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Deep Learning Approaches for High-resolution Solar Irradiance and Solar Power Nowcasting

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PV / solar power production is fostered to become one of the most powerful renewable energy sources in Central Europe to tackle our growing energy demands. While the just recently emerging PV power observations often record highly resolved real-time data for a relatively short time-horizon, solar irradiance offers long time-series using automatized weather station networks. Being closely linked, irradiance can act as a relevant input and estimate for PV forecasting. Particularly, long time series may be exploited for generating synthetic training datasets. However, both irradiance and PV can be challenging in forecasts using machine learning methods as they embrace a high degree of diurnal and seasonal variation.

Deep learning offers us new opportunities to generate highly resolved weather forecasts by learning relations in complex datasets. In this study, we investigate the suitability of several deep learning techniques for irradiance and PV nowcasts. Our main models investigated includes a sequence-to-sequence LSTM (long-short-term-memory; a type of artificial neural network) model using a climatological background model or NWP (numeric weather forecasting model) for post-processing, a Graph ANN (artificial neural network) model, and an analogs based deep learning method. Relevant input features include 3D-fields from NWP models (e.g.: AROME), satellite data and products (e.g.: CAMS), radiation time series from remote sensing, and observation time-series.

Results for selected topologically diverse locations obtained by the developed method yield, in general, high forecast-skills, where we elaborate on interesting cases studies from a meteorological point of view. Different combinations of inputs and processing-steps are considered. We compare obtained forecast results to forecasts produced by traditional methods.