Laboratoire : Centre National de Recherches Météorologiques

Titre du stage: Simulating the impact of aerosols on photovoltaic production over AROME domain

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Sujet du stage :

Context **:**

The share of renewables in the gross electricity production of Europe has rapidly increased over the last decade. In particular, PV capacity has doubled between 2011 and 2017, so that the need for accurate forecasts of PV production has become a critical issue. Numerical weather prediction (NWP) models are generally used to predict direct and diffuse surface incoming shortwave (SW) irradiance (SSI), which are then converted into PV production. The computation of SW fluxes accounts for the properties of the surface (albedo) and the constituents of the atmosphere (gases, clouds, aerosols). Clouds and aerosols are the largest contributors of SSI spatial and temporal variability and explain most of the limitations of NWP models to accurately predict SSI. One reason is that most NWP models account for aerosols solely through climatologies, so that the amount of aerosols simply depends on the location and date. As a consequence, it cannot correctly capture rapid changes in atmospheric composition or particular events of high aerosols loads, with dramatic consequences on the PV forecasts (Rieger et al., 2017). The internship aims at estimating the error on PV production resulting from this simple representation of aerosols in NWP.

Objectives **:**

In a first part the impact of aerosols on PV production will be investigated theoretically by coupling the radiative transfer code ecRad (Hogan and Bozzo, 2018) with a model that converts SSI into PV power. This model will be used to investigate how aerosols affect PV production through absorption, spectral filtering and scattering that converts direct radiation into diffuse. Various aerosol types (dust, black carbon, sulfates and sea salt) will be explored, by varying their amount, vertical distribution and optical properties. The coupling between the spectral signatures of the aerosols and the spectral response of PV modules will be studied in details.

In a second part, the differences in PV estimations between various aerosols configurations of the French operational NWP model AROME (Seity et al., 2011), which covers a large portion of Western Europe, will be assessed. To this end, one year of atmospheric profiles computed by AROME will be fed into ecRad. These profiles will be aerosols-free, or will include aerosols coming either from the current AROME climatology, from the Copernicus Atmosphere Monitoring Service (CAMS) aerosols product, or from the AERUS-GEO satellite product (Carrer et al., 2014). The comparison will provide the relative contribution of each aerosol type to the overall impact on PV production. It will also quantify the current error due to the climatological representation.

References :

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Rieger, D., Steiner, A., Bachmann, V., Gasch, P., Förstner, J., Deetz, K., ... & Vogel, H. (2017). Impact of the 4 April 2014 Saharan dust outbreak on the photovoltaic power generation in Germany. *Atmospheric Chemistry and Physics*, *17*(21), 13391.

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