Statistics-based evaluation of the stray-light effect on ozone measurements in the framework of the European Brewer Network (EUBREWNET)

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1 Introduction

Single Brewers (MKII and MKIV) are inefficient to fully reject light coming from outside the nominal waveband of the slit functions. This stray-light effect is known to lead to both **overestimation of UV** measurements and **underestimation of ozone** retrievals, especially at large ozone slant path columns (SCDs), e.g., at high latitudes or at midlatitudes during wintertime. Several algorithms, relying on an accurate per-instrument characterisation, were proposed in the scientific literature to compensate for this effect, however, they require comparisons to a double-monochromator Brewer as reference or Langley plots at pristine sites. Conversely, the selection of a proper **cut-off** value in terms of the SCD, beyond which the ozone measurements are rejected from further analysis or flagged as uncertain, appears as the simplest solution **on a network basis**.

2 Method

Multi-year datasets from several European stations (Fig. 1) operating single and/or double Brewers were analysed. A **statistical approach** (Cede et al., 2014) was used, which consists in:

- plotting the **differences between the single measurements** of the ozone vertical column (VCD) **and the median** column of the same day as a function of the measured ("apparent") ozone SCDs (Fig. 2);
- assuming that the average of the deviations should be zero.

The reference daily medians were calculated using only data (extracted from the B-files) in a fixed SCD range to avoid biases due to the annual cycle and different schedules. All anomalies outside ±50 DU were discarded to remove measurements likely resulting from instrumental errors. The measurements were processed separately for the morning and afternoon and for **each season**, to identify possible influences by the daily photochemical cycle of the **tropospheric ozone**.

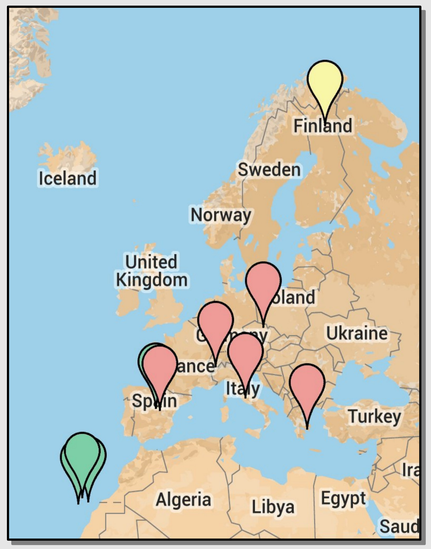


Figure 1. Domain and instruments considered in the study. Red markers: MKIV; green: MKIII; yellow: MKII.

3 Results and conclusions

In MKIV Brewers, underestimations of 1% of the ozone VCD generally occur when the measured SCD is above 950 DU (median among different instruments), -2% for SCDs above 1110 DU and -5% for SCDs above 1420 DU SCD. However, **the results remarkably differ even among instruments of the same type**. As expected, double-monochromator Brewers don't show any relevant stray-light effect. Slight underestimations (<-1%) were found in only two MKIII instruments and for large SCDs. Underestimations beyond 2% were found for only one MKIII Brewer. MKII performances are halfway those of MKIV and MKIII. Slight asymmetries between morning and afternoon were observed in few polluted stations (Athens, Rome), probably as a result of the daily cycle of tropospheric ozone.

The analysis also represents a first and successful **proof-of-concept** of using measurements from the **EUBREWNET database**, thus showing the capability and usefulness of a European Brewer network. Furthermore, the characterisation, needed for the correction algorithms, is one of the main objectives of the EMRP funded project **ATMOZ** (Traceability of the Atmospheric Ozone). During this project, selected Brewer and Dobson instruments will be characterised for stray-light.

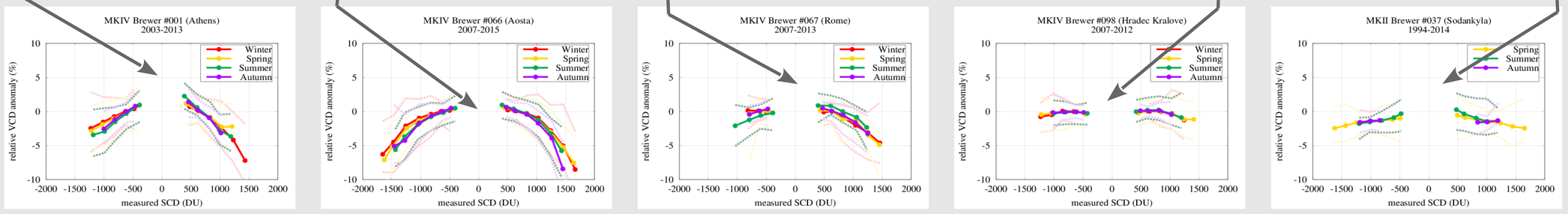
Summer maximum and morning-afternoon asymmetry. Influence by tropospheric ozone?

Very large stray-light effect, as already noticed during RBCC-E campaigns.

Asymmetry morning-afternoon in summer. Tropospheric ozone?

Excellent stray-light rejection for a MKIV Brewer. "Class-1" instrument?

Stray-light is generally lower in MKII than in MKIV owing to different gratings.



Single and double Brewers at same location. No clear evidence of tropospheric ozone.

The Izaña triad shows an excellent stray-light rejection. Slight differences at high SCDs even among MKIII Brewers, insignificant.

Figure 2. Stray-light effect on ozone vertical column density as a function of the ozone slant path (negative SCD = morning, positive SCD = afternoon). Solid and dashed lines represent the median of the daily anomalies and the 10th or 90th percentiles, respectively.

http://www.eubrewnet.org/cost1207/
http://rbcce.aemet.es/iberonesia3/brewer/list
http://projects.pmodwrc.ch/atmoz/

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