

Table A.2

Summary of error statistics for network forecasts for all 91 days. Error statistics were calculated for the entire dataset at once. Only forecasts and data with solar zenith angle less than 75° were used. The mean irradiance was $\bar{y} = 694 \text{ W/m}^2$ and the mean clear-sky index was $\bar{k} = 0.96$.

FH (min)	rMAE (%)	MAE (W/m^2)	MBE (W/m^2)	rRMSE (%)	RMSE (W/m^2)	Avg. skill (%)
1	2.92	18.40	−0.97	8.84	61.67	22.54
3	4.40	28.31	−1.69	11.71	81.31	22.77
5	5.43	35.09	−4.05	13.70	93.09	19.36
10	6.76	42.90	−8.48	16.19	103.53	18.33
20	7.78	49.06	−9.79	17.58	111.76	18.43
30	8.16	51.35	−8.43	17.91	112.73	20.97
60	8.97	56.41	−7.88	19.44	117.55	20.74
120	9.89	62.72	−4.75	21.34	126.16	19.33

Appendix B. Supplementary material

Location metadata, measurements, clear-sky expectations, and cloud motion vectors used in this study have been released online under the CC-BY-NC 4.0 license (Lorenzo et al., 2015).

References

- Achleitner, S., Kamthe, A., Liu, T., Cerpa, A.E., 2014. SIPS: solar irradiance prediction system. In: IPSN-14 Proceedings of the 13th International Symposium on Information Processing in Sensor Networks, pp. 225–236. <http://dx.doi.org/10.1109/IPSIN.2014.6846755>.
- Bilionis, I., Constantinescu, E.M., Anitescu, M., 2014. Data-driven model for solar irradiation based on satellite observations. *Sol. Energy* 110, 22–38. <http://dx.doi.org/10.1016/j.solener.2014.09.009>.
- Bosch, J., Zheng, Y., Kleissl, J., 2013. Deriving cloud velocity from an array of solar radiation measurements. *Sol. Energy* 87, 196–203. <http://dx.doi.org/10.1016/j.solener.2012.10.020>.
- Chu, Y., Pedro, H.T., Li, M., Coimbra, C.F., 2015a. Real-time forecasting of solar irradiance ramps with smart image processing. *Sol. Energy* 114, 91–104. <http://dx.doi.org/10.1016/j.solener.2015.01.024>.
- Chu, Y., Urquhart, B., Gohari, S.M., Pedro, H.T., Kleissl, J., Coimbra, C.F., 2015b. Short-term reforecasting of power output from a 48 MWe solar PV plant. *Sol. Energy* 112, 68–77. <http://dx.doi.org/10.1016/j.solener.2014.11.017>.
- Cormode, D., 2015. Large and Small Photovoltaic Powerplants. PhD Dissertation. University of Arizona.
- Diagne, M., David, M., Boland, J., Schmutz, N., Lauret, P., 2014. Post-processing of solar irradiance forecasts from WRF model at Reunion Island. *Sol. Energy* 105, 99–108. <http://dx.doi.org/10.1016/j.solener.2014.03.016>.
- Elsinga, B., van Sark, W.G., 2014. Inter-system time lag due to clouds in an urban PV ensemble. In: 2014 IEEE 40th Photovoltaic Specialist Conference (PVSC). No. 4, pp. 0754–0758. <http://dx.doi.org/10.1109/PVSC.2014.6925029>.
- Franke, R., 1982. Scattered data interpolation: tests of some methods. *Math. Comput.* 38 (157), 181–200. <http://dx.doi.org/10.1090/S0025-5718-1982-0637296-4>.
- Fung, V., Bosch, J.L., Roberts, S.W., Kleissl, J., 2014. Cloud shadow speed sensor. *Atmos. Meas. Tech.* 7 (6), 1693–1700. <http://dx.doi.org/10.5194/amt-7-1693-2014>.
- Gueymard, C.A., 2008. REST2: high-performance solar radiation model for cloudless-sky irradiance, illuminance, and photosynthetically active radiation validation with a benchmark dataset. *Sol. Energy* 82 (3), 272–285. <http://dx.doi.org/10.1016/j.solener.2007.04.008>.
- Hammer, A., Heinemann, D., Lorenz, E., Lücke, B., 1999. Short-term forecasting of solar radiation: a statistical approach using satellite data. *Sol. Energy* 67 (1–3), 139–150. [http://dx.doi.org/10.1016/S0038-092X\(00\)00038-4](http://dx.doi.org/10.1016/S0038-092X(00)00038-4).
- Hill, C.A., Such, M.C., Chen, D., Gonzalez, J., Grady, W.M., 2012. Battery energy storage for enabling integration of distributed solar power generation. *IEEE Trans. Smart Grid* 3 (2), 850–857. <http://dx.doi.org/10.1109/TSG.2012.2190113>.
- Ineichen, P., Perez, R., 2002. A new airmass independent formulation for the Linke turbidity coefficient. *Sol. Energy* 73 (3), 151–157. [http://dx.doi.org/10.1016/S0038-092X\(02\)00045-2](http://dx.doi.org/10.1016/S0038-092X(02)00045-2).
- Inman, R.H., Pedro, H.T., Coimbra, C.F., 2013. Solar forecasting methods for renewable energy integration. *Prog. Energy Combust. Sci.* 39 (6), 535–576. <http://dx.doi.org/10.1016/j.pecs.2013.06.002>.
- Joskow, P.L., 2011. Comparing the costs of intermittent and dispatchable electricity generating technologies. *Am. Econ. Rev.* 101 (3), 238–241. <http://dx.doi.org/10.1257/aer.101.3.238>.
- Kleissl, J. (Ed.), 2013. *Solar Energy Forecasting and Resource Assessment*, first ed. Elsevier, Oxford. <http://dx.doi.org/10.1016/B978-0-12-397177-7.18001-5>.
- Lauret, P., Diagne, M., David, M., 2014. A neural network post-processing approach to improving NWP solar radiation forecasts. *Energy Procedia* 57, 1044–1052. <http://dx.doi.org/10.1016/j.egypro.2014.10.089>.
- Lave, M., Kleissl, J., 2013. Cloud speed impact on solar variability scaling application to the wavelet variability model. *Sol. Energy* 91, 11–21. <http://dx.doi.org/10.1016/j.solener.2013.01.023>.
- Leuthold, M., 2015. The University of Arizona Department of Atmospheric Sciences – Arizona Regional WRF Model Data. <<http://www.atmo.arizona.edu/index.php?section=weather&id=wrf>>.
- Lipperheide, M., Bosch, J., Kleissl, J., 2015. Embedded nowcasting method using cloud speed persistence for a photovoltaic power plant. *Sol. Energy* 112, 232–238. <http://dx.doi.org/10.1016/j.solener.2014.11.013>.
- Lonij, V.P., Brooks, A.E., Cronin, A.D., Leuthold, M., Koch, K., 2013. Intra-hour forecasts of solar power production using measurements from a network of irradiance sensors. *Sol. Energy* 97, 58–66. <http://dx.doi.org/10.1016/j.solener.2013.08.002>.
- Lorenzo, A.T., Cronin, A.D., Holmgren, W.F., 2015. Irradiance Monitoring Network Data and Wind Motion Vectors. <<http://zenodo.org/record/29070>>.
- Lorenzo, A.T., Holmgren, W.F., Leuthold, M., Kim, C.K., Cronin, A.D., Betterton, E.A., 2014. Short-term PV power forecasts based on a real-time irradiance monitoring network. 2014 IEEE 40th Photovoltaic Specialist Conference (PVSC), pp. 0075–0079. <http://dx.doi.org/10.1109/PVSC.2014.6925212>.
- Marquez, R., Coimbra, C.F.M., 2012. Proposed metric for evaluation of solar forecasting models. *J. Sol. Energy Eng.* 135 (1), 011016. <http://dx.doi.org/10.1115/1.4007496>.
- Marquez, R., Pedro, H.T., Coimbra, C.F., 2013. Hybrid solar forecasting method uses satellite imaging and ground telemetry as inputs to ANNs. *Sol. Energy* 92, 176–188. <http://dx.doi.org/10.1016/j.solener.2013.02.023>.
- Mathiesen, P., Kleissl, J., 2011. Evaluation of numerical weather prediction for intra-day solar forecasting in the continental United States. *Sol. Energy* 85 (5), 967–977. <http://dx.doi.org/10.1016/j.solener.2011.02.013>.