Traceability and on-site calibration for permafrost temperature sensors

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TRACEABILITY AND ON-SITE CALIBRATION FOR PERMAFROST TEMPERATURE SENSORS

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Permafrost is a key component of the cryosphere through its influence on energy exchanges, hydrological processes, natural hazards, carbon dioxide and methane emissions and the global climate system. Its degradation is seen as a major challenge in the current discussion of global warming (IPCC, 2013), due to the possible effects on climate. On these basis, accurate measurements of the permafrost properties and improved data quality in the evaluation of permafrost temperature profiles become fundamental aspects for achieving more reliable knowledge on the evolution of this component of the cryosphere.

The Sommeiller Pass permafrost monitoring station, at about 3000 m of altitude, is the key site of the regional network installed in 2009 during the European Project “Permanet” in the Piedmont Alps (NW Italy). The station consists of 3 vertical boreholes of 5, 10 and 100 m depth, equipped with thermometric chains for a total of 36 temperature sensors (thermistors type). The collected data shows a constant active layer 8-9 m of thickness, while the permafrost temperature curves show a degradation of the base at approximately 60 m of depth since 2014. In order to verify this variation (about 0.25 °C), considering the station history, sensor calibration campaigns were carried out both in laboratory and on-site aimed to understand the reliability of the measurements in progress. The accurate determination of the permafrost temperature in deep holes (100 m) will improve knowledge on ancient permafrost for climate and paleoclimate considerations. A dedicated calibration procedure was adopted and the calibration results were used in order to adjust the Sommeiller Pass permafrost monitoring station database and permafrost profiles. The permafrost temperature profiles obtained with the data to which the calibration curve was applied, reported a potential thawing of permafrost starting from 2012 at a depth of about 60 m, while a potential melting is indicated by the profile to which the calibration curve was not applied only from 2014 onwards but at the depth of 79.9 m, with a difference in the temperature value equal to 0.063 °C, annual average.

This study showed the advantage of the joint collaboration between metrology and the community working in cryosphere observations. A need emerged to discuss and agree on common approaches, best practice and uncertainty evaluation on the numerous measurements made in glacial and periglacial areas. Accuracy and data quality are a key aspect for comparability of observations from different stations taking parts in networks and among different networks. Calibration of instruments and sensors becomes then a fundamental aspect of measurement procedures to achieve full traceability of results and evaluate measurement uncertainty.