Severe Storm Prediction and Impact Assessment of Electric Facilities Under Global Warming

Background and Objective

The influence of global warming might be gradually actualized in 20 or 30 years in the future, and there is a possibility that this will affect power industries in Japan. The first purpose of this study is to improve the accuracy of the numerical weather prediction model for assisting the maintenance and operation of electric power facilities, such as delivery equipments and water power dams. The second purpose is to predict the climate change on Japanese region using the improved regional model, and to make an impact assessment of electric power equipment under global warming.

Main results

1. Research on climate change prediction on Japanese region

The numerical weather forecasting and analysis system (NuWFAS) developed in CRIEPI has been improved for application to regional climate prediction [N09024]. Using the improved system, we conducted a year-long weather reproduction from Oct. 2008 to Sep. 2009 and compared the results with observations for evaluating its performance. The results show that the land surface sub-model well reproduced the seasonal variation in the soil temperature, soil moisture, and snow depth. The system also well reproduced the accumulated precipitation and daily maximum rainfall in a year (Fig. 1), as well as extreme weather events such as local heavy precipitation. Finally, we confirmed that the NuWFAS has the capability of the regional climate simulation with practically high accuracy [N10044].

2. Research on the impact assessments of electric power facilities due to global warming

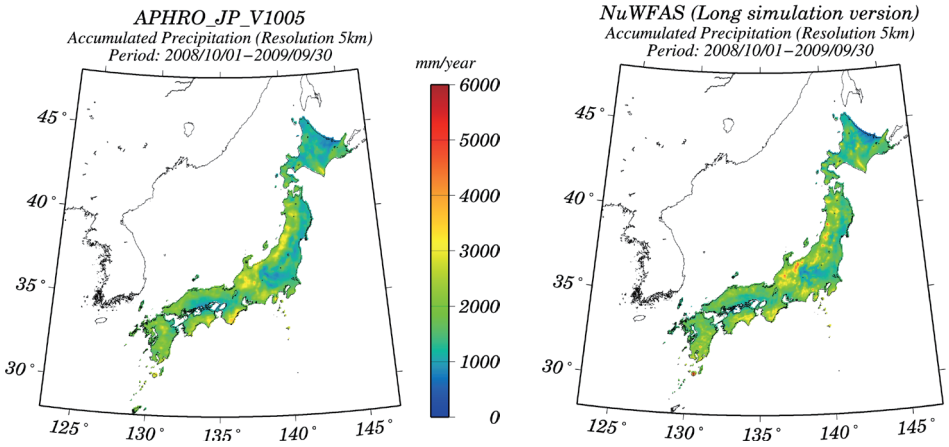
For the wind risk assessment of power transmission and distribution facilities due to global warming, it is important to investigate the change in design wind speed, which provides for the structural safety of the facilities. We calculated the changes in design wind speeds using the Monte Carlo method with the typhoon model assuming that mean values of the generation number of typhoons and the central pressure drop, respectively, increase by 5% than the current state. As a result, in the case of 5% increase of the generation number of typhoons, the wind speeds tend to be larger than the current design, and change rates are slightly less than 2%. On the other hand, as for 5% increase of central pressure drop, design wind speeds increase by about 0% to 6% and have localization (Fig. 2).

3. Development of a rainfall estimation method using polarimetric weather radar data

Data processing techniques were developed for dual-polarized weather radar system. A convectional algorithm of rain rate estimation is based on an empirical relation using only radar reflectivity. A new algorithm developed in this study uses differential phase and differential reflectivity computed from horizontal and vertical polarization. This algorithm shows a good performance of radar rainfall estimation, especially in the case of heavy rainfall (Fig. 3) [N10041].

4. Observation of precipitation particles in clouds using a videosonde system

In-situ observations of precipitation particles were performed using a balloon-borne videosonde system for understanding severe storm meteorology and improving microphysical modeling. Vertical profiles of diameter and mass density of hydrometeor were successfully estimated in each launch by analyzing a movie image obtained by a CCD camera that was installed in a sonde (Fig. 4) [N10042].



(a) Analyzed precipitation by Observation (b) Calculated precipitation by NuWFAS

Fig. 1 Comparison of one year accumulated precipitation during Oct 2008-Sep 2009
The result of Observation and NuWFAS was corresponding well, and the correlation coefficient was 0.79.

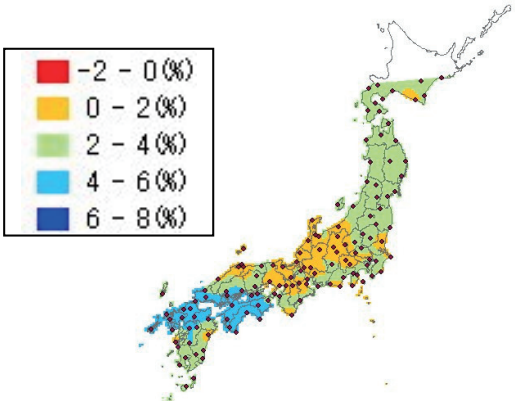


Fig. 2 Change rates map of design wind speeds
In the case of 5% increase of central pressure drop, the change rates of the designed wind speeds were larger in West Japan than in East Japan and showed localities.

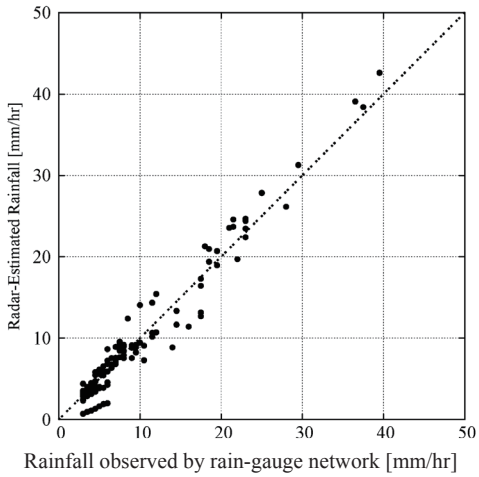
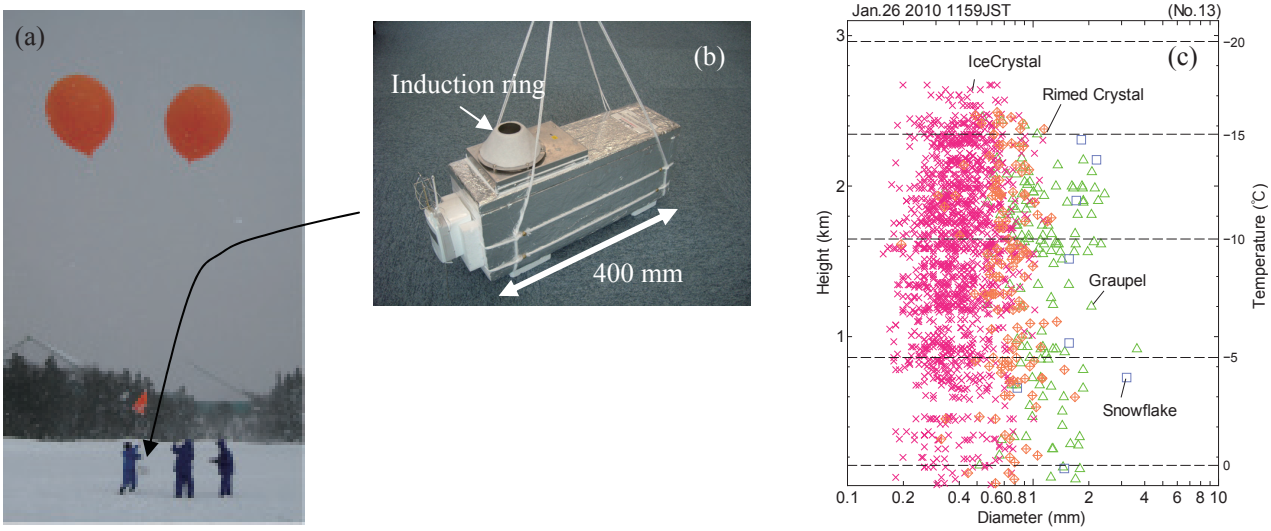


Fig. 3 Comparison of rainfall amount estimated by a proposed algorithm with observed rainfall amount



(a) Scene of launching ballon (b) Overview of a videosonde (c) Profile of precipitation particles

Fig. 4 Balloon-born videosonde observation and observed vertical profile of precipitation particles