

Anthropogenic effect on the underground environment

Lycée International de Valbonne (France)

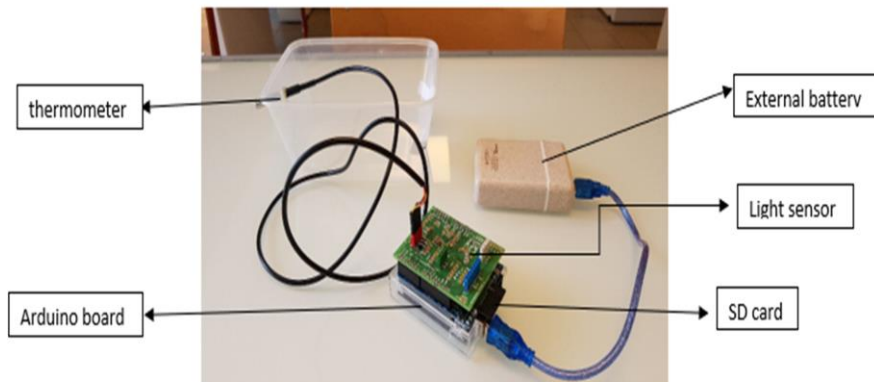
Class 2nd7 2022-2023

Problem

- Scientific research confirms an increase of internal temperature in numerous caves worldwide
- Many scientific papers show that an increase in a cave's temperature negatively affects its ecosystem
- It is certain that global warming is also warming the temperature inside caves
- *However, does the excess of human visitors also have an impact on the underground environment?*

Are regular human visitors impacting the variations of temperature in Baume Obscure?

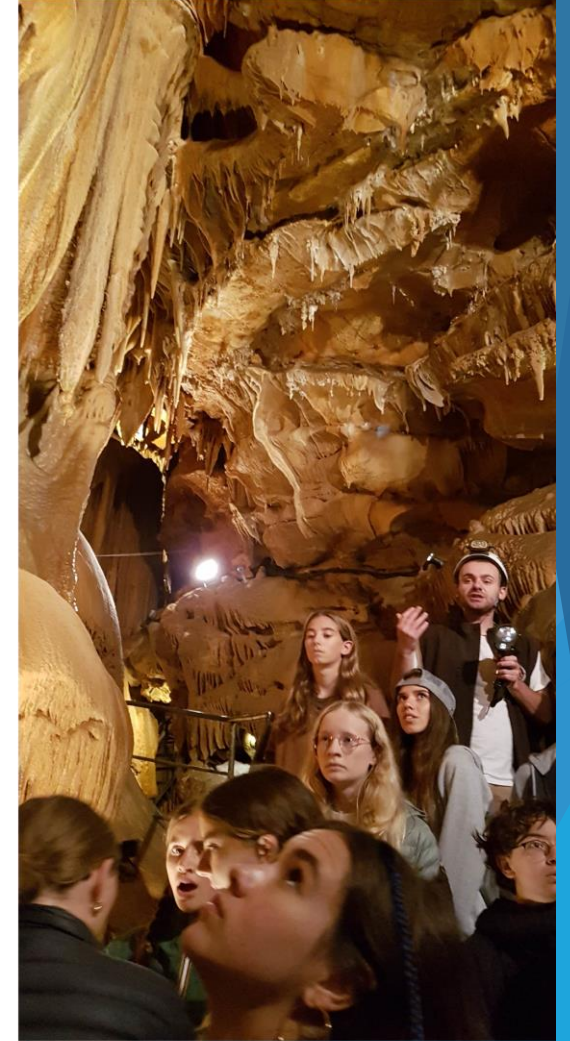
- Our cave of study, Baume Obscure:
 - is situated at an average altitude of around 700 m
 - is in a karstic environment, close to Saint Vallier de Thieu
 - contains tunnels and rooms equipped with stairs and footbridges for easy access
- Our study used 2 boxes:
 - each box contained one temperature sensor and one luminosity sensor
 - one box was placed inside the cave, the other was placed outside the cave
 - data was being taken every 10 seconds
- Baume Obscure has motion-detection lighting to guide visitors through the cave:
 - increases in internal cave luminosity indicate the presence of visitors



TEMPERATURE AND LUMINOSITY SENSOR



The sensors positioned in the Baume Obscure cave



Visit to the Baume Obscure Cave with the 2nd7 class

Average data summary

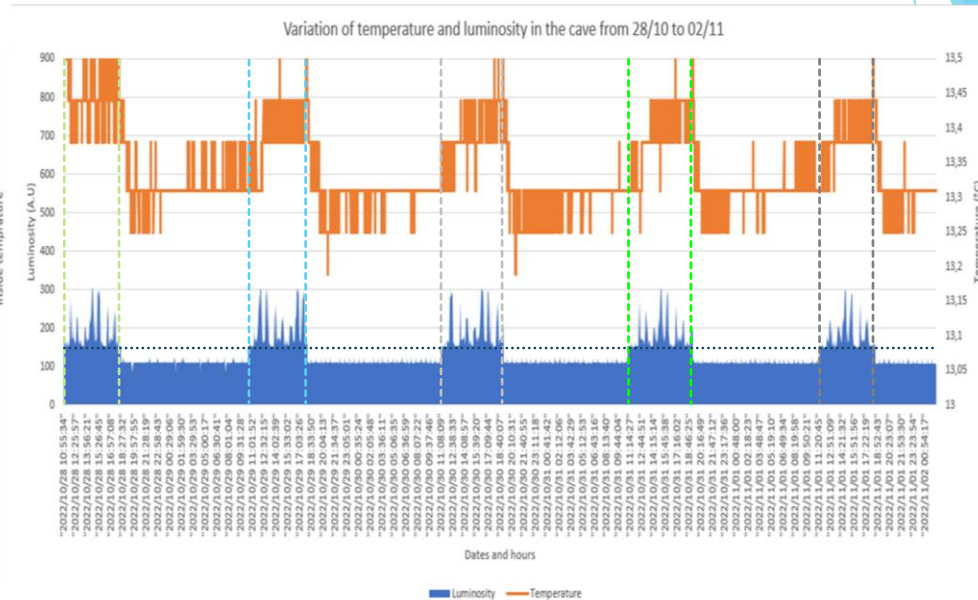
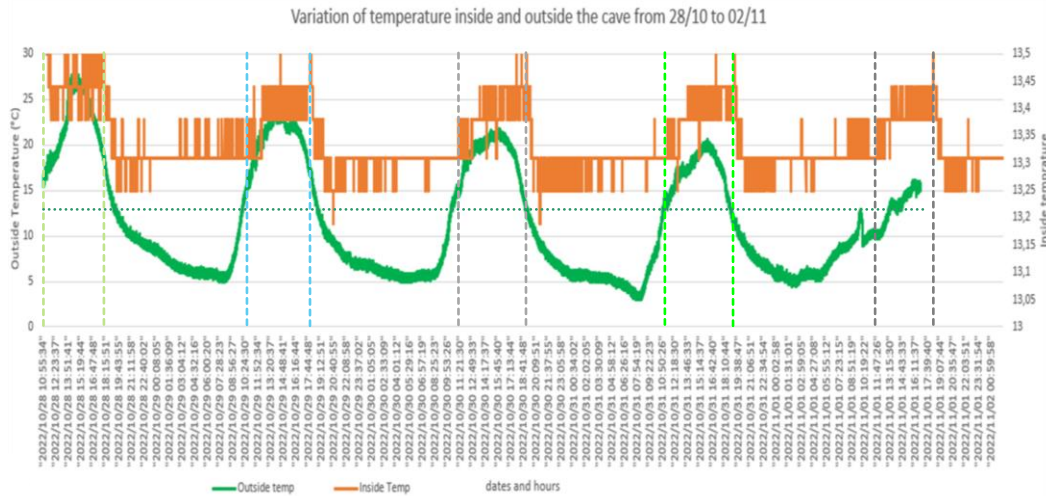
Dates	Number of visitors	Average temperature inside the cave from 10h to 17h	Average temperature outside the cave from 10h to 17h	Average temperature inside the cave from 17h to 0h00	Average temperature outside the cave from 17h to 0h00	Day/night inside average temperature differential	Day/night exterior average temperature differential	Difference between exterior and interior temperature during the day
28/10/2022	231	13,44	22,45	13,34	12,67	0,10	9,78	9,01
29/10/2022	362	13,38	20,60	13,30	9,74	0,08	10,86	7,22
30/10/2022	551	13,36	18,67	13,31	9,73	0,05	8,94	5,31
31/10/2022	593	13,36	16,52	13,33	9,25	0,03	7,27	3,16
01/11/2022	487	13,36	12,59	13,31	6,66	0,05	5,93	-0,77

Cave Entry:
10h-17h

Takes
30-45 mins to
reach chamber
with sensor

- The average temperature inside the cave is almost constant
- Small changes are seen inside the cave between day and night
- Highest temperature interior cave is seen on 28/10
 - hottest exterior temperature and least number of visitors
- Average data shows link between exterior and interior temperatures

Understanding interior temperature (from 28/10 to 02/11)



Cave Entry:
10h-17h

Takes
30-45 mins to
reach chamber
with sensor

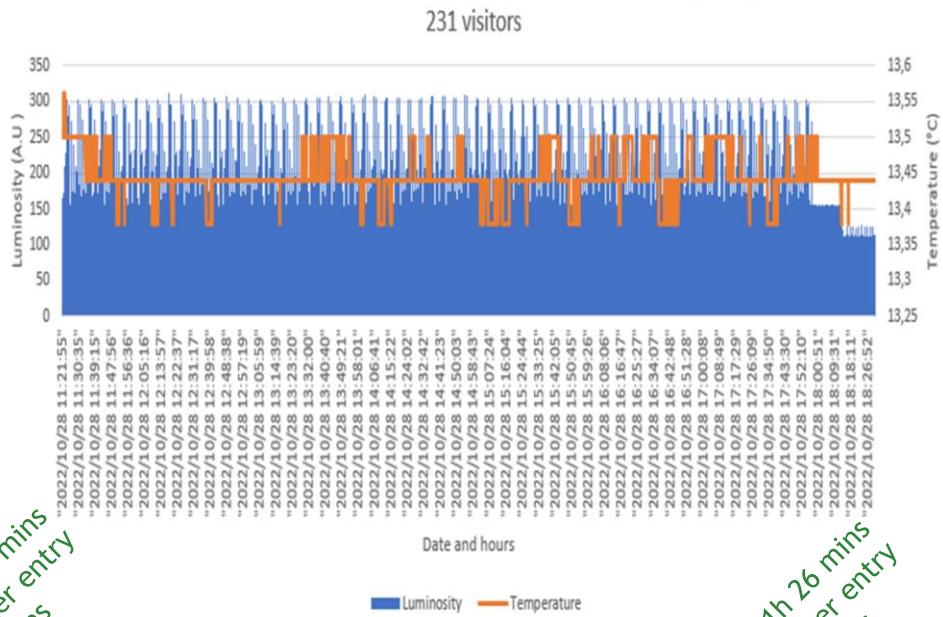
- Both interior and exterior temperatures increase during the day and decrease during the night
- Also:
 - Ext. temp peaks occur from 13h52 to 16h02
 - Ext. temp=int. temp occur at different times
 - However, the daily interior temperature *decrease* appears to occur just after closing time *every day*
 - This suggests that the exterior temperature is not the only factor that influences cave temp at the end of the day

Does interior temperature correlate to visitors (increased interior luminosity)?

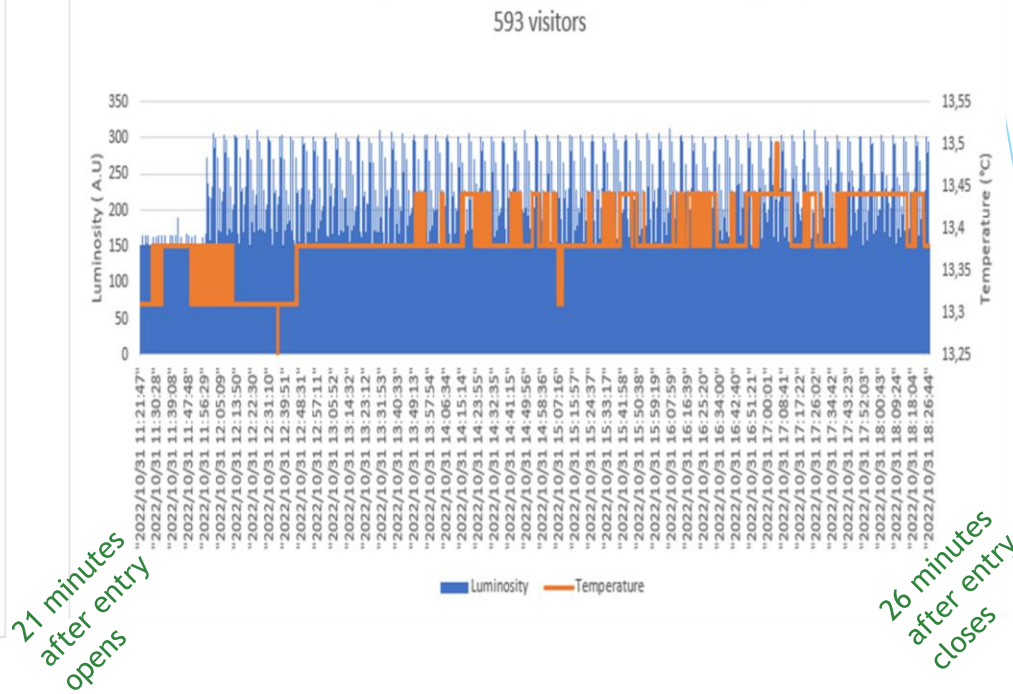
- Both temperature and luminosity in the cave increase simultaneously
- Small variations of temperature occur during the night (sensor accuracy and/or air flows)

Interior cave data (28/10 and 31/10)

Variation of temperature and luminosity in the cave for the day of 28/10



Variation of temperature and luminosity in the cave for the day of 31/10



Cave Entry:
10h-17h

Takes
30-45 mins to
reach chamber
with sensor

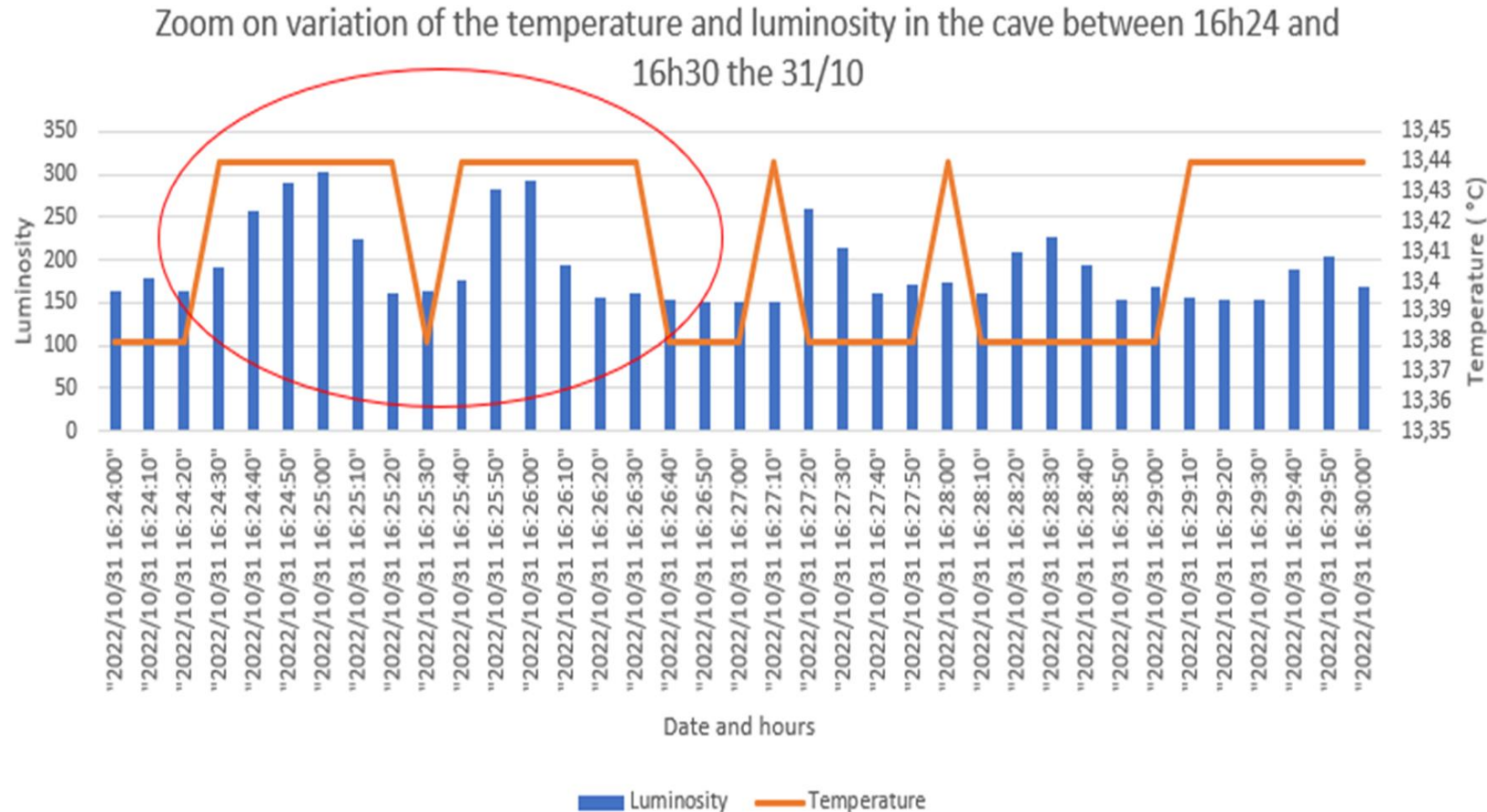
➤ On the 28/10:

- there were 231 visitors
- temperature spikes continue until just *after* luminosity spikes
- temperature spikes seen *after* visitors leave and while permanent lights are on

➤ On the 31/10:

- there were 593 visitors
- temperature spikes start
- the peak luminosity is identical, despite a greater number of visitors

Data (afternoon of the 31/10, from 4:24 PM to 4:30 PM)



- Some peaks in temperatures (highlighted on graph) are correlated with increases in luminosity, due to the presence of visitors
 - these small increases of temperature do not correspond to variations of outside temperature
- Understanding variations:
 - one sensor location (direct and reflected light can be blocked)
 - visitors move (causing air currents), use light-emitting block light
 - air flow (due to movement of a group) can change temperature
 - suggested by small temperature data variations recorded at night

Conclusion

- The *average* measurements do not prove a link between the presence of visitors and an increase in temperature inside the cave
 - The effect of the outside temperature is dominant
- However, there appears to be a lag between luminosity spikes and temperature spikes in instantaneous data
- Furthermore, the data, on a fine scale, *does* imply a link between the presence of visitors and slight temperature increases inside the cave
- Indisputably, the presence of humans increases the light levels in the cave
- Scientific research has shown that:
 - in the Pech Merle cave (Occitanie, France), for example, the ambient temperature has increased by 0.3°C due to the number of visitors
- Despite the cave temperature being approximately constant all year long, it is still dependent on the outside temperature
 - An increase in outside temperature (due to global warming) will produce an increase in temperature in the cave
- A temperature rise (from any source) poses a threat to the whole cave ecosystem