Developing Solar Forecasting Model Diagnostics of Cloud Impacts on Solar Variability

L. Riihimaki[1,2], J. Sedlar[1,2], K. Lantz[1,2], and L. Berg[3]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309; 303-497-5244, E-mail: laura.riihimaki@noaa.gov
[2]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[3]Pacific Northwest National Laboratory, Richland, WA 99352

Solar forecasting can help manage the inclusion of solar energy with its inherent variability into the electrical grid. Because traditional weather models were designed to predict temperature and precipitation, they have not been optimized for solar forecasting. To improve intraday and day-ahead forecasts of the solar resource in weather forecasting models, we need observational tools to quantify the impacts of clouds on surface solar irradiance at short and long time scales, allowing testing and development of new parameterizations and model configurations to better simulate surface irradiance. To produce these observational tools, we examine surface irradiance amounts and variability by cloud type and cloud fraction. Initial testing and development is done at the Atmospheric Radiation Measurement (ARM) Southern Great Plains site using cloud type determined from cloud layer height measurements from vertically pointing cloud radar and lidar. The combination of cloud radar and lidar can give a relatively comprehensive picture of the vertical structure of multilayered clouds. We test and show that using a ceilometer alone, which measures lowest cloud base, can still give a reliable cloud type classification for the purposes of estimating surface irradiance variability and amount. The Surface Radiation (SURFRAD) network is now installing ceilometers at all sites. This allows us to expand the cloud type analysis to the SURFRAD network throughout the continental U.S., giving a much wider observational data set for testing models in different climatic regimes and weather conditions.

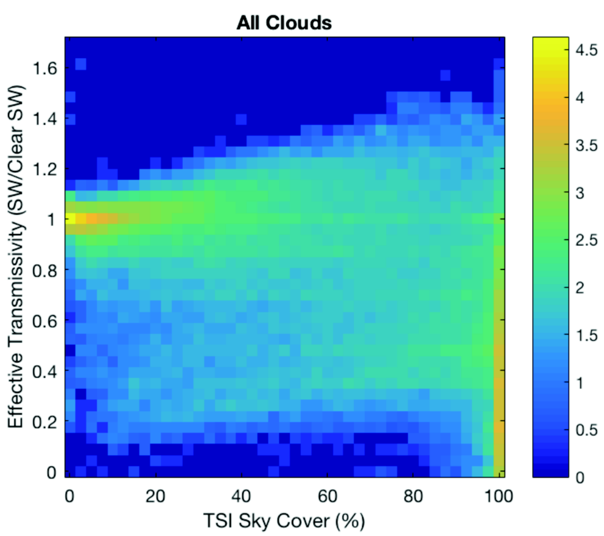

Figure 1. Density plot of cloud fraction (measured by a Total Sky Imager) versus Effective Transmissivity (calculated from irradiance measurements using the Radiative Flux Analysis method) for data at SGP from 2016. Color bar shows a log scale of the number of 1-minute measurements in a given bin.

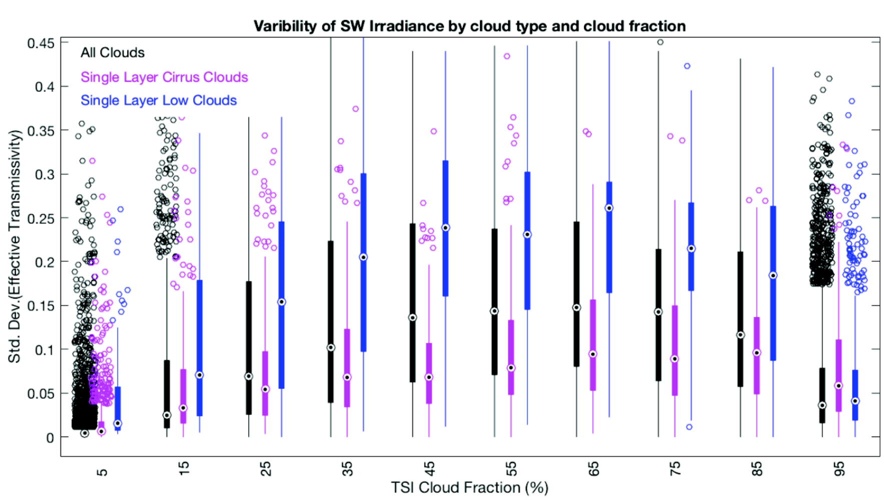

Figure 2. Distributions of the 15-min standard deviation of effective transmissivity in 10% cloud fraction bins. Median values are shown in the circles, solid bars show 25/75 percentiles, full range in thin lines. Colors show different cloud types.