IMPACT OF MEASUREMENT INTEGRATION TIME ON THE OBSERVED ACCURACY OF SOLAR RADIATION NWP FORECAST MODELS

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Introduction

Hourly solar radiation models are generally validated against hourly integrated measurements. However some models are inherently instantaneous models. This is the case for satellite-derived irradiance models which process instantaneous (albeit spatially integrated) images. Numerical weather prediction (NWP) forecast models also produce time-specific outputs.

This note investigates the impact of measurement time integration upon the observed accuracy of hourly NWP GHI forecasts.

Methods

In a recent study undertaken as part of the present contract, Perez et al. (2011) compared the performance of several NWP GHI forecasts models. Performance was evaluated against one year of hourly-integrated irradiances measured at the seven SURFRAD network locations listed in Table 1.

TABLE 1

Station	Latitude	Longitude	Elevation	Climate
Goodwin Creek	34.25	89.87	98 m	subtropical
Desert Rock	36.63	116.02	1007 m	Arid
Bondville	40.05	88.37	213 m	Continental
Boulder	40.13	105.24	1689 m	Semi-arid
Penn State	40.72	77.93	376 m	humid continental
Sioux Falls	43.73	96.62	473 m	Continental
Fort Peck	48.31	105.10	634 m	Continental

For the present investigation, we selected one of the models that performed best in this evaluation: the European Center for Medium Range Weather Forecasts (ECMWF) model provided by the University of Oldenburg (Lorenz et al., 2009).

Retaining the validation data from the model comparison analysis, we modified the data by considering integration times ranging from one minute up to two hours – centering the integration upon the model time stamp – and looked at the impact of integration upon on four metrics quantifying accuracy. The four metrics include.

1. The mean bias error MBE,
2. The root mean square error RMSE,
3. The mean absolute error MAE , and
4. The Kolmogorov-Smirnov Integral statistic, KSI.

Results

Figure 1 reports observed relative RMSE, MAE, MBE and KSI as a function of measurement time integration.

While the MBE increases marginally with time integration, the RMSE, MAE and, to a lesser extent, the KSI markedly improve with time integration, with the best apparent performance registering for two hours integration.

Discussion

Why is the comparison with short time integration data worse than long integration time? While short time integration exactly matches the models' solar geometry conditions, this is not enough of an advantage to make up for the fluctuation smoothing induced by longer time integration. This smoothing reflects the nature of the day-ahead NWP models which cannot account for short-term variability/specificity. NWP forecast models (and satellite models to lesser extent) offer results which inherently deliver temporal (and spatial) integration and cannot yet deterministically predict the time/site specific microstructure of cloud fields.

The fact that two hours does the best on day-ahead forecasts provides a measure of the spatial/temporal precision of these models.

Trends are consistent for all sites, with a small departure for Boulder which is the one site were time exactitude is slightly more valuable because of the site's propensity for rapidly evolving conditions.

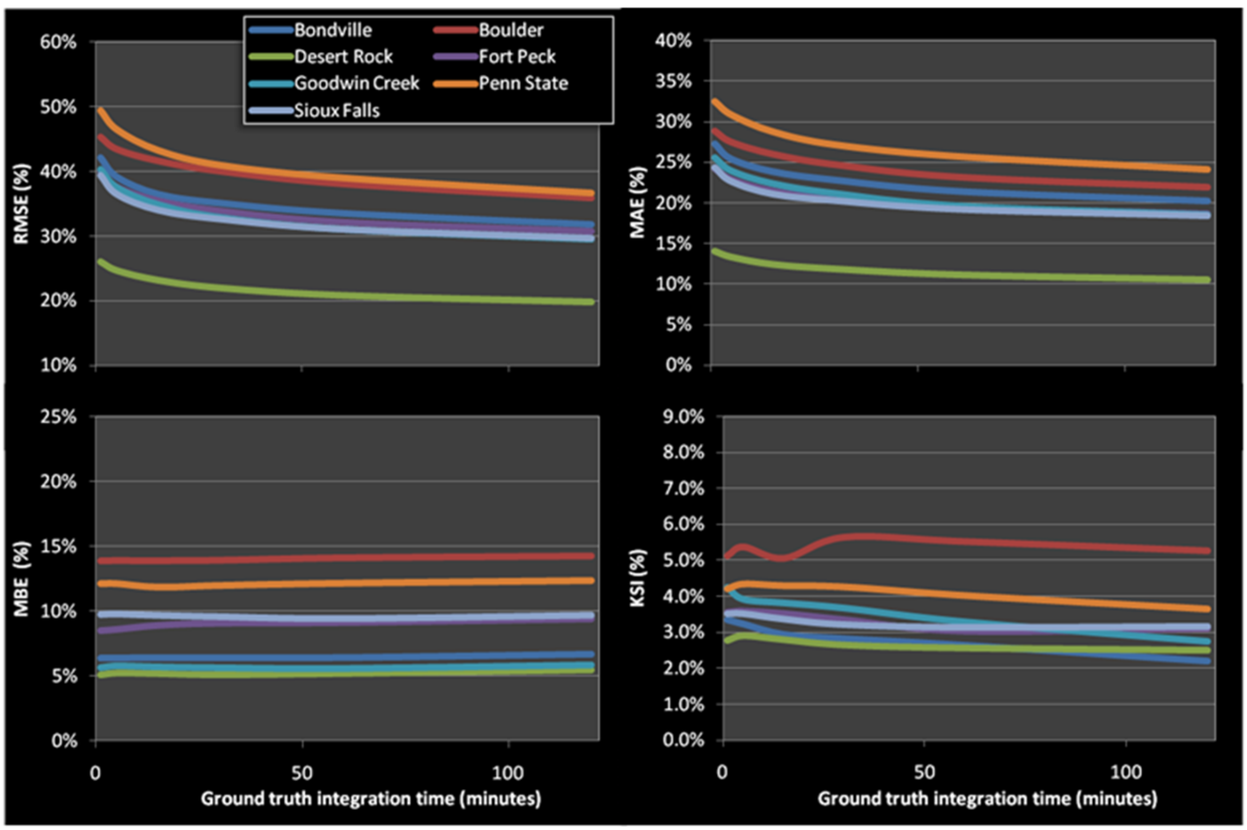

Figure 1

Reference

Perez R., M. Beauharnois, K. Hemker, Jr., S. Kivalov, E. Lorenz, S. Pelland, J. Schlemmer, G. Van Knowe (2011): Evaluation of Numerical Weather Prediction Solar Irradiance Forecasts in the US. Proc. ASES National Conference, Raleigh, NC.

Lorenz, E; Hurka, J; Heinemann, D, Beyer H.G (2009): 'Irradiance Forecasting for the Power Prediction of Grid-Connected Photovoltaic Systems', IEEE Journal of Special Topics in Earth Observations and Remote Sensing, 2, 2–10