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Campbell-Stokes sunshine duration measurements: An analysis of the possible effect of aerosol loading

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Since the end of the 19th century, the Campbell-Stokes sunshine recorder (CSSR) has been the instrument used to measure the sunshine duration (SD), i.e, the length of time that the ground surface is irradiated by direct solar radiation. 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. The World Meteorological Organization (WMO) defines the SD as the time during which the direct solar irradiance (DSI) exceeds the level of 120 W/m2. The burn is typically wider (narrower) when the direct insolation is stronger (weaker). The aim of this research is to test the impact of aerosols on the SD measurements, and to obtain a new and valuable method to extract information of the temporal evolution of aerosols.

The research was carried out in Girona (NE Spain), using cloudless days since February 2011. Two CSSR with two different types of bands and a pyrheliometer from Kipp&Zonen were used to measure the SD and the DSI, respectively. Other meteorological and radiometric variables were also stored for the study. To select the cloudless days, direct and global solar irradiance measurements were considered, with the support of the whole sky camera. For each band of these days, we have measured the burned area in intervals of 30 minutes, after applying a digital image processing that increases the contrast of the burn.

We assume that, if SD is indeed affected by the aerosol loading, the effect would not be punctual and the narrowing in the burning will be extended over a certain period of time. That is the reason why we are more interested in measuring areas and not widths of burning. Moreover, only cloudless days were selected in order to assure that a decrease of the burn is not due to thin clouds. We have considered that characteristics of band burns could also depend on other meteorological variables (temperature, humidity, etc.).

This method has been applied to a limited series of bands, so the results and conclusions are preliminary, but could offer a practical way to exploit the worldwide sets of long-term CSSR data to create long time series of atmospheric aerosol content. For further research we need to increase the number of burned sunshine bands and describe with more accuracy the limitations of the CSSR.