Investigation of Methods to Predict Snow Accretion Using Numerical Weather Prediction Models

Background

On January 2005, snow accretions grew up to the power lines at Unazuki region (Toyama prefecture). Around that time, though west and north-west wind was prevailing in the Hokuriku surrounding region, long lasting south-west wind was observed in Unazuki region. In general, this snow accretion is generated by the conditions of :

1. Snow attaching temperature (0-2.0 degrees centigrade)
2. Strong wind perpendicular to the power line
3. Snowfall event

It has been necessary to examine weather fields when a lot of snow accretion occurs, and to develop the prediction method for snow accretion.

Objectives

To analyze wind fields using Doppler radar when snow accretion occurs, and to develop a method of prediction for snow accretion phenomena using the weather prediction model.

Principal Results

1. Analysis of wind direction discontinuity using the Doppler radar

We recognized that the southerly wind is prevailing near the surface, and westerly wind is prevailing higher than 1500m, in Unazuki region using automated meteorological data acquisition system data, and upper air observational data. It is well known that this wind direction discontinuity leads to a lot of snowfall. We made sure that these snowy clouds with wind direction discontinuity stayed in Hokuriku region for a long time using the meteorological satellite data. We further analyzed and estimated the wind speed using Doppler radar data. And more precious wind field was clarified. That is the southerly wind was prevailing in the lower atmosphere, and the westerly wind was prevailing in the upper atmosphere in Toyama region, and we could observe the wind direction discontinuity. The lower southerly wind was well developed at the heavy snowfall time. This is because the snowy westerly wind can not surpass the Hida range, and the wind goes around to the north. It is suggested that this is the cause of the wind direction discontinuity.

2. Numerical simulation using the weather prediction model, and definition of the snow accretion potential

We conducted the simulation of the snowy event by 5km mesh calculation. The results showed that temperature around the Unazuki region is suited to snow accretion (0-2.0 degrees centigrade) (Fig.1), and the wind 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. 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 (Fig.2). 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 the east part of the Toyama prefecture particularly with the north-west and south-east power line direction. This is in accordance with the direction that the snow accretion actually occurred, and we can estimate effectivity of the method (Fig.3).

This study was a collaborative project with Hokuriku Electric Power Co.

Future Developments

Since snow accretion potential is effective to precipitation, we will further investigate the precipitation data using the radar data. After we comprehend the relationship between snow accretion potential and actual snow accretion amount, we will clarify the snow accretion rate more precisely.

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Reference
Toyoda, et.al., 2006, "Consideration of methods to predict the snow accretion using numerical weather prediction models", CRIEPI Report N05058 (in Japanese)
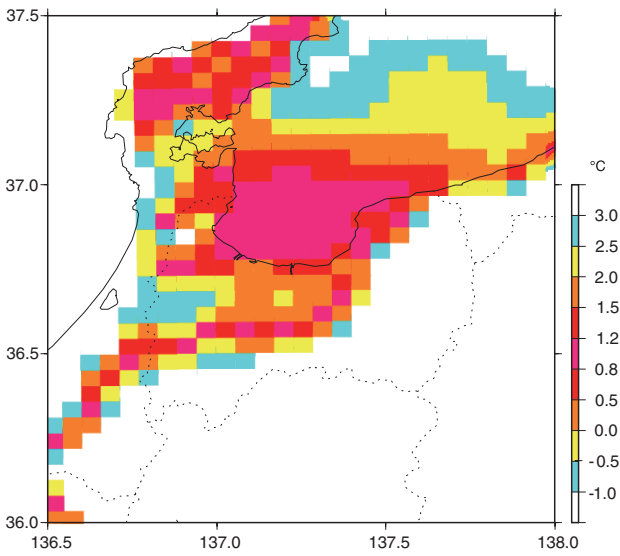
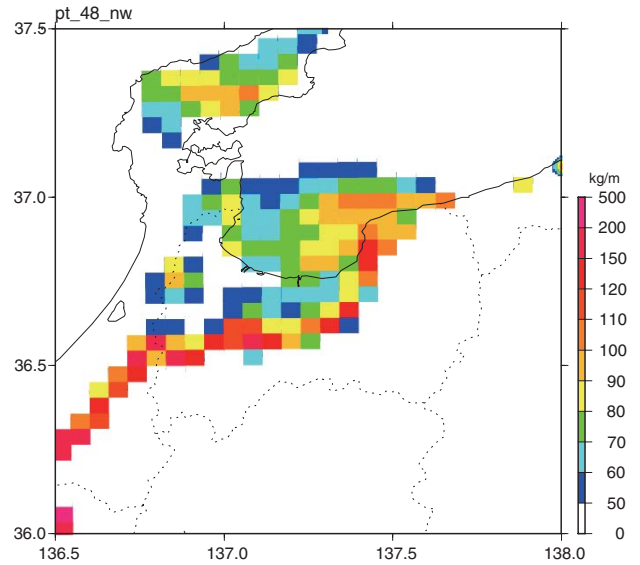**Fig.1** Temperature distribution by meteorological model

Fig.3 Snow accretion potential derived from the meteorological model

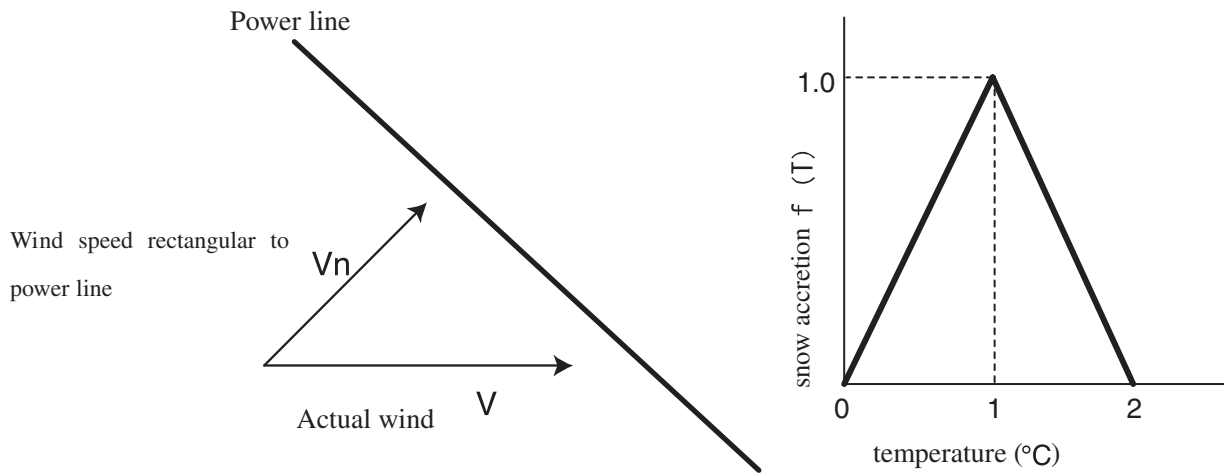**Fig.2** Concepts of the snow accretion potential

$$\text{Snow accretion potential(kg}\cdot\text{m/m}^2) = \frac{1}{3600}\int R\times V_n \times f(T)\,dt$$

R : precipitation (mm/hour)

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

f (T) : snow accretion rate

T : temperature (°C)

t : time (s)