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IS UST-KAMENOGORSK WARMING? WEATHER-STATION RECORDS AND NASA POWER MODEL DATA, 1981-2024

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Abstract: NASA POWER, a free online source of climate data, shows no warming in Ust-Kamenogorsk between 1981-1990 and 2015-2024 (+0.01 °C). This study compares it with the monthly records of the city's weather station and of Semey. The published station series warms by 2.09 °C, but it contains a shift of about +1 °C in August 2007, found against two other stations; its cause is not documented, and a change from an airport record to the city station is the leading but unconfirmed candidate. With the shift removed, the city warmed by about 1.0 °C (95% interval -0.03 to 2.10), or 0.21 °C per decade over 1976-2023 (-0.04 to 0.47). With this cautious estimate of the shift neither value is significant; most other ways of measuring the shift give a significant warming of 1.1-1.8 °C. Both stations became warmer relative to POWER, with a step after 2012 at both (+0.6 °C at Semey, +1.0 °C at Ust-Kamenogorsk); a shared date points to the model data or a regional change rather than to the stations. In 2015-2024 the winter offset from the model minus the summer offset is +0.06 °C at the airport, against +1.72 °C at the city station 12 km away and +2.66 °C at Semey. The city is probably warming; this rests on the regional trend and on the uncertain station estimate.

Keywords: climate change, weather station, homogeneity, temperature inversion, urban heat island, NASA POWER, MERRA-2, Ust-Kamenogorsk

1. Introduction

Kazakhstan is warming. According to Kazhydromet, the national weather service, the mean annual air temperature averaged over the country rose by 0.36 °C per decade in 1976-2023, and in East Kazakhstan Region by 0.30 °C per decade [1]. Ust-Kamenogorsk (Oskemen), the centre of the region, lies on the Irtysh, in a river valley surrounded almost on all sides by spurs of mountain ranges [2]; its weather station is at 292 m above sea level [3].

Free online climate data are often used to describe such places. One of the easiest to use is NASA POWER [4], which gives temperature for any point on Earth from 1981 [5]. Its temperature comes from the MERRA-2 reanalysis, a weather model combined with observations [6]; values are given on a grid of ½° of latitude by ⅝° of longitude [7] and are "taken from the model at 2 m above the average elevation of the grid box" [5]. For the point of Ust-Kamenogorsk, POWER gives the same mean annual temperature, 3.79 °C, for 1981-1990 and for 2015-2024, and a colder January, -14.65 instead of -13.16 °C. If this were true, the city would have missed the warming of its region.

A model cell of about 55 by 45 km cannot represent a valley or a city inside it. In mountain valleys cold air collects at night and in winter, and the temperature there can change differently

from that of the free air above, which coarse models follow [8]. Cities also change the temperature around them; one way their effect has been estimated is by comparing city stations with stations in the surrounding rural areas, and another by comparing station trends with those of a reanalysis that does not use surface temperature observations [9]. A station record can also change for reasons that have nothing to do with climate, such as a move of the station; such changes are found by comparing a station with its neighbours [10].

The questions are: (1) Is Ust-Kamenogorsk warming according to its weather station, and by how much? (2) Does POWER show the same, and if not, when and in which seasons does it differ? (3) Is the difference larger in Ust-Kamenogorsk than in Semey, about 180 km to the west? (4) Can the difference be explained by the height of the model cell, by cold air near the ground or by the city itself? The main regional reference used here is Kazhydromet's climate bulletin; no comparison of station and model temperature for Ust-Kamenogorsk was found in the OpenAlex and Crossref records and the Kazhydromet bulletins searched for this study.

2. The author's expectations

The mentor proposed the topic with the POWER result for Ust-Kamenogorsk (3.8 °C in both decades, a colder January) and asked the author why, in his view, the city does not warm according to these data. Before he had seen any station data, he answered (26 October 2026, translated from Russian): "Most likely because the orography of the city is pronounced. The city lies in a basin, so a temperature inversion can occur, when dense cold air from the mountains flows down the slopes of the mountains." He thus explained the POWER result by an inversion.

The next day, when he was given the points to download, he asked about Astana in five consecutive messages (27 October 2026, translated, joined with "/"): "Listen, should I take Astana itself or a suburb? / Astana is much bigger than Semey or Oskemen / and so is the city's heat island / I just think that if I take the city itself, the data will be strongly influenced by the city itself / and not by the climate of the region in general." This question, whether data for a city reflect the city rather than its region, is related to Section 4.5.

Following his mentor's instructions (the POWER website, its settings, the coordinates of the three cities and the two decades), the author calculated with a calculator and reported the POWER decade means for the year, January and July, and for autumn, with his conclusion (5 November 2026, translated): "The mean annual temperature of Ust-Kamenogorsk hardly rose, compared with Semey (+0.12) and Astana (-0.09). Thus Ust-Kamenogorsk shows weaker warming than Semey, and partly than Astana. The largest seasonal difference is in autumn: in Ust-Kamenogorsk the mean temperature fell by 0.95, in Semey by 0.47 and in Astana by 0.41. This partly agrees with my hypothesis about temperature inversions but does not prove it (other data are needed to prove it)." Apart from one typing error, his numbers agree with the values recalculated here within 0.01 °C.

3. Data and methods

Model data. Monthly temperature at 2 m (T2M) for 1981-2024 was taken from the POWER point service [4] for 49.95° N, 82.61° E (Ust-Kamenogorsk), 50.41° N, 80.23° E (Semey) and 51.17° N, 71.43° E (Astana), the points and decades the mentor gave the author. POWER reports the average elevation of each cell: 473, 257 and 365 m. POWER's own annual value is weighted by the number of days in each month (3.79 °C in both decades for Ust-Kamenogorsk); here every annual mean, for model and stations alike, is the mean of the twelve monthly values (3.71 and 3.72 °C).

Station data. Monthly means for 1976-2024 for the stations Ust-Kamenogorsk (WMO 36403), Semey (36177) and Astana (35188), and for two other stations of East Kazakhstan, Ridder (36208) and Shemonaikha (36186), were taken from the "Weather chronicle" of the website "Pogoda i klimat" (PiK) [11], which compiles them from online reports and printed sources. No month is missing. PiK's description of the Ust-Kamenogorsk station [2] says that it was moved "16 km to the north-west" on 21 June 1951 and gives a position of 50.04° N, 82.49° E, which is the position of the airport station in NOAA's station list. NOAA lists the Ust-Kamenogorsk station for 1957-1997 at 49.97° N, 82.63° E, 292 m [12], and Kazhydromet gives the same "current location"

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[3], which is in the city. The available descriptions of where the station stood thus disagree. NOAA gives a height of 196 m for Semey [12]; PiK places its Astana station in the city, at 347 m [13].

Other records. NOAA's daily summaries (Global Summary of the Day, GSOD) [12] were averaged into months when at least 20 days were present. They hold the Ust-Kamenogorsk station only for 1981-1997, with many gaps, and, from 22 August 2007, the Ust-Kamenogorsk airport station (286 m, about 12 km north-west of the city position). The airport record has 13-22 reports per day in 2007-2011 and 24 from 2012. NOAA's Astana file has 7-11 reports per day until 1999 and 15-24 from 2000; it agrees with PiK's Astana series until 1999 (PiK 0.04 °C colder on average), but from 2001 PiK's series becomes steadily warmer than it, by 1.11 °C on average in 2005-2024. The two Astana records therefore describe different sites after 2000, and neither can be checked by the other; Astana is shown for the POWER result and PiK's series, but it is not used as a reference or for conclusions. Three recent values for the Ust-Kamenogorsk station were taken from Kazhydromet's monthly bulletins [14]. Population at the beginning of each year is from the Bureau of National Statistics [15].

Calculations. Decade means were compared for 1981-1990 and 2015-2024, as in the author's task. Winter is the mean of January, February and December of the same calendar year, so that both decades contain the same years. For each change a 95% confidence interval was calculated from the ten yearly values of each decade (Welch's t-interval, with exact quantiles of the t distribution). Trends were estimated by ordinary least squares on annual values, with the interval widened for the correlation between neighbouring years. To test whether the Ust-Kamenogorsk series is homogeneous, the series of other stations were subtracted from it, and the differences were tested for a single shift with the Pettitt test [16] and with the standard normal homogeneity test [10]. Because neighbouring months are correlated, the p-values of the monthly tests are too small and are used only to locate the shift; the annual tests give its significance. The reference stations were tested against each other in the same way. The shift was removed by adding, for each calendar month, the mean difference after the shift minus the mean difference before it, over the whole period, to all months before the shift. To see how much the result depends on this choice, the shift was also measured from the 3, 5 and 10 years on each side of it, and by a regression of the difference on time with a step. "Station minus model" is the station value minus the POWER value. Its annual series were tested for one step with the standard normal homogeneity test (p from 20,000 simulated series of independent years), the best least-squares step and the Pettitt test, also after removing a linear trend. All calculations were made with a script that reads the downloaded files; every number comes from its output. Results for single months are descriptive.

4. Results

4.1. The published station series and POWER

In the published Ust-Kamenogorsk series the mean annual temperature rose from 3.07 °C in 1981-1990 to 5.17 °C in 2015-2024, by 2.09 °C (95% confidence interval 1.02 to 3.16), while POWER changed by 0.01 °C (-0.95 to 0.97) (Table 1, Figure 1). Section 4.2 shows that about half of this rise comes from a shift in the series.

Table 1. Mean annual temperature in two decades, its change and its trend

Series	1981-1990, °C	2015-2024, °C	Change, °C (95% CI)	Trend 1976-2023, °C per decade (95% CI)
Ust-Kamenogorsk, published	3.07	5.17	+2.09 (1.02; 3.16)	+0.51 (0.29; 0.73)
Ust-Kamenogorsk, adjusted (Semey)	4.13	5.17	+1.04 (-0.03; 2.10)	+0.21 (-0.04; 0.47)
Ust-Kamenogorsk, adjusted (Ridder)	4.13	5.17	+1.04 (-0.03; 2.10)	+0.21 (-0.04; 0.47)
Ust-Kamenogorsk, POWER	3.71	3.72	+0.01 (-0.95; 0.97)	-
Semey	4.12	4.98	+0.87 (-0.10; 1.83)	+0.25 (0.02; 0.48)
Semey, POWER	4.17	4.30	+0.13 (-0.87; 1.13)	-
Ridder	2.65	3.30	+0.65 (-0.26; 1.56)	+0.15 (-0.03; 0.33)
Astana, PiK	3.18	4.79	+1.61 (0.64; 2.58)	+0.51 (0.31; 0.70)
Astana, POWER	3.16	3.09	-0.08 (-1.06; 0.91)	-

Source: calculated from [4, 11]. "Adjusted": the 2007 shift removed, measured against the station in brackets over the whole period, from August 2007 for Semey and October 2007 for Ridder (Section 4.2). POWER starts in 1981, so no 1976-2023 trend is given for it. PiK's Astana series cannot be checked independently after 1999 (Section 3).

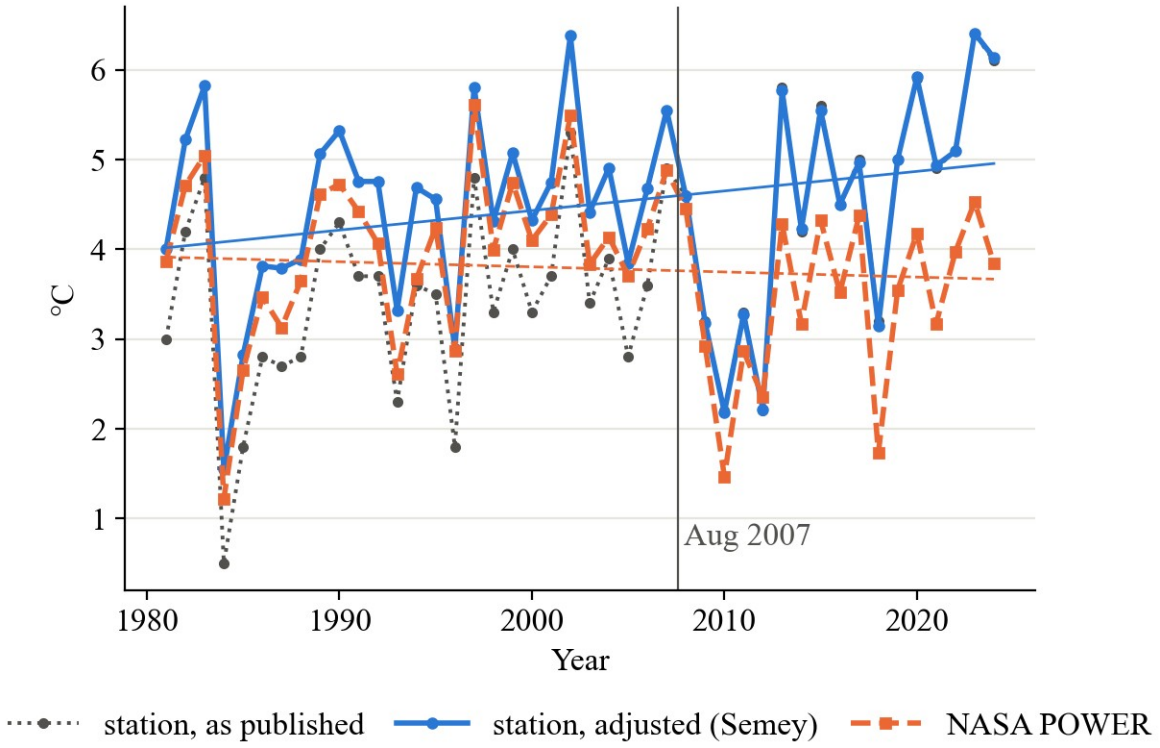


Figure 1. Mean annual temperature in Ust-Kamenogorsk, 1981-2024: station series as published, the same series adjusted for the 2007 shift (measured against Semey), and NASA POWER, with linear trends for 1981-2024. Source: calculated from [4, 11]

4.2. A shift in the station series in 2007

Until 2007 Ust-Kamenogorsk was colder than Semey every year, on average by 0.93 °C in 1976-2007; from 2008 it was on average 0.05 °C warmer (Figure 2). Over 1981-2007 the two stations warmed at almost the same rate, 0.43 and 0.44 °C per decade. Tested on annual values, the difference shifts after 2007 (Pettitt test $p < 0.001$). The same shift, of 1.05-1.06 °C, appears against Ridder (Table 2). Semey and Ridder show no significant shift against each other (the largest, +0.27 °C from 1999, has $p = 0.13$). Shemonaikha also shows the 2007 shift, but smaller, because it has its own shift: against Semey (+0.27 °C from 2000, $p = 0.02$) and against Ridder (+0.53 °C from 2000, $p = 0.001$); it is therefore not used as a reference. The standard normal homogeneity test puts the last year before the shift at 2007 against Semey and at 2012 against Ridder. The shift is largest in the cold season (1.43-2.38 °C from November to March, measured against Semey) and smallest in May-September (0.13-0.60 °C).

Table 2. Shift in the Ust-Kamenogorsk series relative to other series

Reference	First month after the shift	Shift, °C	p, annual test
Semey	August 2007	+1.05	< 0.001
Ridder	October 2007	+1.06	< 0.001
Shemonaikha (own shift, not used)	August 2007	+0.77	< 0.001
NASA POWER	February 2008	+1.69	< 0.001

Source: calculated from [4, 11]. Pettitt test on monthly anomalies, Ust-Kamenogorsk minus reference, 1981-2024, used to locate the shift; shift: mean difference after that month minus before

it; p from the Pettitt test on annual differences. The adjustment uses the mean of the twelve calendar-month shifts, 1.06 °C against both Semey and Ridder. The shift against POWER also contains the change of the model relative to the stations (Section 4.3).

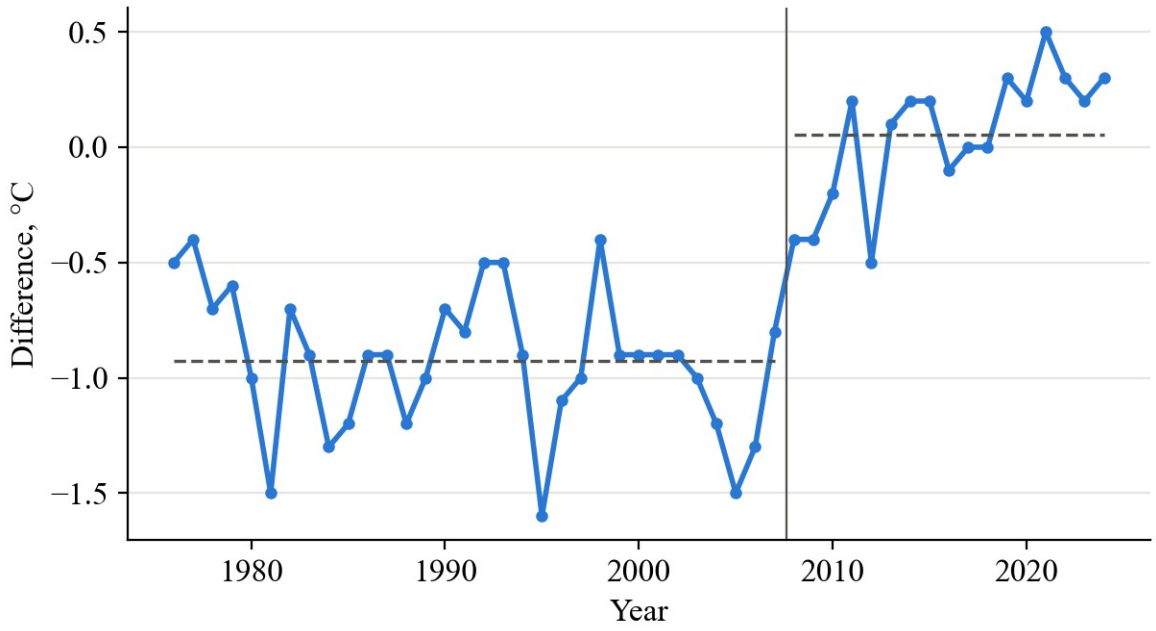


Figure 2. Mean annual temperature, Ust-Kamenogorsk minus Semey, 1976-2024; dashed lines are the means of 1976-2007 and 2008-2024. Source: calculated from [11]

The cause is not documented. The leading candidate is that the series before August 2007 comes from the airport station and the series after it from the city station, for four reasons. First, PiK places the station since 1951 at the airport's position (Section 3). Second, NOAA's separate airport record begins on 22 August 2007 [12], the month in which the shift begins. Third, the seasonal pattern of the shift is close to the present difference between the city and the airport: in 2015-2024 the city station was warmer than the airport by 1.8-2.2 °C in December-February and by 0.1-0.3 °C in May-July (Section 4.5). Fourth, in 1981-1990 the published series had almost the same winter and summer offsets from the model (winter minus summer -0.24 °C), as the airport has now (+0.06 °C), unlike the city station now (+1.72 °C; Section 4.4). No document confirming such a change was found, so the cause is treated as unknown.

Kazhydromet's own anomalies for February 2023 (+5.2 °C) and March 2024 (+4.6 °C), the largest in Kazakhstan in those months [14], are close to those of the published series against its own 1991-2020 mean (+4.95 and +4.51 °C) and not to those of the adjusted series (+3.79 and +3.16 °C). The official 1991-2020 normal therefore probably contains the same colder values before 2007, and the shift is probably not only a feature of PiK's compilation. The two compilations are not identical: the October 2023 mean, 8.8 °C in both, is a new October record in the series of Kazhydromet's monthly bulletin, which starts in 1941, with the previous record 8.5 °C in 1945 [14]; PiK gives 8.4 °C for October 1945.

The series was adjusted by adding the shift for each calendar month to all months before August 2007. Measured against Semey, the adjusted city warmed by 1.04 °C between the two decades (-0.03 to 2.10; 0.71 to 1.34 °C over all pairs of decades shifted by up to two years), at 0.21 °C per decade over 1976-2023 (-0.04 to 0.47). Against Ridder, with the shift from October 2007, the result is the same: 1.04 °C (-0.03 to 2.10) and 0.21 °C per decade (-0.04 to 0.47). With this cautious estimate of the shift neither value is significant. The size of the shift depends on how it is measured. Against Semey it is 0.93-1.08 °C by all methods, and the warming 1.01-1.16 °C. Against Ridder, whose differences with Ust-Kamenogorsk vary more from year to year, the local windows and the regression give 0.32-0.72 °C, and the warming 1.37-1.77 °C. The whole-period shift used here is thus near the cautious end: seven of the eight other estimates give a significant warming

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between the decades, of 1.08-1.77 °C. The adjusted trends are consistent with the regional 0.30 °C per decade [1], but this comparison is partly circular: the regional value probably includes the unadjusted Ust-Kamenogorsk series, and when Semey is the reference, agreement with Semey is partly built in. In the Semey-adjusted series spring warmed by 2.06 °C (0.72 to 3.40) and summer by 0.81 °C (0.21 to 1.40), while the winter (+1.27 °C, -1.74 to 4.28) and autumn (+0.01 °C) changes are uncertain (Figure 3); February and March warmed most, by about 3 °C each.

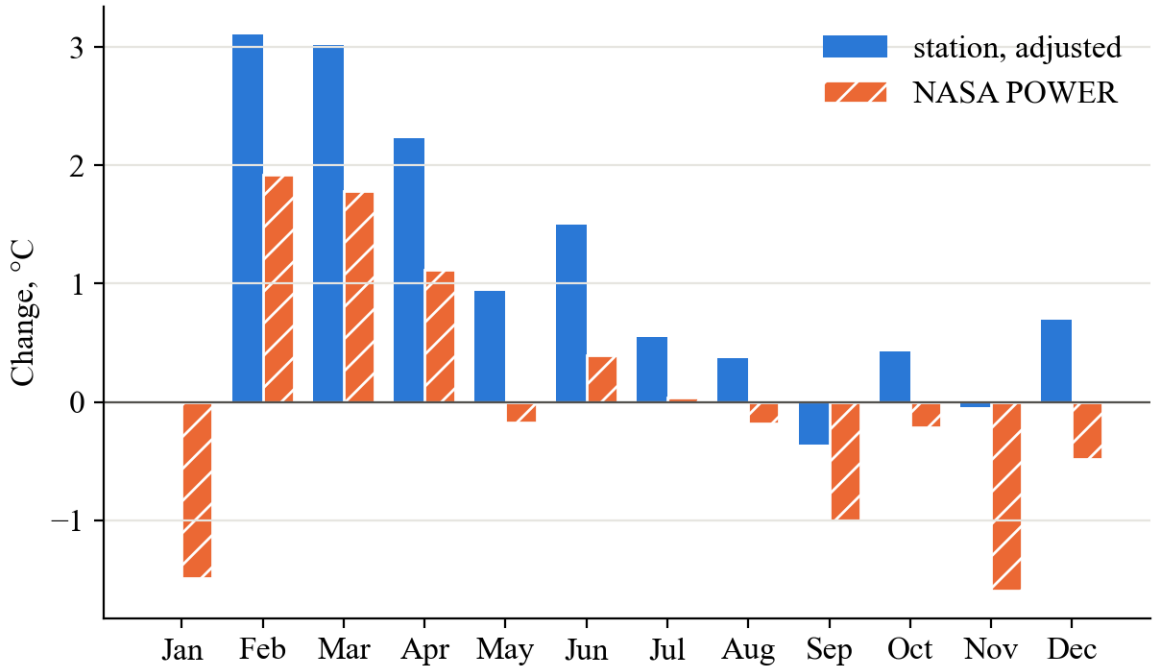


Figure 3. Change of the monthly mean temperature in Ust-Kamenogorsk from 1981-1990 to 2015-2024, by calendar month: station series adjusted against Semey, and NASA POWER. Source: calculated from [4, 11]

NOAA's daily summaries agree with the PiK series of Semey almost exactly (515 months, mean difference 0.03 °C). For the Ust-Kamenogorsk station of the 1980s and 1990s the NOAA record has too many gaps to serve as a check (117 usable months, standard deviation of the monthly differences 0.93 °C).

4.3. Where POWER differs from the stations

Relative to POWER, both stations became warmer over 1981-2024: the station minus model difference rose by 0.28 °C per decade (0.11 to 0.44) at Ust-Kamenogorsk (adjusted) and by 0.20 °C per decade (0.13 to 0.27) at Semey. Its mean rose from 0.45 °C in 1981-2007 to 1.08 °C in 2008-2024 at Ust-Kamenogorsk and from 0.02 to 0.50 °C at Semey. Tested on annual values, the standard normal homogeneity test and the best least-squares single step both place a step after 2012 at both stations: +0.60 °C at Semey and +0.99 °C at Ust-Kamenogorsk ($p < 0.001$ for both if the years are independent). The Pettitt test agrees at Ust-Kamenogorsk but gives 2003 at Semey (+0.49 °C, $p < 0.001$), because it also reacts to a steady trend; after a linear trend is removed it finds no significant step at either station ($p = 0.29$ at Semey, 0.10 at Ust-Kamenogorsk), so a gradual change cannot be ruled out. A step in the same year at two stations about 180 km apart points to a change in the model data or to a change over the whole region, not to the surroundings of one station. POWER itself has a trend of 0.37 °C per decade over 1981-2007 and 0.62 over 2008-2024, but -0.06 (-0.34 to 0.22) over 1981-2024. A second reanalysis would be needed to tell the model and the region apart. Seasonally, POWER at Ust-Kamenogorsk became warmer in spring (+0.91 °C, -0.16 to 1.98) and colder in autumn (-0.94 °C, -2.35 to 0.48) and in January (-1.49 °C, -4.33 to 1.35); none of these changes is significant, and in the annual mean they cancel.

The height of the model cell explains roughly the level of the difference but not its change over time. The Ust-Kamenogorsk cell is on average 181 m above the station. With the annual mean

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cooling with height of 3.9-5.2 °C per kilometre measured on the windward side of one mountain range, or the often assumed 6.5 °C per kilometre [17], the station should be 0.7-1.2 °C warmer than the model. In 1981-1990 the adjusted series was 0.42 °C warmer, 0.3-0.8 °C below this expectation; in 2015-2024 it was 1.45 °C warmer, 0.3-0.7 °C above it, after the rise described above.

4.4. Cold air near the ground

If cold air collects near the ground at a site, the site should be colder relative to the model in winter than in summer, compared with other sites. Table 3 shows the winter offset minus the summer offset, where the offset is station minus model. In 2015-2024 this value is +0.06 °C at the Ust-Kamenogorsk airport, against +1.72 °C at the city station and +2.66 °C at Semey. The cold winter signal is thus found at the airport but not at the city station, although the two are only 12 km apart and at almost the same height (286 and 292 m). It is thus seen at one site in the valley but not at the other; the warmer winters in the city may also come from the city itself (Section 4.5). The adjusted values for 1981-1990 cannot test this idea, because the adjustment takes its seasonal pattern from the reference station; and because the cause of the 2007 shift is unknown, the published values before 2007 are not used as evidence either. The Ust-Kamenogorsk cell is also much higher above its station (181 m) than the Semey cell (61 m), which can affect this comparison.

Table 3. Winter offset minus summer offset (station minus NASA POWER)

Station series	1981-1990, °C	2015-2024, °C
Ust-Kamenogorsk city station, adjusted (Semey)	+1.16	+1.72
Ust-Kamenogorsk city station, adjusted (Ridder)	+1.45	+1.72
Ust-Kamenogorsk airport, NOAA	-	+0.06
Semey	+1.83	+2.66

Source: calculated from [4, 11, 12]. Winter: January, February and December of the same year; summer: June-August. The 1981-1990 values of the adjusted series partly copy the seasonal pattern of the reference station; the 2015-2024 values are not adjusted.

4.5. The city and the airport

From 2008 to 2024 the city station was warmer than the airport every year (Figure 4). Because the airport record has fewer reports per day before 2012 (Section 3), the comparison uses 2012-2024: the difference averaged 0.78 °C in 2012-2016 and 1.07 °C in 2020-2024 and grew by 0.34 °C per decade (0.06 to 0.61). Over the same years the city station warmed relative to Semey by 0.46 °C per decade (0.08 to 0.85), while the change of the airport relative to Semey, +0.13 °C per decade (-0.35 to 0.60), is uncertain. In 2015-2024 the city was warmer than the airport by 1.8-2.2 °C in December-February and by 0.1-0.3 °C in May-July. Over 2009-2021, the years with a consistent series, the urban population of the Ust-Kamenogorsk city administration grew from 303,826 at the beginning of 2009 to 335,679 at the beginning of 2021; the series jumps to 351,362 in 2022 and is 360,689 at the beginning of 2026 [15].

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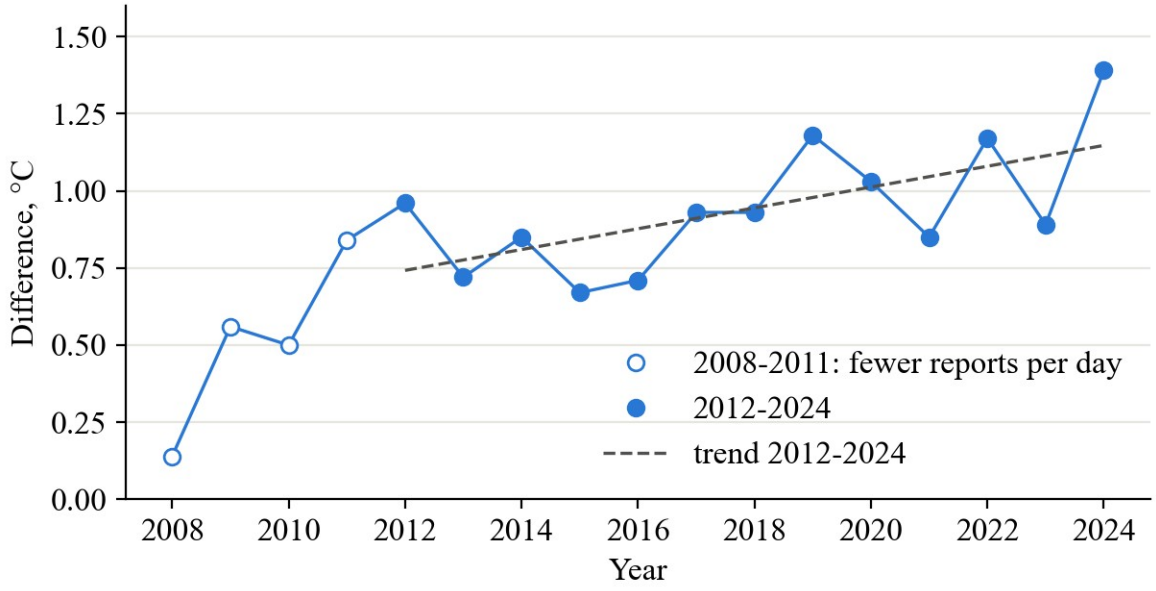


Figure 4. Mean annual temperature, Ust-Kamenogorsk city station minus Ust-Kamenogorsk airport station, 2008-2024, with the linear trend for 2012-2024; open circles: years with fewer reports per day at the airport. Source: calculated from [11, 12]

5. Discussion

Ust-Kamenogorsk is probably warming. After the 2007 shift is removed, the city warmed by about 1.0 °C between the 1980s and the last ten years, mostly in late winter and spring, at about 0.2 °C per decade. With this cautious estimate of the shift neither value is significant; most other ways of measuring the shift give a significant warming of 1.1-1.8 °C. The word "probably" rests on two things together: this uncertain station estimate and the significant regional trend of 0.30 °C per decade [1], with which it is consistent, although that comparison is partly circular. The 2.1 °C rise of the published series is about half warming and half the shift. Any trend read from this station record, as published or against the official normal, has to take the 2007 shift into account.

NASA POWER shows no warming at Ust-Kamenogorsk, but the tests do not point to the valley. Both stations become warmer relative to the model, with a step after 2012 at both; a shared date points to the model data or to a regional change rather than to one station, and one model product cannot tell which. The only land-surface observations in the list that the POWER documentation gives for its model are of surface pressure [5], so its 2 m temperature over land depends largely on the model; its makers report good agreement with station data on average (mean bias of daily values -0.53 °C) [5], which does not guarantee the right trend at one place. For local temperature change in this region, POWER alone is not a safe source.

The author's first hypothesis, the inversion, is partly supported, though not as an explanation of the missing warming. The airport now shows a winter that is colder, relative to summer and to the model, than at the city station and at Semey, which is what cold air collecting near the ground would produce [8]; the city station does not. Asked (5 November) why a model with a cell of 55 by 45 km could miss the warming of the published station series, he answered (translated): "I think this is a result of topography and orography. NASA [has cells of] 55 by 45 km and probably also takes into account microclimates near the mountains, where atmospheric phenomena that lower the temperature may well occur. Or perhaps, because of topography, the model takes data from higher up than in Semey and Astana, so the final NASA data may be colder than the real ones. But I think it is still because of topography and the features of the model." His second reason, the height of the model cell, was his own: the model does take its temperature at the average height of the cell [5], 181 m above the station, which explains a station 0.7-1.2 °C warmer than the model, but not a change of the difference over time.

What changed in the city itself? Asked what could have changed in Ust-Kamenogorsk over 40 years for the published series to warm by 2.1 °C, with examples (the size of the city, new districts, cars, heat-and-power plants and heating, factories), the author wrote (8 November 2026, translated): "Over the last 40 years the city has changed enormously, and so have the factors that raise the temperature. 1) The city itself has grown. There are many more heat-storing materials than before. New districts have appeared, and the suburbs have grown. 2) There are more cars, in line with population growth." He also gave (10 November 2026) 301.7 thousand residents in 1985 (source not given; not in the Wikipedia article he named) and about 400 thousand now; the Wikipedia article gives 400,142 for 2023 [18], and the official count at the beginning of 2026 is 380,858 for the whole city administration and 360,689 for its urban part [15]. The data support his idea only in part. The city station is warmer than the airport, mostly in winter, and the difference has grown since 2012; comparing a city station with one outside the city is one way the effect of a city has been estimated [9]. But a growth of 0.3 °C per decade over 13 years can also come from new buildings next to the station or from changes at either site, and the urban population grew by about 10% in 2009-2021, so the cause cannot be identified with these data.

Limitations. The 2007 shift is found statistically but its cause is not documented, and its size depends on the reference and the method (0.32-1.08 °C). If the series before 2007 does come from the airport, the adjusted series joins an airport record to a city record, and its trend contains the city's own warming relative to the airport after 2007 (Section 4.5). The station series come from one website that compiles them; independent records check the Semey series fully, but the Ust-Kamenogorsk series only for three recent months. The two Astana records disagree after 2000, so Astana could not be used. Only one model product was examined. The comparison of the city and airport stations covers 13 years with full records, and the comparison of sites in Section 4.4 rests on few stations with different heights below their model cells. With ten values per decade, the intervals of the decade changes are wide.

6. Conclusion

According to its weather station, after a shift in 2007 is removed, Ust-Kamenogorsk warmed by about 1.0 °C between 1981-1990 and 2015-2024, or about 0.2 °C per decade over 1976-2023. With this cautious estimate of the shift neither value is significant; most other ways of measuring the shift give a significant warming of 1.1-1.8 °C. The published station series shows about twice as much warming because of the shift. Kazhydromet's anomalies for two recent months are consistent with the unadjusted series, so the official normal probably contains the shift. NASA POWER shows no warming, and both stations become warmer relative to it, with a step after 2012 at both; this shared date points to the model data or to a regional change, and one model product cannot tell which. A colder winter relative to the model, as the author expected from cold air near the ground, is seen at one site in the valley, the airport, but not at the city station. Since 2012 the city station has also warmed relative to the airport; whether this comes from the growth of the city cannot be decided from these data. The city is probably warming, a conclusion that rests on the regional trend and on this uncertain station estimate.

Author contributions and use of AI tools

The author chose the topic on 26 October 2026 from two directions proposed by his mentor in the ADMIT programme, Kurakbay Myrzabek, who is the scientific supervisor named above; the mentor marked this direction as recommended and gave the POWER result for Ust-Kamenogorsk in the same message. The author wrote the inversion explanation quoted in Section 2, asked about the urban heat island of Astana (27 October), calculated with a calculator and reported, following his mentor's step-by-step instructions, the POWER decade means for the year, January, July and autumn and his conclusion (5 November), wrote the explanation quoted in Section 5 (5 November), answered the question about changes in the city (8 November) and gave two population figures (10 November), all in Russian. The mentor made the graph of that task. The mentor, working with a generative AI tool (Claude, Anthropic), proposed the research questions, the points, the decades and the comparison with weather stations, downloaded the station, NOAA, Kazhydromet and population data, made the tables and figures, found and read the sources cited and wrote the English

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text; the author wrote none of the English text. The comparison with an airport station follows a suggestion made in the author's group chat by another ADMIT mentor. The analysis code was written with the AI tool under the mentor's direction and run by the mentor; no number was typed in by the tool: every number comes from the code's output, a cited source or the author's messages. The author's words in Sections 2 and 5 were translated into English with the same tool. Of the cited works, [6], [8], [9], [17], [16] and [10] were read as abstracts only. The author and his scientific supervisor are responsible for the content.

Data availability

All data are public: NASA POWER [4], the station pages of PiK [2, 11], NOAA GSOD [12], the Kazhydromet bulletins [1, 14] and the population tables of the Bureau of National Statistics [15]. The analysis code, the downloaded files and the adjusted series are available from the scientific supervisor on request.

Conflict of interest

The author takes part in the ADMIT mentoring programme, a paid educational service, whose mentor carried out the analysis and wrote the text as described above. The author declares no other conflict of interest.

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