# The Seasonal System of Urban Temperature Surplas in Szeged

by J. UNGER

*J. A. University, Szeged, Egyetem u. 2. H—6722, Hungary*

The data of city climate observations carried out at *11* stations in the area of the town of Szeged between *1977* and *1980* having been used, the degree and system of city temperature surplas has been investigated.

The investigations into pointing out the more marked characteristics of city climate have covered the sunny, advection-free days. By the help of the seasonal means counted from the daily mean temperatures of such days, the seasonal system of the appearing temperature excess has been compiled. Accordingly, the town centre is averagely *1·5—2·0*°C warmer than the surroundings of the town, but the urban—rural temperature difference may even exceed *2·5*°C.

*A városi hőmérsékleti többlet évszakos rendszere Szegeden.* Szeged város területén *11* állomáson *1977—80* között végzett városklímamérések adatait felhasználva vizsgáltuk a városi hőmérsékleti többlet mértékét és rendszerét.

Vizsgálataink a városklíma markánsabb jellegzetességeinek kimutatására a derült, advekciómentes napokra terjedtek ki. Az ilyen napok napi hőmérsékleti átlagából számolt évszakos középértékek segítségével megszerkesztettük a megjelenő hőmérsékleti többlet évszakos rendszerét. Eszerint a belváros átlagosan *1·5—2·0*°C-kal melegebb a város környezeténél, de a különbség a *2·5*°C-ot is meghaladhatja.

The bigger the town is, the more conspicuous the characteristics of urban climate are. The local features of temperature show themselves even in the cases of towns of medium order. Therefore, it is worth investigating the factors of city climate in Szeged also, though, in comparison to cities of the order of millions, their presence can only be demonstrated in a moderate form.

Szeged is found in the lowest-lying area of the Great Hungarian Plain, in the south—east of Hungary. Its geographical potentialities are explicitly advantageous from the point of view of the development of urban climate because the town and its sur-roundings are free from orographic effects. The number of its inhabitants is *178 000* (*7*).

Between *1977* and *1980*, under the direction of the Department of Climatology of József Attila University, observations covering several climatic components were going on at *11* points of the town, different from the view-point of building density. By partial using of the data obtained during these observations, several studies have been born (*2*), (*3*), (*6*), but a great deal of the data still lack processing. This lack is somewhat reduced by this study, the first part of the further, it is to be hoped, complete processing.

The Aerological Observatory at the airfield, as Station *1*, by virtue of its situation on the outskirts, represents the environment free of urban effect. About the situations of this and the other stations, as well as about the major morphological types of the building density of the town, information is given by *Fig. 1*.

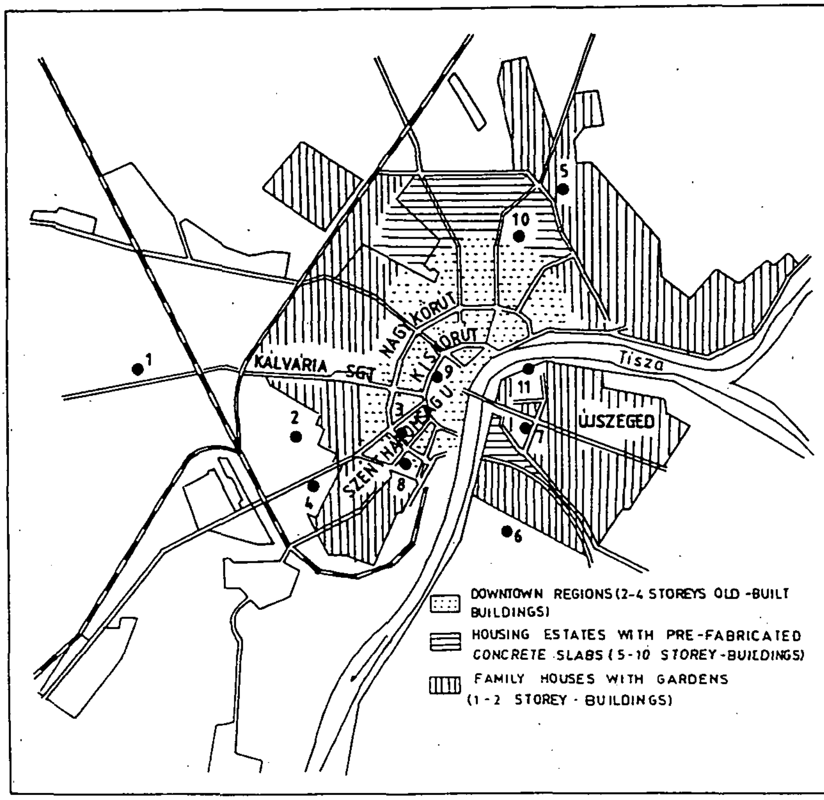


*Fig. 1. The Szeged urban climate network: 1. Airfield, 2. 'Lakes Sancer', 3. 'Ady Square', 4. Agricultural Department, JGYTF, 5. Petőfi-telep (Petőfi Inhabitation), 6. Botanical Gardens, 7. Children's Hospital, 8. Bécsi körút ('Vienna Boulevard'), 9. Napsugár-bisztró ('Sunbeam Bistro'), 10. 'Water-Tower Square', 11. Lower Tisza Country Directorate for Water Matters*

In the study the urban—rural temperature differences are investigated on the basis of daily temperature means, broken down according to seasons in the period between *1978* and *1980*.

On sunny, advection-free days, the characteristics of city climate as peculiar mesoclimate manifest themselves more strongly, while on cloudy, windy days, more weakly, or they completely disappear. According to the relation used in literature, in order to discontinue the difference of temperature between a city and its surroundings, a critical wind velocity

$$v = 3{\cdot}41\ lgP - 11{\cdot}6\ [m\ s^{-1}]$$

is needed averagely, where $P$ means the number of the population of the residence. In this way, in the case of Szeged, the critical wind velocity happens to be $6{\cdot}2\ m\ s^{-1}$, (*1*), (2), (*4*).

In the light of the above, from the daily observing data of the 3 years examined, the days below an average cloudiness of *3* octas and an average wind velocity of $5\ m\ s^{-1}$ were filtered out. Further on, the temperature means of these days were, station by station, investigated. The advection-free and sunny days chosen are, by date, included in *Table I*.

**Table I**

Sunny days without advection between 1978 and 1980, as well as their percentages

| | | |
|---|---|---|
| 1978 | | |
| January | 1,2,3,5,6,10,14,15,19 | (29%) |
| February | 21,22 | (7%) |
| March | 3,4,13,23,28,29,30,31 | (26%) |
| April | 1,7,10,23,29 | (17%) |
| May | 31 | (3%) |
| June | 1,2,10,16,19,20,22,23,30 | (30%) |
| July | 1,4,5,9,13,14,16,17,18,20,23,24,26,27,28,29,31 | (55%) |
| August | 1,2,3,6,7,11,12,13,16,17,19,21,22,23,24,25,27 | (55%) |
| September | 4,14,15,16,21,26 | (20%) |
| October | 8,9,10,11,12,14,15,16,19,22,24,28 | (39%) |
| November | — | (0%) |
| December | 5,6,7 | (10%) |
| 1979 | | |
| January | 3,5,7,8,13 | (16%) |
| February | 21,22,23,24,27 | (18%) |
| March | 2,3,4,7,9,15,20,25 | (26%) |
| April | 2,3,9,12,13,14,15,16,20,23,30 | (37%) |
| May | 10,15,16,18,19,20,21,25,29,30,31 | (35%) |
| June | 1,2,3,4,5,11,24,25,26,27,28,30 | (40%) |
| July | 6,11,16,19,20,24,25,26,29,30 | (32%) |
| August | 1,2,3,5,6,7,15,16,21,22,23,24,26,28,30,31 | (52%) |
| September | 1,2,3,6,7,8,12,13,14,17,19,20,21,25,30 | (50%) |
| October | 1,3,4,5,9,10,11,12,20,21,24,26,27 | (42%) |
| November | 23 | (3%) |
| December | 2,13 | (6%) |

1980

| | | |
|---|---|---|
| January | 4,5,13,28 | (12%) |
| February | 20,21,27 | (11%) |
| March | 5,31 | (6%) |
| April | 12,13,14,15,16,17 | (20%) |
| May | 7,8,22,23,26,27 | (19%) |
| June | 2,12,13,14,15,20,21 | (23%) |
| July | 1,3,12,13,15,16,19,25,27,31 | (32%) |
| August | 1,3,5,6,7,8,10,16,17,18,19,26,27,28,30 | (48%) |
| September | 4,5,6,7,17,20,21,22,23,26 | (33%) |
| October | 4,7,17,21,23,29,31 | (23%) |
| November | 20,21,22,23,24,25,26 | (23%) |
| December | 13,19,30 | (10%) |

On the basis of the data of *Table I* it is observable that the days with the required qualities mostly appear as groups of days succeeding one another. That can obviously be explained by the range of the station by station identical weather situations over several quite long periods.

The days, selected, are grouped according to seasons. With this we obtained the season-to-season relative frequencies of the cases examined (*Table II*).

Table II

Seasonal and annual distribution of the sunny days without advection

| | winter | spring | summer | autumn | year |
|---|---|---|---|---|---|
| Numbers of the days investigated | 270 | 276 | 276 | 273 | 1095 |
| Numbers of the days chosen | 36 | 58 | 113 | 71 | 278 |
| Relative frequencies of the days chosen (%) | 13·3 | 21·0 | 40·9 | 26·0 | 25·4 |

It is visible from the table that the weather situations causing quite considerable temperature differences between the city and its environment are the most frequent in summer (*40·9* %). In autumn (*26·9%*) and spring (*21·0%*), however, they occur fewer times, while in winter (*13·3%*), again, they are quite rare. This is explicable mainly by the greater cloudiness of the winter months and less by the force of the wind, for, at such times, wind velocities are generally smaller than in the summer months.

Later on, on the basis of the observations at *0700*, *1300* and *1900* hours (CET) the daily mean temperatures of the *3* years' days, selected, and grouped season by season, were calculated, station by station. The averages of these three observations are taken because uniformly in the cases of all *11* stations, observations had happened only at these three times.

From the daily mean temperatures we calculated the seasonal mean temperatures. The values of these averages, concerning the individual points of observation, are compared to the, identically calculated, seasonal means of Station *1* out of the town (*Table III*).

Table III

Seasonal means of each station and their differences from the seasonal means of the Station 1

| Station | Winter | | Spring | | Summer | | Autumn | |
|---|---|---|---|---|---|---|---|---|
| | Season | Differ. | Season | Differ. | Season | Differ. | Season | Differ. |
| 1. | -3·07 | 0 | 12·92 | 0 | 22·03 | 0 | 12·76 | 0 |
| 2. | -2·78 | 0·29 | 13·51 | 0·59 | 22·32 | 0·29 | 13·70 | 0·94 |
| 3. | -1·72 | 1·35 | 15·15 | 2·23 | 23·09 | 1·06 | 15·39 | 2·65 |
| 4. | -2·82 | 0·25 | 13·75 | 0·83 | 22·71 | 0·68 | 13·26 | 0·50 |
| 5. | -2·33 | 0·74 | 13·77 | 0·85 | 22·39 | 0·36 | 14·66 | 1·90 |
| 6. | -2·97 | 0·10 | 13·09 | 0·17 | 21·85 | -0·18 | 12·74 | -0·02 |
| 7. | -2·02 | 1·05 | 13·50 | 0·58 | 22·80 | 0·77 | 14·15 | 1·39 |
| 8. | -2·07 | 1·00 | — | — | 22·93 | 0·90 | 14·16 | 1·40 |
| 9. | -0·69 | 2·38 | 14·62 | 1·70 | 23·76 | 1·73 | 15·46 | 2·70 |
| 10. | -1·42 | 1·65 | 14·14 | 1·22 | 22·93 | 0·90 | 14·49 | 1·43 |
| 11. | -2·52 | 0·55 | 13·72 | 0·80 | 23·79 | 1·76 | 14·04 | 1·28 |

The spring mean of Station *8* was disregarded because here in this period the series of observations were extraordinarily defective, so the mean, counted from few data, cannot be compared with the airfield value, counted up from the average of far more data.

By means of the difference values in *Table III*, the season-by-season system of the deviations of the daily mean temperatures from the corresponding values, representing the surroundings of the town, have been compiled. The isothermal charts of the anomalies are shown in *Figs. 2 to 5*.

It is visible in *Fig. 2* that in the winter months, in the centre and the closely built-up quarter lying north—west of it a little, there formed a mean temperature difference greater than *2·0*°C. The other parts of the centre, the quarters Tarján and Felsőváros ('Upper Town'), built up with big blocks, the vicinity of Nagykörút ('Great Boulevard'), as well as the Újszeged ('New Szeged') housing estate possess a considerable temperature excess (*1·0—2·0*°C).

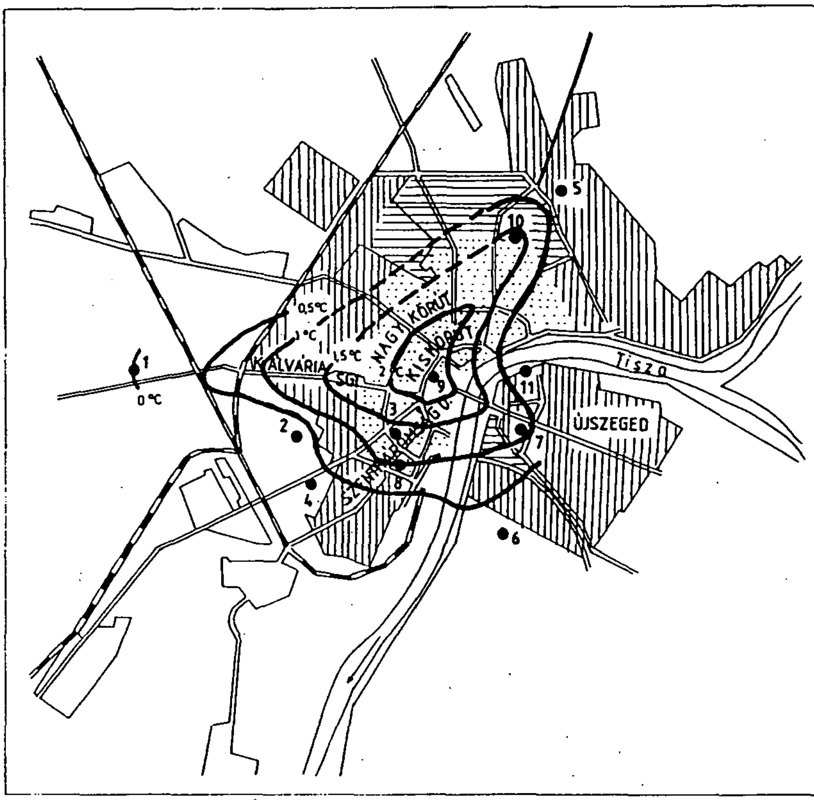


*Fig. 2. The distribution of the winter mean daily temperature differences (1978—1980)*

In the areas on the outskirts, mainly covered by houses with gardens, the difference is no longer very significant, it is as little as about *0·5*°C.

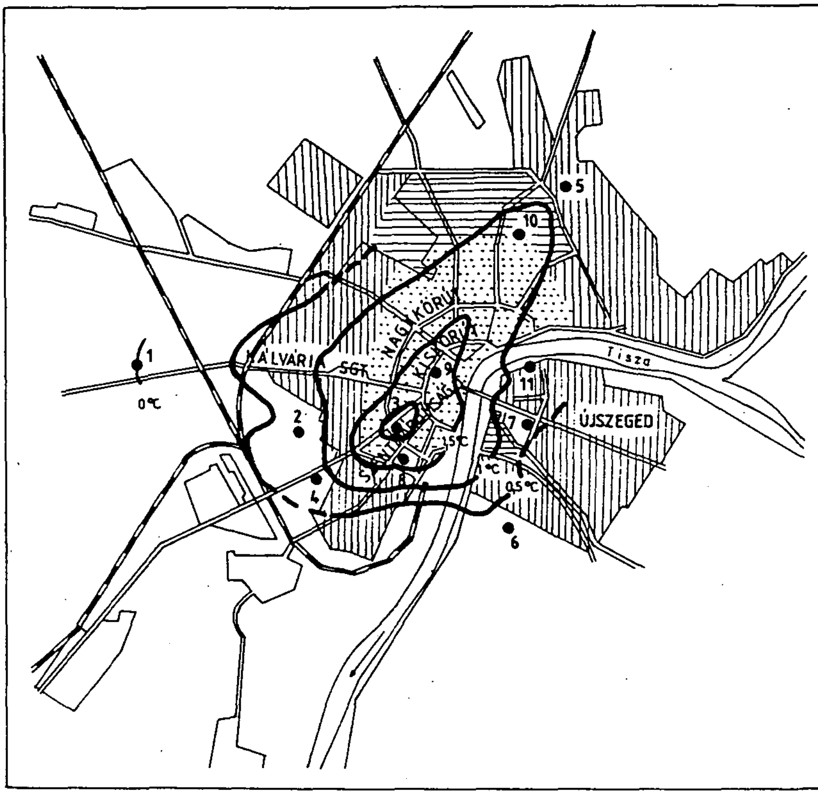


*Fig. 3. The distribution of the spring mean daily temperature differences (1978—1980)*

In the spring months (*Fig. 3*) the area possessing a major temperature difference (*2·0* °C) extends a little to the south—west, the area between Kálvária sugárút ('Calvary Avenue') and the beginning of Szentháromság utca ('Holy Trinity Street'). In addition, the difference is considerable (*1·5—2·0* °C) in all but the whole inner quarter, bordered by Nagykörút ('Great Bouleward'). Compared to the winter months, the extent of the area possessing a fairly great excess has reduced, which is explicable by the gradual ending of the heating season, and by the cessation of the heat radiation of household and communal heatings.

On the investigated days of the summer (*Fig. 4*), the isothermal system, formerly closed, slackens a little, the deviations are less marked. A fairly considerable temperature excess, which, however, only somewhat transcends *1·5* °C, comes into being in the north of the town centre. In the areas on the fringe, the difference is entirely insignificant already, and what is more, the more wooded Botanical

Gardens (Station *6*) are even cooler a little than the surroundings of the Airfield, lying in an open area.

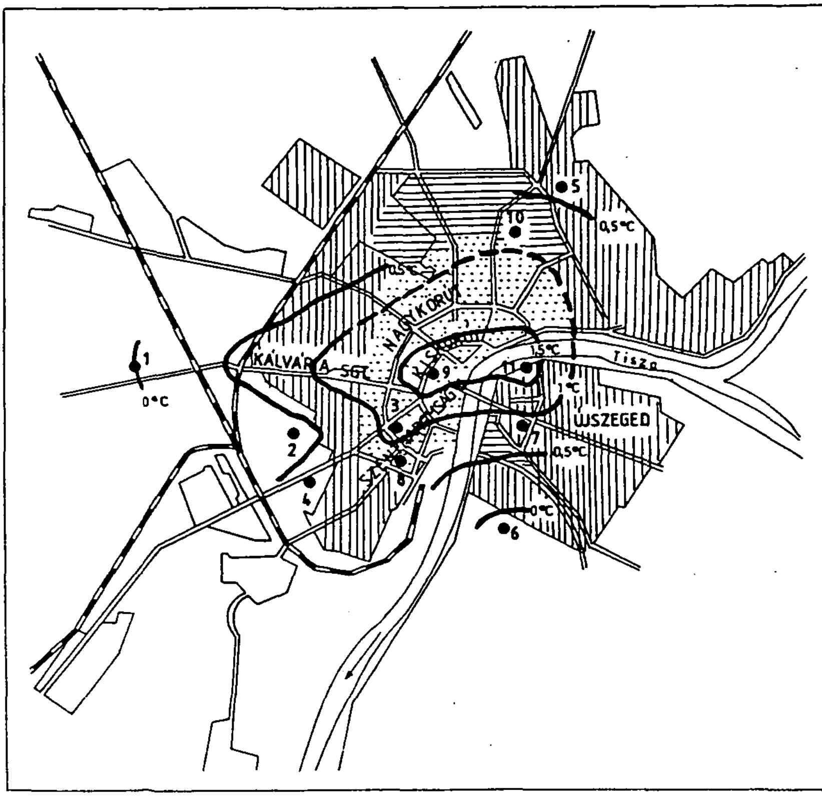


*Fig. 4. The distribution of the summer mean daily temperature differences (1978—1980)*

In the autumn months (*Fig. 5*), the temperature excess is considerable again (above 2·*0*°C) in all but the whole inner town, overlapping even Nagykörút ('Great Bouleward'). However, the northern part of the area between Kiskörút ('Little Bouleward') and Nagykörút, as well as the innermost and westernmost part of the Újszeged ('New Szeged') area already belong to the districts showing a lesser (*1*·*5*—*2*·*0*°C) temperature excess. The surroundings of the Botanical Gardens are not warmer in autumn than the Airfield either, while in Petőfi-telep ('Petőfi inhabitation'), an area showing a major deviation has formed. Compared to the summer period, the system of isotherms is much more closed, which refers to the more definite characters of the deviations.

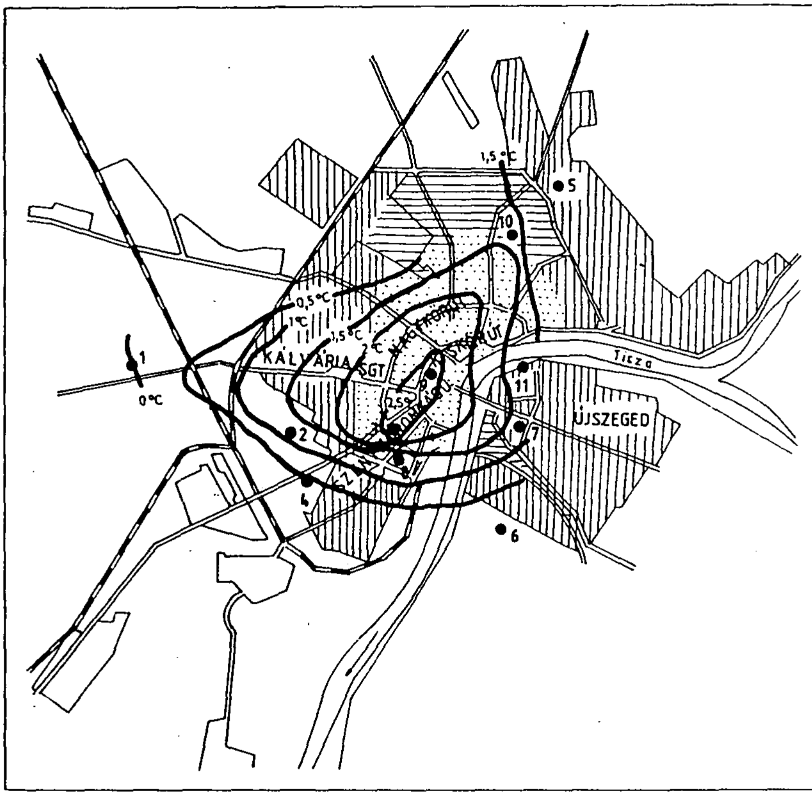


*Fig. 5. The distribution of the autumn mean daily temperature differences (1978—1980)*

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