



## Improved climate change monitoring

Climate change presents many challenges to society, including the effects of global warming and an increase in severe weather event frequency. Data from weather stations generated for short-term forecasting could be used to identify climate change trends, but higher quality measurements are needed. To achieve more accurate air temperature measurement, for example, sources of error caused by weather station siting and poor housing design need to be better understood.

### **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

Around the world, automatic weather stations measure parameters including temperature and humidity, with networks gathering data from multiple locations to generate short-timescale weather forecasts. This data could also be used to make climate change predictions, but characterising long-term trends, such as global warming, requires better data quality.

Weather measurements can be affected by various unwanted influences, with poorly designed shielding, for example, causing potential errors when measuring air temperature. Consider how the temperature inside a car with its windows closed rises rapidly in sunshine, a similar affect can also be experienced by sensors inside weather station shielding introducing air temperature measurement errors. Poor weather station shielding designs can also expose temperature sensors to back-reflected solar radiation from their surroundings. In mountainous or polar regions, snow cover can act as a reflector, whilst for urban weather stations, buildings or roads nearby can raise temperatures artificially.

To make weather station measurements sufficiently accurate for use in climate predictions, unwanted effects of weather station design, siting and other local conditions need to be minimised. More accurate temperature measurement, for example, could be achieved with better shielding, as improved designs would minimise heat trapping and shield temperature sensors from high levels of back-reflected solar radiation such as that from snow cover.

# Solution

The EMRP project *Metrology for Essential Climate Variables* assessed the effects on weather station measurement accuracy including the influence of nearby features such as buildings or trees, housing design, and other local conditions. The influence of these was shown to have a smaller effect on measurement parameters, including temperature, than previously estimated in a World Meteorology Organisation guide. This information has now been incorporated in to a recent revision of this important guide for the weather monitoring community, removing reliance on overestimated corrections.

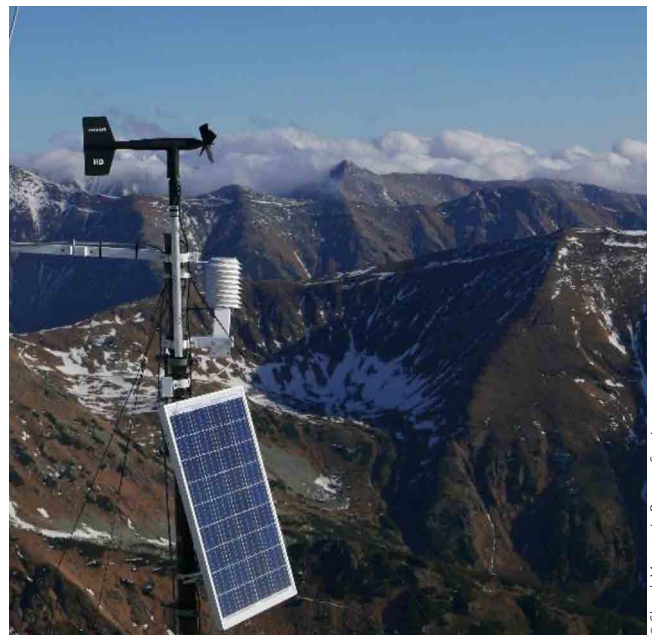
Different solar shields for weather station instrumentation were tested in the project, with a new novel design that shields temperature sensors from direct and back-reflected solar radiation whilst minimising heat trapping effects demonstrating significantly reduced measurement errors. The results demonstrated that up to 3 °C in temperature variation was attributable to the "albedo effect" where snow reflects sunlight onto a temperature sensor. This demonstrates the importance of good solar shield design.

# Impact

Barani Design, an SME producing weather station sensors, had a prototype solar shield independently validated in the project. In addition to the shielding of instrumentation from direct and reflected radiation, the prototype's novel helix design was shown to allow free airflow over housed sensors so minimising heating effects. These design features improve ambient air temperature measurement accuracy by reducing errors caused by solar radiation heating and the trapping of warm air. The validated helical shielding will be launched commercially in 2019. The product's affordability will make it attractive in regions currently lacking a developed meteorological infrastructure such as Africa and south-east Asia.

## 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 under the ocean. Automatic 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. These developments will increase weather monitoring data accuracy and increase its potential for use in climate change predictions.



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## EMRP

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[www.euramet.org/project-ENV58](http://www.euramet.org/project-ENV58)

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