AIR QUALITY IN SPECIAL ENVIRONMENTS
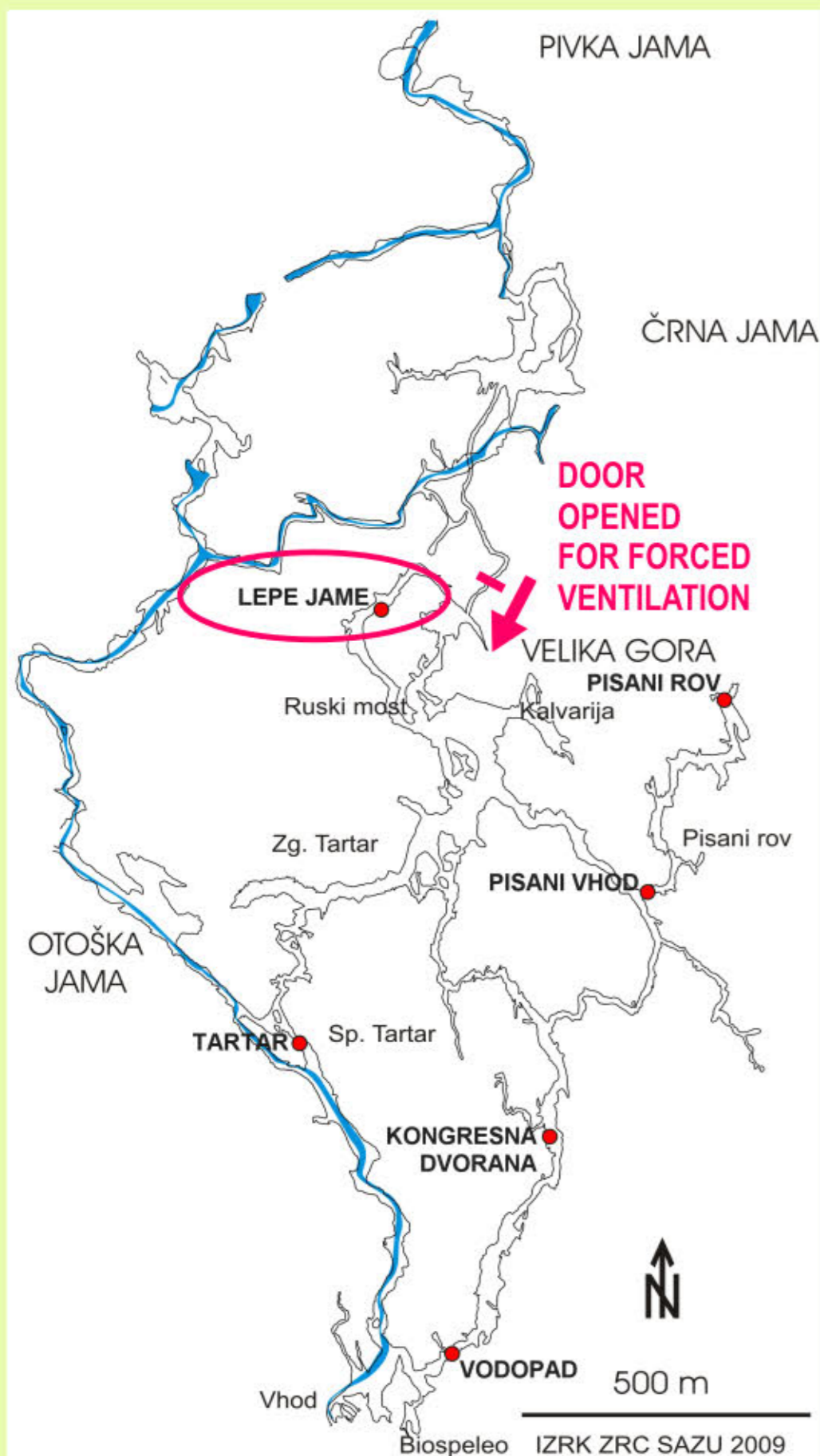# CO2 IN A TOURIST KARST CAVE WITH A MILLION VISITORS
POSTOJNA KARST CAVE

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The quality of air in the outer atmosphere is subject to the European Directive for a number of pollutants. Furthermore, the air parameters are under supervision in the indoor working areas. However, there are also environments which are neither one nor the other, but still host numerous visitors.

Our article will shed some light on the issue of air quality in a karst cave visited by huge numbers of tourists.

Karst caves are one of the karst phenomena. Due to their awe-inspiring beauty they are extremely interesting for tourists. In Slovenia, the country of original karst, there are numerous and extremely large caves. The Škocjan Caves are entered in the UNESCO list of world heritage, and Postojna Cave is our extremely large (14-kilometre long) and the most frequently visited cave; we could say it is almost besieged. Tourists are transported in the heart of the cave by a special train, and afterwards a footpath is maintained through the halls and passages. There are meteorological stations set up along the entire trail and in the control side tunnels, which measure the natural conditions and possible physical impacts of tourism on the cave, and they also measure the concentrations of CO_2.

The huge number of tourists in partially ventilated underground halls causes a noticable increase in the CO_2 level due to the exhaled air.

We present an analysis of CO_2 concentrations along the footpath and in other areas. The analysis shows how large the differences are between the days with large numbers of visitors and after the season. We present the connection with the external atmosphere – natural and forced ventilation.

We wish to transfer the experience from measurements, modelling and the control of air quality in the external atmosphere to special environments, such as large karst caves visited by huge numbers of tourists and any other environments which have not received any attention so far, but are important from the point of view of extensive tourism.
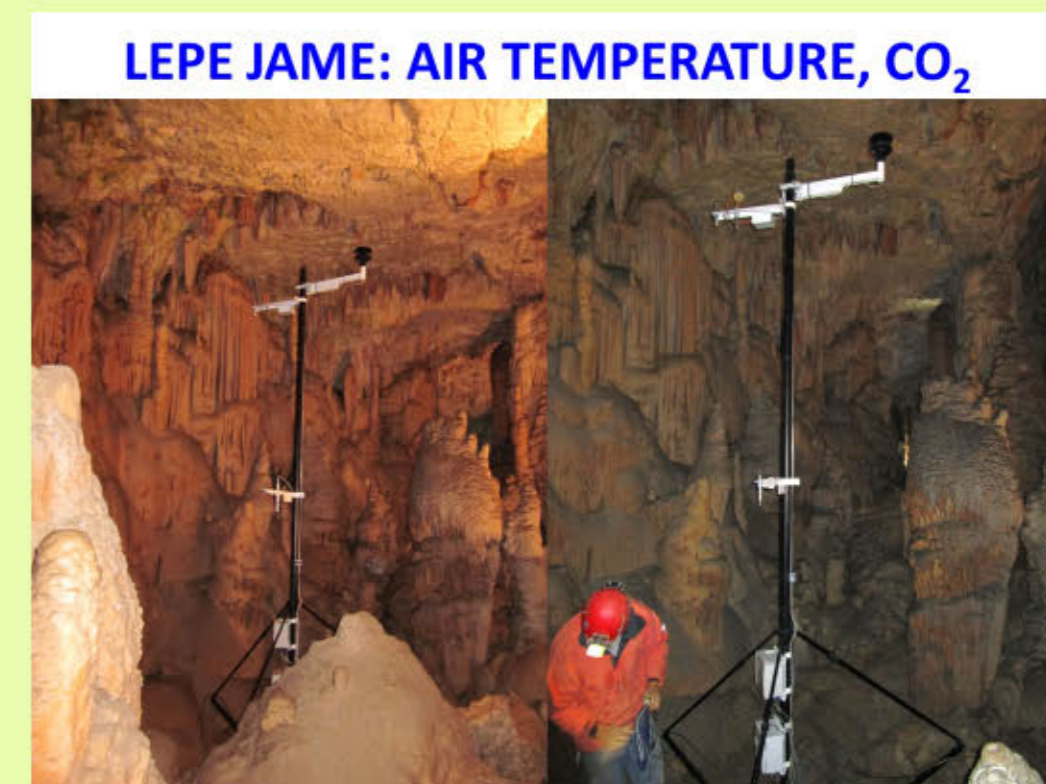
LEPE JAME: AIR TEMPERATURE, CO2
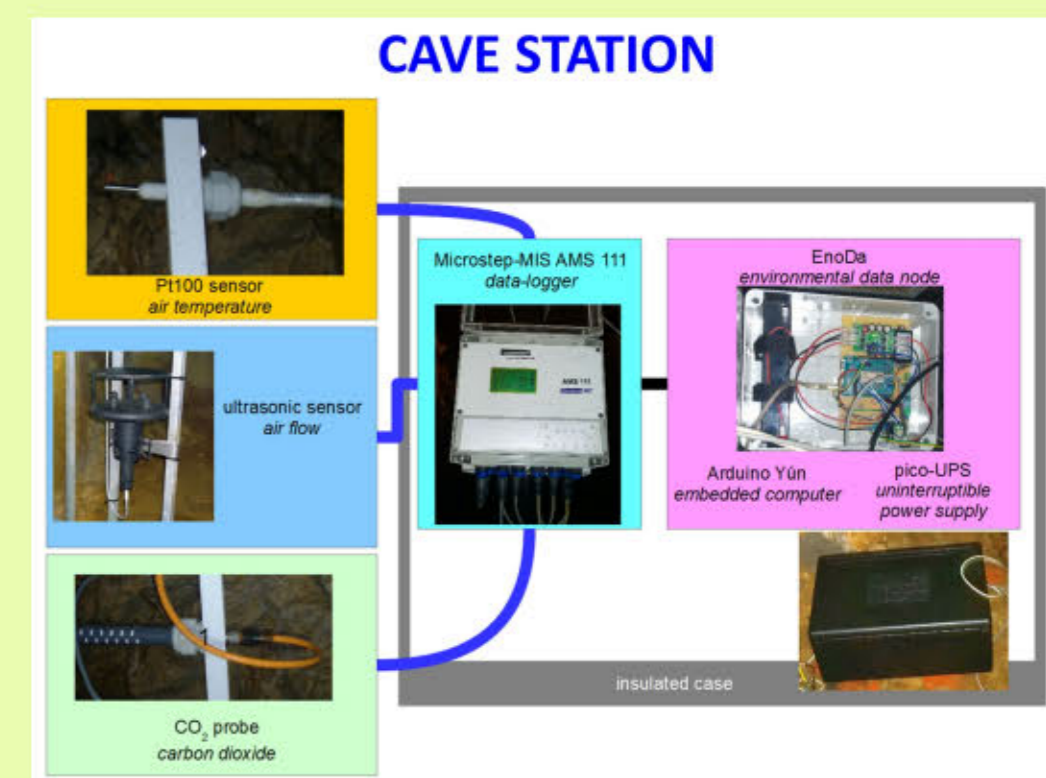
CAVE STATION

The sunflowers (Božnar, 2015) of CO_2 clearly show that start of forced ventilation significantly change the pattern of high CO_2 concentrations occurrence in the midday-afternoon period.
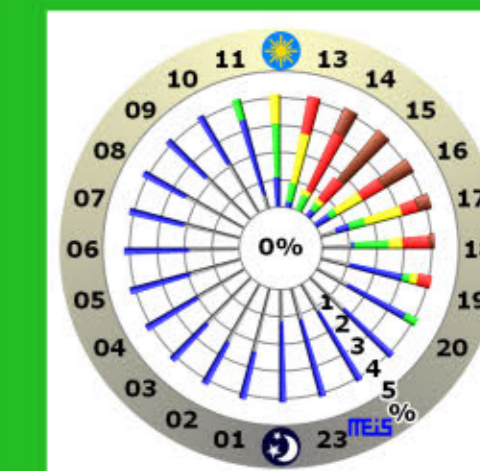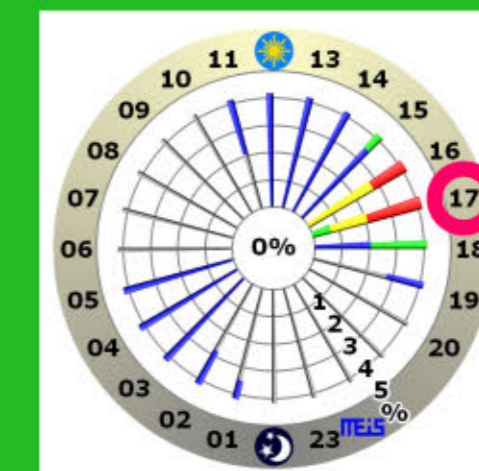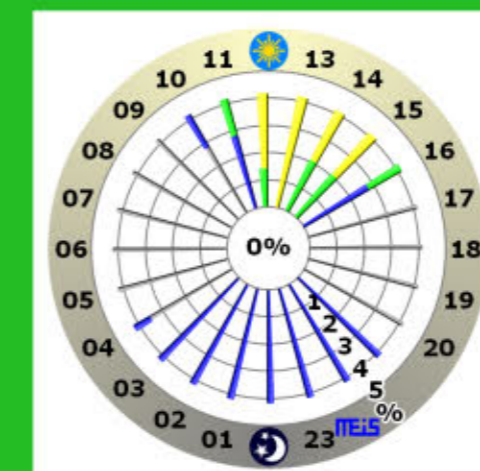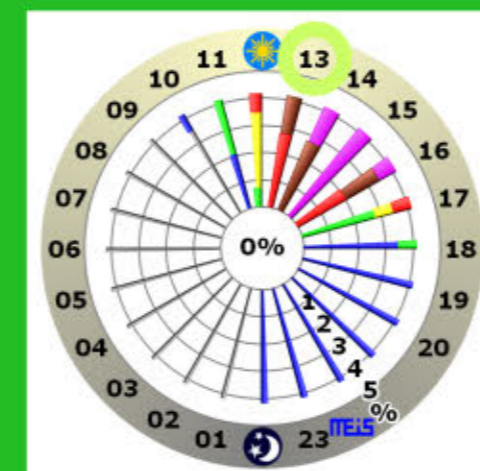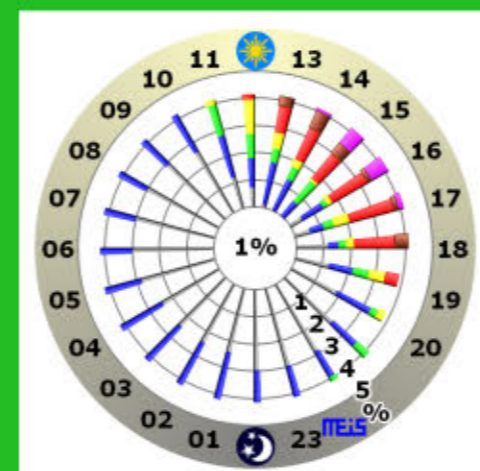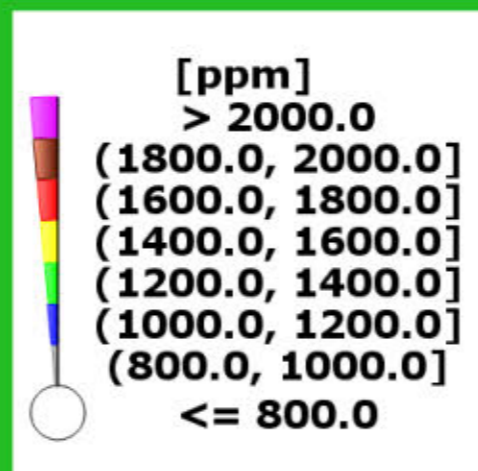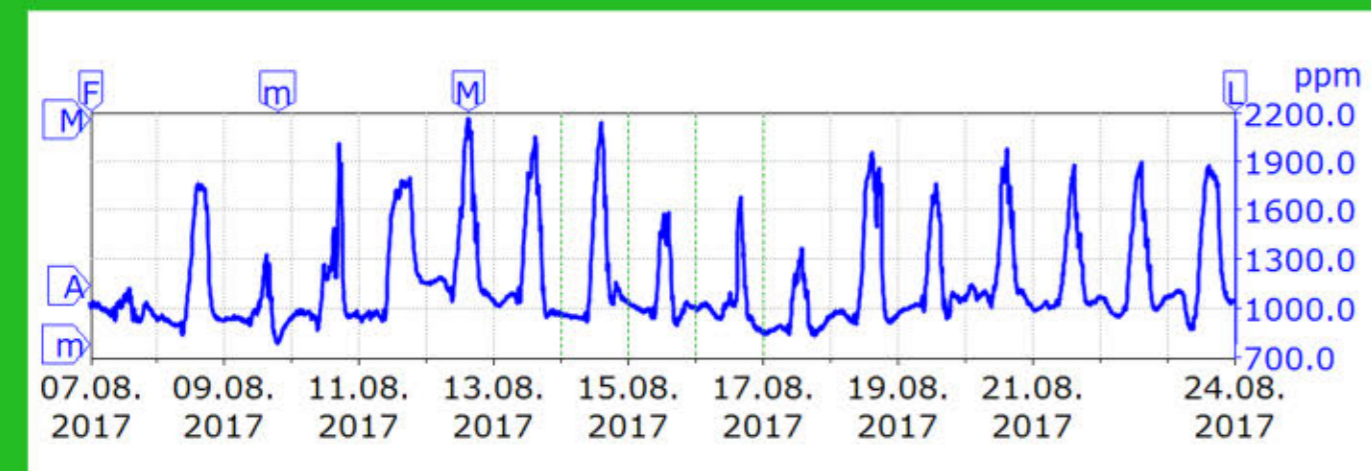First and last sunflower of CO_2 show one week statistics of CO_2 in August. Three sunflowers in the middle show significantly different pattern (decreased concentrations) of CO_2 during forced ventilation.
Other meteorological variables sunflowers show additional information for description of the events.

References
Božnar, M.Z., Grašič, B., Mlakar, P., Soares, J.R., de Oliveira, A.P. and Costa, T.S. (2015) 'Radial frequency diagram (sunflower) for the analysis of diurnal cycle parameters: solar energy application', Applied Energy, Vol. 154, pp.592–602, DOI: 10.1016/j.apenergy.2015.05.055.
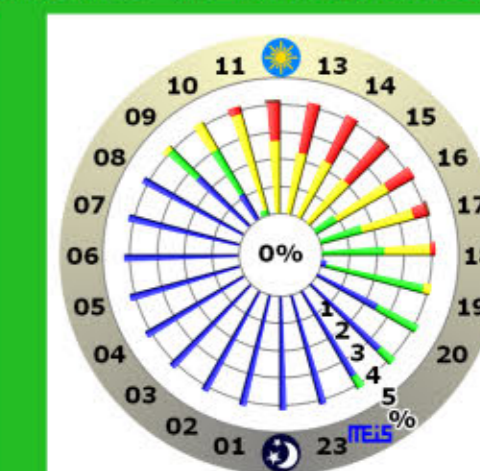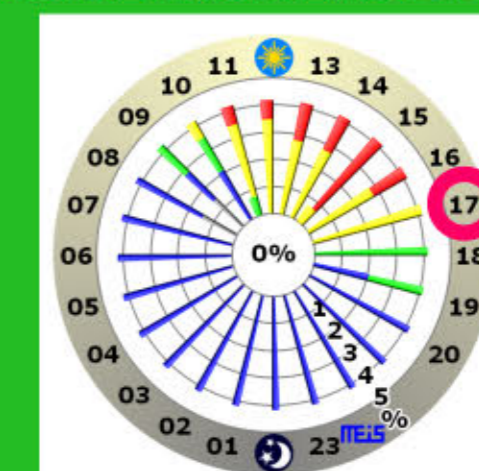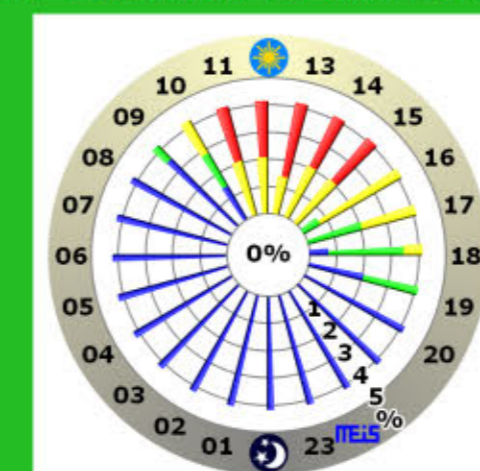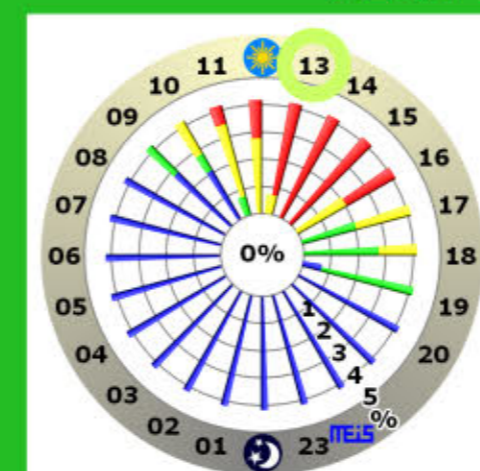
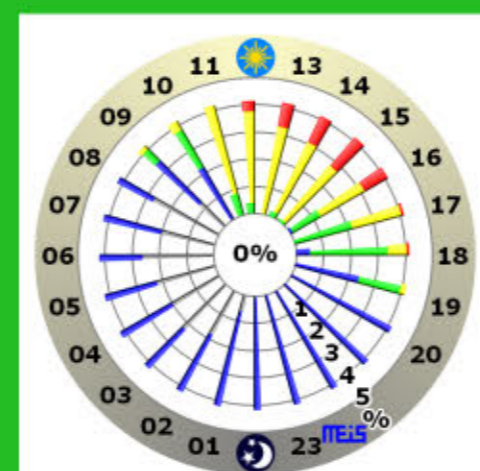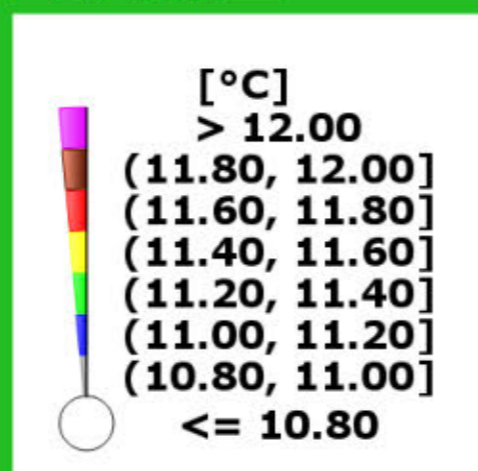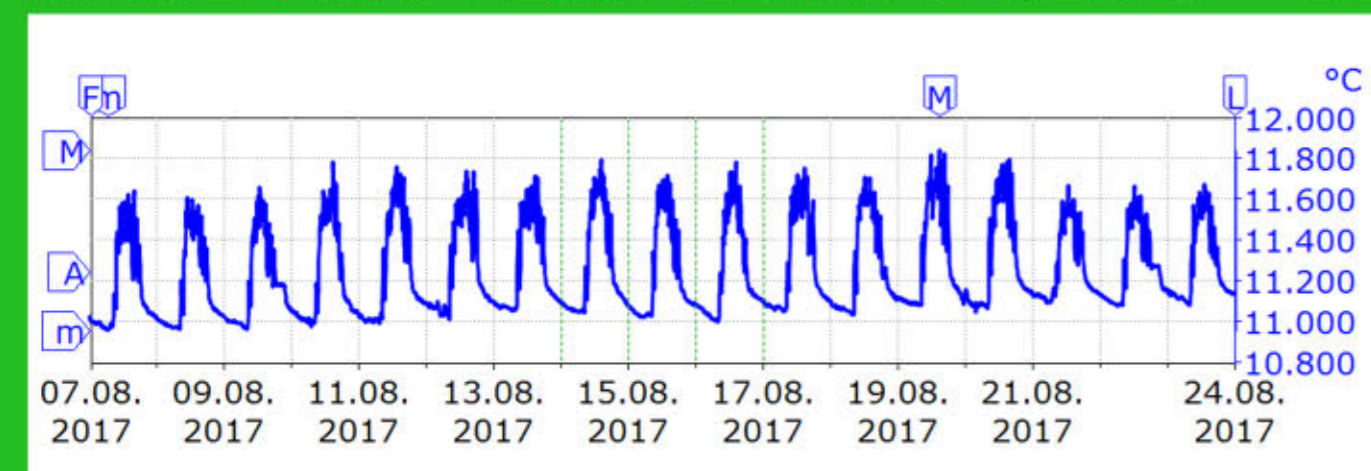|	TIME PERIOD	07.08.2017 00:10 14.08.2017 00:00	14.08.2017 00:10 15.08.2017 00:00	15.08.2017 00:10 16.08.2017 00:00	16.08.2016 00:10 17.08.2017 00:00	17.08.2017 00:10 24.08.2017 00:00
LEGEND OF VARIABLE		**start of forced ventilation** week before	**EXPERIMENT WITH FORCED VENTILATION OF CAVE TOURIST HALLS FOR CO2 DECREASE** three consecutive days in August 2017			**end of forced ventilation** week after

CO2 AT "LEPE JAME" ON TOURIST PATH
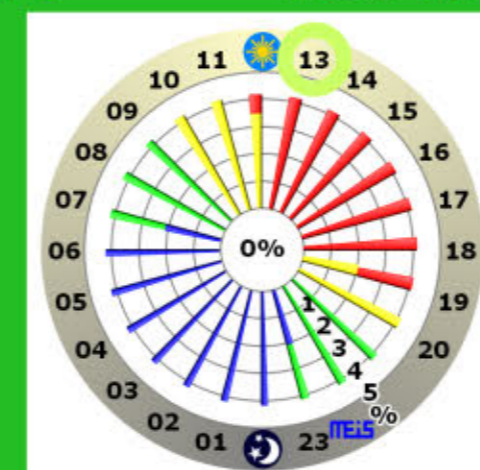SIGNIFICANT DECREASE OF CONCENTRATION DURING VENTILATION

[ppm]
> 2000.0
(1800.0, 2000.0]
(1600.0, 1800.0]
(1400.0, 1600.0]
(1200.0, 1400.0]
(1000.0, 1200.0]
(800.0, 1000.0]
<= 800.0

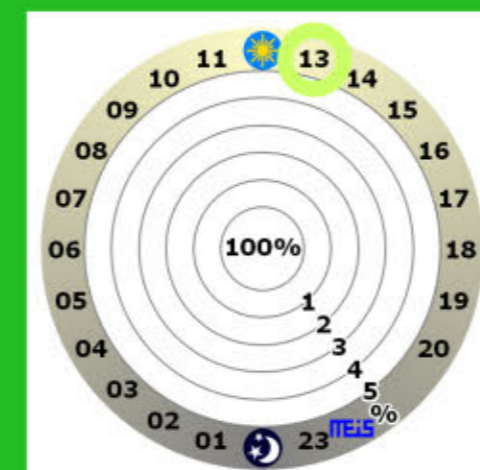## CAVE AIR TEMPERATURE AT "LEPE JAME"
VERY SMALL AIR TEMPERATURE INCREASE DURING VENTILATION

[°C]
> 12.00
(11.80, 12.00]
(11.60, 11.80]
(11.40, 11.60]
(11.20, 11.40]
(11.00, 11.20]
(10.80, 11.00]
<= 10.80

AIR TEMPERATURE OUTSIDE AT METEO STATION POSTOJNA
HOT AFTERNOONS, DECREASE OF AIR TEMPERATURE AFTER RAIN
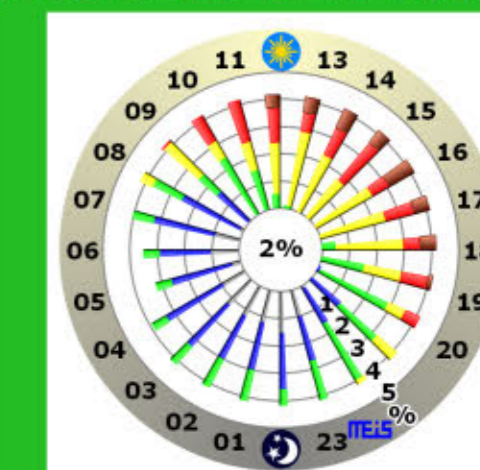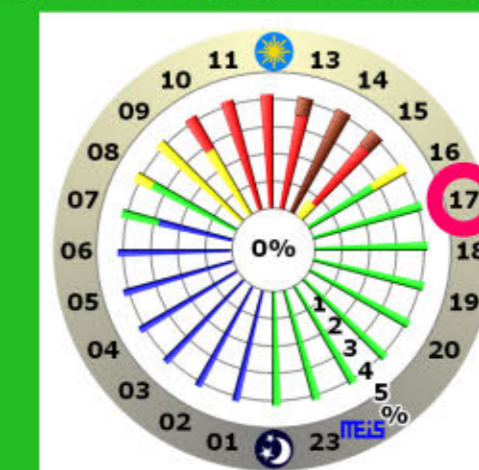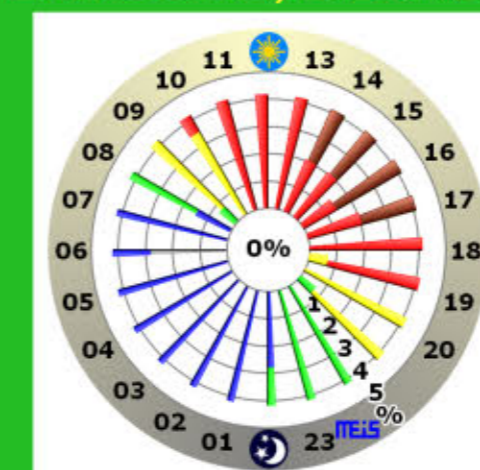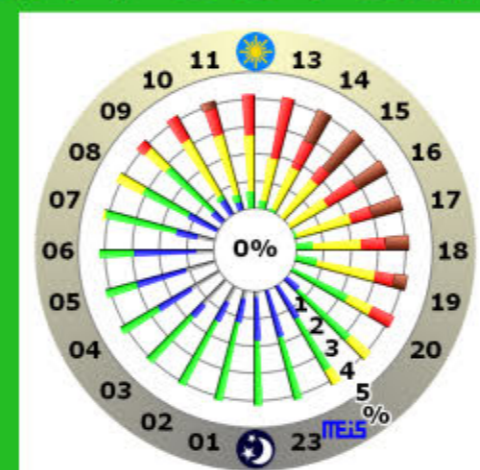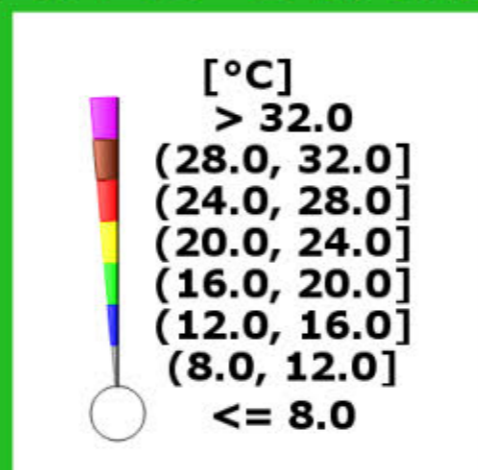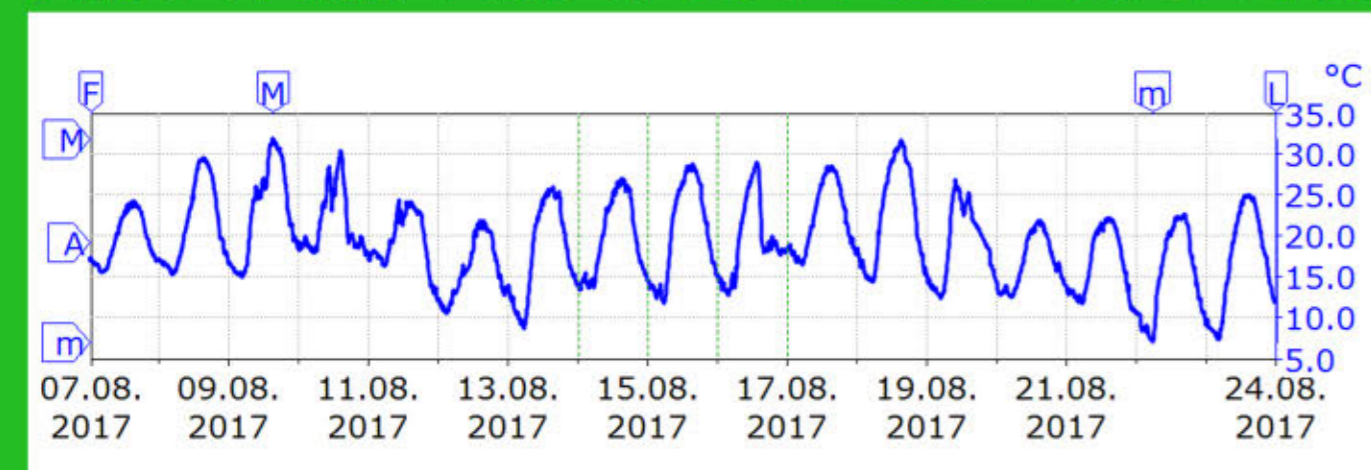
[°C]
> 32.0
(28.0, 32.0]
(24.0, 28.0]
(20.0, 24.0]
(16.0, 20.0]
(12.0, 16.0]
(8.0, 12.0]
<= 8.0

PRECIPITATION AT METEO STATION POSTOJNA
RAIN AND COLDER AFTERNOONS ON 16.08.2017
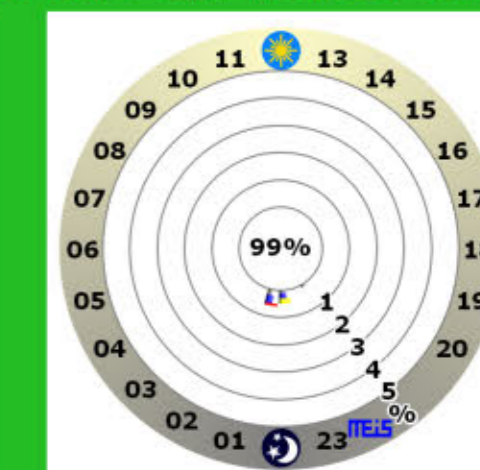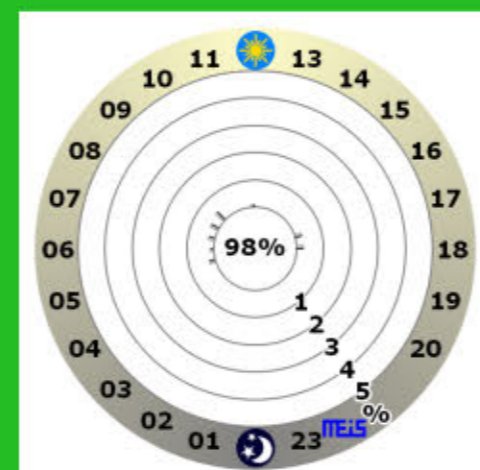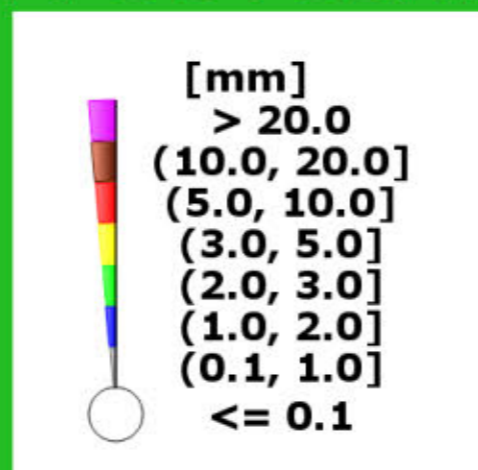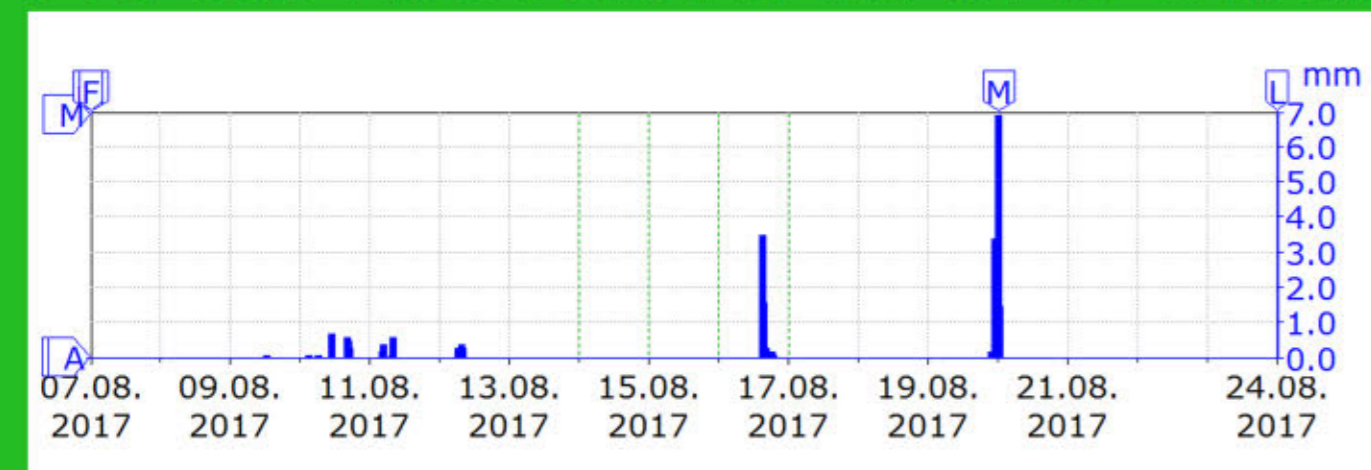
[mm]
> 20.0
(10.0, 20.0]
(5.0, 10.0]
(3.0, 5.0]
(2.0, 3.0]
(1.0, 2.0]
(0.1, 1.0]
<= 0.1