Evaluation of small electronic devices for air extreme temperatures measurements in the cooperative observing network

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Introduction

Due to recent European directives, metallic mercury will be banned soon except in very specific fields where no other solution exists.
In METEO-FRANCE operational networks, mercury is mainly used in thermometers for maximum temperature measurements and in detectors of tipping bucket rain gauges.
It becomes now necessary to replace manual thermometers by small electronic devices, without losing metrological quality of data.
After a survey of the different instruments available from French market, we evaluated them in two consecutive studies in 2005 and 2007.
This poster sums up the results we obtained.

Identification of requirements

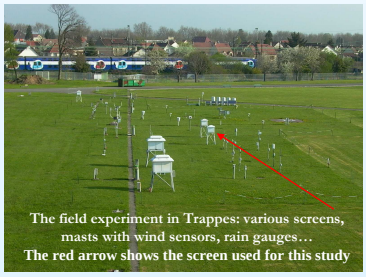
Replacing devices should meet at least the criteria of CIMO Guide, which are:

Thermometer type	Maximum	Minimum
Span of scale (°C)	–30 à +50	–40 à +40
Range of calibration (°C)	–25 à +40	–30 à +30
Maximum error	±0,2 K	±0,3 K

As many cooperative observers do not have home computers, neither Internet connection, there is a need of a screen/display of current temperatures and past values.
We focused on 2 types of instrument:
•Devices that can record temperatures. The observer does not to read the data daily. Numerical data can be sent to the climatological service by email or to a ftp server.
•Devices with no memory. The observer reads temperature twice a day. Written data are sent by traditional mail.

Conditions of the study

All the instruments were put in the same shield (red arrow on the picture), in the experimental field of Trappes. A Pt100 probe was installed in the same shield as a reference.
The sensors that record temperature and the reference probe were set for a 1-minute acquisition.
Calculation of daily extreme temperature was post-processed.


The field experiment in Trappes: various screens, masts with wind sensors, rain gauges…
The red arrow shows the screen used for this study

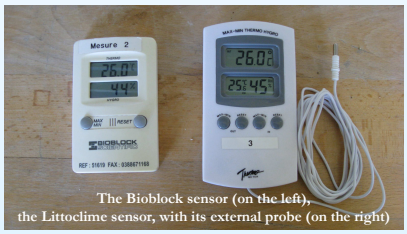
Instruments tested

We tested three different models of dataloggers:
•Hobo model H08-032-08
•Sefram models 1511 and 1555
•Elcowa/Comet Systems model S0110F
For all of them a calibration certificate is available from the manufacturer.
For Hobo and Sefram, temperature sensor is internal. The Elcowa/Comet system was tested in 2005 with an internal sensor, which gave wrong measurements of daily minimum temperature in high humidity conditions. In a second study in 2007, it was equipped with an external Pt1000 probe. The Elcowa/Comet sensor directly processes extreme temperatures (over 18-18 and 06-06 period respectively for the minimum and maximum values) and stores only the two daily values.
Four different models of instruments with direct reading were considered:
•Bioblock model 51619
•Littoclime THGM970
•Oregon Scientific EMR812HGND and BAR122HGN

The Sefram sensor

The Hobo sensor

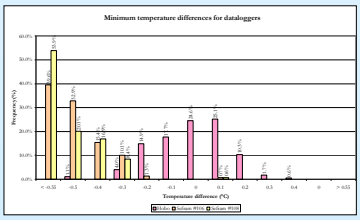

The Elcowa/Comet systems sensor (on the right) and the reference Pt100 probe (on the left)

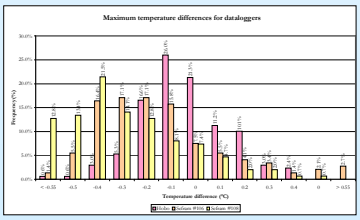


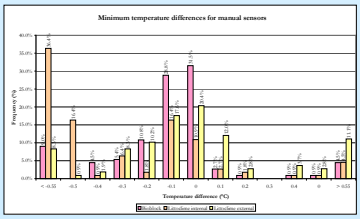
The Bioblock sensor (on the left), the Littoclime sensor, with its external probe (on the right)

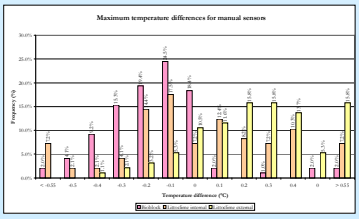
Comparison with the reference sensor

The two Oregon sensors could not be evaluated, because of frequent interruptions in the radio data transmission. Maybe the close radar is responsible for that.
We consider the temperature differences of each sensor to the reference. Histogram plots of the differences clearly show biases of Sefram sensors with respect to the reference. The Hobo sensor gives accurate measures, within specifications, in more than 95% of the cases.
Manuel sensors do not give satisfactory measurements.

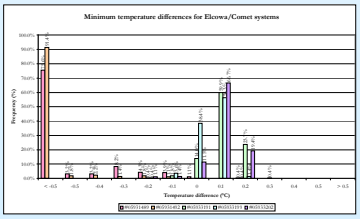


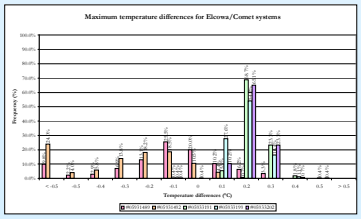






Similar histograms are plotted for Elcowa/Comet systems sensors, with both sensors, internal sensitive element (pink and orange) and external probe (green, blue and purple).
The external Pt1000 probe gives a much better accuracy.





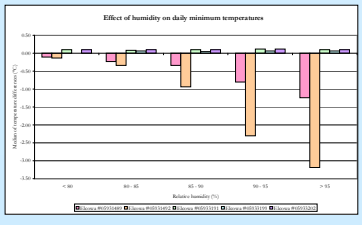
Drifts

Temperature drift

We did not find a significant influence of temperature on measurements of daily extreme temperatures.

Humidity drift

We did observe the influence of high values of humidity on internal temperature measurements on Elcowa/Comet systems. Minimum temperatures differences are much higher when humidity is above 90 %. There is no influence of humidity on daily maximum temperature. It does not happen with external Pt1000 probe.



Conclusions and outlook

Among the data loggers we tested, only Hobo and Elcowa/Comet systems sensors meet the requirements of WMO concerning accuracy.
Elcowa/Comet systems sensors have a display of current and last extreme temperatures. Cooperative observers appreciate it, especially those who do not have a personal computer.
METEO-FRANCE has planned to replace liquid-in-glass thermometers by electronic devices in the cooperative network over the 2009-2011 period.

References

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