Monitoring the Jochloch cave

Veerle J. Sterken[1,2], Christian Lüthi[1,2,3], Thomas Arbenz[4], Nicole Wächter[5], Rolf Wächter[5], Marc Lütscher[3,6]

[1] Swiss Society of Speleology, Section Bern, Bern, Switzerland
[2] Swiss Society of Speleology, Section Interlaken, Interlaken, Switzerland
[3] Swiss Institute of Speleology and Karst Studies, la Chaux-de-Fonds, Switzerland
[4] Swiss Society of Speleology, Section AGN, Solothurn, Switzerland
[5] Swiss Society of Speleology, Section OGH, Zürich, Switzerland
[6] Swiss Society of Speleology, Section SCV J, Switzerland

info@veerlesterken.ch
luethi@forstinfo.ch

Keywords: cave exploration; temperature monitoring, hoar ice crystals, caving photography

1. Project description

The "Jochloch" is the highest (documented) karst cave in Europe and is located in the continuous mountain permafrost zone at Jungfraujoch, Switzerland. The object was discovered during expansion work on the tourist facilities in the 1980s (new restaurant). The cave was added to the list of tourist attractions at Jungfraujoch a few years ago. It is assumed that the tourist facilities will have medium to long-term effects on the cave and in particular on heat exchanges and temperature developments, as the large temperature gradient of about 7°C between the *Endmeander* and the tourist hall indeed indicates. We refer to the HFSJG Activity Report of 2017 and [Häuselmann2004] for more details about the cave.

Temperature fluctuations may, apart from human interventions, also relate to seasonal (or local climate) changes in the outside atmosphere. In order to be able to estimate the effects of changing boundary conditions on the cave environment, measurements as well as accurate knowledge of the cave environment are necessary. Daily and seasonal fluctuations are quantified using recording sensors (temperature loggers), and the environment is monitored by targeted surveys.

Project tasks defined were:

- Cave surveying using more accurate equipment than before; creation of digital cave plan
- Installation of cave surveying in a 3D model of Jungfraujoch
- Installation of temperature sensors at selected locations in the cave
- Investigation of the ice distribution in the cave
- Checking previously unknown continuations in the cave
- Cave monitoring
- Additional surveys as required
- Evaluation and interpretation of the data, correlation with temperatures outside and tourist activity, etc.

One expedition to the Jochloch cave took place this year on 27-28 October 2018 (participants: Thomas Arbenz, Veerle Sterken, Nicole Wächter, Rolf Wächter). We entered the cave on 27 October after the tourist access to Jungfraujoch closed, shortly after 5PM, and left again in the late evening around 11.30PM, after a long, intensive, but fruitful visit.

Temperature loggers

The temperature logger of Dr. Marc Lütscher in the *Endmeander* was replaced in order to obtain the hourly temperatures since our last visit (July 2017). Hourly temperature measurements in the *Endmeander* are now complete from November 2015 until October 2018 with an accuracy of about ±0.2°C (see Fig. 1). The temperature slowly increases, but longer-term measurements are needed to determine exactly the trend. Four additional loggers from Geotest Ltd. were installed: one beyond the *Endmeander*, and three on the way between the *Endmeander* and the tourist hall.

Hoarfrost crystals

Hoarfrost crystals were photographed (Nicole Wächter) and a few were determined for monitoring their growth.

Surveying and mapping

The first part of the cave - from the cave tourist hall until the icy narrow passage towards the *Endmeander* - was surveyed again for more accurate mapping, using a Disto-X laser measurement device and a handheld computer (Thomas Arbenz, Rolf Wächter, Veerle Sterken, see Fig. 2). A map is currently being drawn (Thomas Arbenz). One more expedition will be needed to finish the surveying for the icy part of the cave.

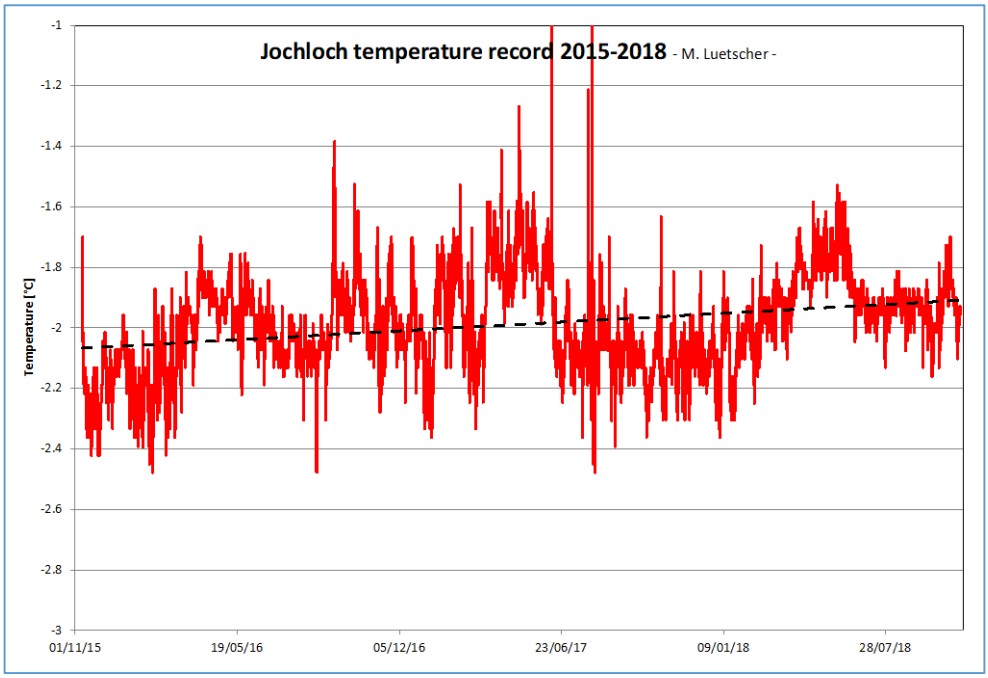

Figure 1. Temperature in the Endmeander from November 2015 until October 2018 in °C.

Cave environment

Between 2017 and 2018, hoarfrost has declined between the Kristallkammer and the narrow passage towards the *Endmeander*. On the other hand, a thin new layer of hoarfrost had formed in the narrow part towards the *Endmeander*. The cave roof seems unstable at some places. New rubbish was found, most likely carried in the cave by animals.

The next morning, a project brainstorm took place, and we left the station contented by backpack full of data.

We thank the Jungfraubahnen AG, the High Altitude Research Station, Geotest Ltd, and the Austrian Academy of Sciences. We also owe many thanks to the friendly and helpful personnel from the HFSJG secretariat as well as Martin and Joan Fischer at the Jungfraujoch station for the excellent support.

References

Häuselmann, Ph., Das Jochloch: die höchstgelegene Höhle Europas, Stalactite, **54**, 2, SZ ISSN 0038-9226, 2004.

HFSJG Activity Report 2017, Exploration of the Jochloch cave (www.hfsjg.ch).

Figure 2. Cave surveying in the Jochloch with a Disto-X.

Collaborating partners / networks

Geotest Ltd., Zollikofen, Switzerland
Dr. Philipp Häuselmann, Swiss Institute of Speleology and Karst Research, Switzerland
Dr. Carol Norberg, Umea University & Swedish Institute of Space Physics, Kiruna, Sweden

Scientific publications and public outreach 2018

Popular publications and presentations

Sterken, V., Ice crystals in caves, lecture at the Kiruna Winter Course on Arctic Science 2018, course organized by Umea University, IRS Kiruna, Sweden, February 13, 2018.

Magazine and Newspaper articles

"Jochloch", brief project update, Stalactite, **68**, 1, p. 58, SZ ISSN 0038-9226, 2018.

Address

Schweiz. Gesellschaft für Höhlenforschung, Switzerland
Sektion Bern und Interlaken

Contacts

Dr. Veerle Sterken
e-mail: info@veerlesterken.ch

Ing. Christian Lüthi
luethi@forstinfo.ch