Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-107-RC2, 2020
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Interactive comment on "Cryogenic cave carbonates in the Dolomites (Northern Italy): insights into Younger Dryas cooling and seasonal precipitation" *by* Gabriella Koltai et al.

Anonymous Referee #2

Received and published: 25 October 2020

Koltai et al. use a combination of cave air temperature modeling and U/Th dating of cryogenic cave carbonates (CCC) to discuss climate variability during the YD in the SE Alps (Dolomites). The topic is becoming a hotly debated one, as more and more studies suggest that climate during the YD was spatially, temporally and seasonally different throughout Europe and the author's paper comes to add more information to this debate. While bot the title and discussion are tantalizing, I fond that the authors overstretch themselves in analyzing to many climate variables over a long period of time based on a limited data set (several U/Th dates) buttressed by modeling. Several points should be made clear before publication of the paper. I detail these in a few general and technical comments below.

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Several papers discussed climatic inferences based on the U/Th age of CCCs and a wide range growth periods have been found leading to several possible climatic conditions leading to the precipitation of CCC (Zak et al., 2004, 2009, 2012, Luetscher et al., 2013, Spoetl and Cheng, 2014 – quite a few of these are missing from the cited literature section. . .). These authors have found CCS growing during warm and cold, dry and wet periods during MIS6, MIS4, MIS3, MIS 2, mid-to-late Holocene (Roman and Medieval Warm Periods). From these studies, it occurs that a wide range of external climatic conditions are possibly favourable for the formation of CCCs in caves and it is the peculiarities of cave climate that are in the end responsible for this. Consequently, I find the climatic inferences made in this paper somehow only poorly supported by the data but strongly relying on the thermal modeling. While the data are what they are, the modeling methods and results should be explained in more detail and the various assumptions (e.g., lack or presence of permafrost, assumed temperatures, buffering effect of snow cover etc) in choosing input data and favouring one model over the other better explained. Further, the authors could summarize the climatic conditions during the YD in a simplified figure, emphasizing the seasonally distinct climatic conditions and the two-part YD climate and than add their data in support of the inferred climatic conditions. The concluding figure 6 does not clearly supports the authors' claims.

Specific comments:

28 – GS1 starts at 12.9 ka, not 12.8 ka (Rasmussen et al., 2014)

35 – catastrophic is rather human-centered

37 – perhaps "cold" is enough, Siberian-like is quite subjective (and given that this is a paleoclimate paper, Siberian climate varied widely in the past)

41 – relative to. . .?

48-52 – to which season do these reconstructions refer?

69-70 – not clear how "enhanced precipitation differences between the northern, cen-

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tral and southern part of the Alps" would result in a YD maximum. Also, check the 13.5 ka age, it is well before the onset of the YD

73 – what do you mean by "double response"? Two periods of glacier advance? Please clarify

86-88 – I particularly enjoy this statement, but please clarify 1) what do you mean by "strong winter", 2) what season the "1-2 C warming" refers to and 3) the reference for the 'drier" comparative (e.g., "drier" compared to early YD?)

91 – This sentence is a odds with the cave's description here

103-104 – over what period were these snow depth values measured? Snowfall heights do not record the amount if snowfall accurately, please provide the total amount of winter and early winter (September-December) precipitation.

114 – What was exactly sampled for stale isotope analyses? Entire CCC? Outer/inner part f it? Please detail.

120 – I understand that these CCCs grow over prolonged periods of time. What part of the individual CCCs was sampled for dating? Or was it whole sample?

200 – why was a 5 °C temperature chosen for the buffering effect of snow cover?

230 – how long does it take for these CCCs to form? Several years is not that much in terms of YD climate variability, so with only 3 ages for the early YD, the inferences made in this article might be slightly far-fetched

235-236 – here is a bit of a jump in logic, as a few lines above (230) a few years are required for CCC to form and now the suggestion is that cave climate was stable for centuries

245 – do you have any indication on when ruble closed the connecting gallery? It could have been open during the YD and hence the cave would have been out of thermal equilibrium with the outside, as discussed above

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246-248 – I would argue that CCC record changes in the thermal state of the cave, that could be or not in equilibrium with external conditions. The assumption is that the ruble blocking the cave was there throughout and since the YD

250-251 – Liquid water reaching the cave would have a dramatic impact on temperature, given the extremely high specific heat capacity of water. I think this is to easily dismissed. And if I understood right, liquid water was required to form CCC (line 259 in the text)

264 – U/Th ages show that CCC formed well (several hundreds of years) into the YD, not at the transition.

274 – how likely is that the cave was perennially frozen throughout both winters and summers for several centuries? If not, than the proposed shielding by snow is not required to induce changes in cave air temperature around 0 and thus facilitate the precipitation of CCC

277 and subsequent discussion – winter or summer very cold YD? The distinction was heavily promoted in the introduction, it should be made here, as well.

289 – see my comment on the ruble blocking the cave and its effect on cave climate. How was the 3 C temperature obtained?

292 and subsequent –warm YD summers indicate that the cave would have been warm enough to lead to ice melting and prevent the all-over freezing of cave. Consequently, CCC could have precipitated by the freezing of water formed during warm summers on the surface of (cold winter forming) cave ice. Is this a likely scenario?

303-305 – this shielding would not be required if the scenarios presented above could be happening.

320 – U/Th ages indicate that CCC formed for several centuries, so why the emphasize on this correlation with the mid-YD transition? The age errors and the widespread ages of all CCCs are to large compared to the narrow age of the transition to support the

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subsequent discussion.

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