Local Climatological Studies of the Temperature Conditions in an Urban Area

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Abstract

The following article deals with an investigation of the local variations in the horizontal temperature distribution in the Uppsala district during different times of the year, of the day and under changing weather conditions. The article treats mainly the methods of investigation, especially the choice of observation stations, but also comments briefly upon some of the results. An attempt is made to place the established temperature contrasts in relation with simple climatological elements such as cloudiness, wind velocity, temperature and absolute humidity. The article is a preliminary report of an investigation, the complete results of which are shortly to be published in Geographica (Papers from the Geographical Institute, University of Uppsala, No. 22).

Introduction

It very often happens that a thorough treatment of a particular problem requires a basic knowledge of the purely local variations of the climatological elements. This applies, for example, to problems of mechanical weathering, questions concerning the location of plant boundaries and plant colonies, and the problem of the physiological importance of climatological factors.

The observation series of meteorological stations give at best only a good picture of the climate just at the place and in the location where the meteorological instruments are placed. Unfortunately they give us little indication of the purely local deviations in the climatological elements. And yet these deviations are often of such an order of magnitude that one must move many scores of miles in order to obtain corresponding changes in the "macroclimatological" elements. Our only possibility of finding a solution to this problem is in obtaining through special investigations an increased knowledge of the distinctive features of local climate.

A determination of the influence of urban areas on the climate has for a long time and for many reasons been an important task of inquiry. A compact city area with its mass of houses, industrial structures, streets and parks constitutes a pronounced interruption in the natural formation of the landscape. The changes in the surface configuration alone are sufficient to produce a modification of the climatological elements. More significant, however, are the consequenses of the commercial and industrial activity which characterize the city. Combustion processes and other transformations of energy make the city a heat generator of great magnitude. These processes are simultaneously accompanied by a considerable production of dust particles, which surround the city and influence, at first hand, the radiation balance of its climate. Not only is the radiation balance a typical in and near a city, but the other climatological elements as well e.g. temperature, humidity, wind and precipitation.

The clearly noticeable influence of an urban area on climate makes desirable city planning, which seeks to eliminate the undesirable effects of a community upon healthful climate. A good knowledge of urban climate is also necessary for the study of other climatological problems. Our oldest and most valuable meteorological observation-series were in general obtained from cities. It follows that our understanding of secular climatic changes can be influenced to a certain degree by the growth of the urban community. It is impossible to discuss the magnitude of this effect without closer investigation.

Methods. General

In order to determine the distinctive features of the climate of a city, comparisons are usually made between parallel meteorological observation series taken inside and outside of the city area in question. The disadvantage of this method, is the difficulty of obtaining fully comparable values. Very seldom are stations located in such a way that the influence of the community expresses itself clearly in their record. In addition, there is of course uncertainty in the given numerical values. It was therefore a great step forward, when SCHMIDT (1927) in Vienna and PEPPLER in Karlsruhe (1929) developed a method of using an automobile equipped with meteorological instruments. This method has since come to be used in a number of investigations in different countries.

An extensive literature concerning city climatological problems has appeared during the last decade. ALBERT KRATZER in 1937 published a survey, Das Stadtklima, which gives a summary of all literature on city climate published prior to that time. This work contains an exhaustive description of all research results achieved in addition to a bibliography of 250 titles. Among the more modern works one should mention an investigation by MIDDLETON and MILLAR (1936). In this investigation the temperature distribution during a winter night was examined along a street in Toronto with the help of a resistance thermometer attached to an automobile. The temperature profiles registered show, among other things, the importance of topography in the horizontal temperature distribution.

During recent years two important works have been published concerning temperature and precipitation conditions in the Bergen district in Norway; one by SPINNANGR (1942) and the other by GODSKE (1943). Finally one may cite an important English investigation in city climatology by BALCHIN AND PYE (1947), concerning temperature conditions in the Bath district.

For the investigation of temperature conditions in the Uppsala area, the following three alternative methods were available:

I: A number of self-registering instruments, thermographs could be placed at points inside and outside the city.

II: Fixed stations equipped with instruments designed for regular reading could be established at corresponding points.

III: Observations could be made with help of a thermometer mounted on an automobile according to the method of Schmidt and Peppler.

Also, one can conceive of a combination of the three methods in some suitable way.

The advantage of the first two methods in comparison with the third is that one can obtain a larger number of simultaneous temperature determinations from separate points. The first method has however the disadvantage that the values obtained are relatively unreliable, since errors in thermograph registrations are often as great as $\pm$ 0,5° C. With the second method it is difficult to select especially interesting weather situations for closer investigation, since all readings must necessarily occur at previously determined times. Moreover, both of these methods possess the inconvenience of requiring large and expensive equipment and a number of dependable observers. It should be pointed out, further, that unless preliminary investigation is carried out, difficulties will arise in the selection of instrument station locations. In order to obtain representative data one needs *a priori* a good knowledge of the local temperature variations.

Because of these circumstances, the third method was chosen as the only one which would permit a single person to obtain relatively correct results without too great an expenditure of funds. The limitations of this method have been reduced as far as possible, as will be explained later.

Instrumental equipment

An electrical resistance thermometer, constructed by Professor Hilding Köhler, was used for the observations. Fabrication of the instrument had been accomplished at the Cambridge Factories, in England. This thermometer satisfied all reasonable demands which were placed upon it.

Fig. 1 shows a sketch of the instrument's construction, and in fig. 2 the instrument appears mounted on an automobile. A copper tube was wound in a spiral so that the coils formed a mantle surface to a truncated cone. Its wider opening was turned forward, thereby improving ventilation. Inside of the copper tube is a double, isolated platinum wire, which constitutes the electrical resistance wire. The resistance thermometer was provided with a double radiation shield. The dimensions of the outer shield are: length 18 cm and diameter 10 cm. The thermometer was placed on the automobile in such a way that its center was situated 150 cm above the ground and 15 cm from the edge of the automobile roof.

A guide wire ran from the resistance thermometer to a Wheatstone bridge and galvanometer located inside of the automobile. The Wheatstone bridge was manufactured by the Rubicon Company, Philadelphia, USA. (Portable Wheatstone Bridge Test Set No. 1352.) It is equipped with built-in batteries and the galvanometer is not sensitive to jans and jolts. The galvanometer is a powerful pointer-galvanometer with a sensitivity of one microampere per scale millimeter and a period of two seconds. In the bridge are four resistors of altogether $9 \times (1000 + 100 + 10 + 1)$ ohms and a multiplier instrument with adjustments for 0.001, 0.01. 0.1, 1, 10, 100 and 1000. The resistors are made of manganese and therefore have an extremely low temperature coefficient. The battery is a 4.5 volt dry battery composed of three standard cells. In the present investigation, one should be able to determine the resistance used to 0.1 % or something less, which corresponds to a temperature uncertainty of less than 0.2° C.

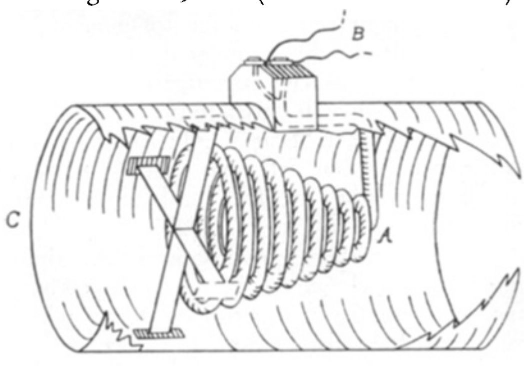

Fig. 1. Sketch of the construction of the resistance thermometer. *A* coiled copper tube. *B* electric wires to the Wheatstone Bridge. *C* inner radiation shield.


Fig. 2. The instrument mounted on the automobile roof.

Ventilation of the thermometer was achieved through the movement of the automobile. The speed of the car was kept in general at about 40 km/hr, but in the city it was, of course, often necessary to drive slower. In the country the speed was sometimes higher, never greater, however, than 60 km/hr. If one considers a speed interval of 20—60 km/hr (about 6—17 m/sec.) it is obvious that the speeds used were fully sufficient to secure adequate ventilation. At the same time no account need be taken of dynamically conditioned temperature changes. Readings were always taken with the automobile in motion or immediately after stopping.

The thermometer apparatus was carefully examined for sources of error such as the conduction resistance of the guide wire, radiation influences, effects of heat from the automobile, unsuitably adapted reaction speed, insufficient ventilation, etc. No detailed account of these investigations will be presented, but it can be said summarily that the average error in the readings was estimated at about 0.1° C.

Representativity of the observation points

A prime problem in an investigation of this type is the choice of the observation points. Not all points in any given area will give reliable or representative values. A certain variation in the reliability or representativeness of the points chosen is unavoidable. One should therefore attempt a definition of what is meant in this case by representativity, so that a final selection of observation points can be made with the help of this definition.

If one choses a limited terrain area not all points at any certain level above the earth's surface have the same temperature at the same moment. One may assume that the value which at a certain moment best represents the temperature of the whole area at this level is the mean value of the temperatures at a large number of points evenly distributed over the area. This mean value is indicated Θ_M and the temperature at a certain point P Θ_P, then we have the relation:

$$\Theta_P = \Theta_M + \Delta_P \qquad (1)$$

Δ_P is a quantity which indicates the deviation of the temperature at point P from the mean value for the whole area. Its value, of course, changes with time and varies from point to point. For a large number of observations, n, we have:

$$\frac{\Sigma\,\Theta_P}{n} = \frac{\Sigma\,\Theta_M}{n} + \frac{\Sigma\,\Delta_P}{n} \qquad (2)$$

$\dfrac{\Sigma\,\Delta_P}{n}$ constitutes the average value of the deviation and is subsequently indicated by k_P.

k_P is therefore expressed by the relation:

$$k_P = \frac{\Sigma\,\Theta_P}{n} - \frac{\Sigma\,\Theta_M}{n} \qquad (3)$$

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k_P can of course take both positive and negative values. A positive value k_P means that the point P has *on the average* a higher temperature than the mean value for the whole area. Even if a point of observation shows a large numerical value of k_P, it can at least theoretically give reliable values of the temperature of the whole area if one knows the magnitude of k_P and if Θ_P and Θ_M vary in a systematic manner.

The variations in Δ_P are therefore unsuitable for determining the representativity of a point. Instead $k_P + \delta_P$ may be substituted for Δ_P thus obtaining:

$$\Theta_P = \Theta_M + k_P + \delta_P; \qquad (4)$$

where k_P is a constant typical for the point P and δ_P is a variable. It follows from the definition of k_P that $\Sigma\,\delta_P$ for a large number of observations is equal to 0.

If one has in some way determined k_P, then a reading of the temperature at P gives a good understanding of the temperature of the area as a whole independent of the magnitude of k_P, provided that δ_P is small in magnitude. Indeed, one can say that the smaller the magnitude of δ_P, the more representative is the point P. Hence variations in δ_P can be said to give a measure of the representativity of the point P. The statistical expression for standard deviation has been chosen as the quantitative expression for representativity.

$$\sigma = \sqrt{\frac{\Sigma\,\delta^2}{n}} \qquad (5)$$

where n is the number of observations. It therefore holds that: *the less σ, the better the representativity.*

The above reasoning and definitions are of a statistical nature and may be applied without regard for the form or size of the area for which the statistical calculations are made. In practice the determination of the size and the limits of the area to be investigated is a problem of decisive importance. In certain instances a large meshed-net of reference areas is necessary, in others one may perhaps choose very small areas.

For the subject investigation the problem was primarily that of finding observation points of two kinds: those expected to give

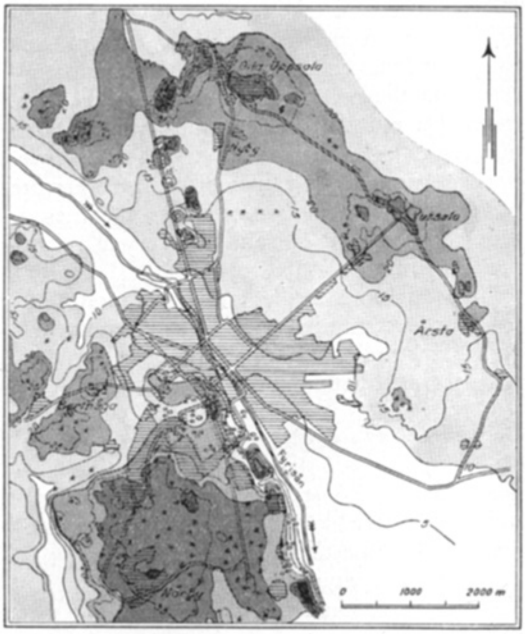

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Fig. 3. General map of the area of the investigation. Level curves have an equidistance of 5 meters. Built-up area is lined. Wooded area is indicated by the conventional signs for forest (rings = hardwood; stars = pine forest).

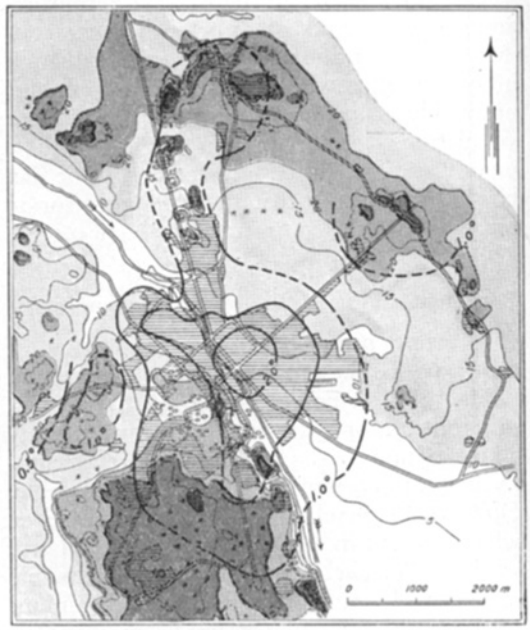

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Fig. 4. Isotherm map based on mean temperatures for 20 observations made during the period January—April 1948.

representative values for the city and those expected to give representative values for the surrounding countryside. In addition, the observations must give abundant and uniform numerical data suitable for statistical analysis.

During December 1947 and January 1948 preliminary attempts were made to find good points of observation. The city was criss-crossed in several directions and temperature profiles were constructed in each case for the area in question. In this way an approximate understanding of the general temperature distribution was obtained. On the basis of this experience an extensive route was selected which included all of the main highways from Uppsala and extended out 4 to 5 kilometers from the city. The total length of this route was nearly five Swedish miles (about 30 English miles) and the number of observation points along the whole stretch was seventy-nine.

From about the middle of January 1948 until the middle of April observations were made along the entire route some 20 times. These observations were carried out at different times of the day and under different weather conditions in order to avoid a subjective preference for any particular weather type. It was intended that the observations taken should compose as good a picture of the "average" weather conditions as possible.

In arranging the material from each observation run it was necessary to take into consideration temperature variations during the time that observation was in progress. One must, in fact, reduce all observations to the same point in time in order to obtain the temperature distribution at that particular moment. Since every run took one and a half hours on the average, it is obvious that significant temperature changes occurred. Four readings were made at Stora Torget, the City Common, during each run (cf. the survey map, fig. 3). In addition, at the beginning and at the end of each run, temperature values were taken from the thermogram recorded at the Meteorological Institute, 1 km west of the center of the city. The temperature

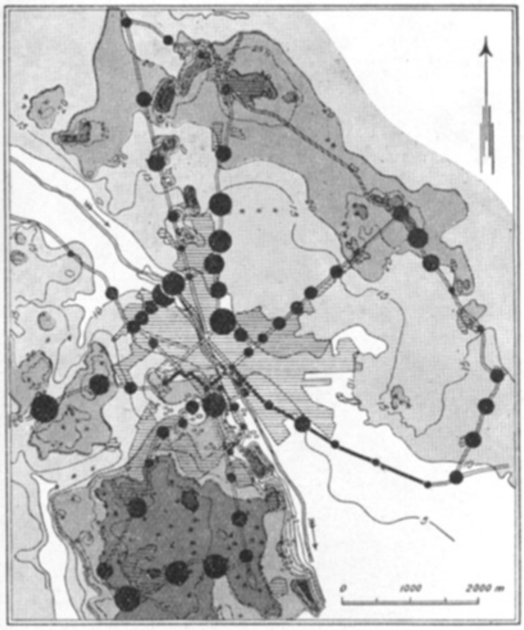

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Fig. 5. Map showing the representativity of the observation points. The continuous line indicates the route finally chosen. Representativity is indicated by the value of σ according to the following scale (Cf. eq. 5):

0.21°—0.30°:	0.61°—0.70°:
0.31°—0.40°:	0.71°—0.80°:
0.41°—0.50°:	0.81°—0.90°:
0.51°—0.60°:	0.91°—1.00°:

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Fig. 6. Map showing representativity of the observation points when the entire area of the investigation is treated as a single reference area.

range was afterwards computed as the mean value of the temperature range at the City Common and at the Meteorological Institute. A linear variation has been assumed wherever the thermogram showed no special irregularity. With a knowledge of the general temperature range and the time of each observations all observations may be reduced to the same point in time. It was therefore possible to construct isotherm maps for each observational run. Examples of these maps will be demonstrated later.

The next phase in the investigation of representativity concerns the determination of mean temperature at each point for all 20 series of observations. The result appears in graphic form in fig. 4. Isotherms are drawn in this figure with an equidistance of one half of one degree. The figure clearly shows a positive temperature anomaly in the settled urban area, but also indicates to a certain extent an influence of topography on the temperature conditions. The largest positive temperature anomaly occurs, as we should expect in the central parts of the city. One degree isotherms generally follow the outer contours of the city but extend both north and south far outside of the inhabited area; this probably results from topographical conditions. The majority of the observation runs were taken during the winter or early spring when temperature inversions are likely to occur. Therefore it is to be expected that points in the north and south, situated at higher levels, should have higher temperatures than the surrounding terrain.

The isotherm map in fig. 4 were used in subdividing the general area for the studies of representativity. The more or less concentric lines around ,the center of the city roughly indicate the degree of influence of the settled city-area upon the temperatures. The areas thus selected consist of

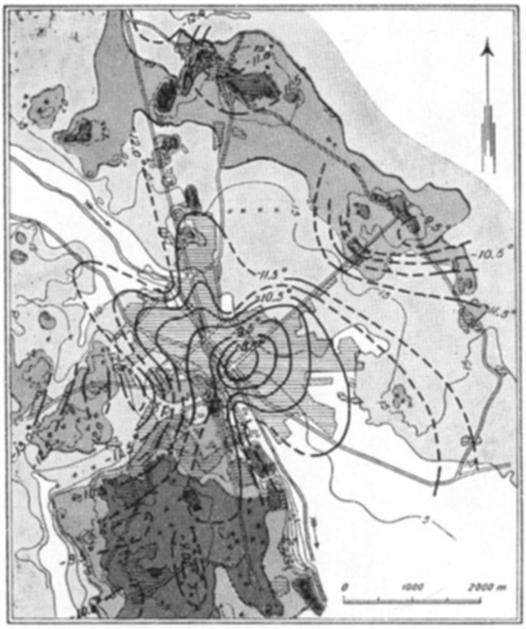

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Fig. 7. Isotherm map for February 25, 1948, around 0600 hours. Cloudiness: 0. Wind: SW 1.5 m/sec. Absolute humidity: 1.9 mm. Relative humidity: 91 %. Ground completely covered with snow.

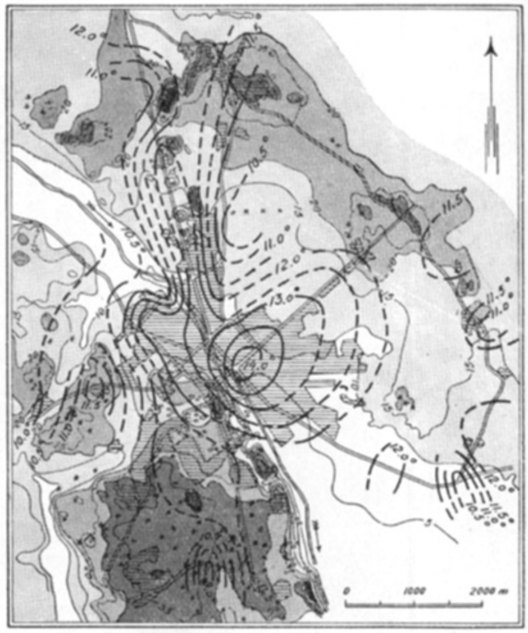

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Fig. 8. Isotherm map för August 30, 1948, around 2000 hours. Cloudiness: Acu, ci 0. Wind: ENE 1.0 m/sec. Absolute humidity: 8.9 mm. Relative humidity: 88 %.

a central city area with three more or less concentric surrounding rings. It is obvious that the variations in size and form of the several areas somewhat affect the values for δ. In spite of this, such a division of the general area is preferable to the more artificial one, e.g. in form of a regular square net.

Fig. 5 shows the representativity of the different station points. It is noticable that all of the observation points near the central parts of the city show very small standard deviations. This results from the fact that temperature variations at all points inside the area occur in phase, a fact favoured to some extent by the small dimensions of the area, but also clearly indicating that almost all central points are representative for their area.

If one proceeds from the center of the city towards the surrounding countryside, points in the boundary zone between the city and the countryside show especially large deviations. The explanation is perhaps that the horizontal temperature gradient in this boundary zone is often especially large. A large temperature gradient means that these observation points are sometimes found inside of the effective area of the city and sometimes outside of it, depending upon the prevailing wind direction and velocity. This promotes great variations in the value of δ and of σ.

Outside of the effective area of the city proper one sees immediately the influence of the topography. Points having a typical location (high or low elevation) show large relative standard deviations.

A third factor can also be pointed out. In the wooded section south of the city high values are probably partly conditioned by the vegetation which gives this district a more maritime temperature climate than the adjacent terrain.

The best points of observation in the country are found where neither topography nor vegetation gives the area a special character. It is therefore completely consistent that the observation points located on the plateau south-east of the city show the best representativity. The terrain is especially level, no mounds or depressions occur, and the entire area forms essentially one homogeneous, cultivated surface.

A final observation route was chosen based upon these results and is shown in fig. 5. This route embraced a stretch of about 1 Swedish mile (6 English miles) and included 15 observation points. Some of the points chosen were representative of the urban area and some of the country. The effect of topography and vegetation was extremely slight in these points.

Fig. 6 shows for comparison the result obtained when the entire area under investigation is treated without subdivision. The most characteristic feature of the preceding figure also recurs here; the pronounced influence of topography and vegetation. A significant difference remains however; the influence of the city is expressed in an entirely different manner. Points situated in the center of the city, certainly representative for the central part, are in no way representative for the larger area embracing the city and for the countryside. Accordingly observation points inside the city now show the greatest deviations. The unsuitableness of placing a meteorological station in a city follows naturally from this.

Isotherm maps

From a study of isotherm maps one can obtain a good understanding of the general temperature distribution and of the factors which determine it. Some of the most important observations will be stated.

The temperature in the settled area is in general higher than in its surroundings. Significant differences never arise during the day, but at night differences can often become very large. Positive city-countryside temperature differences are favoured by clear and calm weather. In such weather situations an especially strong temperature gradient can often be established in the boundary zone between the populated and unpopulated areas. The inhabited area is enveloped by a limited, warm-air mass. The center of this warm-air mass is generally displaced somewhat in the direction of the wind. The concentration of isotherms, which often appears in those parts of the city outskirts which face the wind, can then be understood as a wind effect.

The connection between topography and temperature distribution can be shown very easily. The vertical temperature gradient is in this respect, the most important factor in determining of the size of topographically-conditioned differences. When the temperature decreases with height, those points situated at higher levels show somewhat lower temperatures than those located in the surrounding area. The differences, however, are not large, usually only a few tenths of one degree, provided that the differences in level do not exceed ten meters or so. If the vertical temperature distribution is reversed, however, i.e. if we have an inversion, the topographically-conditioned temperature differences may reach values of many degrees.

It was possible to study the influence of vegetation on the temperature distribution in the forest south of Uppsala. A persistant effect on the daily temperature trend was ascertained: the forest climate is more maritimely stressed. This observation is in general agreement with known conditions. Vegetation reduces outgoing nocturnal radiation and therefore prevents temperature inversions near covered surface from becoming as pronounced as those above open fields; as a result temperatures in the forest are higher during the night than those over the surrounding terrain. The situation reverses itself, however, during the day. Incoming radiation is obstructed by the vegetation and the temperature can not rise to values as high as those observed over the open areas around.

Temperature profiles

In certain interesting or especially typical weather situations measurements were carried out at short time intervals along the shorter observation route. These temperature profiles made it possible to study how the city-countryside temperature contrast is developed and how it changes with time. Two examples are shown in figs. 9 and 10; the text with these illustrations describes briefly the effect of the meteorological factors on the temperature contrasts.

The relation between temperature contrast and simple climatological elements

The isotherm charts and temperature profiles clearly indicate that an intimate connec-

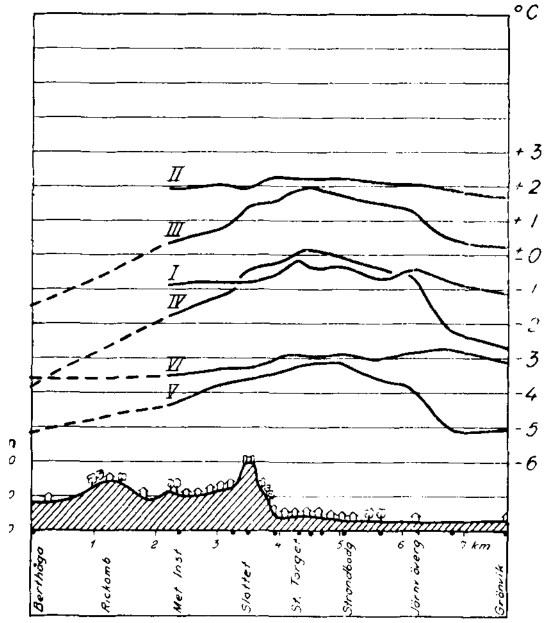

Fig. 9. Temperature profiles through Uppsala October 28—29, 1948. In the lower part of the figure a raised profile shows the topographical conditions along the route (Cf. the continuous line in fig. 5). Built-up area is schematically shown by the sign for building.

Profile	Time	Cloudiness	Wind		Humidity
I	1100	0	NNW	1.3	3.4 (80)
II	1415	0	N	1.8	3.8 (73)
III	1605	0	N	1.6	3.9 (78)
IV	1820	0	NNW	1.5	3.5 (88)
V	0040	1	NNW	2.1	2.9 (89)
VI	0405	10	N	2.2	3.1 (91)

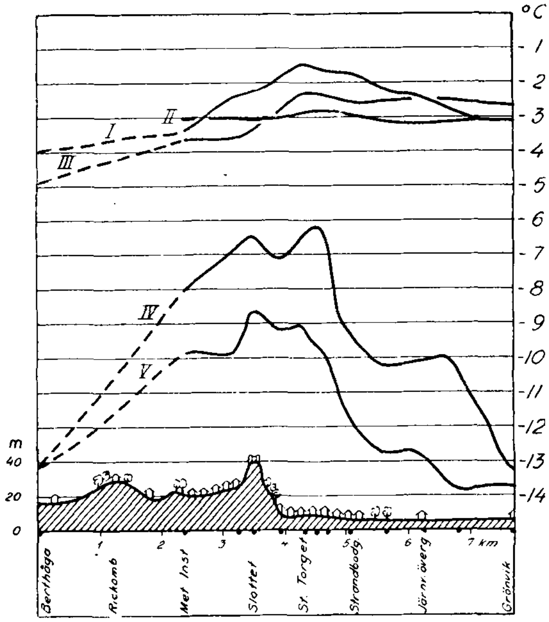

Fig. 10. Temperature profiles through Uppsala January 18—19, 1949. Ground completely covered with snow.

Profile	Time	Cloudiness		Wind		Humidity
I	1435	Stcu	1	W	1.3	3.2 (92)
II	1645	Stcu	8	W	2.6	3.1 (94)
III	2005	St	10	NW	4.0	3.2 (92)
IV	0100	0		SW	1.6	2.1 (89)
V	0820	Acu	3	ENE	1.9	1.8 (91)

tion exists between the temperature differences and the simple climatological elements; especially cloudiness and wind velocity. Particularly in the analysis of the temperature profiles it became apparent that small variations in cloudiness and wind velocity were also clearly reflected in the local temperature contrasts. One may therefore suppose that there is a possibility of deriving a quantitative expression from which the temperature difference between two arbitrary points could be computed.

For a period of about 1 year, from May 1948 until May 1949, it was possible to determine more than 200 values of the temperature contrast between city and country. The measurements were, as far as possible, distributed equally over the seasons and time fo day. During the entire period every effort was made to include all possible weather types.

The mean value of three readings at the City Common with the reading at the nearby observation point situated south-east of the Common has been used as the value for the temperature in the centre of the city. The temperature of the open country has been defined as the mean value of the readings taken at the two most distant points of observation along the route. The readings have been reduced to the same time in all cases. The difference between the mean temperatures computed in this way was taken as the observed temperature contrast between city and country.

The simultaneous values for the simple climatological elements; cloudiness, wind velocity, temperature, as well as absolute and relative humidity; were obtained partly by the investigator's own observations and partly from recorded data taken at the Meteorological Institution.

If in a diagram one represents the observed temperature contrast as a function of one of the simple climatological elements, e. g. wind velocity, one obtains a result having very great diffusion at the points. One can certainly discern a general tendency toward lower temperature contrasts with higher wind velocities, but such a technique cannot provide the foundation for a quantitative calculation. It is therefore impossible to isolate immediately a single factor and treat it separately. Instead one must attempt to treat in some way the whole complex of causes simultaneously.

An attempt was made to solve this problem by calculating the partial correlation coefficients for the relation between the temperature contrast and a particular meteorological element. Thereafter the regression equations were derived in which the temperature contrast is represented as a function of the elements included in the calculation.

Fundamentally, the material should be divided into several groups with respect to season, time of the day, etc., and then each group should be subsequently treated individually. Such a subdivision is limited, however, by the fact that soon the numerical data in each subgroup becomes so small that it does not permit statistical analysis. In view of this difficulty it was decided to divide the material into two large groups; observations made during the day and observations made during the night. In this way the material is divided into those two groups which with respect to radiative phenomena can be expected to be more or less uniform. Since the number of observations remaining in each group amounts to 96 and 111 respectively, the material permits certain quantitative conclusions. In this paper only a short summary of the statistical result (without more detailed discussion) is given.

The temperature contrast D between the central parts of the city and the open country is assumed to be expressed by the linear relation:

$$D = A + b_1 N + b_2 U + b_3 \cdot \Theta + b_4 e; \quad (6)$$

where N is cloudiness in the ten-degree scale, U the wind velocity, Θ the temperature and e the absolute humidity.

Insertion of the numerical values obtained from the statistical calculations gives the equations the following form:

$$D_{\text{Day}} = 1.4° - 0.01\,N - 0.09\,U - 0.01\,\Theta - 0.04\,e \ (°\text{C}); \quad (7)$$

$$D_{\text{Night}} = 2.8° - 0.10\,N - 0.38\,U - 0.02\,\Theta + 0.03\,e \ (°\text{C}); \quad (8)$$

The coefficients for the different meteorological elements may not of course be considered as certain in the final numerical values. The order of magnitude should however be essentially correct. The coefficients of correlation between D_{Obs} and D_{Cal} were calculated at $+0.49 \pm 0.05$ and $+0.66 \pm 0.03$ for day and night respectively.

It is necessary to clearly realize that the correlation relations obtained are of a formal, mathematical nature, and that the statistical computations do not in themselves answer questions concerning the causal complex. They can however be of guidence in further study and of some use in practical investigations.

Summarily it can be said that equations 7 and 8 approximately represent the temperature difference between city and country in Uppsala expressed in simple climatological elements. The lack of good agreement between the calculated and observed differences, especially at high and low values, seems to indicate that the assumption of a linear relation between the wind velocity and the temperature difference is incorrect. No appreciable variation in the representativity of the equations was observed during different seasons of the year. Equation 7 appears to give values for the temperature difference which are somewhat too low near the times of sunrise and sunset. Very small or negative values for the difference were observed only in relatively high solstice. Very large differences were associated with situations having well developed temperature inversions.

The effect of the growth of the inhabited community

The foregoing has sought to indicate that local city climate often exhibits great tem-

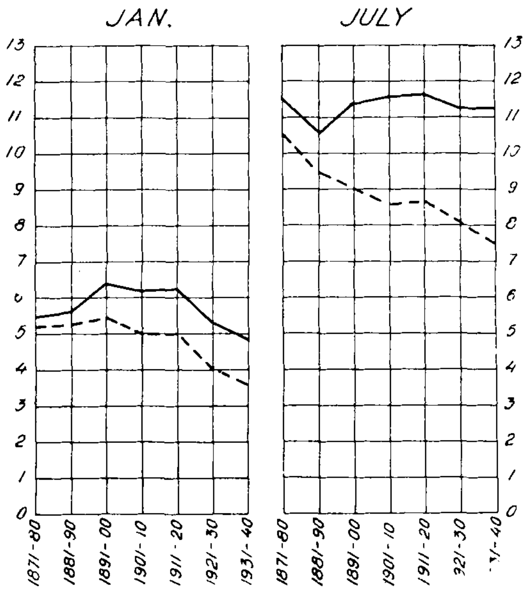

Fig. 11. The daily temperature amplitude in Stockholm (broken line) and Uppsala (continuous line) for January and July. Mean numbers for decennial periods from 1871 to 1940.

perature contrasts between city and the surrounding countryside. In a rapidly growing city the influence of the inhabited area upon a place of observation in the city can be expected to increase continually. An interesting example of this effect can be seen in a comparison between the temperature values from Stockholm and from Uppsala.

In fig. 11 decennial mean values for the daily temperature amplitude in Stockholm and in Uppsala are given for the months of January and July over the period 1870—1940. The amplitudes were calculated as the difference between the daily maximum and minimum temperatures. Uppsala's temperature amplitude shows a relatively horizontal course. One can perhaps detect a very slight tendency towards decreasing amplitude. The condition in Stockholm is otherwise; for both months one notes a significant and continual decrease of the temperature amplitudes. This diminution for the month of July goes to more than 2° C in comparison with the Uppsala values. It can be stated parenthetically that the changes in amplitudes were produced both by an increase in the minimum temperature and by a decrease in the maximum temperature. The cause for these changes is difficult to explain; possibly it is related to changes in the vegetation around the place of observation, but it is also probable that the development in Stockholm of the populated area itself plays an important rôle.

It then follows that even observations from very good stations must, under such conditions, be most carefully interpreted. Especially when one wishes to discuss secular climate changes it becomes particularly important that the influence of a developing city or changes in the local surroundings of the observation point be not interpreted as real climatic changes.

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