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Viability of satellite derived irradiance data for ML-based nowcasts

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Photovoltaic (PV) power production is increasingly becoming a central pillar in the shift to renewable power sources. The use of solar irradiance has great potential, as it is practically limitless and globally provides magnitudes more energy to the Earth than currently or foreseeable required. Solar irradiance as a power source does, however come with certain downsides. Besides the effects of seasonality and day-night-cycles on its usable potential, it´s broad use suffers mostly from uncertainty through its volatility. The actual extent of solar irradiance at the surface of the Earth is strongly influenced by a variety of atmospheric phenomena, most prominently clouds and atmospheric turbidity. The forecasting of near-future solar irradiance can thereby be beneficial in the estimation of PV power production in itself and with the goal of maintaining a stable equilibrium in electrical grids.

To achieve nowcasts on a larger grid scope, forecasting of solar irradiance from satellite data can substitute forecasting of power output for individual sites. Satellite data, in contrast to ground-based data sources or NWP model estimates, is less reliant on the proper workings of a wide range of externalities. General-purpose spatiotemporal neural networks can be adapted to this task and provide predictions within a very short timeframe, with no requirement of HPC-infrastructure. A sparse model relying on a single satellite-based data source has less points of failure that could affect its forecasting performance and can be very efficient, but this sparsity could also reduce the achievable predictive accuracy. Benefits of smaller and simpler forecasting pipelines therefore may need to be balanced with requirements in terms of accuracy.

To gather more meaningful and reliable results, a variety of spatiotemporal neural networks is implemented and tested to provide a more meaningful foundation. The models were selected and evaluated with respect to their different architectural patterns and designs, to get a notion of architectures beneficial to this task and achieve a more generalizable argument concerning the use satellite data as the sole basis of solar irradiance nowcasting.

In an attempt of improving the viability of satellite-based nowcasting a commonly occurring flaw in near-real-time satellite data sources, missing or skipped frames, solutions to mitigate issues in operational nowcasting are considered. In place of ad-hoc preprocessing such as interpolation of missing data frames, an attempt to condition the models to missing frames is made.