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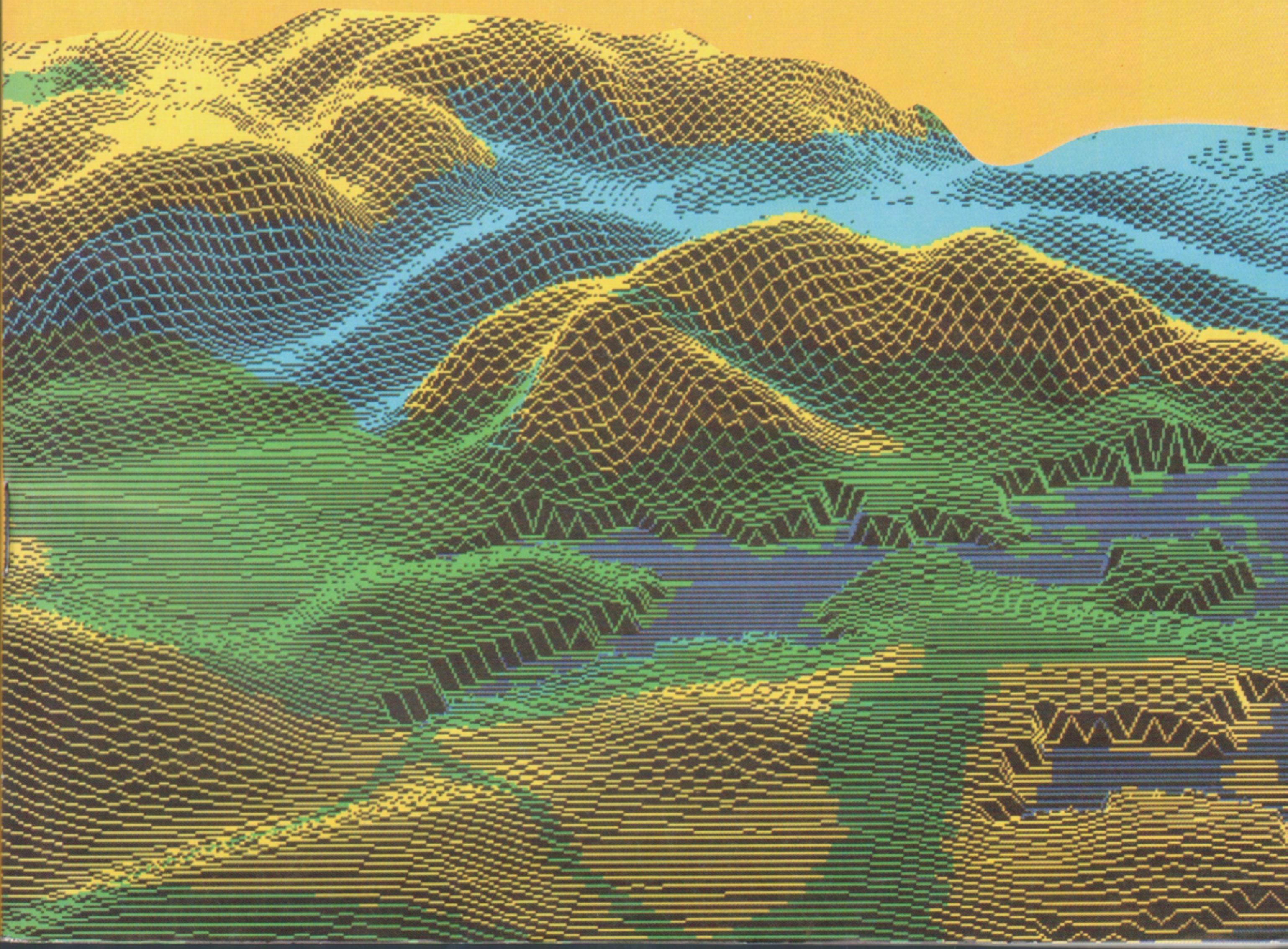

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Contents

TOPOCLIMATIC MAP AS A BASIS FOR ATMOSPHERE PROTECTION AND REGIONAL DEVELOPMENT OF THE LANDSCAPE

Evžen QUITT

Abstract

A detailed topoclimatic map, sheet 34-22 Hodonín, at the scale of 1:50 000 illustrates the most significant processes which take place in the lower part of atmosphere boundary layer and in the atmosphere layer immediately adjacent to the active surface. It is therefore an important source of information about primary interactions between topography of the terrain, character of the active surface, and socio-economic activities - and as such, it is an integral part of the set of environmental maps.

Shrnutí

Topoklimatická mapa jako základ ochrany ovzduší a regionálního rozvoje krajiny

Podrobná topoklimatická mapa list 34-22 Hodonín v měřítku 1:50 000 zobrazuje nejvýznamnější procesy odehrávající se ve spodní části mezní vrstvy ovzduší, ale i ve vrstvě atmosféry bezprostředně přiléhající k aktivnímu povrchu. Je tedy významným zdrojem informací o základních interakcích mezi reliéfem terénu, charakterem aktivního povrchu a socioekonomickými aktivitami. Je tedy významnou součástí v souboru map životního prostředí.

Key words: topoclimatic map, atmosphere boundary layer, ground layer of the atmosphere, system of geographical information

1. Introduction

Importance of topoclimatic mapping as a basic source of data for atmosphere protection has lately considerably increased with breakthrough of information science and particularly in consequence of rapid development of geographical information systems. Various thematic documents (geobotanical, biogeographical, hydrogeological, pedological, aerial or satellite photographs) inspire to the export of results from these surveys at assessing possibilities of rise, duration and intensity of processes occurring in the ground- and lower parts of atmosphere boundary layer, which is the fundamental scope of topoclimatic maps. On the other hand, these documents are also a primary and irreplaceable source of information at building information systems for atmosphere protection.

At setting up area plans of all hierarchic categories, and especially at decision-making by stateadministration authorities, it is necessary to be familiar with the whole complex of processes taking place in the ground- and lower parts of atmosphere boundary layer.

It is namely these processes which to decisive extent participate not only at distribution of air pollutants but also at the character of wind field, humidity, distribution and thickness of snow cover, and at many other climatic characteristics whose knowledge is essential in order to be able to evaluate conditions for regional development or atmosphere protection of the area. Long years of experience from topoclimatic mapping in the Czech Republic and countries of Central Europe gained by the former Geographical Institute, Czechoslovak Academy of Sciences resulted in a knowledge that an information system for atmosphere protection must be built up, which would further provide efficient support to the process of decision-making. Quantification of topoclimatic processes will make it possible to evaluate their effects on for example dispersion potential of atmospheric admixtures directly in the atmosphere layer which is most dangerous to health status of the population, damage to landscape natural components or depositions of foreign substances in ecosystems.

Thus, with such a topoclimatic map, designers and state administration authorities get in their hands an important document for setting up area planning projects, for decision-making at protection of air, regional development of the landscape and dwelling environment. These documents serve particularly:

a) to work out area- and regional plans for extension of heat or gas supply systems and to assess individual stages at the transition from small air pollution sources towards utilization of clean energy which would not mean any load to environment,

b) to up-date technologies of existing boiler houses,

c) to evaluate possibilities of situating new small and medium-sized point sources of air pollution opened into the lower part of atmosphere boundary layer,
d) to assess effects of localization of sources of annoying odours.
e) to assess localization of dumps for communal and industrial wastes,
f) at specifying newly projected tracks for high voltage lines,
g) as a basis for correction of dispersion studies in point, line and planary sources of air pollution,
h) at planning localization of stand-by parking places, large train stream railway systems,
i) at evaluating danger to population after failures of chemical plants, nuclear plants and incinerators of industrial and communal wastes,
j) to assess routes for newly projected or reconstructed line sources of air pollution (motor ways, roads, railways) with costs for their operation and maintenance,
k) to judge possibilities for utilization of solar radiation as non-traditional and environment-friendly energy source as well as its efficiency,
l) to judge possibilities for utilization of wind energy as non-traditional and environment-friendly source of energy as well as its efficiency,
m) to evaluate possibilities of landscape utilization for recreation, sports and agrotourism,
n) to set up price maps of landscape and dwelling environment.

The topoclimatic map together with information system registers help to explain processes occuring in anthropogenically exploited part of atmosphere, local differences in depositions of heterogeneous substances, to suggest methods of their solution or to recommend additional verification of the terrain, which can distinctly assist to precise results and provide necessary information on accuracy of the information.

2. Contents of the detailed topoclimatic map

The topoclimatic map, sheet 34-22 Hodonín, at the scale of 1:50 000, elaborated within the scope of the project E5.5 "Inventory, record and evaluation of ecosystems in the Czech Republic" defines four categories of the climate dominating in the lower part of atmosphere boundary layer.

2.1 Climate of plains (blue colour in the map, explanatory note 1)

Flat relief with differing height of up to 50m . 16km^{-2} has a vague influence on the structure of atmosphere boundary layer. Under the weather of radiation type and with vortex flow, action of thermic effects prevails, ie. that of temperature contrasts between individual kinds of the active surface. This means that intensity of turbulent flow is largest in supra-adiabatic section of the day, being negligible in the inversion day section, ie. at night. Dynamic displacement of the flow is limited to the ground- or lower parts of atmosphere boundary layer. It is formed behind small obstacles such as houses, trees, shrubs and the like on the active surface. Atmospheric vortices are mainly of small spatial scale: radius of curvature r=1 to 102 m and duration t=1 to 102 sec. Recorded is also low wind vector variability with height, high rate of dispersion of atmospheric admixtures. Significant influence of air flow structure is exhibited by vortex movements risen via thermic turbulence. Wind vector above the ground layer does not differ significantly from gradient flow and is supposed to be identical with it at the height of about 500 m.

2.2 Climate of uplands (ochre colour in the map, explanatory note 2)

Hilly relief with differing height of up to 50-150m. 16km^{-2}shows a distinct influence on the structure of atmosphere boundary layer. Dynamic causes to the rise of vortex flow are markedly affected by broken topography, which overlaps with the influence of small obstacles such as buildings and forests on the active surface. Thermic causes to the formation of vortex flow are still affected mainly by temperature contrasts between individual types of active surface, ie. by management of received energy. Signs of confluence and difluence of flowlines begin to show in the lower part of atmosphere boundary layer. This means that wind vector is already markedly affected by terrain relief in both vertical and horizontal direction, which results in variable values of atmospheric admixtures dispersion. Flow direction in the ground layer is often markedly distinguished from gradient flow, both directions coming to congeniality at elevations beyond 500 m above the surface.

2.3 Climate of hilly lands (brown colour in the map, explanatory note 3)

Topography of hilly lands with heights from 150 to 300m . 16km^{-2} exhibits a pronounced influence on the structure of atmosphere boundary layer. Thermic causes to the formation of vortex flow consists not only in different management of received solar energy in subsurface layers but also in radiation balance of differently inclined slopes and their different aspects. Higher values of linear momentum flow (convection) distinctly influence the air flow. The favourable inclination facilitates formation of anabatically conditioned microcirculation which makes the component of flow thermic displacement very efficient under radiation type of the weather. In contrast to the climate of uplands, action of the flow dynamic displacement is more apparent. Phenomena of flowline confluence and difluence are to be seen within the entire lower part of atmosphere boundary layer. Atmospheric vortices often acquire radius of curvature r=103 to 104m with duration t= up to 103sec. This indicates that wind vector is distinctly affected by relief, which leads to considerable deviations from gradient flow. Similarly, values of dispersion of atmospheric admixtures are many times very variable, too. The local differences in rate of active surface heating by solar radiation cause considerable vertical exchange of air masses. Participation of turbulence effects of thermic character at vortex flow is very significant, particularly in situations with lower wind velocities and under the clear weather. Effects of mechanical turbulence prevail at higher wind velocity values.

2.4 Climate of indented small flat relief forms (yellow colour in the map, explanatory note 4)

In this category, thermic causes to flow displacement consist mainly in temperature contrasts between individual types of the active surface. However, many times they coincide with dynamic flow displacement affected by topography surrounding the indented formation. In vertical direction, wind vector is to considerable extent influenced by the character of immediately adjacent relief rather than by the indented formation itself. Atmospheric vortices are mostly those of small spatial scale, radius of curvature r= 1 to 10^2m, duration t= 1 to 10^2sec. Low values of atmospheric admixtures dispersion are recorded at more frequent stable stratification with suppressed vertical component of turbulence. With regard to the surrounding upland relief which forms cool air-collection area and to the small area of accumulation space of the proper concave formation, we presume mean incidence of short-term weak temperature inversions. Low angle of superelevation with surrounding relief results in effective radiation decreased by as much as 2%.

Other ten categories formed climate of the ground layer of atmosphere, affected mainly by character of the active surface and its parent rock. In addition to the climate of fields and meadows, we defined the climate of forests, urbanized and water areas. In principle, the climate of fields and meadows has been classified by thermal conductivity of parent rock. Energy flows which cause heating of atmosphere ground layer as well as evaporation are namely influenced -besides global radiation- mainly by thermal and water status and properties of the parent rock. Differences in albedo in grass cover and cultural plants are great, too. However, they depend on growth stage of the vegetation cover throughout the year as well as on type of the cover.

2.5 Climate of fields and meadows with parent rock of low thermal conductivity (inclined black hachure in the map, explanatory note 7)

Low thermal conductivity parent rock is characterized by a tendency toward extreme surface temperatures under radiation type of the weather, and thus also by significant influence on vertical movements in the atmosphere. At a favourable inclination, these surfaces support rise and development of catabatic and anabatic processes. There are high maximum and low minimum temperatures here, accompanied by low relative as well as absolute air humidity. Increased production of cool air is a predestination of these areas for significant support of radiation type ground inversions. The following structure of heat flows can be expected under radiation type of the weather by midday: conductivity heat flow G=20%, turbulent heat flow H=60%, latent heat flow E=20%.

2.6 Climate of fields and meadows with adequately humid parent rock and normal thermal conductivity (without hachure in the map, explanatory note 8)

Climate in question is that of areas with common climatic status in the atmosphere ground layer and structure of heat flows under radiation type of the weather by midday, which is as follows: conductivity heat flow G=30%, turbulent heat flow H=40%, latent heat flow E=30%, and with normal predispositions to occurrence of inversions, catabatic and anabatic processes.

2.7 Climate of fields and meadows with adequately humid parent rock and high thermal conductivity (with inclined hachure in the map, explanatory note 9)

Climate in question is characterized by reduced temperature maxima and higher temperature minima under radiation type of the weather. Approximate heat flow structure by midday is as follows: conductivity heat flow G=40%, turbulent heat flow H=20%, latent heat flow E=40%.

2.8 Climate of fields and meadows with adequately humid parent rock and extremely high thermal conductivity (dotted screen in the map, explanatory note 10)

Areas with parent rock of extremely high thermal conductivity can be distinguished by high values of latent heat flow. Heat flow structure under rariation type of the weather by midday is as follows: conductivity heat flow G=40%, turbulent heat flow H=10 to 20%, latent heat flow E=40 to 50%. Usual records show higher evaporation and increased probability of fogs, maximum and minimum air temperatures are significantly lower and usually increased, respectively.

Forest-covered surface is characterized by low total values of long-wave heat radiation. Compared with open terrain, less than a quarter of global radiation gets to the surface. The distinctly lower effective radiation reflects in lower values of mean diurnal air temperature. Height-related variability of wind vector is slightly increased in the ground layer, both catabatic and anabatic processes are markedly suppressed similarly as intensity of vertical movements in the atmosphere. Intensity of aeration in the ground layer is heavily reduced, temperature maxima are lower while temperature minima are higher, durability of snow cover is distinctly prolonged. Immediate evaporation from soil and transpiration of the lower herb layer in the forest are low with regard to poor offer of solar radiation and weak turbulent transmission. From the viewpoint of effects on energy and water balance, forest areas in the sample sheet of Hodonín topoclimatic map have been divided into coniferous, deciduous and floodplain.

2.9 Climate of coniferous forest (dark green horizontal hachure in the map, explanatory note 11)

This climate is typical of low albedo around 10%, heavily reduced effective radiation from the soil surface and the following approximate structure of heat flows under radiation type of the weather: conductivity heat flow G=25%, turbulent heat flow H=25%, latent heat flow E=50%. Anabatic and catabatic processes are severely suppressed, maximum air temperature values are reduced, minimum air temperature values elevated, slightly increased is also relative humidity, evaporation is lower. Snow cover durability is markedly prolonged, intensity of turbulent exchange is reduced over the whole year, interception of precipitations is significantly increased (up to 40%).

2.10 Climate of deciduous and mixed forests (yellow-green horizontal hachure in the map, explanatory map 12

This type of climate is characterized by slightly lowered albedo of around 20%, heavily reduced effective radiation from the soil surface, structure of heat flows similar to that of coniferous forests. Severely suppressed are both anabatic and catabatic processes. In summer, minimum air temperature values are increased, maximum air temperature values decreased. Influence of crown canopy disappears in winter, which reflects in changed structure of heat flows as well as in effect on maximum and minimum air temperature values. Compared with the open grass surface, snow cover durability is slightly prolonged. Interception of precipitations is about 20%, intensity of turbulent exchange is heavily reduced in summer, slightly reduced in winter.

2.11 Climate of floodplain forest (blue-green horizontal hachure in the map, explanatory note 13)

Floodplain forest with slightly reduced albedo of about 20%, structure of conductivity heat flows G=40%, turbulence H=10%, and latent heat flow E=50%, maximum and minimum air temperature values are reduced and elevated, respectively. Markedly increased relative air humidity relates to higher frequency of fogs.

Urbanized areas with vertically articulated active surface of building materials, intensive anthropogenic heat flow, many times also with polluted air. The active surface of urbanized areas has a great thermal capacity, ie. it accumulates thermal energy at the day time in order to radiate it at night. Increased turbulent heat flow is associated with pronounced increase in aerodynamic roughness of the active surface. Vertical component of flow velocity develops to the detriment of horizontal component, which -along with anthropogenic production of heat and overheating of dark urban surfaces such as roofs and roads - leads to distinctly increased convection. Apparent reduction of latent heat flow is the cause to low water content in the urbanized areas. Most water is namely being drained off the town by sewerage systems. Dominant factors of the urbanized areas are therefore seen in production of waste heat, differences in thermal conductivity and thermal capacity of building material, changes in water balance and changes in turbulent transmission. All this reflects density and height of housing.

2.12 Climate of urbanized areas with medium housing density (thin yellow vertical hachure in the map, explanatory note 14)

This climate is characterized by apparent anthropogenic heat flow in the winter period. Expected structure of heat flows under radiation type of the weather by midday is as follows: conductivity heat flow G=30%, turbulent heat flow H=50%, latent heat flow E=20%. Apparent is wind vector variability with height and rate of vortex flow $r=10^1$ to 10^2m with duration t=101 to 102sec. Air temperature maxima and minima are elevated, relative air humidity is lower than that in the open landscape. Snow cover durability is shorter.

2.13 Climate of densely built-up urbanized areas (thick yellow vertical hachure in the map, explanatory note 15)

This type of climate is distinguished by lower values of direct solar radiation and by distinct anthropogenic heat flow over entire year. Albedo amounts to 20-30%, effective long-wave radiation is significantly reduced due to atmosphere turbidity. Expected structure of heat flows under radiation type of the weather is as follows: conductivity G=20%, turbulent heat flow H=70% and latent heat flow E=10%. Variability of wind vector with height is very high, vortex flow values amount to $r=10^2$m and $t=10^2$sec. All this results in considerable vertical movements in the atmosphere. Intensity of aeration in atmosphere ground layer is very low. Both maximum and minimum values of air temperature are increased. Relative air humidity is decreased and evaporation is very low. Snow cover durability is distinctly shortened.

Water reservoirs exhibit typical energy balance following out of physical properties of water. Their influence on atmophere ground layer is given namely by size, shape, depth and turbidity of water in the reservoir. Solar radiation penetrates to certain depth in the water, reaching the bottom in riverine parts and in shallow reservoirs. This is why absorption of the radiation is distributed across a much greater space than in soil. Water area albedo is generally lower than in the majority of other surfaces. However, water heating is slower, which is given by its large-volume thermal capacity as well as by existence of turbulent flows. High values of latent heat flow play an important role in energy balance, being dependent on water surface temperature, saturation cofactor, and intensity of aeration in the vicinity of water table. In comparison with latent heat flow, turbulent heat flow above the water table is considerably smaller. From the viewpoint of flowing, water table roughness is namely very low, and this is why we can often record laminar flows here. Turbulent heat flow into the atmosphere above the water table is therefore considerably limited. Dominating factors which play the most important role at affecting topoclimate of water reservoirs and their surroundings include specific energy balance that is conditioned by depth, size and shape of the water reservoirs.

2.14 Climate of water reservoirs (thick blue vertical hachure in the map, explanatory note 16)

Small and shallow water reservoirs are typical of absorbing direct solar radiation within the entire vertical profile including the bottom. At the time of insolation, vertical profile of water temperature is thus influenced by partial increase of temperature near the bottom. Higher values of latent heat flow are caused by advection of unsaturated air from surroundings. Small size of the reservoirs facilitates higher intensity of turbulent transmission of water vapours. Turbulent heat flow values remain unreduced (as it is usual in water reservoirs) due to overgrowing of riverine parts as well as with regard to effects of contrasting temperatures of surrounding areas. Due to overgrowing and low depth albedo can be even greater than 10%. Reduced aerodynamic roughness of water table does not show in vertical flow profile due to small size of the reservoir. Significant diurnal fluctuation in water temperature values has only a negligible influence on air temperature with relative air humidity being slightly elevated.

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Explanations to the map - Appendix No.2

CLIMATE DOMINATING IN LOWER PART OF ATMOSPHERE BOUNDARY LAYER

1-climate of plains, 2-climate of uplands, 3-climate of hilly lands, 4-climate of small flat concave formations, 5-slopes with excessive insolation, 6-slopes with insufficient insolation.

CLIMATE DOMINATING IN ATMOSPHERE GROUND LAYER

7-climate of fields and meadows with parent rock of low thermal conductivity, 8-climate of fields and meadows with adequately humid parent rock and normal thermal conductivity, 9-climate of fields and meadows with adequately humid parent rock and high thermal conductivity, 10-climate of fields and meadows with adequately humid parent rock and extremely high thermal conductivity, 11-climate of coniferous forest, 12-climate of deciduous and mixed forests, 13-climate of floodplain forest, 14-climate of urbanized areas with medium housing density, 15-climate of densely built-up urbanized areas, 16-climate of water areas.

CLIMATE DOMINATING IN THE LOWER PART OF ATMOSPHERE BOUNDARY LAYER

1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	5	1	1	1
2	2	2	2	2	2	3-5	1-2	1-2	1-2
3	3	3	3	3	4	2-5	1-2	1-3	1-2
4	2	2	1-2	2	2	3	2	2-3	2
5	+1						-1		-1
6							+1	+1	

1-number of explanatory note in the map, 2-thermic causes of turbulence, 3-dynamic causes of turbulence, 4-size and duration of vortex flow, 5-wind vector variability with height, 6-confluence and difluence of flowlines, 7-dispersion of atmospheric admixtures, 8-duration of temperature inversions, 9-frequency of temperature inversions, 10-intensity of temperature inversions.

CLIMATE DOMINATING IN ATMOSPHERE BOUNDARY LAYER

1	2	3	4	5	6	7	8	9	10
7	1	1	3	2	2	4	1	2	3
8	1	3	2-3	3	2	3	2	3	3
9	1	3	2	3	2	2	3	3	3
10	1	4	2	4	2	2	3	5	3
11	1	2	2-3	3	4	2	4	2	5
12	1	2	2-3	3	4	2	4	4	4
13	1	4	2-3	4	4	2	4	4	4
14	3	3	4	2	4	4	3	2	2-3
15	5	2	5	1	5	5	5	1	1
16	1	5	1-2	5	2	2	3-4	5	-

1-number of explanatory note in the map, 2-anthropogenic heat flow, 3-conductivity heat flow, 4-turbulent heat flow, 5-latent heat flow, 6-size of vortex flow, 7-maximum temperature, 8-minimum temperature, 9-evaporation, 10-durability of snow cover.

CLASSIFICATION CRITERIA

1-absent, negligible, heavily reduced
2-weak, low, reduced
3-medium, normal
4-strong, high, reduced
5-very strong, very high, highly increased

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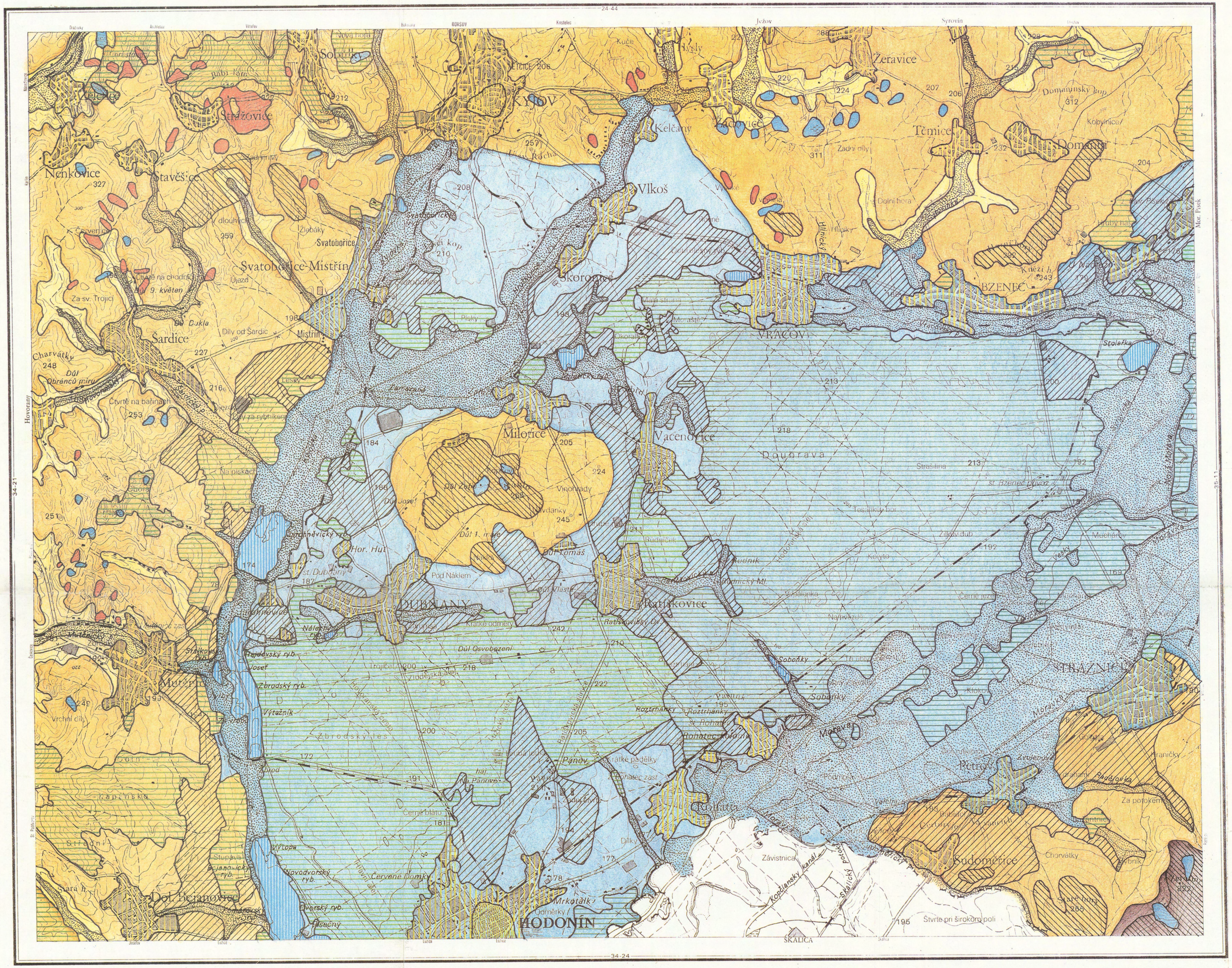
Reviewer

Doc. RNDr. Alois HYNEK, CSc.

2

TOPOKLIMATICKÁ MAPA

34-22 Hodonín

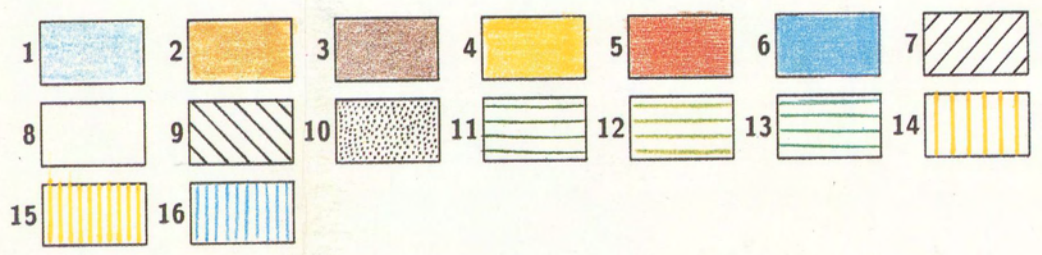


1 : 50 000

1 cm = 500 m

Základní interval vrstevnic 10 m

LEGENDA:



KLIMA DOMINUJÍCÍ VE SPODNÍ ČÁSTI MEZNÍ VRSTVY OVZDUŠÍ:

1 - klima rovin; **2** - klima pahorkatin **3** - klima vrchovin **4** - klima malých plochých konkávních tvarů; **5** - nadměrně osluněné svahy; **6** - nedostatečně osluněné svahy.

KLIMA DOMINUJÍCÍ V PŘÍZEMNÍ VRSTVĚ OVZDUŠÍ:

7 - klima polí a luk s podložím s nízkou tepelnou vodivostí; **8** - klima polí a luk s přiměřeně vlhkým podložím a normální tepelnou vodivostí; **9** - klima polí a luk s přiměřeně vlhkým podložím a velkou tepelnou vodivostí; **10** - klima polí a luk s přiměřeně vlhkým podložím a extrémně vysokou tepelnou vodivostí; **11** - klima jehličnatého lesa; **12** - klima listnatého a smíšeného lesa; **13** - klima lužního lesa; **14** - klima středně zastavěných urbanizovaných ploch; **15** - klima hustě zastavěných urbanizovaných ploch. **16** - klima vodních ploch.

KLIMA DOMINUJÍCÍ VE SPODNÍ ČÁSTI MEZNÍ VRSTVY OVZDUŠÍ

1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	5	1	1	1
2	2	2	2	2	2	3-5	1-2	1-2	1-2
3	3	3	3	3	4	2-5	1-2	1-3	1-2
4	2	2	1-2	2	2	3	2	2-3	2
5	+1						-1		-1
6							+1		+1

1 - číslo vysvětlivky na mapě; **2** - termické příčiny turbulence; **3** - dynamické příčiny turbulence; **4** - velikost a trvání vírového proudění; **5** - variabilita vektoru větru s výškou; **6** - konfluence a difluence proudnic; **7** - rozptyl atmosférických příměsí; **8** - trvání teplotních inverzí; **9** - četnost teplotních inverzí; **10** - intenzita teplotních inverzí.

KLIMA DOMINUJÍCÍ V PŘÍZEMNÍ VRSTVĚ OVZDUŠÍ

1	2	3	4	5	6	7	8	9	10
7	1	1	3	2	2	4	1	2	3
8	1	3	2-3	3	2	3	2	3	3
9	1	3	2	3	2	2	3	3	3
10	1	4	2	4	2	2	3	5	3
11	1	2	2-3	3	4	2	4	2	5
12	1	2	2-3	3	4	2	4	2-3	4
13	1	4	2-3	4	4	2	4	4	4
14	3	3	4	2	4	4	3	2	2-3
15	5	2	5	1	5	5	5	1	1
16	1	5	1-2	5	2	2	3-4	5	-

1 - číslo vysvětlivky na mapě; **2** - antropogenní proud tepla; **3** - proud tepla tepelnou vodivostí; **4** - turbulentní proud tepla; **5** - latentní proud tepla; **6** - velikost vírového proudění; **7** - maximální teplota; **8** - minimální teplota; **9** - výpar; **10** - délka trvání sněhové pokrývky.

CHARAKTERISTIKA BALOVÉHO OHODNOCENÍ

1 - chybí, nepatrná, silně snížená
2 - slabé, nízké, snížená
3 - střední, normální
4 - silné, vysoké, snížená
5 - velmi silné, velmi vysoká, silně zvýšená

SOUBOR GEOGRAFICKÝCH MAP ŽIVOTNÍHO PROSTŘEDÍ

TOPOKLIMATICKÁ MAPA

List 34 - 22 Hodonín, měřítko 1 : 50 000. Zpracováno v rámci projektu E 5.5 "Inventarizace, evidence a evaluace ekosystémů České republiky". Odpovědní řešitelé podprojektu "Evidence stavu a geografické hodnocení biotopů České republiky": ing. Jan Lacina, CSc., RNDr. Vítězslav Nováček, CSc.

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