Using weather regimes to improve predictions of solar power generation

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Forecasting power from solar panels to optimize plant operations, verify that design criteria have been met, or that maintenance schedules are accurate, can be estimated in many ways from simple theoretical models to sophisticated dynamical weather models. However, in addition to their large computational demands, weather models require validation and verification against some baseline observations. Where reliable and complete observations are not available, approaches utilizing weather proxies have been used in the past. We present a novel application that combines statistical inference with dynamical reasoning to improve forecast verification. The case study examines forecasted solar power for a large plant in the southern desert area of Kuwait. There are limited sub-daily observational data at the immediate location (since 2017 only), and WMO meteorological observations are sparse and unreliable. We utilize 1 minute satellite observations of global horizontal irradiance (GHI) obtained from Copernicus Atmospheric Monitoring Service (CAMS) for 2005-2017 for clear skies and actual weather conditions. Daily total and maximum GHI are estimated for both the clear sky and actual conditions, then a time series of daily differences calculated. Mixture distributions are fitted to these daily difference series, identifying 3 or 4 mixtures of Gaussian distributions corresponding to clear, semi- and obscured skies. Composites of sea level pressure for the days with the highest probability of falling in each distribution component are then compared. This facilitates identification of typical weather conditions driving the at site GHI that can then be used in a predictive mode to enhance power forecasts.