Snow Accretion Prediction Method Using WRF Calculation Results.

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1. INTRODUCTION

North part of Japan is one of the heaviest snowfall regions in winter. In a certain case, wet snow accretes to civil engineering structure such as power lines. There is a demand for the prediction that when the snow accretion will occur.

General weather forecast is not enough resolution and meteorological variable for estimating snow accretion. By calculating weather condition on our own account, we can extract related information about snow accretion, and use for prediction.

In this study, we consider about the snow accretion prediction method using numerical weather prediction model WRF.

2. CALCULATION USING NUMERICAL WEATHER MODEL

On December 2005, cold air outbreaks blew up continuously, and extraordinarily heavy snowfall came down, especially to areas along the Sea of Japan. At Wakasa region (Fukui prefecture) a lot of snow accretion was generated to power lines.

We select 12-15 December case and perform WRF meteorological calculation, and extract the parameter related to snow accretion amount.

2.1 MODEL CONFIGURATION

WRF Version 2.1.2 was used. The first domain is 100 x 100 grid point with 45-km grid spacing, and second domain is 130 x 130 grid point with 15-km grid spacing with 2-way nesting, and third domain is 151 x 151 grid point with 5-km grid spacing with 2-way nesting (Fig. 1)

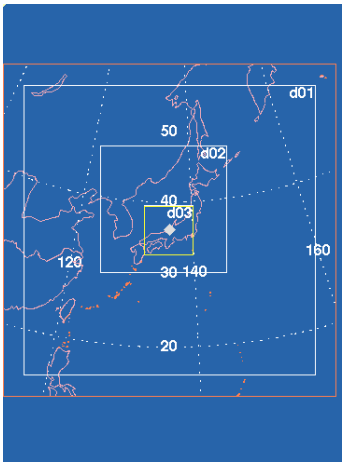

Figure 1 Model domain used by WRF simulations

The numerical integration starts at 00 UTC 12 Dec 2005, and runs for 90 hours. NCEP-FNL data is used for creating initial and boundary conditions. The model configuration is in Table 1.

Table 1 Configuration of WRF model setting.

Model Version	WRF Ver. 2.1.2
Microphysics	WSM 6class
Radiation	RRTM／ Dudhia
Surface Scheme	Noah LSM
Planetary Boundary Layer	YSU PBL
Cumulus Parameterization	Kain-Fritsch (First & Second Domain) No Cu (Third Domain)

2.2 RESULTS OF THE SIMULATION OF WINTERTIME COLD-AIR OUTBREAK

Figure 2 shows surface weather chart by Japan Meteorological Agency (JMA) and sea level pressure field by WRF. Long lasting wintry atmospheric pressure field is prevailing, and WRF model reproduce the pressure field properly. Model also showed cold air outbreak from Eurasian continent appropriately.

Getting snow accretion to consider, local scale meteorological representation is required. We compare WRF output with several weather station data. Figure 3 shows comparison with Tsuruga city (City along Wakasa Bay). At Tsuruga, the temperature reads 0-2 degrees Celsius for a long time, and model reproduced this situation. At some other point, model had a little bit warm bias (not shown). Especially at weak wind period, the accuracy of the wind direction is not adequate, but accuracy of the wind speed is looking good. Time series of the accumulated precipitation is also good accordance with observation

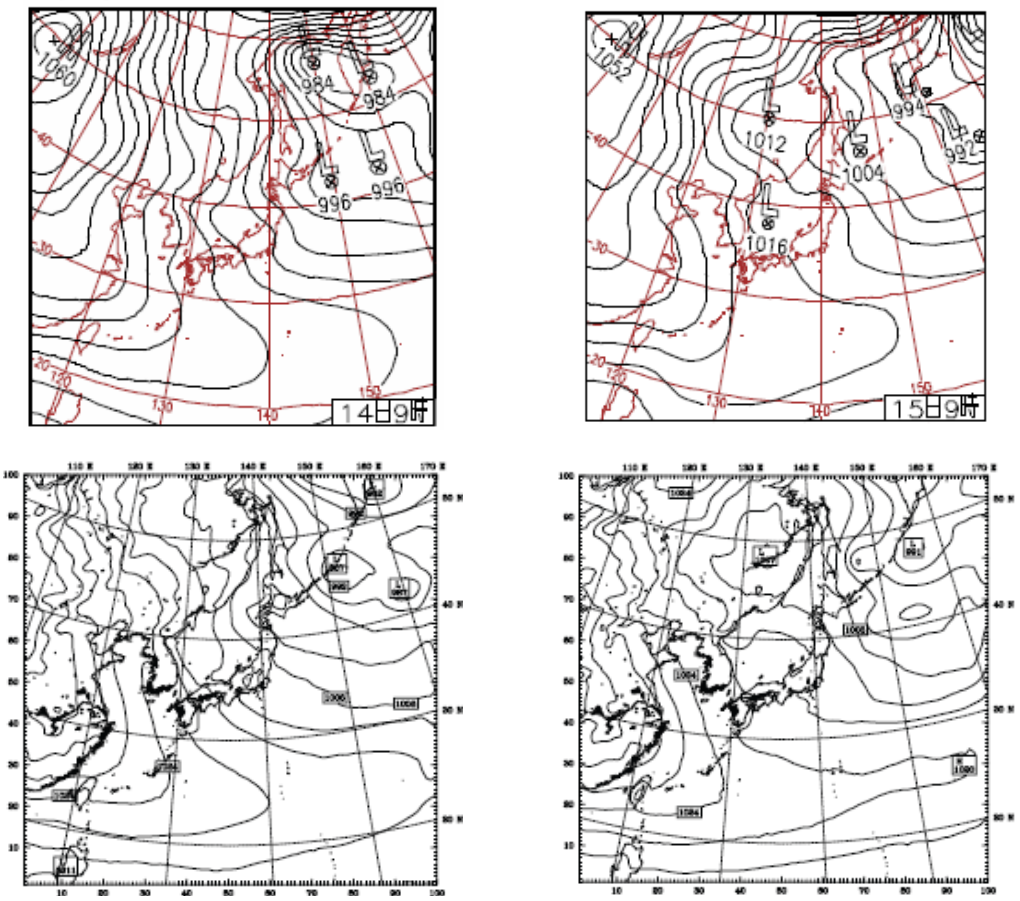

Figure 2 Surface weather chart (Upper) on 00Z 14 December 2005 and 00Z 15 December 2005, and sea level pressure field by WRF (lower).

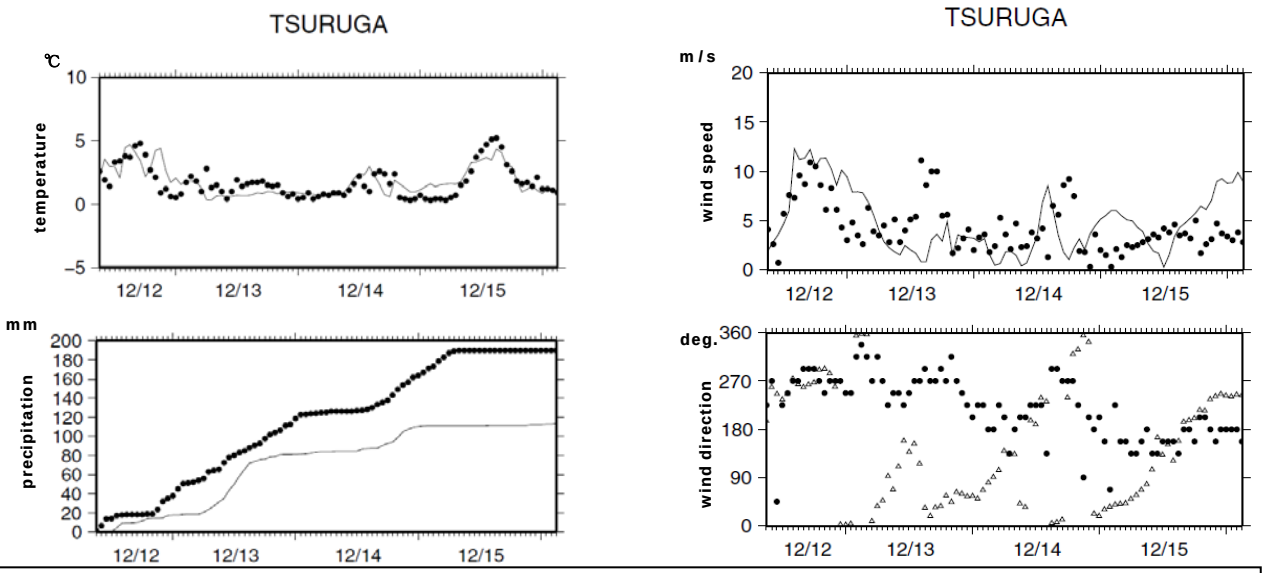

Figure 3 Comparison with weather station data. (Upper left: temperature [℃], Lower left: accumulated precipitation [mm], right: wind speed [m/s] and wind direction [degree]) Dots mean observational data. Solid line and triangles mean WRF output time series.

3. SNOW ACCRETION POTENTIAL

We defined the indicator of the amount of the snow attachment to the power line as “snow accretion potential”. In order to calculate the wind speed rectangular to power line, we separated the wind constituent each azimuth direction, crossed the snowfall amount, and picked out the amount when it was “snow attaching temperature”. If the temperature is below the freezing point, the precipitation is composed by solid particle, and snow accretion rate is very low. If the temperature is over 2 degrees centigrade, the precipitation is almost composed by rain, and there is little need to be anxious about snow accretion. So, we define “snow attaching temperature” as 0-2 degrees centigrade, and define snow accretion rate as figure 5.

In this way, as indicator of the snow accretion amount, we define snow accretion potential as formula (1). By substituting temperature, surface wind field and precipitation calculated by WRF model to formula (1), we can calculate indicator of snow accretion amount at the same resolution as WRF calculation.

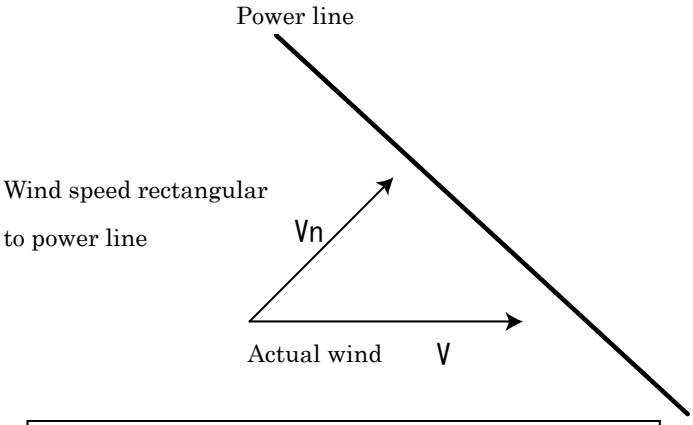

Figure 4 Concepts of the snow accretion potential

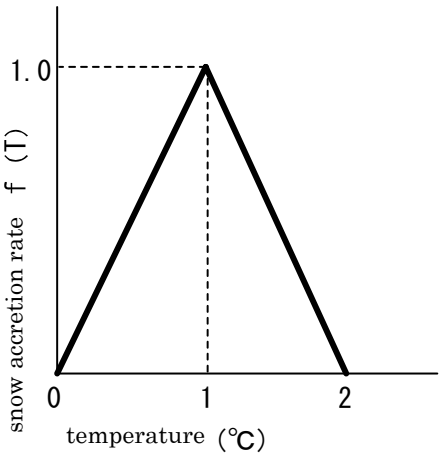

Figure 5 Function form of the snow accretion rate

Snow accretion potential (kg･m/m²) ＝

$$\frac{1}{3600}\int R \times V_n \times f(T)dt \quad \cdots(1)$$

R: precipitation (mm/hour)

Vn: wind speed rectangular to power line (m/s)

f(T): snow accretion rate

T: temperature (℃)

t: time (s)

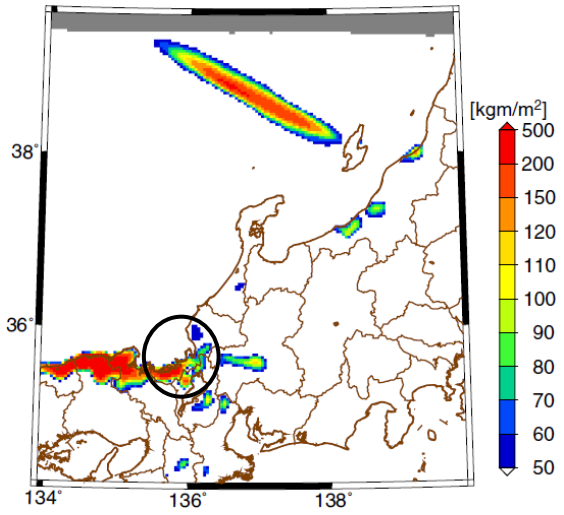

Figure 6 Snow accretion potential derived from WRF model output. The circle shows Wakasa region. Power Line of strike: North-South direction

Using the model output of the Dec 12-15 case, results of the snow accretion potential is shown in figure 6. Red region means high risk of the snow accretion. And the circle indicate Wakasa region. We have not confirmed the model yet, because of lack of observational data of snow accretion. We have a plan to observe snow accretion on the power line.

4. SUMMARY

We conducted the simulation of the snowy event by 5km mesh calculation. The results showed that temperature around the Wakasa region is suited to snow accretion (0-2.0 degrees centigrade), and the other meteorological field showed good accordance with observations.

We defined the indicator of the amount of the snow attachment to the power line as “snow accretion potential”. Accumulating the snow accretion potential, we could see the value proportional to the snow accretion amount. We calculated the snow accretion potential at 5km mesh, and the results showed that the high potential value is shown in Wakasa Bay. This is in accordance with the place that snow accretion actually occurred, and we can estimate effectivity of the method.

Reference

Toyoda, et al., 2006, "Consideration of methods to predict the snow accretion using numerical weather prediction models", CRIEPI Technical Report N05058