Application of the JMA data for a renewable energy management field -AIST efforts and future initiatives-

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Recently, many photovoltaic (PV) power systems have been installed in the Japan islands from an introduction of feed-in-tariff in 2012. In the current situation, over 20 GW of PV systems has been penetrated. However, renewable energy such as PV power production and wind power production has significant large temporal and spatial variations due to cloud moving and wind speed over complex topography. In order to control a total electric power system in an electric power service area, electric power service companies has to adjust other power outputs (thermal power plants (oil, coal, natural gas), hydraulic power, water pumping etc.) not only renewable energy resources. For a safety control of energy management system (EMS) using renewable energy resources, forecast and monitoring data of renewable power outputs will be necessary more and more.

National Institute of Advanced Industrial Science and Technology (AIST) develop a PV power forecast technology based on machine learning algorism (support vector machine, SVM). In this system, grid point values (GPV) of a mesoscale model (MSM) of the Japan Meteorological Agency (JMA) are used as an input data. In the current situation, solar irradiance forecast data are not included in the GPV datasets of the JMA. Therefore, we must forecast solar irradiance and/or PV power output based on a numerical prediction model. In order to forecast of PV power output, we use the SVM with both MSM GPV and solar irradiance data as an input data. To perform a bias correction, the SVM are also used in our forecast system.

Research center for photovoltaics of AIST also collaborated with the Meteorological Research Institute (MRI) of JMA and has been validated the solar irradiance forecast data from the MSM and a local forecast model (LFM). Each horizontal resolution is 5km and 2km, respectively. MSM performed 39 hours forecasts every 3 hours and LFM performed the 9 hours forecasts every 1 hour. Therefore, MSM was used day-ahead forecast and LFM are expected for short-term forecast in the EMS. From our validation of solar irradiance forecast, negative bias in summer and positive bias in winter are remained in the MSM. Actually, bias correction using the SVM is performed to reduce systematic forecast errors in AIST. Furthermore, validation results would be useful information to improve solar irradiance forecasts of the Numerical Weather Prediction[u1] (NWP). In previous study, our research group investigated the relationship between solar irradiance forecasts and cloud types in cases of large forecast errors. In PV forecasts, forecast errors are included in the model outputs because of both uncertainties of model schemes of NWP and meteorological observations when initializing models. Therefore, confidence intervals of solar irradiance forecasts are also required for users of PV power outputs (or electrical system operators). A usability of ensemble forecasts using different dataset from overseas NWP centers[u2] has been also examined.

Recently, users of PV power outputs have paid attention to aerosol optical depth and/or volcanic ash not only clouds distribution because of the decrease of PV power outputs due largely to the reduction of direct normal irradiance (see a related presentation by Dr. Uno (AIST) in the section “Dynamics of eruption cloud and cumulonimbus; modelling and remote sensing” of JpGU 2016).

AIST has taken part in the Japan Science and Technology Agency (JST) Core Research for Evolutional Science and Technology (CREST) project of “Creation of Fundamental Theory and Technology to establish a Cooperative Distributed Energy Management System and Integration of Technologies Across Broad Disciplines Toward Social Application” (EMS). In this presentation, we will show our effort in the JST CREST EMS project.

Keywords: Forecast of PV power generation, Numerical Prediction Model, JMA data

