

# Short-term Forecast System of Ice-covering for power grid

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**Abstract:** The ice-covering on the transmission line is formed under the interaction of three influencing factors, including temperature, rainfall and inversion layer, and the boundary value of temperature for ice-covering is between  $\pm 0.1^{\circ}\text{C}$ . Concerning this, the short term icing forecast method of power grid is developed based on the short-term weather forecast. Besides, through simulating the natural environment and taking the icing experiment of transmission line, the ice-covering increasing formula can be given after analysis. Then through the combination of the forecasted temperature, rainfall and wind speed of the next two days with the ice-covering increasing formula, the short term icing forecast model can be realized. Taken this proposed forecast method, the power grid icing for winters in 2008~2009 and 2009 ~2010 have been forecasted. While in 115 short term forecast conclusions for winters of 2009~2010, only three of which are inaccurate, thus the short term forecast accuracy has reached 98% till now. Though the weather process has been preferably predicted, however, since the rapid changing rate of weather process is hard to forecast, it produces difficulty to predict the exact time of the icing. Thus, it causes the little error of the beginning or ending time of the ice-covering process, which may be a little former or latter than the actual time. Furthermore, on the basis of the proposed short-term forecast method, the short term forecast system of ice-covering for power grid has been developed. This system is able to make icing forecast through receiving weather forecasting data, and giving the short term forecast result of power grid through calculation and analysis. Then on the platform of GIS system, it releases the short term forecast information on the Web. Thus according to the need, this system offers the function of human-computer interactive operation, which can input or rectify the boundary conditions, initial values, and forecast conclusion in manual. This system can offer forecast conclusions in time, and is of great importance to make clear the icing condition and carry out ice-melting strategy.

**Key words:** Short-term forecast of ice-covering for power grid, Weather forecast, Ice-covering

*increasing model*

## I. INTRODUCTION

The ice-covering on the transmission line is formed under the interaction of three influencing factors, including temperature, rainfall and inversion layer. The boundary value of temperature for ice-covering is between  $\pm 0.1^{\circ}\text{C}$  [1][2]. However, the current high-altitude meteorological detects one time for 12 hours, it's hard to find the change of the atmospheric inversion layer in time, which makes short-term ice forecasting to be much difficult. The current weather prediction business basically takes method of numerical weather forecast with the combination of the traditional forecasting experience. Nowadays, the weather department has given short-term icing forecast for the weather station, but not aimed at the transmission line. Besides, those weather stations are mostly located in the places with low altitude, however, transmission lines has distributed all over the worse terrains such as high mountains, many of which are of high altitudes and easy to be covered with ice[3]. The short-term icing forecast based on the weather stations can't effectively reflect the icing characteristic of the power grid. Thus, to develop the short-term icing forecast aimed at the power grid is of high importance[4], which can give great guidance to take the provisional icing-protection measurements to guarantee the safety of the power grid.

## II. The method for short-term forecast

The short-term icing forecast for power grid is important to guide the de-icing or ice-melting work. Based on the enrich experience, through analysis of large amount of historical weather conditions data, and researches on the weather process of the severe icing disaster in the past few years, we develop the icing forecast method in accordance with characteristic of Hunan province, and establish a series of short-term forecast indicator system. We make use of the real time weather information, and confirm the forecast factors and conditions including three aspects of temperature, rainfall, inversion layer. Based on it, the short-term icing forecast method for power grid has been proposed.

The weather map is the particular map with the meteorological observation recorded in each area within the same time, which can reflect the weather conditions for the certain area. The weather map consists of two different kinds, inner surface weather map and the high air weather map, which have covered the weather conditions of all the altitude, including inner surface, 500hPa, 700hPa, 850hPa. Through analyzing the weather maps of all layers, we can make judgments of the short term movement direction, movement velocity, system intensity of weather system. Thus we can keep whole abreast of the short-term future weather. The analysis of weather map is the basis to adjust the change of weather conditions.

Through analyzing the weather map, when there appear the following weather conditions, such as the blocking high pressure system on the binary of collapse, strong cold air move to the south area etc, the forecast factors are needed to be analyzed. According to the fulfillment degree of the three forecast conditions, including temperature, rainfall, inversion layer, the short-term icing forecast conclusions for power grid will be given[5]. When these three

conditions are all fulfilled, it's easy to form icing on the transmission line in Hunan province.

### A. Temperature condition

a. The average temperature of forecast day  $T \leq 4.5^{\circ}\text{C}$  (the average of 08:00 temperature and 14:00 temperature);

b. The average temperature of forecast day  $4.5 < T \leq 6.5^{\circ}\text{C}$ , and the maximum temperature for the next day of the forecast day has decreased more than  $2^{\circ}\text{C}$ ;

c. The average temperature of forecast day  $6.5 < T \leq 8.5^{\circ}\text{C}$ , and there will be a strong cold air across the area, that is the 850hPa temperature of ChangSha is  $10^{\circ}\text{C}$  higher or lower than that of Zhengzhou.

When each of conditions a, b, or c is satisfied, the condition of temperature is hold.

### B. The Rainfall Condition

When it's predicted there is a rainfall in the next 24 hours of the forecast day, the condition of rainfall is hold.

### C. The Inversion Condition

a. In the 700hPa layer, Guiyang and Kunming is south wind at 08:00 on the forecast day, and the 700hPa temperature of KunMing is not lower than  $-1^{\circ}\text{C}$ ;

b. In the four weather station of Yichang, Hankou, Changsha, Huaihua, there is at least one station's temperature at 700Hpa is higher than temperature at 850hPa.

When a and b are both satisfied, the condition of inversion layer is hold.

When A, B and C are all satisfied, it can be forecasted that there will be ice-covering on the transmission lines, and those areas with low temperature and rainfall are ice-covering areas.

## III. The short-term icing forecast system

Since the short-term icing forecast method is established based on the meteorological mechanism, which involves prediction indicators

of three aspects, thus this method has the advantages of clear logic and concise computer condition, and also of great guidance to the anti-icing work in practice. Therefore, we develop the short-term icing forecast system using this method. It can automatically collect the meteorological data, and realize the analysis process of short-term forecast to make it an operational application, which has greatly improved the working efficiency.

This short-term forecast System has the following module:

1) Acquisition interface of weather forecast data, which will collect the metrological data needed for short-term forecast, including temperature, rainfall, wind at each layer.

2) Analysis of forecast indicators module, which will analyze the forecast indicator and judge the fulfill degree of the three forecast conditions using the proposed method based on the weather data, and give the short-term forecast conclusion.

3) Forecast information release module, which will publish the short-term forecast results on the web pages.

The flow chart of the short-term system is presented as followed:

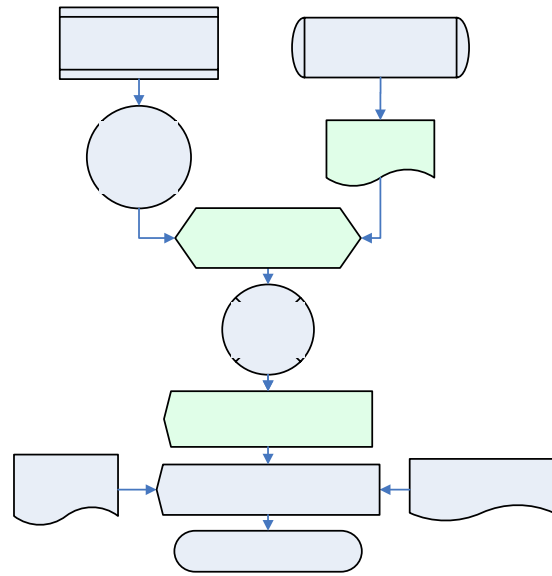


Fig.1. Flow chart of the ice-covering forecast system

The main interface for the short-term icing forecast system based on the meteorological prediction indicators is as followed, Fig.2:

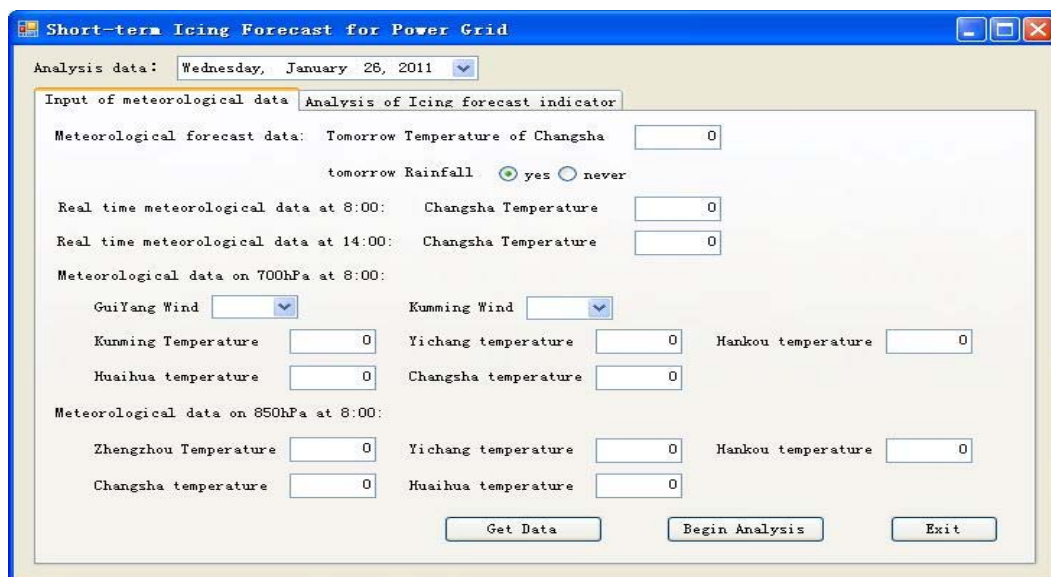


Fig.2. The Main interface for the short-term Icing forecast System

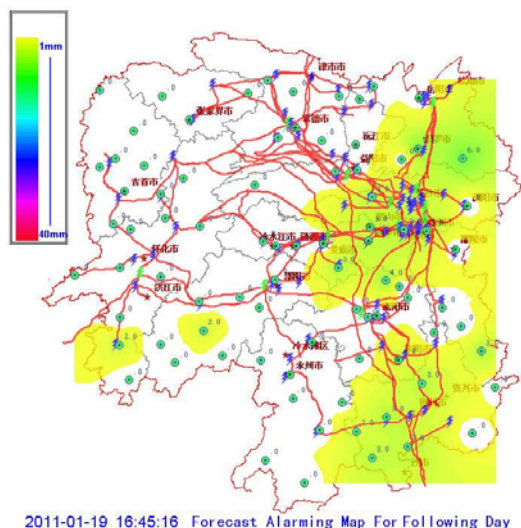


Fig.3 Forecast Alarming Map for next day

#### IV. The Analysis on the Forecast Application

Based on the proposed short-term icing forecast method for power grid, we have carried out the short-term icing forecast ever since 2008. In the winter, we will give the two follow-up day icing forecast of the transmission line. Till now, we have given 208 issues in total, with only 4 issues inaccurate, which is mainly due to the

forecast error of temperature within  $1^{\circ}\text{C}$ . The forecast work has shown that we can accurately understand the whole weather situation. The accuracy of the short-term icing forecast has reached 98% till now, which takes the leading level in the international. It can provide scientific and reasonable ice-prevention strategy for the power grid, and offer important technical support for the stability of normal operation of society.

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## 1.INSTRUCTION

Nowadays, the weather department hasn't given short-term icing forecast aimed at the transmission line. Besides, those weather stations are mostly located in the places with low altitude, however, transmission lines has distributed of high altitudes and easy to be covered with ice. The short-term icing forecast based on the weather stations can't effectively reflect the icing characteristic of the power grid.

Through analysing the weather maps of all layers, we can make judgments of the short term movement direction, movement velocity, system intensity of weather system. Thus we can keep whole abreast of the short-term future weather.

Through analysing the weather map, when there appear the following weather conditions, such as the blocking high pressure system on the binary of collapse, strong cold air move to the south area etc , the forecast factors are needed to be analyzed. According to the fulfillment degree of the three forecast conditions, including temperature, rainfall, inversion layer, the short-term icing forecast conclusions for power grid will be given.

When these three conditions are all fulfilled, it's easy to form icing on the transmission line in Hunan province.

## 2. APPLICATION AND ANALYSIS

On this basis, we develop the short-term icing forecast system using this method. It can automatically collect the meteorological data, and realize the analysis process of short-term forecast to make it an operational application, which has greatly improved the working efficiency.

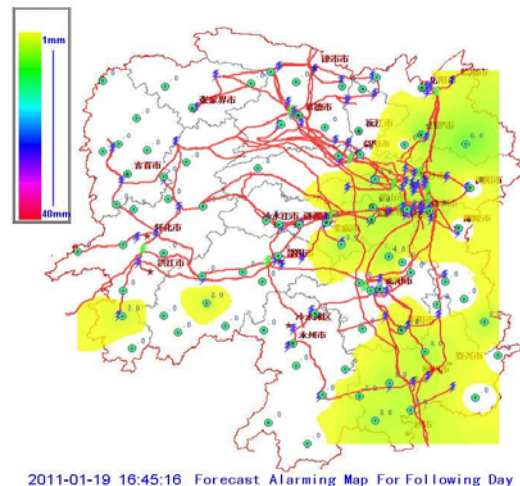


Fig.1 Forecast Alarming Map for next day

Till now, we have given 208 issues in total, with only 4 issues inaccurate, which is mainly due to the forecast error of temperature within 1°C. The forecast work has shown that we can accurately understand the whole weather situation. The accuracy of the short-term icing forecast has reached 98% till now.

## 3. REFERENCES

- [1] J.Z. Lu, H.X. Zhang, Z. Fang, B. Li. "Result and its analysis of ice disaster monitoring of Hunan power system. Power System Protection and Control", Power System Protection and Control, vol. 37, pp. 99-105, June 2009.