

# REVIEW OF OLD SPECIAL ICING MEASUREMENTS AND SOME NEW ICING ACTIVITIES IN THE MOUNTAINOUS REGIONS OF BULGARIA

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## Abstract

The initial icing observations in Bulgaria started in 1949 at peak Cherny vrach, Vitosha mountain (2286 m) and after that at many other stations. Later at the same peak additional special measurements of the rime-icing on plastic and metal cylinders with different diameters were carried out. Data about the meteorological conditions during icing events and the final ice depositions have been collected but these data have not been analyzed until nowadays. In this paper the results from our analysis of the available information will be presented and compare with some results from our rime-icing model.

The recent activities, which are currently carried out in Bulgaria in the frame of the COST 727 project “Measuring and forecasting atmospheric icing on structures”, will be also presented.

**Keywords:** *ICAM, snow and ice, mountainous area*

## 1. INTRODUCTION

The initial icing observations in Bulgaria started in 1949 at peak Cherny vrach (2286 m) on a telephone cable. After that the ice measurements were continued on a special device, which was a couple of horizontal wires with diameter of 5mm located perpendicular to each other in the directions N-S and E-W. Such measurements were set at another 22 stations from the Bulgarian meteorological network. Additional special measurements of the rime-icing on plastic and metal cylinders with different diameters were carried out some years later at the same peak. Data about the meteorological conditions during icing events and the final ice depositions have been collected.

Now only three from all these stations have kept their special icing observations. Most of these old data have not been analysed until nowadays because they have been considered as lost. Luckily they were occasionally found during the renewal of the archive building last year. In this paper the first results from the analysis of the available information will be presented and compare with some results from our former investigations.

The recent activities, which are currently carried out in Bulgaria in the frame of the COST 727 project “Measuring and forecasting atmospheric icing on structures”, will be also presented.

## 2. DATA

### 2.1 Icing measurements based on the couple of wires

To this moment the information about icing has been gathered only from the regular SYNOP messages as well as from the icing reports from the last three stations which still have such special observations – Razgrad, Dobrich and Kaliakra. However all these stations are located in low part of the country (NE Bulgaria). The typical icing conditions here are glazes caused by freezing rains and freezing drizzles.

The icing information from the couple of wires includes: the two main diameters of the ice depositions, the amount of the melted water and some meteorological data as wind speed, wind direction, air temperature and the present weather and was written down in paper register. Because of the great amount of information, which has to be manually checked and saved in electronic files, in order to be carried out, here only the list of the stations and the period of measurements will be presented – Table 1. Only information from two stations – Snežanka and Rojen has been already practically applied for the design of telecommunication masts in the Rodopes Mountain after customer requests.

The time period with available icing measurements is different for the different stations. For some it is only a few or one year, for other it spans over than 25 years. The stations with long period and good quality of the data are marked with (\*).

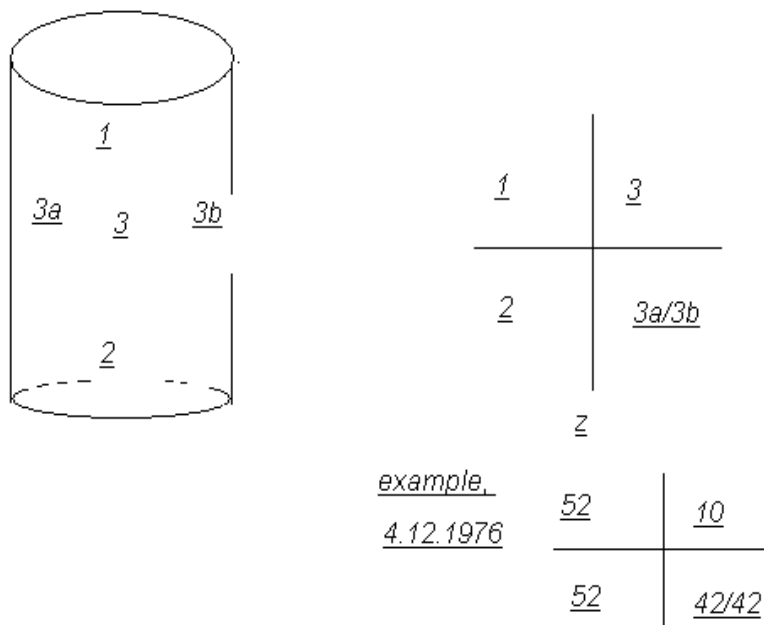
**Table 1:** Meteorological stations with icing observation

<b>Station</b>	<b>Altitude, m</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Part of country, mountain</b>	<b>Years of icing observation</b>	<b>Data quality</b>
<b>Kozloduy</b>	34	43.47	23.44	NW	1969-1970	not good
<b>Vidin</b>	31	43.59	22.51	NW	1992-1993	relatively good
<b>Orjahovo</b>	29	43.43	23.58	NW	1955-1964	relatively good
<b>Gramada*</b>	257	43.50	22.40	NW, Stara planina	1955-1986	very good
<b>Petrohan</b>	1400	43.25	23.14	NW, Stara planina	1968-1983	good
<b>Peak Murgash*</b>	1678	42.50	23.40	NW, Stara planina	1980-1994	very good
<b>Vakerel*</b>	851	42.55	23.17	W, Lozenska planina	1959-1989	very good
<b>BAC station, Vitosha</b>	1485	42.41	23.10	W, Vitosha	1968-1974	not good
<b>Borovec*</b>	1244	42.15	23.36	SW, Rila	1960-1975	relatively good
<b>Smoljan</b>	1180	41.34	24.12	SW, The Rhodopes	1968-1978	relatively good
<b>Pamporovo</b>	1599	41.39	24.41	SW, The Rhodopes	1976	not good
<b>peak Snejanka*</b>	1925	41.40	24.41	SW, The Rhodopes	1974-1999	very good
<b>Rozen*</b>	1750	41.53	24.44	SW, The Rhodopes	1999-currently	
<b>Elhovo</b>	136	42.11	26.35	SE	1959-1969	not good
<b>Krumovgrad</b>	235	41.28	25.39	S	1956-1975	relatively good
<b>peak Botev*</b>	2376	42.43	24.55	Central Stara planina	1966-1994	very good
<b>Chirpan</b>	178	42.18	25.17	Central Bulgaria	1971	not good
<b>Ljuljakovo</b>	217	42.53	27.05	E	1957-1974	not good
<b>Kaliakra*</b>	63	43.21	28.27	NE	1969-currently	very good
<b>Gen. Toshevo*</b>	236	43.39	28.01	NE	1956-1986	very good
<b>Dobrich*</b>	200	43.35	27.50	NE	1987-currently	very good
<b>Razgrad*</b>	346	43.33	26.30	NE	1978-currently	very good
<b>Gara Samuil*</b>	474	43.30	26.44	NE	1955-1979	very good

## 2.1 Special icing measurements at Cherny vrah

Besides the first icing measurements on telephone cable in Bulgaria another two types of special icing investigations were conducted in this region. The first one has examined the possible relations between the meteorological parameters and some quantities needed as input values for the modeling of the process. As results some correlations have been revealed and reported [3,4].

The second one was special measurements of ice depositions on metal and plastic cylinders with different diameters - aluminum and Plastic cylinders with  $D = 50$  cm and a Plastic pole with  $D = 3$  cm. The measurements were taken in 5 points and information about the part of the cylinder covered with ice was also given. The scheme of the measurements is given on Figure 1.



**Figure 1** Scheme of the measurements of the cylinder and the written form in the paper register. 1, 2, 3, 3a and 3b measurements points (in cm)

The investigation was carried out in the period February 1972 – March 1977. 194 cases from all reported icing cases were measured. The information about the meteorological conditions incases of icing has been compared with a former investigation for the same region [3].

**Table 2** Comparison between some characteristics of the process of rime-icing for station Cherni vrah for two periods of investigations.

	Mean number of cases	Max. Duration, hours	Mean air temperature ( $^{\circ}$ , C)	Mean wind speed, (m/s)
1972-1977	39	182	-6.5	14.0
1981-1990	51	189	-6.3	11.9

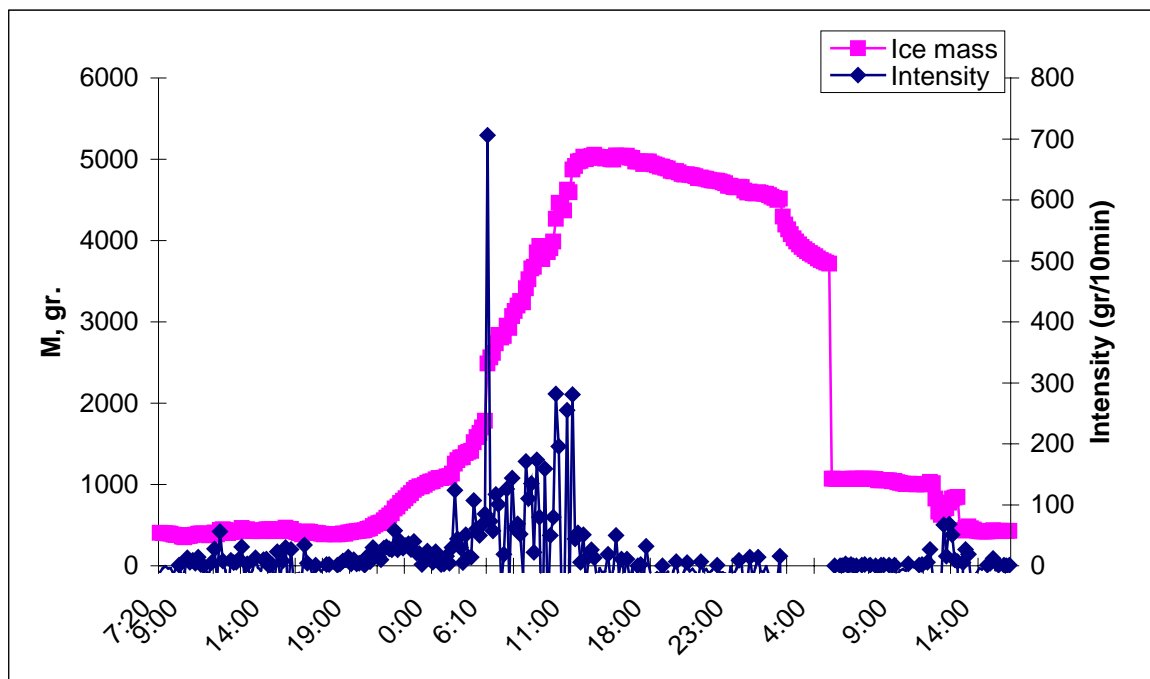
The table shows that despite the different length of the periods the values are comparable.

The collision coefficient has been experimentally determined and compared using different theoretical approaches.

The main results from these old icing measurements was the determining of the relation between the intensity of the process and the wind speed giving an averaged formula for the cylinders with diameter 50 cm  $I = 3.6 \cdot 10^{-3} V$ .

### 3. NEW ICING MEASUREMENTS

In the last two years two automated icing sensors were installed at different locations in the Bulgarian mountains. The first sensor is the sensor ICEMETER developed by the Czech Institute of Atmospheric Physics ([www.ufa.cas.cz](http://www.ufa.cas.cz)), and the second one is one T26 Icing-Rate Sensor™ from HoloOptics ([www.holooptics.net](http://www.holooptics.net)). The ICEMETER were installed firstly at Cherny vrah in January 2006 and the other sensor on peak Mussala (<http://beo-db.inrne.bas.bg/moussala/>) in January 2007. During the operation in winter 2005/2006 the first sensor encountered several icing cases. On figure 2 is presented the most severe case for his period. The duration of this process was 32 hours and the maximal ice mass – 5054 gr.



**Figure 2** Icing at Cherny vrah on 25-26.02.2006.

Another chez sensor is planned to be installed this year at peak Murgash where there is also a long old data set available. This will be done in the frame of joint project for comparison of the icing conditions at two couple of test stations in Bulgaria and Slovakia. The project is financed by the Ministry of Education and Science.

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