Meteorological signatures of the partial solar eclipse of March 20, 2015, recorded in Jena

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On March 20, 2015 a partial solar eclipse occurred, which was visible in Jena from 09:34:27 until 11:54:26 (CET, computed with the solar eclipse calculator at EclipseWise.com). The maximum eclipse obscuration (fraction of the sun obscured by the moon) was 73.1% occurring at 10:42:58 CET. The eclipse affected not only the incoming solar radiation, but its effects are also seen in the local temperature, relative humidity and possibly also the atmospheric CO_2 concentration. Figure 1 shows the observed diurnal cycle of these parameters (red line) compared to the climatology as recorded at the MPI weather station.

Measurements from the institute weather station are available since the year 2003 with a temporal resolution of 10' (MPI weather station. For the calculation of the climatology, only records from the calendar days March 10 to March 31 were chosen. Furthermore, since March 20, 2015 was a clear weather day, only days with a recorded diurnal temperature range of more than 14°C were selected. Out of the 264 March days in the database, 41 days matched this criterion. The climatology was then obtained by computing the average and standard deviation of the mean of these 41 daily records. The resulting diurnal cycle of temperature and CO_2 concentration were further normalised by subtracting the mean.

The incident shortwave downward radiation shows the expected reduction during the eclipse. The local minimum recorded at 10:50:00 CET of 249 Wm^{-2} compared to the climatology at that time of day of 1035 Wm^{-2} indicates a slightly larger reduction (77%) than computed from the geometrical/astronomical maximum eclipse obscuration (73.1%).

The temperature shows a small dip in the diurnal cycle compared to the climatology. The maximum temperature depression of 3.3 °C compared to the climatology occurs at 11:10:00 CET, slightly later than the minimum of the incident solar shortwave radiation. The temperature depression is mirrored in an increase in the relative humidity of about 10 %.

More speculative is the effect on the local CO_2 concentration (Figure 1, bottom panel). Since the CO_2 sensor at the MPI weather station was only installed in Feb 2008, the computation of the climatology is statistically less robust. Nevertheless, the observations during the time of the eclipse show a slight enhancement of about 10 ppm compared to the climatological diurnal cycle. During this time of the year the morning reduction of the CO_2 is caused by increased vertical mixing of the atmosphere near the ground, which dilutes the night-time accumulation. Since the mixing is driven by the incoming solar radiation, during the solar eclipse it is reduced, inducing slightly higher CO_2 concentrations compared to the climatology.

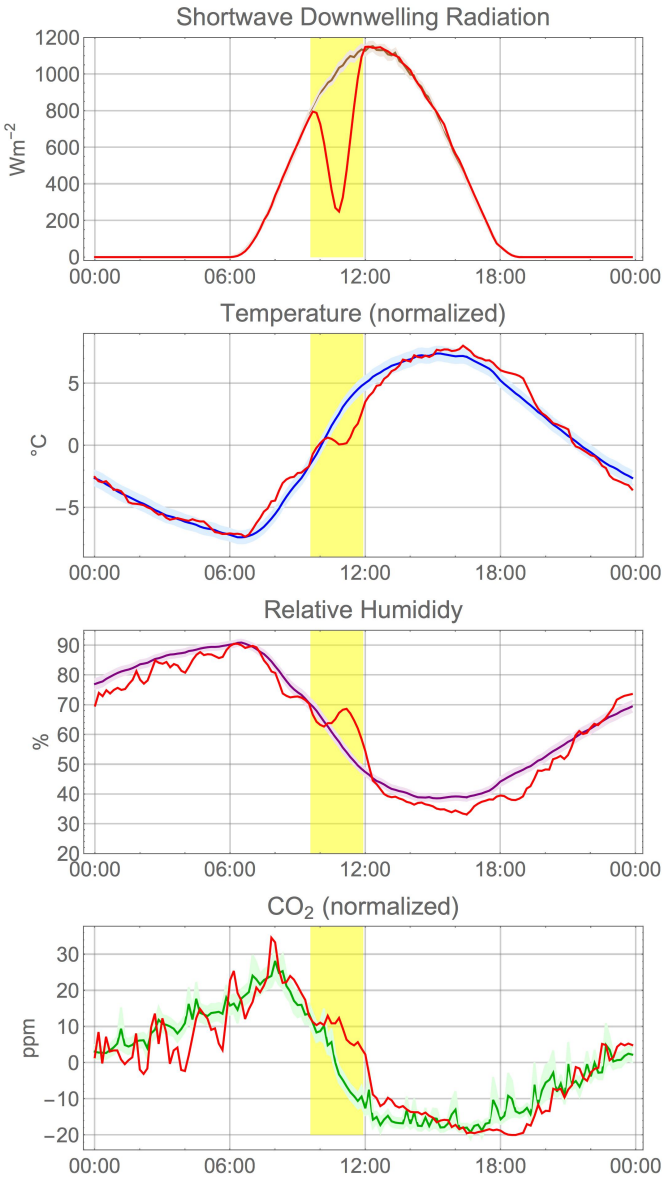

Figure 1: Diurnal cycle of meteorological parameters recorded at the MPI weather station on March 20, 2015 (red line) compared to the climatology computed from the station records over the years 2003-2015 (see text). The yellow band shows the duration of the eclipse as observed in Jena.