

Interactive comment on “Using digital image processing to characterize the Campbell–Stokes sunshine recorder and to derive high-temporal resolution direct solar irradiance” by A. Sanchez-Romero et al.

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GENERAL COMMENTS

This paper presents a useful, detailed and clear description of a digital image-processing system to measure the width and length of the burn produced by direct solar radiation on the daily cards used in the Campbell–Stokes sunshine recorder. Results obtained using this system with a sample taken from two years of measurement from two models of CS sunshine recorders are then compared with measurements of direct

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beam irradiance obtained with a pyrheliometer. I recommend the paper's publication after the authors have addressed the few general and detailed comments listed below.

We really appreciate the referee's comments about our work. We also appreciate his support for the publication of our paper in Atmospheric Measurement and Techniques. The general and detailed comments suggested by the referee are addressed below.

General comment 1. The important comparison between length and breadth of burn as proxies for direct solar beam radiation presented in this paper should be supplemented by a comparison with the use of their product: that is the area of the burn. This would resemble the initial approach in which Campbell used the volume of wood burnt, and more recently and relevantly the paper by Galindo Estrada and Fournier D'Albe (1960 Q. J. Roy Met Soc 86) who compared daily values of the mass of sun card burnt with pyrheliometer readings.

We agree with the referee about the importance of the paper of Galindo Estrada and Fournier D'Albe (1960), so we have introduced this reference in the manuscript. On the other hand, we consider that the mean burn width, for example in an hour, is a representative value of the area of the burn during this hour and, in consequence, of the loss of mass during this time. For example, let's consider the next figure. The burnt area (A) is related to the sum of the burn width (h) multiplied by the time interval ($\Delta t = 1$ min) during the hour (i.e. to the sum of the sixty measures of burn width). But this measure is obviously related to mean burn width (h_m) during the 60-minutes (T), as it shows the next formula. In consequence, the area of the burn in an hour or a day is related to the mean burn width during this hour or day.

$$h_m = \sum(h \Delta t) / T = A / T$$

General comment 2. Some practical details would be helpful to those thinking of using the system; How long does it take to process a sun card? What is the cost of the equipment needed? How available are sun cards stored in national meteorological service archives? Do sun cards deteriorate with time?

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In our case, the process of scanning and manual intervention (i.e., image positioning) can last 1.5 - 2 minutes for card, i.e. it is possible to process a year of burnt cards in about 12 hours of work. In consequence, after hours of routine work, it is possible to extract information of long time series as we propose in the conclusions section. We have added this information in the manuscript. On the other hand, the equipment is very simple and cheap: a computer and a commercial scanner. Of course, we have to consider the cost of personnel that scan and run the program. The method we have presented here would allow generating very long DSI series in a high temporal resolution with a commensurate effort. It can be used for certain meteorological services and specific stations that have long SD series and maintain the CSSR cards, as for example we have stated in the last sentence of the conclusions section. We believe that some meteorological services keep CSSR cards in their archives but we haven't yet confirmed it. About the deterioration of CSSR cards with time, we suppose that the shape and the colorfulness haven't varied along the years (at least to allow using the same threshold for all years). In addition, in this research we have used one type of card and CSSR that are quite all old (Negretti and Zambra CSSR and Mod.98 cards) and we didn't observe any deterioration with time, comparing with the other type of card and CSSR (Thies Clima CSSR and cards), which are newer.

DETAILED COMMENTS

Lines 169-172. Why were only 269 sun cards examined out of 731 possible and how was this sample selected?

We are not interested in building a long SD cards series, only to prove that CSSR records may become a proxy measurement of direct solar radiation. Thus, the number of cards is relatively small because we don't put cards every day (e.g., holidays, weekends...). We also removed the cards that were too damaged due to the rain or with no trace of burnt (i.e., totally overcast days), for example. We have added this information in the manuscript.

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Line 276. Transparent rather than efficient.

Done. We have changed the word "efficient" for "transparent".

Line 372. Also shown to be dependent on time interval.

Done. We have introduced the time interval dependence in the manuscript.

Lines 443-447. The differences described are more than 'slight'.

We agree with the referee. We have removed the word "slightly" of the sentence.

Lines 530-531, 584-585, 622-624, 627-628, and 634-635. These references are incomplete.

Done. We have completed these references.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 9537, 2014.

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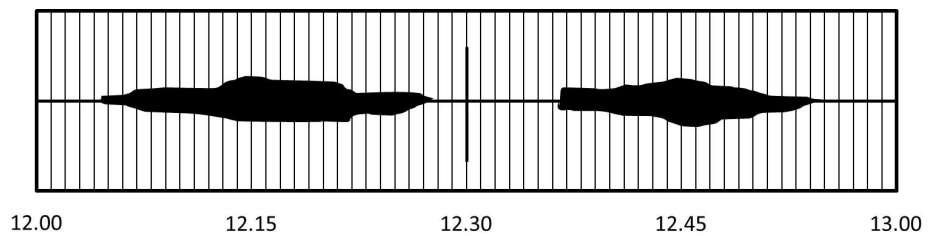


Fig. 1.

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