

## Introduction, location and instruments

The Royal Meteorological Institute of Belgium performs spectral UV measurements with Brewer spectrophotometers at two stations: Uccle, Belgium (50.8° N, 4.35° E, 100m asl) and Utsteinen, Antarctica (Belgian research station Princess Elisabeth, 71.95° S, 23.35° E, 1380m asl). The UV time series at Uccle started with measurements of the single monochromator Brewer #016 in 1990 and is complemented by measurements of the double monochromator Brewer #178 since 2002. At Utsteinen, the Brewer #100 double monochromator started measuring in 2011. The measurements of Brewer #100 only cover the periods of austral summer (November – February). The other months, Princess Elisabeth station (PES) is not inhabited and Brewer #100 is thus not operational.



Brewers 178 and 016

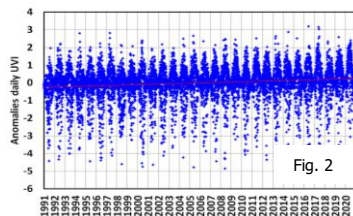
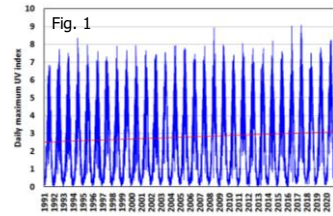


Brewer 100 at PES



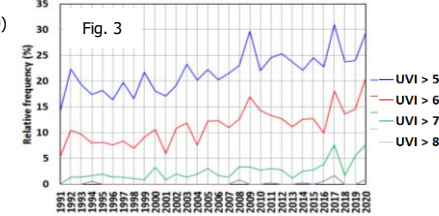
Princess Elisabeth Station East-Antarctica (Draining Moist Land)

## UV index time series analysis / Brewer #016 Uccle



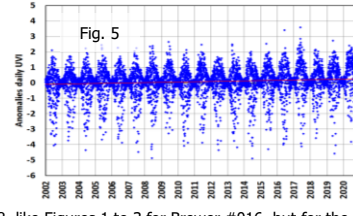
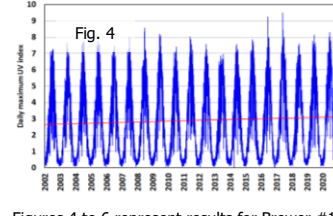
trends per decade % (1991-2020)

daily Max	6.9 ± 0.9
monthly Max	3.4 ± 3.9
monthly Avg	6.6 ± 4.4
daily Anom.	5.8 ± 0.4
monthly Avg Anom.	5.9 ± 0.6
monthly Max Anom.	3.1 ± 0.5



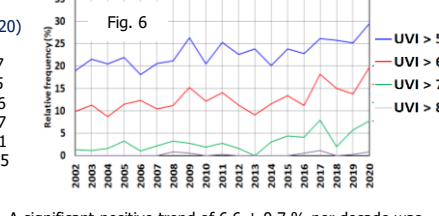
For each individual day, the maximum daily UVI value was determined (Fig. 1). From these daily maximum values, the long-term mean daily values were calculated. These were used to derive the daily anomalies of the maximum daily UVI values. A significant positive trend of  $5.8 \pm 0.4$  % per decade can be found in the anomalies time series between 1991 and 2020 (Fig. 2). There is a clear increase in the occurrence of higher daily maximum UVI values. Whereas only 15% of all UVI values were > 5 in 1991, this value has risen to almost 30% in 2020 (Fig. 3).

## UV index time series analysis / Brewer #178 Uccle



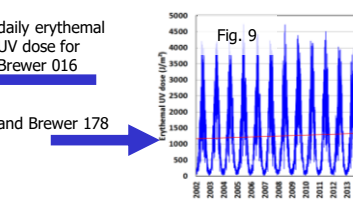
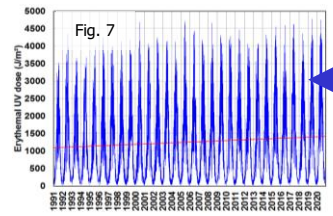
trends per decade % (2002-2020)

daily Max	7.6 ± 1.7
monthly Max	4.3 ± 7.5
monthly Avg	6.3 ± 8.6
daily Anom.	6.6 ± 0.7
monthly Avg Anom.	6.5 ± 1.1
monthly Max Anom.	3.1 ± 0.5



Figures 4 to 6 represent results for Brewer #178, like Figures 1 to 3 for Brewer #016, but for the respective time period 2002 to 2020. A significant positive trend of  $6.6 \pm 0.7$  % per decade was found for the anomalies time series 2002-2020 (Fig. 5). The 75%-percentile of the difference of UVI values between the two Brewers is  $\pm 0.05$  at a maximum time difference of 1 min.

## Erythemal UV dose time series analysis / Brewer #016 and #178 Uccle



The daily erythemal UV dose measured by both Brewers is compared in Fig. 11. Correlation  $r^2 = 0.999$  for  $y = 1.014x + 11.921$  (time period 2002 – 2020)

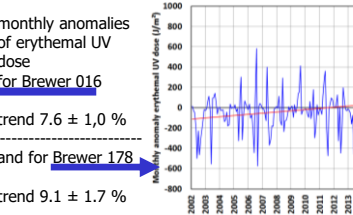
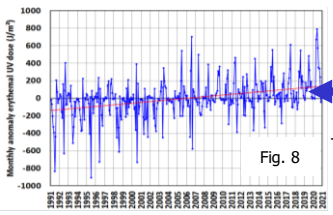
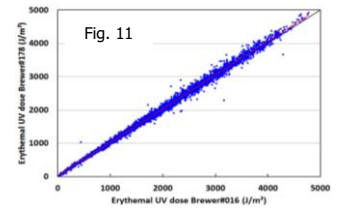
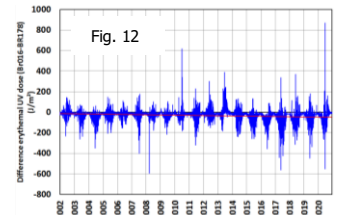
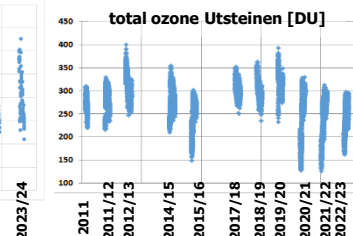
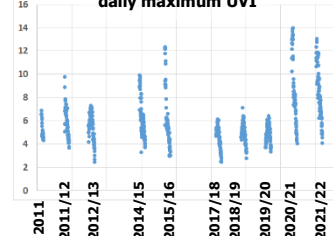


Fig. 12 shows the absolute difference between the daily erythemal UV doses from the two Brewers, for the period 2002 – 2020.

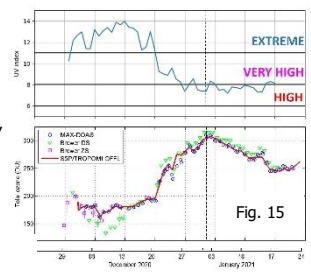


Further, in De Bock et al., 2014, the relationship between time series of erythemal UV dose, average total ozone, total global radiation and average aerosol optical depth were analyzed.

## UV measurements with Brewer #100 in Antarctica



UVI values, in particular in November and December, are strongly influenced by the variation of the total ozone column amount. For example, in November and December 2020, extreme UVI values up to 14 were reached. Fig. 15 to the right shows this period in more detail, and with comparison to a co-located MAXDOAS instrument and total ozone from Tropomi satellite data.



**take home:** time series of UV index and of erythemal UV dose have been analyzed / 1991-2020 for Brewer #016 / 2002-2020 for Brewer #178 / significant positive trends found for maximum daily UVI anomalies: 5.8% (Brewer #016) and 6.6% (Brewer 178) per decade / monthly anomalies of erythemal UV dose also show positive trend per decade: 7.6% (Brewer #016) and 9.1% (Brewer #178) / good agreement of UV measurements between both Brewers / UV measurements in Antarctica strongly influenced by the variation of total ozone, with UVI up to 14