The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2022-67

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Referee comment on "Multi-annual temperature evolution and implications for cave ice development in a sag-type ice cave in the Austrian Alps" by Maria Wind et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-67-RC2, 2022

7-8: this sentence is quite uninformative

11:

26: "trap" would suffice

39-40: it is not clear how this sentence is linked to the case study. "Comprehensive" analysis for several caves or for this one only? It could be safely left out.

41: perhaps "ice level dynamics" (or similar) instead of "stake" records?

61: the diameters of the entrance shafts could be an important information for air circulation, please add them if available

76: please give the distance between the air measurement point and the nearest ice body. It is helpful to interpret air temperature variability and role of latent heat in shaping it.

96: what is the altitude of the precipitation sampling site?

104: does this shoveled snow reaches areas where air temperature ad/or ice dynamics are

monitored?

105: somewhat strange, perhaps the climate is manipulated, not the entire cave?

122: how does this filtering influences the long-term averages calculated below?

131: this could be very useful for any subsequent studies. However, while deriving potential temperature from pressure data is quite straightforward in the free atmosphere, it might prove problematic in cave settings due to potential biases induced by pressure changes linked to movement of air inside cave passages. Did you consider these, and also potential differences between summer and winter?

147: normalized?

161-162: the warming trend is quite interesting, and puzzling, all the same. While it is tempting to see it as a sign of a warming climate, the fact that the logger located in the non-glaciated part of the cave does not register it (nor the external one) makes one wonder if the trend is related perhaps to changing distance from ice. melting of ice would necessarily act as a heat sink, thus keeping the temperature of air in the nearby atmosphere at 0 °C as long as ice is present. Any additional hat added to the air (by, e.g., warming outside) would be used to melt additional ice and thus removing any increase. So, how far from the ice are the loggers showing the warming trend placed? Did this distance increase? Did you detect any breakpoint in the time series linked to, e.g., drop in ice level?

179: how was this threshold chosen?

189-192 (and lines above): I find the discussion on the net external cooling required to induce a net cave cooling interesting and stimulating. Especially intriguing are the values of the net differences between outside and inside which are quite high (8.5 °C!). Perhaps daily means are masking the real difference, as minima tend to occur at different times in and out of the cave? Did you try a cross-correlation analysis that would indicate the time lag between external and internal variations and thus help sustain these very large differences? Perrier et al. (2005) for instances found very short times for cold air ”avalanches„ reaching lower parts of caves

202-203: this is an important observation, yet difficult to reconciliate with physics. Basically, the ms says that weak cooling in winter somehow results in warmer summers. Now, in any system where a heat sink is present (melting ice, in this case), temperature will be controlled by latent heat. Further, the rock surrounding the cave has an oversized

fingerprint on the overall thermal balance of the cave air+cave ice system. In the absence of the meting ice, one could imagine that weaker cooling in winter leads to warmer summer air temperatures, but the melting of ice would obliterate any such influence. Basically, you should provide a mechanistic explanation for the processes that lead from weak winter cooling to warmer summers – this would be a major point for future similar studies.

Chapter 3.3. This is a long chapter with very detailed discussion of the data that seems to result in a loss of focus. Perhaps the data description should be shortened and the discussion focus on the interaction between cold air intrusion, distance of air measurements points from ice and the role of internal air circulation. These are all linked and the presence of ice acts as a strong modifier of air circulation/temperature. This could/should perhaps merged with the subsequent chapter 3.4 (which I will not discuss further down).

Chapter 3.5. The discussion of rock/ice temperatures could be used to support/reject the inferences made on lines 202-203 (see above).

Chapter 3.6. I miss a discussion of the links between PDD outside the cave and ice dynamics – this would help understand the role of external air temperature variations on ice dynamics – see also the opening line of the discussions (L343)

312 – well, this lack of correlation is somehow normal. Dripping water, direct snowfall and snow shoveling by cave managers result in a complex and possibly impossible to understand link between snow accumulation and precipitation amount.

315-319: I am not sure a model that excludes outside temperature would help understand the ice dynamics, this should be included.

335 – this density refers to ice at maximum density. Is this the case here? I would expect lower density, based on how ice forms.

338 – these are extremely high values. What are the errors associated to the measurements?

344-346 – this is extremely interesting, but perhaps it should be moved after the discussion of the data.

351-358 – this section somehow does not fit well in here, especially given the strong opening statement of the section (344-346)

372 and subsequent: again, apart from correlation, which can be the result of artifacts in statistical analyses, an explanation is required. Basically here, the results are presented again but no discussion follows.

412-415: again, see my comments above. Melting in summer has to be the result of warm temperatures and/or the sum of low winter accumulation and (high) summer melting, rather than warm winters only. Also, the unquantified snow shoveling must play an (oversized) role.

General observation for the "discussions" section: this study can be broken down on a climate analysis and links between ice dynamics and climate. The first part is nicely done, however, the links with ice dynamics are somehow weakly supported by the observations and hampered by the anthropic influence. I suggest reducing the entire discussion to the discussion of 1) cave climate and 2) links with ice, but with the later stating from the beginning the fact that snow shoveling inside the cave strongly masks the natural processes.

Perrier, F., Le Mouel, J.L., Kossobokov, V., Crouzeix, C., Morat, P. & P. Richon, 2005: Properties of turbulent air avalanches in a vertical pit.- European Physical Journal B, 46, 4, 563–579.