Geophysical Research Abstracts
Vol. 17, EGU2015-7732, 2015
EGU General Assembly 2015

What is the role of aerosols and clouds in the observed brightening since the mid-1980s over Spain?

Arturo Sanchez-Lorenzo (1), David Mateos (2), Manuel Antón (3), Martin Wild (4), Josep Calbó (5), Pierre Nabat (6), Victoria E. Cachorro (2), Maria João Costa (7), Samuel Somot (6), Marc Mallet (8), Benjamin Torres (2), Blanka Bartok (4), Maria Hakuba (4), Joel Norris (9), Sergio M. Vicente-Serrano (1), and Jörg Trentmann (10)

(1) IPE-CSIC, Zaragoza, Spain (arturo.sanchez@udg.edu), (2) Grupo de Óptica Atmosférica, University of Valladolid, Valladolid, Spain, (3) Department of Physics, University of Extremadura, Badajoz, Spain, (4) Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland, (5) Department of Physics, University of Girona, Girona, Spain, (6) Météo-France, CNRM-GAME, UMR3589, Toulouse, France, (7) Évora Geophysics Centre and Department of Physics, University of Évora, Évora, Portugal, (8) Laboratoire d'Aérologie, UMR5560, Toulouse, France, (9) Scripps Institution of Oceanography, University of California San Diego, La Jolla, United States, (10) Deutscher Wetterdienst (DWD), Offenbach, Germany

The contribution of clouds and aerosols to the decadal variations of downward surface shortwave radiation (SSR) is a key issue in the study of the dimming/brightening phenomenon and its causes. In this study, we first describe a dataset of SSR in Spain based on the 13 longest series with records starting in the early 1980s. Particular emphasis is placed upon the homogenization of this dataset in order to ensure the reliability of the trends, which can be affected by non-natural factors such as relocations or changes of instruments (for more details, we refer to Sanchez-Lorenzo et al., 2013). The mean annual SSR series over Spain shows a tendency to increase since the 1980s (i.e. brightening period), with a significant linear trend of around 4.0 Wm-2 (2.0%) decade-1, although with the strongest rate of increase since the 2000s. In a second step, radiative transfer simulations fed with reanalysis data of ozone, water vapour and surface albedo, are used to evaluate the changes in the cloud and aerosol radiative effect (CARE), the water vapour radiative effect (WRE), and ozone radiative effect (ORE) in the same 13 stations over Spain since the mid-1980s. The linear trend of the mean annual CARE series is statistically significant with positive sign (i.e. positive values point out a decrease in the radiative effects caused, and thus a weaker effect). On the other hand, the radiative effects of WRE and ORE show no significant trends since the mid-1980s (for more details, we refer to Mateos et al., 2013). These results point towards a diminution of clouds and/or aerosols over the area. Consequently, in addition, we have examined climate simulations based on reanalysis-driven coupled regional climate system modeling (for more details, see Nabat et al., 2014), which suggest that aerosol changes explain a large part of the brightening observed in Europe and Spain since the 1980s. Specifically, the direct aerosol effect is found to dominate the simulated brightening. Nevertheless, changes in clouds also play a significant role in the observed trends in SSR, as highlighted by a significant decrease in total cloud cover as observed by using ground-based and satellite-derived observations, and consequently of the cloud cover radiative effect, since the 1980s. Finally, we have focused on the strong brightening observed since the early 2000s in Spain. Specifically, we have used a method based on surface-based SSR measurements, aerosol observations, and radiative transfer simulations (in cloud-free and cloud- and aerosol-free scenarios), to evaluate CARE, cloud (CRE), and aerosol (ARE) radiative effects (more details in Mateos et al., 2014). The calculations are performed only for three surface-based sites and limited to the period 2003-2012 due to data availability. The average trends for the analyzed period of CARE, CRE, and ARE are +7, +5, and +2 Wm-2 decade-1, respectively. Overall, three fourths of the SSR trend during the period 2003-2012 is explained by clouds, while the other one fourth is related to aerosol changes. In summary, the results presented in this study highlight the need of accurate estimates of the changes in the aerosol and cloud radiative effects in order to understand the causes of the dimming/brightening phenomenon.

References

Mateos, D., M. Antón, A. Sanchez-Lorenzo, J. Calbó, and M. Wild (2013), Long-term changes in the radiative effects of aerosols and clouds in a mid-latitude region (1985–2010), Global Planet. Change, 111, 288–295, doi:10.1016/j.gloplacha.2013.10.004.

Mateos, D., A. Sanchez-Lorenzo, M. Antón, V. E. Cachorro, J. Calbó, M. J. Costa, B. Torres, and M. Wild (2014), Quantifying the respective roles of aerosols and clouds in the strong brightening since the early 2000s over the Iberian Peninsula, J. Geophys. Res. Atmos., 119, doi:10.1002/2014JD022076.

Nabat, P., S. Somot, M. Mallet, A. Sanchez-Lorenzo, and M. Wild (2014), Contribution of anthropogenic sulfate aerosols to the changing Euro-Mediterranean climate since 1980, Geophys. Res. Lett., 41, doi:10.1002/2014GL060798.

Sanchez-Lorenzo, A., J. Calbó, and M. Wild (2013), Global and diffuse solar radiation in Spain: Building a homogeneous dataset and assessing trends, Global Planet. Change, 100, 343–352, doi:10.1016/j.gloplacha.2012.11.010.