TOPOCLIMATOLOGICAL RESEARCH IN ÚDOLÍ BYSTŘICE RIVER NATURE PARK (CZECH REPUBLIC): FUNCTIONAL METEOROLOGICAL NETWORK

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Abstract

Topoclimatological research has a long-term tradition at the Department of Geography, Natural Science Faculty, Palacky University of Olomouc. Thanks to the financial support of the Czech Ministry of Education, the latest meteorological instruments and equipment have been acquired and thus the establishing of the meteorological functional network has been made possible. Due to the assumed topoclimate variability, the "Údolí Bystřice River Nature Park" has been selected as an experimental area. This paper deals with the physio-geographic characteristics, instruments and observation methodology of the local climate in the "Údolí Bystřice River Nature Park".

KEY WORDS: The Údolí Bystřice River Nature Park, topoclimate, meteorological functional network, field observation, cross section measure

1. INTRODUCTION

Topoclimatological research has a long-term tradition at the Department of Geography, Natural Science Faculty, Palacky University of Olomouc. It is based on a topoclimatic map construction when the used methodology (e.g. Vysoudil, 1998, 2000,) allows expressing a spatial distribution of supposed topoclimate types and linked climate generating processes in the local scale landscape. In a functional network, field measuring significantly increases the quality of the topoclimatic research. However, this is very demanding especially on the instrument equipment. Without the field measuring, it would be difficult to prove some of the local climatic effects.

Thanks to the grants given to the "Educational laboratory for the landscape study", it was possible to buy automatic mobile meteorological stations. Mentioned stations became the basis for the functional topoclimatological network. Obtained test measurements have

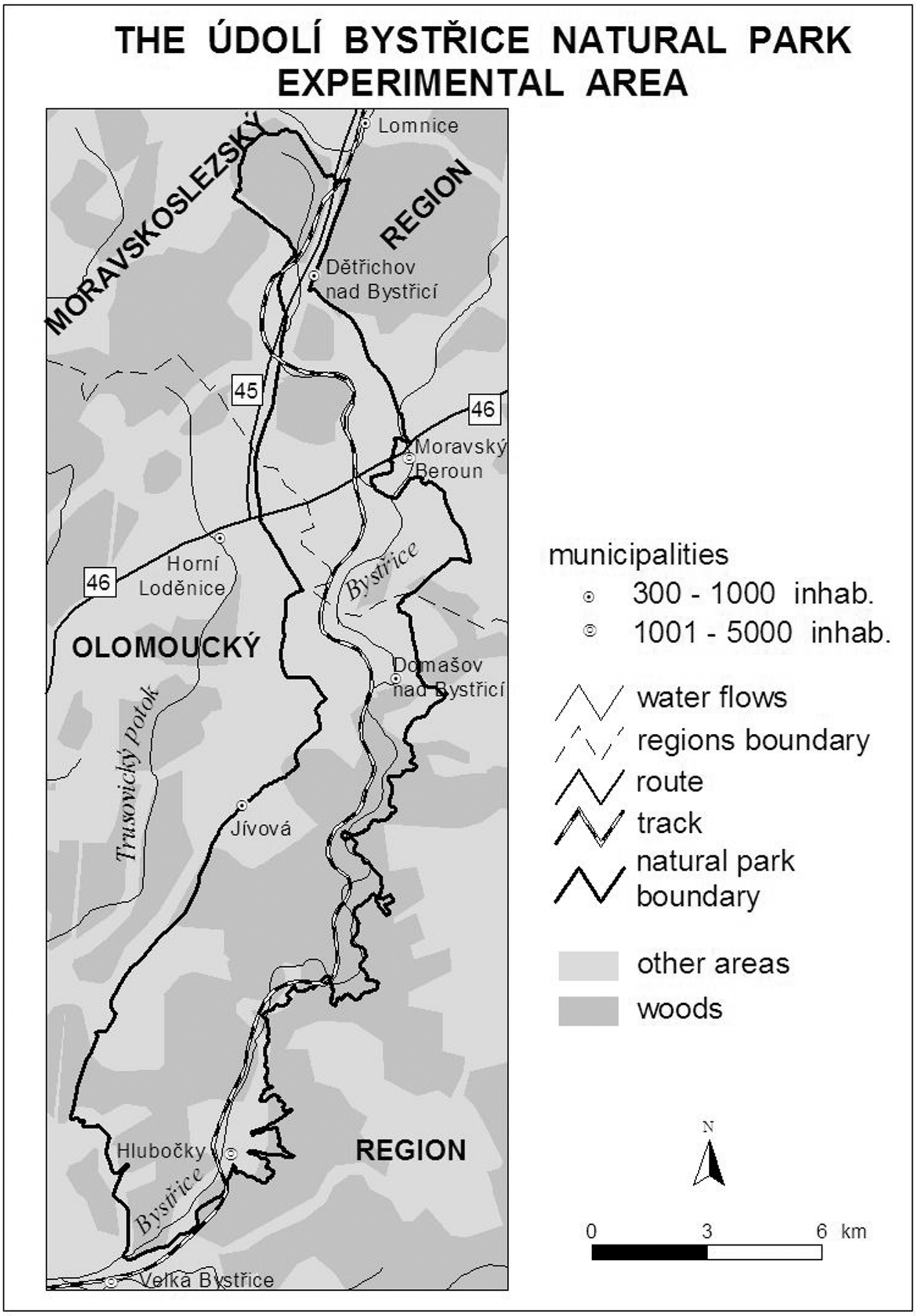


Figure 1: Experimental area

become a part of the next research project "Local climatic effects and their influence on the possibility of pollutants dispersion in the ***"Údolí Bystřice River Nature Park"***.

This contribution, as the first of series dedicated to the topoclimate research in the ***"Údolí Bystřice River Nature Park"***, includes detailed physio-geographic description of the research area, network, instruments and the used topoclimate measure methodology.

2. EXPERIMENTAL AREA PHYSIOGEOGRAPHY CONDITIONS

The experimental area is situated predominantly in the eastern part of the ***'Olomouc'*** region. Only the northernmost part lies within the ***'Moravskoslezský'*** region (fig. 1). The ***"Údolí Bystřice River Nature Park"*** was established in 1995 by the ***'Olomouc'*** and '***Bruntál'*** district authorities (Šafář, 2003). Its area is 99.3 km^2. The Bystřice River represents the natural axis of the area, even though in the southern half it sporadically forms the area's eastern boundary.

Approximately 50 % of the Nature Park area is covered with woods, mainly beech and spruce. Municipalities are concentrated either along the ***'Bystřice River'*** narrow valley or in the tablelands here. Pastures mainly represent the remaining sections. In some places the slopes of the river valley and the neighbouring valleys are quite steep (fig. 2).

2.1. Geomorphological conditions

From the geomorphological viewpoint, the experimental area is a part of the ***Nízký Jeseník*** geomorphological unit. Four subunits contribute their regions to the experimental area. The ***Domašovská*** Highland lies mainly in the central and the southern section of the nature park, the ***Bruntálská*** Highland is in the northern section, the ***Oderské*** Highland and the ***Tršická*** Upland are in the southeastern area. The highest altitude here, 701m, is at a nameless peak, which lies to the south of the ***Bystřice River*** spring. The lowest elevation of 250 m a. s. l. is at the point where the ***Bystřice*** River leaves the nature park area.

Figure 2: Steep slopes within the Údolí Bystřice River Nature Park (photo M. Vysoudil)

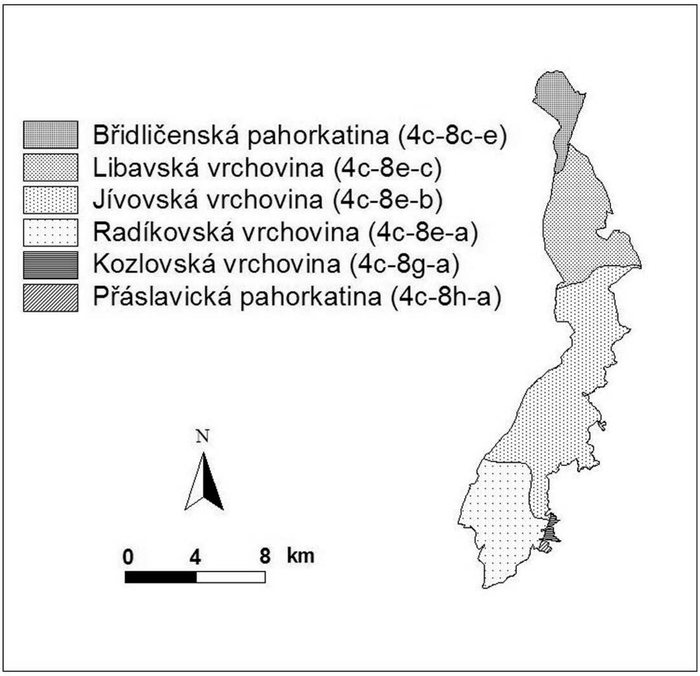


Figure 3: Geomorphological districts (according to Balatka et al., 1987)

The ***Domašovská*** Highland's mean altitude is 548m. Within the natural park area three districts represent this subunit. They are the ***Libavská,*** the ***Jívovská*** and the ***Radíkovská*** Highlands districts (fig. 3). It is a tectonic plate highland formed of mostly sub-Carboniferous slate. The experimental area has a rugged surface cut by young deep valleys (Balatka et al., 1987). This is especially evident in the southern part of the ***Bystřice*** valley. The ***Pštrosí údolí*** and the ***Hluboký Důl*** valleys have a similar landscape. These two valleys join the ***Bystřice*** valley from the right. The valley to peak elevation rise exceeds 200 m in some places, which provides suitable conditions for the topoclimatic research. There are many cryogenic modulations found on the slopes here such as frost riven cliffs and block streams (Janoška, 2003).

The ***Bruntálská*** Highland mean altitude is 567m. Within the Natural Park area this section is characterized by well-rounded ridges and widely spread valleys (Balatka et al., 1987). The ***Břidličenská*** upland district represents the ***Bruntálská*** Highland in the Natural Park (fig. 3). The valley to peak elevation variation is not prominent in this part and does not exceed 100 m. This is where, at 660 m a.s.l., the ***Bystřice*** river springs.

Oderské Highland, which represented by the ***Kozlovská*** Highland district, and the ***Tršická*** Highland, represented by ***Přáslavická*** Upland district, are situated in the southeastern part of the ***Údolí Bystřice*** Natural Park region and their area contributes only marginally to the natural park area.

2.2. Hydrological conditions

The ***Bystřice*** River, springing at 660 m a. s. l., presents a hydrological axis of the nature park area. It empties into the ***Morava*** River near the ***Olomouc*** city's core at 212 m a. s. l.; the catchment area is 267 km^2, the river length is 54 km; an average outflow in the entry slightly exceeds 1 m^3/s (Vlček et al., 1984). The hydrographic system is rather dense with plenty of short and rapid tributaries draining the area into the ***Bystřice*** River. The vast majority of the water in the Nature Park is collected by The ***Bystřice*** River catchment while the ***Trusovický Potok*** catchment only collects water from the westernmost portion in the **Véska** and **Pohořany** municipalities.

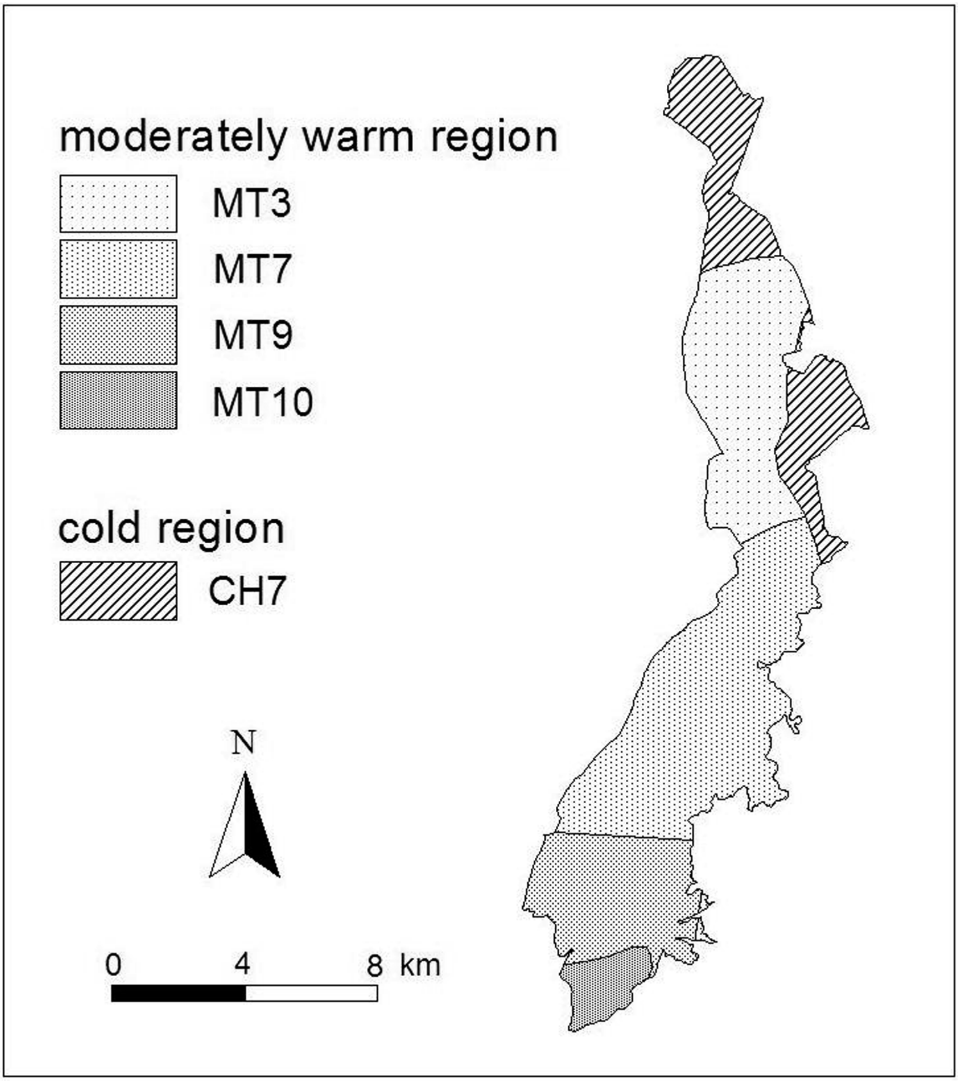


Figure 4: Climatic regions within The Údolí Bystřice River Nature Park (according to Quitt, 1971)

2.3. Climatic conditions

According to Quitt (1971), moderately warm and cold climatic regions play a role in the Nature Park area (fig. 4). The Moderately warm climatic region is represented by four subregions. There are MT10 and MT9 subregions in the southern part; MT7 is in the central part and MT3 is in the north from the center section. Only the northernmost park sector and the segment along the eastern boundary, south of ***Moravský Beroun*** and in the ***Domašov nad Bystřicí*** vicinity, lie within the cold climatic region; subregion CH7. Because the elevation gradually increases heading north, the summer season duration declines in this direction. Therefore, the winter season length and the snow cover period increase correspondingly.

Tab. 1 and fig. 5 present the course of the mean monthly air temperatures at the ***Moravský Beroun*** station (nonexistent nowadays) and at the ***Olomouc*** station during the 1901-1950 period. The ***Moravský Beroun*** station was situated closest to the natural park area at an altitude of 570m, and its geographical location was 49° 48´ north latitude and 17° 27´ east longitude. The ***Olomouc*** meteorological station is situated within the ***Olomouc*** city area. Its altitude is 215 m and the geographical location is 49° 36´ north latitude and 17° 16´ east longitude.

Table 1: Annual course of air temperature [°C] in Olomouc and Moravský Beroun (1901–1950)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	annual mean
Olomouc	–2,7	–1,2	3,4	8,5	13,9	16,6	18,5	17,7	14,0	8,7	3,3	–0,5	8,4
Moravský Beroun	–4,6	–3,3	0,8	5,9	11,6	14,6	16,6	15,4	11,8	6,6	1,3	–2,4	6,2

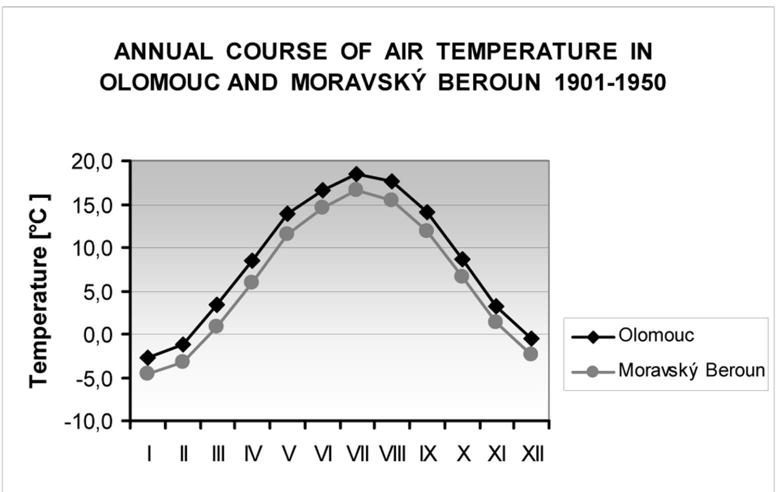


Figure 5: Annual course of air temperature [°C] in Olomouc and Moravský Beroun (1901–1950)

The annual mean air temperature is lower in Moravský Beroun (6.2 °C) than the temperature in Olomouc (8.4 °C); which is explained by the Moravský Beroun's higher altitude.

The annual long vegetation season ($t_d \geq 5.0$ °C) lasts on average 198 days in Moravský Beroun and 218 days in Olomouc. This season begins on 10. IV. and 29. III., respectively, and ends 24. X. and 1. XI, respectively. The annual main vegetation season ($t_d \geq 10.0$ °C) lasts on average 142 days in Moravský Beroun and 160 days in Olomouc; it begins on 7. V. and 27. IV., respectively, ending on 25. IX. and 3. X., respectively.

The highest air temperature ever recorded in ***Olomouc***, 35.5 °C, was measured twice; on 21. and 22. VIII. 1943. The lowest temperature ever recorded, –38.0 °C, was measured on 11. II. 1929 at the same station.

The average number of tropical days per year in Olomouc ($t_{dmax} \geq 30.0$ °C) is 9.5; the average number of summer days (tdmax ≥ 25.0 °C) is 59.1; the frost days ($t_{dmin} \leq -0.1$ °C) 116; and the ice days ($t_{dmax} \leq -0.1$°C) 35.5. The average number of the arctic days in Olomouc ($t_{dmax} \leq -10.0$ °C) is 2.3 days during the 1926–1950 period.

Tab. 2 and fig. 6 present the annual course of precipitation at the ***Olomouc*** and ***Moravský Beroun*** stations.

Table 2: Annual course of precipitation [mm] in Olomouc and Moravský Beroun (1881–1980)

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	annual mean
Olomouc	27	23	28	39	61	75	86	74	47	46	41	30	578
Moravský Beroun	48	40	42	55	74	84	99	93	65	64	57	53	767

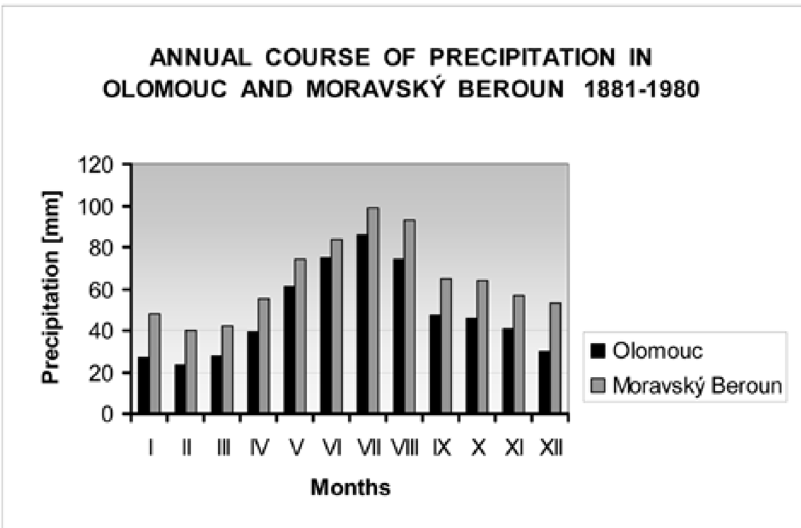


Figure 6: Annual course of precipitation [mm] in Olomouc and Moravský Beroun (1881–1980)

It is evident that higher precipitation amounts, of the two stations, were consistently measured in ***Moravský Beroun***. The lowest monthly precipitation amounts were measured in February in ***Moravský Beroun*** and ***Olomouc***, 40 mm and 23 mm respectively. The highest monthly precipitation amounts, 99 mm and 86 mm respectively, were measured in July at both stations (Vysoudil, 1989).

During the 1920/1921 – 1949/1950 period, 47.7 snow days were recorded in the ***Moravský Beroun*** and 28.2 snow days were recorded in ***Olomou***c. The snow cover duration was on average 96.8 days in ***Moravský Beroun*** and 40.9 in ***Olomouc*** during the same period.

The sunshine duration and the wind direction distribution data are presented for the ***Olomouc*** meteorological station only.

Table 3: Wind direction distribution [%] in Olomouc (1946–1954)

Wind direction	N	NE	E	SE	S	SW	W	NW	calm
Percent occurence	10.1	7.6	4.0	9.0	12.1	6.9	10.2	15.0	25.1

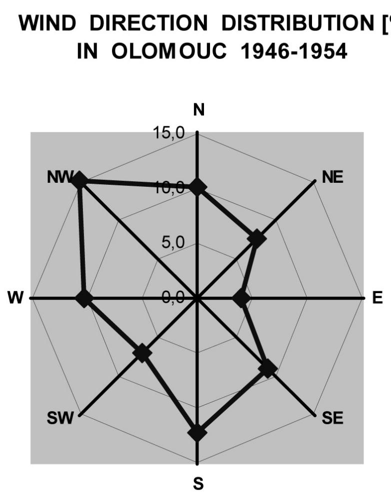


Figure 7: Wind direction distribution [%] in Olomouc (1946–1954)

In ***Olomouc*** the northwesterly winds had the highest percentage occurrence, 15 %; the easterly winds had the lowest percentage occurrence, 4 %. The highest was the calm occurrence percentage, 25, 1 %.

Tab. 4: Sunshine duration (hours) in Olomouc (1946–1955)

It is evident that the sunshine duration in ***Olomouc*** was the longest in July, ranging from 273 to 278 hours, the shortest was in December, ranging from 25 to 26 hours.

The annual mean air relative humidity was 76 % during the 1926–1950 period at the ***Olomouc*** station.

2.4. Biogeographic conditions and nature protection

Mainly spruce and beech participate in the forests species composition within the experimental area. The western and the northern parts of the Nature Park are covered with meadows and pastures. There are some rare plant species that have been preserved in the meadows, Iris Sibirica for instance. Chiroptera often hibernate in quarries and empty adits. Within the Nature Park region, eight Chiroptera species have been discovered (Šafář, 2003); Rhinolophus hipposideros and Myotis myotis can be presented as examples. Salamandra salamandra that hibernates in adits is also one of the rare wild life species worth mentioning.

Within the Nature Park area ***'Kamenné Proudy u Domašova'*** block streams, declared as the Natural Monument in 1974, can be found (Šafář, 2003). Also within the Nature Park is the ***'Hrubovodské Sutě'*** site which was declared the Nature Preserve in 2001.

3. EXPERIMENTAL AREA SOCIOECONOMIC CONDITIONS

Mostly small municipalities are within the experimental area. The largest one is ***Hlubočky*** with a population of 4500, as of 1. March 2001 (Statistický lexikon obcí ČR, 2005). During the second half of the 20th century the population decreased significantly in all municipalities. The biggest settlements are found in the ***Bystřice River*** valley. They are ***Hlubočky, Dětřichov nad Bystřicí, Domašov nad Bystřicí***. The ***Dětřichov nad Bystřicí*** municipality, located in the northernmost part of the Nature Park, lies within the ***Moravskoslezský*** region. The ***Domašov nad Bystřicí***, ***Hraničné Petrovice***, ***Jívová, Hlubočky*** and ***Dolany*** with its parts ***Pohořany*** and ***Véska*** municipalities lie within the ***Olomoucký*** region. ***Moravský Beroun*** is outside the Nature Park area, and only its two urban neighbourhoods, ***Ondrášov*** and ***Sedm Dvorů*** are within the experimental area. ***Radíkov*** and ***Lošov*** are town districts of the **Olomouc** city and have a direct connection with the experimental area by the urban public transportation.

A vital railroad # 310 connecting ***Olomouc*** and ***Opava*** runs through the Nature Park. A major highway connecting ***Olomouc*** and ***Opava*** cuts through the northern part of the park.

There are two major industrial sites within the park area: the Foundeik foundry plant and the Mora producing non-electric devices for private households. They are listed as a category REZZO 2 in terms of the pollution source classification. However, the home furnaces and the increasing automobil traffic present the greatest hazard to the air quality, especially during the temperature inversions.

In the highest locations of the Nature Park, above 600 m a. s. l., with an abundace of meadows and pastures the mountain agricultural production practised dominated by beef raising. In the lower altitudes potatogrowing, grain farming and beef-raising are predominant.

Because of the natural conditions, especially the geomorphological and the climatic ones, an industrial production as well as an agriculture play an isignificant role within the area. Because of the abundance of the leisure time facilities in the park land the area is frequently visited by holidaymakers from ***Olomouc*** and its surrounding areas.

4. NETWORK AND INSTRUMENT DESCRIPTION

At this time, the station network consists of 4-automatic meteorological stations. There are 3-***Fourier system*** stations equipped with a data logger ***MultiProLog*** and 1-***Grant system*** equipped with a data logger ***Squirrel 1209***. Supplementary air temperature and humidity measurements are provided using Forier system miniloggers ***MicroLog EC650.***

4.1. Technical specification

Technical specifications for both systems are described bellow.

a) Fourier Systems Ltd.

<u>Fourier weather station</u>

At present, there are 3-***Fourier*** weather stations located in the experimental area. Their source of energy are solar arrays, which continually charge two batteries. The station allows using two operating modes, the '***Continuous run'*** mode and the ***'Stand-alone Experiment'*** mode. The ***'Continuous run'*** mode saves the data automatically to the computer and requires continuous service software operation. Wireless connection is possible up to 300 meters. The ***'Stand-alone Experiment'*** mode, presently used for technical reasons, saves the data directly to the data logger and requires occasional field trips to download the collected data to a computer.

After setting the stations in leveled position, they were anchored to the surface to withstand even very high winds. The solar panel was set to face south to be optimally exposed to the sun. It is recommended to check the station monthly, to download and to archive the data. The stations' operations were gradually fine-tuned for a practical observation during the summer months, based on the knowledge gained observing their function in the real environment. The first comprehensive time series of meteorological elements from Fourier stations were obtained for the months September – November 2005.

The station Fourier system Ltd. works with Data Logger MultiLogPRO version 8.6WTI, which is equipped with six sensors (tab. 5).

Table 5: Fourier Weather Station sensors specification

Sensor	Range	Sensitivity	Accuracy
Temperature	–15 to 110 °C	0.25 °C	± 2%
Humidity	0 to 100% RH	0.4%	± 2%
Barometric Pressure	800 to 1150 hPa	1 hPa	± 15 Pa
Rain Collector	0 to 204 mm	0.2 mm	± 0.2 mm
Wind Speed	0 to 270 km/h	0.36 km/h	± 0.36 km/h
Wind Direction	0 to 360°	0.46°	± 0.46°

Sampling

Memory capacity	100 000 samples
Sampling Rates	from 1 sample per hour to 1 sample per 10 seconds

Power Supply

Solar Panel	Max. power 10W
Battery	2 parallel 12V 2.3 Ah rechargeable dealer lead-acid batteries

Software
WeatherLab

MicroLog EC650 Fourier

Device is used for temperature and humidity monitoring support (tab. 6).

Table 6: MicroLog sensors specification

Sensor	Range	Resolution	Accuracy
Temperature	–30 to 50 °C	0.5 °C	± 0.6 °C
Relative Humidity	0 to 100%	0.5%	± 3%

Sampling

Memory capacity	16.000 samples
Sampling Rate	from every 10 seconds to 2 hours

Power Supply

Battery	3.6V/1.2 Ah internal lithium battery

Software
MicroLab

b) Squirrel Mini-Met Weather Station, Grant Instruments

At present, there is only one ***'Squirrel Mini-Met Weather Station, Grant Instruments'*** located in the experimental area. The station is powered by lead-acid battery and can supply the station for up to 6 months. During the winter season, with the air temperatures bellow –20 °C, it is necessary to change the battery more frequently. The system stores data directly into the data logger '***Squirrel 1209'*** which requires field trips to download the collected data to a computer.

Used data logger Squirrel 1209 is equipped with six sensors (tab. 7).

Table 7: Mini-Met Weather Station sensors and its specifications

Sensor	Range	Sensitivity	Accuracy
Temperature	–50 to 150 °C	0.1 °C	0.1 °C
Humidity	0–100%	–	2–3%
Rain Collector	–	0.2 mm	0.2 mm
Wind Speed	0–270 km/h	0.3 m/s	2%±0.1m/s
Wind Direction	0 to 360°	0.3 m/s	± 10°
Solar radiation	300–1100 nm	–	–

Sampling
Memory capacity 40.000 samples
Sampling Rates from 1 sample per second

Power Supply
Battery 12V, 7Ah valved regulated lead-acid rechargeable battery

Software
Squirrel View

5. SPATIAL LOCATION OF STATIONS

When chosing the most suitable stations locations, two major chalenges had to be faced. The fisrt one was selecting representative locations that would be suitable for the topoclimatological research. Vertical differences in the experimental area are considerable. In the end, station sites representing the character of their surroundings were found. Two stations have been located at the bottom of ***"Údolí Bystřice River Nature Park"*** in places where the surrounding slopes are steep. Two other stations were situated at the summit part of the terrain. The second chalenge when an appropriate location was protecting the stations from vandalism and theft. All of the selected sites have met both requirements.

Table 8: Weather stations geographical location

Weather station	Latitude	Longitude	Altitude	Terrain location
DD Hlubočky	N 49° 39,6´	E 17° 24,6´	307 m	valley bottom
Domašov nad Bystřicí – líheň	N 49° 43,3´	E 17° 27,0´	458 m	valley bottom
Moravský Beroun	N 49° 47,3´	E 17° 26,4´	545 m	peak site
Radíkov	N 49° 38,5´	E 17° 22,1´	425 m	peak site
Pohořany	N 49° 40,3‘	E 17° 22,6´	561 m	peak site

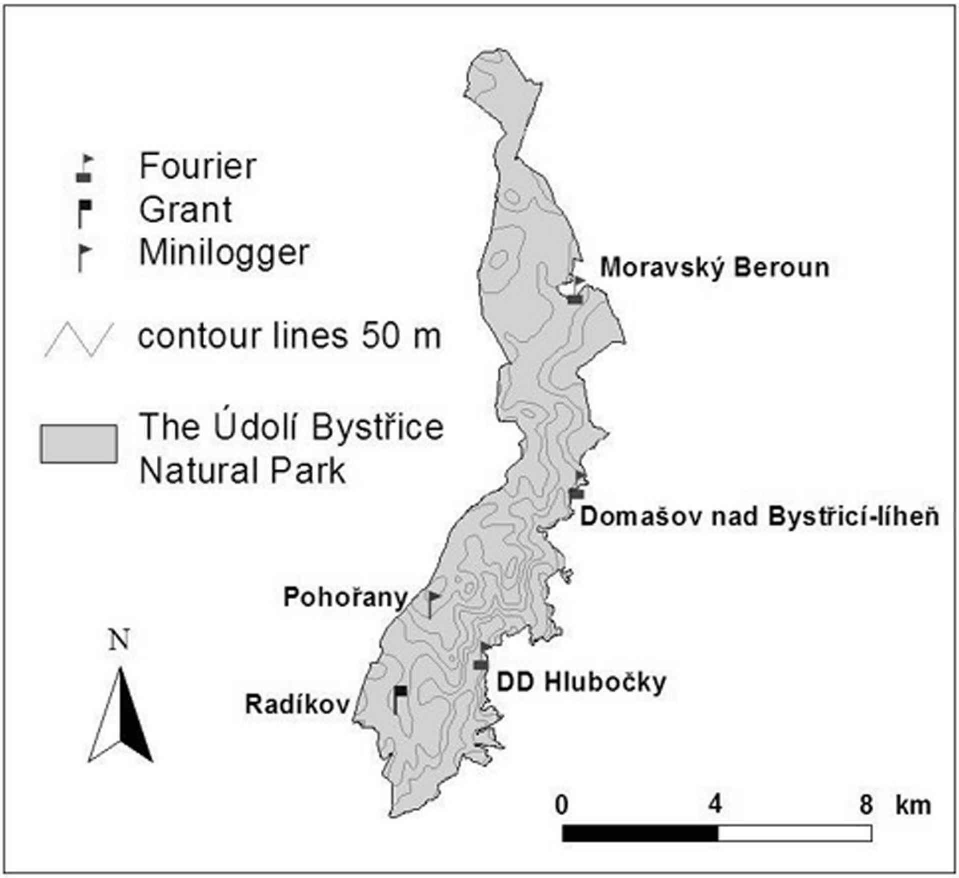


Figure 8: Weather stations geographical location

Geographical positions of the stations have been surveyed by GPS. One Fourier station is located in the Retirement Home garden in the village ***'Hlubočky'*** (bottom of the ***'Bystřice River Valley'***), second one near the Trout Hatchery in ***'Domašov nad Bystřicí'*** cadastral area (bottom of the '***Bystřice Rriver Valley'***), and the third one in a private orchard in '***Moravský Beroun'*** (summit location on the plateau). The station Grant system (summit location) is placed in ‘***Radíkov’*** in the radiotelecommunication platform area (see tab. 8 and fig. 8).

The highest station elevation is in ‘***Moravský Beroun’*** (545 m a.s.l.), the lowest one is the station in the Retirement Home in ‘***Hlubočky’*** (307 m a.s.l.). The elevation difference is 238 metres. Worth mentioning is the fact that the ‘***Radíkov’*** (summit location) elevation is lower than that of the Trout Hatchery in ‘***Domašov nad Bystřicí***, located at the bottom of the ‘***Bystřice River Valley’***.

MicroLog system is placed in the ‘***Dolany-Pohořany’*** village and represents meteorological conditions in the western part of the Nature Park.

6. STATION AND THEIR SURROUNDING FEATURE

6.1. Stations Fourier system

The ‘***Moravský Beroun’*** station (Num. 1) is situated on a plateau, at 545 m a.s.l. (Fig. 9), in a private orchard on the southern city border. Houses are scattered in this area and the surface blends into the hilly land. The active surface is represented by a stable and regularly harvested grassland. Low fruit trees in the garden represent the closest terrain barrier. The garden owner’s house is approximately 20 meters away.

Figure 9: Moravský Beroun Station (photo M. Vysoudil)

The Domašov nad Bystřicí’*– Trout Hatchery station (Num. 2)** is also located at the bottom of the ‘Bystřice River Valley’*** (Fig. 10) in the Trout Hatchery area close to both, the ‘***Bystřice River’*** stream and the small hatchery ponds. Active surface is represented by stable and regularly harvested grassland. The valley and the riverbed here are narrower than the one at the ***‘Hlubočky’*** Retirement Home station.

Figure 10: ‘Domašov nad Bystřicí’ – Trout Hatchery Station
(photo M. Vysoudil)

The Retirement Home ***'Hlubočky'*** station (Num. 3) is located in the Retirement Home vicinity in the ***'Bystřice river'*** flood plain (Fig. 11). The riverbed is approximately 100m from the station. The Active surface is represented by a stable and regularly harvested grassland. The closest full-grown vegetation is 10 meters away and is approximately 5 meters high. The station is situated in the southern part of the experimental area where the valley is wider than in the northern section.

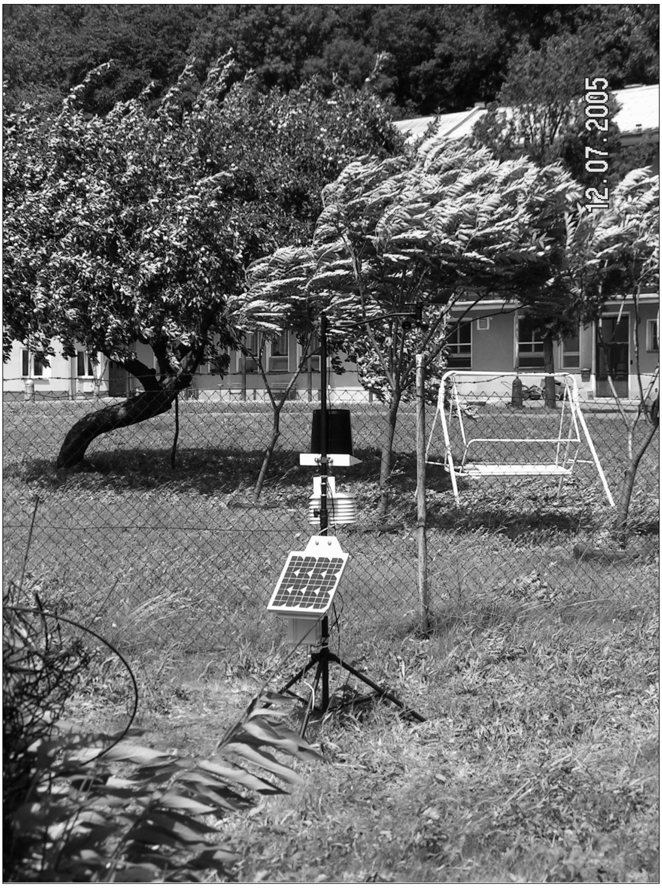


Figure 11: DD Hlubočky Station (photo M. Vysoudil)

6.2. Station Grant system

Station ***'Radíkov'*** (Num. 4), equipped with Grant system, is placed in ***'Radíkov'*** in the summit in the area near the radiotelecommunication platform. The elevation is 425 m above the sea level. The active surface is represented by a stable and wild growing grassland. The fact that a forest surrounds the station location must be taken into account when processing this station's data. Also, some meteorological characteristics, such as the wind speed and/or wind direction, can be influenced by the proximity of the 35 meters tall radiotelecomunications tower.

Figure 12: Radíkov Station (photo M. Vysoudil)

6.3. MicroLog EC650 Fourier

Station ***Pohořany*** (Num. 5), is equipped with MicroLog EC650 sensor for temperature and humididy recording. It is placed in a private orchard on the southern village border cca 800 meters from peak Jedová (633 m a.s.l.). The elevation is 561 m above the sea level. The active surface is represented by a stable and regularly harvested grassland. Fruit trees in the garden represent the closest terrain barrier.

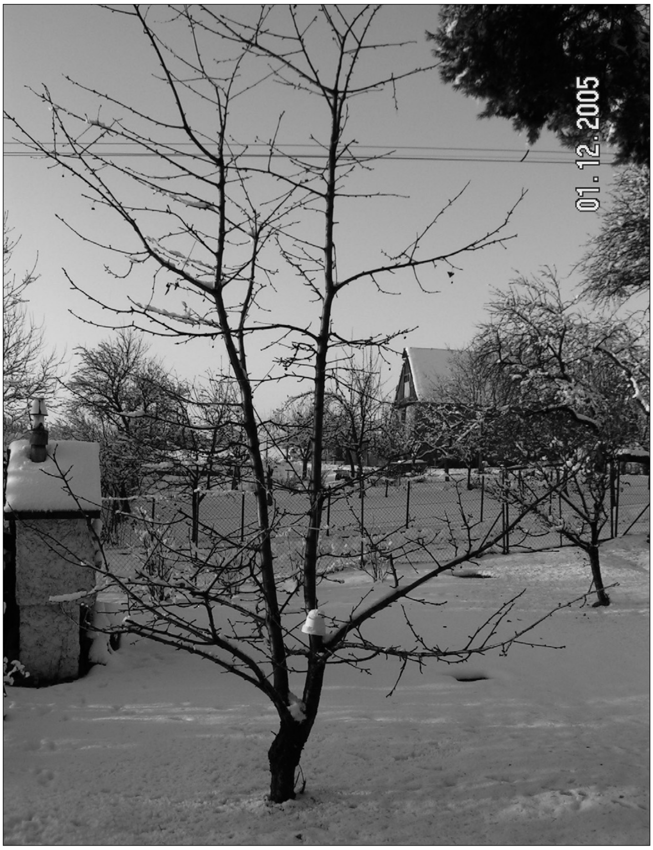


Figure 13: Pohořany Station (photo M. Vysoudil)

7. OBSERVATION METHODS

7.1. Station measurement

Used observation methods are based on general principles for topoclimatic measurement described e.g. by Vysoudil 1981, Obrebska-Starklowa 1995 etc. They involve continual and done in sequence observation lasting several months. The best time for the observations is the warm half of the year.

The influence of the georelief on forming of a stable atmospheric stratification is enormous in deep and narrow valleys (e.g. Colette et al., 2003). Therefore, the spatial distribution of the stations has been done so they can best record the development of the air temperature inversion. The probability of their occurrence in the experimental region is extremely high and the test measurements conducted in 2005 confirmed these presumptions.

For verification of the wind direction modification in deep and narrow, from north to south oriented ***'Bystřice'*** river valley, Mansikkaniemi's (1990) experiences can be applied. He identified relevant changes in the course of these conditions in two dissimilarly oriented valleys (from north to south and from west to east). The results revealed that the prevailing winds are from the north and from the south. The calms also played a significant role. Other registered wind directions were insignificant. On the other hand, the summit station with a low influence of the georelief roughness registered predominantly westerly and southwesterly winds with rare calms. The conducted observations indicate that the deep and narrow valleys greatly modify wind characteristics.

All stations record the air temperature, humidity, wind speed, wind direction, and the precipitation. The ***'Radíkov'*** station (Grant system) is also equipped with a solar radiation registration sensor. Table 9 presents the level of the sensors above the active surface (in cm). The sampling interval for all registered characteristics is 30´, which guarantees detailed overview of their daily courses. Station Fourier, unlike the Grant station and the mini logger, does not allow an automatic start of the recording.

To complete a purpose-built network, a mini logger MicroLog is installed in the ***'Pohořany'*** village to monitor the air temperature and the humidity. Due to the operational and technical restrictions, the measuring at Fourier stations is interrupted during the winter season and the monitoring is partly altered by using mini loggers MicroLog. Only the Grant system station, where the rain collector is disconnected, provides a continuous monitoring.

7.2. Sensors manage

Tab. 9: Location of sensors above ground level (cm)

Station	air temperature	humidity	wind speed	wind direction	solar radiation	rain collector
Fourier	100	100	200	200	×	150
Grant	100	100	250	250	250	150
MicroLog EC650	100	100	×	×	×	×

× – characteristic is not registered

Air temperature and humidity

The air temperature and humidity sensors are mounted 150 cm above the active surface. The 150 cm level is a compromise between the standard 200 cm level and some lower levels used in microclimatological experiments. This height sufficiently reflects the influences of the active surface on the surface atmosphere layer and at the same time eliminates immediate effects of the free atmosphere.

Precipitation

The upper edge of the rain collector is installed 150 cm above the active surface. This height is consistent with the meteorological stations standards.

Wind speed and wind direction

Due to the stations construction, the wind sensor is placed 200 cm (resp. 250 cm station Grant) above the active surface. The influences of the georelif roughness on the wind parameters are significantly expressed at this level which makes for desireable topoclimate study conditions.

Solar radiation

A radiation sensor is only used in the Grant system and is placed 250 cm above the active surface. Some of the Fourier stations will be equipped with these sensors during the year of 2006.

7.2. Cross section measurement

Cross section monitoring, continual stationary as well as sporadic mobile, is considered an important part of the topoclimate study. Quitt's methodology (1972) will be used in the ***'Údolí Bystřice'*** Natural Park experimental area.

Mobile cross section measurement

Mobile cross section measurements provide up to date information about the regime of particular meteorological characteristics, mostly air temperature and humidity. This way of measurement is important where the stationary stations density is insufficient and the need for detailed topoclimate description data is crucial.

Methodology of cross section measurement is relatively standard and in fact offers two choices:

a) reading values and a time at pre-set points from a vehicle moving at a costant speed.
d) reading values at set time intervals from a vehicle moving at a costant speed.

The measurements must be taken either on a closed, circular, route or on a two directional, return, route (there and back). The next step requires a correction of values based on the time difference between the opening measurement and the end measurement.

To satisfy the need for the mobile cross section measuring, three profiles were marked in the Natural Park using GPS. The profiles have a relatively great elevation variation, which is the fundamental requirement for their delineation, and the margin points have maximal, resp. minimal level a.s.l.

Cross section ***'Jívová' – 'Jívová'*** crossroad

The length is 3600 meters and the elevation variation is 137 m (Fig. 14). The highest point (562 m a.s.l.) is in the centre of the ***'Jívová'*** village, the lowest one is the ***'Jívová'*** crossroad (425 m a.s.l.) located cca 100 meters before the ***'Jírovec Brook'*** and the ***'Bystřice River'*** river intersection. The entire cross section follows ***'Jírovec Brook'*** along its flow.

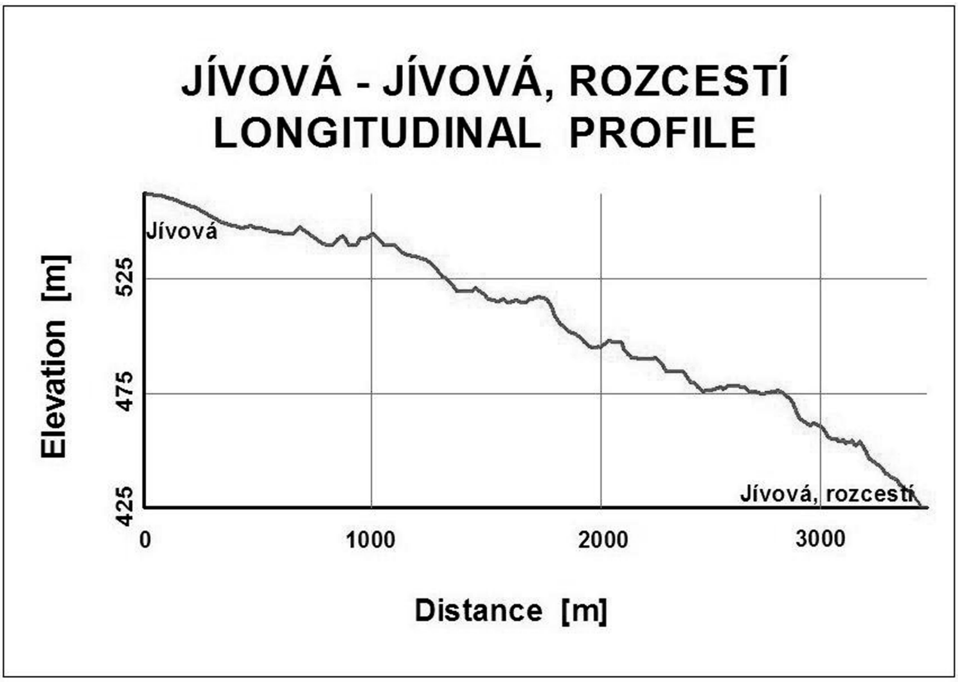


Figure 14: Longitudinal profile ***'Jívová' – 'Jívová'*** crossroad

Cross section ***'Hrubá Voda – Nad Jívovovou'***

This cross section is a little longer (3700 meters). The elevation variation is 225 meters (Fig. 15). The highest point is at ***'Nad Jívovou'*** (554 meters a.s.l.) 1.5 km south from the ***'Jívová'*** village centre. The lowest point is 329 m a.s.l. and is located in the ***'Hrubá Voda'*** village where the ***'Jírovec Brook'*** and the ***'Bystřice River'*** river meet. This cross section almost entirely follows the ***'Pstruží potok'*** brook.

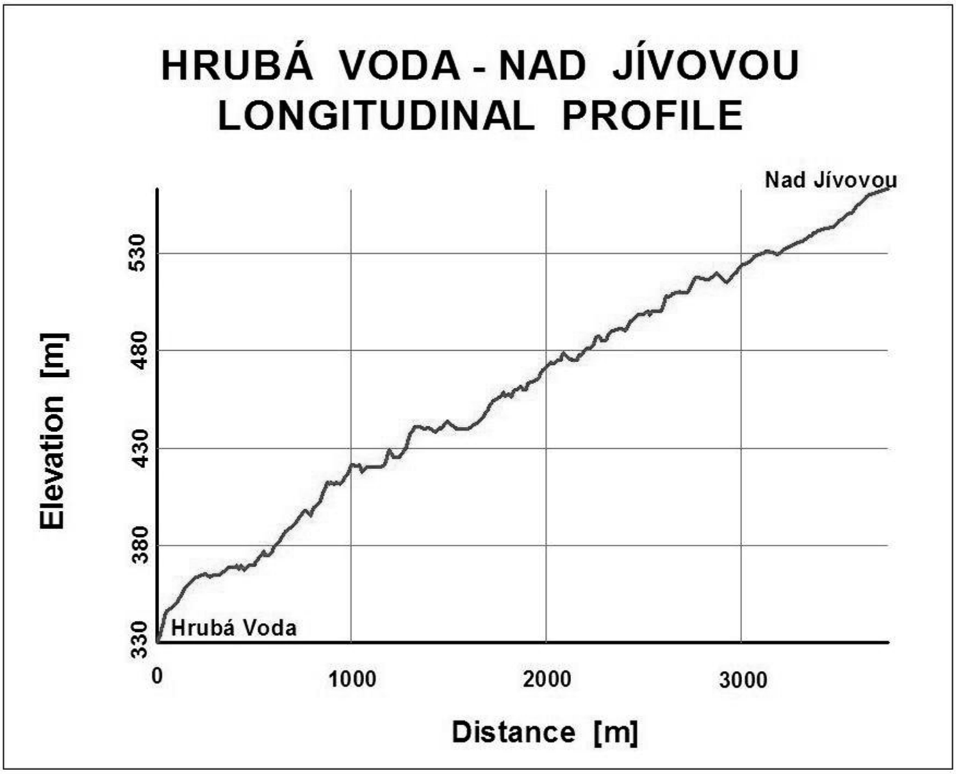


Figure 15: Longitudinal profile ***Hrubá Voda – Nad Jívovovou***

Cross section ***'Dolany – Pohořany'***

This is the longest cross section, 6600 meters, and its 312 m elevation rise is the largest of the three (Fig. 16). The lowest elevation point is 250 meters a.s.l. and is located in the centre of the ***'Dolany'*** village. The highest elevation is 562 meters a.s.l. situated in the ***'Pohořany'*** village. Only the upper part of this cross section is within the experimental area, and its lower part is outside the boundaries.

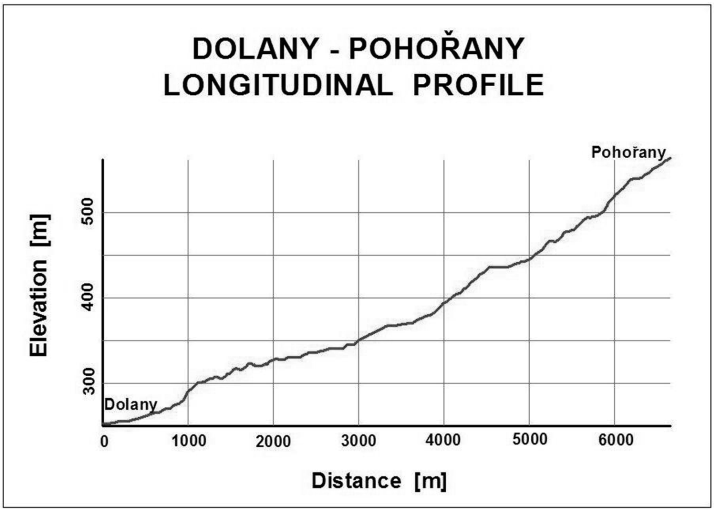


Figure 16: Longitudinal profiles‘***Dolany – Pohořany’***

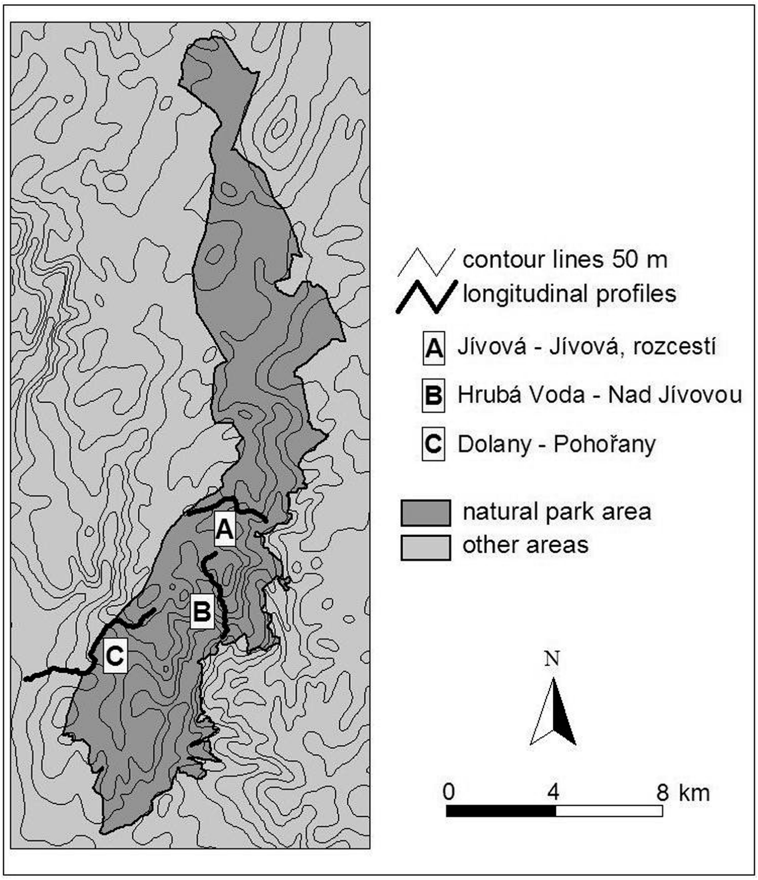
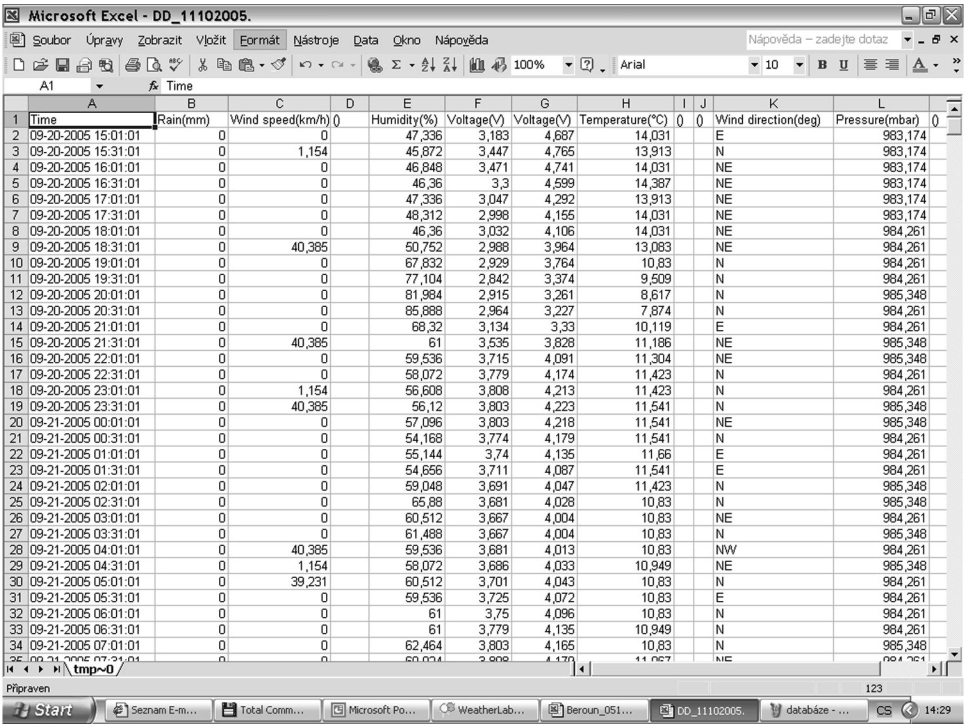


Figure 17: Longitudinal profiles in the ***“Údolí Bystřice River Nature Park”***

9. TIME SERIES AND ITS CHARACTERISATION

Topoclimatic research requires analyzing especially those meteorological data, which are under the direct influence of topography and its active surface. Those data are best received during the anticyclonic weather type especially when the cloud cover is ≤ 2/10 and the wind speed is ≤ 2 m.s^{-1}. To define anticyclonic weather days, the wind characteristics are available from the weather station network and the air temperature daily course curve shape or daily temperature amplitude can be used to determine the cloud cover level. Also, it is possible to use Synoptic Situation Catalogue for the Czech Republic area to identify these days.

To determine a rugged topography influence on the wind direction and the wind speed modification it is possible to use all measured data in a defined period on the local scale.



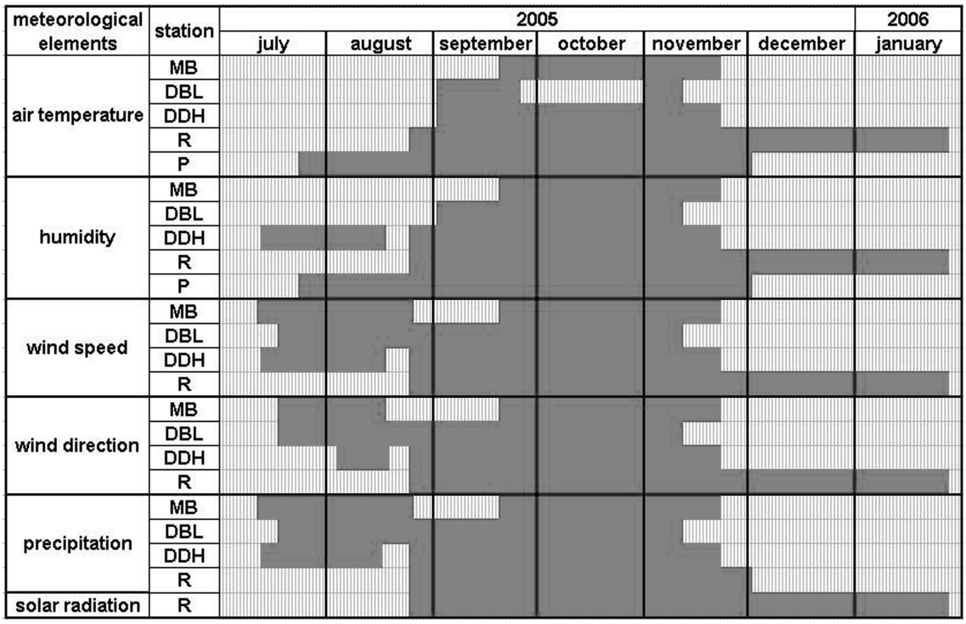
	A	B	C	D	E	F	G	H	I	J	K	L	
1	Time	Rain(mm)	Wind speed(km/h)	()	Humidity(%)	Voltage(V)	Voltage(V)	Temperature(°C)	()	()	Wind direction(deg)	Pressure(mbar)	()
2	09-20-2005 15:01:01	0	0		47,336	3,183	4,687	14,031			E	983,174	
3	09-20-2005 15:31:01	0	1,154		45,872	3,447	4,765	13,913			N	983,174	
4	09-20-2005 16:01:01	0	0		46,848	3,471	4,741	14,031			NE	983,174	
5	09-20-2005 16:31:01	0	0		46,36	3,3	4,599	14,387			NE	983,174	
6	09-20-2005 17:01:01	0	0		47,336	3,047	4,292	13,913			NE	983,174	
7	09-20-2005 17:31:01	0	0		48,312	2,998	4,155	14,031			NE	983,174	
8	09-20-2005 18:01:01	0	0		46,36	3,032	4,106	14,031			NE	984,261	
9	09-20-2005 18:31:01	0	40,385		50,752	2,988	3,964	13,083			NE	984,261	
10	09-20-2005 19:01:01	0	0		67,832	2,929	3,764	10,83			N	984,261	
11	09-20-2005 19:31:01	0	0		77,104	2,842	3,374	9,509			N	984,261	
12	09-20-2005 20:01:01	0	0		81,984	2,915	3,261	8,617			N	985,348	
13	09-20-2005 20:31:01	0	0		85,888	2,964	3,227	7,874			N	984,261	
14	09-20-2005 21:01:01	0	0		68,32	3,134	3,33	10,119			E	984,261	
15	09-20-2005 21:31:01	0	40,385		61	3,535	3,828	11,186			NE	985,348	
16	09-20-2005 22:01:01	0	0		59,536	3,715	4,091	11,304			NE	985,348	
17	09-20-2005 22:31:01	0	0		58,072	3,779	4,174	11,423			N	984,261	
18	09-20-2005 23:01:01	0	1,154		56,608	3,808	4,213	11,423			N	984,261	
19	09-20-2005 23:31:01	0	40,385		56,12	3,803	4,223	11,541			N	985,348	
20	09-21-2005 00:01:01	0	0		57,096	3,803	4,218	11,541			NE	985,348	
21	09-21-2005 00:31:01	0	0		54,168	3,774	4,179	11,541			N	984,261	
22	09-21-2005 01:01:01	0	0		55,144	3,74	4,135	11,66			E	984,261	
23	09-21-2005 01:31:01	0	0		54,656	3,711	4,087	11,541			E	984,261	
24	09-21-2005 02:01:01	0	0		59,048	3,691	4,047	11,423			N	985,348	
25	09-21-2005 02:31:01	0	0		65,88	3,681	4,028	10,83			N	985,348	
26	09-21-2005 03:01:01	0	0		60,512	3,667	4,004	10,83			NE	984,261	
27	09-21-2005 03:31:01	0	0		61,488	3,667	4,004	10,83			N	985,348	
28	09-21-2005 04:01:01	0	40,385		59,536	3,681	4,013	10,83			NW	984,261	
29	09-21-2005 04:31:01	0	1,154		58,072	3,686	4,033	10,949			NE	985,348	
30	09-21-2005 05:01:01	0	39,231		60,512	3,701	4,043	10,83			N	984,261	
31	09-21-2005 05:31:01	0	0		59,536	3,725	4,072	10,83			E	984,261	
32	09-21-2005 06:01:01	0	0		61	3,75	4,096	10,83			N	984,261	
33	09-21-2005 06:31:01	0	0		61	3,779	4,135	10,949			N	984,261	
34	09-21-2005 07:01:01	0	0		62,464	3,803	4,165	10,83			N	985,348	

Figure 18: Measuring data example

Figure 18 presents original data measured at the Fourier automatic station. The data that fail to satisfy the above mentioned parameters would be sorted out. To achieve high data accuracy it is essential to have long time series, ideally yearlong series. That is the reason for conducting the research during consecutive periods. The longest continuous data time series are available from the ***'Radíkov'*** station lasting till 1st February 2006 (see tab. 10). Only the precipitation time series are shorter, because the rain collector was switched off as of 1st December 2005. Shorter continuous temperature and humidity time series are also available from the ***'Pohořany'*** station.

Climatic time series from the other stations are not complete. Nearly complete climatic time series are only available for October 2005. The only measuring failure during this period occured at ***'Domašov nad Bystřicí'***–Hatchery station (temperature time series). Considering that this was a station network test run requiring fine tuning this problem is to be expected.

Table 10: The times series



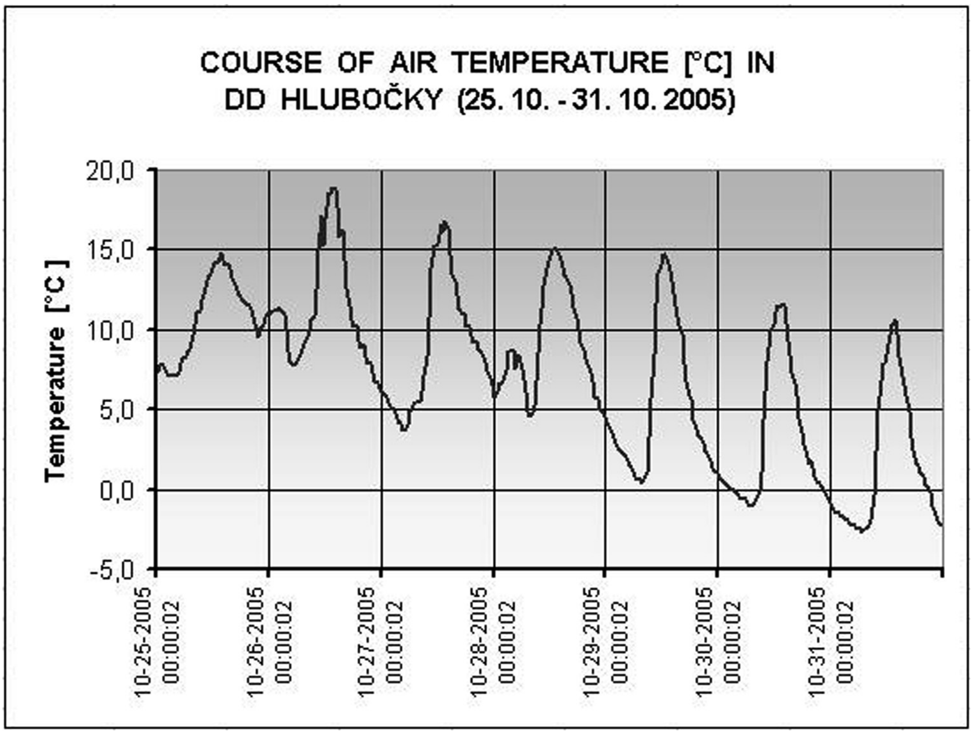


Figure 19: Air temperature course at DD Hlubočky weather station

Fig. 19 presents the weekly course of air temperature at DD ***'Hlubočky'*** station during the anticyclonic weather. The curve run is typical for a clear and cloudless weather, when the differences between the morning and the afternoon temperatures are considerable during the same day.

10. CONCLUSION

The establishment of the trial topoclimatological measurements in the ***"Údolí Bystřice River Nature Park"*** experimental region in 2005 formed a good groundwork for a long-term experiment. It was demonstrated, that obtaining representative series of meteorological data is fundamental for the topoclimate study as well as the local climatic effects study.

It turned out, that to gain adequate long-term and representative time series, the most suitable time for the measurements is mainly the warm half of the year. It also appears necessary to enhance the stationary measuring by performing mobile measuring in selected cross sections.

SOUHRN

Výzkum topoklimatu v Přírodním parku Údolí Bystřice (ČR): Účelová staniční síť

Příspěvek popisuje topoklimatický výzkum organizovaný Katedrou geografie Přírodovědecké fakulty v Olomouci v experimentálním území Přírodní park Údolí Bystřice (Česká rapublika). Území bylo vybráno vzhledem k pestrým fyzickogeografickým poměrům, zejména značné vertikální členitosti terénu. To představuje vhodné podmínky pro studium topoklimatu a místních klimatických efektů. Vzhledem k charakteru georeliéfu a aktivního povrchu se dají předpokládat specifické teplotně vlhkostní poměry, zejména výrazné inverze teploty vzduchu. Také modifikace parametrů proudění a výskyt místních systémů cirkulace jsou pravděpodobné.

Takto organizačně i finančně náročný výzkum bylo možné zahájit díky řešení grantu FRVŠ 3356/2005/A-a „Společná výuková laboratoř pro studium krajiny“. Z jeho prostředků byly zakoupeny automatické meteorologické stanice s příslušenstvím. První testovací měření proběhla take za podpory grantu FRVŠ 2490/2005/G6 „Místní klimatické efekty a jejich vliv na možnost rozptylu znečišťujících látek na území Přírodního parku Údolí Bystřice“.

V experimentálním území byly umístěny 3 automatické meteorologické stanice Fourier System (Moravský Beroun, Domašov nad Bystřicí, Hlubočky) a jedna stanice Grant System (Radíkov) tak, aby svojí polohou pokud možno reprezentovaly výrazné výškové rozdíly a pestrost georeliéfu. Stanice Radíkov má charakter vrcholové stanice, Moravský Beroun zarovnaného povrchu náhorní plošiny a stanice Hlubočky a Domašov nad Bystřicí a jsou typické údolní stanice. Na těchto stanicicíh byla zaznamenávána teplota vzduchu a vlhkost, tlak vzduchu, atmosférické srážky, rychlost a směr větru (na stanici Radíkov též intenzita slunečního záření). V obci Pohořany byl v průběhu testovacích měření umístěn automatický mini data logger MicroLog pro registraci teploty vzduchu a vlhkosti. Byly zaměřeny výškové profily, ve kterých budou v roce 2006 probíhat mobilní měření s cílem získat detailní informace o teplotním zvrstvení přízemní atmosféry.

Během zkušebního provozu v období červenec až listopad 2005 byly postupně odstraňovány především technické problémy. Problémy vykazovaly stanice Fourier System, resp. jejich napájení a softwarová podpora. K dispozici tak jsou více méně neúplné časové řady. V průběhu měření v roce 2006 by se uvedené nedostatky neměly vyskytovat.

První analýzy získaných dat signalizují častý výskyt výrazných teplotních inverzí a také změn v charakteru proudění. Prokázání těchto a dalších specifik místního klimatu bude předmětem výzkumu v roce 2006.

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