EMS Annual Meeting Abstracts
Vol. 14, EMS2017-791, 2017
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Optimized DNI forecast using combinations of nowcasting methods from the DNICast project

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Introduction

The efficient operation of concentrating solar technologies (CST) requires reliable forecasts of the Direct Normal Irradiance (DNI) for two main reasons: a better management of the thermodynamic cycle and the optimization of electricity produced/supplied to the grid. Within the EU FP7 project DNICast (Direct Normal Irradiance Nowcasting methods for the optimized operation of concentrating solar technologies), a set of innovative and/or improved forecast methods are proposed. Three different methodologies with different nowcast windows have been developed and combined to improve the nowcasting outputs:

- DNI nowcasting method with all sky imagers for the next 0 to 15 min (part of the intra-hour nowcasting window according to the definition used in electricity grid operations).
- Satellite based cloud and DNI nowcasting methods: intra-hour and intraday window, 5 min – 360 min.
- Numerical Weather Prediction (NWP) based nowcasting methods: intraday and intraweek window, 60 min – 360 min and more.

Combination methodologies and results

Two combination approaches have been tested. We have selected different nowcasting outputs from the DNICast project which have been tested at PSA. Data of 12 months have been analyzed.

The first approach makes use of the uncertainty of each input nowcasting data set. To calculate the optimal combination of the different provided nowcasts, the method of is applied to derive a combined product, considering the individual uncertainties of the nowcast products.

The second combination method uses a time-dependent multi-regressive model inspired by the forecasting optimization of precipitation. An adaptive linear merging model is presented. The explanatory variables are DNI values predicted in previous forecast events. Thus, each DNICast nowcasting output provides a number of variables depending on the forecasted horizon, the refresh time and the time step.

In the full paper, the models and the validation of the combined models with pyrheliometer measurements of DNI in comparison to each individual nowcast for several periods from 2010 to 2015 will be presented. It was found that the RMSE of the combined nowcasts lies significantly below the RMSE of the single nowcast methods. For example for the uncertainty based nowcast combination a reduction from 305-339 W/m^2 of the different methods to 272 W/m^2 was found for June to August 2015. In general, combined model underestimates the variability when the optimized model overestimates it.