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The Cryosphere Discussions

Interactive comment on "Rapid changes of the ice mass configuration in the dynamic Diablotins ice cave – Fribourg Prealps, Switzerland" *by* S. Morard et al.

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Specific comments

Referee: 1. Despite the fact that the measurement campaign reported here was very short, the authors should try to use the measured and reconstructed data to roughly estimate the magnitude and rates of ice formation or degradation and thus give more quantitative support to their hypotheses concerning processes such as sublimation and condensation

ANSWER: You're right. A more detailed quantification of ice formation and degradation is a key-challenge. Unfortunately, it is currently quite ambiguous to quantify precisely

these processes for two main reasons: firstly, we only know the changes in ice surface at one point (ice plug) and only for 5 dates (table.1 which indicated the quantitative changes in the ice volume at the ice plug). In the other parts of the lower gallery, we only observed the changes in ice volume (by comparing photographs). We know that sublimation concerned all the parts of the lower gallery in wintertime (floor, walls, ceiling) (see 2.2.1), and that the formation of new ice in May 2010 is only observed in the floor (and not in the walls as for the sublimation). Second reason follows from the paper of Law and Dijk (1994) (4.3). Currently we don't know the relative importance of the variables temperature, humidity and wind speed in the sublimation process. Similarly, the rate of ice formation during snowmelt periods (and probably also during summer) is not known. But precise quantification of ice changes is foreseen in the near-future (see answer to specific comments 4) and we added a paragraph in that sense in the Conclusion and Perspectives chapter. For the reconstructed data, the main problem is that the processes inside the Diablotins ice cave have widely change during the last 20 years. Between 1990 and 1996, air circulation occurred inside the ice cave. But between 1997 and 2007, the probable occurrence of an unfrozen water pocket could have highly modified the ventilation effect. To estimate the rate and magnitude of ice formation and degradation is in that way very difficult.

Referee: 2. Particular care is required with terms referring to air temperature or air displacement - please consider rephrasing for example 'cold atmospheric waves' (Fig. 4), or 'the external air temperature is thus sucked inside the cave' (3.2.2, line 9-10) and 'colder winters would favor the recharging of the cave in coldness' (4.4. line 5) or 'air flow was blowing out / blowing airflow' (several occurrences).

ANSWER: In the revised version of the paper, we clearly make the distinction between the cave air temperature and the air displacement. We also modified Fig.2 (Devices location): temperature and humidity measurements concerned the cave air and are recorded at several places inside the lower gallery (and also outside the cave), while the air displacement (airflow) is only measured in the ice plug by windmill anemome-

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ter or by hand measurements during the visits of the cave. We used terms like “inward/outward airflow” or “inward/outward ventilation events”. We rephrased “cold atmospheric waves” in “periods of cold weather”; ’the external air temperature is thus sucked inside the cave’ in “advection of cold air toward the lower entrance of the cave”. For the airflow, we used the terms “inward / outward airflow” (or inward/outward ventilation events) instead of ’air flow was blowing out / blowing airflow’. ’Colder winters would favour the recharging of the cave in coldness’ was replaced by “during winters with long periods of low temperatures weather, an important cold reservoir could form inside the cave, favouring the freezing of percolation water and the preservation of ice in summertime”.

Referee: 3. The figures are clearly legible but please use a consistent terminology for the different sectors of the cave - e.g. it is not clear whether the ’lower gallery’ corresponds to the ’lower entrance’ or not.

ANSWER: The locations of the different parts of the cave were more precisely detailed in Fig.2 (see attachment). In particular we clearly indicated the extent of the lower gallery. The lower entrance is the first part of the lower gallery.

Referee: 4. For future analyses, the authors could consider the use of automatic cameras, terrestrial surveys or laser scanning to allow the observation and quantification of changes in ice volume within the more easily accessible parts of the cave.

ANSWER: We already though to plan such measurements in the future (the precise date will depend on the funding of the project). We added a paragraph in chapter 5 “Conclusions and Perspectives”. “Nevertheless more detailed measurements are required in the near-future to analyse the internal structures of the ice and to quantify the rate of sublimation / condensation processes. Main challenges lie in the observation and quantification of changes in ice within hourly or daily time interval by the use of automatic cameras, ultrasonic range sensors and/or laser scanning.”

Technical Comments:

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Referee: 1. The quality of the English is rather poor at the moment and the language needs to be revised carefully before re-submission.

ANSWER: The paper has been sent for improvement of the English text.

Interactive comment on The Cryosphere Discuss., 4, 1035, 2010.

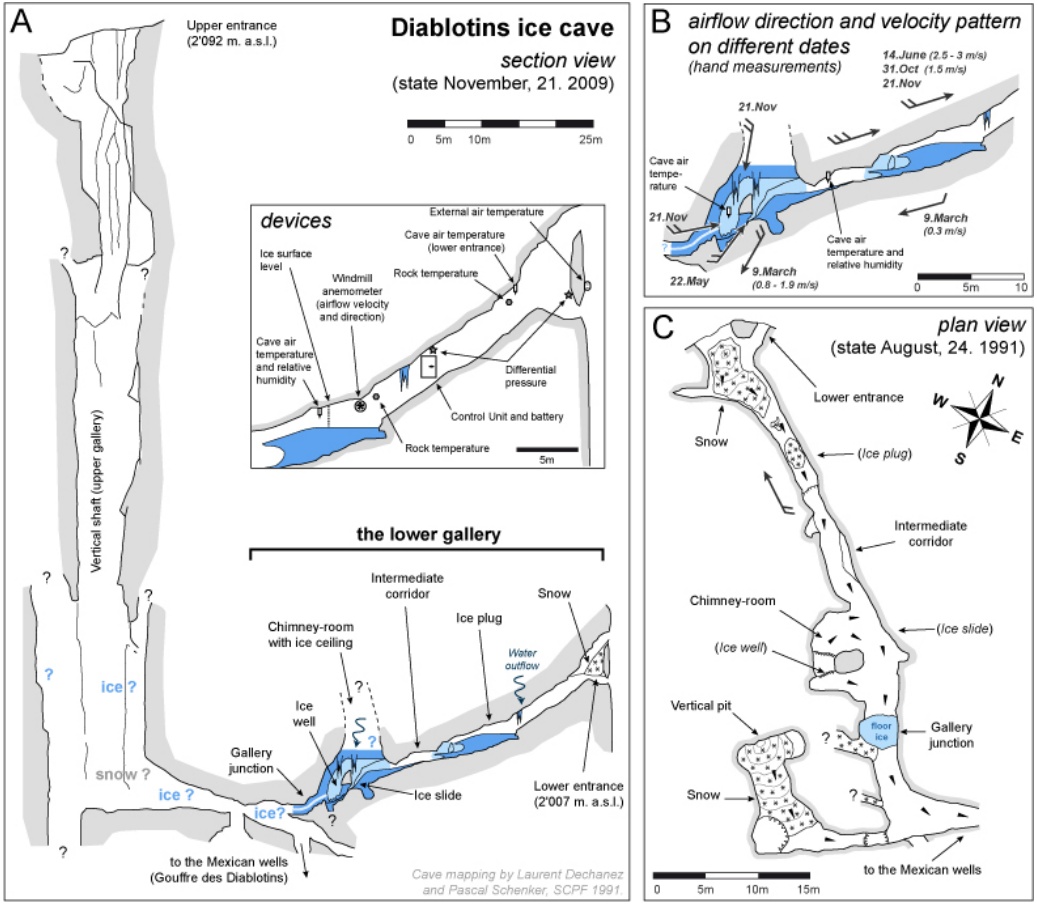

Fig. 1. Figure 2

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