MUTUAL INFLUENCES OF WEATHER STATIONS POSITIONING ON METEOROLOGICAL MEASUREMENTS

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INFLUENZE RECIPROCHE DOVUTE AL POSIZIONAMENTO DELLE STAZIONI METEOROLOGICHE SULLE MISURAZIONI DELLE GRANDEZZE METEO

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Abstract
Hill and mountain agricultural sites are often close to the forests where a high tree canopy influences weather conditions in the vicinity. The presence of trees density affects humidity, temperature and solar radiation measurements.
Vineyards or other cultures planted on slopes, sometimes force a non-ideal position of weather instruments and the outcome data do not take into account of the measurement uncertainty related the slope, the proximity of trees, and intensity of solar radiation.
Aim of this study is the investigation of the effect on meteorological measurements due to the automatic weather station (AWS) positioning in an agricultural site located in Monferrato. The different position in field of two AWSs has been analysed, in order to evaluate the effect of the positioning of the sensors on sloping hills, in terms of the influence on temperature, humidity and solar radiation measurements.

Keywords Weather station, positioning, meteorological measurements, uncertainty
Parole chiave: Stazioni meteorologiche, posizionamento, misure meteorologiche, incertezza

Introduction

In situ calibrations of weather stations are usually performed by positioning standard instruments, such as hygrometers, thermometers, etc., close to the station under calibration. Reference sensors are left for a short period and the calibration is performed by comparison (Rana *et al*., 2004). This procedure was metrologically evaluated and showed relevant weak points (Sanna *et al.,* 2013). Reference sensors are not always made to operate in open air, it is not possible to cover the whole range for the quantities, thus it is not possible to evaluate linearity and uncertainties for several sensors over the whole range and the evaluation of the mutual influences between parameters is not achievable.
Moreover, vineyards or other agricultural sites are often positioned on slopes, close to the forests where the canopy influences the weather conditions in the vicinity. This forces a non-ideal position of weather instruments and the outcome data do not take into account the measurement uncertainty related the slope, the proximity of trees, and intensity of solar radiation.
There is a need for testing various types of sensors, their calibration (Rao *et al.*, 2009), and to evaluate the measurement uncertainty related the meteorological quantities gathered from automatic weather station (AWS).
The proposed research aims to achieve a metrological approach applied to agrometeorological studies and goes to implement of traceability in weather measurements, to investigate on the effect on meteorological measurements due to the AWS positioning in agricultural sites, to disseminate by researchers of calibration methods and procedures to agriculture operators.

Materials and Methods

Two AWSs, provided by MTX S.r.l., have been installed in a vineyard placed in locality Vezzolano (Monferrato, province of Asti), both composed by air temperature, relative humidity and solar radiation sensors. The first one has been placed in conform to WMO recommendations (WMO, 2008) called VA. The second has been installed in proximity of trees (approx. 8 and 17 m), where the canopy influences weather measurements (VB).
The air temperature and relative humidity sensors have been calibrated using the "EDIE" facility (Lopardo *et al.*, 2014), developed under the European ENV07 MeteoMet project (Merlone *et al.*, 2012).
Meteorological data, required for the simulations of infection on grapevines, have been collected hourly from 2013 to 2014.
Four simulations by employing EPI epidemiological forecasting model, improved as described in Sanna *et al.*, (2014) have been performed: using data from VA without inclusion of measurement uncertainties in the input values (not calibrated, VA-NC), the second using data from VA with inclusion of the measurement uncertainty for temperature and relative humidity (calibrated, VA-C); the third, using data from VB without inclusion of uncertainties (not calibrated, VB-NC), the fourth, using data from VB with inclusion of the measurement uncertainty for temperature and relative humidity (calibrated, VB-C).

Results and Discussion

During all the research period, surveys in field have been performed, contemporary observation of pathogen symptoms, meteorology data recording, evaluation of measurement uncertainty and assessment of mutual influences between parameters due to AWSs positioning. Analysis of the measurement results and reporting were also carried out.

Average data of temperature and humidity of the same AWS (calibrated/not calibrated) and between the two AWS are always statistically different (Kruskal-Wallis non parametric test).

Despite this, it can be appreciated a slightly difference between the information recorded by the 2 AWSs (calibrated), both as regards the temperature and the humidity. The difference is also confirmed by the high coefficient of variation of their ratio.

Moreover, the Figure 1 shows how the solar radiation measured in VB is often lower than that measured in VA, especially at the higher solar radiation values, confirming a marked influence, in addition to the position, also of the leaf coverage present in the vicinity of AWS VB.

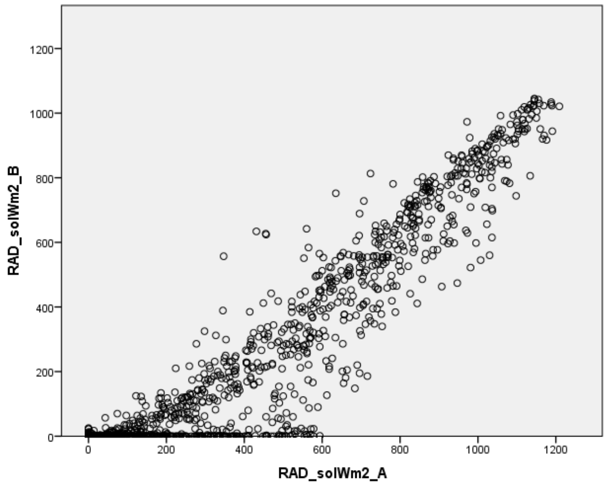

Fig.1 – Relation between the solar radiation measured in VA and VB, the intensity of the latter is often lower than in VA.

Fig.1 – Comparazione tra la radiazione solare misurata nelle due stazioni, l'intensità è spesso inferiore in VB rispetto a VA

Going backward from the date of primary infection symptoms onset, the most probable period of germination was calculated, according to Giosuè *et al.* (2002), around April 27.

The four simulations of pathogen infection show different results. The forecasting of VA-NC and VB-C are overlapped around of the estimate period of germination, while VA-C postpones the forecast and VB-NC anticipate of about three and six days, respectively.

Although the comparison between data calibrated and not calibrated brings forward the forecasting models of only three days, this fact must be added to the positioning of the AWS, which amplifies the date up to a week (Figure 2).

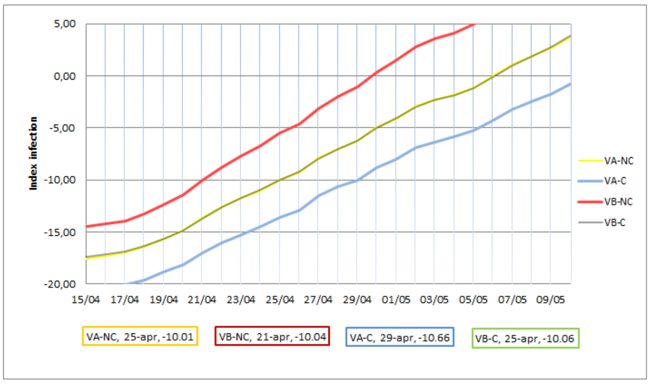

Fig. 2 – EPI index focused on period in which is highly recommended make a treatment. The boxes explained the day in which EPI value reach the critic value -10.

Fig. 2 – Valori di EPI focalizzato nel periodo in cui è consigliato effettuare un trattamento. I riquadri descrivono la data in cui l'indice EPI raggiunge il valore critico -10.

Conclusions

The sum of the two components (calibration and position) changes the prediction up to a week. Therefore, it is considered that forecasting models should include measurement uncertainties in the input values, and provide traceability to the AWSs at the reference sensors, in order to have more accurate meteorological data and better models output data.

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