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Impacts of aerosols on photovoltaic energy production in the Euro-Mediterranean area

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The overall increase in the photovoltaic (PV) installed capacity over the world in last decades, has lead to a demand of better understanding of solar resource and its spatiotemporal variability. In the energy sector, stakeholders needs range from the short-term forecasting in operational activities to longer time scale issues, related to planning activities or feasibility studies.

Regarding the link between solar resource and changes in atmospheric variables, there is an increased concern about its availability under climate change conditions. Due to that, climate modeling has revealed itself as a valuable tool for evaluating the near future energy potential, even considering some constraints of these models like spatial resolution and characterization of clouds.

Cloudiness are generally the main source of variability of solar resource but in clear sky conditions, aerosols become the main cause of the depletion in photovoltaic electricity production.

The Mediterranean region is highly influenced by aerosols coming from different sources. The possible changes in solar resource and PV potential in climate change scenarios have been recently investigated using either global or regional climate models over Europe. However, most of the regional studies show limitations due to the lack of consideration of aerosols in the simulations and the application of simplified PV production models.

Here we evaluate the impact of aerosols in the spatiotemporal variability of photovoltaic production in the Euro-Mediterranean area. We use climate simulations of a regional climate model that includes a realistic interannual climatology of aerosols and then we apply a detailed PV production model to simulate the system performance, including tracking movements of the panels.

Three different approaches are evaluated to show the implications that aerosols have in PV production: first, long simulations of the 'brightening' period are able to reproduce the positive trend observed in solar radiation since the eighties, illustrating the impact that pollution control policies could have in PV energy production for high polluted areas.

Secondly, simulations from the period between 2003-2009 show that aerosols reduce PV production over the Euro-Mediterranean area for more than 10% in some regions for fixed panels in annual terms. For PV panels including tracking system, the sensitivity to solar radiation changes increases, reaching values above 15% in some regions. Seasonality of aerosols over the studied area causes an annual cycle where relative PV power can be significantly reduced (more than 15%) for some months.

Finally, some RCP4.5 scenario runs from the MED-CORDEX initiative are evaluated to show the differences in the evolution of solar resource when aerosols are included in the simulations, highlighting its importance.