Project Subjects

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

Background and Objective

In recent years, meteorological disasters by rain storms and the heavy snows happen frequently, and its relationship with global warming has been pointed out. The influence of the global warming might be gradually actualized in 20 or 30 years in the future, and there is a possibility to affect electric power industries in Japan. One 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 equipment and water power dam. The second purpose is to predict the climate change over Japan by using the improved forecast model, and to make an assessment of the climate change effect on the electric power equipment.

Main results

1. Research on climate change prediction over Japan due to global warming.

We have developed the numerical weather forecast and analysis system (NuWFAS) to predict severe storms with the resolution of 3 or 5km. The numerical model of the system has been improved for evaluating soil water contents, soil temperature, and sea ice, which have an effect on the accuracy of weather and climate simulations. We evaluate the performance of the system from one year long-term simulation (Fig. 1) [N09024]. For the next step, long-term simulation for the climate change prediction will be carried out.

2. Research on the climate change prediction of ocean currents and waves around Japan

We developed regional ocean current model and ocean wave model for the short range forecast of storm surges and the near future assessment of that on the climate change. These models were applied to Japan Sea in Dec 2005, and are compared with the observed time series of significant wave height and sea surface elevation. The model outputs agreed with observations induced by the storms, although the model could not calculate the sea level for the descending period at some observation points due to lack of information of eddies propagating from the outside of the boundaries (Fig. 2).

3. Research on the improvements of the weather forecast and analysis

To evaluate wind gust intensity, which is very important for wind load design of transmission lines, we developed the numerical model. As usual, it is very difficult to estimate the intensity of wind gusts through meteorological models using coarse grids. However, we show that the Large Eddy Simulation (LES) model with the grid scale of 50m can capture wind gust features observed in the field (Fig. 3) [N09010].

In order to improve accuracy of heavy rain and snow amounts, we investigate the cloud micro physics in NuWFAS. The models with different cloud micro physics were applied to typhoons, heavy rain events, and cyclones in winter, and were compared with observations. We settled the dual polarization Doppler radar at Abiko, and observed heavy rain and snow due to thunderstorms, typhoons, and tornados (Fig. 4). These observed data and cloud micro physics information will be used for the data assimilation model developed in this study.

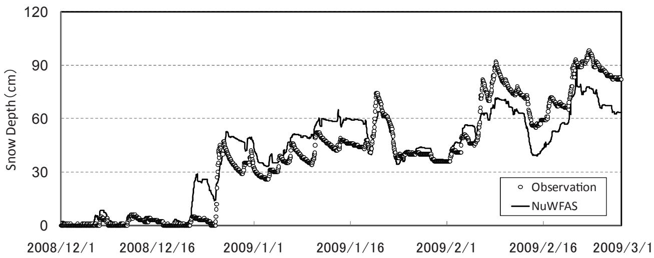
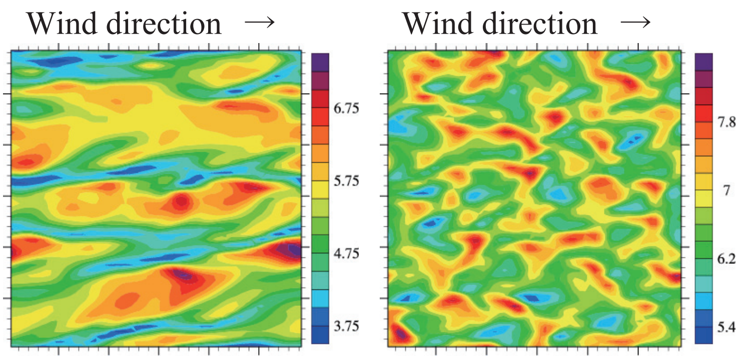


Fig. 1　Snow depth comparison

Snow depth results from NuWFAS were compared with the observational data at the National Agricultural Research Center in Hokkaido, Japan. The results are in good agreement with the observations.



(a) Large-eddy simulation　　**(b) conventional simulation**

Fig. 3　Comparison of surface wind predictions（area:6km×6km）

A large-eddy simulation has a capability to capture stream-wise streaky structures with low speed fluid motions, which is the source of wind gusts ("kaze no iki"), whereas predictions with conventional simulations show only mere disturbed wind fields.

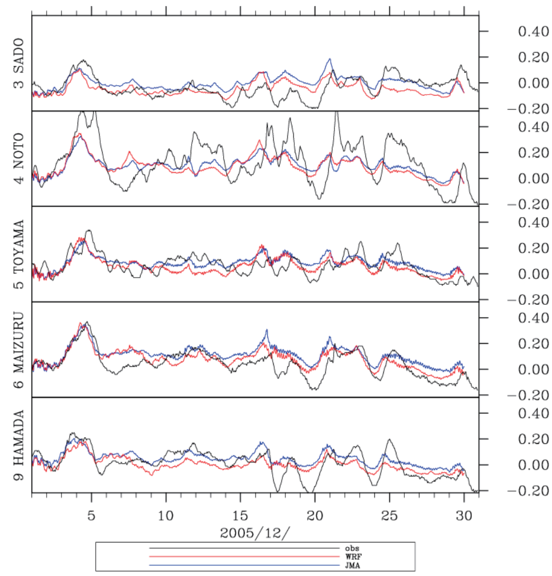


Fig. 2　The comparison of the simulated and measured water surface elevation at the five stations (Sado, Noto, Toyama, Maizuru and Hamada) around Japan Sea in Dec. 2005.

The black line is the observation by JMA which has been removed is periodical astronomical tide. The red and blue lines are the simulation results driven by the atmospheric data from NuWFAS model and JMA, respectively. The calculated magnitude and occurrence time of peak surge agreed with the measurements, although the model could not reproduce the sea level for the descending period at some stations.

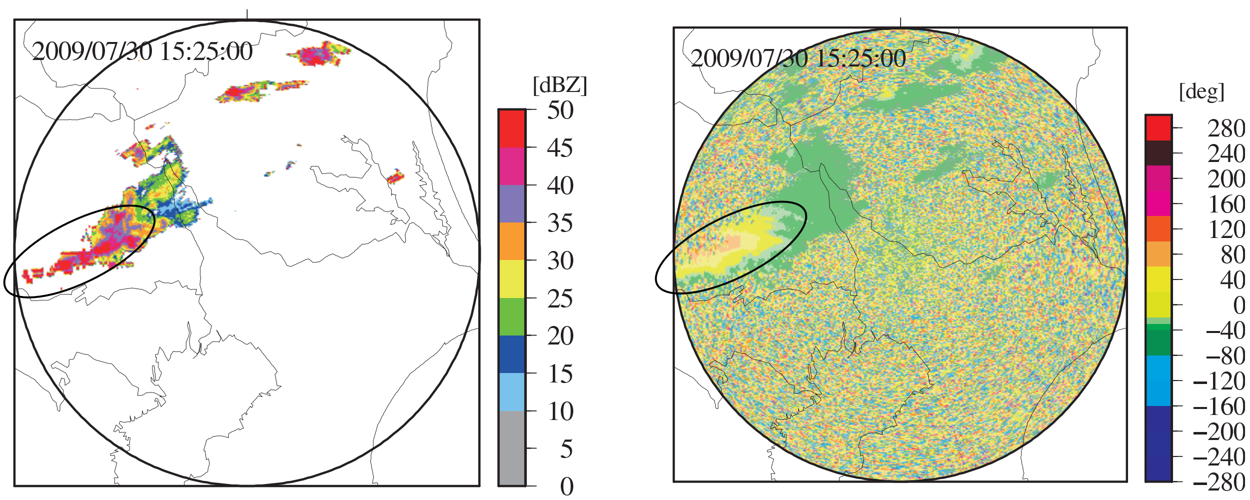


Fig. 4　Images of data observed by our polarimetric Doppler radar

(Observation range is 60 kilometers; Left: r adar reflectivity factor, Right: differential propagation phase)

Precipitation amount is estimated from radar reflectivity factor in the conventional radar system. Such a method, however, can lead to a difficulty that the accuracy of estimation degrades largely in areas (circled in Fig. 4) far beyond heavy rainfall, because of severe attenuation of radio waves. Polarimetric radar can radiate and receive both horizontally- and vertically-polarized radio waves. Differential phase between waves is not affected by the attenuation effect, so that the accuracy of precipitation estimation based on differential phase is expected to be better than the conventional method.