Scoresbysund O3S-DQA Homogenization Report

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1 Scoresbysund Metadata Timeseries

Scoresbysund data is dowloaded from NDACC server and processed by KMI. The timeseries starts at 1989/02. There are missing metadata which are temperature (TLab), humidity (ULab) and pressure (PLab) of the laboratory. For the missing values, climatological means are calculated for each month and these values are used for the corresponding missing metadata. TLab, PLab and ULab are used for pump flow rate humidity correction. For the background correction, iB2 is used. The related plots are shown in Figs 1 - 7.

2 O3S Corrections

Assumptions made for homogenization are indicated in blue, to be confirmed by the station PI
Unusual behaviours are indicated in red

The recommended and applied O3S-DQA corrections are summarized below.

1. Conversion efficiency
   (Transfer functions from ENSCI 1.0% to SPC 1.0% is applied after 2015-12-17. This correction is un-corrected to calculate current from ozone partial pressure values. 3ml of cathode solution is used all entire period that the absorption efficiency is taken as 1 always.)

2. Background current
   (iB2 is used trhough entire time-series)
   (iB2 values are very variable, especially for the period before 1995 and after 2017)

3. Pump temperature measurement
   (For 5A SPC sondes, pump temperature thermistor was taped externally and for 6A and ENSCI sondes was taped internally. 5A sondes were launched until 1995-11-11.)

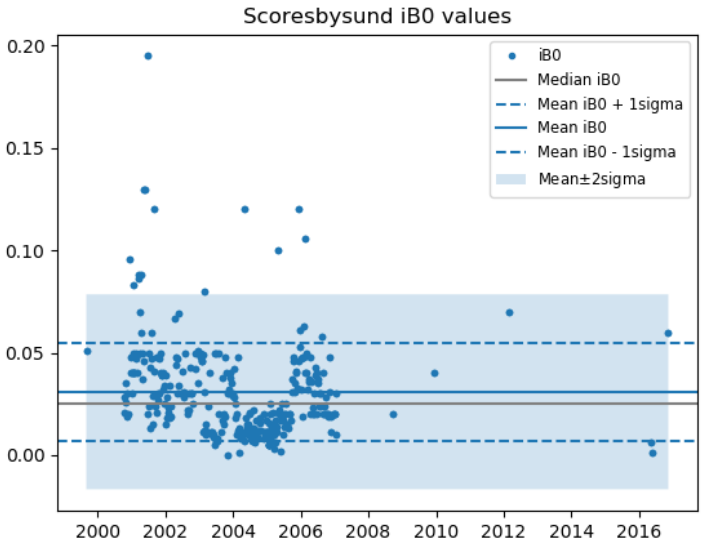

Figure 1: Scoresbysund iB0 timeseries

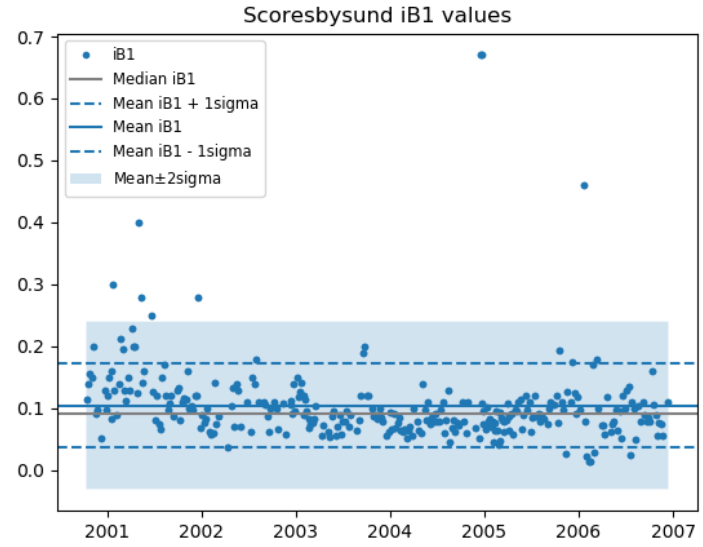

Figure 2: Scoresbysund iB1 timeseries

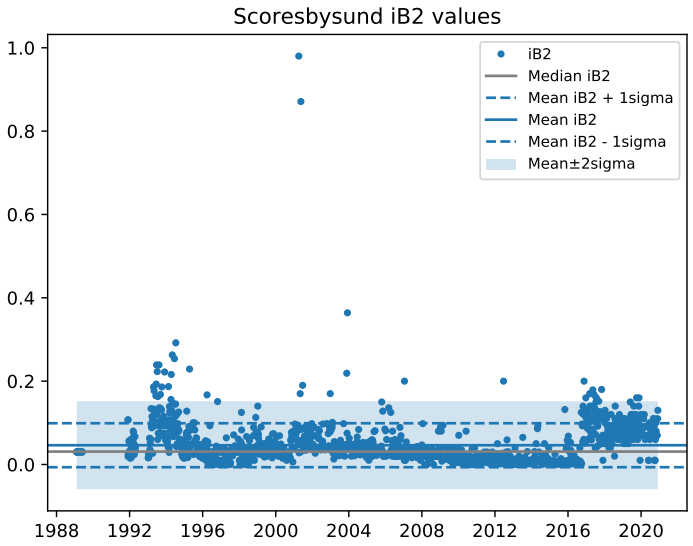

Figure 3: Scoresbysund iB2 timeseries

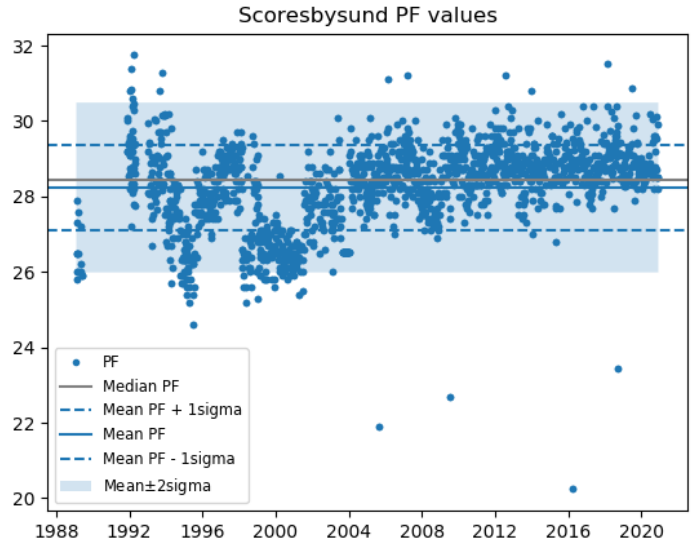

Figure 4: Scoresbysund pump flow rate timeseries

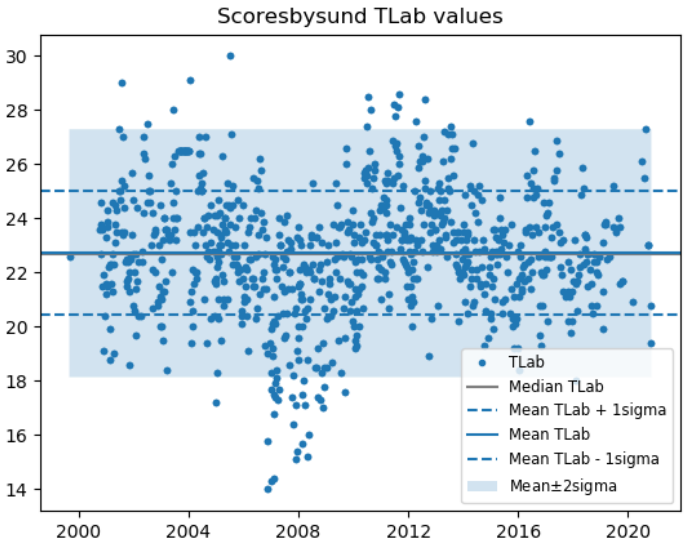

Figure 5: Scoresbysund laboratory temperature timeseries

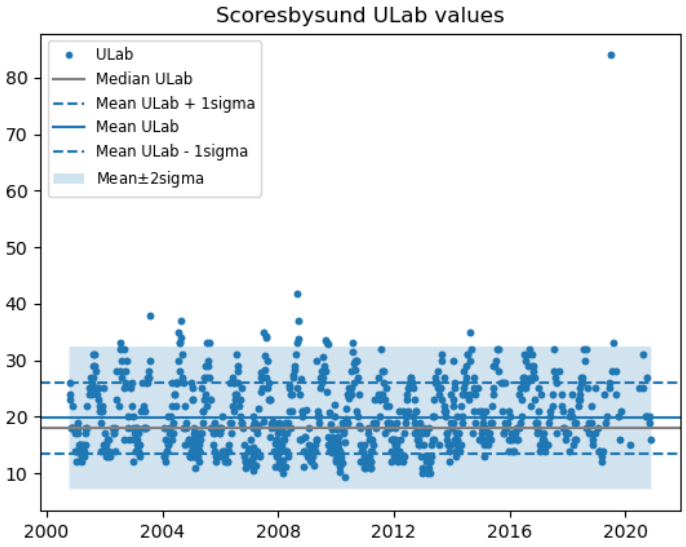

Figure 6: Scoresbysund laboratory humidity timeseries

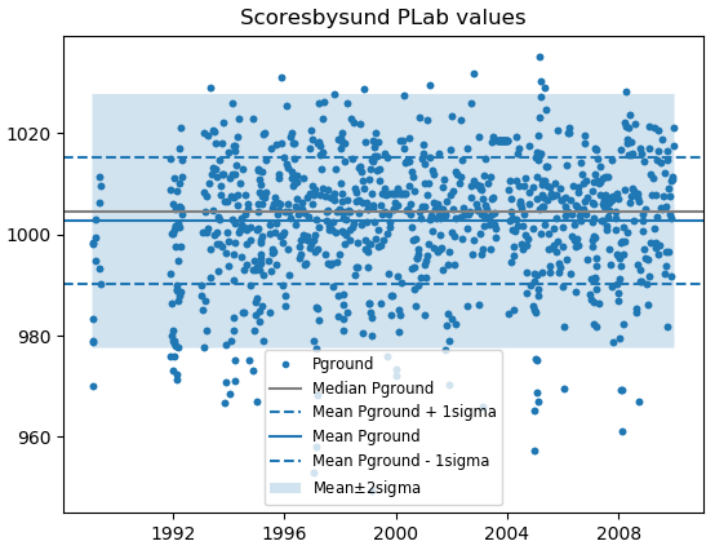

Figure 7: Scoresbysund laboratory humidity timeseries

4. Pump flow rate, moistening effect
   (Humidty correction is not applied in the Vaisala software that the NDACC O3 values are not corrected for humidity.)
   (There is a large variety in PF rate values for the period before 2003)

5. Pump flow efficiency at low pressures
   (PF efficiency tables are applied as in the Vaisala software. These are:
   SPC Table = [1.171, 1.171, 1.131, 1.092, 1.055, 1.032, 1.022, 1.015, 1.011, 1.008, 1.006, 1.004, 1, 1]
   for Pressure = [0, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000, 1100] values and ENSCI Table = [1.24, 1.24, 1.124, 1.087, 1.066, 1.048, 1.041, 1.029, 1.018, 1.013, 1.007, 1.002, 1, 1]
   for Pressure = [0, 3, 5, 7, 10, 15, 20, 30, 50, 70, 100, 150, 200, 1100] values.)

6. Total ozone normalization: in O3S-DQA guide this correction factor is recommended to be added in the data-set, but the normalization factor is not applied.
   (TO values from Dobson/Brewer spectrophotometers are missing in the metadata.)

7. Radiosonde changes: RS80 radiosonde correction is tested but not applied in the DQA homogenization.
(RS80 radiosondes were used from 1989-02 till 2007-01, RS92 used from 2007-01 till 2015-12 and RSA411 are used afterwards.)

The O3S-DQA corrections are applied to the raw current measured by the ECC's. The raw current values are determined from converting partial ozone values that are in the NDACC files to current.Knowing pump temperature values, pump flow rate and background values (iB2) is essential to obtain the raw current values. The corrections that were applied to have the NDACC ozone partial pressure values, are un-corrected to get the raw current values. These un-corrections correspond to the corrections applied in the Vaisala software, which are: pressure dependent background correction for SPC sondes and pump flow efficiency correction. The pump flow efficiency correction table used at this stage is slightly different than the table used for O3S-DQA pump efficiency corrections. The correction applied for uncorrecting the NDACC pump flow efficiency can be seen in Ozone Sounding with Vaisala Radiosonde RS41 User's Guide M211486EN, page 74 and the correction table used for O3S-DQA can be seen in O3S-DQA Activity: Guide Lines for Homogenization of Ozone Sonde Data (Version 2.0) at page 34. Additionally, transfer functions from ENSCI 1.0% to SPC 1.0% was applied, if an ENSCI 1.0% sonde is used, from 2015-12-17.

The ozone partial pressure values converted from raw current wihout applying any correction are denoted as 'Raw' or 'No correction', the O3 values from NDACC files are denoted by 'NDACC' and the ozone partial values that have all the DQA corrections are denoted by 'DQA' in the rest of the manuscript.

2.0.1 Conversion efficiency

3ml of cathode solution is used all entire period that the absorption efficiency is taken as 1 always. The stoichiometry correction is needed when ENSCI 1.0% sondes have been used. ENSCI 1.0% sondes have been used in 1989, between 1994-11 and 1998-02, between 1998-09 and 1999-01, and 2004-04 till 2022. SPC 1.0% sondes have been used in the rest of the time-series. The transfer function from ENSCI 1.0% to SPC 1.0% has been used in order to have a consistent stoichiometry factor. The effect of the converison efficiency is shown in Fig 8

2.0.2 Background current

Background correction, using iB2, applied Scoresbysund data is shown in Fig 3. If I_B exceeds $I_{B,\mathrm{Mean}} + 2\sigma_{IB}$ then I_B, it should be replaced by the more representative climatological value of $I_{B,\mathrm{Mean}}$, however with larger uncertainty of $2\sigma_{IB}$. Therefore if I_B values are falling above $I_{B,\mathrm{Mean}} + 2\sigma_{IB}$ in Fig 3, the background correction is applied. For the mean and standard deviations of the iB2 values, 3 different periods are considered. As it can be seen in Fig 3, iB2 values are larger for the period between 1993 and 1996 and after 2017. There-

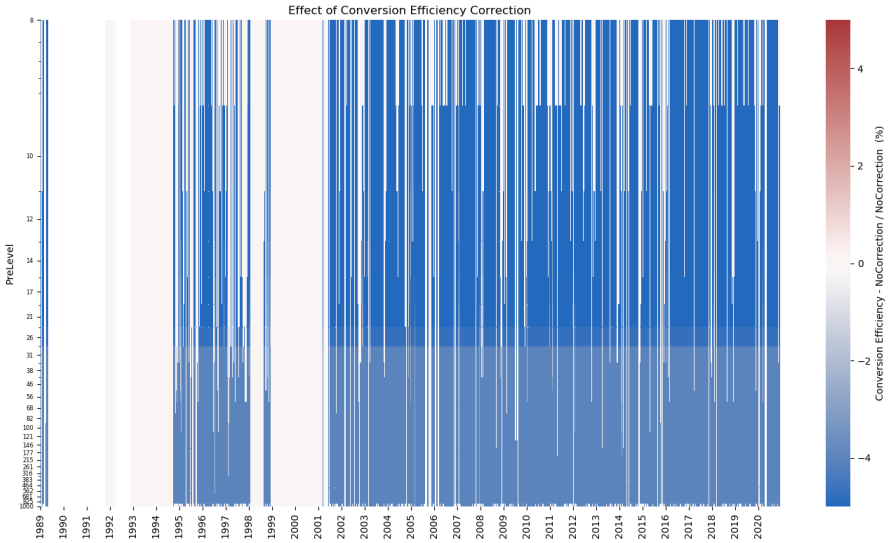

Figure 8: Conversion efficiency correction

fore the mean and corresponding standard deviations are calculated and applied separately in these periods.

2.0.3 Pump temperature measurement

Truest pump temperature correction is applied according to Eq.13 of the O3S-DQA Guidelines. Until 1995-11 SPC-5A sondes, and after on the SPC 6A and ENSCI sondes have been launched. These periods need different corrections and their effects are shown in Fig 10.

2.0.4 Pump flow rate (moistening effect)

This correction, Eq.15 of the O3S-DQA Guidelines, is applied and shown in Fig 11. The details of the values used for correction is explained in Sec 1.

2.0.5 Pump flow efficiency

This correction, Eq.22 of the O3S-DQA Guidelines, is applied using Table 6 of the O3S-DQA Guidelines and shown in Fig 12. The effect of this correction is shown in Fig 12.

The effect of all DQA correction with respect to no correction is shown in Fig 13 and the comparison of DQA corrected and WOUDC O3S values is shown in Fig 14.

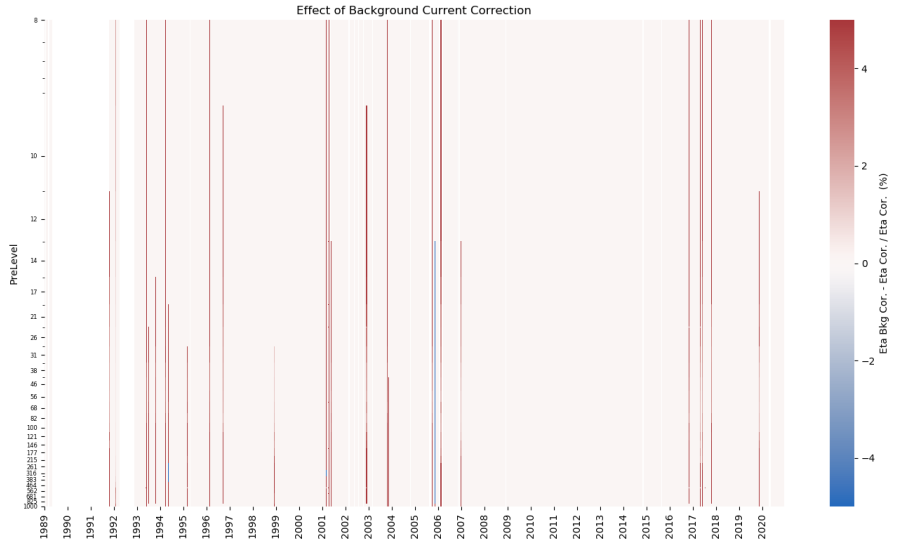

Figure 9: Background current correction

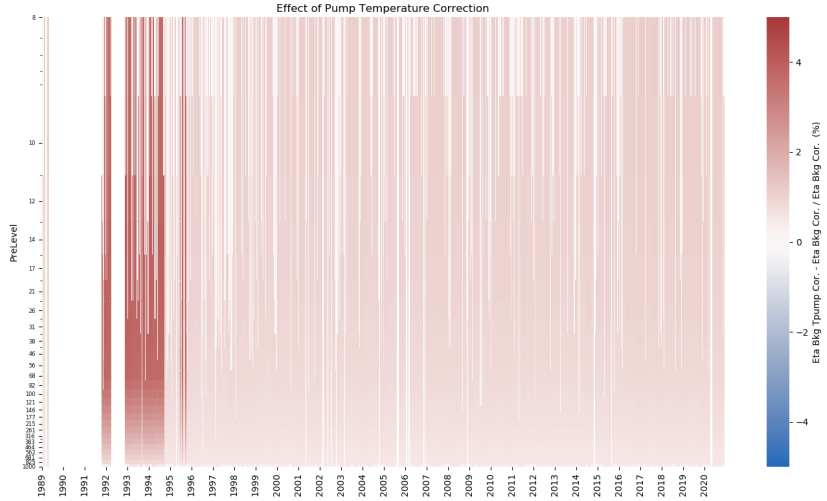

Figure 10: Pump temperature correction

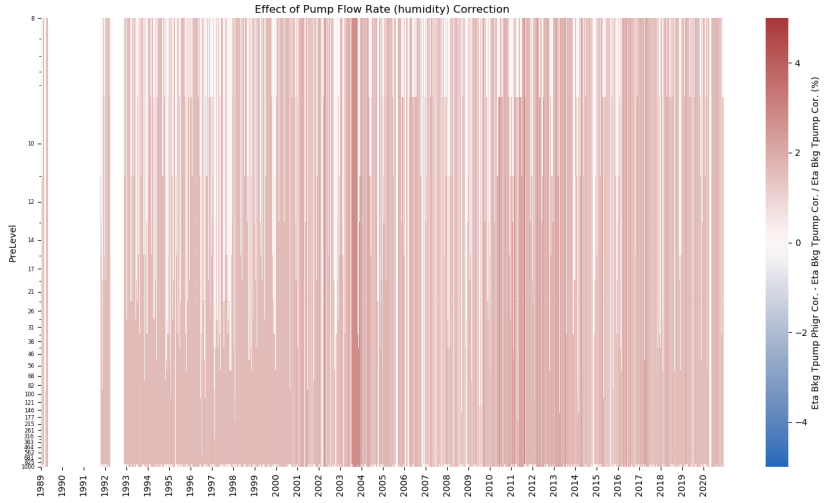

Figure 11: Pump flow rate correction applied

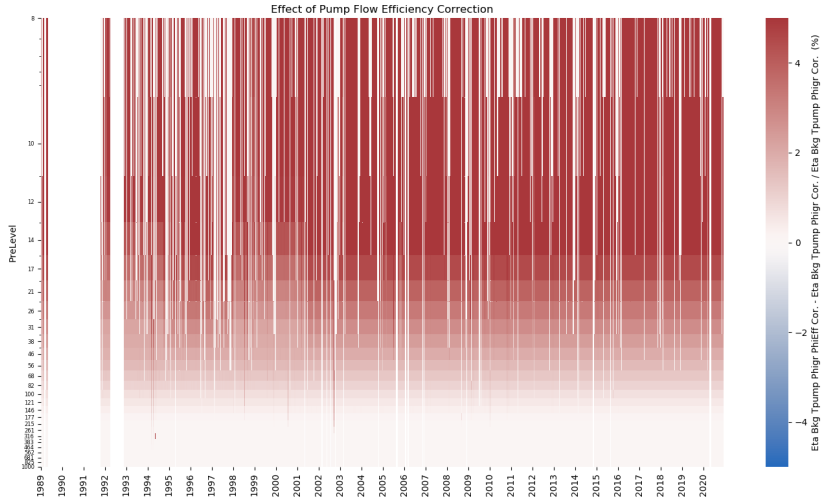

Figure 12: Pump flow rate correction applied

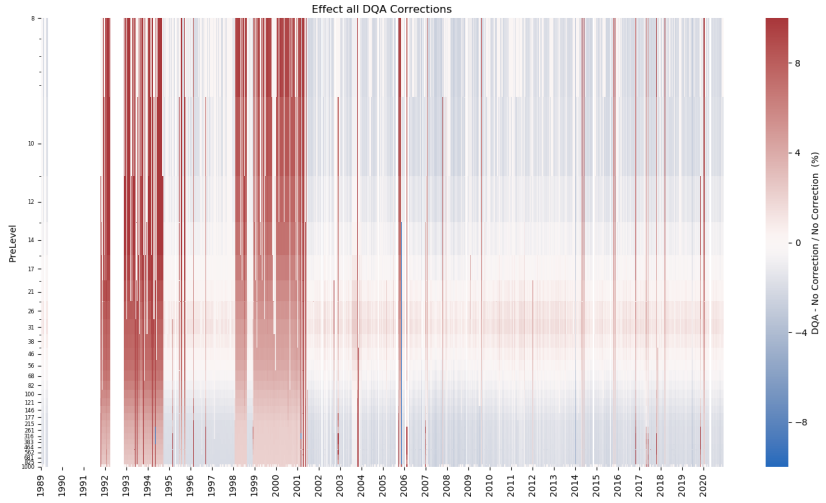

Figure 13: Effect of all DQA corrections

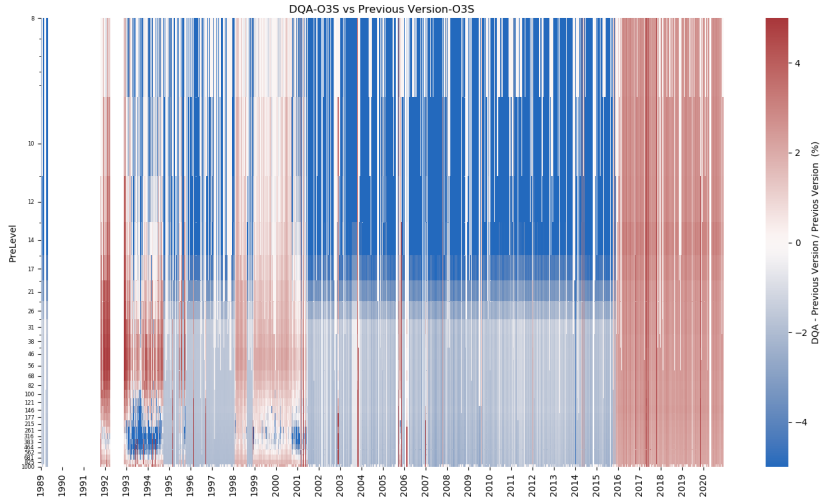

Figure 14: Comparison of DQA and NDACC O3S values

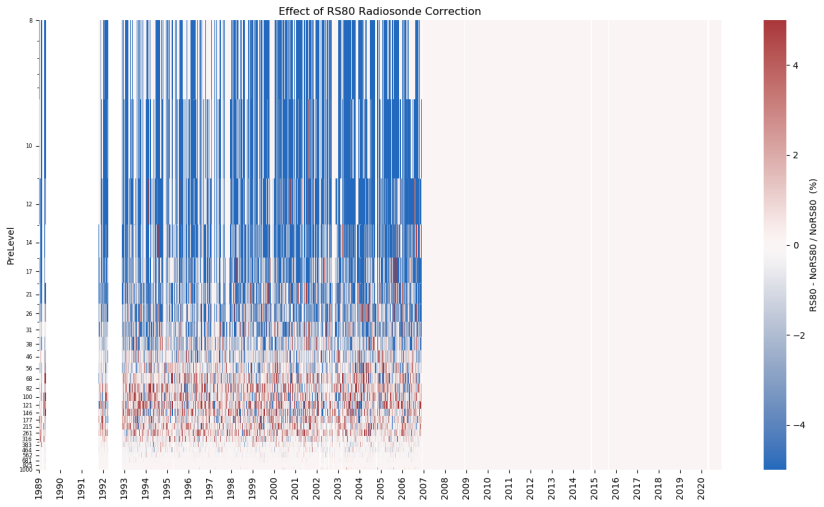

Figure 15: RS80 correction applied

2.0.6 Radiosonde correction

The RS80 radiosonde correction is applied to correct the pressure offset difference. This correction is not included in the DQA corrections, but only applied to see its effect. The effect of RS80 correction is shown in Fig 15.

3 Effect DQA corrections on ozone profiles

In order to see the effect of DQA corrections, explained in Sec.2, on the ozone profiles the ozone profiles have been explored with and without DQA corrections. In Fig16, the ozone profiles with DQA and NDACC corrections are shown. The effect of the RS80 correction for the period before 2007 is shown in Fig17

4 Comparison plots to AURA MLS v04

The homogenized and non-homogenized Scoresbysund data is compared with AURA-MLS data using v04. The NDACC, DQA homogenized and DQA with RS80 correction O3S data sets are compared and shown in figures between 18 and 20.

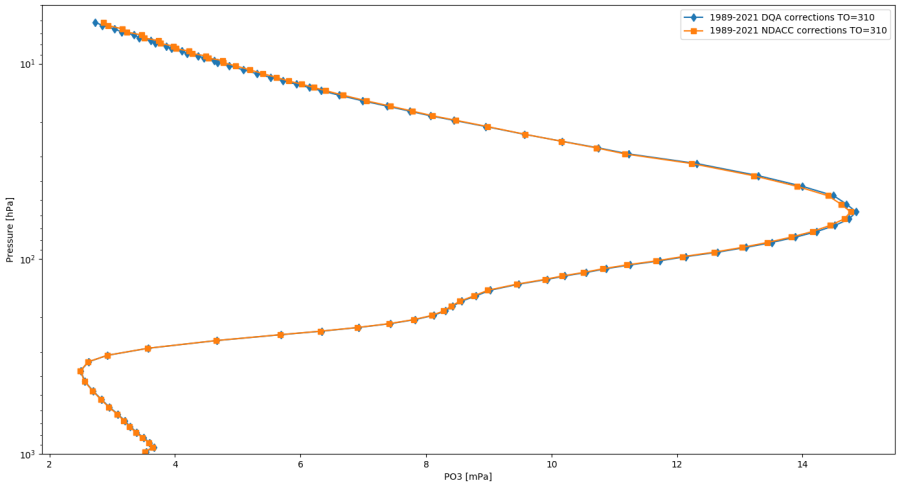

Figure 16: DQA corrections and NDACC corrections

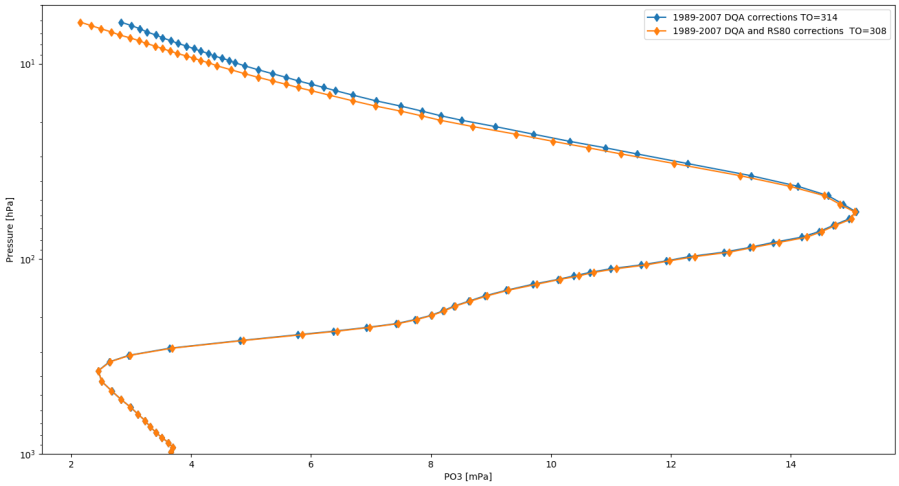

Figure 17: Effect of RS80 correction before 2007

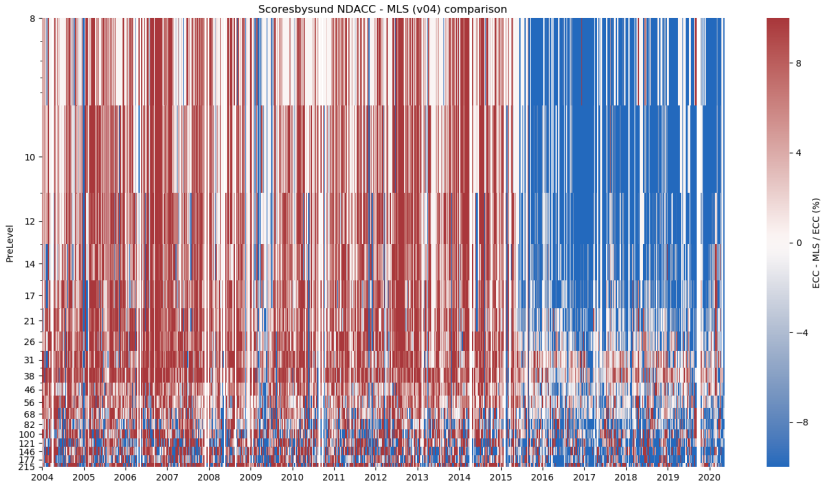

Figure 18: NDACC Scoresbysund O3S vs AURA MLS v04

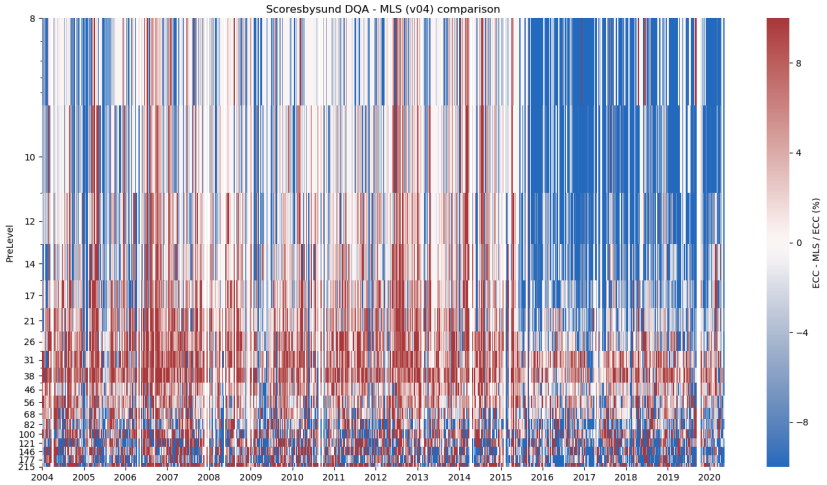

Figure 19: DQA Scoresbysund O3S vs AURA MLS v04

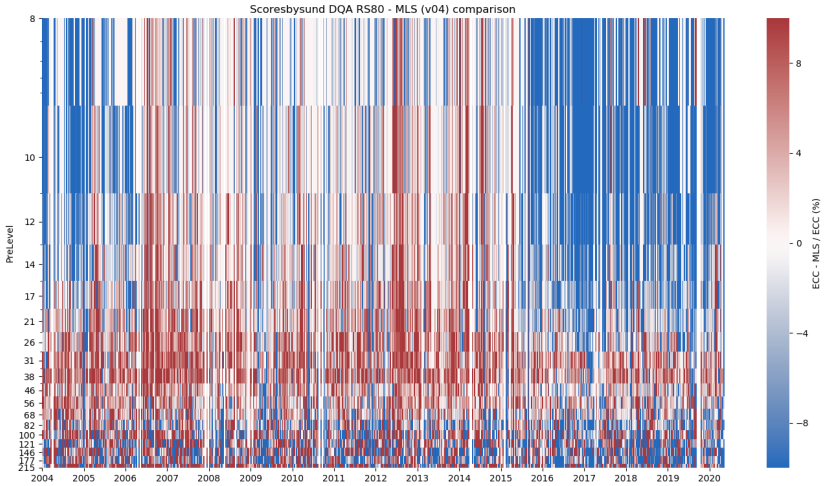

Figure 20: DQA Scoresbysund O3S vs AURA MLS v04

5 Total Ozone and Total Ozone Normalization Factors

The Total Ozone Normalization (TON) factors have been calculated with and without DQA corrections. For the TON the ratio of TO from the sonde to TO from the satellites are taken. For the TO from the sonde, the TO is integrated until burst (max. 10hPa) and the residuals, calculated from climatological means, are added. The corresponding plots are shown in Fig.21 and Fig.23.

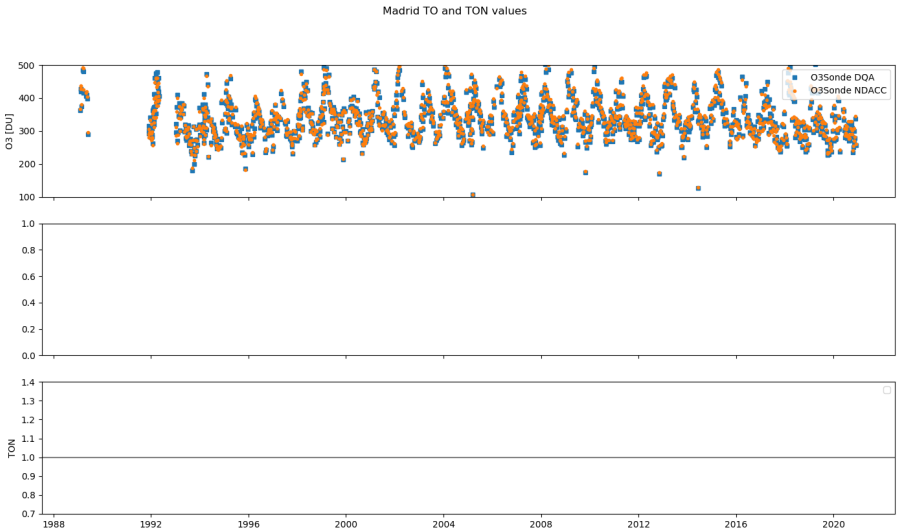

Figure 21: TO values calculated with NDACC and DQA corrected ozonesonde data

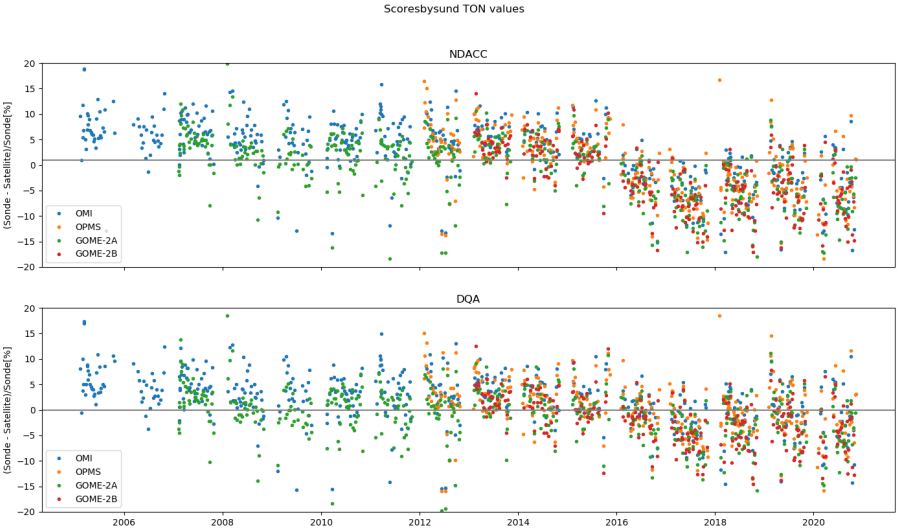

Figure 22: Relative differences of TON values with respect to satellite data calculated with NDACC and DQA corrected ozonesonde data

Figure 23: Relative differences of TON values with respect to satellite data calculated with NDACC and DQA corrected ozonesonde data