METEOROLOGICAL CHARACTERISTICS OF A SNOW PIT IN *GORSKI KOTAR* REGION (CROATIA)

Dubravka Rasol, Kornelija Špoler Čanić

Meteorological and Hydrological Service, Grič 3, 10 000 Zagreb, Croatia
E mail: *rasol@cirus.dhz.hr*

Abstract: This paper outlines the first meteorological measurements taken from a snow pit in the *Gorski kotar* region, which is located in the mountainous western part of Croatia. The aim of the research was to determine the main meteorological characteristics of the location. The research rested on the assumption that meteorological conditions in snow pits could be indicators of regional climate change.
Temperature and relative humidity were measured inside and in the vicinity of the snow pit. Two samples from different depths of snow accumulated at the bottom of the pit were collected for analysis. Changes in temperature and relative humidity in the vicinity of the snow pit showed typical seasonal variations. The values inside the pit were constant. The pH measurements of the snow samples showed no indication of an increased acidity of snowmelt at the monitoring location. Further research in some other snow pits should be conducted in order to test the general relevance of the obtained results.

Keywords - *snow pit, climate, karst*

1. INTRODUCTION

Almost a half of Croatian territory is of karstic morphology with numerous speleological objects (Garašić,1995), which calls for a systematic and detailed meteorological research of caves and pits. Until now Croatian meteorologists have conducted no systematic speleometeorological and speleoclimatological research. Speleometeorological measurements have so far only been carried out sporadically, by amateur speleologists.

Weather conditions and climate shaping at specific locations on the Earth's surface are mainly influenced by short to medium-term (regional to global scale) changes. On the other hand, the speleoclimate depends on local conditions (Bögli,1978) and cavern morphological peculiarities (Mavlyudov,1997). Typically, conditions in speleological objects are continuously homogenous e.g. high relative air humidity prevails over long periods of time, temperature variations are very low and air movements are weak or totally absent (Pflitsch and Piasecki, 2003). Any climate change in a local area should show variation in such a specific and in time persistent microclimatic conditions. Numerous authors researched connection between climate change e.g. global warming and the disappearance of ice caves (Sesiano,1996; Brulhart,2001), presence of mountain permafrost (Vonder Muhll,2002) and the reduction of snow cover (Harris *et al*., 003).

Our research, initiated by *The Croatian Meteorological Society* and *The Meteorological and Hydrological Service of Croatia*, is the first attempt of Croatian meteorologists to research the climate conditions of snow pits and the first step in connecting these conditions with local climate change.

2. MEASUREMENTS

Air temperature and relative humidity inside and in the vicinity of the snow pit were measured between the 22nd and 28th of August 2004. The period and the location of measurements were chosen on the basis of historical reasons. Croatian naturalist and travel writer Dragutin Hirtz was the first known researcher to measure the temperature inside a speleological object in Croatia. It happened in the same snow pit on the 25th August 1884. He measured the temperature at the surface and at the bottom of the snow pit and recorded 14.1°C and 3.1°C, respectively (Hirtz, 1891).

2.1. Study site

The snow pit, named "Radiator", is situated near *Slavica*, a village in the *Gorski kotar* region. This mountainous western part of Croatia is known for its karstic characteristics, a wealth of caves, pits, karst sinkholes and crags. This is an area of mixed woodland (mostly beech, fir and spruce trees). The snow pit is encircled by vertical rocks about 3 m in height with a narrow pass on the north side and it is more sheltered on the south side. Such conditions are favourable for snow persistence during the whole summer. The entrance to the pit is at 45°20"N, 14°46"E and at the altitude of 1000 m a.s.l. The pit depth is approximately 40 m.

2.2. Measuring equipment

The Lambrecht hygrothermograph was placed on the bottom of the pit, situated on a rock, with its sensor approximately 5 cm above the ground. The measurement records were corrected on the site comparing the values with Vaisala temperature/humidity probe (HMI41). Samples from the snow accumulation on the bottom of the pit were taken to determine snow density by means of a spring scale. Two snow samples were collected for analysis from the depths of 1.5 m and 1.0 m of accumulated snow.
Outside the pit, Lambrecht hygrograph and thermograph were placed with their sensors approximately 5 cm above the ground. At the same spot, at the height of 140 cm, Lambrecht psychrometer and Thermoschneider minimum and maximum thermometers were placed (data not shown). Geothermometers, Tlos 5 cm and Termoschneider 10 cm, were placed in the vicinity where there was enough available soil for their installation.

In the course of the measurements it was raining and the precipitation amount was also measured.

3. RESULTS

During the whole period of measurements, the temperature at the bottom of the snow pit was 2.9°C, and the relative humidity was 94.6% (Fig. 1). Snow sample taken from the bottom of the snow pit from 0.5 m depth had pH value 5.56, and the one from 1.0 m depth had pH 6.44. The density of snow taken from the bottom of the pit was 0.5 g/cm^3.

The highest and lowest temperature outside the snow pit measured 16.9°C and 7.6°C respectively (Fig. 1 left). The highest relative humidity was 95%, and the lowest was 62% (Fig. 1 right). The amount of rain recorded was 44 l/m^2 and the rain water's pH was 6.30. Soil temperatures measured at 5 cm depth ranged from 12.1°C to 14.6°C, and those at 10 cm depth from 12.0°C to 13.6°C (data not shown).

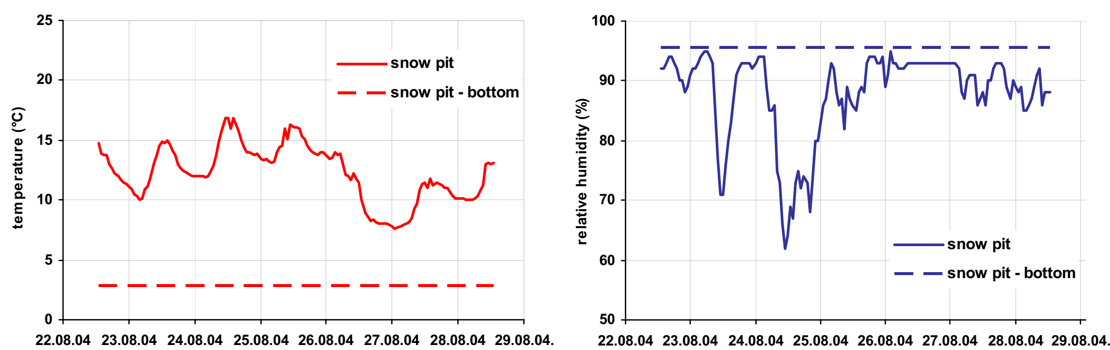

Figure 1. Diurnal courses of the temperature (left) and relative humidity (right) at the bottom and outside of the snow pit during the whole period of measurements.

4. CONCLUSION

Changes in temperature and relative humidity in the vicinity of the pit showed typical seasonal variations. The values inside the snow pit were constant. The pH measurement of the snowmelt and of the rain water showed no indication of acid rain at the monitoring location, despite the fact that the region had been exposed to long range pollution (Potočić *et al.*, 2003). Further research of snow pits should be conducted to test the general meaning of the obtained results.

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