



## Forecasting snow-related hazards

The extreme environments of high mountain regions cause a range of natural hazards. Weather conditions introduce risks, creating avalanches from snow cover or downstream river floods from meltwaters. To help assess these risks, networks of weather stations monitor local conditions. Temperature data is a key input for hazard forecasting, but measurement errors resulting from poor sensor shielding design need reduction to improve both measurement accuracy and risk assessments.

### Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

# Challenge

The stability of snow cover in mountain regions is highly dependent on the weather – local conditions, for example, will influence the occurrence of avalanches, or river flooding due to an increase in meltwater production. To estimate the risk, networks of weather stations are used to gather the data needed to help forecast the likelihood of these snow-related natural hazards. Because air temperature, for example, influences mountain snow cover stability and the associated risk of avalanche, more accurate measurements are needed to improve hazard forecasting.

The accuracy of weather station measurements can be affected by a variety of influences arising from station siting and the design of protective shielding for instrumentation. In the extreme conditions of mountain regions, ground snow cover can reflect a significant amount of solar radiation on to unshielded thermometers within a weather station's housing. Consequently, air temperature measurements can be in error by several degrees Celsius due to this unwanted heating. The effect of snow-reflected radiation on air temperature measurement accuracy must therefore be addressed if forecasting snow-related risks from avalanches or river flooding due to meltwater is to be improved.

# Solution

The EMRP project *Metrology for essential climate variables* assessed influences on weather station measurement accuracy including the effects of nearby features such as trees or buildings, station housing design, and other local conditions.

The project investigated radiation shields designed to prevent weather station thermometers from receiving unwanted direct and back-reflected solar radiation, such as from ground snow cover in mountainous regions or buildings in urban areas, whilst also preventing heat trapping within the housing itself. With testing conducted over snow-covered ground, a difference of up to 3 °C was observed when comparing air temperature measurements from thermometers shielded with a prototype design versus a commercially available shield. Well-designed solar shielding is important to reduce errors introduced by the "snow albedo" effect created by reflected solar radiation. Improving the accuracy of temperature data from weather stations monitoring snow cover data will help improve forecasting of snow-related risks such as those from avalanches or meltwater production.

# Impact

CAE SPA, a leading company in environmental monitoring and warning systems, had prototype shielding and sensors independently evaluated during the project. As a result of this testing, CAE have upgraded their weather station shielding and temperature sensor combination, using the new superior design.

The Regional Authority for the Environmental Protection of Piedmont (ARPA), Italy, is responsible for assessing risks associated with snow cover in the regions mountains and has started introducing the upgraded CAE weather stations. By installing the newly validated design to run alongside other weather stations in their network ARPA is able to compare results and gain insights into differences between the measurements obtained, as required by the WMO. This is important to avoid step changes in trend analysis that are difficult to understand.

Predicting avalanches or snow-melt river flooding risks in mountain regions requires accurate temperature data for forecasting models. By adopting technologies such as the improved solar shielding to minimise temperature measurement errors, forecasts are improved, thereby providing more accurate natural hazard warnings for people living and working in mountainous regions like Piedmont.

## Improvements for climate change monitoring

The EMRP project *Metrology for Essential Climate Variables* investigated the performance of various climate-monitoring instruments under conditions likely to be encountered in their upper atmosphere, deep sea, or mountain operating environments. It developed a humidity calibration chamber for radiosonde instrumentation, used to monitor water vapour in the upper atmosphere, and a high-pressure calibration facility for temperature sensors used deep in the ocean. Weather station performance was also assessed, leading to an increased understanding of the effects of back reflected radiation from the ground or surroundings on sensor accuracy. The project derived protocol for confirming the equivalence of calibrations performed on temperature, pressure and humidity instrumentation used at weather stations has been adopted by the World Meteorological Organisation Commission for Instruments and Methods of Observation for use in large scale laboratory performance comparisons.



## EMRP

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