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REASSESSING PERMAFROST THAWING BY METROLOGICAL TOOLS: CALIBRATION OF THERMOMETRIC CHAINS IN THE ALPS

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The deterioration of permafrost is a progressively significant consequence of climate change. Monitoring the reduction of permafrost, specifically its area, depth, and the movement of the active layer, is crucial for assessing the extent of ongoing trends and implementing appropriate responses and alerts. Temperature measurements within permafrost provide direct insight into the condition of the frozen subsurface and its changes over time.

The Sommeiller Pass permafrost monitoring site, situated at approximately 3000 meters altitude, serves as the central hub of the regional network established in 2009 during the European "PermaNET" project in the Piedmont Alps (northwest Italy). This site features three vertical boreholes, outfitted with a total of 36 temperature sensors arranged in three separate strings.

Initial data revealed a decline in the permafrost base at around 60 meters depth beginning in 2014, corresponding to a warming rate of approximately 0.03 °C per year. To validate and refine this potential degradation, three on-site sensor calibration efforts were conducted to assess the accuracy of these readings. By conducting repeated calibrations across different years, two primary outcomes were realized: the temperature profiles were corrected for inaccuracies, and the re-calibration enabled the differentiation of genuine permafrost temperature changes from potential sensor drift, which could be of a similar magnitude to the observed thermal variations.

The warming trend of the permafrost base at a depth of roughly 60 meters was validated, with a rate of $(4.2 \pm 0.5)\cdot 10^{-2}$ °C per year. This document details the establishment and deployment of the on-site metrology laboratory, the specific calibration methodology employed, the calibration findings, and the resulting adjusted data, temperature profiles, and their temporal evolution. It aims to contribute further to ongoing research and the development of best practices, enhancing data traceability and comparability, as mandated by the WMO's Global Cryosphere Watch program.

The metrological tools and expertise employed in this research have been included in the 2024 edition of WMO Guide No.8 to Instruments and Methods of Observation, in a dedicated chapter (Permafrost Best Practices). It has also been translated into a regular calibration service by the WMO Measurement Lead Centre on Traceability and Field Metrology, managed by INRiM.