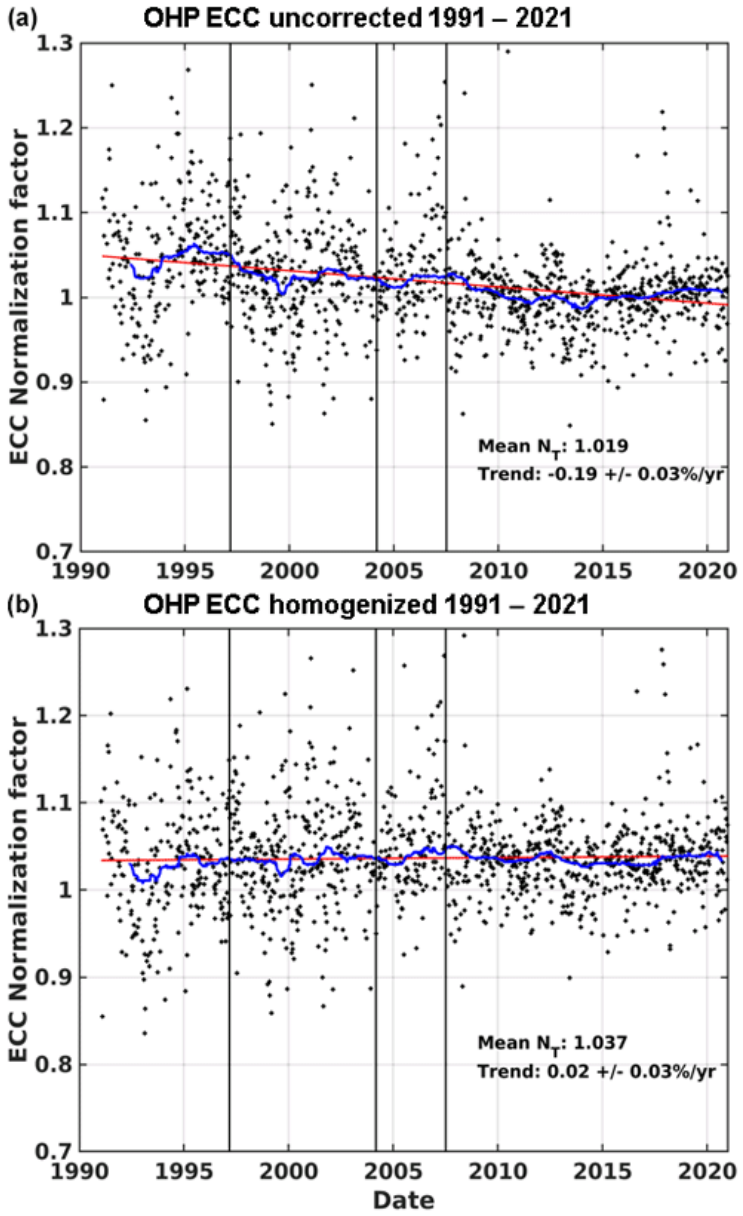
Fig. taken from the new WMO-GAW Report No. 268, courtesy of A. Thompson

O3S-DQA: success stories

OHP Ancellet et al., AMT, 2022

Comparison with MLS





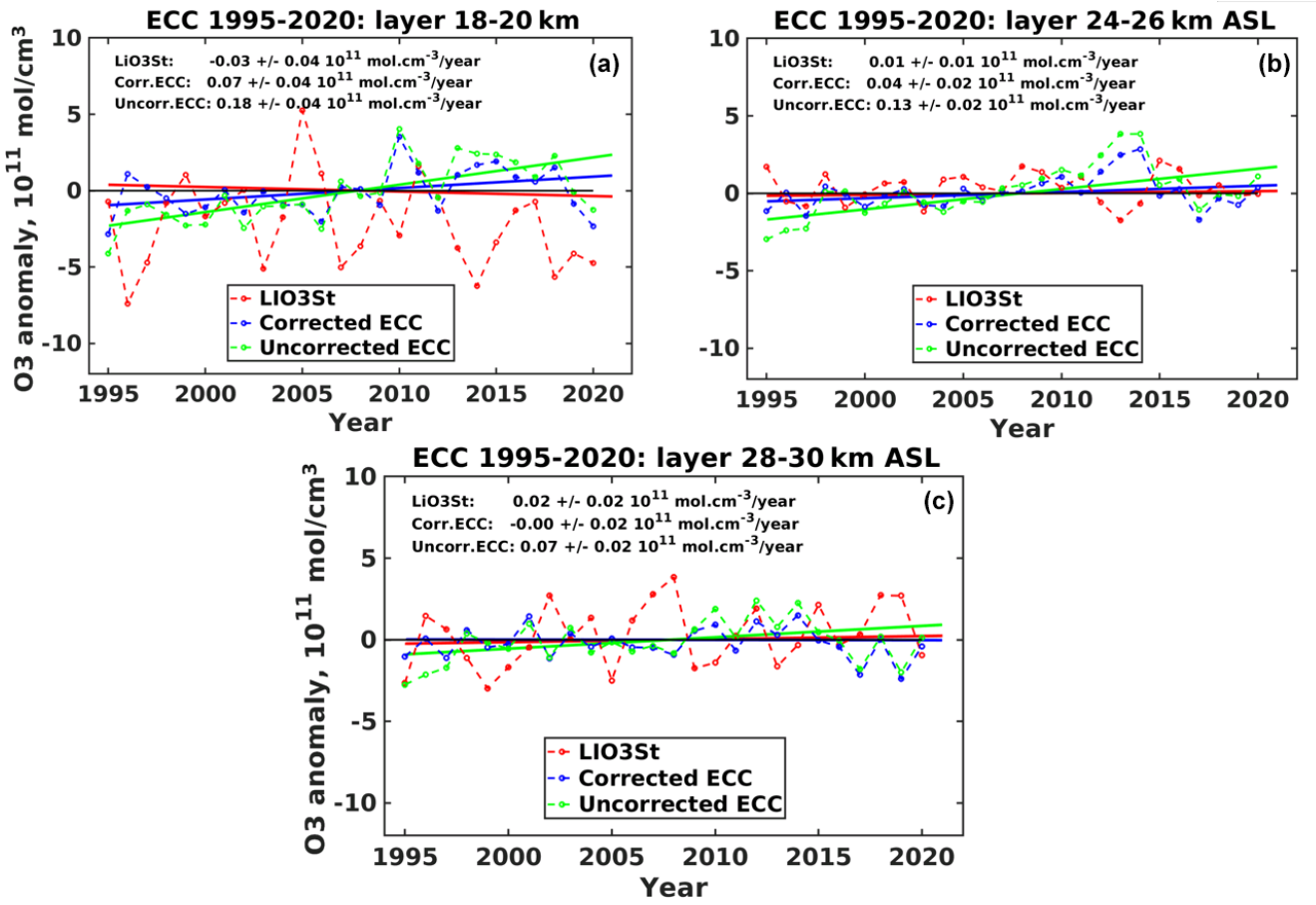
- Homogenization improves comparison with MLS and decreases trend/variability in total ozone normalization factors!
- But larger negative bias of ECC TCO compared to spectrophotometer TCO.

O3S-DQA: success stories

OHP Ancellet et al., AMT, 2022

The homogenization greatly improved the stratospheric 30-year trend assessment, with a better agreement with the lidar trend analysis:

significant positive → small/insignificant positive trends

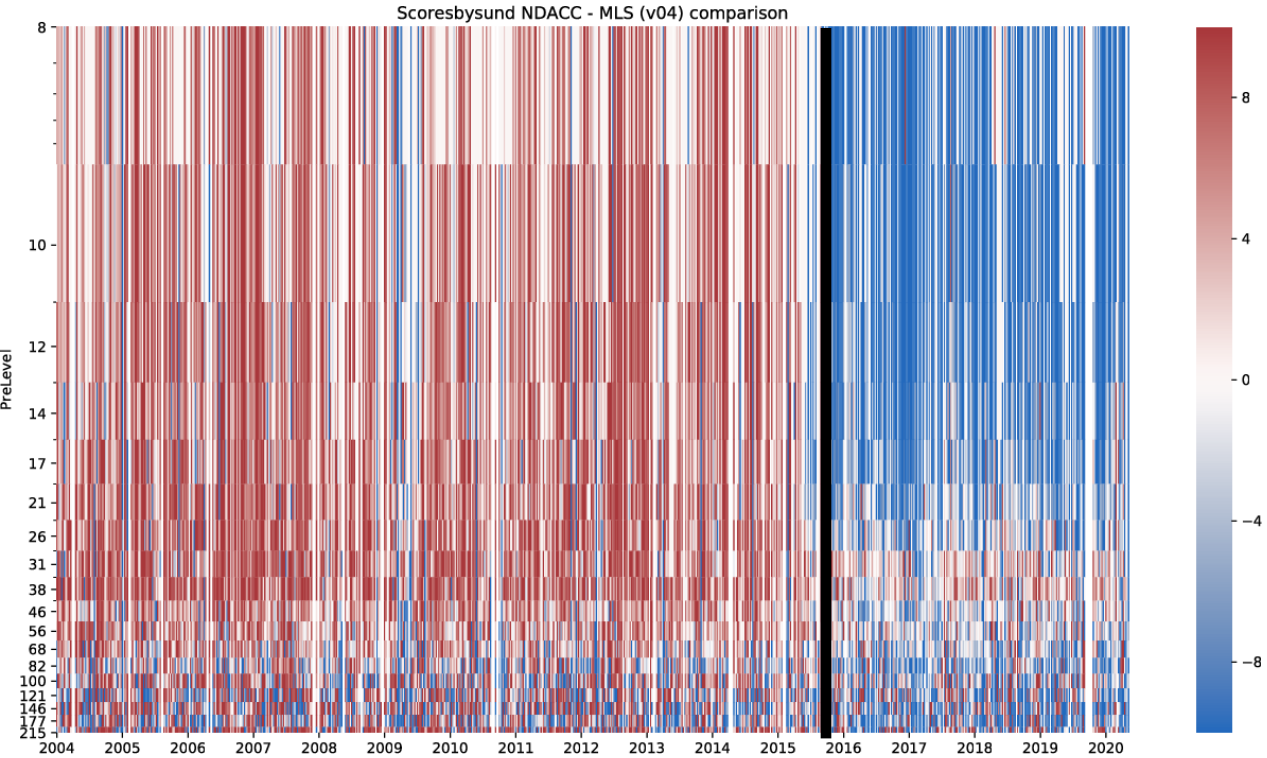


O3S-DQA: success stories

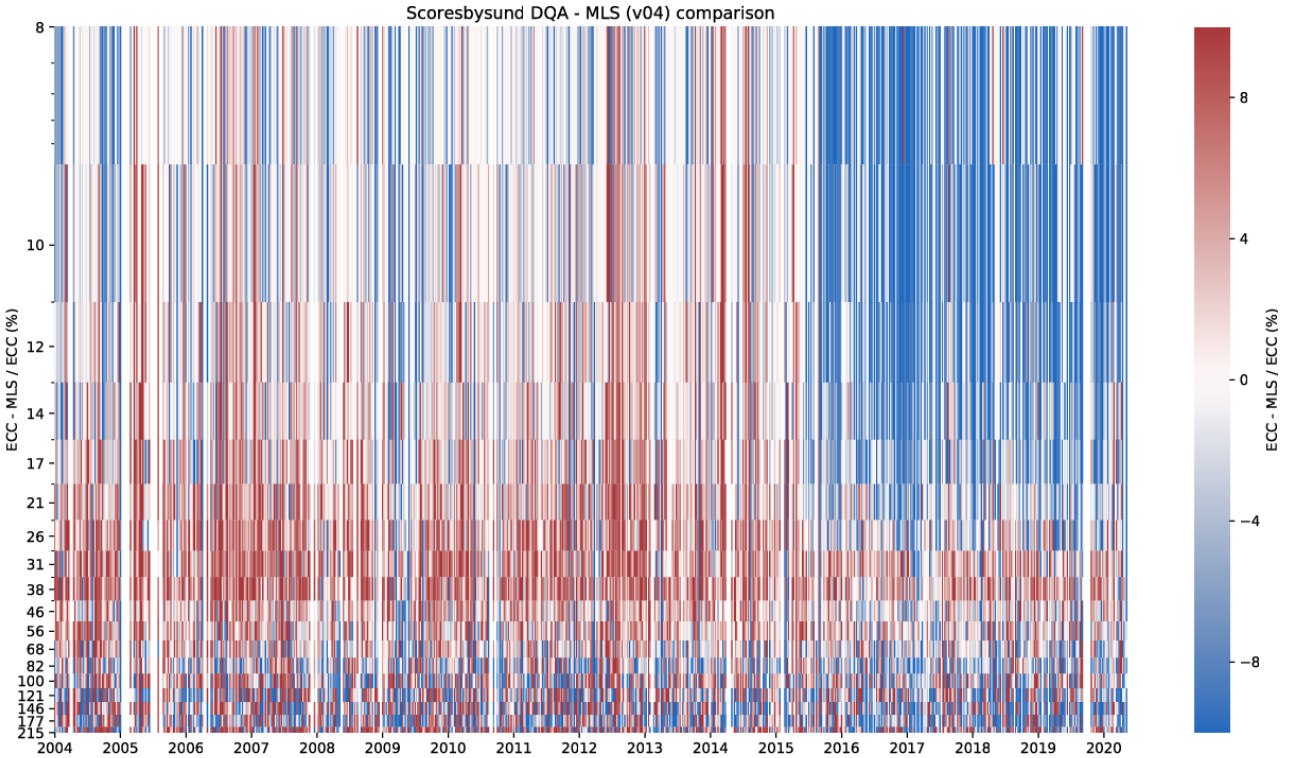
Scoresbysund (Greenland)

Comparison with MLS

Uncorrected



Corrected



start of application of transfer function to network standard (En-Sci 1.0 → En-Sci 0.5)

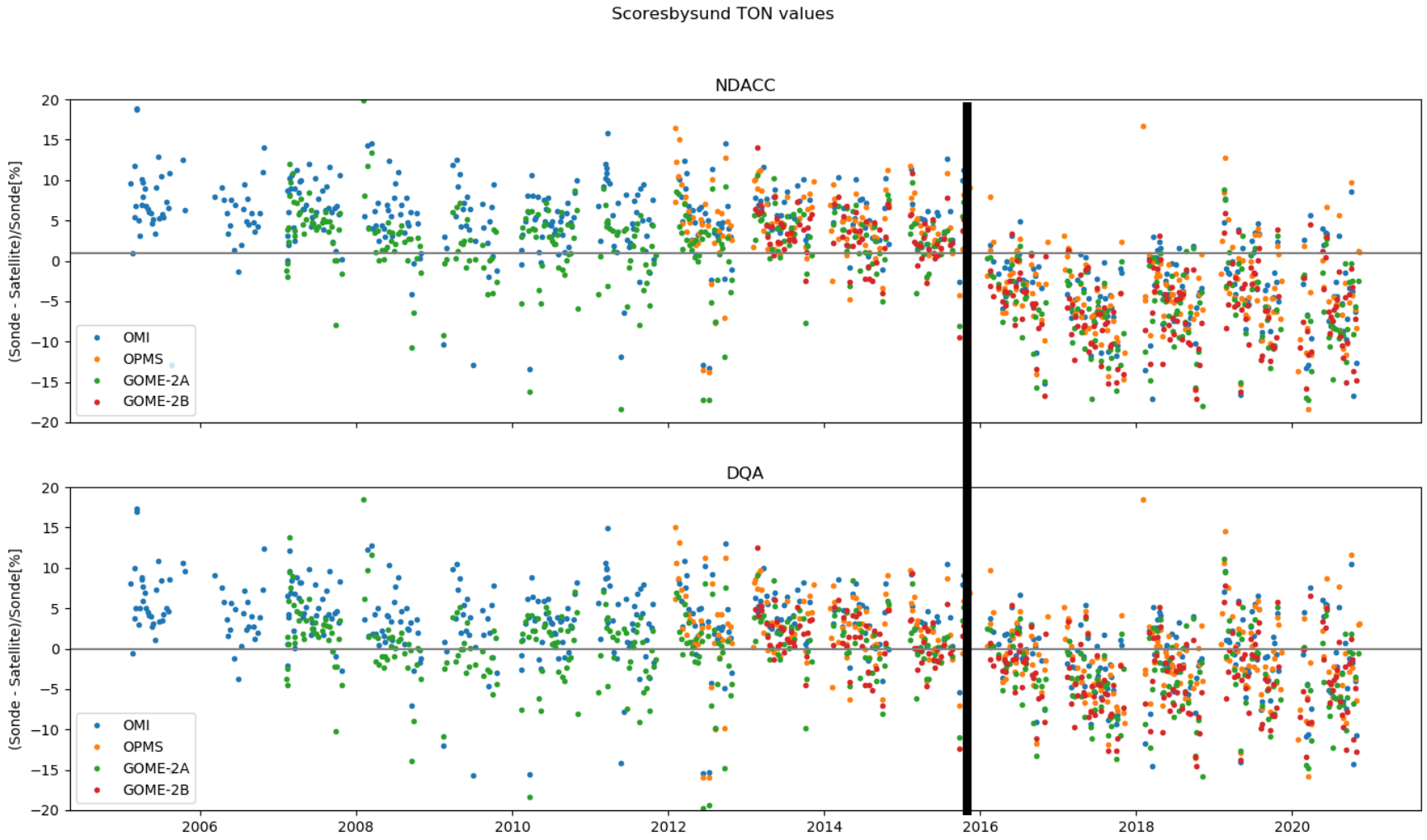
O3S-DQA: success stories

Scoresbysund (Greenland)

TCO comparison with OMI, OMPS, GOME-2

Uncorrected

Corrected



start of application of transfer function to network standard (En-Sci 1.0 → En-Sci 0.5)

O3S-DQA: success stories

Scoresbysund (Greenland)

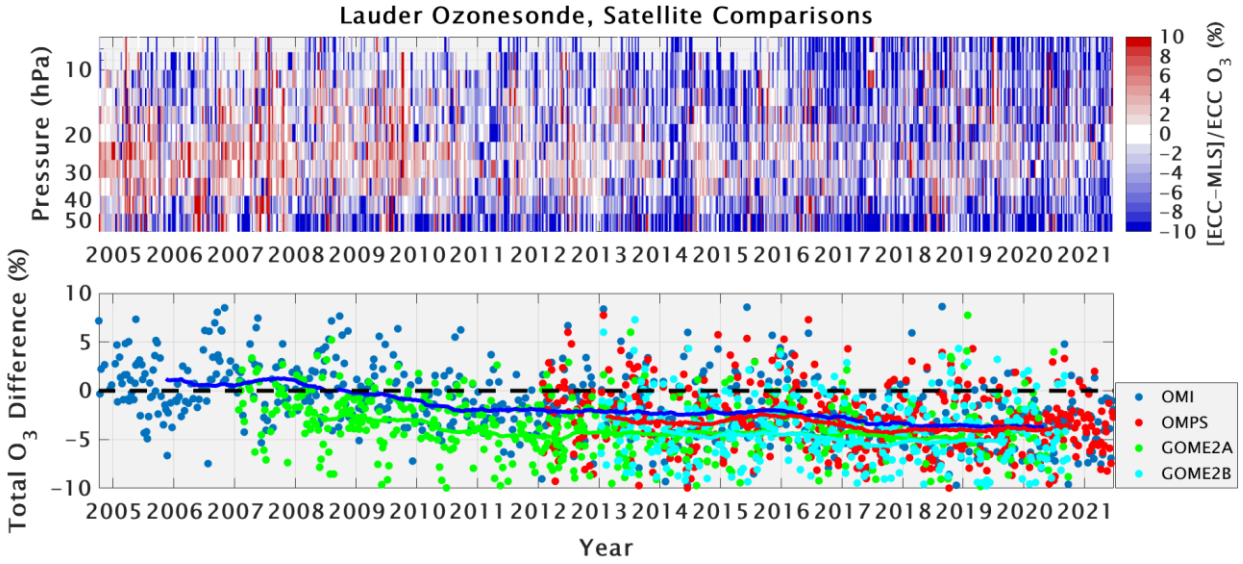
- Reprocessing improved long-term consistency with other ozone measuring techniques!
- Remaining TCO drop-off present in data after 2016! Needs to be confirmed!

O3S-DQA: unsolved issues

Lauder

Comparison with MLS

Uncorrected



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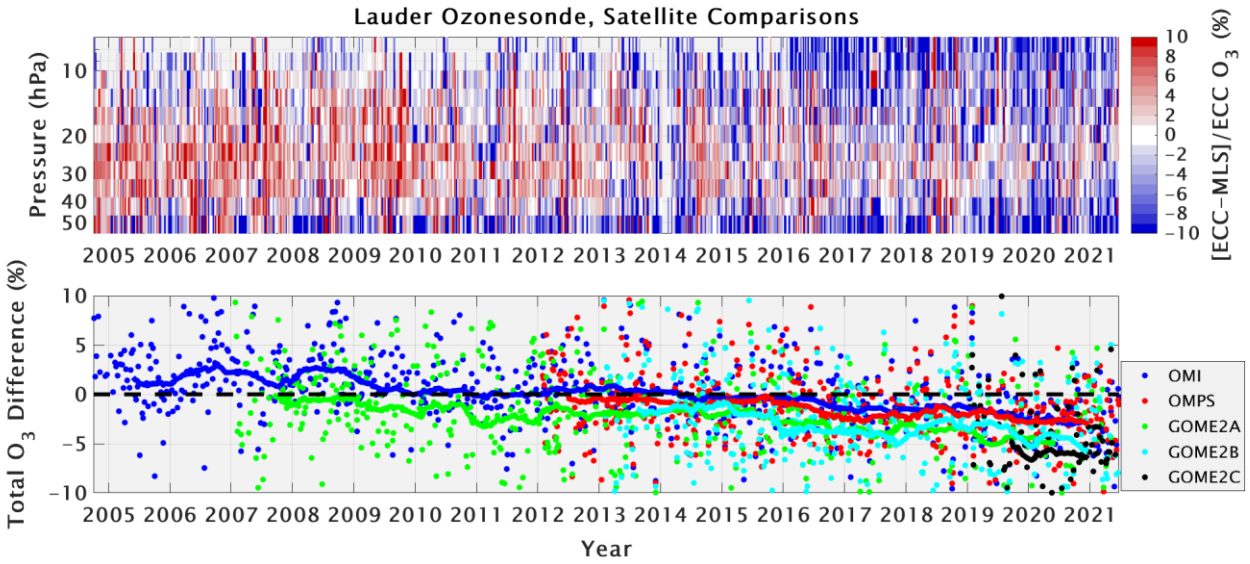


➔ overall improvement

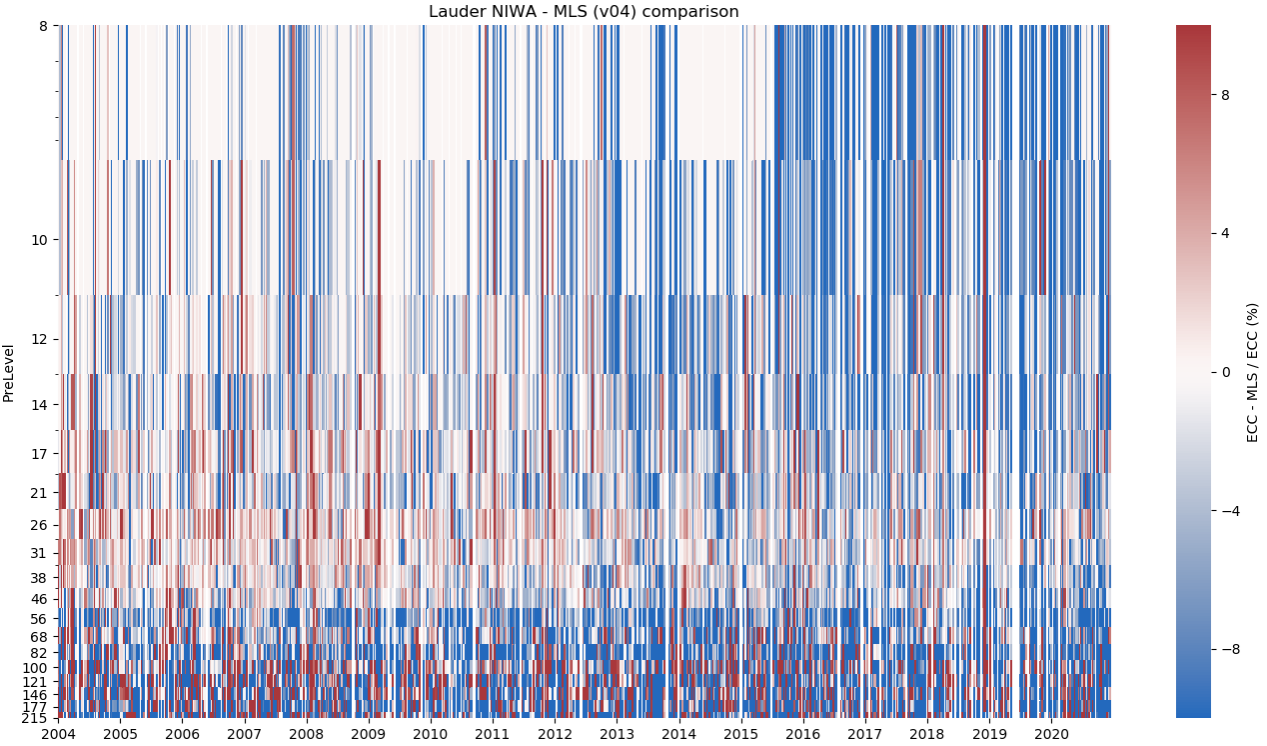
https://tropo.gsfc.nasa.gov/shadoz/SHADOZ_PubsList.html

O3S-DQA: unsolved issues

Lauder

Comparison with MLS

Uncorrected



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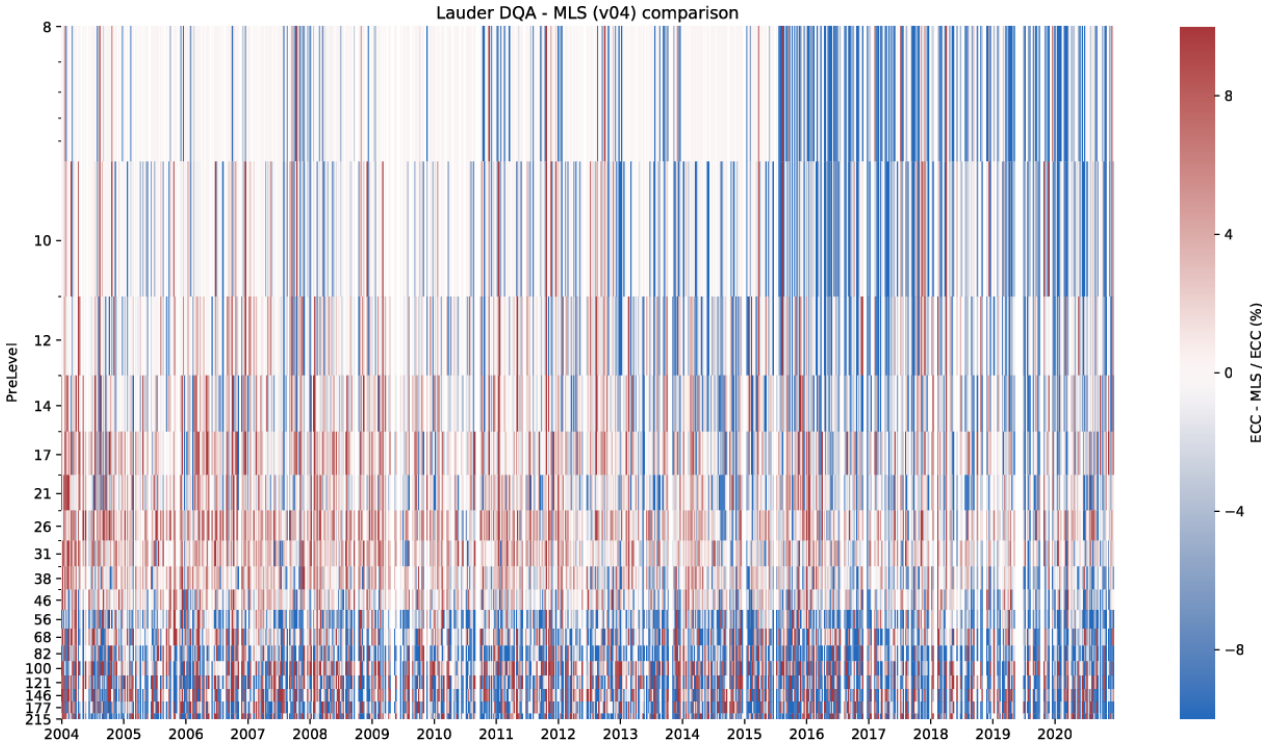


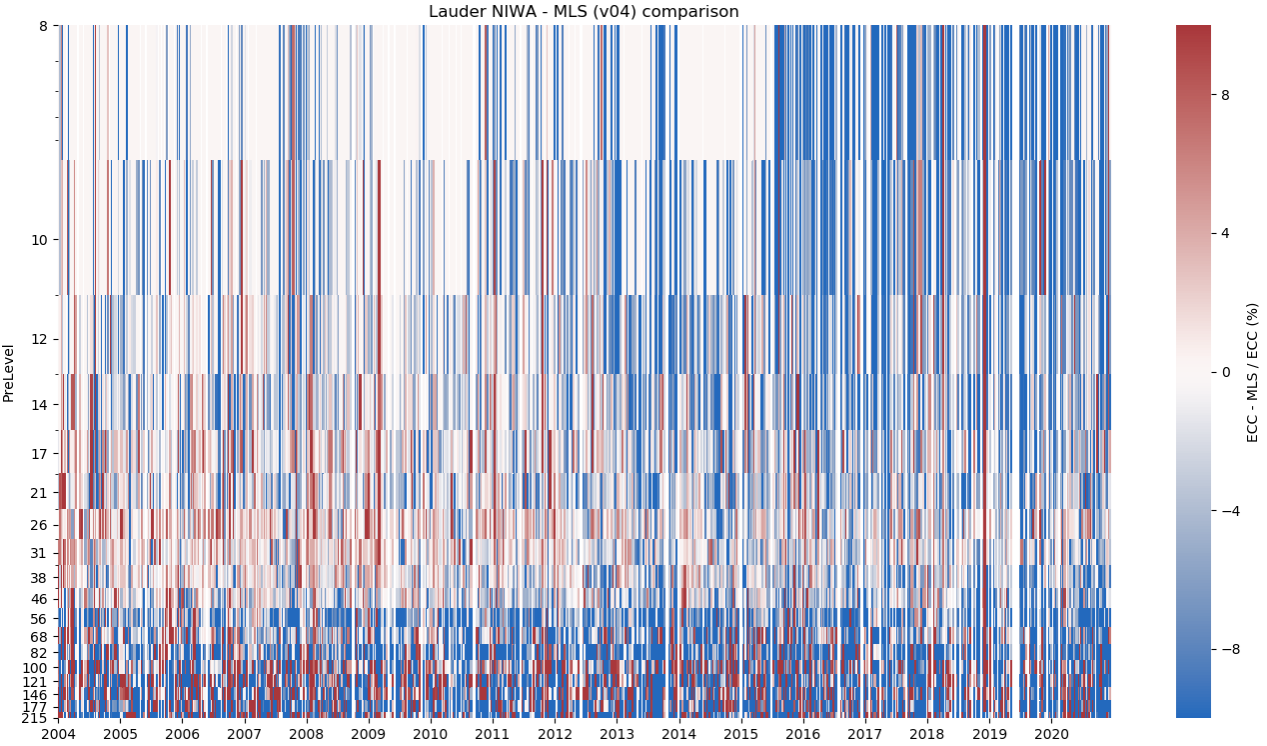
➔ overall improvement

O3S-DQA: unsolved issues

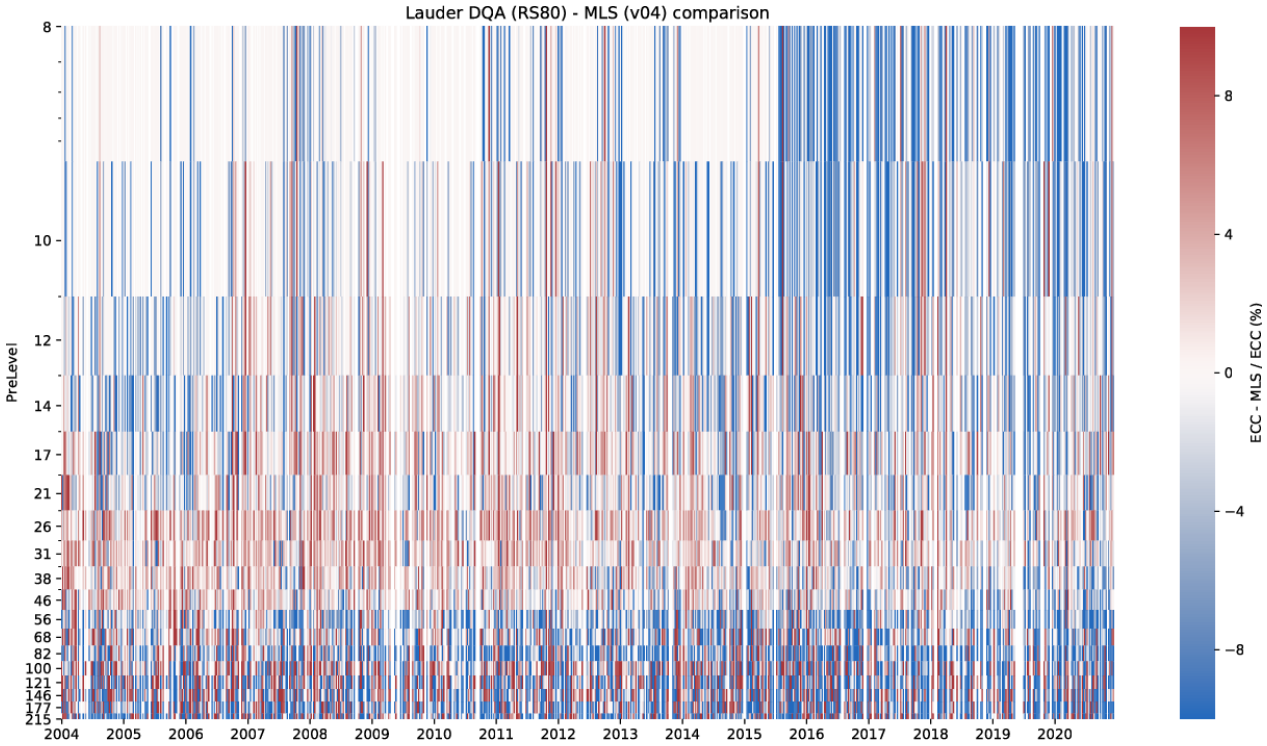
Lauder

Comparison with MLS

Uncorrected



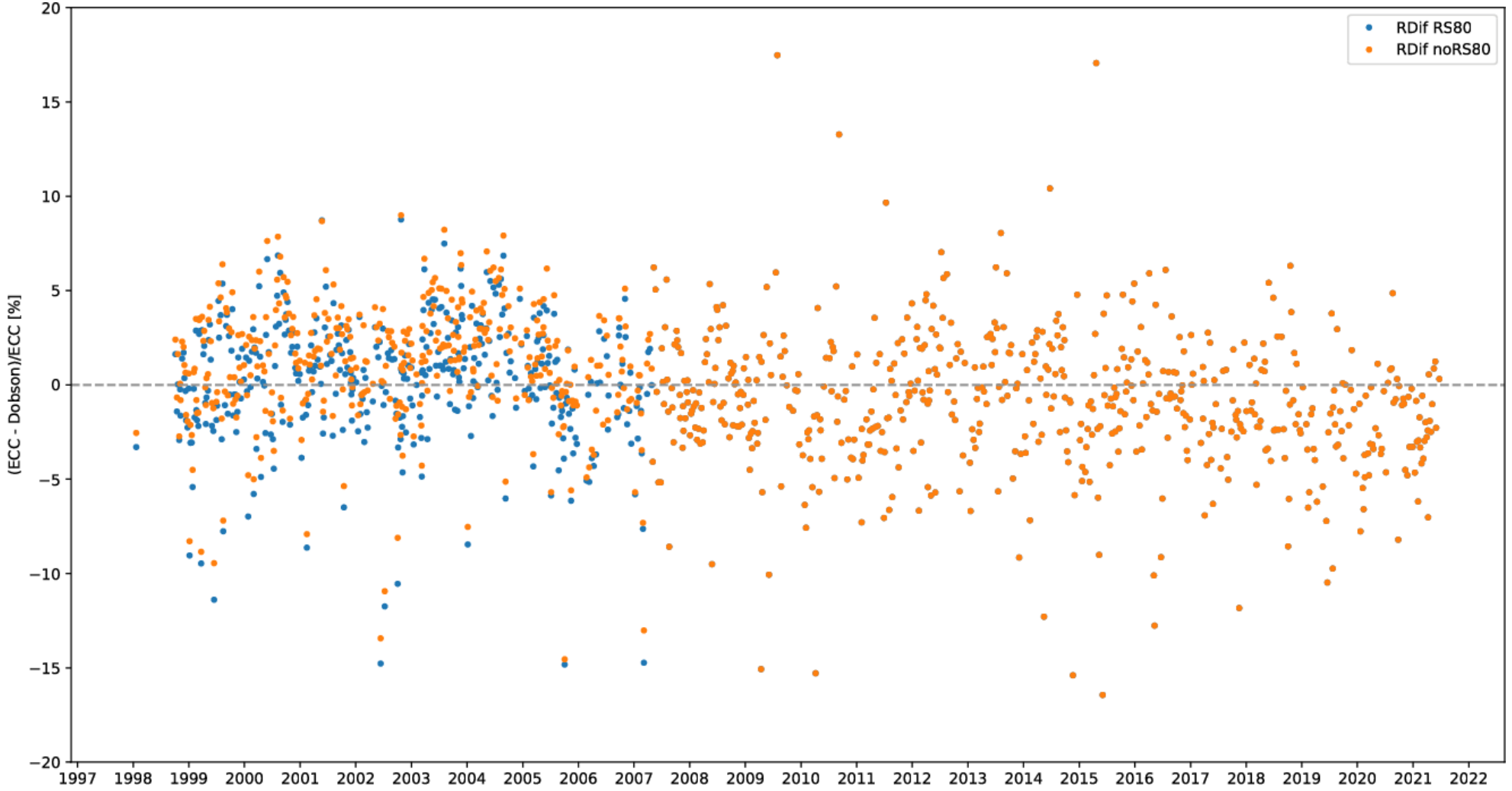
Corrected + RS80 pressure correction



O3S-DQA: unsolved issues

Lauder

TCO comparison with co-located Dobson

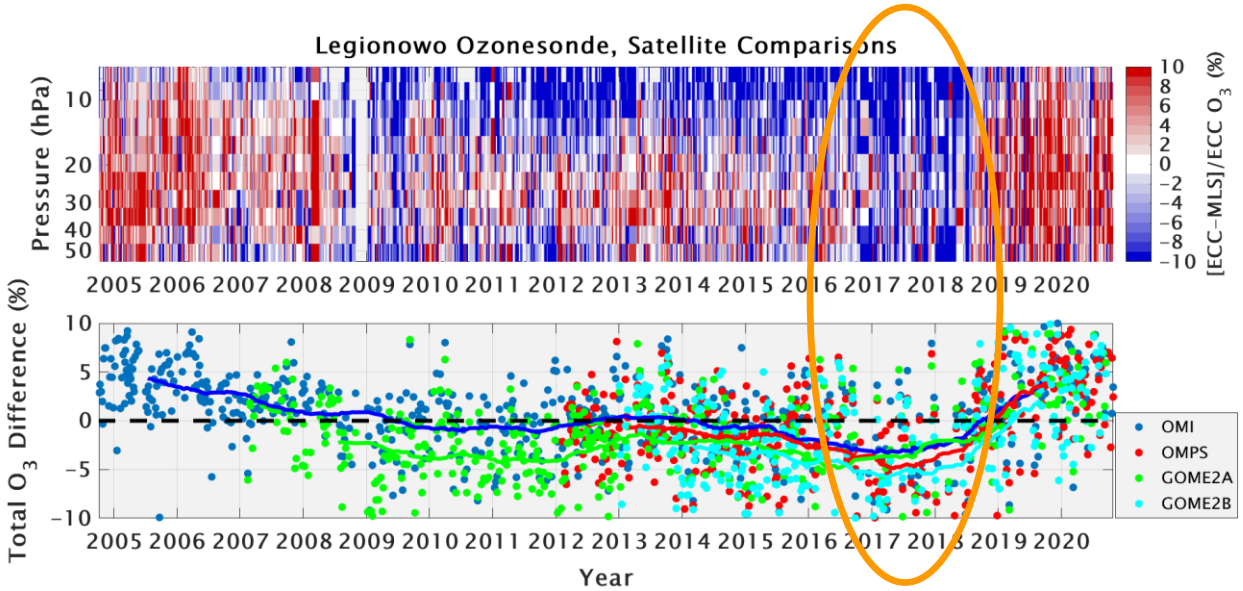


RS80 pressure sensor bias correction helps in decreasing the TCO drift in the ozonesonde time series

O3S-DQA: unsolved issues

Legionowo

Uncorrected



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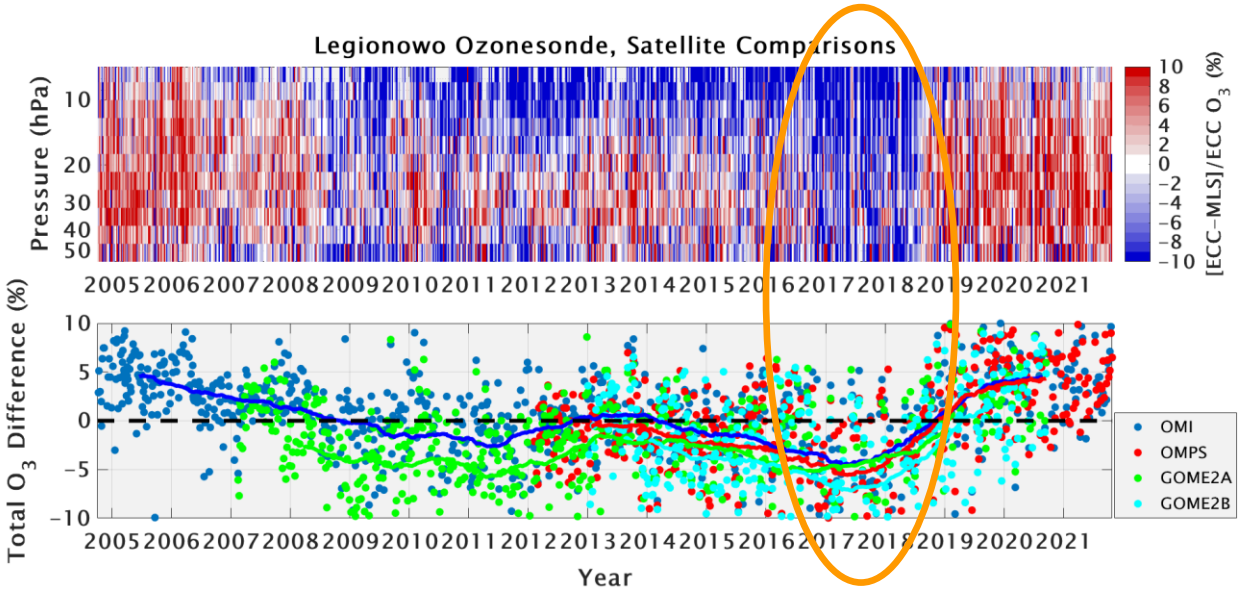
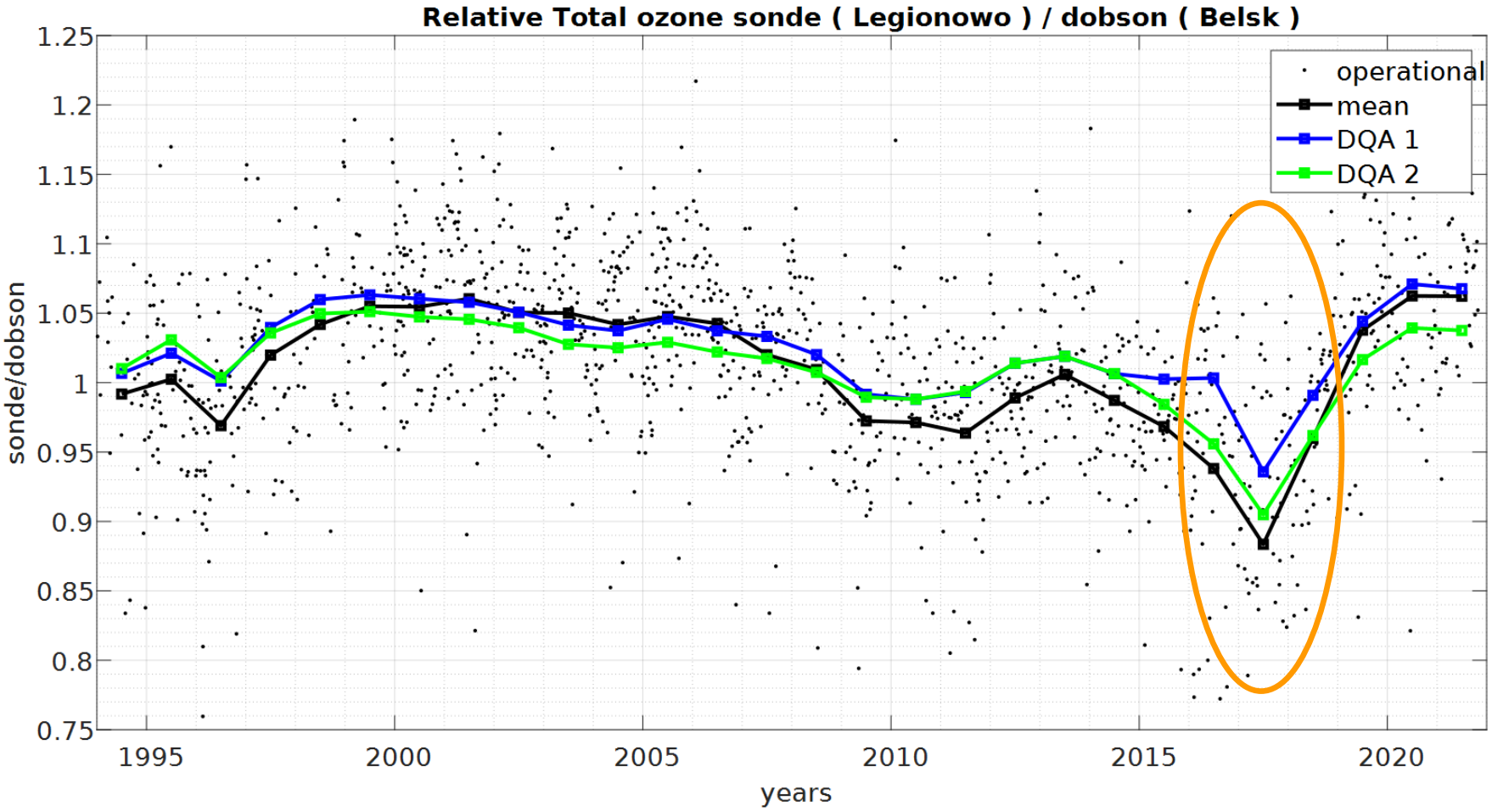


➔ homogenization does not give an improvement

https://tropo.gsfc.nasa.gov/shadoz/SHADOZ_PubsList.html

O3S-DQA: unsolved issues

Legionowo



Courtesy of Bogumil Kois

O3S-DQA: unsolved issues

Legionowo

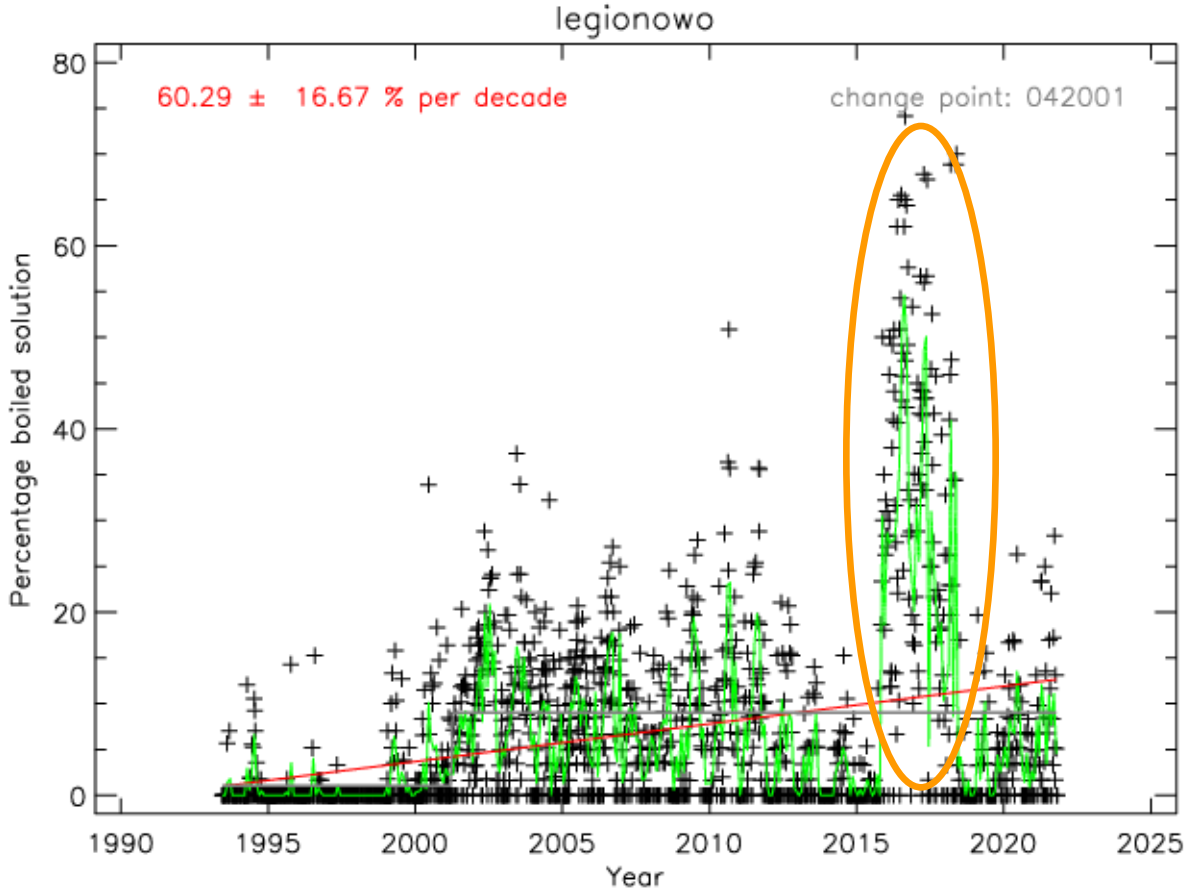
Let's have a look at the pump temperatures now!

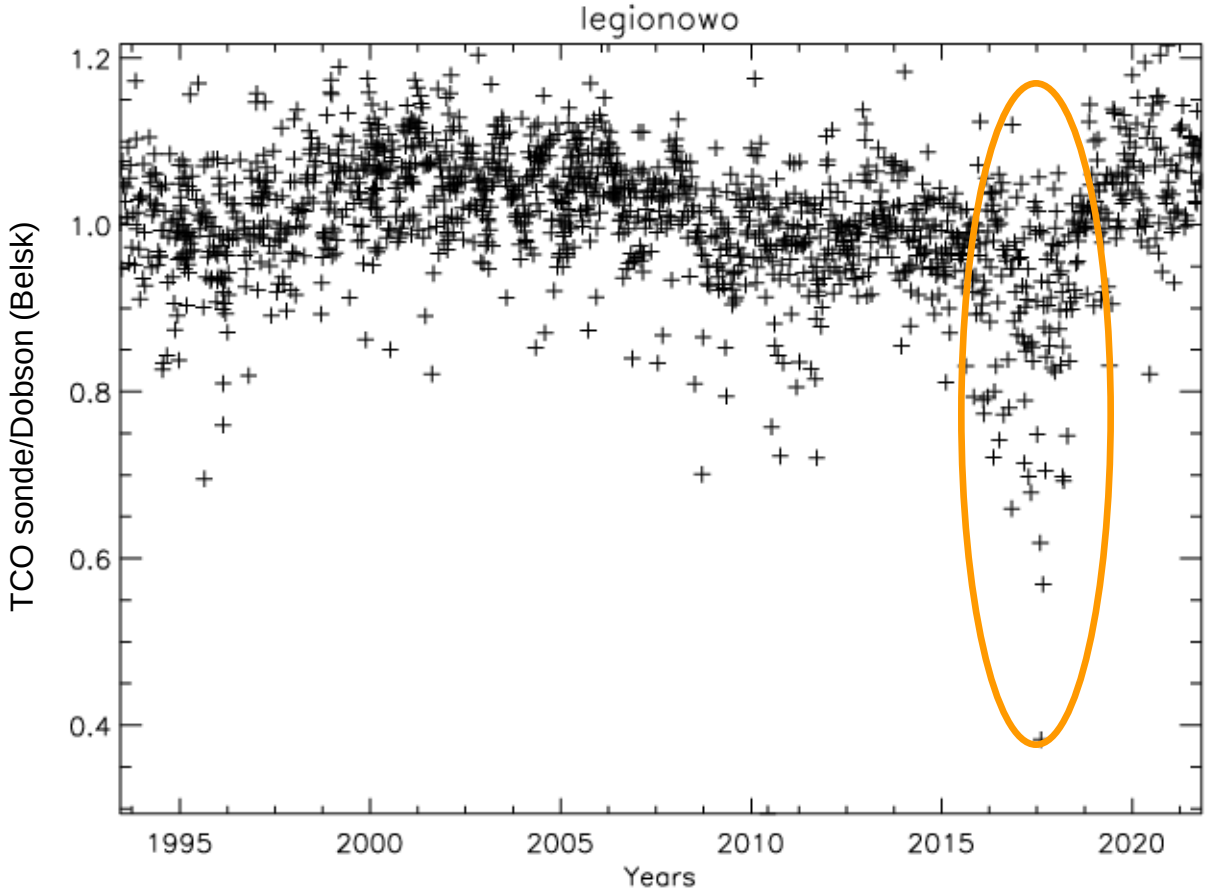
- pump temperature → cell temperature (JOSIE simulation chamber experiments)
- calculate the probability (percentage/integrated amount) that, for pressures lower than 100 hPa,
  - ✓ Tcell < 0°C ➔ frozen solutions in cell
  - ✓ Tcell > Tboil ➔ boiling/evaporating solutions in cell
- in both cases: underestimation of ozone concentrations

O3S-DQA: unsolved issues

Legionowo

boiled solution – time series+ monthly means





high amount of soundings with boiled solutions in 2016-2018 period is reflected in lower ratios of sonde/dobson (Belsk)

O3S-DQA: conclusions and outlook

- around 15 sites still remaining to be homogenized (EU + AUS + Japan + Antarctic sites)
- O3S-DQA homogenization is a global best effort approach, but heavily relies on the quality of the metadata (knowledge + measurements).
- Possible improvements are RS80 pressure sensor bias correction and investigation of pump temperatures.
- Homogenization is a pre-requisite and essential for trend analysis and TCO drop-off investigations (Scoresbysund: -5.6% TCO drop-off before homogenization).
- For future reprocessing activities (e.g. Vömel et al., AMT 2020), O3S-DQA homogenization, generating currents from the ozone partial pressures, is a necessary intermediate step!

THANK YOU

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