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Impact of atmospheric aerosols on solar energy production - Dust outbreak in West Africa

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Solar energy plants are one of the key options to serve the rising global energy need with low environmental impact. Aerosols reduce global solar radiation due to absorption and scattering and therewith solar energy yields. Depending on the aerosol composition and size distribution they reduce the direct component of the solar radiation and modify the direction of the diffuse component compared to standard atmospheric conditions without aerosols. The aerosol characteristics are highly variable due to changing meteorological conditions influencing aerosol microphysical processes and transport. In addition variable land surface conditions act as the source region. Especially extreme events like dust outbreaks can cause high variations in aerosol optical properties over a whole region. By being a region with a lack in conventional energy production and prone to high solar radiation, West Africa shows high potential for the development of solar energy systems. However, dust outbreaks occur frequently in the Sahel zone and affect the whole region for several days. Their effect on energy production and therewith on storage dimension and network development needs to be considered for the development of an energy system with a considerable share of solar power.

This study aims to identify the effect of atmospheric aerosols during a dust outbreak in March 2006 for two solar energy technologies, namely a photovoltaic (PV) and a parabolic through (PT) power plant. Here we focus on West Africa, where six stations with available meteorological data are located (Agoufou (15.3 N, 1.5 W), Banizoumbou (13.5 N, 2.7 E), Dakar (14.4 N, 17 W), Djougou (9.8 N, 1.6 E), Niamey (13.5 N, 2.1 E) and Maine-Soroa (13.2 N, 12 E)). Guided by observations a model chain is used to determine potential PV and PT power yields. The atmospheric aerosol composition is defined by using the desert scenario of the Optical Properties of Aerosols and Clouds (OPAC) library. During the identified dust outbreak between the 6th and 17th of March 2006 aerosol optical properties and water vapor from the aerosol robotic network (AERONET, http://aeronet.gsfc.nasa.gov/) are used as an input for radiative transfer (libRadtran) and subsequent solar power calculations (PV and PT). To investigate the impact of the dust outbreak on top of the background conditions for each location, predominantly cloud free days are selected and the daily reduction of solar power yields due to aerosols is determined over total 2006 with our model calculations.

This presentation will introduce the modeling chain to assess PV and PT power yields for different stations in West Africa and address their relative dependence on aerosol conditions with a focus on a twelve days dust outbreak.