Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MGI37-15 Room:203 Time:May 28 10:15-10:30

Application possibility of the JMA observations and forecasts data for an electric energy management system

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Many photovoltaic (PV) systems have been installed in Japan after an introduction of a feed-in-tariff in summer of 2012. For an electric energy management system (EMS) including many PV systems, a PV power generation forecast based on an engineering model with a grid point value of a mesoscale model (MSM-GPV) from the Japan Meteorological Agency (JMA) and/or a solar irradiance forecast based on a numerical prediction model (NWP) has been useful technologies. For forecast data users in the EMS, the PV power generation forecasts and/or solar irradiance for a relative large area (i.e., electric power area by an electric power company) also are expected, because the PV power generation produced by PV systems are transferred to transmission lines.

Recently, the NWP have been used to forecast solar irradiance, because NWPs can directly calculate and produce solar irradiance (or downward shortwave radiation) at each grid point. However, the solar irradiance forecasts also have invariably errors. Therefore, we must use the forecast data considering its error. Before using the forecast datasets, validation of solar irradiance forecasts are desired for a stable system operation in the EMS.

In this study, we investigated seasonal and/or regional errors of global horizontal irradiance (GHI) from the MSM of the JMA. From the results, underestimation of solar irradiance forecasts in summer and overestimation of ones in winter are found. In the southwestern part of Japan islands (around Okinawa prefecture), relatively large forecast errors of GHI values were found compared with the Japan main islands.

We also attempted to estimate a confidence interval for hourly forecasts of GHI values obtained from the MSM. In the recent study, we found that the GHI forecasts from the MSM have a systematical forecast errors; the GHI forecasts are depended on the clearness indices, which are defined as normalized GHI values divided by hourly extraterrestrial solar irradiance theoretically calculated.

Information of the errors of hourly GHI forecasts, that is, the confidence interval of GHI forecasts, is of great significance for planning the EMS included a lot of PV systems. For the relatively large area, a spatial-smoothing method of GHI values is performed by an integration of GHI values for both the observations and forecasts. The spatial-smoothing method caused the decline of range of confidence intervals of the hourly GHI forecasts.

In addition, MSM-GPV data is powerful datasets for research institutes and business persons. They can calculate cloud fields and surface solar irradiance based on NWPs for the EMS. The MSM-GPV is used for a boundary data and an initialization data. However, GPV data do not include solar irradiance forecasts. The data of solar irradiance forecasts would become also powerful datasets for the EMS field including PV systems. In future, an ensemble forecast for one-day forecast would be useful tool for the estimation of confidence intervals of hourly GHI values.

Furthermore, monitoring PV power generation, maintenance processes and fault diagnosis of PV systems are more and more important for stable production of electric power. For the maintenance and the fault diagnosis of PV power system, solar irradiance observation data will be necessary. However, installation cost of pyranometers for each residence would be high. In addition, the maintenance of PV systems installed on a roof of a residence is not safety because a worker have to go up the roof. Therefore, spatial monitoring of solar irradiance based on satellite observations would be also useful for monitoring surface solar irradiance.

Both the GHI forecasts and the monitoring data from the JMA would be useful for both the EMS and the maintenance of PV systems.

Keywords: Photovoltaics, power generation forecasts, solar irradiance forecasts, numerical prediction models, forecast errors, energy management system