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On the relationship between cardboard burning in a sunshine recorder and the direct solar irradiance.

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Since the end of XIX century, the Campbell-Stokes recorder (CSR) has been the instrument used to measure the insolation (hours of sunshine during per day). Due to the large number of records that exist worldwide (some of them extending over more than 100 years), valuable climatic information can be extracted from them. There are various articles that relate the insolation with the cloudiness and the global solar irradiation (Angstrom-Prescott type formulas). Theoretically, the insolation is defined as the number of hours that direct solar irradiance (DSI) exceeds 120 W/m^2, thus corresponding to the total length of the burning in the bands. The width of the burn has not been well studied, so the aim of this research is to relate this width, first with the DSI and then, with other variables.

The research was carried out in Girona (NE Spain) for a period extending since February 2011. A CSR from Thies Clima and a pyrheliometer from Kipp&Zonen were used to measure insolation and the direct solar irradiance. Other meteorological variables were also stored for the study. For each band, we made two independent measurements of the width of the burn every 10 minutes: first, we measured directly the width of the perforated portion of the burn; second, we measured the width of the burn after applying a digital image process that increases the contrast of the burn.

The burn in a band has a direct relationship with the DSI. Specifically, correlation coefficients of the perforation width and the burning width with DSI were 0.838 and 0.864 respectively. However, we found that there are times when despite of DSI is as high as 400 W/m^2 (i.e. much greater than 120 W/m^2), there is no burn in the band. Contrarily, sometimes a burn occurs with almost no DSI. Furthermore, a higher DSI does not always correspond to a wider burn of the band. Because of this, we consider that characteristics of band burns must also depend on other meteorological variables (temperature, humidity...). The physical characteristics of the heliograph and of the cardboard from which the bands are made may also have an important role in this relationship.

The method was applied to a limited series of bands so the results and conclusions are preliminary. The first conclusion is the lack of accuracy that has the threshold value of 120 W/m^2 and the difficulty of giving a single value of this threshold. The sudden changes and intermittent weather conditions, combined with the poor temporal resolution of the measure of the burn width, reduce the correlation between burn and DSI. For further research aimed at the study of the behavior of the insolation due to the changing concentration of aerosols in the atmosphere, we need to increase the number of burned sunshine bands and to describe with more accuracy the limitations of heliographs.