CLIMATE OF POLAND 2024

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Climate is one of the key factors shaping the conditions for social and economic development, as well as the level of human safety. Climate change – already observable and measurable today – affects many aspects of our lives: from public health, food security, and water management to infrastructure and environmental protection. In the global context, 2024 was recorded as the warmest year in the history of instrumental measurements, with the average global temperature exceeding the pre-industrial level by more than 1.5°C for the first time on an annual basis. While the 1.5°C threshold defined in the Paris Agreement refers to a long-term average, exceeding it even for a single year is a significant warning signal.

Europe remains the fastest-warming continent in the world, with the rate of temperature increase approximately twice the global average. The year 2024 brought Europe record-high average temperatures and an exceptionally high number of days with extreme heat stress and so-called tropical nights. Extensive heatwaves occurred, including the longest on record in the southeastern part of the continent. There were also pronounced weather contrasts – warmer and drier conditions in Eastern Europe clearly differed from the cooler and wetter conditions in the West.

Europe experienced its most widespread floods since 2013. In September alone, as a result of several days of heavy rainfall associated with the deep and extensive Genoa low "Boris", river flows in Central and Eastern Europe reached at least twice the average annual peak values across thousands of kilometers of waterways.

These processes are also taking place in Poland. An analysis of long-term observations by IMGW-PIB (Institute of Meteorology and Water Management – National Research Institute) shows a clear and ongoing warming trend, continuing through 2024. Since 1951, the average annual air temperature in Poland has increased by over 2°C. The impacts of this climate change are evident in the increasing frequency and intensity of extreme events – heatwaves, droughts, and torrential rains, causing flash floods and localized flooding.

In response to these challenges, continuous climate monitoring and research are essential, along with forecasting future changes and, above all, developing and implementing adaptation strategies. For over a century, IMGW-PIB has been conducting systematic climate measurements and observations, informing the public and public administration about the state of the climate system and the risks associated with it.

We present to you the report "Climate of Poland 2024", the latest in a series of annual summaries of Poland's climate conditions against the backdrop of long-term trends (1991-2020) and in the context of global climate change. We hope that the data and analyses contained in this report will contribute to a better understanding of today's climate challenges and support actions for climate adaptation and mitigation in Poland.

Dr Bogdan Rosa, Deputy Director of IMGW-PIB for Science

The presentation was prepared based on the POLISH CLIMATE MONITORING BULLETIN developed by the team consisting of: prof. ZBIGNIEW USTRNUL, dr DAWID BIERNACIK, KAROLINA WALUS, ANNA CHILIŃSKA, KAMILA WASIELEWSKA, DIANA KOPACZKA-LEPA, KLAUDIA KUSEK.

Supplementary materials were prepared by the team: dr GRZEGORZ URBAN, dr JANUSZ FILIPIAK, MICHAŁ KITOWSKI, dr DAWID BIERNACIK, dr MICHAŁ MAROSZ, BEATA KOWALSKA. Comments: The team of the Department of Meteorology and Climatology.

POLISH CLIMATE MONITORING BULLETIN was created as part of the CLIMATE project and has been published since 2010. The multi-annual series data were used in the presentation: Warsaw (Halina Lorenc 2010), Poznań (Leszek Kolendowicz et al. 2019), Gdańsk (Mirosław Miętus 1996) and Wrocław (Krystyna and Tadeusz Bryś 2010) extended by Janusz Filipiak. The precipitation series from Krakow was developed and shared by prof. Robert Twardosz.

IMGW-PIB own study 2025.

Graphic design: Michał Seredin (IMGW-PIB).

CLIMATE OF POLAND IN 2024

The average area air temperature in 2024 in Poland was 10.9°C and was as much as 2.2 degrees higher than the annual multi-year average (climatological normal period 1991-2020). The year 2024 should be classified as an extremely warm year, taking into account the average for Poland. It was also the warmest year in the history of Polish instrumental measurements, with an average temperature as much as 0.7°C higher than the previous record year of 2019.

The warmest region was Podkarpacie, where the average area air temperature was 11.3°C and was 2.3 degrees higher than the norm for this region. The coldest region outside the mountainous areas was the Pobrzeże – there the average annual temperature was 10.7°C (1.8 degrees above the norm).

If we look at the Lake District and the Lowlands, taking into account their division into western and eastern parts (along the 19°E meridian), the strong differentiation of thermal conditions in the western and eastern parts of the two largest regions of Poland is clearly noticeable – the difference in average annual values was 0.8°C and 0.9°C, respectively (with higher temperature values in the western parts). The western part of the Lowlands Belt was the warmest part of the country in 2024 – the average annual air temperature there was as much as 11.8°C.

Last year, February, March, and September were particularly warm. The average area air temperature in February in Poland was 5.7°C and was as much as 5.8 degrees higher than the long-term average for this month (climatological normal period 1991-2020). In March, it was 6.7°C (3.6 degrees above normal), and in September, it was 16.9°C (3.2 degrees above normal). In turn, the coldest month was November with an average temperature of 3.8°C (0.2 degrees lower than the 1991-2020 multi-year norm for this month). It is worth noting that in all months except November, average temperatures exceeded the 1991-2020 norm.

The highest air temperature in 2024 (36.5°C) was recorded on July 10 in Wrocław (information applies only to synoptic stations), while the lowest – in Suwałki, where –23.8°C was recorded on January 17. The lowest air temperature at the ground, i.e. at a height of 5 cm, was also recorded on the same day in Suwałki (–29.3°C).

The highest anomalies in the average air temperature in the individual seasons were distinguished by winter 2023/2024 and spring 2024, with local temperatures higher than the multi-year average by even more than 3°C. In summer and autumn, positive temperature anomalies were also recorded, ranging from 0.6°C to over 2°C.

The strong upward trend in air temperature in Poland that has been occurring for a number of years continued in 2024. Only since 1951 has the annual temperature increase been estimated at 2.3°C. The trend coefficient value varies slightly across the country's climate regions. The strongest increase in air temperature occurs in the Lake District, Subcarpathians and the Carpathians, where it exceeds 2.4°C, and the weakest in the Sudetes – around 2.1°C.

Analysis of historical data on air temperature indicates that since 1851, air temperature in selected large Polish cities has increased by 1.63°C in Gdańsk to 2.47°C in Warsaw. It is worth noting that over the last 40 years, the rate of this increase in large urban agglomerations has increased significantly. In turn, the analysis of historical data on pluvial conditions shows small changes in precipitation totals since 1851: a small decrease was recorded in Gdańsk by 8.2 mm, while the largest increase occurred in Warsaw by 43.2 mm.

The area-averaged total precipitation in 2024 in Poland amounted to 607.8 mm, which was almost 99.4% of the norm determined on the basis of measurements from 1991-2020. According to Kaczorowska's classification, the past year should be classified as an average year.

In 2024, precipitation was characterized by strong spatial differentiation. Annual precipitation totals ranged from less than 500 mm to over 1000 mm. The highest values were recorded in the Tatra Mountains, on Śnieżka and in Bielsko-Biała. In relation to the multi-annual norm (1991-2020), precipitation in 2024 ranged between 72.9% of the norm in Białystok and 127.9% of the norm in Słubice. The highest daily precipitation totals occurred on August 18, 2024 in Jelenia Góra (153.4 mm), August 21, 2024 in Zamość (147.2 mm) and on September 14, 2024: in Bielsko-Biała (149.4 mm) and in Katowice (140.7 mm).

In most of Poland, precipitation totals in 2024 oscillated around the multi-annual norm. Values below the norm were recorded in the Tatra Mountains, Podkarpacie, Podlasie, and in Sulejów, Kozienice and Opole. At individual synoptic stations in Western Poland and Pomerania and the Coast, they were higher by over 10% (locally over 20%) than the 1991-2020 norm.

In 2024, during the vegetation period (from May to October), in most of the country, evaporation from the ground surface prevailed over precipitation. This was particularly visible in central and western Poland, where the climatic water balance values fell even below –400 mm. Mountainous areas were characterized by positive cumulative climatic water balance values, confirming the predominance of precipitation over evaporation in these regions.

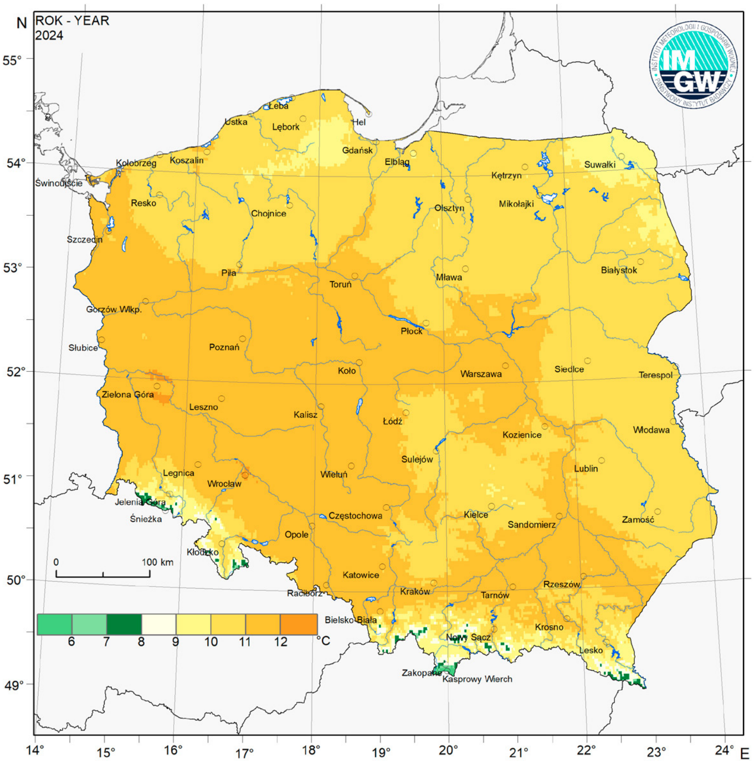
The number of hours of sunshine in 2024 ranged from 1722 hours on Śnieżka to 2254.5 hours in Sandomierz. The maximum daily value of actual sunshine (16.4 h) was recorded on June 26 in Ustka.

CONTENT

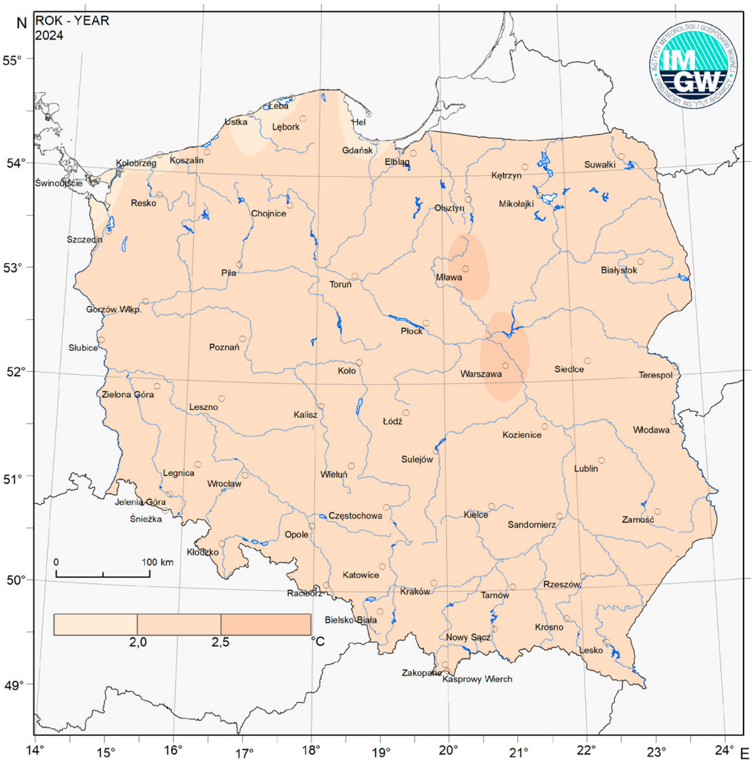
AIR TEMPERATURE

Spatial differentiation of air temperature is a consequence of the amount of solar radiation energy reaching Poland (partly described by sunshine duration), advection of warm air masses, and the influence of local factors. The average area air temperature in Poland in 2024 was 10.9°C and was as much as 2.2 degrees higher than the annual long-term average (climatological normal period 1991-2020). In 2024, the warmest areas of the country were its southwestern part and the area around Tarnów – the highest values of the average annual air temperature occurred at synoptic station in Wrocław (12.1°C) and at synoptic stations in Legnica, Opole, and Tarnów (11.8°C each). The coldest area throughout 2024 was the north-eastern regions of Poland (Suwałki and the surrounding area), as well as the higher parts of both mountain ranges. The lowest values of the average annual air temperature were recorded in Suwałki (9.6°C) and Zakopane (8.5°C). The average annual air temperature at high-mountain stations was 2.7°C at Kasprowy Wierch and 3.4°C at Śnieżka. The highest air temperature in 2024 (36.5°C) was recorded on July 10 in Wrocław (information applies only to synoptic stations), while the lowest – in Suwałki, where on January 17 the thermometer registered –23.8°C.

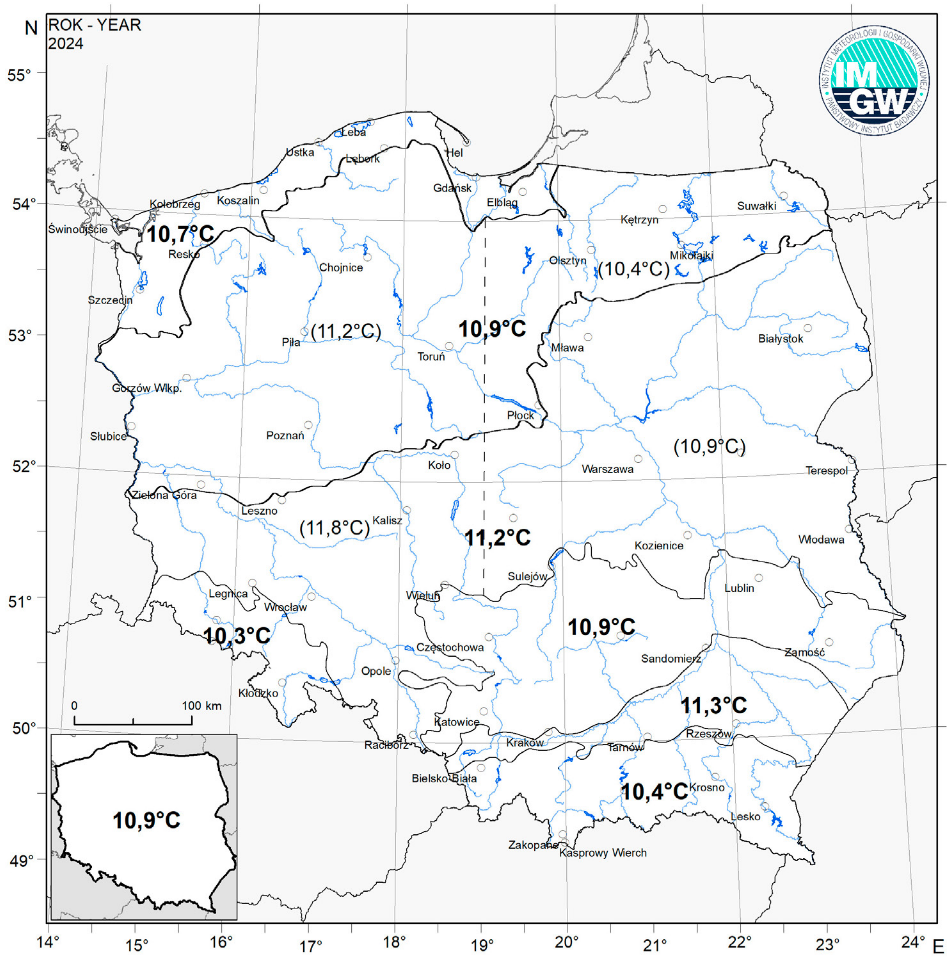
The spatial distribution of anomalies, i.e. deviations from the so-called climatological norm, i.e. the average annual temperature from the period 1991-2020, in 2024 shows that the anomaly values were positive throughout the country. They ranged from 1.8°C to 2.7°C. The highest deviations of the average annual air temperature from the norm were in the vicinity of Warsaw and Mława (2.7°C and 2.6°C, respectively), as well as on Kasprowy Wierch (2.6°C), slightly lower in other parts of the country.



Annual mean air temperature in 2024



Annual mean air temperature anomalies in 2024 in respect to 1991-2020 normal period



Mean annual regional air temperature in 2024

The average area air temperature value is an indicator that allows for a synthetic description of thermal conditions in a given area, and also for comparing them in different regions and relating them to values defining air temperature on a regional or global scale. For this purpose, equal temperature values are determined for the basic physiographic units of Poland. These are (from the north): the belt of the Coast and the Southern Baltic Coastlands, the belt of Lake Districts, the belt of Lowlands, the belt of Uplands, the Subcarpathians and the Carpathians, and the Sudety Mountains. Additionally, in order to reflect the influence of the Atlantic Ocean and the Asian continent, the belt of Lowlands and the belt of Lake Districts were divided into western and eastern parts along the meridian 19°E. Such division allows for showing any possible differentiation related to the thermal regionalization of Poland.

The average area air temperature in Poland in 2024 was 10.9°C and was as much as 2.2 degrees higher than the annual multi-year average (climatological normal period 1991-2020). Last year should be classified as an extremely warm year. It was the warmest year in the history of air temperature measurements in Poland. The warmest region was Podkarpacie, where the average area air temperature was 11.3°C and was 2.4 degrees higher than the norm for this area. The coldest region was the Pobrzeże – there, the average annual temperature was 10.7°C (1.8 degrees above the norm). If we look at the area of the Lake District and Lowlands, taking into account the division along the meridian 19°E, we can clearly see the strong thermal differentiation of thermal conditions in the western and eastern parts of the two largest regions of Poland – the difference in average annual values was 0.8 and 0.9°C, respectively.

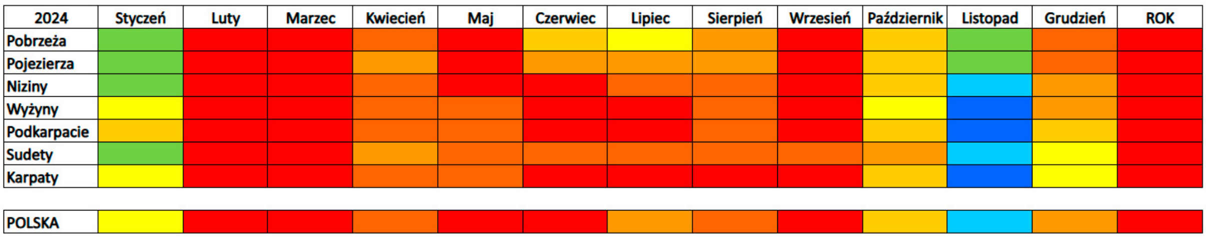
According to this division, in 2024 the warmest region of the country was the western part of the Lowlands Belt – the average annual air temperature there was as much as 11.8°C.

AIR TEMPERATURE
Thermal conditions classification

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	W	S	S	A	YEAR
2024	**–0.3**	5.7	6.7	10.5	16.0	18.4	**20.3**	20.2	16.9	10.1	3.8	2.5	2.5	11.1	19.6	10.3	10.9
Delta	0.9	5.8	3.6	1.9	2.7	1.6	1.5	1.7	3.2	1.3	-0.2	2.3	2.8	2.7	1.6	1.4	2.2

Air temperature is characterized by annual variability. The warmest month in 2024 was July – the average temperature was 20.3°C and was 1.5 degrees higher than the multi-year average temperature for that month. In turn, the coldest month was January – the average monthly temperature was –0.3°C and was 0.9 degrees higher than the climatological norm. November was particularly cool compared to the multi-year norm (the anomaly was –0.2°C). Particularly warm compared to the multi-year norm were February, March, and September, with anomalies exceeding +3.0°C. The highest anomaly was recorded in February (+5.8°C). As for the seasons, winter and spring stand out with clearly positive deviations.

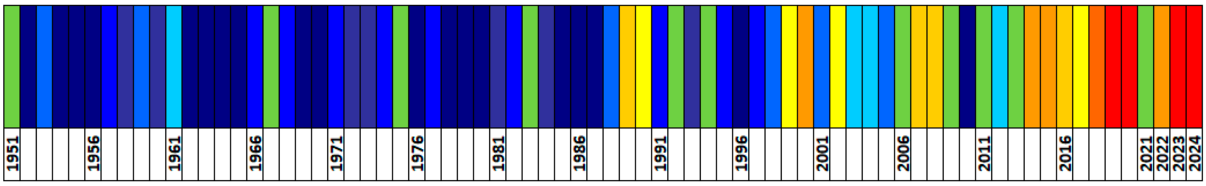
Descriptive classifications are often used to characterize thermal conditions, specifying the extent to which thermal conditions of a given month, climate season, or year differ from typical conditions. One such classification is based on the empirical distribution of average temperature values for individual months, seasons, or years in the normal period 1991-2020, which allows for determining threshold values of given classes based on a specified probability. Individual classes are given descriptive names, as presented below.



kwantyle (%)	charakter termiczny miesiąca	kwantyle (%)	charakter termiczny miesiąca
> 0,95	ekstremalnie ciepły	0,30-0,40	lekko chłodny
0,90-0,95	anomalnie ciepły	0,20-0,30	chłodny
0,80-0,90	bardzo ciepły	0,10-0,20	bardzo chłodny
0,70-0,80	ciepły	0,05-0,10	anomalnie chłodny
0,60-0,70	lekko ciepły	< 0,05	ekstremalnie chłodny
0,40-0,60	normalny		

Based on the classification constructed in this way, thermal conditions in 2024 in all climatic regions were classified as: extremely warm in February and March, anomalously and extremely warm in May and September, very warm, warm and slightly warm in the remaining months, with the exception of January, which was classified as a normal month in thermal terms in some regions, and November, which was classified as a slightly cool month in thermal terms. In these two months, a slightly greater spatial differentiation of thermal classes is noted. On an annual basis, thermal conditions in all regions were classified as extremely warm.

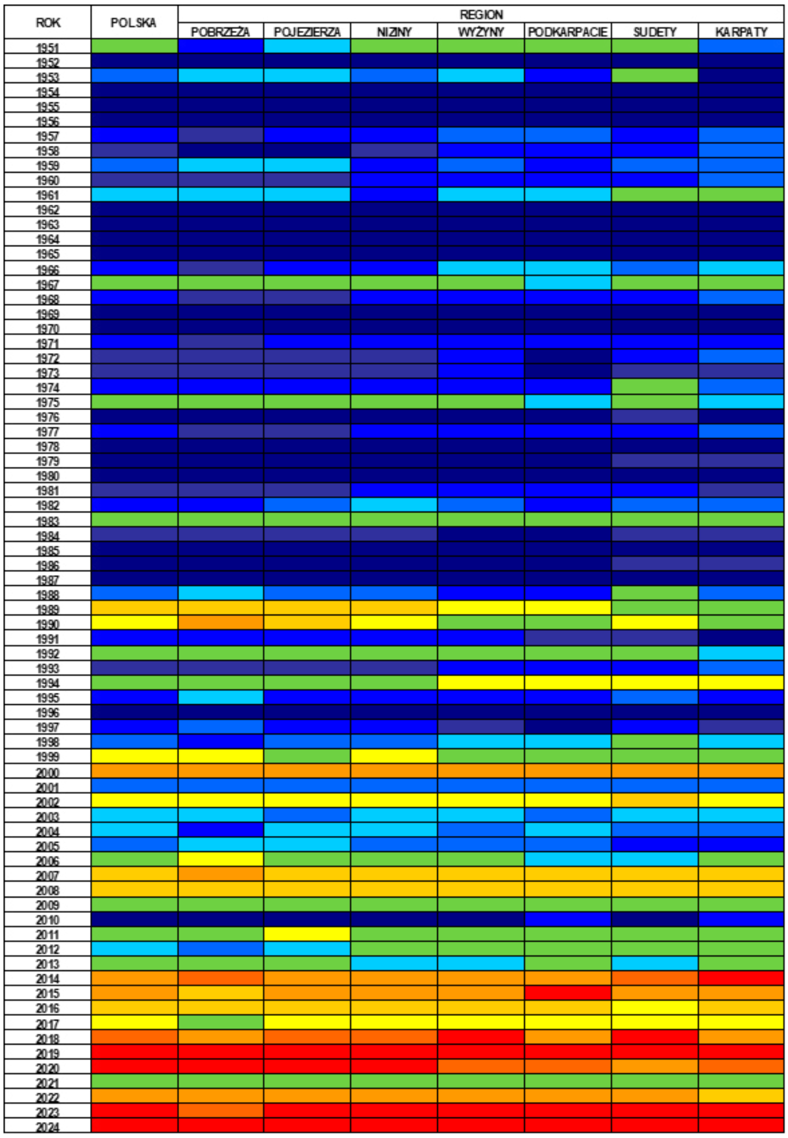
The use of descriptive classification of thermal conditions enables a detailed analysis of air temperature changes in Poland over the years, starting from the second half of the 20th century. This analysis clearly indicates that until the mid-1980s, thermal conditions classified as cool or cold prevailed. Since the second half of the 1980s, however, an increasing frequency of conditions described as normal or warmer than normal has been observed.



A particularly visible warming has been recorded in recent decades. Over the last 10 years (2015-2024), only 2021 has been classified as thermally normal. The remaining years were characterized by a positive deviation from the norm: 2017 was classified as slightly warm, 2016 as warm, 2015 and 2022 as very warm, while 2019, 2020, 2023, and 2024 were classified as extremely warm.

Two exceptions stand out clearly against the background of the warm period: 1996 (average annual temperature 6.6°C) and 2010 (7.5°C) – classified as extremely cold. In the case of 1996, the decisive influence on the low average temperature was the exceptionally cold winter months, both January and February, as well as December. In turn, 2010 was also characterized by low temperatures in January, February, and December, but in July the average monthly temperature reached 20.8°C, which is why it was classified as very warm.

Temperatures are rising! Thermal conditions in physiographic regions vary from year to year. These differences are not significant, but there are some differences in the analyzed periods. There were years when thermal conditions in the regions varied significantly (e.g. 1953, 1966, 1990, 1997). The warming process is clearly visible. As we move along the time axis, cool colors are replaced by warm ones. This color change reflects the climate warming process taking place in all regions. The year 2024 was again extremely warm. It was the warmest year in the history of air temperature measurements in Poland. All regions were characterized by uniform thermal conditions classified as extremely warm.



AIR TEMPERATURE

Thermal conditions variability, 1951-2024

Decade	Average air temperature (°C)		Normal period
1951-1960	7.61		
1961-1970	7.43		
1971-1980	7.61	7.55	1951-1980
1981-1990	7.97	7.67	1961-1990
1991-2000	8.27	7.95	1971-2000
2001-2010	8.59	8.28	1981-2010
2011-2020	9.33	8.73	1991-2020
2015-2024	**9.70**	**8.93**	**1995-2024**

The average air temperature values in the individual decades of the period 1951-2020 range between 7.4°C (more precisely 7.43°C in the decade 1961-1970) and 9.3°C (more precisely 9.33°C in the last decade 2011-2020). The data in the table illustrate the progressive increase in air temperature from decade to decade. The situation is similar when analyzed from the point of view of average values for 30-year periods (so-called normal climatological periods). In this case, the increase is clear, from 7.55°C in the period 1951-1980 to 8.73°C for the last 30-year period, i.e. 1991-2020. This means an increase in terms of 30-year standards by 1.2°C. Note that for the atypical 30-year period in the climatological description, 1995-2024, the long-term average air temperature in Poland is 8.93°C. This is the warmest 30-year period since 1951!

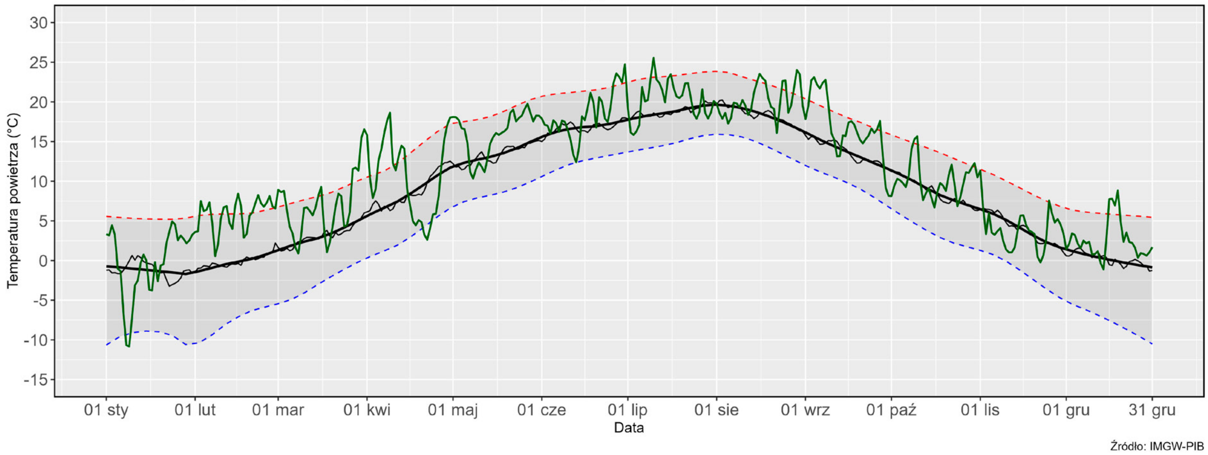
YEAR	Air Temperature (°C)				
	Winter	Spring	Summer	Autumn	YEAR
2000	0.8	9.9	**16.9**	10.2	9.5
2001	0.5	7.9	17.6	8.7	8.3
2002	0.2	9.7	19.0	8.3	9.1
2003	**−3.8**	8.2	18.6	8.3	8.3
2004	−0.9	7.9	17.1	9.1	8.3
2005	−0.1	7.3	17.2	9.3	8.3
2006	−3.2	7.0	18.7	**11.0**	8.7
2007	2.7	**10.0**	18.3	**7.6**	9.4
2008	1.7	8.4	18.0	9.1	9.4
2009	−0.7	8.8	17.5	9.3	8.5
2010	−3.2	7.9	18.7	8.0	**7.5**
2011	−3.0	8.9	17.9	9.0	8.9
2012	−1.2	9.3	18.0	9.4	8.5
2013	−1.8	**6.8**	18.3	9.2	8.5
2014	1.3	9.8	17.9	10.0	9.6
2015	1.1	8.5	18.9	9.3	9.7
2016	1.8	9.0	18.2	8.9	9.2
2017	−0.9	8.8	18.2	9.4	9.0
2018	0.1	9.8	19.5	10.2	9.8
2019	1.0	9.2	**19.9**	10.4	**10.2**
2020	**3.1**	8.1	18.6	10.4	9.9
2021	−0.2	7.1	19.1	9.5	8.7
2022	1.2	7.8	19.3	9.3	9.5
2023	1.6	8.3	18.8	10.9	10.0
2024	**2.5**	**11.1**	**19.6**	**10.3**	**10.9**

As mentioned earlier, the last 24 years have been the warmest period since the mid-20th century. During this period, the warmest winter occurred in the December 2019 – February 2020 season (seasonal temperature 3.1°C), the warmest spring (March-May) occurred in 2024 (11.1°C), the warmest summer (June-August) in 2019 (19.9°C), and the warmest autumn (September-November) in 2006 (11.0°C). In relation to the year, of course, the warmest was in 2024 (10.9°C). 2024 was 0.7°C warmer than the warmest year so far (2019), with an anomaly of +2.2°C compared to the long-term average (1991-2020).

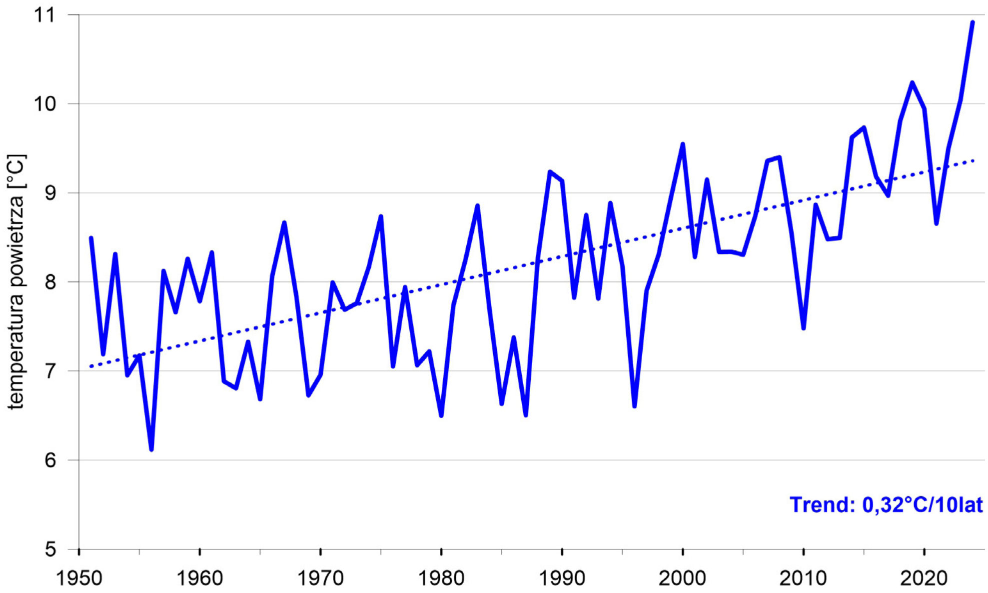
YEAR	Air Temperature (°C)		
	year	Anomaly relative to 1981-2010	Anomaly relative to 1991-2020
2024	**10.9**	**2.6**	**2.2**
2019	10.2	1.9	1.5
2023	10.0	1.8	1.3
2020	9.9	1.6	1.2
2018	9.8	1.5	1.1
2015	9.7	1.4	1.0
2014	9.6	1.3	0.9
2022	9.5	1.2	0.8
2008	9.4	1.1	0.7
2007	9.4	1.1	0.7
2016	9.2	0.9	0.5
2002	9.1	0.8	0.4
2017	9.0	0.7	0.3
2011	8.9	0.6	0.2
2006	8.7	0.4	0.0
2021	8.7	0.4	0.0
2009	8.5	0.2	–0.2
2013	8.5	0.2	–0.2
2012	8.5	0.2	–0.2
2004	8.3	0.0	–0.4
2003	8.3	0.0	–0.4
2005	8.3	0.0	–0.4
2001	8.3	0.0	–0.4
2010	7.5	–0.8	–1.2

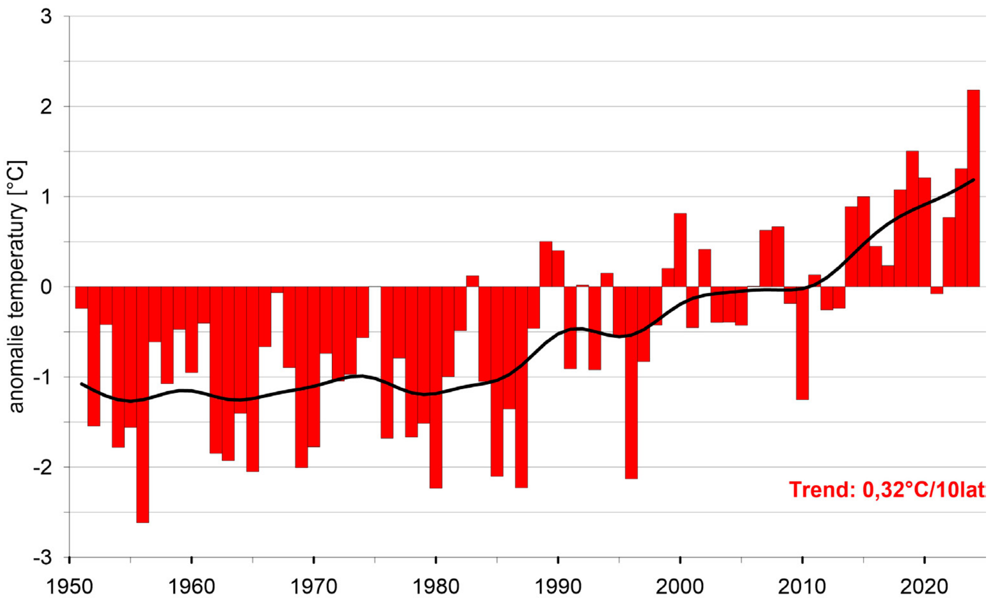
In the last 24 years (since 2001), only in 2010 was the average annual air temperature lower than the multi-year average for the period 1981-2010. The anomaly was –0.8°C and was a consequence of the extremely cold beginning of the year (January-February) and a cold December. However, if we look at this issue from the perspective of the new climatological norms for the period 1991-2020, there will be more years in which the average annual temperature was lower than normal, 8 to be exact. This is due to the fact that the last 30-year period, 1991-2020, was the warmest since the mid-20th century.

Course of spatial average air temperature in Poland in 2024 versus its multiannual characteristics (1991 2020) Lines: green – daily average, black – multiannual average, red dashed – 95% quantile, blue dashed – 5% quantile. Quantiles and multiannual average smoothed with local regression.

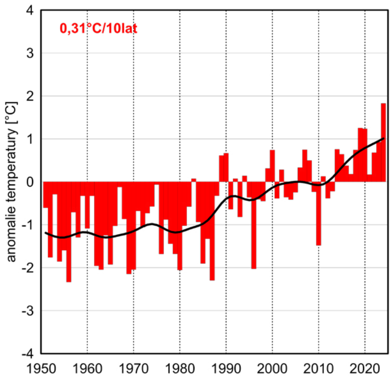


The first quarter of 2024, in terms of the course of the average daily air temperature, was characterized (with the exception of January) by values significantly exceeding the average values. It was a relatively warm period, in which values often exceeded the 95% quantile barrier, and only in January and March were short episodes of drops below the 5% quantile visible. Both February and March were months with the highest recorded air temperature value. The anomalies amounted to +5.8°C (January) and +3.6°C (February), respectively. The second quarter of 2024 begins the warm period with significant exceedances of the 95% quantile, then the average daily temperature gradually drops, and at the beginning of the third decade of April, it falls below the 5% quantile level and then rises again rapidly above the 95% quantile. The following months are characterized by high variability of thermal conditions with a predominance of values above the average from the multi-year period 1991-2020, and episodic exceedances of the 95% quantile value. The beginning of the third quarter of the average temperature pattern is characterized by a downward trend from anomalously high values to values oscillating around the average. The end of the boreal summer and the beginning of autumn is a largely anomalously warm period. The last quarter of the year, i.e. the autumn-winter period, is characterized by significant fluctuations in the value of the average daily air temperature, and it is worth mentioning that September was the second warmest September in the last 74 years (since 1951). Warm periods were interspersed with temperature drops. During this period, the air temperature does not fall below the 5% quantile. It is worth mentioning that November 2024 was the only month with an average air temperature value below the multi-year average (the anomaly compared to the multi-year period 1991-2020 was –0.2°C). In mid-December, there was a several-day period of exceeding the 95% quantile value with an average temperature value exceeding 5°C.

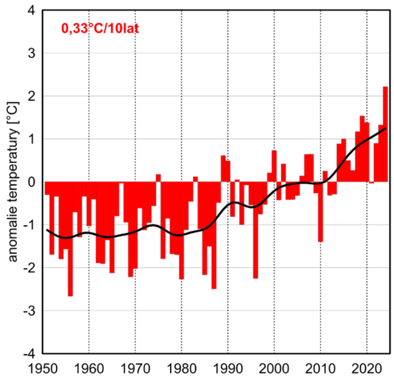




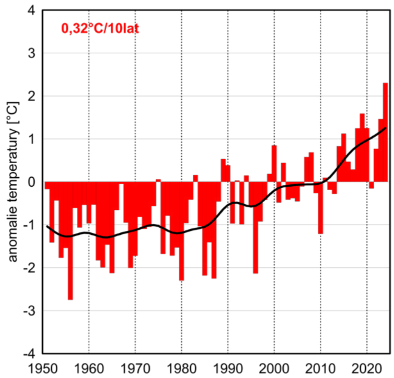
The increase in the average air temperature on an annual scale in the period 1951-2024 is characterized by a positive, statistically significant trend at the level of 1 – a = 0.95, amounting to 0.32°C/10 years. This corresponds to an increase in temperature in the given period since 1951 by as much as 2.4°C. Often, to illustrate temperature variability, instead of a series of absolute values, series in the form of deviations from the climatological norm, i.e. the average value for the last normal period, are presented. Such a series consists of positive values when a given year was warmer than the norm and negative values when it was colder. Using a series of anomalies (deviations) from the norm in the presentation allows for quick visual identification of colder or warmer periods. In addition to the anomaly series, the graph shows a curve illustrating the course of the anomaly series after smoothing it with a Gaussian filter with a 10-year window, i.e. after filtering out short-term temperature fluctuations.



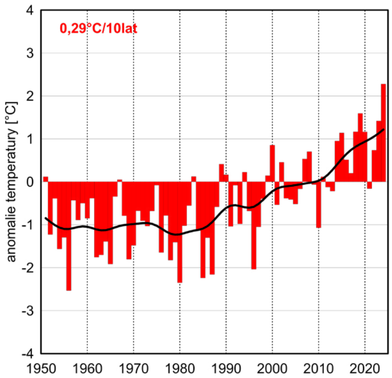
REGION 1 – COASTS



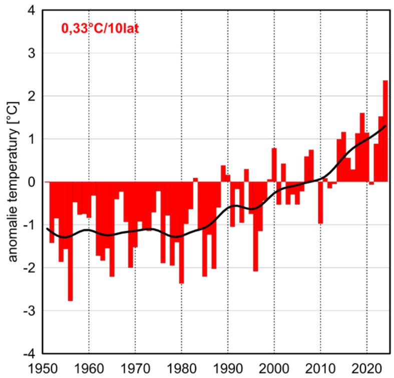
REGION 2 – LAKE DISTRICTS



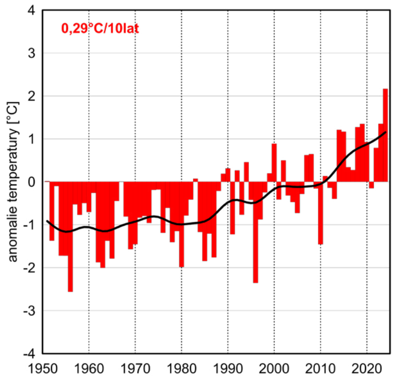
REGION 3 – LOWLANDS



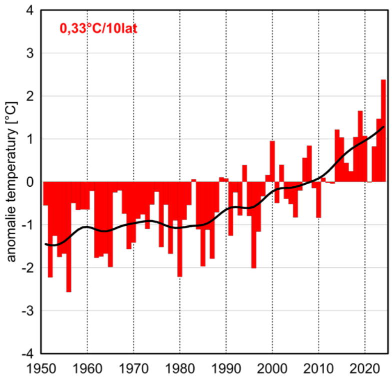
REGION 4 – UPLANDS



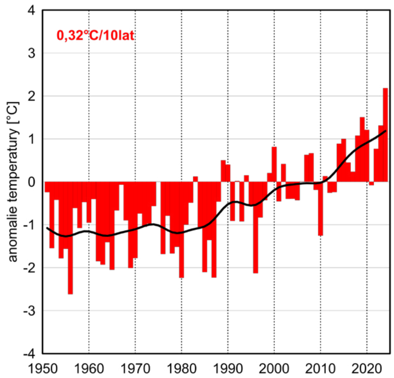
REGION 5 – SUBCARPATHIANS



REGION 6 – SUDETY MOUNTAINS



REGION 7 – CARPATHIANS

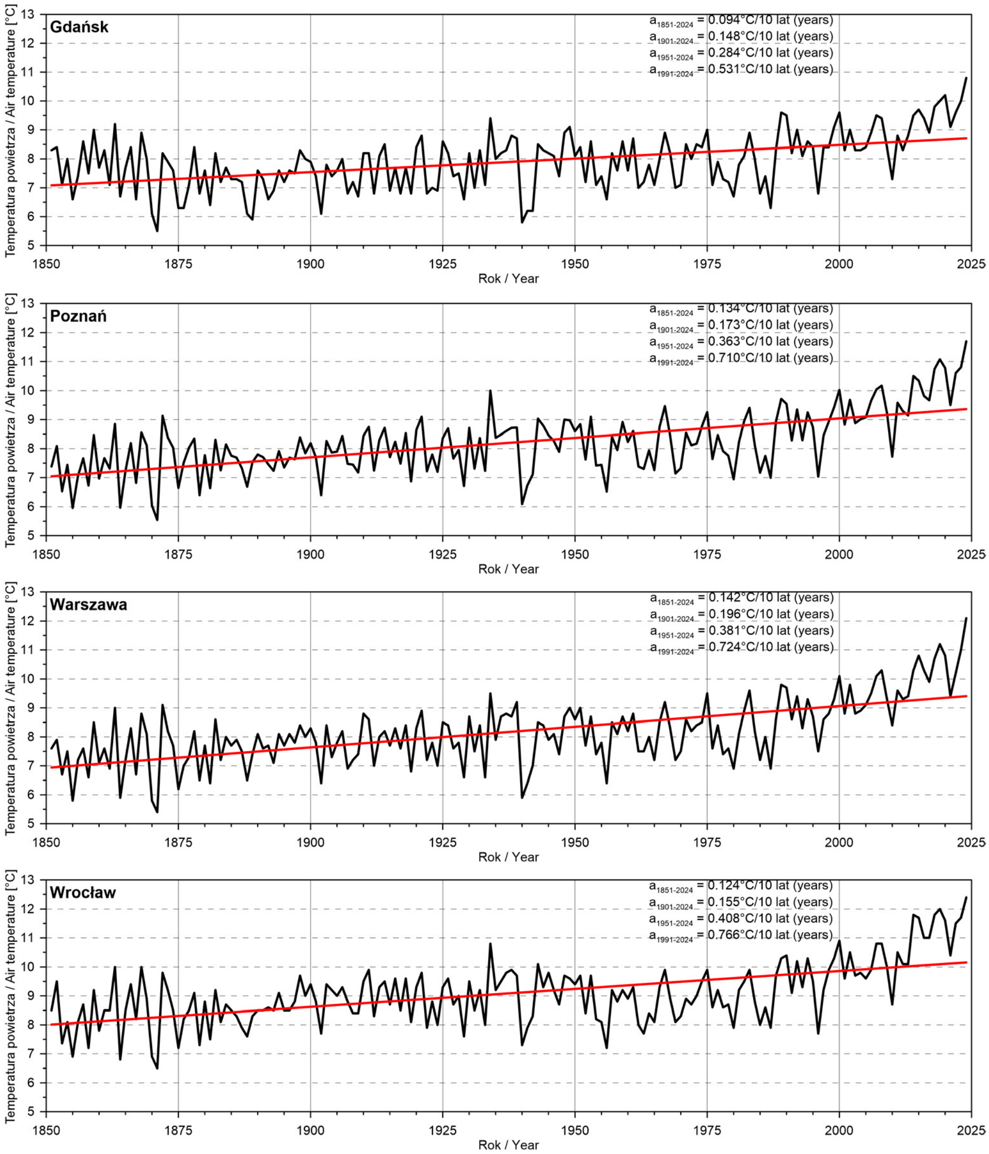


POLAND

Mean annual regional air temperature anomalies in respect to 1991-2020 normal period and the values of linear trend (°C/10 years). Smoothed by 10-years Gaussian filter (black line)

AIR TEMPERATURE

Thermal conditions variability, 1851-2024



Regular, uninterrupted instrumental temperature measurements began in Poland in the 18th century (Gdańsk – 1739, Warsaw – 1779, Wrocław – 1791, Kraków – 1792). Due to the fact that the Intergovernmental Panel on Climate Change (IPCC) systematically publishes analyses of temperature variability for global and regional series since 1851, we also present temperature variability in the indicated cities in the period 1851-2024. Each series clearly indicates an increase in air temperature, although the pace of these changes varies.

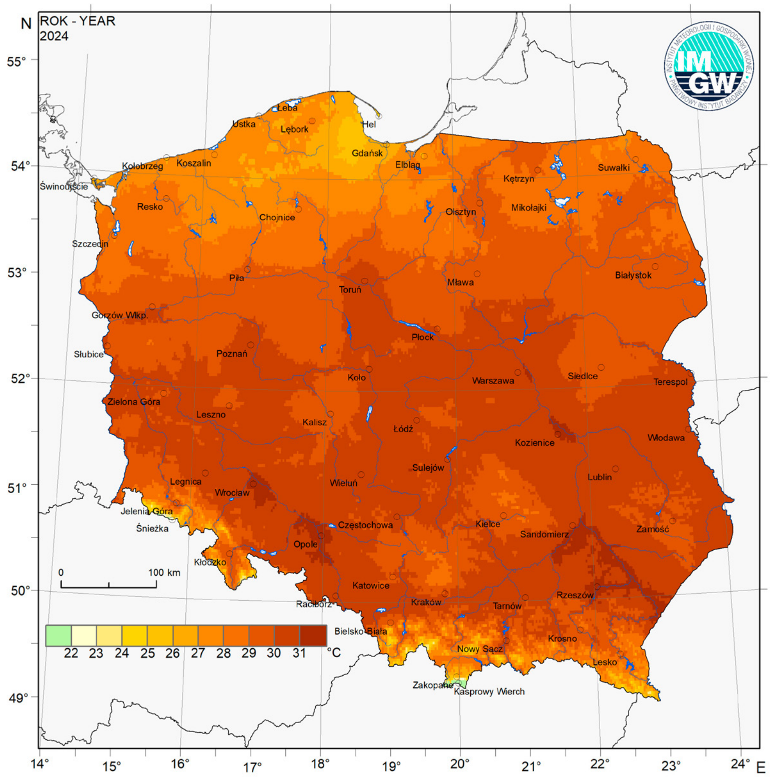
The slowest (over a scale of 174 years) the temperature increases in Gdańsk (1.63°C), and the fastest in Warsaw (2.47°C). The systematic increase in the rate of warming should be considered very significant. Each time the measurement period is shortened, the trend coefficients calculated for increasingly contemporary periods are higher – in the case of 1901-2024 they are higher than those for the period 1851-2024, while those calculated for the period from 1951 are even higher. The values of the trend coefficients increased rapidly after 1990, and in each of the cities analyzed, the rate of air temperature increase was several times higher than for the entire analyzed period. The fastest (0.77°C/decade) was recorded in Wrocław, while the slowest in Gdańsk (0.53°C/decade).

AIR TEMPERATURE

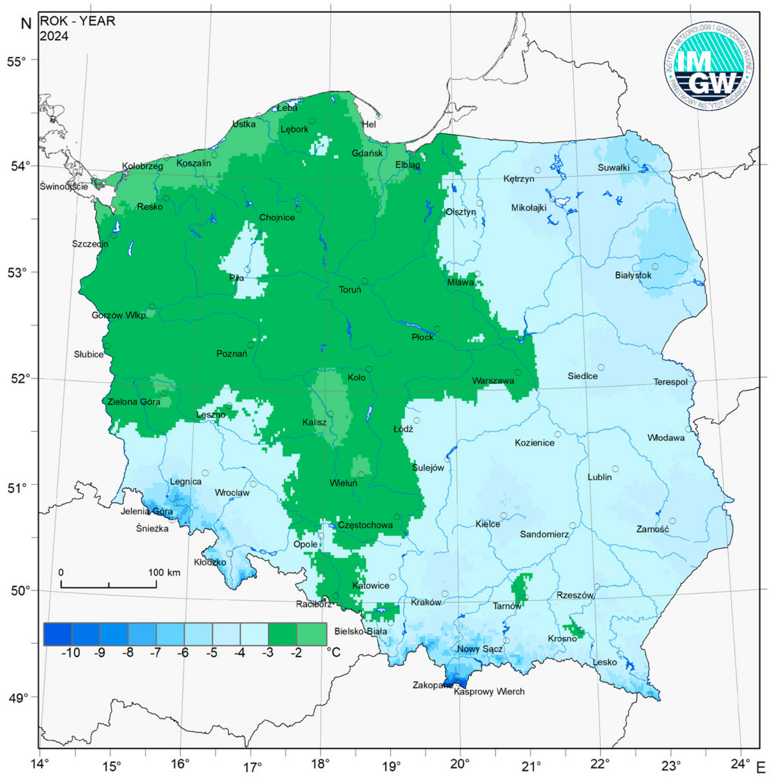
Extreme temperatures – quantiles

The spatial distribution of the 95% quantile of maximum temperature identifies areas where the occurrence of a temperature with a value higher than that shown on the map is equal to at most 0.05. There is a clear general gradient directed from southern Poland (the warmest areas) to the north (the coldest areas). The highest values were recorded near Wrocław, Opole, and in the Vistula River valley, while mountain areas (Sudety Mts. and the Carpathians) were lower. Cool water masses of the southern Baltic Sea clearly affect the decrease in the highest temperature values in late spring and summer.

In turn, the spatial distribution of the 5% quantile (95% probability of exceedance) of the minimum temperature presented a completely different picture. The lowest values of this characteristic occurred (apart from mountainous areas) in north-eastern Poland, and the highest along the coast, in the Lubuskie, Wielkopolskie, and Łódzkie voivodeships. The values of the 5% quantile of the minimum temperature range between –10.9°C and –0.7°C.



Daily maximum air temperature in 2024 with an occurrence probability of 5%



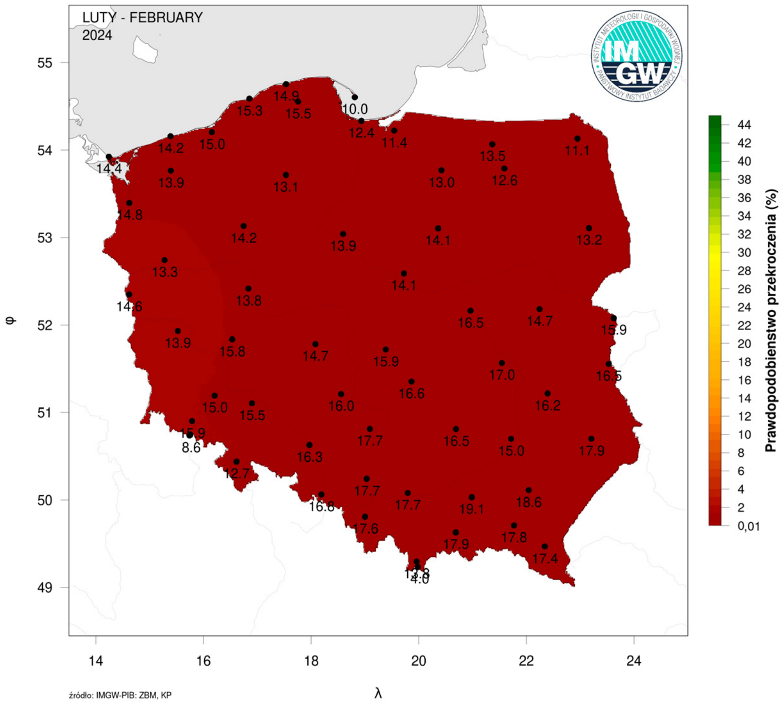
Daily minimum air temperature in 2024 with an occurrence probability of 5%

AIR TEMPERATURE

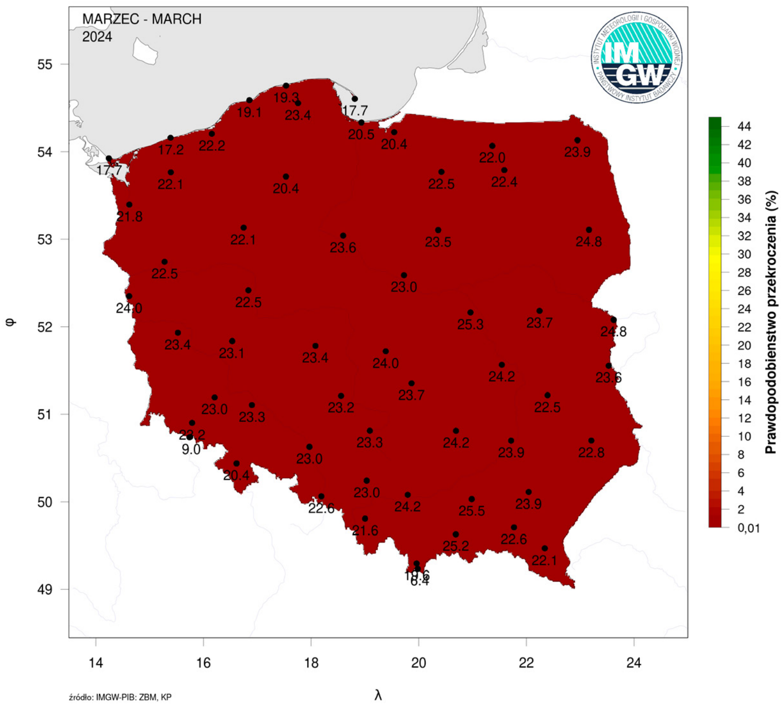
Extreme temperatures – thermal hazards risk

Thermal risk is a threat to human health or life resulting from the impact of extreme temperatures in the work or living environment, including rapid temperature changes. This phenomenon also has serious consequences for the natural environment, infrastructure, especially road, municipal, and energy infrastructure, as well as for the agricultural sector. Below is an assessment of the risk (probability) of a higher maximum daily air temperature than that recorded in a given month of 2024.

Last year, February stood out in particular, with the highest temperature anomaly in relation to the long-term norm (1991-2020), amounting to as much as +5.8°C. It was the warmest February since the beginning of systematic instrumental measurements in Poland, i.e. at least since 1951. The average area air temperature in February 2024 was 5.7°C. March 2024 was also the warmest month in the history of measurements, with an average area temperature of 6.7°C, which is 3.6°C higher than the 1991-2020 norm.



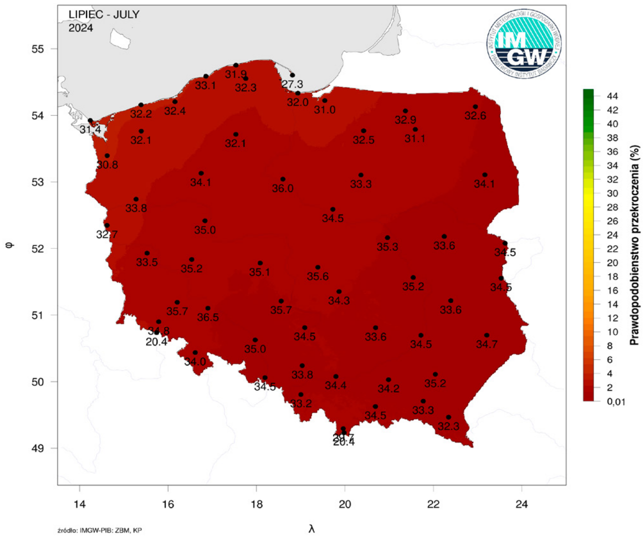
Thermal hazard risk – February 2024



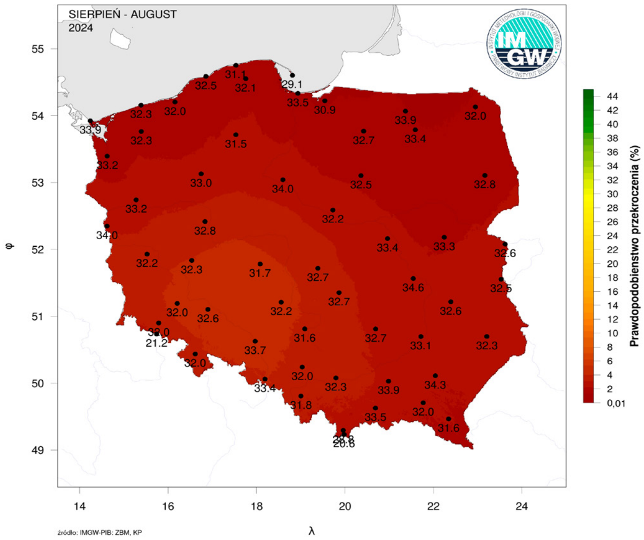
Thermal hazard risk – March 2024

July was the warmest month of 2024, reaching an average temperature of 20.3°C – 1.5°C above the long-term norm for that month. August was almost as warm, with an average area temperature of 20.2°C, which is a deviation of 1.7°C from the norm. September 2024 was one of the extremely warm months – the average temperature was 16.9°C, which is an anomaly of +3.2°C compared to the 1991-2020 norm and only 0.8°C lower than the record-breaking September 2023.

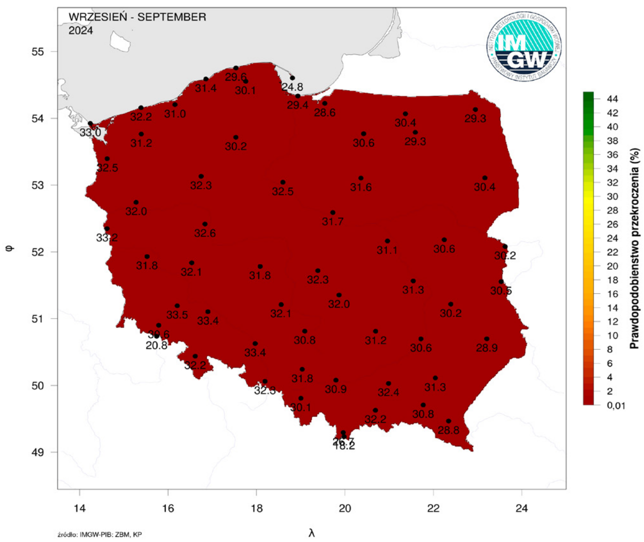
Probabilistic analysis clearly indicates the exceptional nature of all the months mentioned. The probability of exceeding the recorded maximum values was very low, and in February, March, and September, it did not exceed 2% in most of the country.



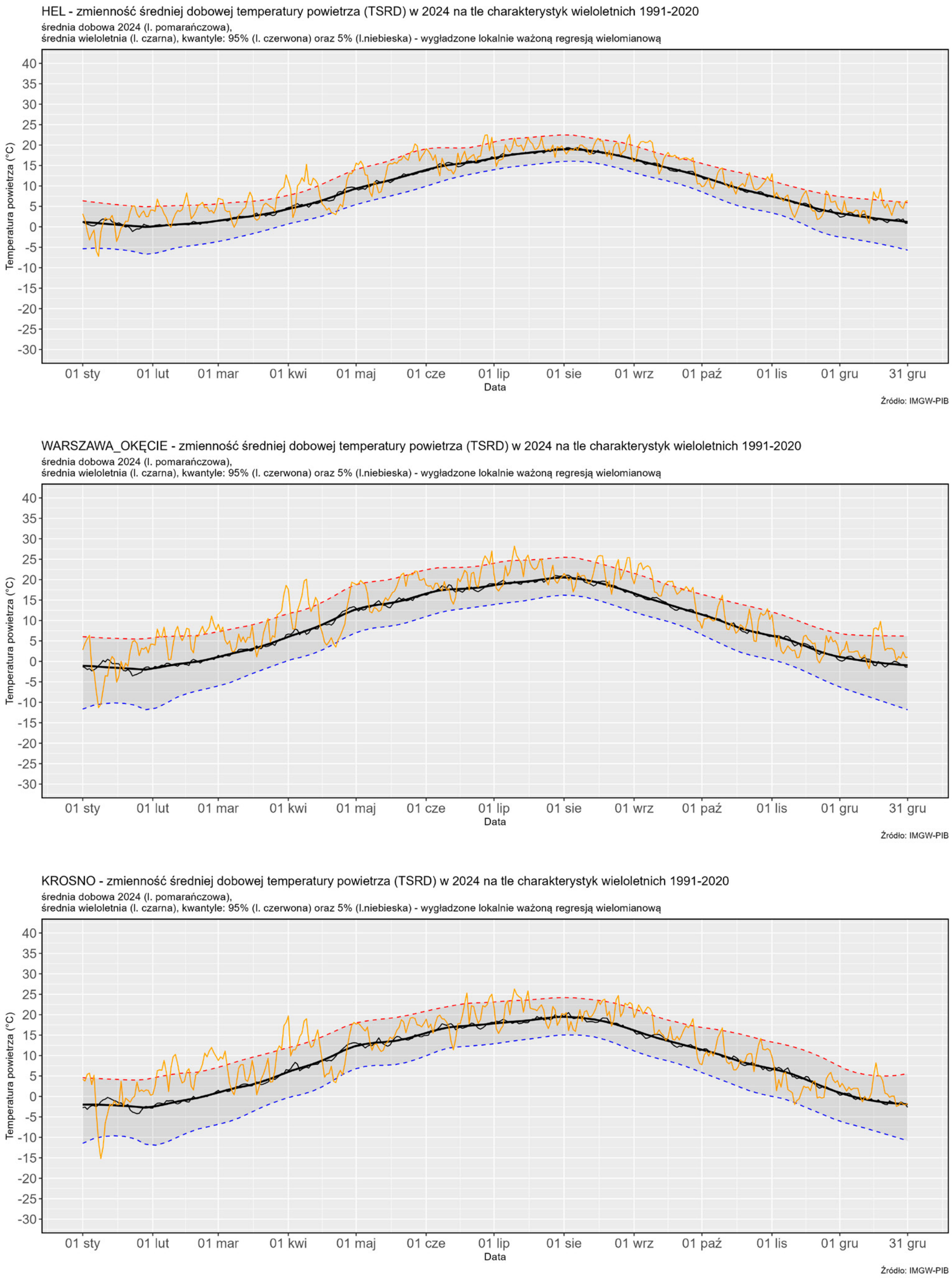
Thermal hazard risk – July 2024



Thermal hazard risk – August 2024



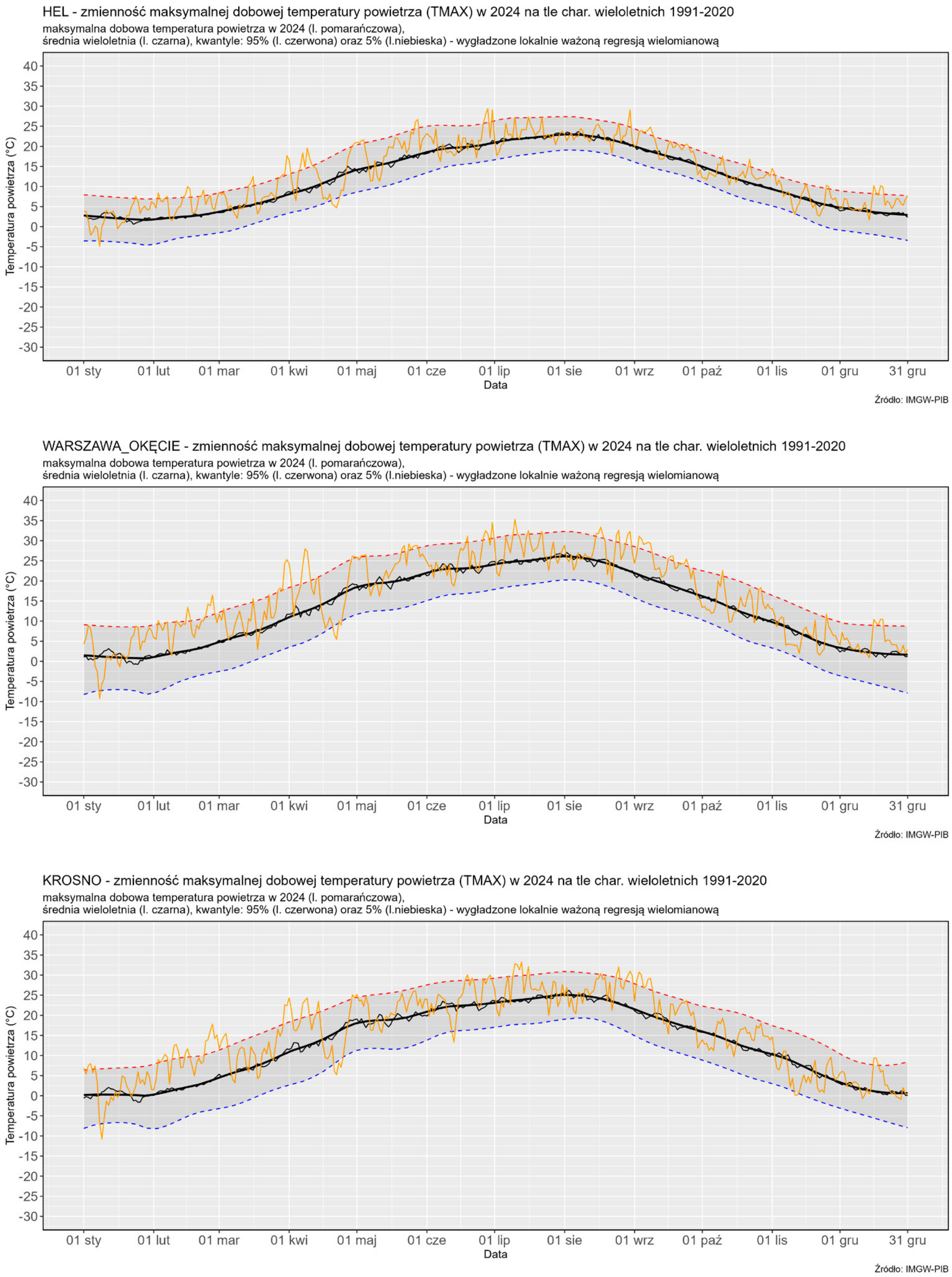
Thermal hazard risk – September 2024



Variability of average air temperature against the background of multi-annual characteristics 1991-2020 in northern, central, and southern Poland on the example of selected synoptic stations

ANNUAL VARIABILITY OF THE MEAN DAILY AIR TEMPERATURE

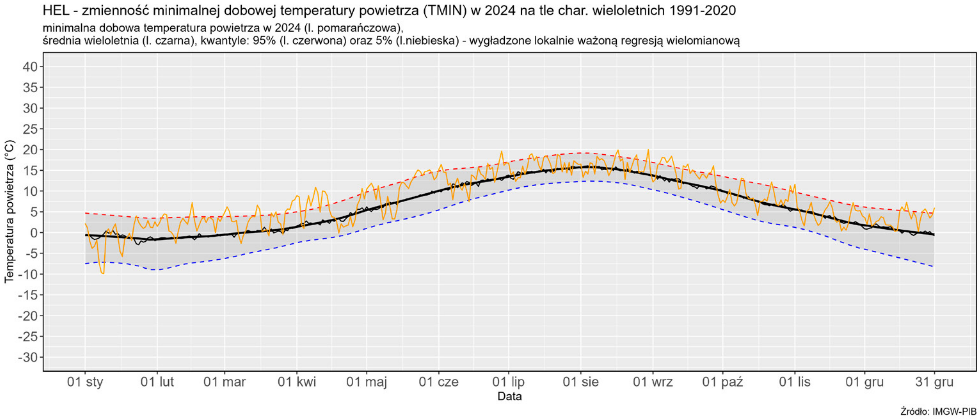
The intra-annual variability of the mean daily air temperature at selected stations shows a picture very similar to that presented in the graph showing the variability of the mean daily value of the area temperature. In the case of the daily variability of the mean area temperature, a general seasonal pattern is noticeable, with the highest values in the summer months and the lowest in the winter months. Episodes and cold waves in January and mid-April (values below the 5% quantile of air temperature) and heat waves (values above the 95% quantile of this element) in July and September occur synchronously at all stations, although they are more clearly visible in the central and southern part of Poland (synoptic stations Warsaw-Okęcie and Krosno).

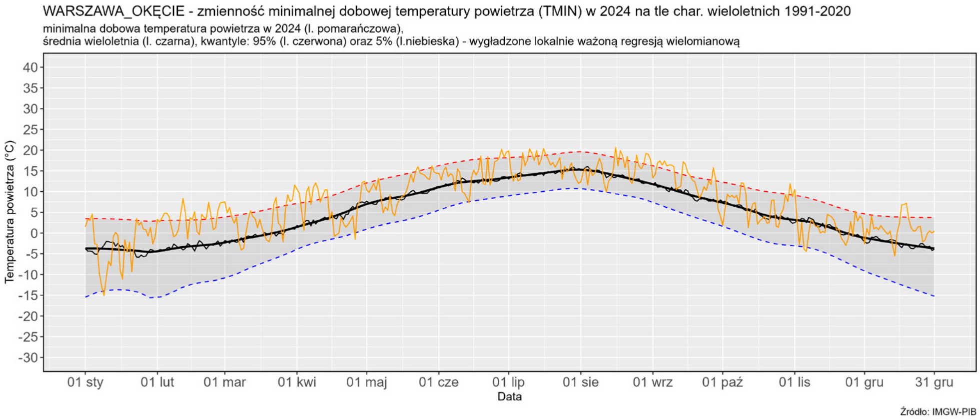


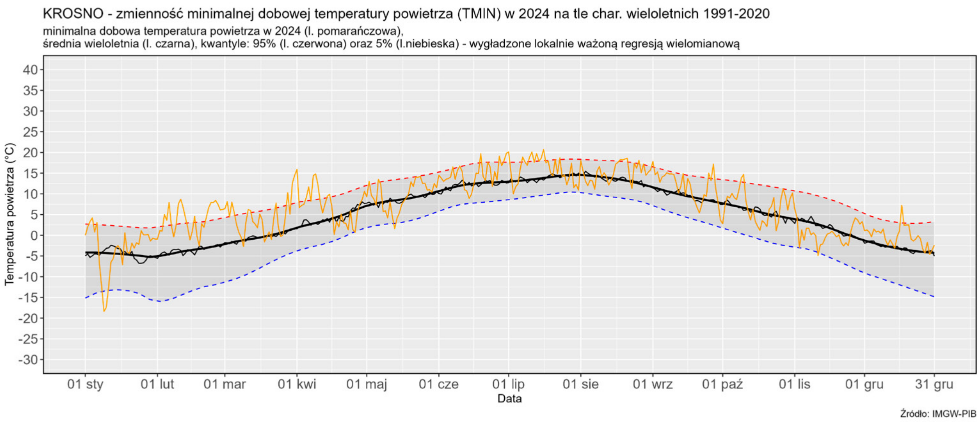
Variability of maximum air temperature against the background of multi-annual characteristics 1991-2020 in northern, central, and southern Poland on the example of selected synoptic stations

ANNUAL VARIABILITY OF THE MAXIMUM DAILY AIR TEMPERATURE

In the case of annual variability of maximum temperature, a significant consistency of general trends is also visible between individual measurement stations. Despite some differences in extreme local values, episodes of increased (heat waves) and decreased (cold waves) temperature occurred in similar periods at all analyzed stations. This suggests the influence of large synoptic systems that affected a wide area simultaneously, leading to relatively uniform thermal conditions on a regional scale.





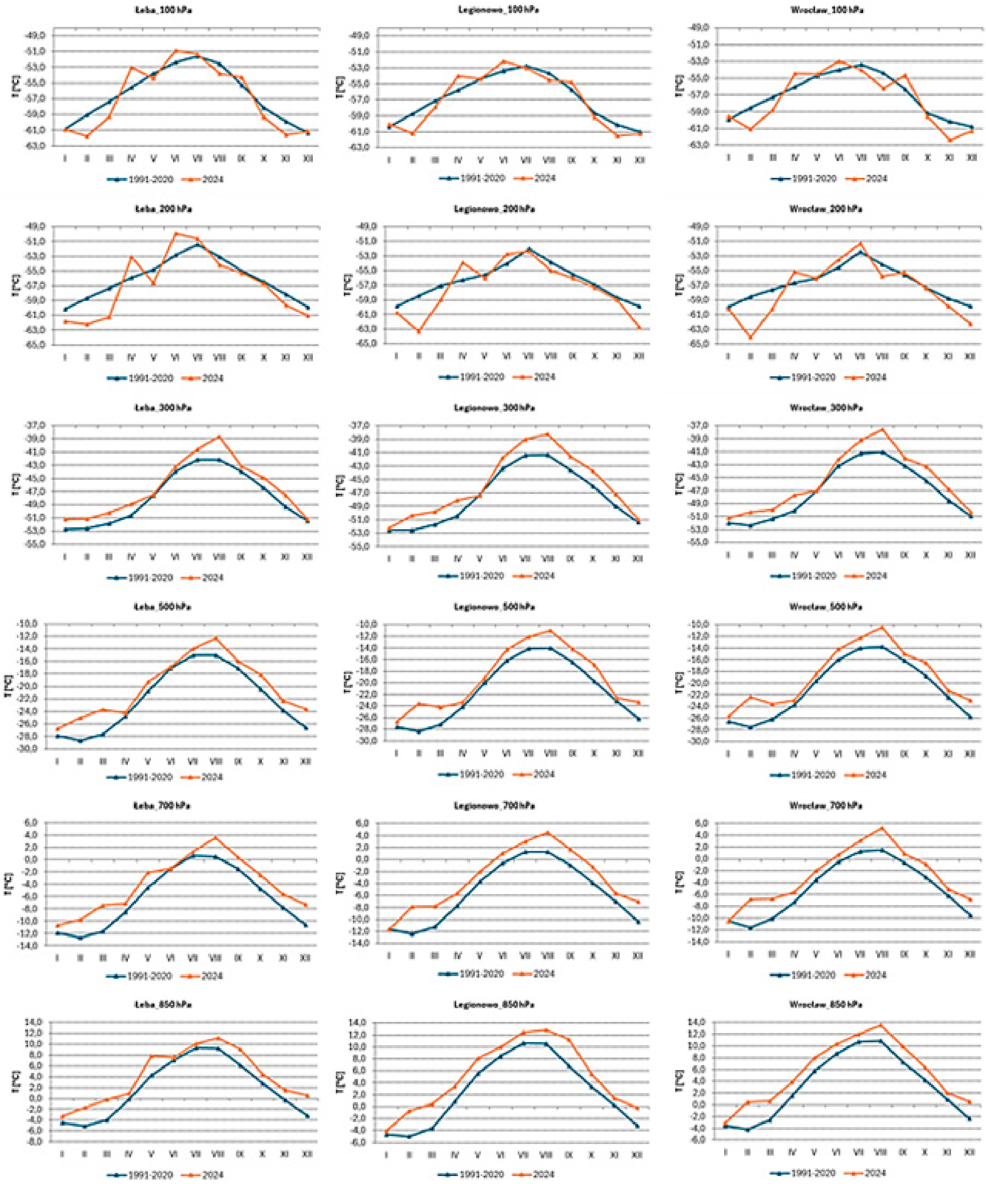


Variability of minimum air temperature against the background of multi-annual characteristics 1991-2020 in northern, central, and southern Poland on the example of selected synoptic stations

ANNUAL VARIABILITY OF THE MINIMUM DAILY AIR TEMPERATURE
Changes occurring in the values of minimum temperature are consistent with the course of average and maximum temperature, seasonal variability is also clearly visible.

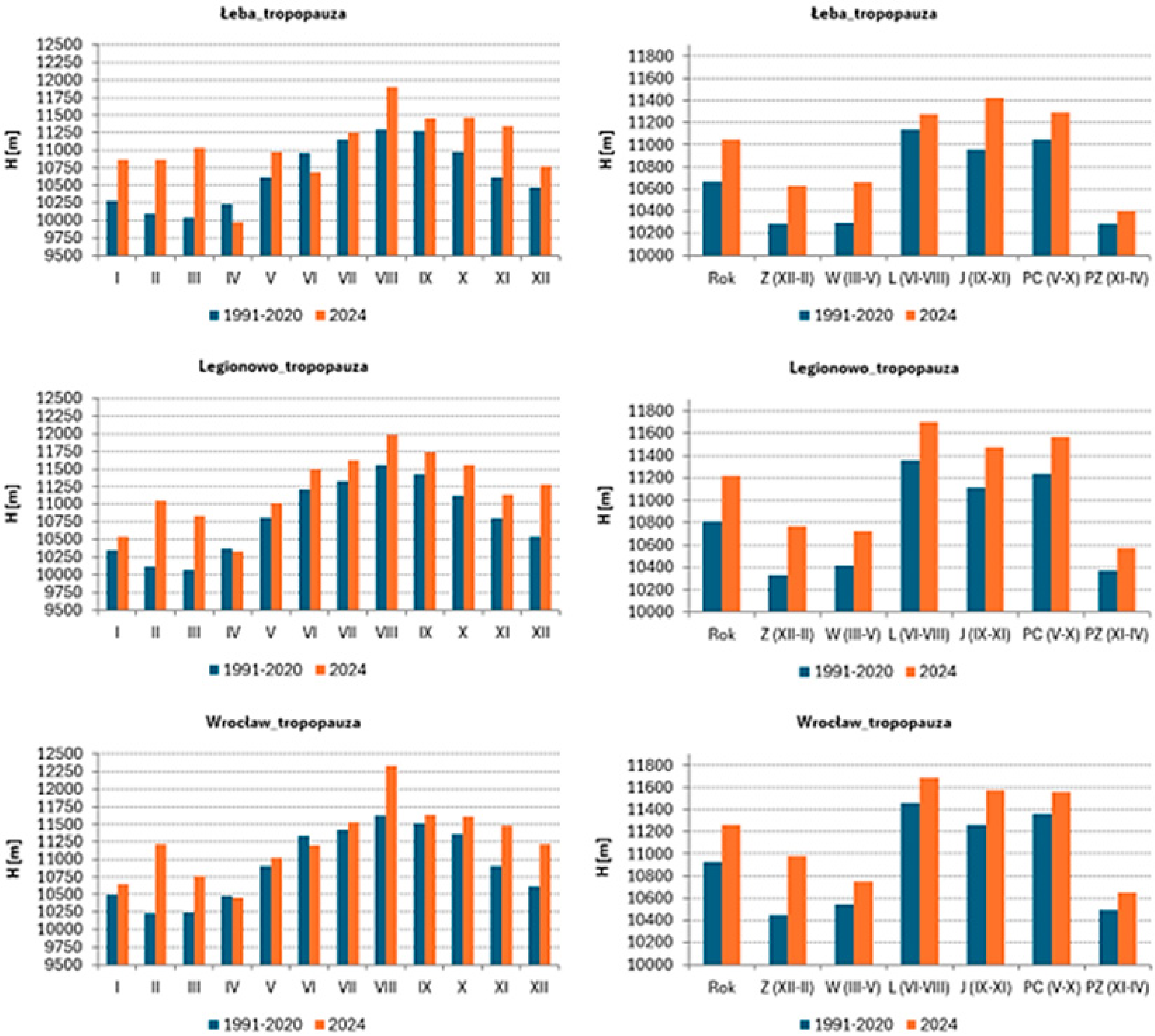
AIR TEMPERATURE

Temperature of selected isobaric surfaces in the troposphere



The course of the average monthly air temperature [T°C] in the troposphere – on selected isobaric surfaces in 2024 against the background of the 1991-2020 norm; date 00 UTC. Note: in Łeba for months I, XI, and XII, a smaller number of radiosondes than in other stations, especially for the upper and middle troposphere

The troposphere is the most important layer of the atmosphere because most weather phenomena are limited to this layer. The change in the vertical profile of air temperature in the atmosphere and the position of the tropopause are important criteria for diagnosing climate change. The analysis of temperature changes of selected isobaric surfaces in the troposphere (850 hPa, 700 hPa, 500 hPa, 300 hPa, 200 hPa and 100 hPa) and the position of the tropopause over Poland in 2024 was made on the basis of daily radiosonde measurements of the atmosphere conducted at the aerological stations of IMGW-PIB: Łeba, Legionowo and Wrocław.
The temperature anomalies that occurred in ground stations measuring air temperature are reflected in the variability of this meteorological element, also in the individual layers of the troposphere. In months that were warmer than normal (1991-2020 average) at the station level, the temperature recorded at the major isobaric surfaces in the troposphere was also higher. In those that were cooler than normal, the troposphere was also cooler.



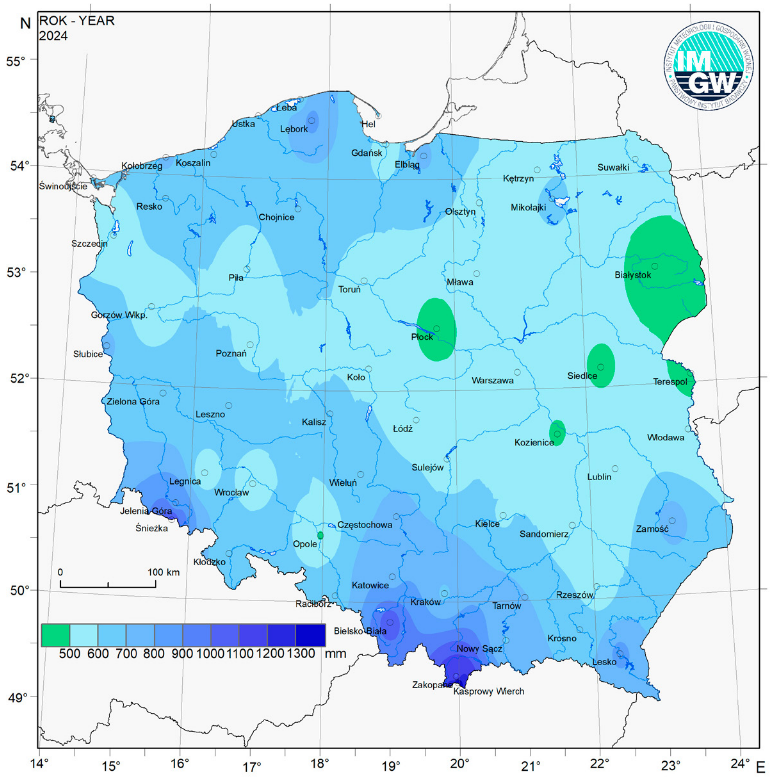
Location of the tropopause H [m] in 2024 against the background of the 1991-2020 norm; date 00 UTC. Note: in Łeba for months I, XI, and XII, a smaller number of radiosondes than in other stations, especially for the upper and middle troposphere

The warm troposphere in 2024 is also indicated by the location of the tropopause. Namely, its average height in individual months (except April and locally June), seasons, and throughout 2024 was higher than normal.

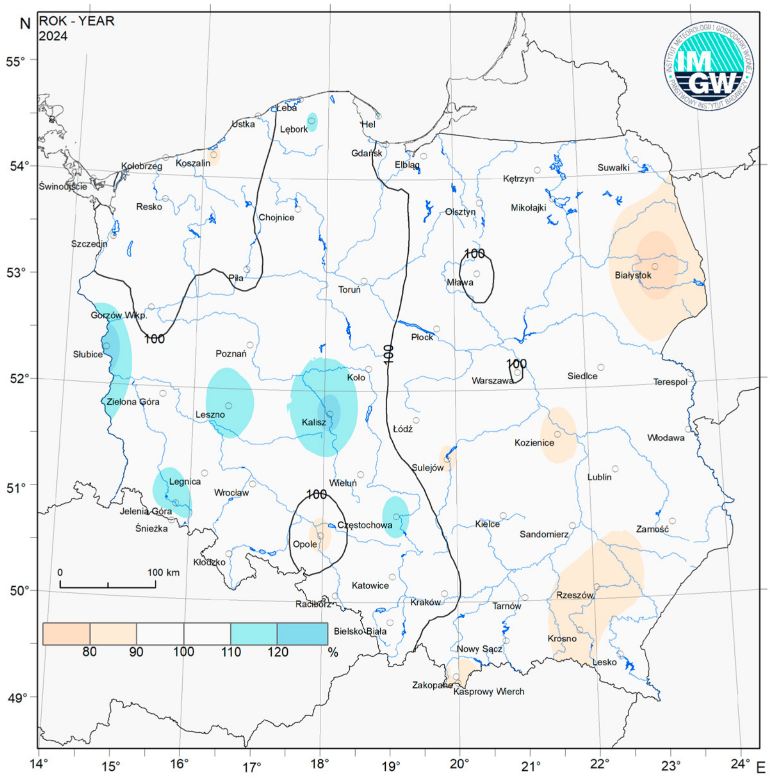
PRECIPITATION

The area-averaged total precipitation in Poland in 2024 amounted to 607.8 mm, which was 99.4% of the norm determined on the basis of measurements in the years 1991-2020. According to the rank classification of the average area precipitation, covering the period since 1951, last year ranks 38th. The most abundant year in precipitation was 2010 (with an average area precipitation of 804.1 mm, which was 132% of the norm), the least – 1982 (with a sum of only 422.6 mm, 69% of the norm).

In the context of the spatial distribution of precipitation totals in 2024, Podlasie and Mazovia, which are significantly less abundant in precipitation, stand out, as well as mountain and foothill areas, where significantly higher precipitation was recorded. Annual precipitation totals in 2024 in Poland ranged from 444 mm in Płock to 1407.4 mm on Kasprowy Wierch. In relation to the long-term norm (1991-2020), they ranged from 72.9% of the norm in Białystok to 127.9% of the norm in Słubice. In most areas, they were close to the long-term average. Values below the norm were recorded in Opole, Sulejów, Kozienice, the Tatra Mountains and in the Podlasie and Podkarpacie regions, while above the norm – in the western edge of Poland and individual stations in Wielkopolska and Lower Silesia, as well as at the synoptic station in Częstochowa.



Annual precipitation totals in 2024

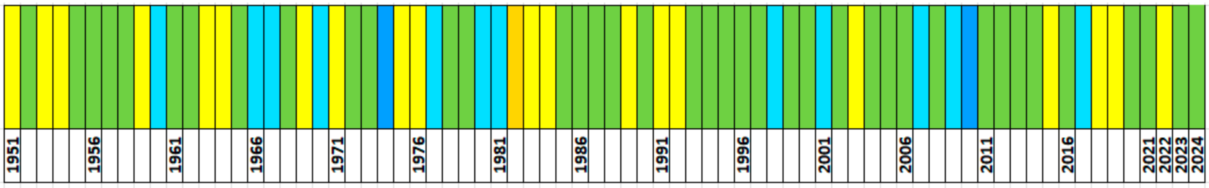


Annual precipitation totals anomalies in 2024 in respect to 1991-2020 normal period

PRECIPITATION

Pluvial conditions classification

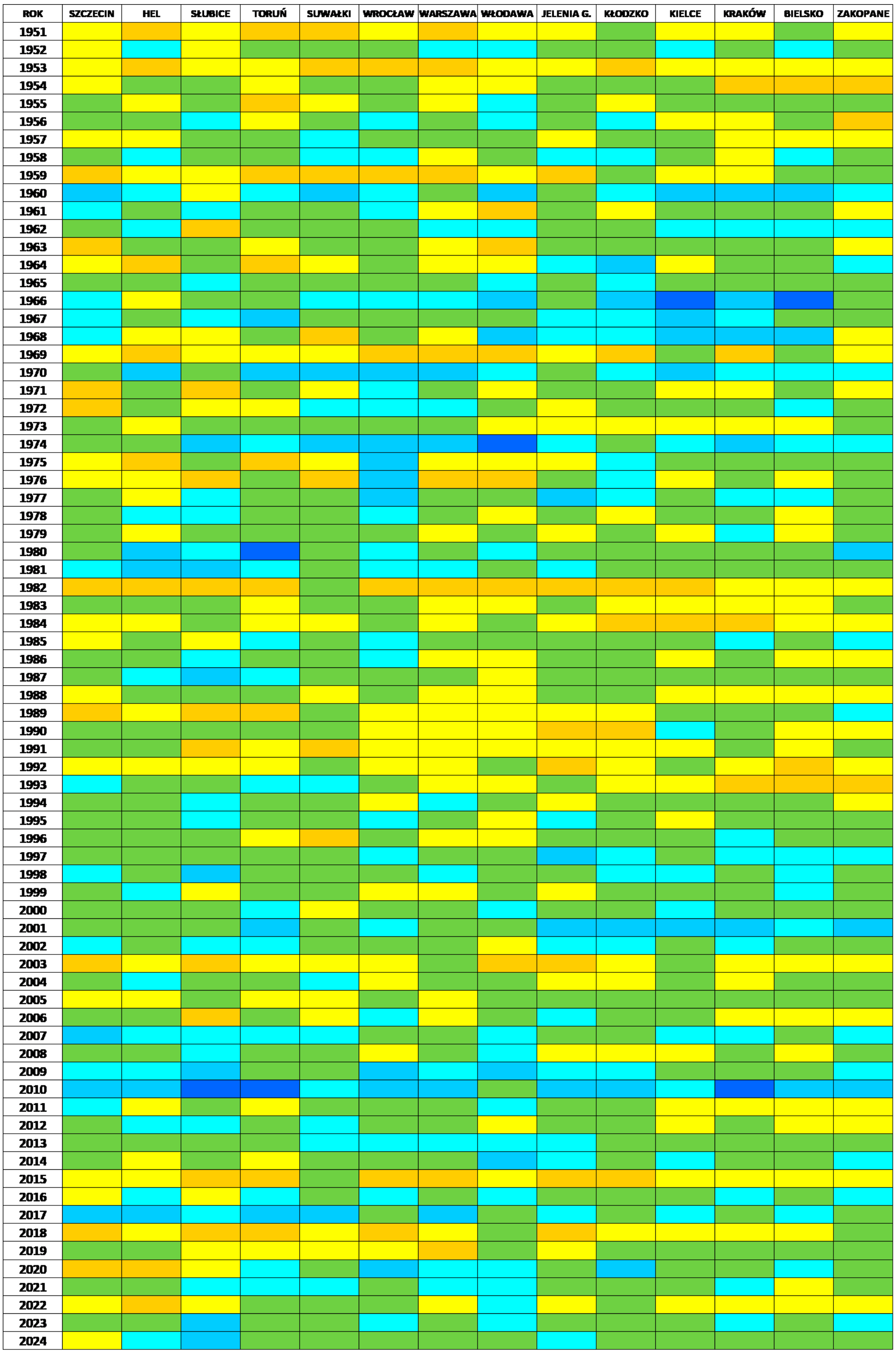
Descriptive classifications are used to describe pluvial conditions, among other things, specifying the extent to which pluvial conditions of a given month, climatic season, or year differed from typical conditions. One of the most popular classifications of pluvial conditions in Poland is the Kaczorowska classification, which is based on the percentage deviation from the precipitation norm for a given location. Individual classes are given descriptive names, as shown below. According to the Kaczorowska classification, the past year should be classified as a normal year in terms of pluvial conditions.



SKALA KLASYFIKACJI OPADOWEJ			%
1		skrajnie sucho	< 50
2		bardzo sucho	50-74
3		sucho	75-89
4		norma	90-110
5		wilgotno	111-125
6		bardzo wilgotno	126-150
7		skrajnie wilgotno	> 150

Variability of areal mean precipitation totals in 2024 (according to Kaczorowska 1962)

SKALA KLASYFIKACJI OPADOWEJ			%
1		skrajnie sucho	< 50
2		bardzo sucho	50-74
3		sucho	75-89
4		norma	90-110
5		wilgotno	111-125
6		bardzo wilgotno	126-150
7		skrajnie wilgotno	> 150

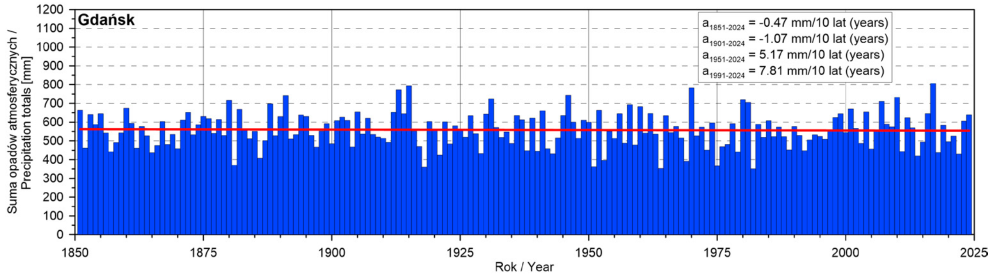


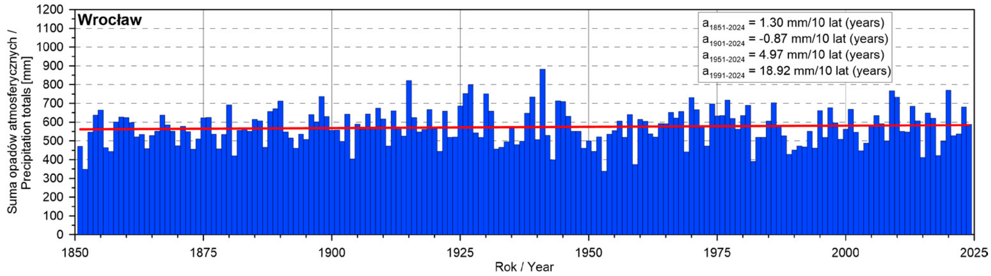
Variability of precipitation conditions on selected synoptic stations (according to Kaczorowska 1962)

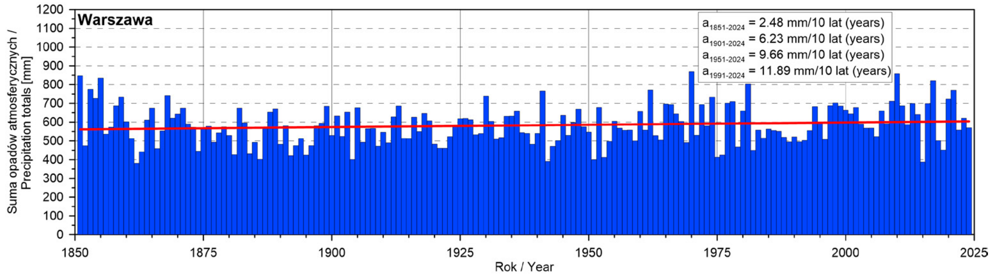
Expressing the amount of precipitation in a given year as a percentage of the amount of precipitation in the normal period allows us to introduce a classification that allows for a descriptive presentation of the pluvial conditions that prevailed at a given station or in a given area. In contrast to thermal conditions, precipitation characteristics are characterized by strong variability in space. Against the background of the multi-year data from 1951-2020, we can state that the spatial variability of precipitation in 2024 was not very diverse. At the vast majority of stations, last year was normal in terms of pluvial conditions. Only at individual synoptic stations was it classified as wet, very wet, or dry.

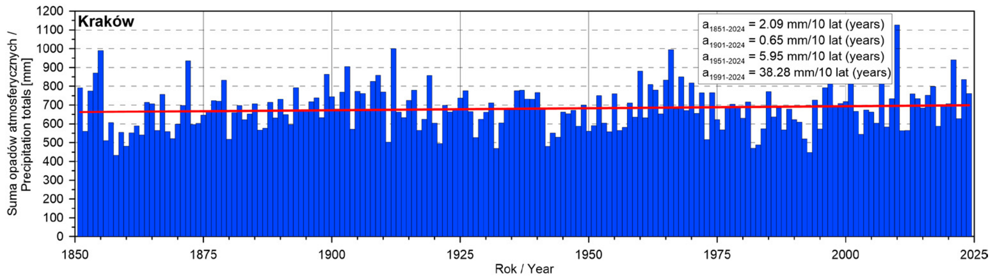
PRECIPITATION

Long-term variability







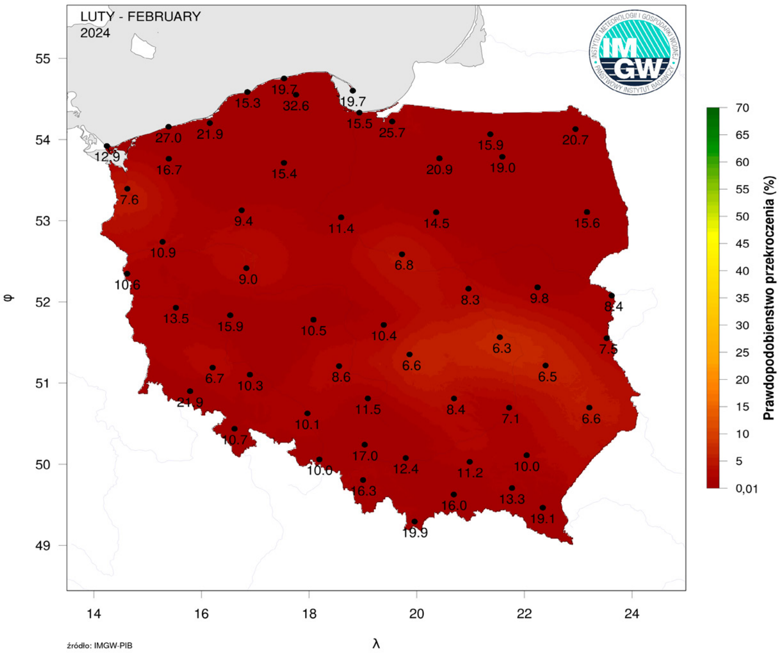


The measurement series of precipitation totals in Poland, as well as worldwide, are shorter than those of air temperature. The analysis of the long-term variability of pluvial conditions in Poland indicates slight changes. The largest, over the 174-year period, concerns Warsaw (a total increase of 43.2 mm). Almost two times lower values were recorded in Wrocław (22.6 mm). In the north of the country, in Gdańsk, there is a slight decrease in precipitation totals over the entire period (–8.2 mm). Greater changes have been recorded since the mid-20th century (1951-2024) – at all the stations analysed, there was an increase in annual precipitation totals, the largest in Warsaw (a total of 71.5 mm). At the remaining three stations, the rate of change was similar and ranged from 4.39 mm/10 years in Gdańsk to 5.95 mm/10 years in Kraków. On average, for these three stations over a 74-year period, this resulted in an increase in the range of 32-44 mm. The last 34 years (1991-2024) have been marked by a significant diversification of the rate of change – from 7.81 mm/10 years in Gdańsk, through 11.89 mm/10 years in Warsaw and 18.92 mm/10 years in Wrocław, to 38.28 mm/10 years in Kraków. It can be seen that in southern Poland the rate of change is an order of magnitude higher than in the north of the country.

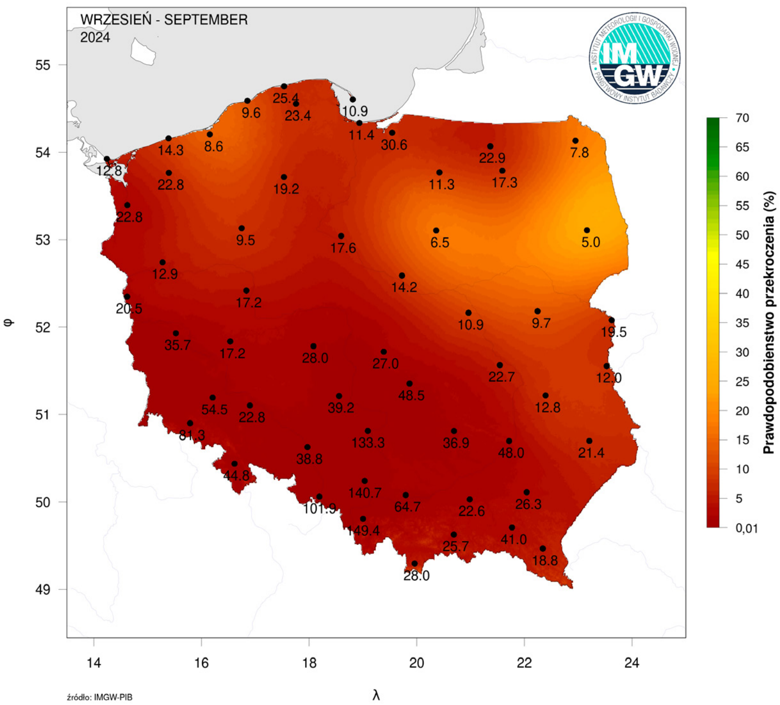
PRECIPITATION

Probabilities of exceedance of the maximum daily precipitation totals in February and September 2024

The presented maps of the distribution of the probability of exceeding the maximum daily precipitation in February and September 2024 show the occurrence of precipitation with significant efficiency in the multi-year period. February 2024 was the most abundant in precipitation in the history of uniform instrumental measurements in Poland (i.e. at least since 1951). In September 2024, this is particularly visible in the southern, western and south-western parts of Poland, where the influence of the Genoese low and its effects in the form of flood threats and floods was clearly visible. In these areas, there was a high probability of exceeding the maximum rainfall totals. This clearly indicates the exceptional nature of the above-mentioned months, with the simultaneous marked influence of deep low systems and small spatial differentiation resulting from local conditions.



Rainfall Risk – February 2024

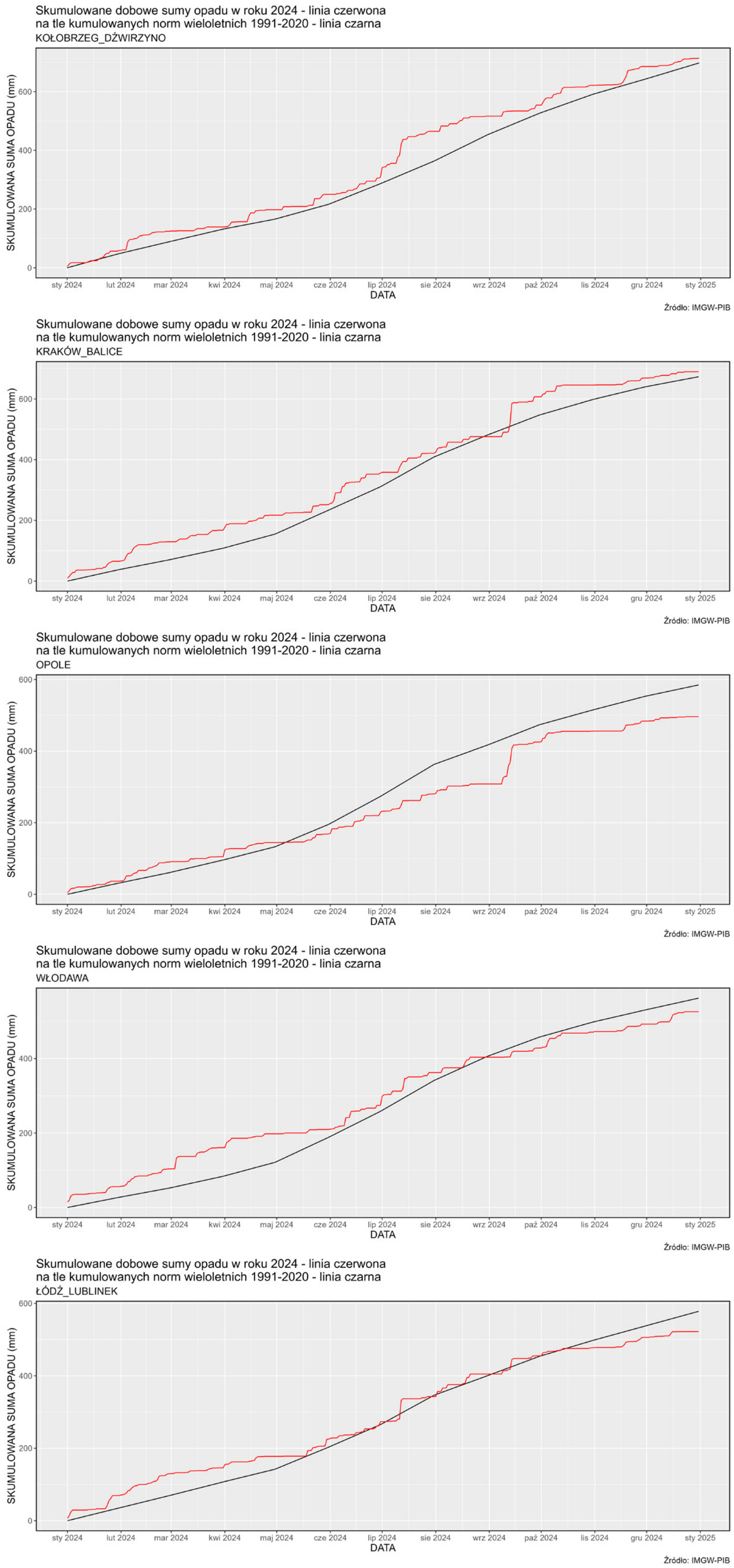


Rainfall Risk – September 2024

PRECIPITATION

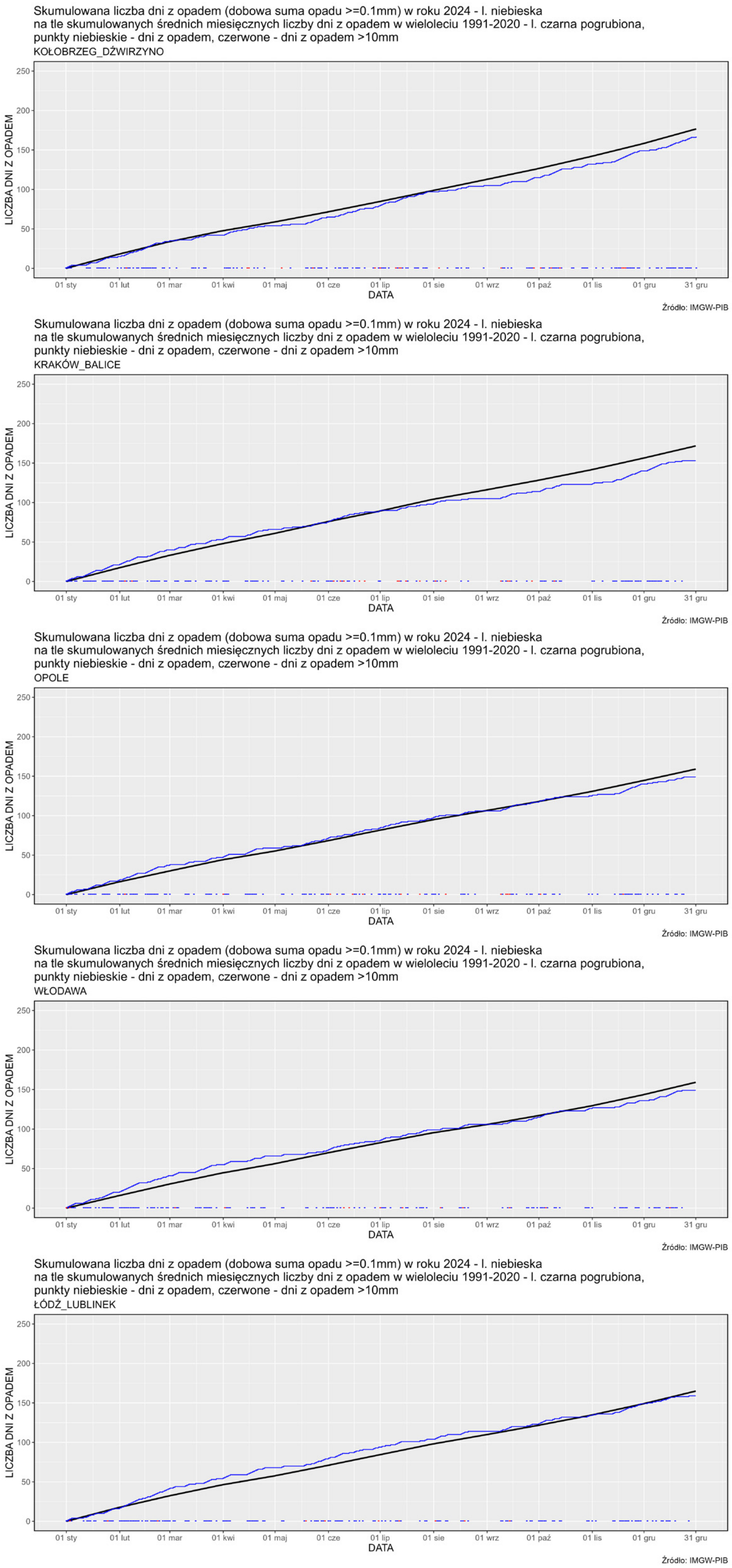
Cumulative precipitation totals and cumulative number of days with precipitation

The ability to calculate area average daily precipitation totals allows for the analysis of the course of pluvial conditions on a national scale. However, the cumulative precipitation totals at the synoptic stations mentioned below were clearly differentiated. At the Kołobrzeg-Dźwirzyno synoptic station, precipitation totals were higher than normal for most of the year (from March to December), but without extreme anomalies at the end of the year. In Kraków-Balice, precipitation above normal was also systematically recorded with a clear jump in precipitation totals in mid-September, but similarly to Kołobrzeg, annual precipitation totals only slightly exceeded the multi-year norm. In Opole, precipitation was significantly lower than normal for most of the year (from March to December), and there were even periods without precipitation. In Włodawa, precipitation totals exceeded the multi-year norm from January to August or were close to it, but in the last quarter of 2024 they remained below normal. In Łódź, rainfall totals from January to March 2024 were higher than the multi-year average, but in May and June, as well as from October to May, rainfall is significantly lower or there are periods without rainfall. Only in August and September were rainfall totals above the norm recorded, with a sudden increase in mid-September. This analysis confirms the fact that intense torrential rainfall is largely determined by regional factors, while the diversification of annual rainfall totals at individual synoptic stations also reflects the influence of local conditions.



Cumulative daily precipitation totals with reference to multi-year norms 1991-2020 at selected synoptic stations

The analysis of the cumulative number of days with precipitation in relation to the norm allows us to assess how often precipitation occurred in 2024 and whether the number of days with precipitation was higher or lower than usual. Comparing the cumulative total precipitation with the number of days with precipitation (e.g. in a situation where the annual total precipitation significantly exceeds the norm and the number of days with precipitation remains within the norm) allows us to assess the effectiveness of precipitation – i.e. whether it was more intense or weaker than usual. In 2024, at all the stations analysed, the number of days with precipitation was lower than the multi-year values.



Cumulative number of days with precipitation (daily precipitation totals >= 0.1 mm) with reference to multi-year norms 1991-2020 at selected synoptic stations

PRECIPITATION

Thunderstorms and distant thunderstorms at selected stations

2024	June			July			August			YEAR
Station	Thunderstorm	Distant thunderstorm	Total	Thunderstorm	Distant thunderstorm	Total	Thunderstorm	Distant thunderstorm	Total	Total
KASPROWY WIERCH	2	10	12	10	40	50	1	17	18	80
KRAKÓW–BALICE	11	17	28	18	23	41	2	2	4	73
ŁEBA	3	5	8	2	8	10		2	2	20
ŁÓDŹ–LUBLINEK	9	14	23	8	9	17	5	9	14	54
POZNAŃ–ŁAWICA	11	14	25	8	13	21	4	3	7	53
RZESZÓW–JASIONKA	1	9	10	5	19	24	0	5	5	39
ŚNIEŻKA	3	2	5	4	9	13	2	23	25	43
WARSZAWA–OKĘCIE	6	7	13	6	4	10	3	2	5	28
WROCŁAW–STRACHOWICE	12	10	22	13	16	29	7	7	14	65

The storm season in Poland peaks in the summer, from June to August. In 2024, a total of over 400 storms and distant storms were observed at selected stations during the summer months. The most at Kasprowy Wierch (80), Kraków (73) and Wrocław–Strachowice (65).

PRECIPITATION
Hail at selected stations*

2024	The number of days with hail by month 2024												YEAR
Station	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Total**
KASPROWY WIERCH					4								4
KRAKÓW–BALICE													0
ŁEBA											1		1
ŁÓDŹ–LUBLINEK			1										1
POZNAŃ–ŁAWICA					1								1
RZESZÓW–JASIONKA													0
ŚNIEŻKA					1								1
WARSZAWA–OKĘCIE													0
WROCŁAW–STRACHOWICE													1

** only synoptic stations with a full-time 24-hour service are included*

Hail is one of the most dangerous phenomena related to convection. It poses a threat to infrastructure, agriculture, and human life. Among the selected stations in 2024, this phenomenon occurred most often at Kasprowy Wierch (4).

PRECIPITATION

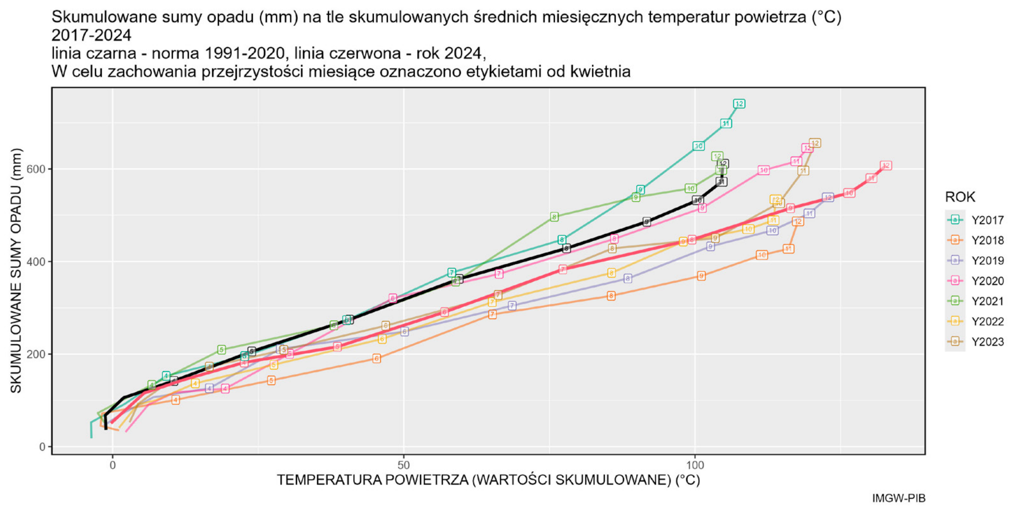
Fog at selected stations*

2024	The number of days with fog by month 2024												YEAR
Station	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Total**
KASPROWY WIERCH	27	28	27	22	18	28	24	22	19	22	19	21	277
KOZIENICE	6	5	9	6	8	9	9	10	13	17	12	11	115
KRAKÓW–BALICE		6	8	4	7	10	5	14	10	10	2	1	77
ŁEBA	3	10	8	7	12	20	13	20	12	11	8	10	134
ŁÓDŹ–LUBLINEK	1	7	4	1	7	8	9	4	4	11	10	11	77
POZNAŃ–ŁAWICA	2		3	3	6	1		5	5	4	6	11	46
RZESZÓW–JASIONKA	26	29	26	24	22	28	21	21	19	27	21	22	286
ŚNIEŻKA	3	6	6	3	2	10	3	4	6	9	4	4	60
WARSZAWA–OKĘCIE	2	6	4	3	7	4	3	7	5	12	8	6	67
WROCŁAW–STRACHOWICE	8	2	4	6	3	7	0	4	7	13	3	10	67

** only synoptic stations with a full-time 24-hour service are included*

Fog is a phenomenon associated with the condensation of water vapor in the near-surface layer of air, which limits visibility to less than 1 km. It is of significant importance from the point of view of the safety of transport operations. As can be seen, in 2024, at most of the analyzed stations, the number of days with fog did not exceed 100. Apart from high-mountain stations with specific location features, where the number of days with fog in 2024 approached or exceeded 275 (Śnieżka, Kasprowy Wierch), only the Łódź–Lublinek station recorded 134 days with fog, and in Kraków-Balice there were 115. The lowest number was recorded at the Rzeszów-Jasionka station (46).

PRECIPITATION AND TEMPERATURE



Cumulative precipitation totals (mm) against the background of cumulative average monthly air temperatures (°C)

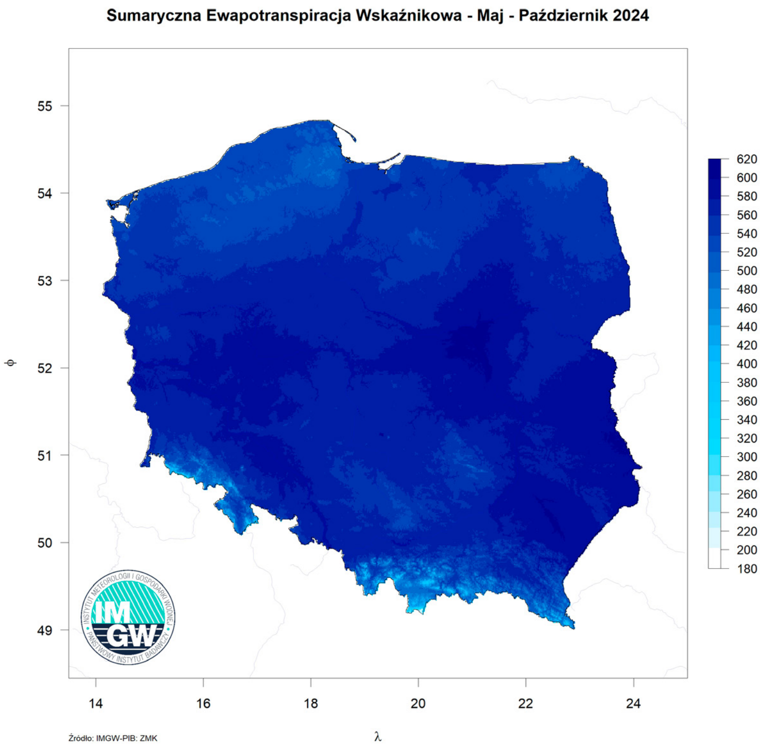
The use of cumulative average monthly air temperature values and precipitation totals allows for a synthetic reference to thermal and pluvial conditions. The year 2024 can be classified as a normal year in terms of cumulative precipitation totals (value slightly below the multi-year norm), although it should be clearly noted that for most of its duration, the year was rather below normal. The year 2024 (the warmest in the history of temperature measurements in Poland) should be classified as an extremely warm year according to the thermal classification (cumulative air temperature values can be considered, in a simplified way, as a cumulative heat resource). Interestingly, in terms of cumulative heat, the year 2024 was warmer than previous years already in October.

CLIMATIC WATER BALANCE

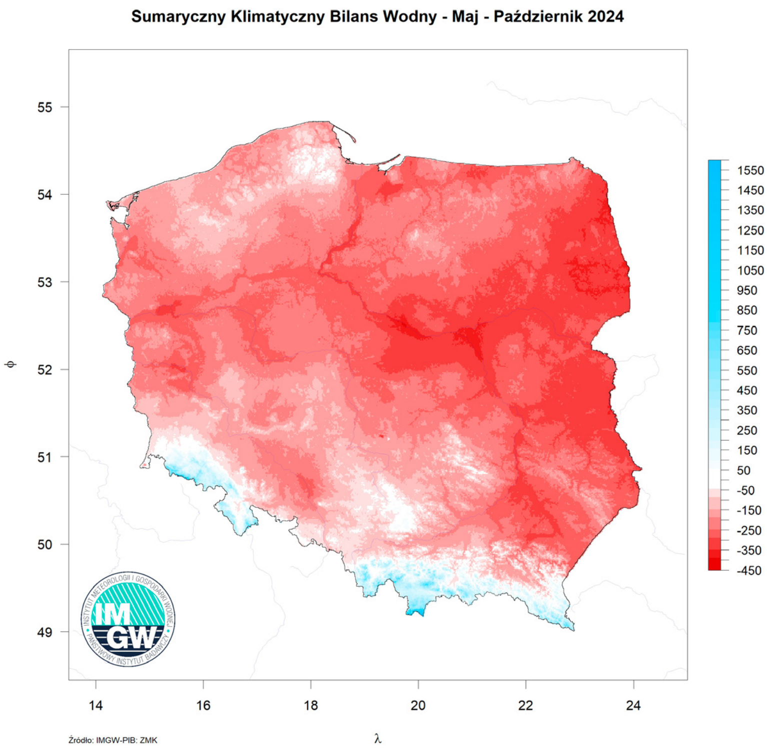
Warm half-year

Evapotranspiration (ET_0) indicates the potential amount of moisture that can be lost from the ground surface during the year as a result of evaporation and plant transpiration. Comparing ET_0 values with the spatial distribution of precipitation allows us to determine the Climatic Water Balance. The Climatic Water Balance (CWB) is the difference between precipitation and evapotranspiration. This evaporation can be determined based on measurements or using empirical formulas. A positive CWB value indicates that precipitation exceeded evaporation in a given period. In turn, a negative value means that evaporation was greater than the total precipitation.

From the point of view of the economy, information about CWB is particularly important in the warm season, when the demand for water increases in Poland – especially in agriculture, which is one of the key sectors of the economy. The cumulative values of the Climatic Water Balance (CWB) from the 2024 vegetation period indicate a negative water balance in most of the country. This phenomenon is particularly noticeable in central and eastern Poland, where CWB values in some places fall below -400 mm. In turn, mountainous areas are characterized by a positive balance, which indicates the predominance of precipitation over evaporation in these regions in 2024.



Spatial distribution of the potential evaporation totals in the period May-October 2024



Spatial distribution of the climatic water balance in the period May-October 2024

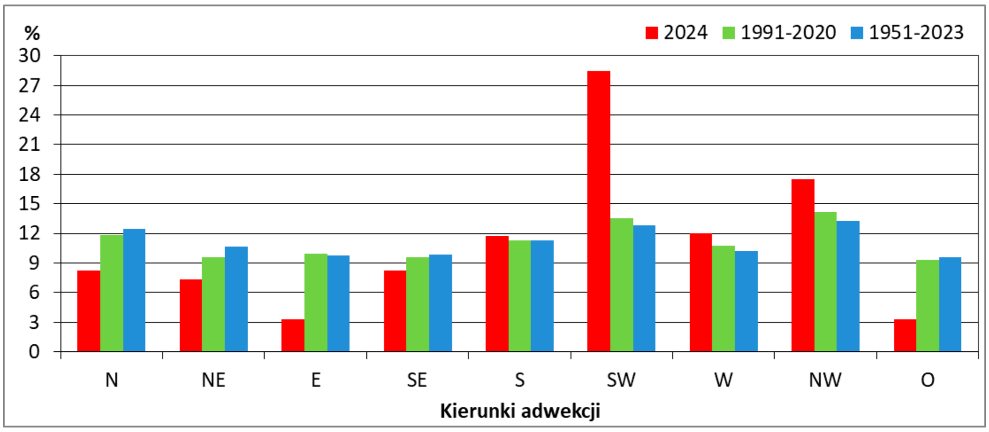
ATMOSPHERIC CIRCULATION

Indices and surface wind

Circulation types by Lityński in consecutive days and months of the year 2024 (Pianko-Kluczyńska 2018)

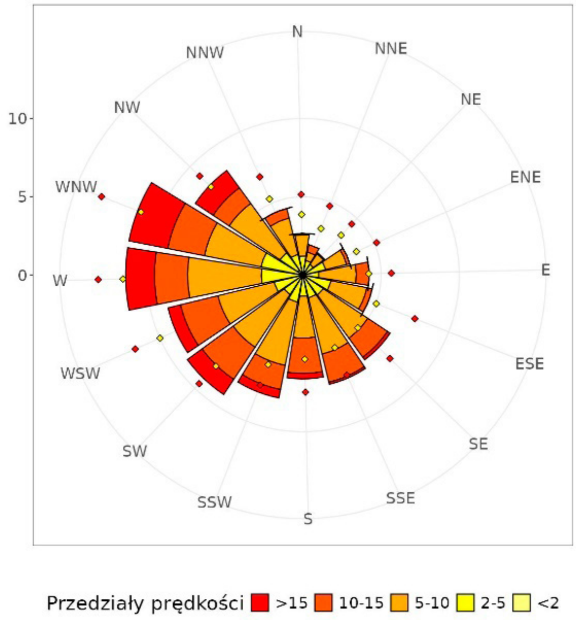
Day/Month	1	2	3	4	5	6	7	8	9	10	11	12
1	SEc	Eo	Ea	NWo	Sc	Wc	SWo	Wa	No	NWa	SWc	NEc
2	SEc	SEc	Ec	SWa	Sc	NWc	SWa	SEa	So	SWc	NWc	Ec
3	Sc	SEc	Sc	SWa	SWc	NWc	SWa	Sa	SWc	SWc	Wc	Ec
4	Wc	Sc	SWo	SWa	NWc	NWc	SWa	SWc	SWc	NWc	Sc	Oc
5	SWc	Sc	SWc	Wa	NWc	NWc	Wa	SWc	Wc	NWc	Wc	Nc
6	Sc	Sc	Wc	SWc	NWc	Oc	Wa	SWc	NWc	NWc	Wc	Oc
7	SWc	Sc	NWc	NWc	NWc	Ec	Na	SWc	SWa	NWc	NWc	Oc
8	SWc	Sc	NWc	NWc	NWc	NEc	Wo	SWa	SWo	NWo	Wc	SEc
9	So	Wc	NWc	NWa	SWo	NWc	NWc	SWa	SWc	Wc	NWc	Sc
10	SEc	SWc	Nc	Wa	SWc	NWc	Wc	SWc	SWo	Nc	Nc	Sc
11	Sc	SWc	Nc	SWo	Wc	NWc	SWc	SWo	Wc	NEc	Nc	SWc
12	Sc	SEc	Nc	NWa	NWc	SWo	SWc	Wa	Wc	Nc	NWc	Wc
13	Oc	SEc	NEc	NWa	NWc	Sa	SWc	SWa	Wo	NWc	SWo	SWc
14	Oo	Ec	NEo	Oa	Wa	SEa	Wo	SWa	SWc	Nc	SWc	Sc
15	SEa	NEc	NEo	Sa	SWa	SEa	Wo	SWo	SWc	No	NWc	SEc
16	NEo	NEc	NEc	SWo	SWo	SEa	Wa	SWa	SWo	Nc	NWc	SEc
17	Ea	NEc	Oc	NEc	SWa	SEc	Wo	SWa	SWc	Nc	NWa	SEc
18	NEo	Oc	SEa	Nc	SWc	Sc	SWa	SWa	NWa	Nc	NEa	SEc
19	NEc	Sc	SEc	Nc	SWa	Sc	SWa	SWa	SWo	Na	NEa	SEc
20	NEc	Wc	Sa	Nc	SWo	Sc	Sa	SWa	Sc	SWa	Ea	Ec
21	NEc	SWc	SWo	Sc	SWc	Wa	SWa	SWa	Sc	SWa	Ea	NEc
22	NEc	SWc	So	So	SWo	Wa	SWo	SWa	Wc	NWa	Ea	Nc
23	NEc	SWc	Sc	Sc	SWa	Wo	SWo	NWa	NWc	NWa	SEa	Sc
24	NEc	Wa	Wc	SWc	Wo	SWa	SWa	NWo	NWc	Nc	Sa	Sc
25	NEc	Oa	NWc	SWo	NWo	SWo	SWa	Wa	NWc	Nc	Ea	Nc
26	NEc	Oc	NWc	Wc	NWo	SWc	SWa	SWc	NWo	Nc	SEo	Nc
27	NEc	NWo	Wo	NWc	NWo	SWc	SWa	SWc	NWc	So	SEo	Nc
28	NEc	Na	So	NWo	SWc	SWo	SWc	SWo	Sc	SWc	SEc	Oc
29	NEc	Na	SWc	So	SWc	SWc	NWo	SWc	Ec	NWo	SEc	SEc
30	Nc		Wc	Sc	SWc	Wc	NWa	NWc	Nc	So	SEc	SEc
31	Eo		NWc		SWc		NWa	NWc		SWc		SEc

Atmospheric circulation is one of the most important weather and climate factors. Thanks to it, the weather in Poland changes from day to day, and even several times a day. There are many methods for describing atmospheric circulation. One of the most popular ways to characterize it is by specifying the direction of air mass advection over the area of interest and determining the nature of the air movement (whether it is cyclonic or anticyclonic). In a given season, these parameters allow us to determine the thermal and humidity characteristics of air masses flowing over the area under study.



Frequency of advection directions in 2024 and in reference periods

The circulation index calendar allows us to state that in 2024, air masses flowing from the western sector (from NW to SW) were significantly dominant, with a total frequency of 57.9%, followed by the southern sector (from SE to SW) with a frequency of 48.4%. Compared to the normal period, the frequency of air masses flowing from the western sector was higher by over 20% than in the multi-year period 1991-2020. In 2024, the SW direction was particularly dominant, reaching almost 28.4% of the frequency, and the NW direction with a frequency of 17.5%. The SW value in 2024 significantly exceeded the values from the multi-year period, where the frequency of this advection direction remained at 13.5%. The smallest share in the analysed year was in direction E with a frequency of 3.3%, while the frequency in the reference period 1991-2020 was 9.9%.



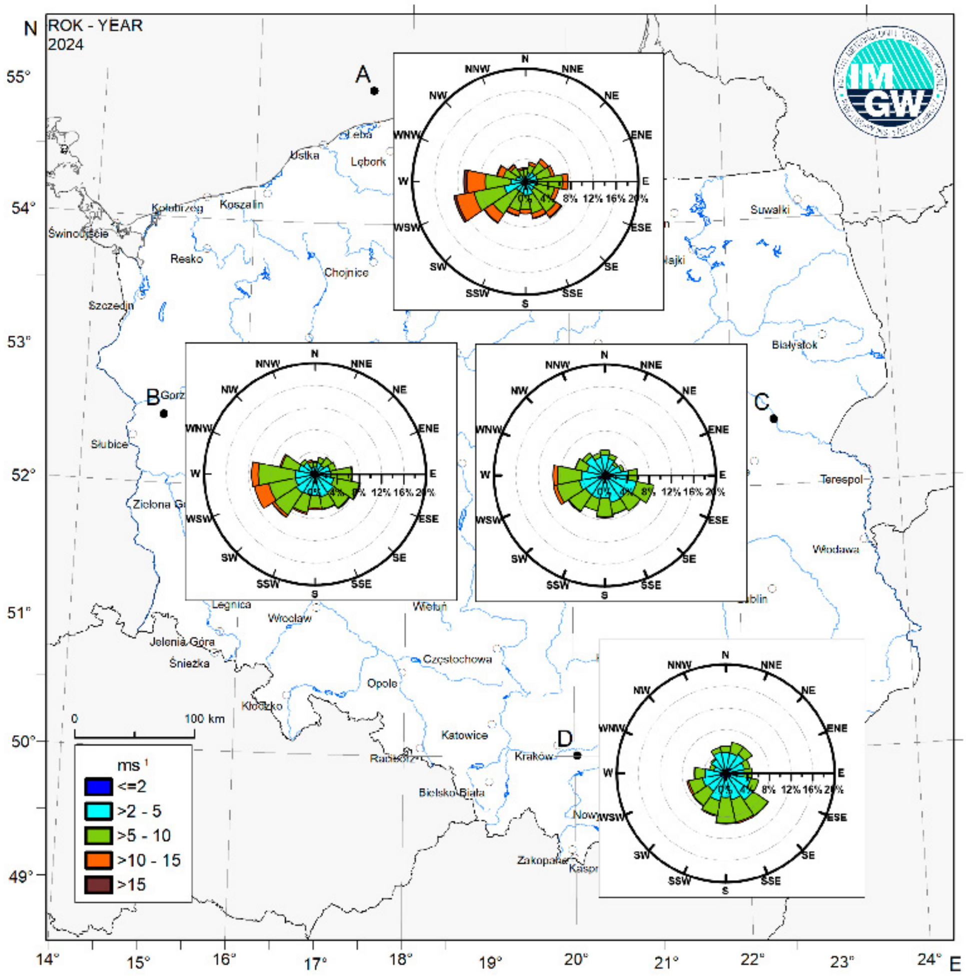
Wind rose of the direction and speed of geostrophic flow over Poland in 2024 with reference period (1991-2020) characteristics of directions frequency: median (yellow diamond) and quantile 90% (red diamond)

Statistics of geostrophic flow over Poland. Q10, Q50, Q90 etc. – quantiles 10%, 50%, 90%, η- wind direction stability coefficient, V – wind speed, u – zonal, v – meridional

Parameter	V (m/s)	u (m/s)	v (m/s)
Mean (1991-2020)	8.2	2.7	0.5
Mean	8.2	2.7	1.3
Minimum	0.9	–13.8	–16.1
Q_{10}	3.4	–5.0	–5.2
Q_{50}	7.1	2.1	1.0
Q_{90}	14.5	11.5	8.8
Maximum	29.5	25.9	17.9
Mean direction (1991-2020)	259		
Mean direction	244		
η	0.37		
η (1991-2020)	0.34		

Another index used to describe atmospheric circulation over a given area is the geostrophic wind vector. It allows determining the direction and strength (speed) of air mass inflow based on the distribution of the pressure field. By taking into account current thermal conditions and correcting the dependence of air density, more realistic values of this indicator can be obtained. However, it is worth remembering that the geostrophic wind vector does not take into account factors such as friction resulting from the terrain or its use. This means that it represents the maximum speed at which the wind could blow in a given area in the absence of the above-mentioned restrictions.

The average geostrophic wind speed in 2024 was 8.2 m/s – its value was equal to the long-term norm for 1991-2020. The average wind direction in 2024 was 244 degrees, which means that it was shifted counterclockwise by 15 degrees from the long-term average. This indicates a greater share of air masses flowing from the southwest. The annual mean values of the vector components indicate a moderate predominance of advection from the western sector and an increase in advection from the south (with an anomaly of the v component of +0.8 m/s). This is also reflected in the wind rose indicating a shift in the dominant directions from west to south-west.



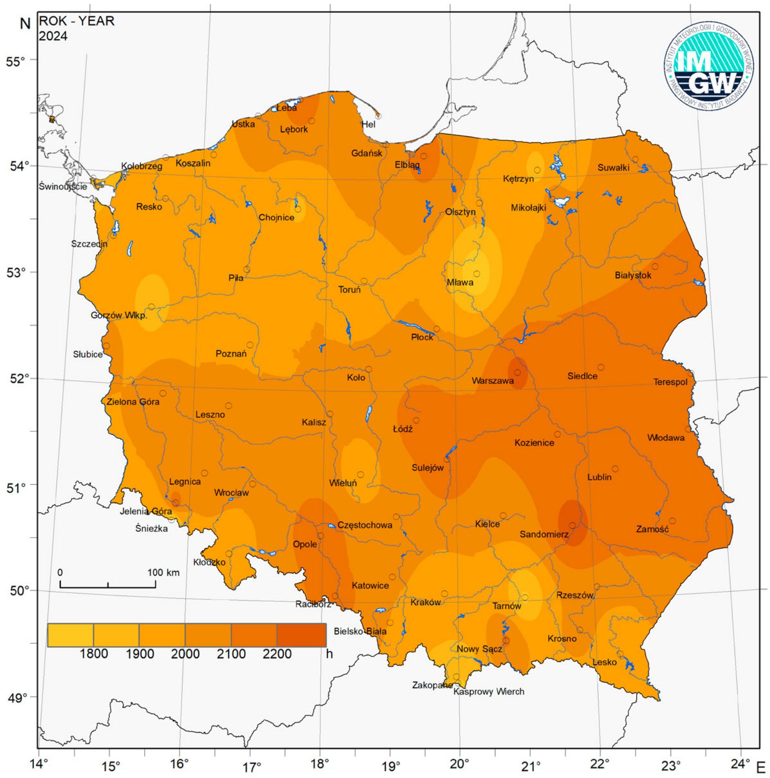
The direction and speed of wind over the points: A (55.0°N, 17.5°E), B (52.5°N, 15.0°E), C (52.5°N, 22.5°E), D (50.0°N, 20.0°E)

The distribution of wind vectors at individual points in Poland also indicates the dominance of the flow from the south-west sector. This direction is maintained in all analyzed locations, which indicates high coherence of regional atmospheric circulation. This situation is characteristic of the dominance of zonal western circulation with a simultaneous increase in the share of advection from the south, which is confirmed by tabular data and the direction-velocity rose of the geostrophic flow for 2024.

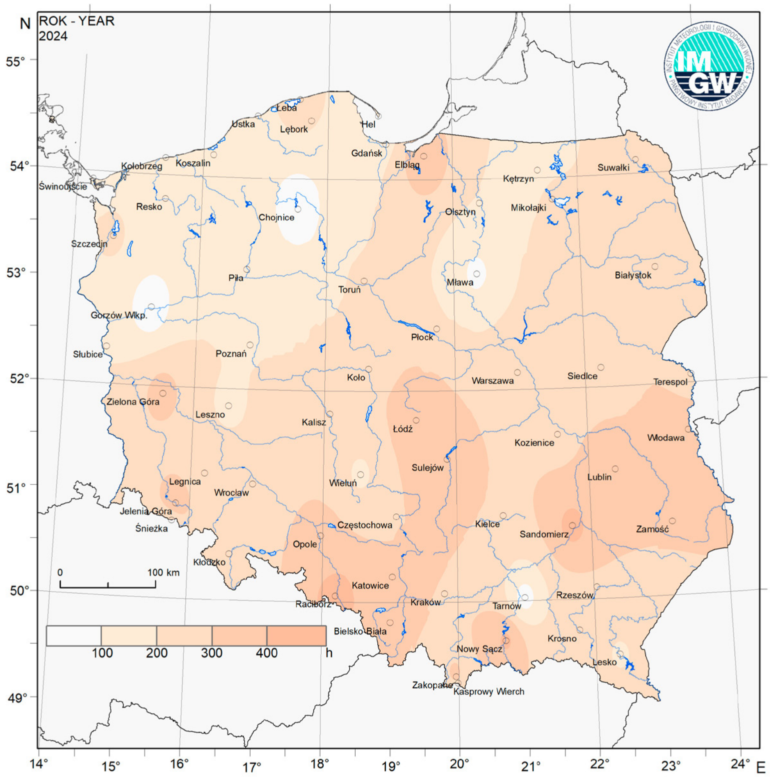
SUNSHINE DURATION

Sunshine duration, or the time with the sun's disc uncovered, depends mainly on location. Other factors that affect it include topography, the degree of sky coverage by clouds and individual types of clouds, and the scattering of sunlight by suspended dust. Relative sunshine duration, or the ratio of the actual time of sunlight to the time of possible sunlight, determined by the length of the day (i.e. from sunrise to sunset), in 2024 ranged between 39 and 51%.

The annual sunshine duration in Poland in 2024 ranged between 1722 and 2255 hours. In most of the country, it was higher than the climatological norm for 1991-2020 by over 240 hours. It should also be emphasized that positive annual anomalies of actual sunshine duration were recorded throughout Poland. The largest differences were recorded in Racibórz (441 hours) and Sandomierz (427 hours), the smallest in Gorzów Wielkopolski (44 hours) and Chojnice (46 hours). The sun shone the longest in Sandomierz (2255 hours), Warsaw (2220 hours) and Włodawa (2197 hours). The fewest hours with sunshine were recorded on Śnieżka (1722 hours), Mława (1739 hours) and Kasprowy Wierch (1740 hours).



Annual amount of sunshine duration in 2024



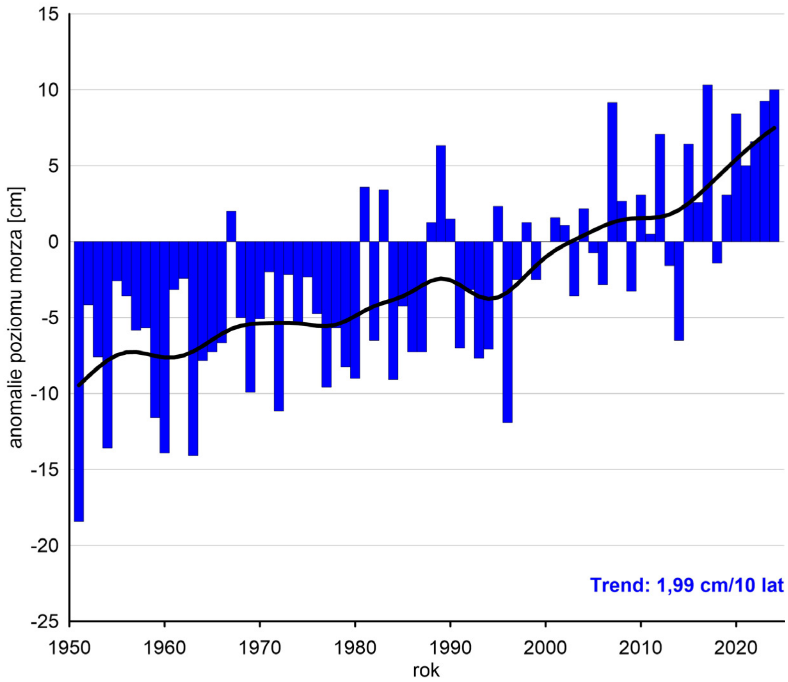
Sunshine duration anomalies in 2024 in respect to 1991-2020 normal period

SEA LEVEL

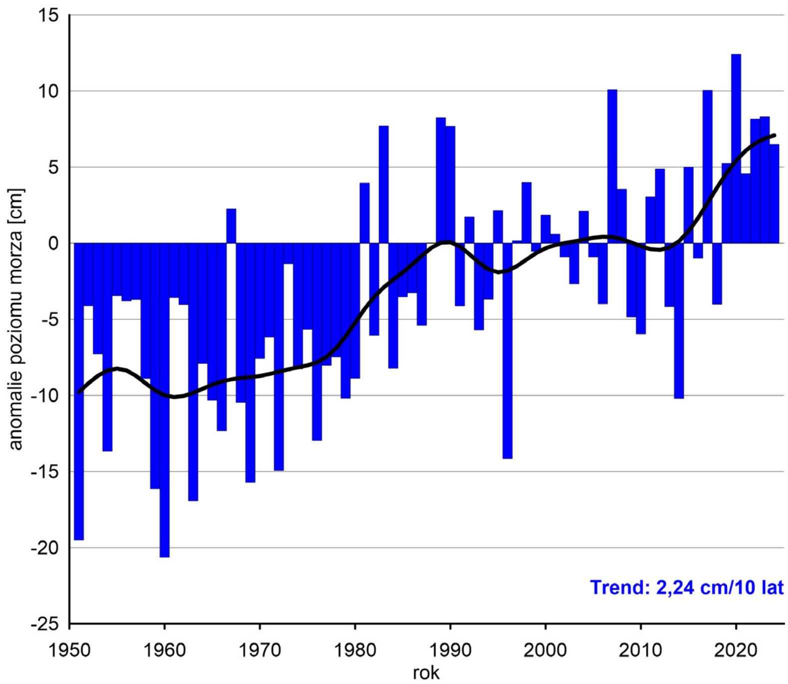
The sea level in the southern Baltic region is systematically rising, which is the result of the increase in temperature on a global scale and the dominance of the western zonal circulation of the atmosphere in this area. The rate of increase is varied – higher in the eastern part of the Coast (an increase in the average sea level by 14.8 cm in Świnoujście and 16.6 cm in Władysławowo over 74 years) – as a consequence of the aforementioned dominance of the western zonal circulation, which maintains a constant inclination of the Baltic surface, increasing from west to east.

In Świnoujście in 2024, the maximum observed mean daily level was 576 cm, while the lowest observed mean daily level was 473 cm. In 2024, average daily levels above the warning level of 560 cm constituted 1.9%, while average daily levels above the alarm level did not occur, similarly to the previous years 2023 and 2022. Similarly, there were no average daily levels below SNW (416 cm from the multi-year period 1951-2024). Most often, average daily sea levels occurred in the ranges: 511-520 cm (27.9%) and 501-510 cm (24.6%).

In 2024, the maximum observed average daily level in Władysławowo was 569 cm, while the lowest observed average daily level was 468 cm. In 2024, average daily sea levels most often occurred in the ranges 510-520 cm (23.8%) and 520-530 cm (21.9%). In 2024, similarly to 2023, the average daily water level did not exceed the alarm level of 570 cm even once, nor were levels below SNW (446 cm) recorded.



Świnoujście



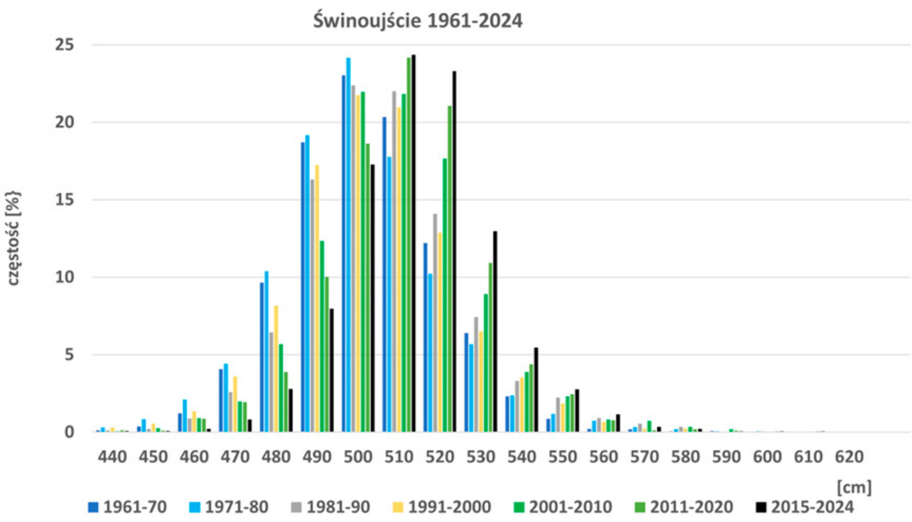
Władysławowo

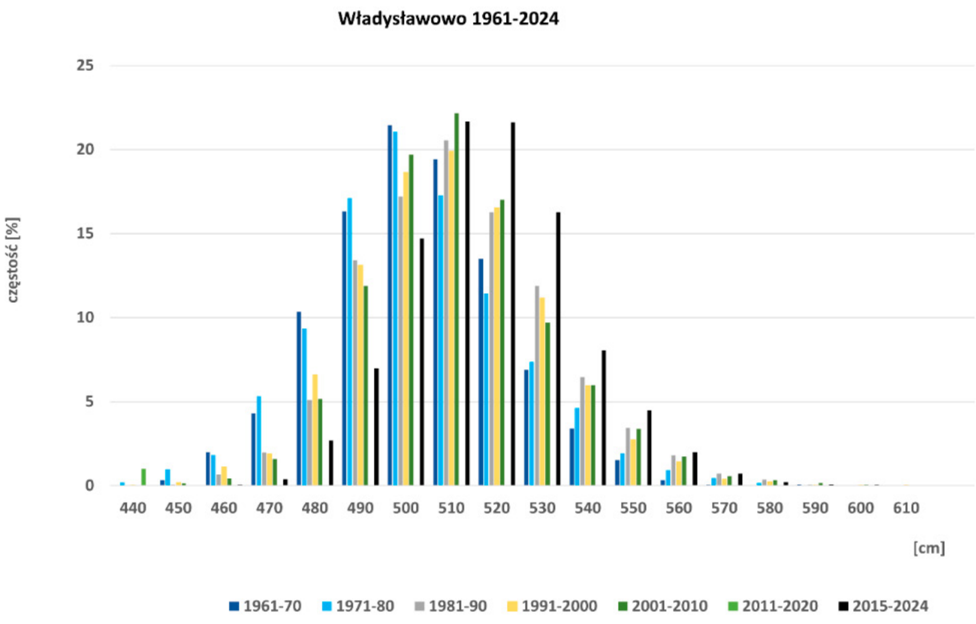
There is a clear change in the frequency of sea levels from the low range of values, below the so-called average level, from decade to decade. Both in the western and eastern parts of the Coast, we can see a decrease in the number of cases of low levels, particularly strong in Świnoujście. At the same time, there is an increase in the number of cases of levels higher than average, in particular to alarm levels.

Świnoujście	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020	2015-2024
below SNW [%]	0	0.028	0	0.027	0	0.082	0.055
above the alert level [%]	0.137	0.11	0.084	0.055	0.219	0.025	0.164

Władysławowo	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020	2015-2024
below SNW [%]	0.082	0.547	0.027	0.109	0.055	0.082	0.027
above the alert level [%]	0.11	0.164	0.465	0.328	0.549	0.411	0.383

Occurrence (%) of sea levels below the SNW and above the alert level in Świnoujście and Władysławowo for selected periods from 1961-2024





Frequency of occurrence of mean daily sea levels in Świnoujście and Władysławowo in decades

EXTREMES

VARIABLE		VALUE	DATE	STATION
temperature* (T°C)	max	**36.5**	10.07.2024	Wrocław–Strachowice
	min	**–23.8**	17.01.2024	Suwałki
	min 5 cm**	**–29.3**	17.01.2024	Suwałki
Precipitation (RR mm)	Σ max day	**153.4**	18.08.2024	Jelenia Góra
	Σ max	**1407.6**		Kasprowy Wierch
	Σ min	**444**		Płock
Sunshine duration (U h)	Σ max day	**16.4**	24.06.2024	Ustka
	Σ max	**2254.5**		Sandomierz
	Σ min	**1722**		Śnieżka

* temperature value without taking into account high mountain stations (Śnieżka and Kasprowy Wierch)
** temperature value at 5 cm above ground level

SUMMARY OF EXTREME WEATHER AND CLIMATE EVENTS IN POLAND IN 2024

Observed extreme weather or climate event	Physical characteristics of event						Interferences occurring
	Event start	Event end	Duration	Location/Area	Rarity	Description of event	
Cold wave	2024-01-08	2024-01-10	3 days	North-eastern, eastern and southern part of the country	Unusual	As a result of the impact of the high-pressure wedge and the inflow of cold continental air masses from Siberia, a large area of the country experienced severe frost. The minimum daily air temperature at many stations dropped below –20°C, at the ground below –25°C (e.g. Zamość station –21.4°C, Jabłonka station –23.9°C, Kętrzyn station –22.0°C).	
Strong wind	2024-01-24	2024-01-24	1 day	Entire country	Unusual	The impact of the „Jitka” low moving across the Baltic Sea towards Belarus caused very strong and gusty winds throughout the country. A gust of 202 km/h was recorded at the high-mountain station Śnieżka, which was the highest measured wind speed of that day in the world.	By 8:00 a.m., due to the wind, firefighters in Lower Silesia had intervened about 160 times in Lower Silesia. Broken branches, broken trees, a fallen shelter.
Strong wind	2024-02-02	2024-02-05	4 days	Entire country	Unusual	As a result of the low pressure centre moving through Central Europe with a system of atmospheric fronts, a significant pressure gradient occurred, which caused gusty winds of 100 km/h to occur throughout the country.	Roof coverings torn off on residential and farm buildings.
Rainfall	2024-02-04	2024-02-05	2 days	Southern and western part of the co-untry	Unprecedented	A warm atmospheric front was over the western and southern parts of the country, within which precipitation of a uniformly continuous nature occurred. At many measuring stations, the daily rainfall total exceeded 30 mm, and locally even 50 mm (e.g. Jakuszyce station – 62.8 mm, Szklarska Poręba station – 52 mm)	Numerous floods in the south of the country (around Krakow and Ojców). Flooded houses, streets, farm buildings. In Małopolska, firefighters intervened over 200 times.
Heat wave	2024-02-13	2024-02-16	4 days	Entire country	Unusual	As a result of the inflow of warm air from southern Europe, the maximum temperature at many stations exceeded 15°C (e.g. Jelenia Góra station 15.9°C, Cieszyn station 17.3°C). In the north of the country, the air temperature anomaly from 16.02 exceeded the long-term norm by 10°C.	
Thunderstorms	2024-02-25	2024-02-26	2 days	Northern and western part of the co-untry	Unusual	In some regions of the northern part of the country, as well as locally in the west, storms appeared, which developed in the warmer, polar maritime air mass. Locally, they brought small hail.	
Heat wave	2024-02-25	2024-02-29	5 days	Entire country	Unprecedented	As a result of the inflow of warm air from southern Europe, the maximum temperature at many stations exceeded 15°C (e.g. Tarnów station 19.1˚C, Cieszyn station 19.2). At several dozen stations, the value of the positive anomaly Tmax exceeded +5˚C, and the maximum temperature anomaly for 27.02 was +12˚C compared to multi-year conditions (1991-2020).	
Heat wave	2024-02-01	2024-02-29	29 days	Entire country	Unprecedented	The average area air temperature in February 2024 in Poland was 5.7°C and was as much as 5.8 degrees higher than the long-term average for this month (climatological normal period 1991-2020). This year's February should be classified as an extremely warm month. The warmest region of Poland was Podkarpacie, where the average area air temperature (6.6°C) was 6.6 degrees higher than normal, and thermal conditions were classified as extremely warm. The coldest region was the Southern Baltic Coast and Coastal Belt – there the average air temperature was 4.8°C. The highest air temperature (19.1°C) was recorded on February 27 in Tarnów (information applies only to synoptic stations). It is worth noting that the highest temperature values in February occurred at all stations in Poland on days 15-16 or 26-28. On Śnieżka, 8.6°C was recorded on February 17, and on Kasprowy Wierch 4.0°C. The lowest air temperature outside high-mountain stations was recorded on February 9 in Suwałki (–6.6°C) and in Elbląg (–6.4°C). On Śnieżka, the coldest day was February 8 (–10.1°C), and on Kasprowy Wierch on February 14 (–10.4°C). The lowest temperature values in February occurred in Poland at most stations at the end of the first and second decade of the month. Many measuring stations did not record days with snow cover this month (e.g. Warsaw–Okęcie).	
Thunderstorms/Hail	2024-03-12	2024-03-12	1 day	Southern part of the country	Unusual	The occurrence of shallow convection in the south of the country brought locally small hail, which appeared in Jurgów in Podhale. The humid air mass, together with the frontal zone, also contributed to the occurrence of large daily rainfall totals in Małopolska. In Jaworzyna Krynicka, 24.1 mm of rain fell in 12 hours, and in Muszyna – 25.1 mm	
Heat wave/Heat record	2024-03-30	2024-04-01	3 days	Most of the country	Unprecedented	A specific pressure system over Europe, created by a large cyclone from the eastern Atlantic in the British Isles region, as well as an anticyclone system stretching from eastern Europe to the southern part of the continent, worked together to create a wide corridor for the inflow of very warm air to Poland from northern Africa. After 50 years, a new record for the maximum temperature for March was broken. At the synoptic station in Tarnów, the maximum daily air temperature was 25.5°C. The scale of warming is evidenced by an unusual anomaly in the maximum temperature, which in many regions of Poland was even 10-14°C above the climatic norm for this time of year.	
Strong wind/Thunderstorms	2024-03-31	2024-04-01	2 days	Southern and western part of the co-untry	Unusual	Due to the distribution of pressure systems over Europe, in the southern part of the country in the mountainous and foothill areas there was a very dry foehn wind (in the Tatras foehn wind) Wind gusts of up to 150 km/h were recorded on Kasprowy Wierch. Gusts of up to 95 km/h were recorded in Zakopane and Gubałówka. Violent storms, including supercells, passed through the west of the country. Earlier, they were accompanied by wind gusts exceeding 70-80 km/h, in places 90 km/h.	The descending hurricane wind into the valleys broke trees and caused huge damage. Many hiking trails were blocked. Unfortunately, as many as 5 people died. The first victims appeared in Zakopane, where a young woman and a 9-year-old boy died in two accidents. 3 victims were also recorded in Rabka-Zdrój. In the local park, a tree crushed two adults and a child. The fire department recorded 736 incidents related to, among others, damaged roofs and broken trees that fell on cars, buildings and blocked roads and sidewalks.
Heat wave	2024-03-01	2024-03-31	31 days	Entire country	Unusual	The average area air temperature in March 2024 was 6.7°C and was as much as 3.6°C higher than the long-term average for this month (climatological normal period 1991-2020). This year's March should be classified as an extremely warm month. The warmest region was the Sudetes, where the average area air temperature was 7.6°C, which was 4.6 degrees higher than normal, and thermal conditions were classified as extremely warm. The coldest region was the coastal strip, where the average air temperature was 6.3°C (3.0°C above normal). According to the ranking classification of average monthly temperatures, covering the period since 1951, March 2024 ranks 1st. It was therefore the warmest March in Poland since at least 1951.	
Drought	2024-03-01	2024-03-31	31 days	Entire country	Unusual	In March 2024, the area-averaged total precipitation in Poland was 28.4 mm and was as much as 9.4 mm lower than the norm for that month determined on the basis of measurements in the years 1991-2020. According to Kaczorowska's classification, last March should be classified as a dry month (75.1% of the norm).	
Heat wave	2024-04-06	2024-04-09	4 days	Entire country	Unusual	Very warm tropical air from northern Africa flowed into the country. At many measuring stations, primarily in the western part of the country, the maximum temperature exceeded 25°C (e.g. Jelenia Góra synoptic station 29.2°C, Dobrogoszcz climatological station 29.7°C). The average air temperature anomaly until April 9 was +6.3°C.	

Observed extreme weather or climate event	Physical characteristics of event						Interferences occurring
	Event start	Event end	Duration	Location/Area	Rarity	Description of event	
Cold wave	2024-04-17	2024-04-19	3 days	Entire country	Unusual	As a result of the inflow of the Arctic air mass from the north, many regions of the country experienced frosts and ground frosts. At the Jelenia Góra synoptic station, the minimum temperature was –3.7°C, and at the Łódź synoptic station, the minimum ground temperature was –6.0°C.	Losses in agriculture and horticulture
Cold wave	2024-04-23	2024-04-23	1 day	Entire country	Unusual	As a result of the inflow of the Arctic air mass from the north, many regions of the country experienced frosts and ground frosts. At the Jelenia Góra synoptic station, the minimum temperature was –7.2°C, and the minimum temperature at the ground was –10.0°C. At the Jakuszyce telemetry station, the minimum temperature was –11.7°C.	Losses in agriculture and horticulture
Tornado	2024-05-19	2024-05-19	A few minutes	Grzędzice – Zachodniopomorskie Voivodeship (53°22'18"N 14°58'17"E)	Unusual	A supercell thunderstorm passed over the region, which, combined with low-level cloud condensation, led to the development of a short-lived tornado.	
Thunderstorms	2024-05-20	2024-05-20	1 day	North-western and western part of the country	Unusual	On the convergence line stretching from west to east, numerous storm cells formed, in places creating extensive multi-cell systems with heavy rainfall and hail. The highest rainfall total was recorded at the Gniezno measuring station – 39 mm, with 27.8 mm falling in 30 minutes. The rainfall was also accompanied by hail, creating snowdrifts in the streets. According to radar data from the RainGRS system, rainfall totals in Gniezno could have reached 80-100 mm in places, but these values could have been slightly inflated by hail.	According to data from the State Fire Service, as a result of storms, 663 calls to atmospheric incidents were recorded throughout the country, the most in the following Voivodeships: Wielkopolska 369 and Zachodniopomorskie 96. The most difficult situation was in the town of Gniezno (325 calls to incidents). Numerous floodings of streets, sidewalks and basements in residential and farm buildings.
Strong thunderstorms	2024-06-02	2024-06-02	1 day	Western and southern part of the country	Unusual	In Kędzierzyn-Koźle, after several storms passed over the city, each of which generated heavy rainfall, numerous floods and inundations occurred. As much as 53.9 mm fell there! After the heavy rain, the hospital building was flooded, where admissions to the Emergency Department were suspended and the Night and Holiday Health Care was closed. A supercell storm passed through Poznań, which brought heavy rainfall, as well as hail with a mean depth of up to 2.5 centimeters.	In Kędzierzyn-Koźle firefighters intervened mainly to pump water out of buildings, roads and properties, as well as to remove broken trees.
Tornado	2024-06-02	2024-06-02	A few minutes	Bogusze Stare – Podlaskie Voivodeship (52°34'26"N 22°40'17"E)	Unusual	A supercell thunderstorm passed over the region, which, combined with low-level cloud condensation, led to the development of a short-lived tornado.	Roof or chimney damage, large broken tree branches, uprooted or broken tree/trees
Heavy rainfall	2024-06-04	2024-06-04	1 day	Southern and south-western and part of the country	Unprecedented	As a result of the impact of the low pressure centre and the atmospheric front system in the south of the country, there was heavy rainfall, locally torrential. At the Wapienica measuring station, the daily rainfall total was 148.4 mm, and at the Bielsko-Biała synoptic station 127.4 mm. This rainfall occurred within 12 hours and was almost the equivalent of the monthly rainfall total for the multi-year period for June. Sudden increases in water levels were observed on many rivers. At the Podkępie hydrological station on the Wapienica River and at the Czechowice-Dziedzice station on the Iłownica River, the water level rose by about 330-350 cm in about 6-7 hours. At the Podkępie hydrological station, the water level exceeded the absolute maximum and amounted to 595 cm that day. In Cieszyn, the Olza River exceeded the alarm level.	In the country, over 2,200 interventions of the Fire Department were recorded, of which over 1,200 were in the Śląskie Voivodeship, specifically the Bielsko district. Flash flood in the city of Bielsko-Biała. Numerous floods of streets, bridges, pavements and basements in residential and farm buildings. Due to storms and heavy rainfall, the fire department in the Śląskie Voivodeship has recorded over 900 interventions since midnight. In Małopolska, the number of interventions is 335. A flood alarm has been declared in Bielsko-Biała.
Severe thunderstorm	2024-06-07	2024-06-07	1 day	Western part of the country	Unusual	A strong storm, probably of a supercell nature, occurred over Turek - radar data indicated the presence of a mesocyclone and large hail. The storm supercell caused very large damage, the strongest of which occurred in the belt from the Rychwał commune, through Tuliszków, the Turek region, Brudzewo, Uniejów (Łódź Voivodeship), to Łęczyca. On its route, dense hail fell, the largest hailstones of which reached at least approx. 4 cm in diameter. In places, the hail formed a cover of several centimetres on the ground. The storm supercell also brought strong gusts of wind.	Hail rainfall caused major losses in agricultural crops. Crop fields were completely covered with a layer of hail.
Severe thunderstorm	2024-06-19	2024-06-19	1 day	Southern part of the country	Unusual	A multi-cell system was moving over Poland. In the town of Pstrążna in the Silesian Voivodeship in Rybnik County, there was major damage caused by the passage of a strong supercell storm. Judging by the damage, it can be concluded that it was caused by strong winds associated with a violent, short-term downdraft. A mesoscale convective system was moving through the southern part of Poland, heading from Silesia towards the Lublin region. Very strong, destructive wind gusts of up to 100 km/h were recorded along the storm route, as well as heavy rainfall and hailstorms	The most serious situation occurred in the belt from the vicinity of Wodzisław Śląski through Żory, Pszczyna to the Brzeszcze region, where very strong winds appeared associated with the downdraft in the supercell. Thousands of fallen trees, impassable roads, dozens of torn off roofs and destroyed power lines. There is also major destruction in the vicinity of Leżajsk, where Bow Echo developed during the night hours.
Severe thunderstorms	2024-06-21	2024-06-22	2 days	Southern part of the country	Unusual	On 21.06, a storm system with supercells came to Poland from the Czech Republic and Germany, causing damage in Lower Silesia, including Legnica, Polkowice, Pławna Dolna, Jarocin, Bielsko-Biała, Lwówek Śląski and Radoniów. Further violent storms passed over the Wielkopolska Voivodeship: in Janów, Kotlin, Wałków, Stara Obra, Biały Dwór, Gostyń, Łagiewniki and Starkówiec. The main threat was hail, up to 4 cm (Pławna Dolna), heavy rain, which caused flooding in Krotoszyn County, Gostyń, Przemków, among others, and strong wind, due to which the fire department intervened to damaged buildings, among others, in Krotoszyn County. 22.06, a strong convective system passing in the early morning hours, directed from the south-western regions towards the center, and to the north-east. It caused damage in the form of strong wind gusts, mainly in Silesia, as well as in Małopolska, Podkarpacie and in the Lublin and Łódź provinces.	Over Cieszyn Silesia and Hurk, the wind damaged several roofs, in Krakow a tree fell on a passing car. In addition to the threat associated with the wind, an absolutely dangerous and life-threatening phenomenon was the heavy hail in the Podkarpacie region, reaching as much as 7 cm! It fell in the town of Harta, while over Dynów the hailstones were 6 cm in diameter. On Saturday, during a storm, three boats capsized at Lake Solina, four of whom were injured.
Downpour	2024-06-27	2024-06-27	A few hours	Western and southern part of the co-untry	Unusual	The storm activity covered primarily the Wielkopolska Voivodeship. On the storm route, heavy/torrential rainfall and very strong gusts of wind were recorded. They resulted in fallen trees in the vicinity of the towns of Panki and Turkolasy (near Kłobuck) in the Silesian province. Streets were flooded near Kalisz (Wielkopolska Voivodeship). Storm centers also moved in the belt from Ostrów Wielkopolski in Wielkopolska and Łódź, to the Świętokrzyskie Voivodeship, and on the border of Małopolska with Podkarpacie. The storms were characterized by very slow movement in the north-westerly direction, which resulted in long-term downpours and, as a result, flooding. In Dąbrowa Tarnowska, 51.3 mm of rain was recorded in 1 hour. Also in Jasło and Gorlice, long-term rainfall caused flooding and flooding. Hail was also recorded in Ustrzyki Dolne and Jasło.	Heavy rainfall in Gorlice led to flooding and undermining. Manholes could not keep up with draining the water. The rainfall was also accompanied by hail.
Severe thunderstorms	2024-06-30	2024-06-30	1 day	Most of the country	Unusual	Three storm zones occurred over Poland. The first one in the north in the area of central Pomerania – a multi-cell storm is observed here, posing a risk primarily of strong wind gusts. The squall line moved over Kartuzy and Wejherowo. The second storm zone is concentrated in the east of the Wielkopolska Voivodeship, gradually entering the Łódź province. In addition to strong wind gusts, storms here also generate hailstorms and heavy/torrential rainfall. A dangerous multi-cell storm formed and passed over the Łódź Voivodeship. Storm cells (including supercells) merged into one compact multi-cell system. In the south of Poland, the multi-cell storm system moved very slowly through the regions of Silesia and Małopolska. A strong supercell storm brought very intense hailstorms over Drągowo in the Twardogóra commune (Dolnośląskie Voivodeship). Additionally, large-scale convective precipitation occurred within it, increasing precipitation totals.	Hailstones reaching and exceeding 4 cm in diameter caused damage to the elevation, and also, based on the documentation sent, broke windows. Above the town of Gręblin in Tczew County, the storm caused significant wind damage. According to local reports, about 40 trees were damaged/fallen.
Tornado	2024-06-27	2024-06-27	A few minutes	Ostrówek – Wielkopolskie Voivodeship (51°53'01"N 18°35'40"E)	Unusual	A supercell thunderstorm passed over the region, which, combined with low-level cloud condensation, led to the development of a short-lived tornado.	
Waterspout	2024-07-02	2024-07-02	A few minutes	Krynica Morska	Unusual	Four condensation funnels were observed over the water, two of which had contact with the water.	

Observed extreme weather or climate event	Physical characteristics of event						Interferences occurring
	Event start	Event end	Duration	Location/Area	Rarity	Description of event	
Thunderstorms	2024-07-07	2024-07-07	A few hours	Podkarpackie Voivodeship	Unprecedented	Due to the movement of a cold atmospheric front from the west with a preceding convergence line, numerous storm cells, including supercells, developed across the country. In the area of Strzyżów, Podkarpackie Voivodeship, a "training storm" phenomenon occurred, as a result of which 74.1 mm of precipitation fell in 80 minutes (Żarnowa precipitation station). The maximum daily rainfall total of 77.7 mm was broken there. It amounted to 84.4 mm. In the area of Mielec, a strong left-handed supercell passed, where a very strong wind associated with a downburst occurred.	Numerous floods of residential and farm buildings; Damage to road and municipal infrastructure; Broken roof coverings and power lines, broken trees; In Mielec, after the passage of a supercell storm, the wind damaged residential and farm buildings, broke trees and damaged power lines, 900 customers were left without power. Wind damage also occurred over Baranów Sandomierski. At the moment, 130 fire department interventions are reported in the Podkarpackie province, most of which concern the Mielec district.
Thunderstorms	2024-07-08	2024-07-08	Several dozen minutes	Wolbrom (50°22'46"N 19°45'29"E)	Unusual	As a result of the passage of a supercell storm formed at the junction of a hot and humid tropical air mass and a cooler maritime polar air mass with strong winds, heavy rain and hailstones up to 3 cm in diameter, streets and roads were flooded and ice drifts were formed.	Flooded streets, roads, properties, fields, and residential and farm buildings Over 70 fire brigade interventions in the Olkusz district.
Storm	2024-07-10	2024-07-11	1 day	Warmia and Mazury	Unusual	Due to the advection of a hot and very humid air mass, which pushed out a cold atmospheric front, convective cells and linear convective systems developed over Poland. A powerful storm passed over the Warmińsko-Mazurskie Voivodeship on the night from Wednesday to Thursday (July 10/11).	Firefighters intervened almost 240 times. The officer on duty at the Provincial Headquarters of the State Fire Service reported that most interventions involved removing fallen trees and pumping water out of rooms. The most serious incident recorded by firefighters was a young man being crushed by a tree - it happened at Lake Skanda in Olsztyn. The man was taken to hospital. In Siemiany at Lake Jeziorak in the Iława district, 445 children and 50 camp staff members were evacuated to a safe place. According to the services of the Warmińsko-Mazurskie Voivodeship, storms were the cause of power outages. 26.3 thousand customers were left without power. The largest number was in the Braniewo and Elbląg areas – approx. 25 thousand, and Miłaków and Morąg – approx. 1.3 thousand. Power outages also occurred in the vicinity of Giżycko.
Tornado	2024-07-11	2024-07-11	A few minutes	Naprawa (49°39'52"N 19°52'35"E)	Unusual	In Małopolskie Voivodeship, in the Sucha district, a mesocyclonic tornado appeared. A supercell storm was passing there, which, combined with a low level of cloud condensation, led to the formation of a short-lived tornado. The storm cluster caused heavy rainfall. During the passing supercell storm, a tornado was formed over the town of Naprawa.	The phenomenon most likely occurred in uninhabited areas. There is no information about injured people or damage.
Strong thunderstorms	2024-07-12	2024-07-13	1 day	Most of the country	Unusual	Over Poland, clusters of individual storm cells formed in the south of the country and a linear storm structure in the west with a bow echo. During the day, a squall bank moved from Lower Silesia to Podlasie. In addition, point storm cells were constantly forming in the south. In many places, the conditions were favorable for the formation of hail with a diameter of up to 6 cm, such as those recorded in Dukla. The storms were accompanied by strong wind gusts of up to 100 km/h and heavy rainfall. In Boczów, as much as 25.1 mm was recorded.	In Tomaszów Mazowiecki, the vast majority of interventions concerned broken branches, fallen trees, clearing roads and communication routes. Some incidents also concerned damaged roofs. There were also interventions concerning pumping water from flooded rooms and basements. Strong gusts of wind tore off 400 square meters of roof, which collapsed onto a nearby street and square. In Cieszyn County, in the town of Jaworzynka Śląskie Voivodeship), a tree branch fell on a caravan, causing a head injury to a man staying there. In the Silesian Province, strong winds tore off 13 roofs, including nine on residential buildings. In addition, seven roofs were damaged, including three on residential buildings. In Łódź, Friday's storm over Łódź caused serious damage and paralyzed traffic in the city. The overflowing water led to the rupture of a bridge on Siewna Street. In Radomsko, during a storm, a piece of sheet metal fell from the roof of a block of flats, hit a car, and broke its window. In turn, in the town of Kamienna Wieś (Łódź Voivodeship), lightning struck a farm building. The roof burned down, but no one was injured. The basements of the hospital in Międzychód (Wielkopolska Voivodeship) were flooded. As a result of the violent storm, a significant part of the forests of the Olsztyn Forest District was devastated.
Violent thunderstorm	2024-07-13	2024-07-14	1 day	Świętokrzyskie Voivodeship	Unusual	Storm cells with reflectivity over 65 DBZ appeared over the Świętokrzyskie region, generating heavy rainfall accompanied by hail. Wind gusts reached 80/100 km/h. Rainfall intensity of up to 20-40 mm/h was recorded. In the capital of the province, streets were flooded in many places.	In Kielce alone, 400 reports of damage caused by rain and wind were recorded. Many broken trees, torn roofs and local flooding. In the Łączna commune, storms caused a lot of damage in the form of torn roofs of residential and farm buildings, trees fallen on buildings, roads and power lines. There is a power outage in many places. In Jędrzejów County, the storm tore roofs off about 20 houses. By 1:00 p.m., Świętokrzyskie firefighters had recorded over 1,100 reports. 113 residential buildings and 68 farm buildings were damaged.
Downpour	2024-08-08	2024-08-08	1 day	Southern part of the country	Unusual	An atmospheric front of an occlusive nature passed over Poland, before which thunderstorms occur in the form of multi-cells, as well as isolated thunderstorm cells. Two precipitation zones have formed over the country. The first in the north of the country: from Sierpc in Mazovia, to the center of the Pomorskie Voivodeship, and over Elbląg in the Warmińsko-Mazurskie Voivodeship. Heavy rainfall is also continuing over the southwestern part of the country, with the total exceeding 25 mm there in places. In Lower Silesia and Opole Region: In Unikowice, in the Paczków commune, 46.6 mm fell in an hour, while in Meszno, in the Otmuchów commune, 43.6 mm was recorded. heavy rainfall, which, especially in urbanized areas, causes flooding and inundation. They occurred mainly in the Silesia, including Żywiec, Sosnowiec, Piekary Śląskie, Ruda Śląska and Bytom – intense hailstorms were also recorded here.	In Dąbrowa Górnicza, due to heavy rains, the fire brigade intervened 250 times. The local tunnel was flooded, as well as roads, parking lots, and properties. The Silesian fire brigade has already recorded about 400 calls in the province, mainly for pumping out water. Unfortunately, as a result of a strong storm, in the town of Podzamek (Kłodzko district) in the Lower Silesian province, a tree fell and then crushed a car passing on DK 46. One person died and four others were injured.
Severe thunderstorms	2024-08-17	2024-08-17	1 day	Most of the country	Unusual	Storms, in the form of single cells, as well as multi-cell structures, passed mainly over the southern part of the country. Strong storms were also recorded in the Warmińsko-Mazurskie Voivodeship and in the Lublin Voivodeship. In Racibórz (Śląskie Voivodeship), as much as 52.7 mm of rain fell, of which 30.2 mm was recorded in one hour.	In the Commune of Kietrz in the Opole Voivodeship, numerous floods and underflows were recorded, as well as difficulties in travel due to flooded streets/roads. Over Lubaczów in the Podkarpacie region, the storm broke trees, several roofs were torn off, and floods occurred. In the Warmińsko-Mazurskie Voivodeship, hail damaged roofs, in Kramarzewo a tree fell on the roof, the storm knocked down trees with their roots. In Kikity (Jeziorany commune), a tree fell on a gazebo, injuring one person. In Małopolska, on Lake Mucharskie, a strong wind capsized a sailboat. No one was injured. In Dąbrowa Górnicza in the Śląskie Voivodeship, as a result of the microburst phenomenon – the city is once again struggling with flooding. It was also accompanied by strong wind, and many broken trees were reported.
Tornado	2024-08-18	2024-08-18	A few minutes	Powiercie-Kolonia by Koło (eastern part of Wielkopolska Voivodeship)	Unusual	Increased storm activity was noted throughout the country due to the presence of a shallow low over the southwestern part of the country. A slowly rotating tornado was noted in the Wielkopolska Voivodeship.	According to witness reports, the tornado associated with the passing storm damaged or ripped off at least eight roofs of residential and farm buildings.
Downpour	2024-08-19	2024-08-20	A few hours	Warszawa (52°15'N 21°00'E)	Unprecedented	As a result of the impact of the low-pressure center, strong storms with long-lasting rainfall developed across the eastern part of Poland. As a result of the impact of the low-pressure center, strong storms with long-lasting rainfall developed across the eastern part of Poland. At the Warsaw-Bielany measuring station, the daily total was 119.5 mm and this was the highest value since the beginning of measurements. At the Borków measuring station, the daily total rainfall was 111.3 mm, and at the Warsaw-Okęcie station 93.8 mm.	Over 120 Fire Department interventions in the city of Warsaw. Numerous floods and under-flooding of properties, roads, and sidewalks.
Thunderstorms	2024-08-21	2024-08-21	A few hours	Eastern and South-eastern part of the country	Unprecedented	As a result of the development of almost stationary storms in the Zamość region, the hourly rainfall total was 88.3 mm, and the total rainfall total was 147.2 mm, which is the highest daily value measured since the beginning of measurements at this station. The hourly rainfall was close to the daily rainfall record. In Czchów, Małopolskie Voivodeship, hail fell during the storm with a mean of up to 7.5 cm.	Over 200 Fire Department interventions in the city of Zamość and Zamość district. Flash flood in the city of Zamość; Numerous floods and under-flooding of properties, roads and sidewalks.
Hydrological drought	2024-06-20	2024-08-31	Over 2 months	Poland	Unusual	Due to the very warm and dry summer, a hydrological drought was recorded in the country. The majority of water gauges on rivers recorded low and extremely low levels.	Losses in agriculture.
Low water levels record	2024-09-09	2024-09-09		Most of the country	Unprecedented	On September 9, 2024, water levels on rivers in Poland were mainly in the low water zone (as much as 73%). The medium water zone was recorded at 25% of hydrological stations, and the high water zone at only 2%. On September 10, 2024, a record low water level (20 cm) was recorded at the Warsaw–Bulwary station. Until now, the absolute minimum was 26 cm – this value was reached several times during the summer-autumn drought in 2015 (August 28 and 29 and September 5). On that day, the absolute minimum water level in the history of measurements was recorded at 26 stations in Poland.	

Observed extreme weather or climate event	Physical characteristics of event						Interferences occurring
	Event start	Event end	Duration	Location/Area	Rarity	Description of event	
Downpour	2024-09-12	2024-09-15	A few days	South-western part of the country	Unusual	The Genoese low Boris moved over the Central European area, bringing more and more clouds and rain. The low itself also moved north towards the Hungarian-Slovak border, heading towards the Carpathians. It reached southern Poland on the night of 13/14.09 and then stopped. It was blocked by high-pressure centers. Carrying with it huge amounts of water vapor, it contributed to the occurrence of heavy rainfall.	Flooding and numerous floods.
Flood	2024-09-12	2024-09-21	Over a week	Southern and South-western part of the country; voivodeships: Dolno-śląskie, Opolskie, Śląskie, Małopolskie, Lubuskie	Unprecedented	Flood in September 2024 especially in the southern Oder basin, caused by the Genoese low, which contributed to heavy and intense rainfall and a general weather breakdown in Central Europe after a long drought. The rise in water levels in the Oder basin began in the Sudetes and the Silesian Lowland. The phenomenon of flooding or flood threat occurred in the Lower Silesia, Opole, Silesia, Lubuskie voivodeships and the rest of Central Europe. The flood, due to its size, can be compared to the flood of the millennium in 1997 11 Central European countries suffered, including Poland.	Huge material damage. The most affected towns: Lądek Zdrój, Kłodzko, Stronie Śląskie, Lewin Brzeski, Głuchołazy. As much as PLN 4.2 billion in losses has been caused so far by the flood wave passing through Poland. The amount established as of September 21 this year. However, it does not include data from the most destroyed towns, such as Głuchołazy or Lewin Brzeski. 11 fatalities. Devastated infrastructure, buildings, houses, blocks, land. Broken bridges and broken dams.
Tornadoes	2024-09-14	2024-09-14	A few minutes	Voivodeships: Mazowieckie and Łódzkie	Unusual	As many as 5 tornadoes were confirmed that passed over Poland on 14.09, of which 4 occurred over the Mazowieckie Voivodeship: in Kociszewo, in the Grójec commune, in Chrosno in the Kołbiel commune, in Wierzchowiny in the Jedlińsk commune, in Nowa Wieś in the Kozienice commune. The fifth tornado appeared in Brudzewice, in the Poświętne commune, in the Łódź province. Based on currently available documentation, it can be stated that the strongest of them occurred in Wierzchowiny. After analysis, it was classified on the IF2 scale.	Roofs of 4 residential buildings and 12 farm buildings in Wierzchowiny have been torn off or damaged. In Jeziorno, roofs have been damaged on 1 residential building, 3 farm buildings and 1 garage.
Tornadoes	2024-09-15	2024-09-15	A few minutes	Karmin – Wielkopolskie Voivodeship, Biadki	Unusual	At least 2 phenomena confirmed in Wielkopolska. One of the tornadoes occurred in the vicinity of Karmin near Dobrzyca. The second was recorded in the vicinity of Krotoszyn in the town of Biadki. In Wielkopolska and Lower Silesia, individual storm cells developed, primarily supercells. The storms brought heavy rainfall and strong gusts of wind.	There was damage to several trees and tombstones.
Strong Wind	2024-10-13	2024-10-13	A few hours	Voivodeships: Dolnośląskie, Opolskie, Wielkopolskie, Lubelskie	Unusual	The vast majority of the country was under the influence of Cyclone Helm with its center moving in the Baltic Sea region. In the frontal zone moving from west to east, there was heavy rainfall and strong winds with gusts of up to 85 km/h.	Firefighters, especially in the Dolnośląskie and Lubelskie Voivodeships , recorded numerous reports of fallen trees, torn off roofs and damaged chimneys.
Strong Wind	2024-11-01	2024-11-01	1 day	Pomorskie Voivodeship	Unusual	A cold front zone has moved in from Northern Europe, causing different weather conditions than in the southern reaches of Poland. Due to the increased pressure gradient in Northern Poland, strong gales and the accompanying jet stream occurred. On the coast, strong winds were recorded, gusting up to 28.9 m/s in Rozewie.	Pomeranian firefighters have intervened over 60 times due to wind. There are fallen trees and broken branches. The most interventions so far have been in Wejherowo and Gdańsk. In Gdynia, at the Witomin cemetery, a fallen tree damaged two tombstones. On Malczewskiego in Sopot, one of the trees is dangerously leaning. A similar intervention was carried out at the cemetery in Władysławowo.
Strong Foehn Wind	2024-11-19	2024-11-21	2 days	Southern part of the country	Unusual	The foehn wind preceded the arrival of the Quiteria low. Its range covered the area from southwestern to southeastern Poland. The greatest intensity was recorded on the night of November 19/20.	In Zakopane, a storm blew a tree down onto a school building. In Radłów, a tree blown down by the wind fell onto a car, and in Rzepiennik Biskupi, part of a house wall collapsed. In Nowy Sącz, firefighters intervened 15 times in similar situations. In Krzewo Mała, roads were impassable. The wind tore trees out with their roots. A similar intervention was also reported in Bielsko-Biała.
Hydrological drought	2024-11-01	2024-11-30	Whole month	Most of the country	Unusual	November 2024 was classified as an extremely dry month. Most of the country received no more than 3 mm of rain.	
Gales	2024-12-16	2024-12-17	1 day	North-eastern part of the country	Unusual	Due to the influence of the Ziva low, a cold atmospheric front moved over Poland on 16.12.24. Poland was under the influence of two pressure systems with a pressure gradient exceeding about 22-25 hPa. The wind speed in the area of the interacting front exceeded 100 km/h (IF1).	As reported on social media by the Main Headquarters of the State Fire Service, firefighters intervened 3,555 times in connection with the strong wind that swept over Poland on Monday. The most interventions were carried out in the following Voivodeships: Mazowieckie (678), Pomorskie (633), Warmińsko-Mazurskie (626) and Podlaskie (455). Strong winds damaged trees and buildings, and two people were injured when a tree fell on a car.

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