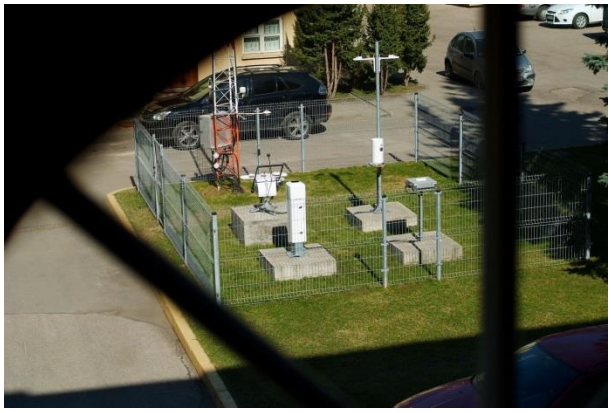
Viktorija Mačiulytė Head of the VU Meteorology station



Radiation analysis during Solar Eclipse of 2015 March 20 in Vilnius

In 2015 March 20th Vilnius had a partial Solar Eclipse. Eclipse began at 10:56 hour, and reached its peak at 12:05 hour; ending at 13:14 hour local time. Calculations showed that the greatest solar disk eclipse in Vilnius was 73 %.

Radiation analysis was made based on data from VU meteorology station (54° 40′ 58.39″ N. lat., 25° 15′ 38.23″ E. long.). It should be noted, that the results of radiation measurements are taken at intervals of 5 minutes, and cloudiness, air temperature, and air moisture – 1 hour intervals. It is important to know, that during the eclipse the ceilometer of meteorology station recorded 0 oct in sky dome cloudiness, while data provided by those who watched the eclipse claim there was a paleness to the sky on the side of the Sun, due to increase of moisture in the middle and upper troposphere. It is assumed that the advection effect of this moisture is of very little relevance, and thus the radiation parameter data can be considered equal to data received on a clear sky day. The appropriate day was chosen to be March 19th.

Instruments for Sun parameter measurements at VU meteorology station: on the left – luminosity duration, middle – net, dispersed, direct, and UV, right – albedo (photo. Laimonas Januška)

On March 20th the levels of net radiation (sum of direct and diffused) were declining until 12:05 hour, and peaked afterwards (**Fig.1**). The highest obscuration of solar disk was reached at 12:05 hour. At the same time net radiation yield was the lowest. Maximal radiation on March 19th was reached at 12:25 hour, a.k.a. noon, when the Sun is at the highest point. Therefore, the peak of the solar disk obscure was reached 23 minutes before the actual noon (March 20th it was at 12:28 hour).

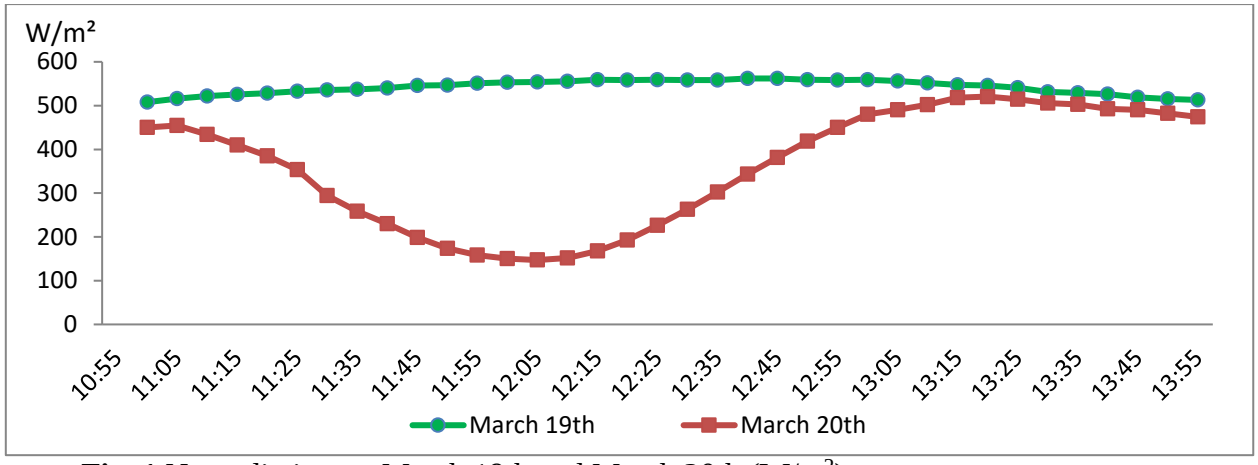


Fig. 1 Net radiation on March 19th and March 20th (W/m^2)

Air temperature graph (**Fig. 2**) of the day before and during the eclipse showed that during the eclipse temperature rise didn‘t stop, and thus negated the theories of temperature drop due to parts of the Sun disk being obscured. Air temperature rise, even if slower than that of March 19th, didn‘t stop due to land surface being heated before the Solar Eclipse. Inert heat transfer to ground air levels took place as Sun disk obscuration grew.

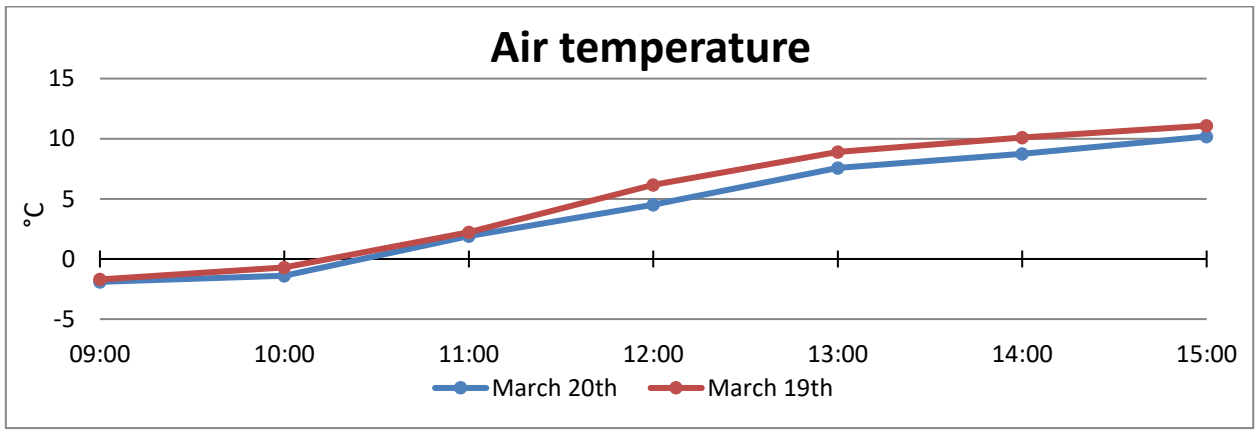


Fig. 2 March 20th and March 19th temperatures (°C)

Percentage of solar obscuration effects was evaluated during the analysis and is presented at fig. 4, which shows the difference in percentage: how much lower were radiation parameters (shown as negative value in graph) on March 20th, or greater (shown as positive value) on March 19th. On March 20th the diffused radiation amount was approximately 40% greater both before and after the eclipse. One of the reasons for this could be increased air moisture in the middle and upper atmosphere, which then as a result increases the radiation diffusion, even though Marth 20th presented opposite circumstance: air moisture was lower than that on March 19th (**Fig. 3**).

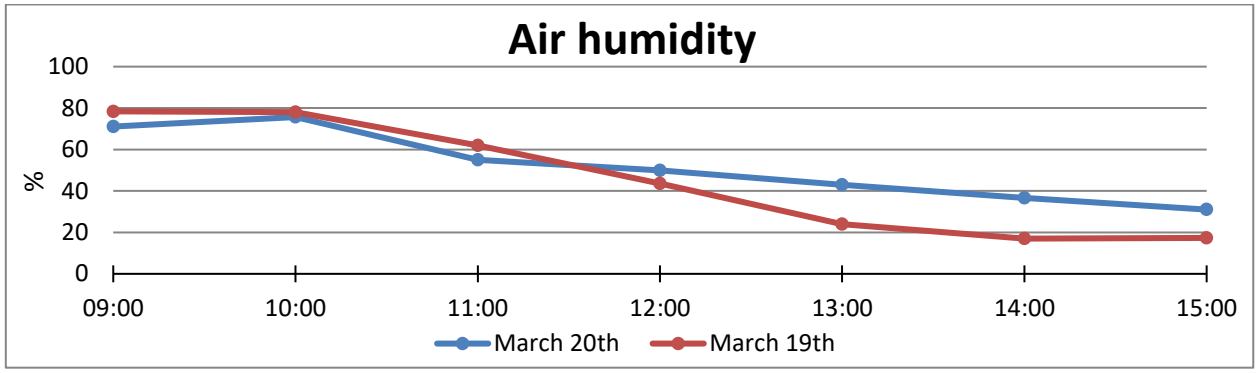


Fig. 3 Relative humidity on March 20th and March 19th

Despite the fact that diffused radiation levels were higher before and after the eclipse, the minimum was still more than 68% lower than that on March 19th, and the total of eclipse impact on diffused radiation is minus 108%. Similarly, net radiation, normally 5-7% lower, dropped more than 73% during the peak of solar eclipse.

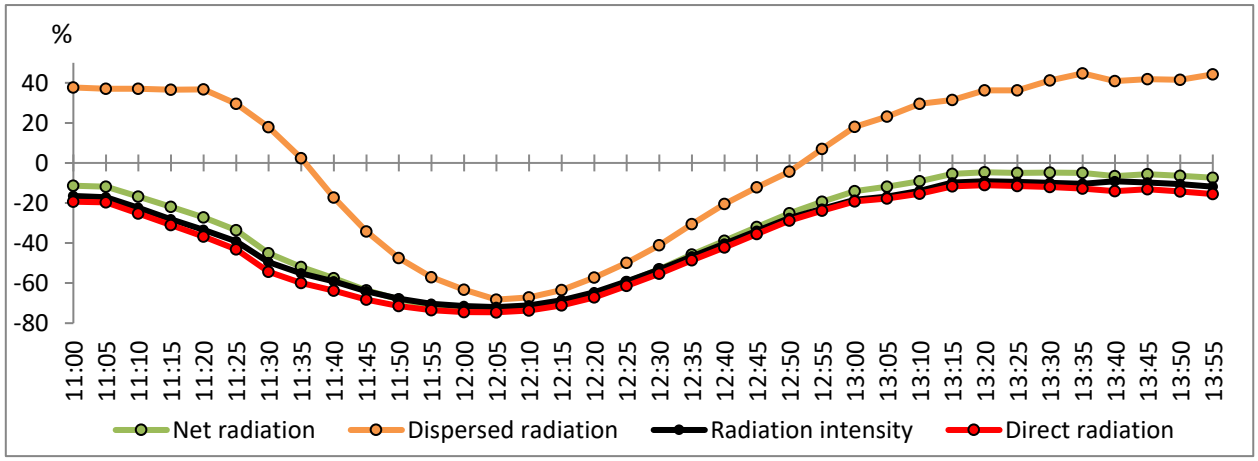


Fig. 4 March 20th radiation deviation from March 19th

Fig. 5 was formed to show the theoretical March 20th radiation mode if there was no eclipse present, taking the given data on radiation levels before and after the eclipse in compare to March 19th. Theoretical net radiation on March 20th was 5-7% lower than factual on March 19th.

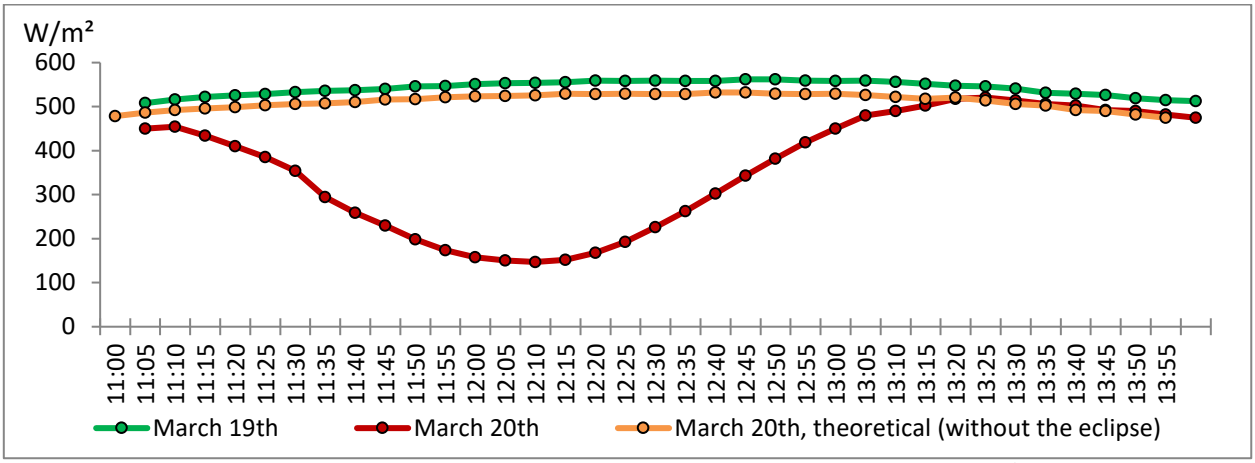


Fig. 5 Net radiation data on March 19th and 20th (W/m^2)

Theoretical March 20th and factual March 19th curve deviation is present due to higher amount of moisture in the upper atmosphere layers on March 20th. Therefore, while conducting analysis, it is appropriate to use the data received as deviation off of the radiation level curve noted on March 20th, that would have been present if eclipse hadn‘t occurred, rather than factual numbers received during both days. Doing so takes into account the actual atmospheric transparency on March 20th, which was lesser than that on March 19th due to moisture advection in the middle and upper troposphere.

Due to solar eclipse radiation decreased the most at 12:05 hour, during the maximal obscuring: net radiation was weaker than 67 %, diffused – 62 %, luminosity intensity - 66 %, and direct radiation decreased almost by 69 %. It should be remembered that at the peak of the eclipse 73% of the solar disk was obscured.

Thus it can be concluded, that the obscuring of solar disk caused proportional, lesser parameter changes in percentage. This mismatch of 4-10% is apparently there due to light wave diffraction and refraction in the atmosphere. Because of these events part of the radiation reaches the Earth even if the solar disk is obscured.

According to NASA calculations, the next similar scale Sun eclipse in Vilnius will be visible on 2026 August 12th.