Parallel measurements at the Ebro Observatory to assess the differences between the automatic weather station and manual air temperature measurements

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Background

➢ Since the last third of the 20th century, abrupt changes on temperature observation conditions have taken place, due to the introduction of new weather observing systems, screens or station relocations (Fiebrich et al. 2009; Hubbard et al. 2005; Milewska et al. 2002).
➢ This fact hinders the comparability between stations and also between periods and compromise the data traceability (WMO-No.1202, 2017).
➢ Another important point is an increase on uncertainty sources that can affect the measurements which are rarely taken into account.

Objective and motivation

➢ Land Surface Air Temperature is one Essential Climate Variable and a Climate Indicator to monitor the Climate Change evolution. Therefore, it is crucial to ensure quality, reliability and traceability of long-term temperature in-situ observations.
➢ Our main objective is to provide the bases to design ad-hoc field trials for analysing different source of bias that can affect this long-term temperature time-series: to assess the differences between Automatic Weather Stations vs. Manual (AWS-MAN) and between Young and Stevenson screens.

Field trials requirements

1. Defining the purpose:
   • Firstly, it is needed to define what it is intended to assess before defining the requirements for the field trial.
   • Isolating what it is intended to assess: It is important to think about different sources that can affect our trial or introduce any bias on our study. This is the only way to reproduce it and to extrapolate the results.
   • Ensuring all times the starting conditions will be maintained: All the conditions should be constant throughout the whole field trial. It is important a frequent maintenance of all instruments/systems involved.

Ebro Observatory field trials (FT) example

1. First FT: AWS – MAN differences
   • Aim: evaluating the AWS bias plus the impact of using calibrated AWS following metrological procedures (AWSc).
   • Requirements: Install the AWSc, according metrological procedures, inside the same Stevenson screen and in the same relative position than the MAN and the uncalibrated AWS (AWSu).
   2. Second FT: Stevenson – Young screens
   • Aim: evaluating temperature measurements differences due to different screens.
   • Requirements: Install a second AWSc inside a Young screen, calibrated according metrological procedures, using the same climatic chamber and both signals transmitted by the same system and processed by the same datalogger.

Results of our field trials considering the basic requirements

1. AWSc – MAN:
   • The adoption of metrological standard procedures has an impact on the measurements and smoothed the transition AWS – MAN. Most part of the differences fall inside the combined calibration uncertainty. Although using AWSc, there are a few differences in comparison of MAN observations, this can be due to the very different inertia and response of the two systems.
   2. Young – Stevenson screen:
   • Mainly differences Stevenson – Young are outside the combined calibration uncertainty. The maximum and minimum differences behave in different way (fig. 3).
     • For maximum temperature (Tmax), the differences depend on temperature itself (fig. 3), with negative (positive) differences for high (low) Tmax values. Also depends on the influence of wind, radiation and humidity (fig. 4), with positive differences for calm, overcast and wet days and negative differences for clear and dry days...
     • For minimum temperature (Tmin), the differences are quite stable and are not dependent of weather conditions.

Results of other field trials

1. AWSu – MAN (AWS uncalibrated)
   • Difference series are inhomogeneous, with clear dependence of AWSu bias (sign and magnitude) for each instrument/measurement system (fig 5 and fig 6). The adoption of comparison procedures and not standard calibration procedures introduces inhomogeneities on the AWSu – MAN difference series (with BPs detected inside SEAC, SOSS and ESOS systems, fig. 5). Therefore, any bias description or correction attempt must carefully account for internal inhomogeneities. In addition, the AWSu – MAN bias is not homogeneous across the year and is highly dependent on the recorded temperature.
   2. AWS – MAN and Young – Stevenson screens.
   • For Fabra Observatory, the AWSu observations are taken in a plate-like screen (fig 6, MCV (manufacturer name) periods), the differences are higher, especially on Tmax. For these MCV’s sub-periods, ΔTmax mean varies from 3.7 °C (MCV1.2) to 0.5 °C (MCV2.3). However, ΔTmax mean is -0.1 °C Nevertheless, it is difficult to conclude if these differences are due to the different screen or the different temperature measurement system.

References


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