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The transition to new ozone absorption cross sections for Dobson and Brewer total ozone measurements

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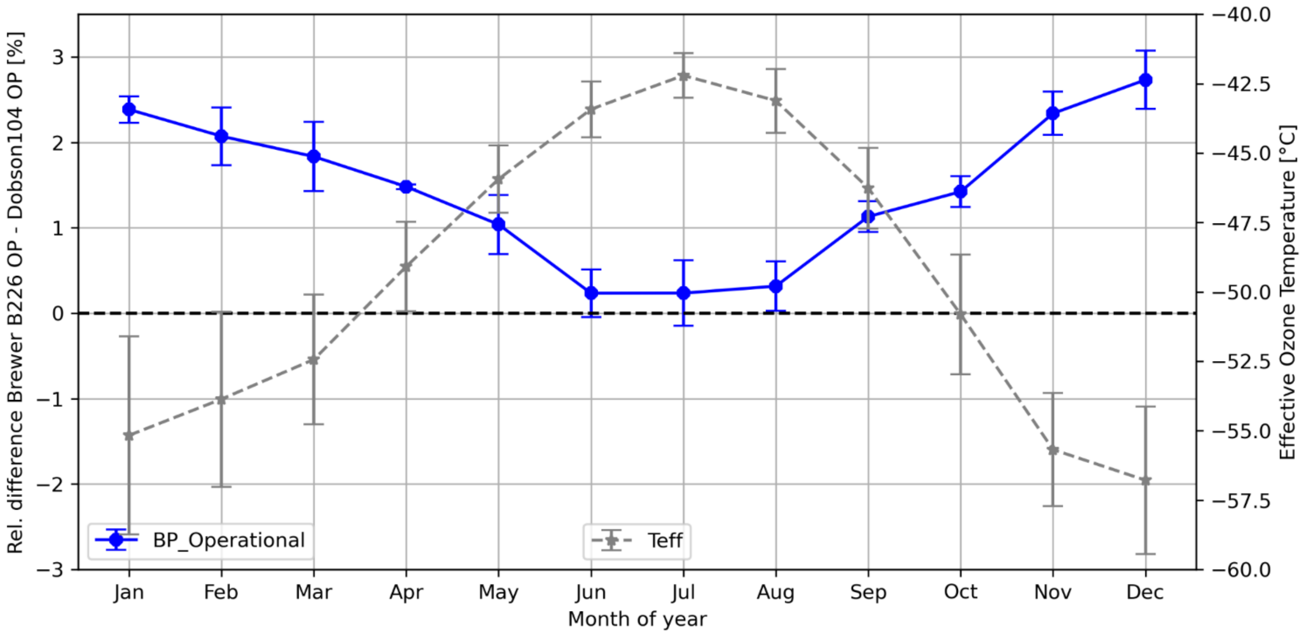

Figure S 1: Monthly mean (2017 – 2020) difference between Brewer226 and Dobson104 (blue line), using the operational Bass and Paur ozone absorption cross sections with fixed T_{eff}. The dashed grey line represents the typical monthly mean effective ozone temperature (T_{eff}) based on measurements at Hohenpeissenberg. The error bars represent the standard deviation over each month.

Same as Fig. 1 of the manuscript, but showing the difference between Brewer 226 (not Brewer 10) and Dobson 104, and for the years 2017 to 2020 (not 1990 to 2020).

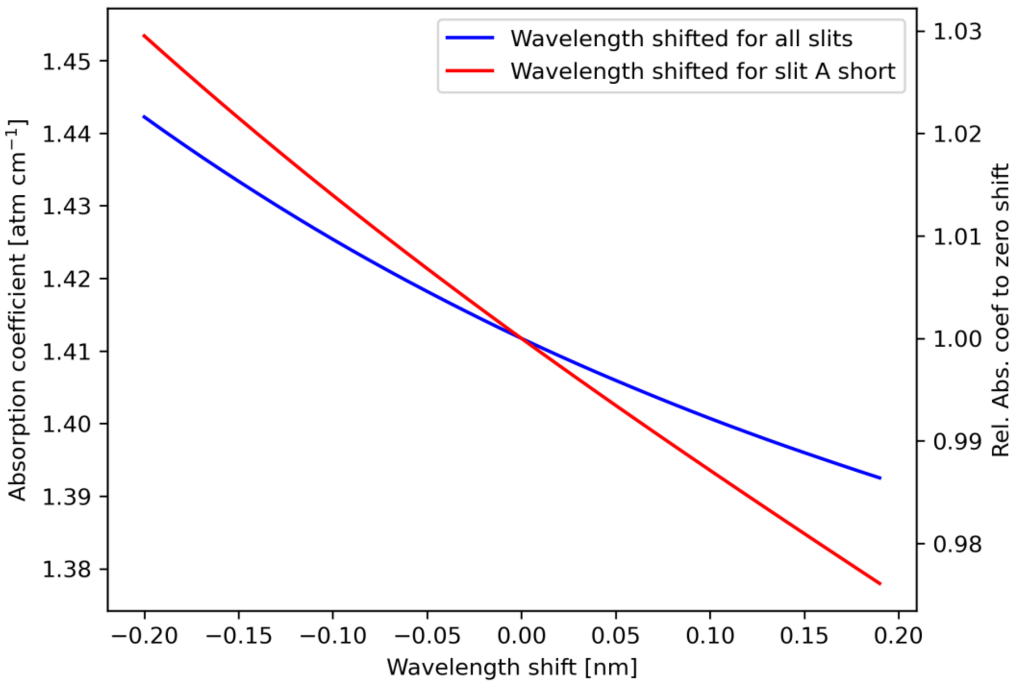

Figure S 2: Influence of Wavelength Shift on calculated absorption coefficient for TuPS Measurements. Red line shows the absolute and relative change in absorption cross section for a shift of only the short A slit (near 305 nm). The blue line shows the effect of shifting all slits.

Figure S2 shows how wavelength shifts or wavelength uncertainties correspond to changes of the effective ozone absorption cross section. Typically, a 0.1 nm wavelength shift changes the absorption cross section by about 1%.

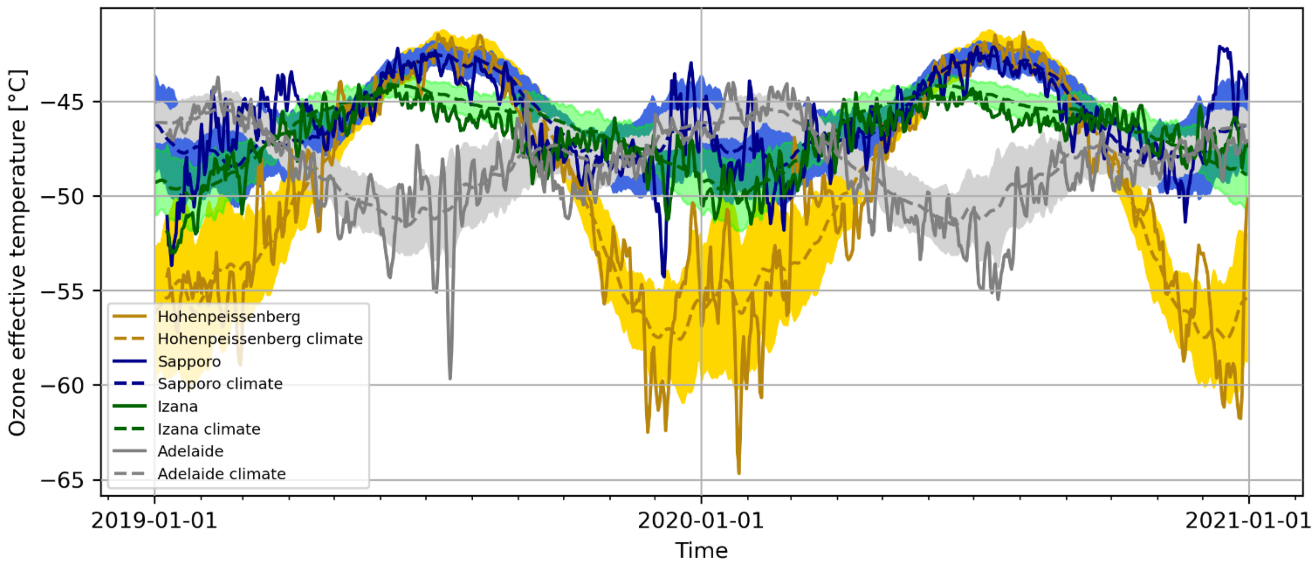

Figure S 3: Timeseries of TEMIS-derived ozone effective temperature T_{eff} for three additional locations. Hohenpeissenberg is at 48°N, Sapporo at 43°N, Izana at 28°N, and Adelaide at 35°S. The dashed lines indicate the long-term climatology (1990-2020), and the shaded areas indicate the year to year variability for each day of year (1 σ).

Same as Fig. 5 of the manuscript, but showing results for additional stations. Note the smaller annual cycle at Sapporo, which is at a similar latitude as Hohenpeissenberg, but is affected significantly by the Aleutian stratospheric anti-cyclone.

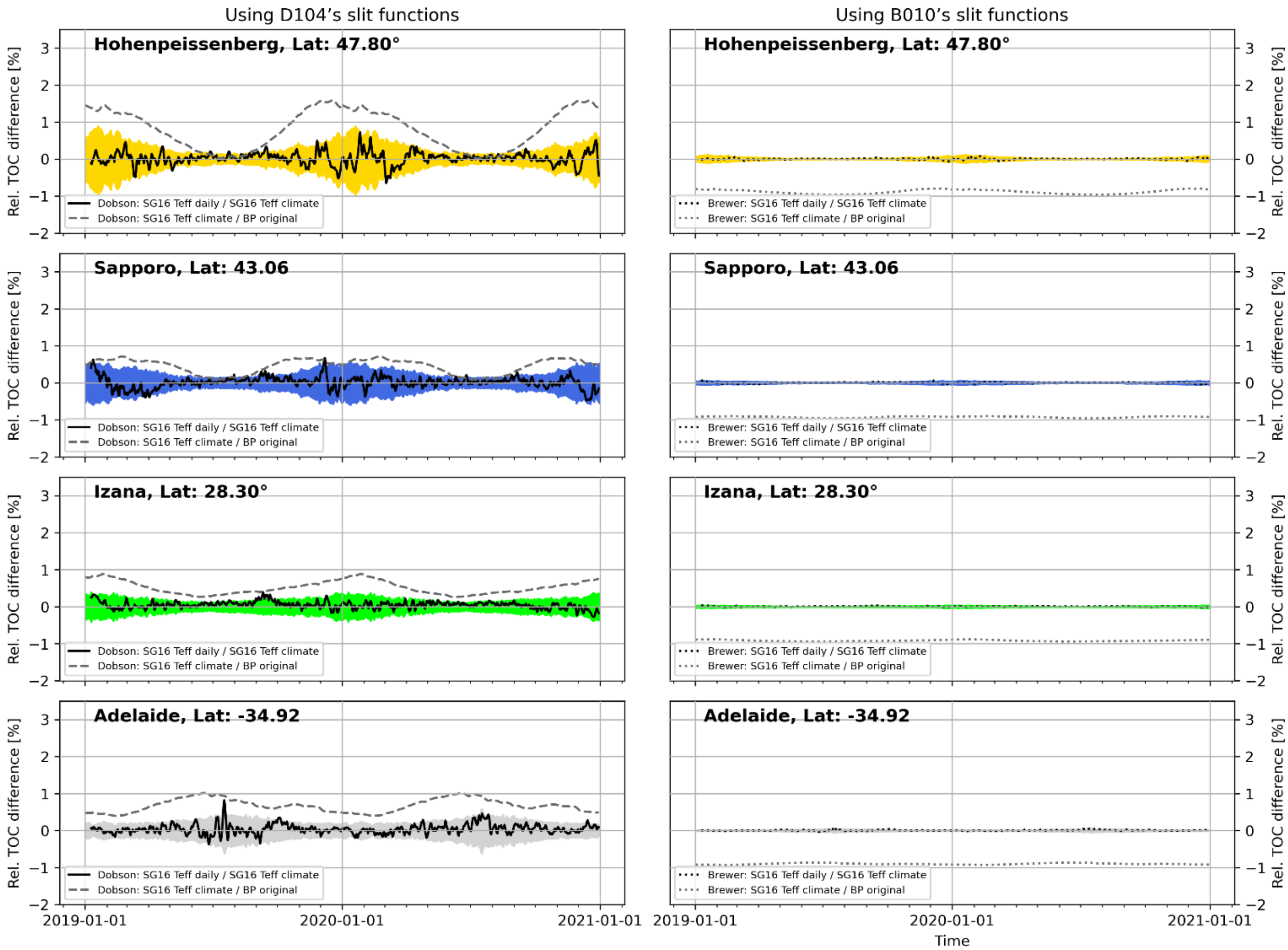

Figure S 4: Relative difference in TOC between new Teff dependent ozone cross sections (SG16, TEMIS climate) and fixed temperature B&P cross sections (grey dashed lines), and between daily and climatological values for Teff (colored shaded regions, SG16 cross section, Teff daily and climatological from TEMIS). Results are given for four locations and Dobson (left panels) and Brewer (right panels). The shaded areas show the potential difference in TOC (2 σ) when using climatological T_{eff} (1990 – 2020) instead of daily TEMIS values. Bernhard slit approximation was used for the Dobson instrument. For the Brewer, the slit functions from Brewer010 as described in Table 2 were applied.

Same as Fig. 7 of the manuscript, but for the same additional stations as in Fig. S3 of this supplement.

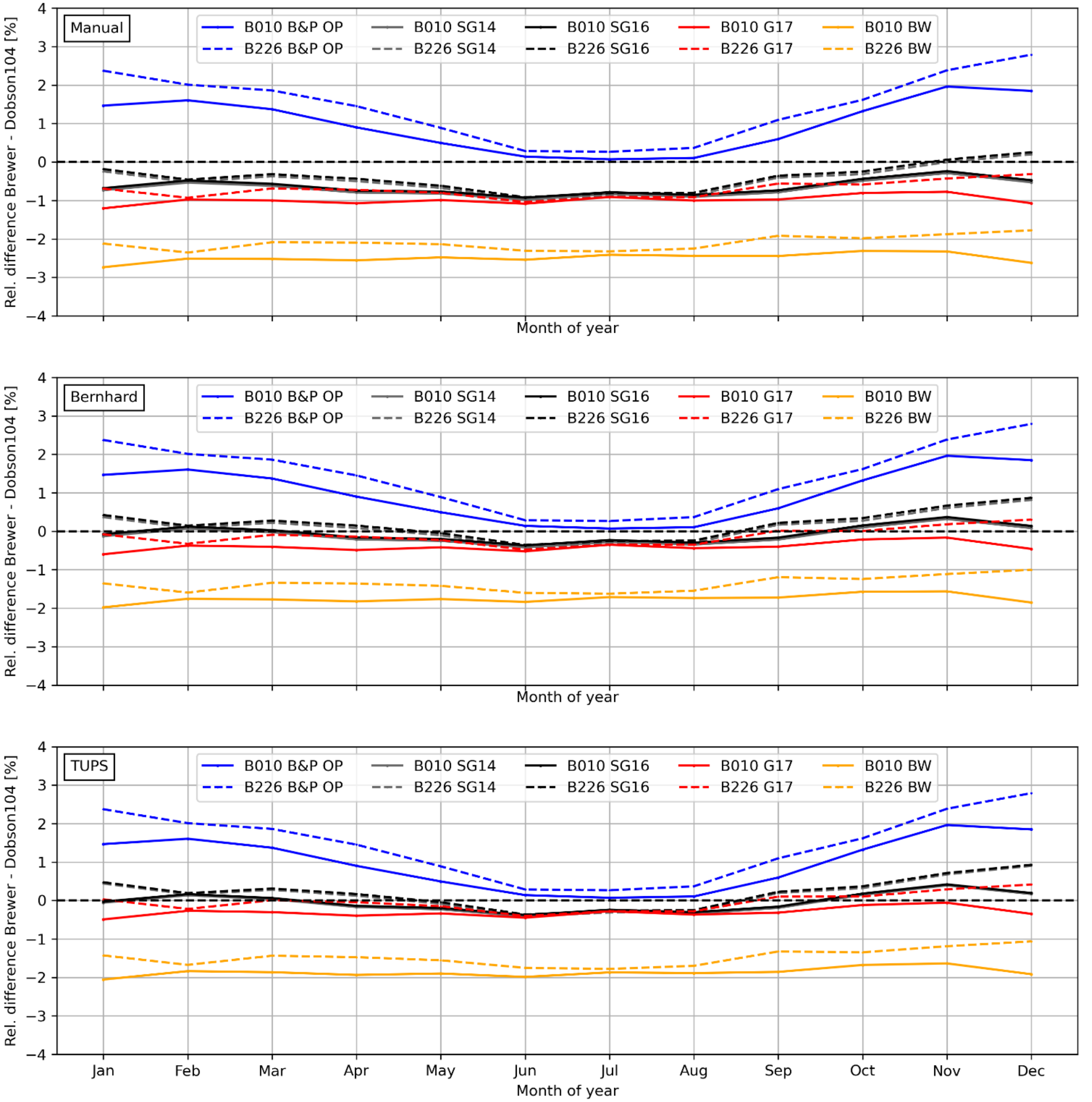

Figure S 5: Monthly mean difference between Brewers 010/226 (solid, dashed) and Dobson104. The three panels show the results for different slit parametrizations for the Dobson instrument. The different colors represent the results obtained using the various ozone absorption cross sections.

Expanding on Fig. 8 of the manuscript, and showing results for all three different options for the Dobson slit functions. All slit function options give very similar results. In the manuscript, the Bernhard approximation is used.

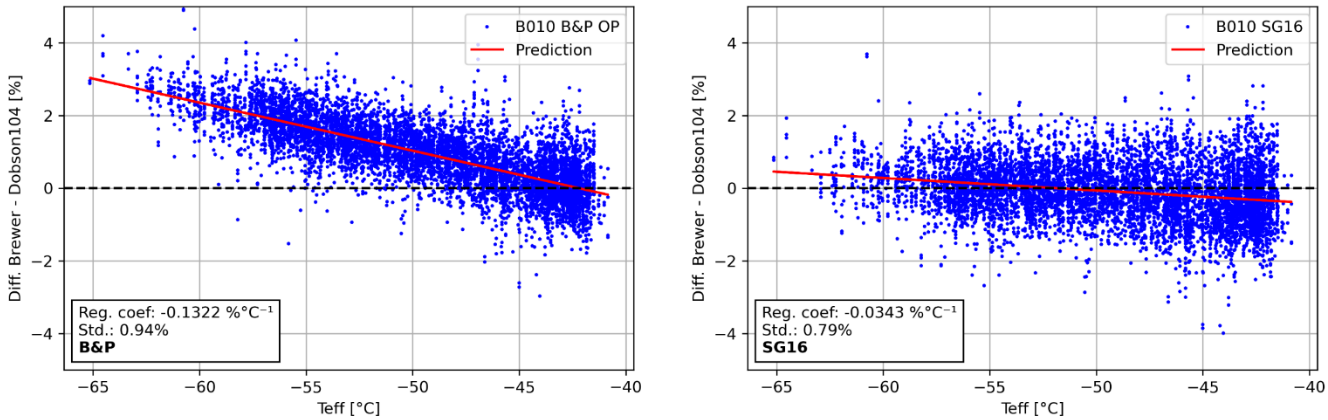

Figure S 6: Relative differences between Brewer 010 and Dobson 104 with respect to ozone effective temperature (T_{eff}). The left panel illustrates the differences using the operational B&P cross sections without accounting for varying Teff values, while the right panel displays the relative differences using the SG16 cross section dataset and accounting for T_{eff} variations. The red line represents the linear fit through the data points. The statistical values of the regression line and the standard deviation (1 σ) are presented in the figure's boxes.

The scatter plots in Fig. S6 show that the systematic temperature dependence of the Brewer – Dobson differences is largely removed when going from B&P cross sections without accounting for varying T_{eff} to the recommended SG16 the SG16 cross section dataset and accounting for T_{eff}. However, the scatter of the individual data points around the regression line, i.e. the remaining instrumental noise, is not reduced very much.

A summary of the annual variation in the difference between Dobson104 and the two Brewer instruments is given in Table S 1. The temperature dependency in the right columns is based on a linear fit to the observed differences versus T_{eff} (Fig. S6). The BW dataset produces a large offset between TOC values from the two instrument types. It is not recommended for implementation in operational networks.

Among the remaining three datasets, the SG14/SG16 cross sections produce the best results for the annually varying difference between the instrument types, with a mean difference of less than 0.18 % (column “mean”). The G17 dataset produces the smallest seasonal variation (column “Std. Dev.”). The remaining temperature dependency of the difference between the instruments is similar to the values reported by Gröbner et al. (2021), who found values ranging from -0.03 $\%K^{-1}$ to 0.00 $\%K^{-1}$ for the SG14/SG16 dataset, and values ranging from -0.00 $\%K^{-1}$ to 0.02 $\%K^{-1}$ for the BW dataset.

Table S 1: Mean difference (%), standard deviation (%) and temperature dependency (% $°C^{-1}$) of the relative total column ozone differences between the two Brewer instruments and the Dobson104 for five distinct ozone cross section datasets. The B&P dataset reflects operational measurements without T_{eff} -correction applied. The mean and standard deviation values are derived from monthly measurements presented in Fig. 8 for the Bernhard slit approximation, while the temperature dependency is calculated using all available paired measurements (see also Fig. S6).

Brewer /	Brewer010			Brewer226		
Dobson104	Mean	Std. Dev.	Temp. dependency	Mean	Std. Dev.	Temp. dependency
B&P	0.99	0.68	-0.13	1.44	0.83	-0.16
SG14	-0.11	0.21	-0.03	0.12	0.36	-0.05
SG16	-0.06	0.21	-0.03	0.18	0.36	-0.05
G17	-0.40	0.12	-0.00	-0.13	0.22	-0.02
BW	-1.76	0.11	0.00	-1.37	0.19	-0.02

* Applying Bodhaine’s Rayleigh cross-section (Bodhaine et al., 1999) decreases the TOC values obtained from Brewer and Dobson instruments by approximately -2.61 DU and -0.45 DU, respectively (based on Gröbner et al., 2021). This would lead to a deviation of about -0.67% when comparing Brewer and Dobson measurements.