



ISTITUTO NAZIONALE DI RICERCA METROLOGICA Repository Istituzionale

Rock-face temperature at high-elevation sites: a new measuring approach

Original

Rock-face temperature at high-elevation sites: a new measuring approach / Nigrelli, Guido; Chiarle, Marta; Silvestri, Paolo; Merlone, Andrea; Coppa, Graziano; Musacchio, Chiara. - (2018), pp. 527-528. (Intervento presentato al convegno 5th European Conference on Permafrost tenutosi a Chamonix (France) nel 22 June - 1 July 2018).

Availability:

This version is available at: 11696/76939 since: 2023-06-05T14:30:50Z

Publisher:

Published

DOI:

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)



5th European Conference on Permafrost, Book of Abstract

Philip Deline, Xavier Bodin, Ludovic Ravanel, Chloé Barboux, Reynald Delaloye, Christophe Lambiel, Florence Magnin, Paolo Pogliotti, Philippe Schoeneich

► To cite this version:

Philip Deline, Xavier Bodin, Ludovic Ravanel, Chloé Barboux, Reynald Delaloye, et al.. 5th European Conference on Permafrost, Book of Abstract. Edited by Philip Deline, Xavier Bodin and Ludovic Ravanel; Co-editors: Chloé Barboux, Reynald Delaloye, Christophe Lambiel, Florence Magnin, Marco Marcer, Paolo Pogliotti, Philippe Schoeneich. 5th European Conference on Permafrost, Jun 2018, Chamonix, France. Laboratoire EDYTEM, 2018. hal-01816115v2

HAL Id: hal-01816115

<https://hal.science/hal-01816115v2>

Submitted on 4 Feb 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

5th EUROPEAN CONFERENCE ON PERMAFROST

EUCOP5

CHAMONIX MONT-BLANC

22 June - 1 July /// FRANCE

2018



Book of Abstracts

5th European Conference on Permafrost
June 23 – July 1, 2018, Chamonix, France

Book of abstracts

5th European Conference on Permafrost

Edited by Philip Deline, Xavier Bodin and Ludovic Ravanel

Co-editors: Chloé Barboux, Reynald Delaloye, Christophe Lambiel, Florence Magnin,
Paolo Pogliotti, Philippe Schoeneich

Laboratoire EDYTEM, CNRS, Université Savoie Mont-Blanc

June 2018

Recommended citation

Deline P., Bodin X. and Ravanel L. (Eds.) (2018): 5th European Conference On Permafrost – Book of Abstracts, 23 June - 1 July 2018, Chamonix, France.
<[hal-01816115](#)>

Disclaimer and Copyright

Each author is responsible for the content of his or her abstract and has the copyright for his or her figures.

Publisher

Laboratoire EDYTEM - UMR5204
Université Savoie Mont Blanc
Bâtiment « Pôle Montagne »
5 bd de la mer Caspienne
F-73376 Le Bourget du Lac cedex

Editors

Philip Deline
Xavier Bodin
Ludovic Ravanel

Rock-face temperature at high-elevation sites: a new measuring approach

Guido Nigrelli¹
Marta Chiarle¹
Paolo Silvestri¹
Andrea Merlone^{1,2}
Graziano Coppa²
Chiara Musacchio²

¹Consiglio Nazionale delle Ricerche – Istituto di Ricerca per la Protezione Idrogeologica, Torino (Italy), guido.nigrelli@irpi.cnr.it

²Istituto Nazionale di Ricerca Metrologica – Metrologia per la Qualità della Vita, Torino (Italy)

Abstract

The Alpine environment and in particular the cryosphere, is responding quickly and with great intensity to climate change. Temperature increase observed in the Alps urge the scientific community to study not only air temperature but also rock temperature, to deepen the knowledge about thermal properties of the potentially unstable geological materials. The metrological traceability of measurements is fundamental for data comparability in space and in time and this can be achieved by the use of calibrated instruments and with the evaluation of measurement uncertainties. Here we present some preliminary results of rock-face temperature analysis based on data acquired at high-elevation sites, by means of sensors with documented traceability to International System of Units Standards and evaluated measurement uncertainty. We found and quantified a strong difference in the hourly rate of temperature increase between air and rock. During summer rock temperature grows more than 8 times over air temperature.

Keywords: Rock, Temperature, Metrology for cryosphere, Permafrost, High-elevation sites, Alps.

Introduction

Cold mountain regions are responding quickly and with great intensity to climate change: the shrinkage of the glaciers, the permafrost degradation and the increase of the natural instability processes (NIP), are the main terrestrial indicators of climate warming (EEA 2017).

In the last 20 years in the Italian Alps, a growing number of NIP has been documented and some authors relate this trend to an increase of the near-surface air temperature (Chiarle *et al.*, 2017; Paranunzio *et al.*, 2016; Turconi *et al.*, 2010). Air temperature (AT) increase can, for example, cause an increase of melting-freezing cycles, with volume change and rock mass damage (Nigrelli *et al.*, 2017). In NIP studies the knowledge of air temperature is not enough: it's necessary to acquire information about rock temperature (RT). RT is not yet widely measured and data are rare, compared to AT data. More importantly, RT data are often acquired by means of sensors with unknown measurement uncertainty. In this research field, the metrological traceability of measurements is actually missing but it is fundamental for data comparability in space and in time (Merlone *et al.*, 2015).

For studying RT at high-elevation sites, it is thus necessary to acquire data with a high level of accuracy,

by means of calibrated sensors and inclusion of measurement uncertainty. The approach here proposed is intended as a case study for the adoption of common and standard procedures. Thanks to the close collaboration with the MeteoMet project (<https://www.meteomet.org/>) it has been possible to:

1. Measure RT by means of sensors with known uncertainty of measurements;
2. Increase knowledge about the thermal conditions of different types of rock;
3. Study relations between climate variability and morphodynamic processes at high-elevation site.

In this work we present the preliminary results of the analysis of the RT's that have been acquired in an experimental glacial basin (Balme, Italy), in the framework of the RiST project (project co-financed by Fondazione CRT).

The new measuring approach

To measure RT we use the MicroTemp sensors and data logger (TDL). Our approach consists of four steps:

1. Laboratory calibration (before and after use) of TDL, necessary to establish documented traceability to S.I. standards;

2. On-site test of TDL, necessary to evaluate components of measurement uncertainty other than the calibration ones;
3. Use of TDL for acquiring RT with known measurement uncertainty;
4. Use of our webcam for visual monitoring of the sites where TDL have been placed (<https://bessanese.panomax.com/>).

The TDL have been inserted into different types of rock at 10 cm depth (Fig. 1). The acquisition interval is every 10 minutes in summer and every 30 minutes in the other seasons (Fig. 1).



Figure 1. Inserting a TDL in a Calcschist rock.

Preliminary results

The total uncertainty of measurements is ± 0.17 °C.

Firstly, we have examined RT during two summer seasons (2016 and 2017), during sunny days and when the rocks were directly exposed to the sun (no clouds, no topographic shadow). In relation to this criterion, we found 12 days that constitute our sample size. In these days we have only considered the hours when RT increases. The study involved two types of rocks: Calcschists and Prasinite rocks (Table 1).

Table 1. Descriptive statistics of the data.

	Sample (n)	Mean (°C/h)	St. dev. (°C/h)	Min÷Max (°C)	Curve f. (r ²)
AT	12	0.5	0.4	-0.2÷1.4	0.6
RT-C	12	3.83	0.49	3.08÷4.67	1.00
RT-P	12	3.89	0.27	3.41÷4.50	1.00

For a description of the acronyms see Fig 1.

We found a strong difference in the hourly rate of temperature increase between air and rock: RT grows more than 8 times over AT during summer, in sunny days with no clouds/shadows. The rate of temperature increase is shown in Fig. 2.

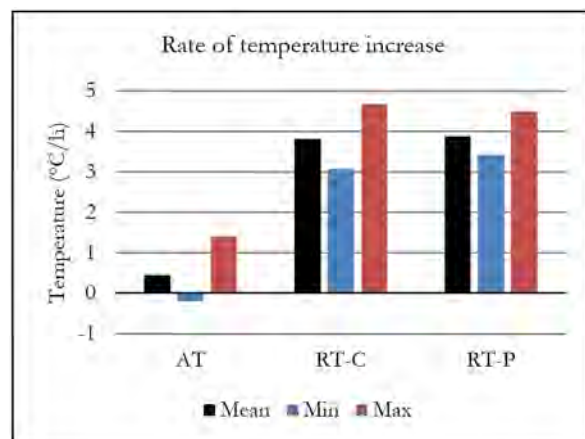


Figure 2. Rate of increase (°C/h) related to air temperature (AT, source ARPA Piemonte), Calcschists and Prasinite rock temperature (respectively RT-C and RT-P).

References

- Chiarle, M. Cat Berro, D. et al. 2017. Slope instabilities occurred at high elevation in the Italian Alps in 2016: regional landscape fragility and meteorological framework.. *Geophysical Research Abstracts*, Vol. 19, EGU2017-8498.
- EEA 2017. *Climate change, impacts and vulnerability in Europe 2016*. Luxembourg: Publications Office of the European Union, 421 pp.
- Merlone, A. Lopardo, G. et al. 2015. The MeteoMet project - metrology for meteorology: challenges and results. *Meteorological Application* 22: 820–829.
- Nigrelli, G. Fratianni, S. et al. 2017. The altitudinal temperature lapse rates applied to high elevation rockfalls studies in the Western European Alps. *Theoretical and Applied Climatology* Online first.
- Paranunzio, R. Laio, F. et al. 2016. Climate anomalies associated to the occurrence of rockfalls at high-elevation in the Italian Alps. *Natural Hazards and Earth System Sciences* 16(9): 2085–2106.
- Turconi, L. Kuman De, S. et al. 2010. Slope failure and related processes in the Mt. Rocciamelone area (Cenischia Valley, Western Italian Alps). *Geomorphology* 114(3): 115–128.