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THE DAY-TO-DAY VARIABILITY OF AIR TEMPERATURE IN CRACOW AND ITS SURROUNDINGS

Abstract: This study examines an annual course in the day-to-day variability of air temperature in the centre of Cracow and its surroundings. By a comparative analysis of the variability of air temperature day-to-day changes in a city and in a non-urban area, an attempt was made to determine if urban build-up influences this variability and if so, what the magnitude of this impact is. Average monthly values and the day-to-day variability of air temperature were analysed. For the day-to-day variability, the frequency of changes of different value and sign were determined. Additionally, the day-to-day variability of air temperature was described for months with the highest and lowest temperatures. The project was based on daily measurements of air temperature (mean, maximum and minimum) for the period 1986-1995 from 5 meteorological stations (Cracow Botanical Garden, Balice, Libertów, Miechów and Gaik-Brzezowa).

Key words: day-to-day temperature variability, frequency of day-to-day temperature changes

1. Introduction and objective

The day-to-day variability of air temperature is a thermal characteristic only rarely used and taken under consideration by researchers examining urban climates. This variability depends, first of all, on macroscale factors and, especially on atmospheric circulation that causes the advection of air masses with specific thermal features. The influence of local conditions, including the character of an urban build-up, is believed to be insignificant, and as such neglected. As a consequence, it does not grasp the interest of urban climate researchers. Kossowska-Cezak (1992) pointed out that many works examining the day-to-day changes in air temperature were based on data obtained from stations located in large cities. Although this is a very well-known fact, it was not accounted for in the interpretation of research results. The present study is one of rare analyses examining the day-to-day variability of air temperature in Cracow. Therefore, it can be a starting point for future works looking at the influence of a city on these day-to-day changes. The temperature changes are an important, though variable, meteorological element.

The research conducted so far in Warsaw and within its vicinity (Kossowska-Cezak 1992, Mierzwiński 1992) has indicated that the thermal characteristics of inflowing air

masses are the main factor determining the conditions of the day-to-day variability of air temperature. The aforementioned research also shows that urban built-up areas can modify these changes. Therefore, it is an inappropriate simplification to neglect their effect. It should be pointed out that, according to researchers examining the climates of urban areas, thermal inertia of urban surfaces is one of the main factors (together with an inflow of artificial heat and atmospheric pollution) that create an urban heat island. This phenomenon results in temperatures within the city being higher than outside the city during the evening and night, and in the likelihood that the city centre has a lower temperature than the outskirts during morning hours (Kossowska 1973; Kossowska-Cezak 1977; Lewińska 1994-1995, 2000; Wawer 1992). The above situation is possible due to urban areas having a high temperature capacity that results in slow warming and slow cooling. Therefore, based on the aforementioned research and other works (Kossowska 1973; Kossowska-Cezak 1992), one can assume that this thermal inertia may affect the magnitude of changes in day-to-day temperature variability.

The present study examines an annual course in the day-to-day variability of air temperature in a city and around it. I define this variability as the difference between the temperature on a specific day and on the preceding day (similarly as other authors, e.g. Kossowska-Cezak 1992). By a comparative analysis of the variability of air temperature in a city and in non-urban area, an attempt was made to determine if urban build-up influences this variability and if so, what the magnitude of this impact is. Average monthly values and the day-to-day variability of air temperature were analysed. For the day-to-day variability, the frequency of changes of different value and sign were determined. Additionally, the day-to-day variability of air temperature was described for months with the highest and lowest temperatures.

The present project was based on daily measurements of air temperature (mean, maximum and minimum temperatures) for the period 1986-1995 from 5 meteorological stations. The following stations were used: Cracow (Botanical Garden) in the city centre, the Balice station located at the airport 10 km to the west of Cracow's city centre, the Libertów and Miechów stations located within the rural areas 10 and 30 km from the city centre, respectively, and the Gaik-Brzezowa station located on an agricultural area, close to Dobczyce Reservoir, 25 km to the south of Cracow. Additionally, a catalogue of synoptic situations developed by T. Niedźwiedź (for the period 1986-1995) for the upper Vistula river basin was used.

2. Average day-to-day variability of air temperature

The annual course of mean day-to-day variability of air temperature indicates some differences among stations. These differences are expressed mainly in the variability range. The shapes of the curves describing the annual courses of day-to-day variability and consequently the dates of the greatest and lowest variability are almost the same for all stations.

The greatest day-to-day variability of the mean daily mean air temperature was noted in either December or January for all stations. It exceeded the average value of 2.2°C during these months. January was the month of greatest variability at the Miechów and Gaik-Brzezowa stations (2.3°C and 2.6°C respectively). For the Libertów station it was

December (2.4°C) and for the Cracow and Balice stations, December and January were the months with the same, greatest variability (2.3°C in Cracow and 2.4°C in Balice, Fig. 1).

The lowest day-to-day variability of the mean daily air temperature was noted at all stations during summer and autumn months. At the Cracow, Balice and Miechów stations, the lowest variability was noted in August (1.5°C) and the value for July and September (1.6°C) was very close to that. July was the month with the lowest variability at the Gaik-Brzezowa station (1.7°C); a similar result was obtained in August (1.8°C). At the Libertow station the lowest variability (1.9°C) was noted during four months: June, July, August and September (Fig. 1).

The mean annual course of the day-to-day variability in maximum air temperature was very similar for all stations. The greatest day-to-day variability of the maximum temperature was noted in April at all stations (2.9°C at Balice, 3.0°C at Miechów, 3.1°C at Libertów and Cracow, and 3.2°C at Gaik-Brzezowa). The lowest variability was observed at the Cracow, Balice and Miechów stations in November and December (2.4, 2.3 and 2.2°C, respectively). At the Libertów station the lowest variability was recorded in February, November and December (2.4°C), whereas February and November had the lowest variability (2.4°C) at the Gaik-Brzezowa station (Fig. 2).

The annual course of the day-to-day variability of the minimum temperature was the feature that differed most among the stations. Actually, it was the extent of these variations that differed among stations; the dates of occurrence of the lowest and highest variability were similar at all the stations. While the greatest differences between the stations were up to 0.4°C in the annual course of the mean day-to-day variability of daily and maximum temperatures, these differences were up to 0.7°C in the case of the minimum temperature.

The highest variability of the day-to-day variability of the minimum temperature was noted during winter months at all the stations. The highest values were recorded at:

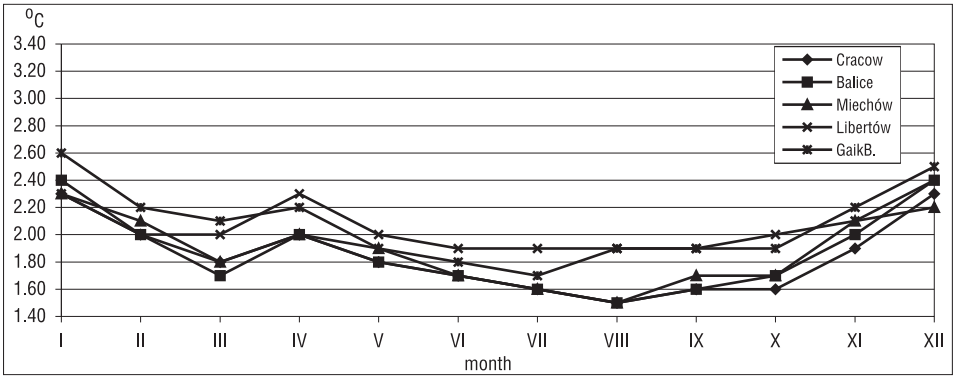

Fig. 1. The annual course of the average day-to-day variability of the daily mean temperature at the Cracow, Balice, Libertów, Miechów, Gaik-Brzezowa stations in the period 1986-1995

Ryc. 1. Przebieg roczny średniej zmienności z dnia na dzień temperatury średniej dobowej na stacjach: Kraków, Balice, Gaik-Brzezowa, Libertów i Miechów za okres 1986-1995.

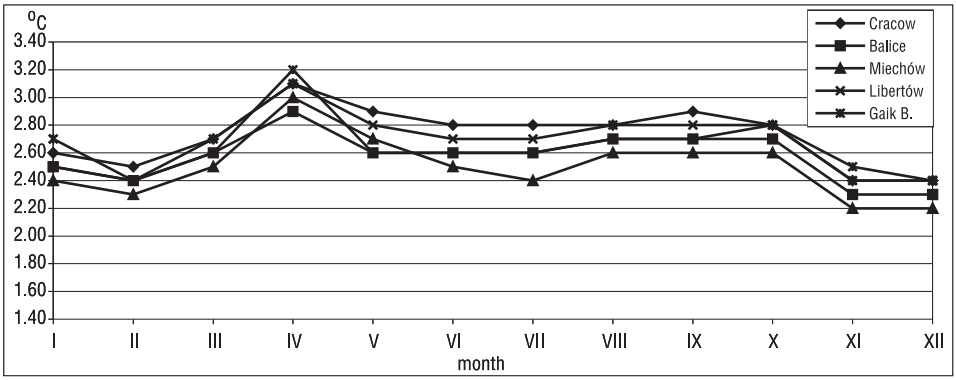

Fig. 2. The annual course of the average day-to-day variability of the maximum temperature at the Cracow, Balice, Libertów, Miechów, Gaik-Brzezowa stations in the period 1986-1995

Ryc. 2. Przebieg roczny średniej zmienności z dnia na dzień temperatury maksymalnej na stacjach: Kraków, Balice, Liberów,Miechów, Gaik-Brzezowa za okres 1986-1995

the Cracow and Balice stations (2.7 and 3.0°C respectively) in January and February, the Libertów station (2.5°C) in January and December, the Miechów and Gaik-Brzezowa stations in February (3.2 and 2.8°C, respectively). The lowest variability of minimum temperature was noted at all stations in July (Libertów 1.7°C, Cracow 1.9°C, Gaik-Brzezowa 1.9°C, Balice 2.2°C, Miechów 2.4°C; Fig. 3).

Tab. 1. Average monthly differences (°C) in the day-to-day variability of the mean daily temperature between the Cracow station and other stations in the period 1986-1995

Tab. 1. Średnie miesięczne różnice (°C) zmienności z dnia na dzień temperatury średniej dobowej między poszczególnymi stacjami a Krakowem za okres 1986-1995

Month	Balice	Miechów	Libertów	Gaik-B.
Jan	0.1	0.0	0.0	0.3
Feb	0.0	0.1	0.0	0.2
Mar	-0.1	0.0	0.2	0.3
Apr	0.0	0.0	0.3	0.2
May	0.0	0.1	0.2	0.1
Jun	0.0	0.0	0.2	0.1
Jul	0.0	0.0	0.3	0.1
Aug	0.0	0.0	0.4	0.4
Sep	0.0	0.1	0.3	0.3
Oct	0.1	0.1	0.4	0.3
Nov	0.1	0.2	0.2	0.3
Dec	0.1	-0.1	0.1	0.2

As expected, the mean daily temperature had the lowest average variability (on an annual scale). It varied from 1.8°C at the Cracow station to 2.1°C at the Libertów and Gaik-Brzezowa stations. The variability of minimum temperature was the greatest (except Balice and Miechów) and reached 2.7°C in Gaik-Brzezowa, Cracow and Libertów. The average annual variability of the minimum temperature was the same as average annual variability of the maximum temperature (2.6°C) at the Balice station. At the Miechów station, the minimum temperature had the greatest variability (2.7°C).

One can see clearly that the annual courses of air temperature variability do not differ significantly

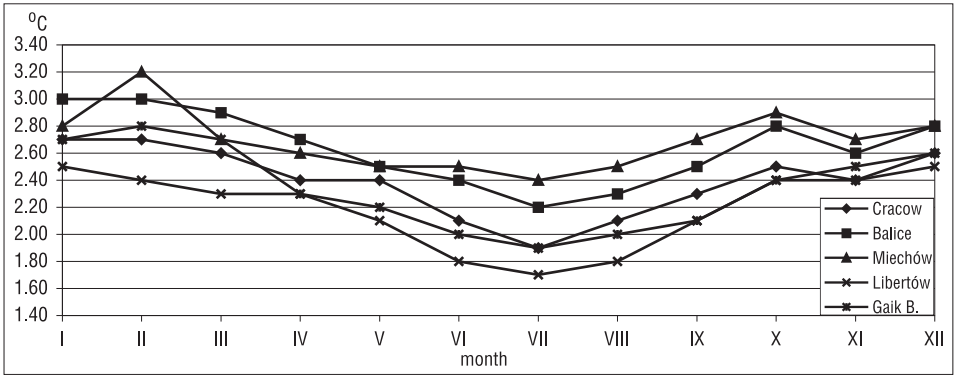

Fig. 3. The annual course of the average day-to-day variability of the minimum temperature at the Cracow, Balice, Libertów, Miechów, Gaik-Brzezowa stations in the period 1986-1995

Ryc. 3. Przebieg roczny średniej zmienności z dnia na dzień temperatury minimalnej na stacjach: Kraków, Balice, Liberów,Miechów, Gaik-Brzezowa za okres 1986-1995

among the stations. The dates of the greatest and lowest variability are almost identical at all stations. The only differences are in the specific values.

In this project, the Cracow Botanical Garden station located in the city centre was the only urban station. Therefore, the measurements of the day-to-day variability of air temperature done at this station were compared to corresponding measurements from the remaining stations, as a reference point.

As far as the mean daily temperature is concerned, the Gaik-Brzezowa and Libertów stations displayed much greater variability than the Cracow station. The differences between those stations and the Cracow station were more than 0.2°C during most of the year and reached the value of 0.4°C in some months (Tab. 1). The day-to-day variability of the mean daily temperature at the Balice and Miechów stations was the same as at the Cracow station during 6 months.

Quite opposite is true for the maximum temperature. Greater temperature variability was recorded at the Cracow station during the entire year. When compared to the other

Tab. 2. Average monthly differences (°C) in the day-to-day variability of the maximum temperature between the Cracow station and other stations in the period 1986-1995

Tab. 2. Średnie miesięczne różnice (°C) zmienności z dnia na dzień temperatury maksymalnej dobowej między poszczególnymi stacjami a Krakowem za okres 1986-1995

Month	Balice	Miechów	Libertów	Gaik-B.
Jan	-0.1	-0.2	-0.1	0.1
Feb	-0.1	-0.2	-0.1	-0.1
Mar	-0.1	-0.2	0.0	-0.1
Apr	-0.2	-0.1	0.0	0.1
May	-0.3	-0.2	-0.1	-0.3
Jun	-0.2	-0.3	-0.1	-0.2
Jul	-0.2	-0.4	-0.1	-0.2
Aug	-0.1	-0.2	0.0	-0.1
Sep	-0.2	-0.3	-0.1	-0.2
Oct	-0.1	-0.2	0.0	0.0
Nov	-0.1	-0.2	0.0	0.1
Dec	-0.1	-0.2	0.0	0.0

Tab. 3. Average monthly differences (°C) in the day-to-day variability of the minimum temperature between the Cracow station and other stations in the period 1986-1995

Tab. 3. Średnie miesięczne różnice (°C) zmienności z dnia na dzień temperatury minimalnej dobowej między poszczególnymi stacjami a Krakowem za okres 1986-1995

Month	Balice	Miechów	Libertów	Gaik-B.
Jan	0.3	0.1	-0.2	0.0
Feb	0.3	0.5	-0.3	0.1
Mar	0.3	0.1	-0.3	0.1
Apr	0.3	0.2	-0.1	-0.1
May	0.1	0.1	-0.3	-0.2
Jun	0.3	0.4	-0.3	-0.1
Jul	0.3	0.5	-0.2	0.0
Aug	0.2	0.4	-0.3	-0.1
Sep	0.2	0.4	-0.2	-0.2
Oct	0.3	0.4	-0.1	-0.1
Nov	0.2	0.3	0.0	0.1
Dec	0.2	0.2	-0.1	0.0

stations, this variability was on average greater by 0.1-0.2°C (Tab. 2).

In the case of the minimum temperature such an unambiguous situation was not observed. The Cracow station noted a lower variability than the Balice and Miechów stations (by 0.4-0.5°C). However, the variability was higher at the Krakow station than at the Libertów and Gaik-Brzezowa stations (by 0.2-0.3°C). Based on the above comparison of the annual courses of mean day-to-day variability of daily, maximum and minimum temperatures, one can conclude that urban build-up decreases slightly the variability of the mean daily temperature and increases the variability of the maximum temperature. In the case of the minimum temperature, such an unambiguous situation was not observed (Tab. 3).

3. Frequency of day-to-day temperature variability

Frequency of the day-to-day air temperature changes (of various magnitude and sign) differs only slightly among the stations. The lowest differentiation of both the increases and decreases was observed in the frequencies of mean daily and maximum temperatures. These differences in the frequency of day-to-day temperature changes among particular stations and in particular value ranges did not exceed 2.6% (Tab. 4).

The frequency of the minimum temperature changes is more differentiated. The differences in the frequency of decreases and increases (above 4.0°C) of the minimum temperature among different stations were up to 5%. The number of days with changes in minimum temperature above 8.0°C in the period 1986-1995 was: 43 in Cracow, 65 at Gaik-Brzezowa, 81 at Balice, 37 at Libertów and 84 in Miechów.

The percentage of air temperature increases and decreases during the year was very similar at all stations. Slightly more increases (49-51.3%) than decreases (47.3-48.6%) were noted at all stations (except the Balice station) in the records of the mean daily and maximum temperatures (Tab. 4). When the annual distribution of the months with a higher proportion of increases than decreases is considered, one should note that this tendency was recorded during 8 months (from February to September) in the mean daily temperature, and during 7 months (from March to September) in the maximum temperature. At the Balice station, the dominance of increases over decreases was observed for the mean daily temperature only. With respect to the maximum temperature,

Tab. 4. Frequency (%) of the day-to-day temperature changes at the Cracow, Balice, Libertów, Miechów, Gaik-Brzezowa stations in the period 1986-1995

Tab. 4. Częstość (%) zmian temperatury z dnia na dzień na stacjach Kraków, Balice, Libertów, Miechów, Gaik-Brzezowa w latach 1986-1995

Station	Decreases (^{0}C)					0.0	Increases (^{0}C)				
	Sum	> 8.0	8.0-4.1	4.0-2.1	2.0-0.1		0.1-2.0	2.1-4.0	4.1-8.0	>8.0	sum
Changes of mean daily temperature											
Cracow	47.1	0.4	4.5	12.8	29.4	2.4	33.0	13.7	3.7	0.1	50.5
Balice	46.8	0.4	5.0	12.7	28.7	1.9	33.2	14.4	3.8	0.2	51.3
Libertów	47.3	0.4	6.6	13.3	27.0	1.5	30.6	14.8	5.6	0.2	51.2
Miechów	47.5	0.4	5.2	12.4	29.5	2.0	32.9	13.1	4.2	0.3	50.5
Gaik-B.	47.4	0.5	6.2	13.6	27.1	1.8	30.9	14.2	5.4	0.3	50.8
Changes of maximum temperature											
Cracow	48.0	1.4	10.1	15.2	21.3	1.5	22.9	16.4	10.4	0.8	50.5
Balice	49.4	1.1	8.5	16.9	22.9	1.1	23.4	15.8	9.7	0.6	49.5
Libertów	47.5	1.3	9.6	16.0	20.6	3.5	22.6	15.2	10.4	0.8	49.0
Miechów	47.6	0.9	8.6	15.6	22.5	2.3	24.7	16.2	8.6	0.6	50.1
Gaik-B.	48.6	1.4	9.1	15.8	22.3	1.4	23.3	15.2	10.8	0.7	50.0
Changes of minimum temperature											
Cracow	50.6	0.3	8.9	15.3	26.1	2.0	24.3	13.6	8.7	0.8	47.4
Balice	50.6	0.8	10.7	14.1	25.0	1.6	22.6	14.1	9.6	1.5	47.8
Libertów	50.3	0.4	6.2	15.1	28.6	3.4	25.7	12.9	7.1	0.6	46.3
Miechów	51.1	0.7	10.2	15.4	24.8	1.9	22.2	13.0	10.2	1.6	47.0
Gaik-B.	51.2	0.6	7.3	16.0	27.3	1.7	25.0	12.9	8.0	1.2	47.1

the percentage of increases and decreases was almost the same at the Balice station (49.4 and 49.5, respectively).

For most of the year there were more decreases (50.3-51.2%) than increases (46.3-47.8%) at all the stations in the minimum temperature (Tab. 4). Although the percentage of increases and decreases in the day-to-day variability of minimum temperature was very similar at all stations, clear differences appear in their monthly distribution. Decreases dominate over increases for 9 months at the Miechów station, for 8 months at the Gaik-Brzezowa and Libertów stations, and for just 6 months at the Cracow station. At the Cracow station the percentage of decreases and increases was the same for 2 months, and there were more increases for 4 months. Therefore, it is apparent that the period dominated by decreases was lengthened (by as much as 3 months) in areas remote from the city centre and shortened in the city centre.

4. The day-to-day air temperature variability in the chosen months

Seven months characterised by specific temperature variability were analysed: 2 months with the greatest variability and 5 months with the lowest variability (Tab. 5 and 6).

Tab. 5. Mean values of day-to-day temperature variability (°C) in the months with the greatest variability in the period 1986-1995

Tab. 5. Wartości średnie zmienności temperatury z dnia na dzień (°C) w miesiącach o najwiekszej zmienności w okresie 1986-1995

Month	Variability	Station				
		Ceacow	Balice	Libertów	Miechów	Gaik-B.
April 1986	T mean	2.5	2.4	3.0	2.5	1.7
	T max	4.2	4.0	4.0	4.0	2.3
	T min	2.4	2.7	2.5	2.6	2.5
January 1987	T mean	4.0	4.7	4.0	4.8	4.6
	T max	3.6	3.8	3.8	3.7	4.3
	T min	4.5	5.5	4.2	5.0	5.0

Tab. 6. Mean values of day-to-day temperature variability (°C) in the months with the lowest variability in the period 1986-1995

Tab. 6. Wartości średnie zmienności temperatury z dnia na dzień (°C) w miesiącach o najmniejszej zmienności w okresie 1986-1995

Month	Variability	Station				
		Cracow	Balice	Libertów	Miechów	Gaik-B.
January 1988	T mean	1.5	1.5	1.8	1.4	2.0
	T max	2.1	1.9	1.8	1.7	2.4
	T min	1.6	1.6	2.1	1.8	1.9
September 1988	T mean	1.0	1.0	1.5	1.2	1.4
	T max	2.2	2.0	2.2	2.3	2.1
	T min	1.5	1.8	1.7	2.2	1.6
June 1992	T mean	1.4	1.3	1.6	1.4	1.4
	T max	2.4	2.2	2.2	2.1	2.2
	T min	1.2	1.5	1.2	1.5	1.4
July 1994	T mean	1.0	1.0	1.2	1.0	1.1
	T max	1.8	1.7	1.7	1.9	1.6
	T min	1.4	1.5	1.2	1.4	1.5
August 1994	T mean	1.1	1.3	1.6	1.3	1.4
	T max	2.8	2.4	2.6	2.5	2.4
	T min	1.8	2.2	1.2	2.6	1.5

The greatest variability of the mean daily and minimum temperatures was noted in January 1987 at all five stations. It was also the month with the greatest variability of the maximum temperature at the Gaik-Brzezowa station. At the Cracow, Miechów, Libertów and Balice stations, the greatest variability in maximum temperature was observed in April 1986 and January 1987 (Tab. 5). In January 1987, very low temperatures were observed. From 3 to *22* and from *27* to 31 January, the minimum temperature at all

stations changed from -12.0°C to -29.0°C. This was caused by the prevailing anticyclonic situations with air advection from the north and the north-east.

Anticyclonic situations conditions with the air advection from the west prevailed in April 1986; they were interrupted by anticyclonic situations with air advection from the north or the north-east. Therefore, the thermal and humidity features of the air masses were very different during this month.

Moreover, both January 1987 and April 1986 were characterised by very frequent changes in synoptic situations. There were more than 20 such changes during each of those months. The greatest changes in day-to-day air temperature were noted in the months and on the days with evident changes in the synoptic situation and in the direction of air masses advection (e.g. in January 1987 the change from the west cyclonic situation to east or north-east anticyclonic situation). Significant temperature changes were accompanied by simultaneous significant changes in cloud cover between consecutive days (5-6 degrees).

It should be noted that among the months with the greatest temperature variability, winter and spring months were dominant (winter and spring months are usually those with greatest weather variability). Very significant changes were not observed during the summer and autumn months.

The lowest day-to-day variability of air temperature was observed at all five stations mainly during the summer months (Tab. 6). January 1988 is the exception here; the lowest average variability of maximum air temperature (1.7°C) was noted at the Miechów station in this month (Tab. 6). During the months with the lowest day-to-day variability of air temperature slight variations (1-2 degrees) in cloud cover and 10-15 changes in synoptic situations were observed. During the months with the highest variability the synoptic situations changed at least 20 times a month. In the months with low variability a clear relationship was observed: there was one type of synoptic situation which prevailed and there was one direction of air advection which dominated (either eastern or western).

5. Results

In terms of the annual courses of the day-to-day variability of air temperature no significant differences among the stations were observed. However, a slight influence of the city that decreased the variability of the mean daily temperature was noted. Similarly a weak, yet noticeable, influence of the city on the changes of the maximum temperature was detected. The present analysis of the annual course of day-to-day variability in air temperature indicates that this variability is determined mostly by the of atmospheric circulation and thermal characteristics of the air masses. This is confirmed for the days and months during which the greatest temperature changes were observed (e.g. 5-7 January 1987 when there was a significant warming followed by a strong cooling). Changes in the minimum temperature on 5/6 and 6/7 January were as follows: +10.0 and -17.8°C at the Cracow station, +12.8 and -21.4°C at the Miechów station, +12.1 and -18.5°C at the Balice station, +7.3 and -17.7°C at the Libertów station, +7.8

and -17.3°C at the Gaik-Brzezowa station. During the months with the lowest day-to-day variability of air temperature some variations in cloud cover and around 10-15 changes in synoptic situations were observed. During the months with the greatest variability of temperature synoptic situations changed at least 20 times a month.

The present project revealed no significant influence of the city on the day-to-day variability of air temperature. At the same time, the outputs of this study do not suggest that such an influence is not present. Therefore, it is a good starting point for future research on the more detailed examination of the potential influence of urban built-up areas on the day-to-day variability of air temperature.

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Zmienność temperatury powietrza z dnia na dzień w Krakowie i jego okolicach

Streszczenie

Niniejszy artykuł jest próbą analizy rocznej zmienności temperatury powietrza z dnia na dzień w mieście i w terenie pozamiejskim. Głównym celem jest poznanie zróżnicowania tej zmienności w zależności od użytkowania terenu. Analizę oparto na danych z pięciu stacji meteorologicznych: Kraków (Ogród Botaniczny), Balice, Libertów, Miechów i Gaik-Brzezowa. Wykorzystano średnie dobowe (24 h) wartości temperatury powietrza, a także codzienne temperatury maksymalne i minimalne z okresu 1986-1995.

Średni roczny przebieg zmienności temperatury powietrza z dnia na dzień został przeanalizowany, a otrzymane rezultaty potwierdziły, że głównymi czynnikami, które decydują o warunkach zmienności temperatury są: cyrkulacja atmosferyczna i własności termiczne napływających mas powietrza. Warunki termiczne niektórych miesięcy także potwierdziły te stwierdzenia, np. w styczniu 1987 r. i w kwietniu 1986 r., oraz warunki termiczne niektórych dni, np. 5, 6 i 7 stycznia 1987 r. W tych miesiącach i dniach

zanotowano największe zmiany temperatury. W styczniu 1987 i w kwietniu 1986 sytuacja synoptyczna zmieniała się ponad 20 razy w miesiącu, a 5, 6 i 7 stycznia 1987 r. naprzemiennie pojawiły się bardzo znaczne ocieplenie i ochłodzenie.

Porównanie poszczególnych stacji wykazało, że nie ma między nimi znaczących różnic w przebiegu zmienności temperatury z dnia na dzień. Największe różnice wystąpiły w rocznym przebiegu średniej zmienności temperatury minimalnej. Różnice w temperaturze minimalnej między stacjami wynosiły średnio 0.7°C, zaś dla średniej dobowej i maksymalnej temperatury różnice nie przekraczały średnio 0.3°C.

Nie stwierdzono jednoznacznego wpływu obszarów zurbanizowanych na zmienność temperatury z dnia na dzień. Jednakże miasto wyraźnie wpływało na zmniejszenie amplitudy dobowej temperatury, zwłaszcza poprzez podnoszenie temperatury maksymalnej. Dalsze badania w oparciu o zmienność wewnątrzdobową pozwolą lepiej rozpoznać wpływ użytkowania terenu na zmienność temperatury powietrza, w poszczególnych porach roku.

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