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Energy meteorology studies investigating the impact of clouds on solar energy production – Coupling a spectrally resolved radiation model and a two-diode model for solar cells to simulate PV power yields

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Solar energy is one option to serve the rising global energy demand with low environmental Impact [1]. Building an energy system with a considerable share of solar power requires long-term investment and a careful investigation of potential sites. Therefore, understanding the impacts from varying regionally and locally determined meteorological conditions on solar energy production will influence energy yield projections. Clouds are moving on a short term timescale and have a high influence on the available solar radiation, as they absorb, reflect and scatter parts of the incoming light [2]. However, modeling photovoltaic (PV) power yields with a spectral resolution and local cloud information gives new insights on the atmospheric impact on solar energy.

In the present study we present a model, which couples atmospheric impacts from clouds on radiation outputs and their influence on PV yields to analyze the impact of clouds on PV power yields. An atmospheric column model, the libradtran library [3], is used, which simulates direct, diffuse and global radiation in a one-nanometer resolution. For the information about cloud coverage and type the satellite based APOLLO [4] methodology is applied and implemented into the radiation model. The determination of the short-circuit-current of the PV plant is directly undertaken by using the quantum efficiency of the cell [5]. Afterwards, the two-diode-model[6,7] is used for the calculation of the PV power yields for each spectral step. The minimal timely resolution is 15min. To validate the model measurements of solar radiation, cloudiness and PV-energy yields are set out at the location of Bonn-Rhein-Sieg University (50°46’47"N, 7°10’58"E).

References:
[1] Solangi, K. H., Islam, M. R., Saidur, R., Rahim, N. a. & Fayaz, H. A review on global solar energy policy. Renew. Sustain. Energy Rev. 15, 2149–2163 (2011).
[2] Cai, C. & Aliprantis, D. C. Cumulus cloud shadow model for analysis of power systems with photovoltaics. IEEE Trans. Power Syst. 28, 4496–4506 (2013).
[3] Mayer, B. & Kylling, A. Technical note: The libRadtran software package for radiative transfer calculations - description and examples of use. Atmos. Chem. Phys. Discuss. 5, 1319–1381 (2005).
[4] Saunders, R. W. & Kriebel, K. T. An improved method for detecting clear sky and cloudy radiances from AVHRR data. Int. J. Remote Sens. 9, 123–150 (1988).
[5] Zinßer, B., Schubert, M. B. & Werner, J. H. Spectral Dependent Annual Yield of Different Photovoltaic Technologies. Proc. 26th Eur. Photovolt. Sol. Energy Conf. Exhib. 3615–3618 (2011).
[6] Sah, C.-T. S. C.-T., Noyce, R. N. & Shockley, W. Carrier Generation and Recombination in P-N Junctions and P-N Junction Characteristics. Proc. IRE 45, (1957).
[7] Ishaque, K., Salam, Z. & Taheri, H. Accurate MATLAB Simulink PV System Simulator Based on a Two-Diode Model. J. Power Electron. 11, 179–187 (2011).