# Madrid O3S-DQA Homogenization Report

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## 1 Madrid Metadata timeseries

Madrid ozonesonde data is taken from WOUDC data-server and the metadata is provided by the station PI. The timeseries in WOUDC server starts from 1994. There are missing metadata which are temperature (TLab), pressure (PLab) values of the laboratory conditions before 2006-02-26, and humidity (ULab) of the laboratory before 2020-11-18. For the TLab, ULab and PLab the climatological means are calculated for each month and these values are used for the missing metadata.

Some of the pump temperature values in WOUDC files, before 2006, are missing. For those data files the climatological means of the pump temperatures with 2 sigma uncertainty are used. Among these files, if the number of data points are considerably less with respect to the total number of points (less than 20%), the missing pump temperature values are interpolated.

## 2 O3S corrections

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

1. Conversion efficiency
2. Background current
3. Pump temperature measurement
4. Pump flow rate, moistening effect
5. Pump flow efficiency at low pressures
6. Total ozone normalization: in O3S-DQA guide this correction factor is recommended to added in the data-set, but this is not extracted yet.

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 WOUDC files using pump temperature values, pump flow rate and background values (iB2). The corrections that had been applied to

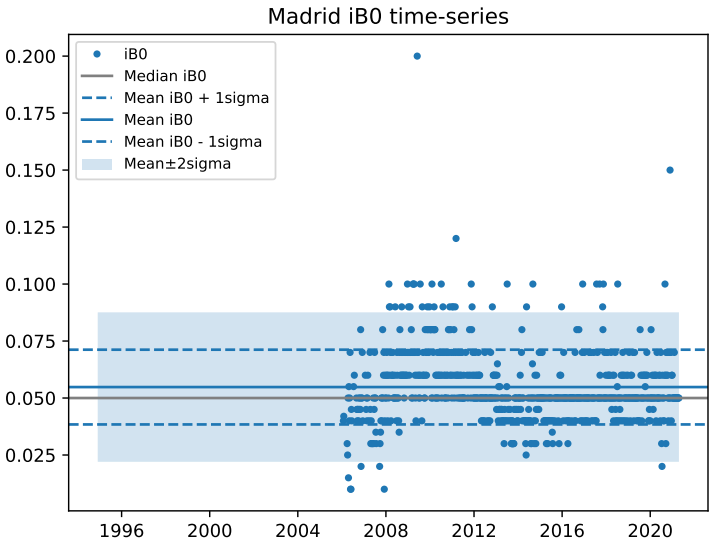


Figure 1: Madrid iB0 timeseries

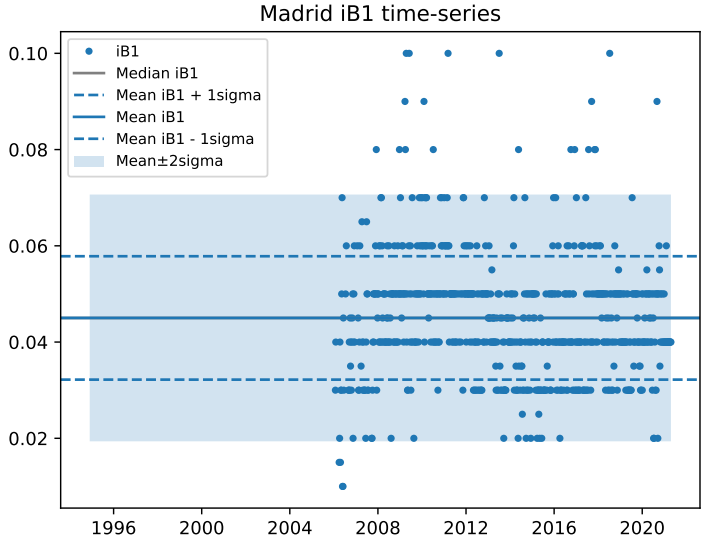


Figure 2: Madrid iB1 timeseries

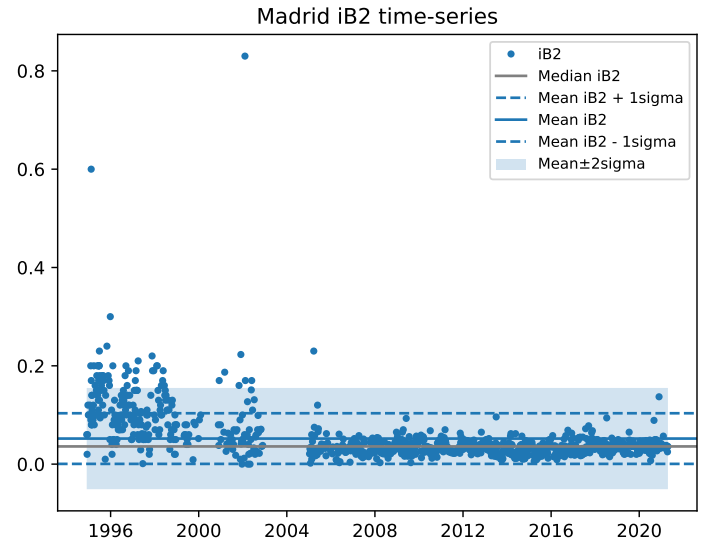


Figure 3: Madrid iB2 timeseries

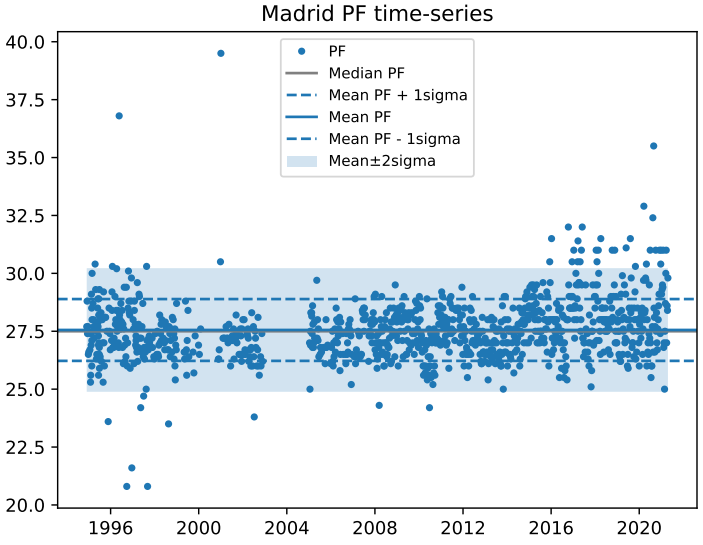


Figure 4: Madrid pump flow rate timeseries

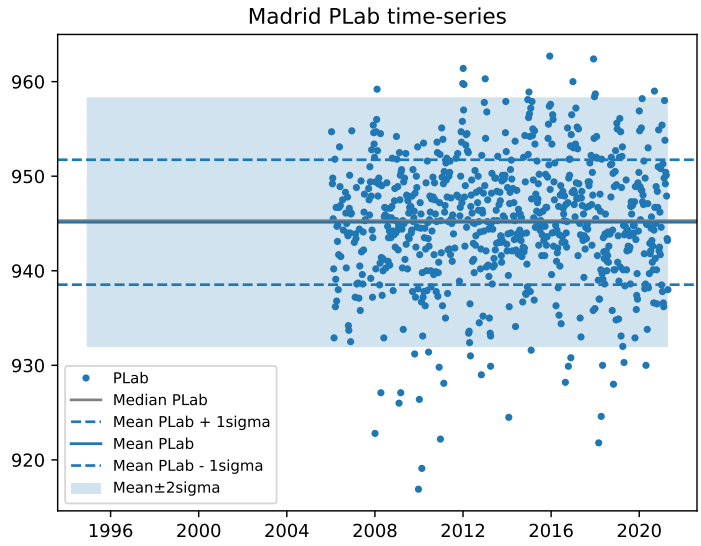


Figure 5: Madrid laboratory pressure timeseries

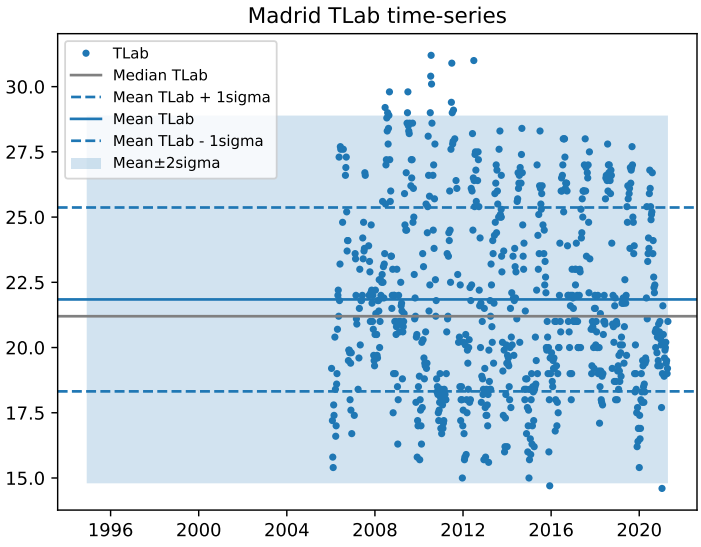


Figure 6: Madrid laboratory temperature timeseries

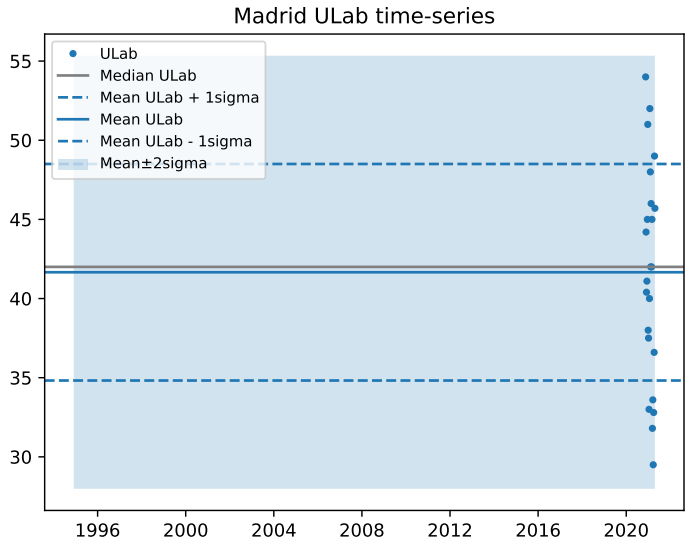


Figure 7: Madrid laboratory humidity timeseries

have the WOUDC 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 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 corrcetions. The correction applied for uncorrecting the WOUDC 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. The ozone partial pressures converted from raw current wihout applying any correction is denoted as 'Raw' or 'No correction', the values taken from WOUDC file-server is denoted by 'WOUDC' 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

The stoichiometry correction is not needed since SPC $1.0\% - 0.1$B ECC's have always been launched.

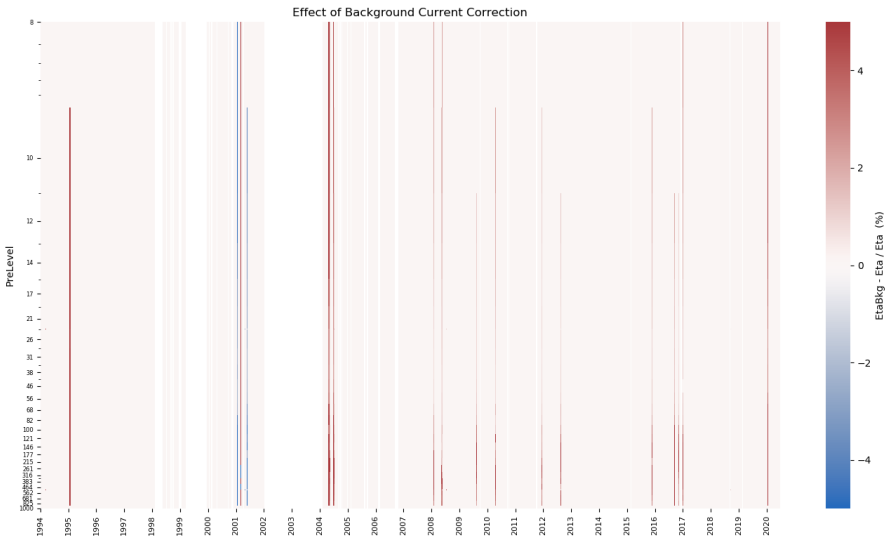


Figure 8: Background current correction

### 2.0.2 Background current

Background correction, using iB2, applied Madrid data is shown in Fig 8. If $I_B$ exceeds $I_{B,\text{Mean}} + 2\sigma_{IB}$ then $I_B$, it should be replaced by the more representative climatological value of $I_{B,\text{Mean}}$, however with larger uncertainty of $2\sigma_{IB}$. Therefore to the $I_B$ values falling above $I_{B,\text{Mean}} + 2\sigma_{IB}$ in Fig 3, the background correction is applied. For the mean and standard deviations of the iB2 values, 2 different period is considered. As it can be seen in Fig 3, iB2 values are larger for the period before 2004 and smaller for the period after 2004. Therefore the mean and corresponding standar deviations are calculated and applied seperately in these 2 periods.

### 2.0.3 Pump temperature measurement

Truest pump temperature correction is applied according to Eq.13 of the O3S-DQA Guidelines. At 1998-12-02 the pump location changed from being in the box to the inside the pump. Therefore Case-III correction is applied to SPC-5A sondes and case-V correction to SPC-6A sondes. The effect of the temperature correction is shown in Fig 9.

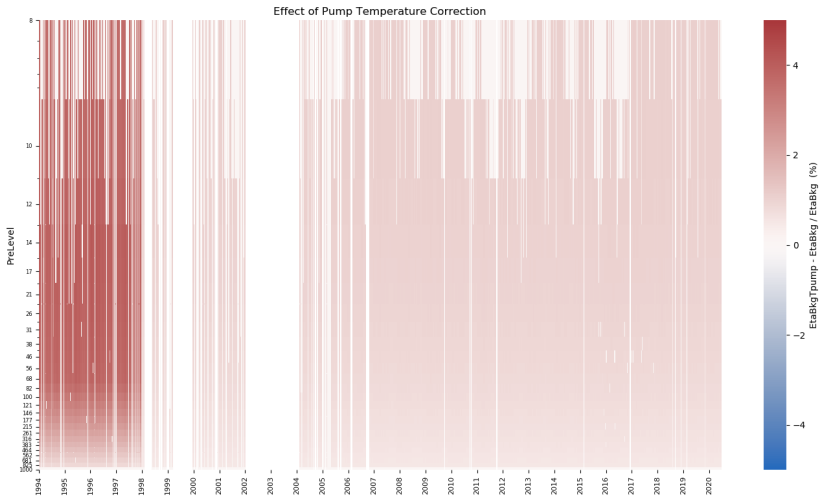


Figure 9: Pump temperature correction applied

#### 2.0.4 Pump flow rate (moistening effect)

This correction, Eq.15 of the O3S-DQA Guidelines, is applied and shown in Fig 10. 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 11. The interpolation of the correction factors are made using the pressure. This method gives the same result as doing the interpolation using the logarithm of pressure and polynomial fit with an error of less than 0.03%. The effect of this correction is shown in Fig 11.

The effect of all DQA correction with respect to no correction is shown in Fig 12 and the comparison of DQA corrected and WOUDC O3S values is shown in Fig 13.

## 3 Effect DQA corrections to 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. The pump temperature location correction is checked for the 2 different periods, before and after 1998, when there was a change in the pump temperature location. All the plots are summarized between Fig.14 to Fig.16.

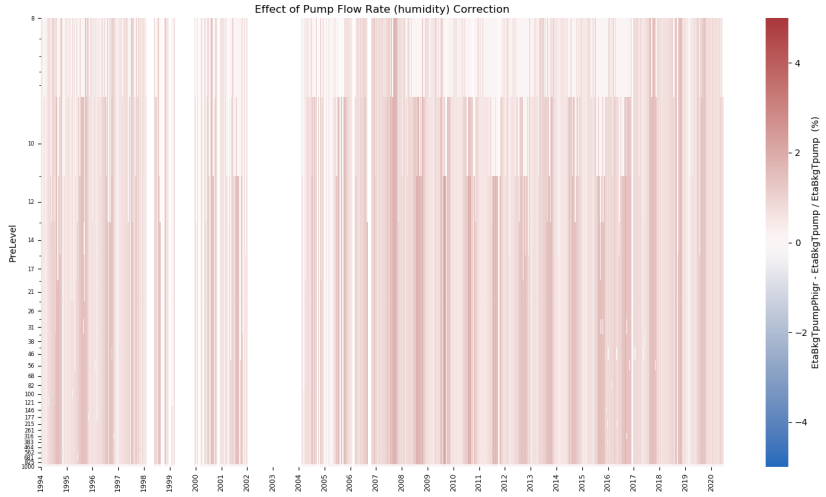


Figure 10: Pump flow rate correction applied

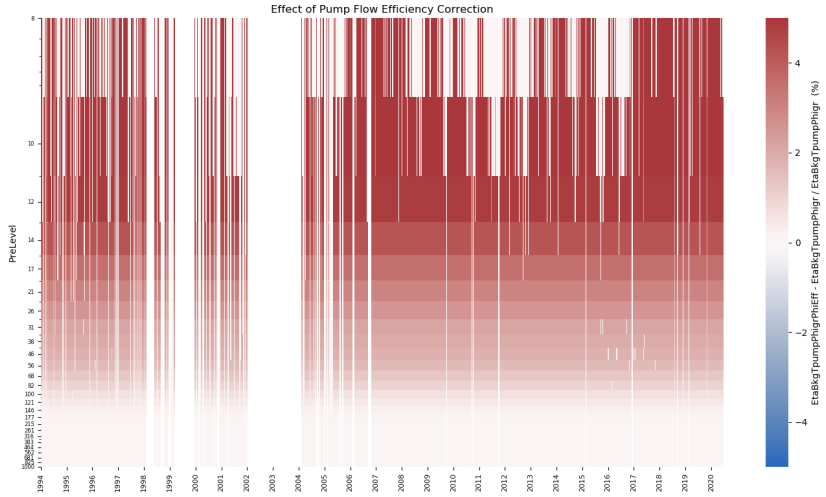


Figure 11: Pump flow rate correction applied

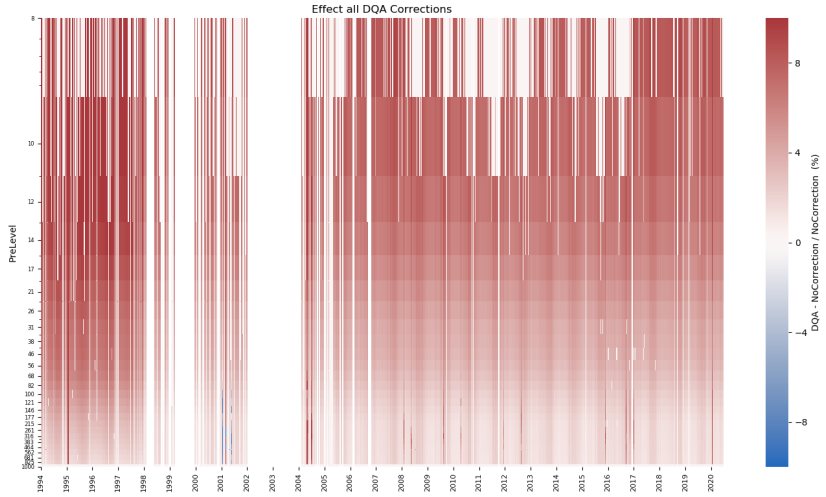


Figure 12: Effect of all DQA corrections

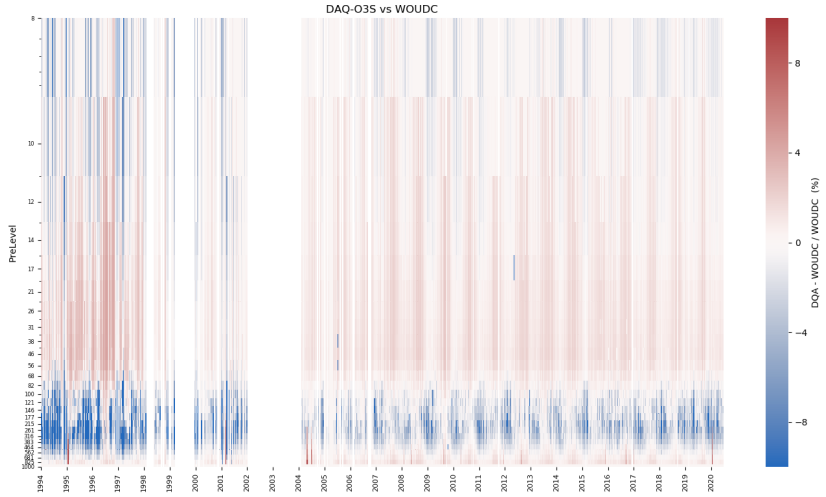


Figure 13: Comparison of DQA and WOUDC O3S values

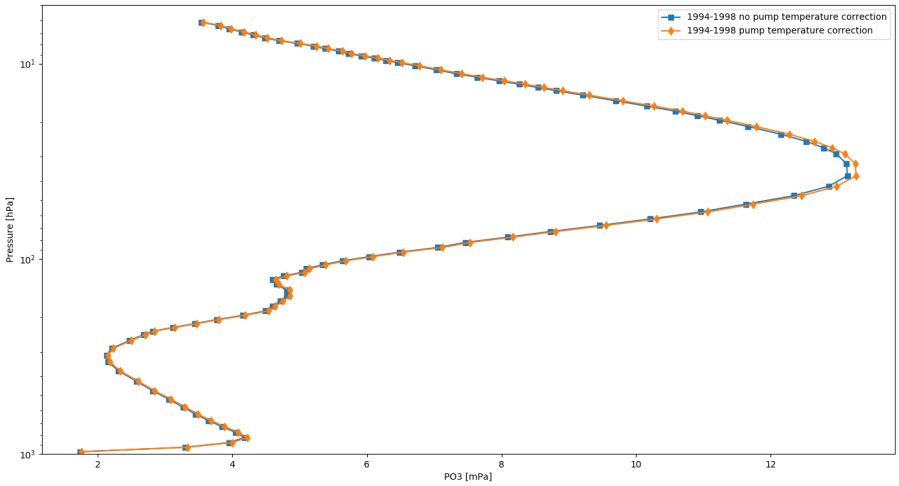


Figure 14: Pump temperature location correction between 1994-1998

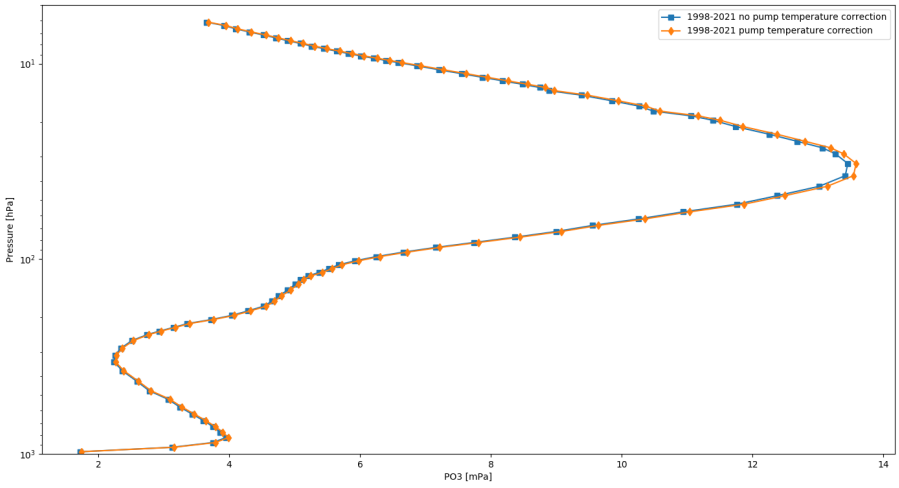


Figure 15: Pump temperature location correction between 1998-2021

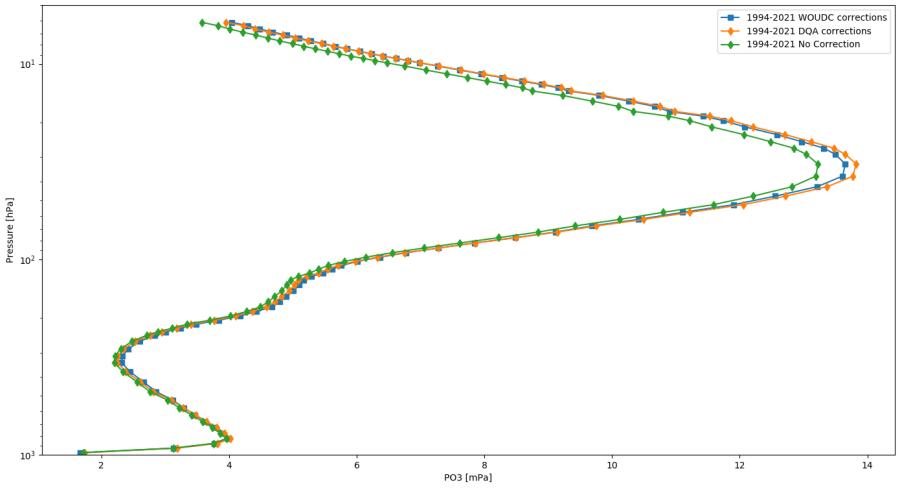


Figure 16: Effect of all DQA corrections with respect to correction applied ozone profiles and comparison to WOUDC

# 4 Total Ozone Normalization before and after homogenization.

The Total Ozone Normalization (TON) factors have been calculated with and without DQA corrections. For the TON the ratio of the TO from Brewer to the TO from the sonde is taken. For the TO from the sonde, the TO is integrated until 10hPa and the residuals, calculated from climatological means, are added. The corresponding plots are shown in Fig.17 and Fig.18.

# 5 Comparison plots to AURA MLS v04 and v05

The homogenized and non-homogenized Madrid data is compared with AURA-MLS data using v04 and v05. Among these two a small difference can be seen in the pressure levels between 45 and 215 hPa. This difference is due to the differences in the AURA MLS data. The not-corrected, homogenized and WOUDC O3S data sets are compared and shown in figures between 19 and 21.


Figure 17: Comparison of WOUDC and DQA TO and TON values

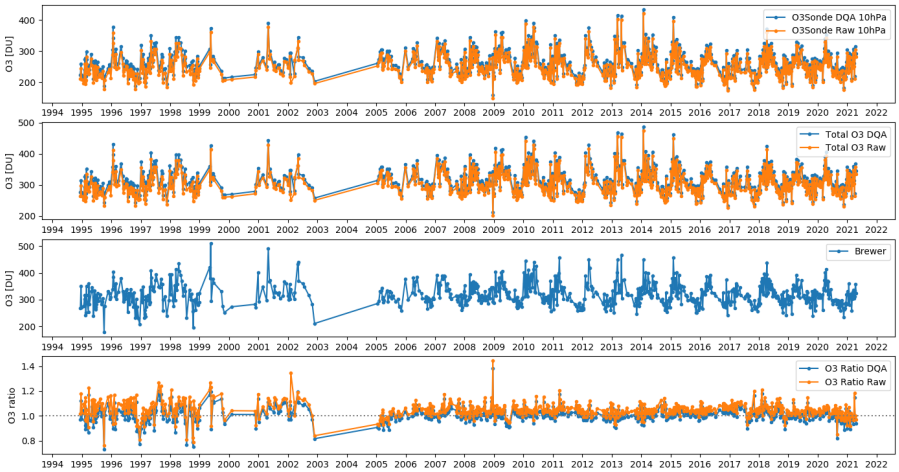


Figure 18: Comparison of DQA and Raw TO and TON values

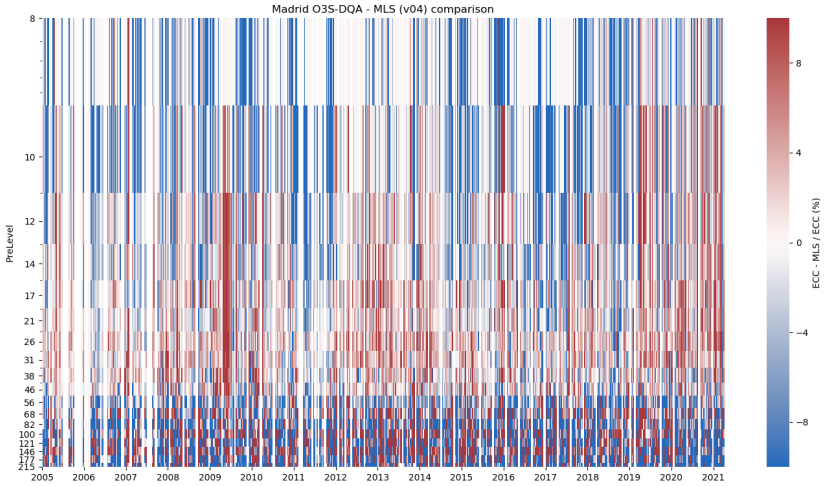


Figure 19: DQA Madrid O3S vs AURA MLS v04

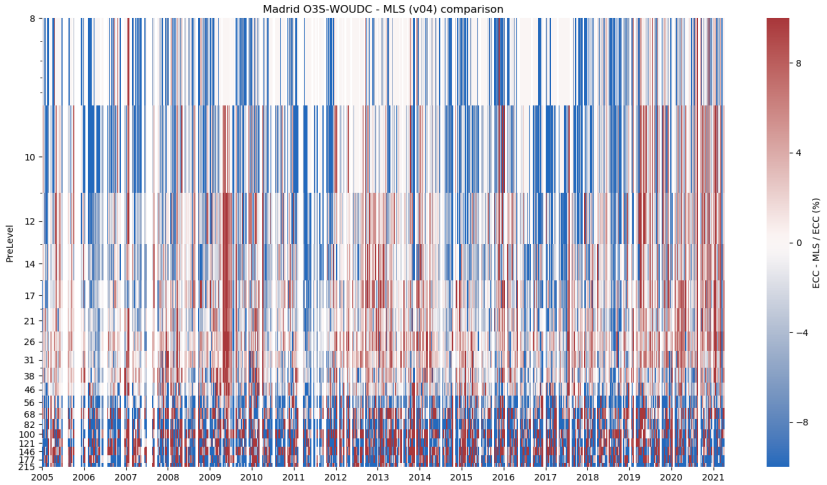


Figure 20: WOUDC Madrid O3S vs AURA MLS v04

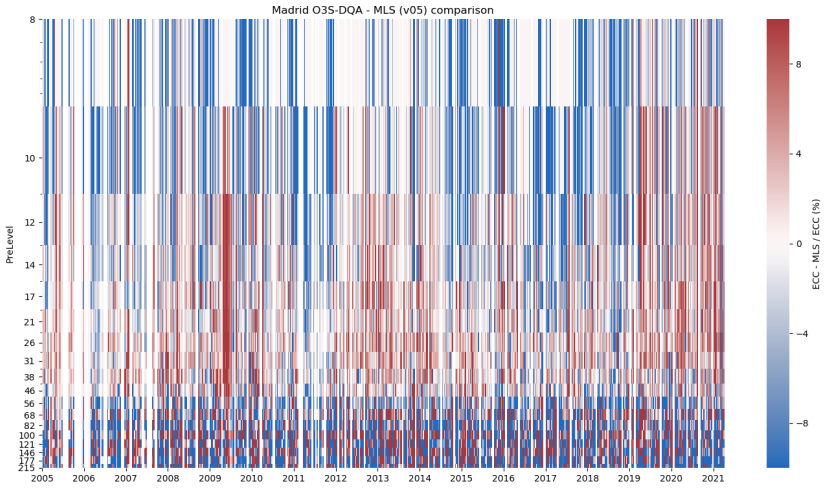


Figure 21: DQA-O3S Madrid vs AURA MLS v05