Proposal of a method to separate the shortwave radiative effects of clouds and aerosols

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The planetary radiative energy balance is a crucial topic to better understand the climate change. Two of the main factors controlling the radiation levels at the Earth's surface are clouds and aerosols. However, it is not a simple task to obtain, simultaneously, their radiative effects. Hence, this study proposes a method which is able to provide, at the same time, the cloud (CRE) and aerosol (ARE) radiative effects. The method is based on experimental shortwave (SW) data, ground-based aerosol observations, and radiative transfer simulations. Furthermore, the entire cloud-aerosol system is also characterized by its radiative effect (CARE). We apply this method to a particular case, the strong brightening period observed in the Iberian Peninsula (Southwestern Europe) between 2003 and 2012. To this end, we used the monthly SW radiation and aerosol optical depth measurements in three ground-based sites: Valladolid and Barcelona (Spain), and Évora (Portugal). For the analyzed period, the average trend rates of CARE, CRE, and ARE are: +7.5, +5.2, and +1.6 W/m2 per decade, respectively. Therefore, almost three-fourths of the recent changes in radiative effects are explained by clouds, while the other one-fourth is related to aerosol changes. Finally, the estimations given by our method are compared against the CRE retrievals from CERES (Clouds and Earth's Radiation Energy Budget System) product. Overall, there is a good agreement between the two estimations, highlighting the relevance of the method proposed in this study. Other variables such as total cloud cover and aerosol load are in line with the temporal trends obtained for CARE, CRE, and ARE during the observed brightening period since the 2000s in the Iberian Peninsula.

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