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Trends in surface solar radiation in Spain since the 1980s: the role of the changes in the radiative effects of aerosols and clouds

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There is a growing interest in the study of decadal variations in surface solar radiation, although the analyses of long-term time series in some areas with major gaps in observations, such as in Spain, are still pending. In the first part of this work, a previously published surface solar radiation dataset in Spain is described (for more details, see Sanchez-Lorenzo et al., 2013) based on the longest series with ground-based records of global and diffuse solar radiation, most of them starting in the early 1980s and ending in 2012. Particular emphasis is placed upon the homogenization of this dataset in order to ensure the reliability of the trends. The linear trend in the mean annual series of global solar radiation shows a significant increase since 1981 of 4.0 Wm-2 (or 2.4 %) per decade. These results are in line with the increase of global solar radiation (i.e. brightening period) reported at many worldwide observation sites (Wild, 2009). In addition, the annual mean diffuse solar radiation series shows a significant decrease during the last three decades, but it is disturbed by strong increases in 1983 and 1991-1992, which might reflect the effects of the El Chichón and Pinatubo volcanic eruptions as a result of enhanced scattering of the aerosols emitted during these large volcanic eruptions. As clouds and aerosols are the main sources of uncertainty in the determination of the energy balance of the Earth, there is a growing interest in the evaluation of their radiative effects and their impact on the decadal variability of the surface solar radiation. Hence, in the second part of this work, the changes of the combined radiative effects of clouds and aerosols in Spain since the 1980s are investigated (for more details, see Mateos et al., 2013). In particular, the global solar radiation data above mentioned and radiative transfer simulations fed with reanalysis data of ozone, water vapour and surface albedo, are used to evaluate the cloud and aerosol radiative effect (CARE) during the 1985-2010 period. The results show a significant decrease of CARE over Spain. Overall, the linear trend of the mean annual CARE series over Spain is 3.1 Wm-2 (or 5%) per decade, in line with those trends obtained for global solar radiation during the same period. Moreover, the radiative effects of water vapour and ozone have no significant trends during the study period. In conclusion, our study in Spain supports the hypothesis usually considered to explain the widespread surface solar radiation trends by changes in aerosols and clouds (Wild, 2009). Other atmospheric variables, such as ozone column or atmospheric water vapour play a minor, almost negligible, role on these trends.

References:

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