Observational Studies Of Hunan Transmission Line Icing At Microtopography And Micrometeorological

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Abstract*—The landform characteristic of Hunan province appears the shape of an open hoof , which is easy to cut off the cold weather from the northern, and forms "the southward Ling motionless cutting edge " when meeting the relatively warm southern weather. Further, the rime or the verglas is formed in this condition, which will lead to the ice-covering on the transmission line and bring great threat to the safety of power grid. Within the Hunan province，it has the complicated natural topography and general configuration of the earth's surface，and there exists several micro terrains，including large-scale water surface , independent hill , high mountain , river valley, canyon, hydraucone, basin and wet land etc. These landform characteristic of micro terrains will take great influence on the various metrological factors, thus form the unique local meteorological phenomena. The characteristic of each micro terrain and local micrometeorology is studied and with the consideration of natural topography ， the appropriate monitoring system locations for typical micro terrain of Hunan province were chosen by the on- pot investigation，and through analyzing the ice-covering data observed under different environments by these monitoring system，the distribution characteristics of icing for each typical micro terrain was concluded, and acquired the conclusion such as ice-covering are easily formed on the inside of hydraucone, instead of the outside of hydraucone, and there are more ice formed near the bottom that at the outlet slope of hydraucone . On this basis, the law/rule for set location of the monitoring system was proposed, and with the combination of the actual topography in Hunan, it can be used to guide the concrete set location of the ice-monitoring system, which plays an important guiding role in the actual engineer project. thus it can acquire much more accurate、reliable icing data served for icing forecast，to optimize icing early-warning monitoring system.

Key words: micro terrain and local micrometeorology, Ice-Covering Characteristic, Set location of monitoring system.

I. INTRODUCTION

The terrain is an important factor which affects the atmospheric circulation of the earth. Topography influence the weather through its impact of circulation, thus people found that the micro-topography have significant impact on the transmission line icing and carried out a number of relevant studies[1]. Some started from the fact, and some started from the analysis and designs, and some started from the prevention and mitigation of disaster, however, they analyzed the impacts of micro-topography on transmission lines, and a lot of useful conclusions have been drawn. But in current

situation, the depth and bread of research on this issue are not enough. One of the reasons is the lack of a large number of observational facts. Therefore, this paper carefully chose observational data based on dozens of micro-topography in a long time, and carried out the system analysis of the impact of microtopography and microtopography situation on transmission lines'icing.

II. CHOOSE THE OBSERVATION POINTS

From July 23 to august 7 in 2008, we went to Chenzhou, Shaoyang, Loudi, Yiyang, and Changsha in hunan province for nearly a month visiting in order to select the typical microtopography[2][3]. According to the terrain and the line's direction, we finally contrastively selected 6 types of microtopography which is referred to the transmission line icing records in the past. They includes typical trains such as the bell, independent hills, mountains, lake, river valley and city.

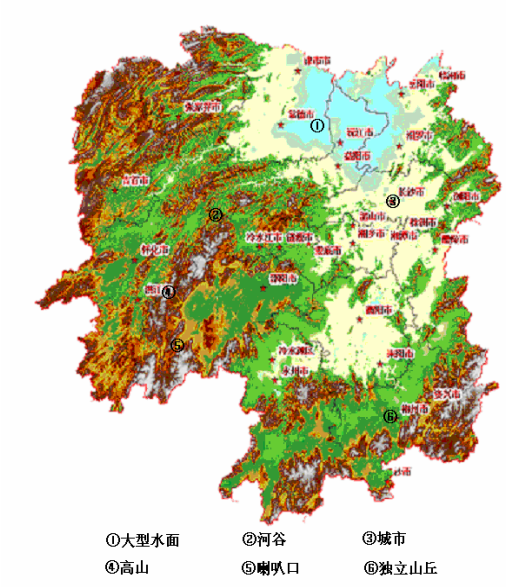

Figure 1:microtopography distribution of observation points

III. THE RESULT OF OBSERVATION

A. the result of the bell's observations

The observation points of Maofang line 1#, 12#, 34# and Baimao line 82#, 88#, 92# are inside the bell[4]; the observation points of Xinning, Suining, Chengbu and Wugang are outside the bell. The result showed that: First, ice coating occurred not outside but inside the bell. When the Maofang line 1#, 12# and the Baimao line 88#, 92# got ice coating, while the Xinning, Suining, Chengbu, Wugang did not. Second, the temperature inside the bell is lower than the outside. Specifically, in the icing-time the average temperatures of automatic observation stations inside the bell is below 0 ℃, but the average temperatures of those weather stations outside the bell is above 0 ℃. Third, all the ice coating inside the bell is at the bottom side and it is hard to getting ice at the opening of the bell. Except Wugang and Maofang line 34# monitoring stations, the other automatic observation stations had ice coating, for he Wugang monitoring stations is at the outside of the opening of the bell with low altitude and Maofang line 34# monitoring stations is at the opening of the bell with relatively low altitude.

Figure 2: The picture of the bell

B. the result of the independent hills observations

The result showed that: first, for the low altitude and high humidity, lines get rime easily. Chengji line Ⅰ 51# located at the northwest side of the independent hills with low altitude and Chengjun line 49# located at the southeast

side of the independent hills with the lowest altitude. those two monitoring stations got ice coating of rime at January 10th and January 11th in 2009, for the humidity were higher than other automatic observation stations but there was no rain. Second, with the similar altitude, the ice coating in windward slope is stronger than which is in leeward slope. Chengji line Ⅰ51# and Chengjun line 49# have similar altitude, but Chengji line Ⅰ 51# is in the windward slope and Chengjun line 49# is in the leeward slope. The temperature of Chengji line Ⅰ 51# was lower than Chengjun line 49#, and the ice coating of Chengji line Ⅰ 51# was stronger than Chengjun line 49# for the moment. Third, the higher altitude, the easier to ice and the ice is thicker. From January 26 to 27 in 2009, all the automatic stations of independent hills had rained, the two automatic stations with low altitude did not got ice coating, but the other stations did. And it appeared that as the altitude increases, the intensity of ice coating gradually increases. The highest station is Yanxian 31#, which has the lowest temperature and the most severe ice coating.

Figure 1: The observations of independent hills

C. the result of river valley observations

River valley's impact on ice coating features is as follows: if the temperature is suitable, the place near the water is easy to get ice coating. Tuoshang line 99# is near by the river valley and Shangqu line 170# is far away from the river valley. On January 7, 2009 those two stations were without the wind blow at 8 o'clock, and Tuoshang line 99# got the ice coating. However, the temperature of Shangqu line 170# was lower than Tuoshang line 99#, for the place near the water got fog easily in the calm wind.

D. The result of the city observations

The result showed that: first, ice coating happened outside the city more than inside the city. The station located in Hunan Electric Power Test & Research Institute and Langguang line 18# are inside city of Changsha, and the other stations located in Changsha suburb and peripheral villages. The temperatures of those two automatic observation stations were above the 0 ℃, and never got ice coating, but the temperatures of other stations were below the 0 ℃, and had the ice coating. Due to all the stations with the similar altitude, the main factors affect ice coating was the heat-island-effect of urban.

E. The result of the lake observations

The result showed that: first, the places near the lake get ice coating harder than near the lake. Yingruan line 65#, Ruanding line 047# and Yingruan line Ⅰ 045# are beside the river, near the lake, while the other automatic observation stations are far away from the lake. Those three automatic observation stations had got ice coating, and the other automatic observation stations didn't. Compared with the land, the lake is characterized by: the temperature is high at the night (22:00 to next day 10:00), and low during the day (next day 10:00 to 22:00).

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IV. MECHANISM ANALYSIS

A. *bell effect*

Table 1 contrast between inside the bell and outside

data	7		8		9		26		27	
stations	88#	Chengbu	88#	Chengbu	88#	Chengbu	88#	Chengbu	88#	Chengbu
icing	1.0	0	1.0	0	1.0	0	2.0	0	0	0
temperature	0.1	0.6	1.5	1.4	-3.1	-0.5	0.1	0.4	0.9	1.1
rainfall	7.0	11.0	7.0	3.0	0.6	0	0.6	5.4	3.8	0.3
wind direction	C	Ne	W	C	Se	C	C	Ne	S	Sw
wind speed	0	3.0	0.1	0	0.9	0	0	2.0	0.6	1.0

As we can see from the table: except the 8th(the ice coating inside the bell was belong to yesterday), the temperature inside the bell is lower than outside; in most cases, the precipitation inside the bell is heavier than outside the bell; the two most important conditions of ice-coating formation is the temperature and precipitation. because of the atmospheric quasi-incompressibility, the accumulation of cold air had increased, thus the precipitation had been strengthened, forming a bell effect obviously.

B. *the impact of windward slope on ice coating*

For mountain area, the mountain as a material role which makes the large flow field changes a lot. After the air meets the mountain, there will be three kinds of flows: the one climbs the mountain body; flows, and returns. these will make it easier to rain on the windward slope, and susceptible to accumulate cold air, thus the temperature is relatively low, and it would get ice coating easily.

C. *the impact of altitudes on ice coating*

Generally speaking, the temperature decreases with altitude. For dry air, the temperature decreases 1 ℃ by every 100m increasing in altitude, called the dry adiabatic lapse rate. for wet air, 0.6 ℃ for every 100m, called the wet adiabatic lapse rate. the temperature must fall below 0 ℃ or less to freeze, so the high altitude conducive to icing.

D. *valley effect*

In general, the topography of river valley has two effects: the one is the valley effect which makes it easy to form the mountain wind and valley wind, then affects the rainfall; the other is water vapor effect, making the humidity relatively heavy inside the valley forming fog easily. For the combined with those two effects, under the same conditions, the location near the valley would get ice coating easily.

E. *lake effect*

Different from river valleys, lakes are easier to form the lake-land breeze due to the large area of the lake water, and the lake temperature is lower than the around land during the day and it is opposite at night, so the flow field changes in the lake region and the wind blows from the land to lake in the day and blows from the lake to land at night. For a wide range of air, temperature at night is lower than the day, so the areas away from the lake get ice easily.

F. *heat-island-effect ofurban*

Comparing urban and suburban areas, there are three significant differences: more population, more buildings and more factories

in cities. Those make their temperature always higher than suburban's, and this is called heat-island-effect of urban. It makes city to get ice coating harder than suburban.

V. CONCLUSION

Through the above analysis, we can draw the following conclusions:

（1）The specific mircotopography, such as bells, independent hills, mountains, river valleys, lakes, and particular urban environment will affect the line's ice coating;

（2）The topography of bell affects the ice coating by affecting the field of temperature and wind fields: the temperature inside the bell is higher than outside, but it is easier to get ice coating inside the bell than the outside; the ice-coating is always around the bottom of the bell, and it is hard to get ice coating at the mouth of the bell.

（3）The higher altitude, the easier to get ice coating and the ice is thicker; to the similar altitude, it is harder to get ice coating at leeward than windward.

（4）Impacted by the lake effects, it is hard to get ice coating near the lake and easy to do so away from lake at night.

（5）Because of the mountain effect and water effect, it is easy to get ice coating inside the river valley.

（6）The heat-island-effect of urban impacts obviously on ice coating. In the urban areas, it is hard to get ice coating, but at suburbs, it is easy.

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