**OPIS PROJEKTA**

**Statistička obrada temperature zraka i usporedba podataka škola Virovitica i Virje za razdoblje od 1.1 2014. do 31.12.2018.**

**Statistical interpretation of air temperature and comparison of school data from Virovitica and**

**Virje, January 2014 - December 2018**

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OŠ Vladimir Nazor Virovitica

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OŠ prof.Franje Viktora Šignjara Virje

1. **Sažetak**

Cilj istraživanja je bio usporediti izmjerene temperature zraka u Virju i Virovitici. Zanimalo nas je razlikuju li se srednje dnevne, srednje mjesečne i srednje godišnje temperature kao i srednje minimalne i maksimalne mjesečne i godišnje temperature. Podudaraju li se apsolutne minimalne i maksimalne godišnje temperature kao i broj toplih, vrućih, hladnih i studenih dana. Koristili smo podatke GLOBE postaja za razdoblje 1.1 2014. do 31.12.2018. te ih kontrolirali sa podatcima Državnog hidrometeorološkog zavoda. Pretpostavka je da će apsolutne razlike u temperaturama biti u rasponu do najviše 5°C, a iz obrade podataka vidljivo je da su apsolutne razlike u granicama od 5°C čime smo potvrdili našu hipotezu.

**Summary**

The aim of the research was to compare measured temperatures in Virje and Virovitica. We were interested in differences between mean daily, mean monthly and mean annual temperatures as well as mean maximum and minimal monthly and annual temperatures.We wanted to find out is there a correspondence between absolute minimal and maximum annual temperature as well as between the number of warm, hot, cold and freezing days. We have used the data of GLOBE stations for the period between 1 January 2014 to 31 December 2018 and controlled them with the data of a Croatian Meteorological and Hydrological Service. The hypothesis is that absolute differences in temperatures will range up to 5 °C and according to the data processing it is obvious that the differences are in the range of up to 5 °C which confirms our hypothesis.

1. **Istraživačka pitanja / Hipoteze**

Obzirom da se dvije škole (Virje i Virovitica) nalaze u istom klimatskom području (umjereno topla kontinentalna klima), a zračna udaljenost iznosi 40 km za istraživanje smo uzeli period 2014. - 2018. godine te smo postavili sljedeća pitanja:

1. Razlikuju li se trenutne i srednje dnevne temperature zraka na našim GLOBE postajama u Virovitici i Virju?
2. Razlikuju li se srednje dnevne mjesečne i godišnje temperature zraka na našim GLOBE postajama u Virovitici i Virju?
3. Razlikuju li se srednje minimalne i maksimalne mjesečne i godišnje temperature zraka na našim GLOBE postajama u Virovitici i Virju?
4. Razlikuju li se apsolutne godišnje maksimalne i minimalne temperature zraka na našim GLOBE postajama u Virovitici i Virju?
5. Podudara li se broj toplih, vrućih, hladnih i studenih dana u Virovitici i Virju?

Naša hipoteza je: Srednje dnevne mjesečne i srednje dnevne godišnje, te srednje minimalne mjesečne i godišnje i srednje maksimalne mjesečne i godišnje temperature zraka, te apsolutne godišnje maksimalne i minimalne temperature zraka najviše će se razlikovati za 5°C na našim GLOBE postajama u Virovitici i Virju?

Na temperaturu zraka utječe nadmorska visina, lokalne prilike na mjernom mjestu kao što su blizina zgrada, prometnica, prirodne površine. U tablici 2 prikazan je geografski smještaj škola i slika pozicija s web stranica google maps. Iz satelitske snimke vidljivo je da se OŠ Vladimir Nazor Virovitica nalazi u centru grada i okružena je prometnicom i drugim zgradama dok je OŠ prof. Franje Viktora Šignjara Virje okružena otvorenim prostorom (nogometno igralište, oranice). Zbog ovih okolnosti uzeli smo razliku od 5°C. .

1. **Metode istraživanja**

U radu su korišteni GLOBE protokoli za atmosferska mjerenja temperature zraka (trenutna, minimalna i maksimalna). Da bismo odgovorili na sva naša postavljena pitanja koristili smo podatke GLOBE postaja za razdoblje 1.1 2014. do 31.12.2018. Obje škole vrše svakodnevna mjerenja. Jedno mjerenje podrazumijeva očitanje trenutne, minimalne i maksimalne temperature zraka. U tablici 1. prikazani su podaci o broju izvršenih mjerenja po danima u razdoblju od 1.1.2014. do 31.12.2018.. Iako obje škole imaju više od 90% mjerenja za usporedbu su uzeti samo dani za koje obje škole imaju mjerenja što je smanjilo broj na 1590 što iznosi 87% . Podaci su preuzeti iz baze podataka kao .csv datoteke i bilo ih je potrebno pretvoriti u čitljivu excel tablicu (.xlsx datoteku). Za kontrolu podataka koristili smo podatke Državnog hidrometeorološkog zavoda za mjesta Đurđevac (kontrola za OŠ prof. Franje Viktora Šignjara Virje) i Virovitica (kontrola za OŠ Vladimir Nazor Virovitica).

Tablica 1. Broj izvršenih mjerenja na GLOBE postajama OŠ prof. Franje Viktora Šignjara Virje i OŠ Vladimir Nazor Virovitica u razdoblju od 1.1.2014. do 31.12.2018

Table 1. Number of measurements at GLOBE stations of Primary school prof. Franjo Viktor Šignjar, Virje and Primary school Vladimir Nazor, Virovitica in the period from 1st January 2014 to 31st December 2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Naziv škole** | **Mjesto** | **Broj mogućih mjerenja** | **Broj mjerenja** | **Postotak** |
| OŠ prof. Franje Viktora Šignjara | Virje | 1826 | 1658 | 91% |
| OŠ Vladimir Nazor Virovitica | Virovitica | 1826 | 1755 | 96% |

Tablica 2. Geografski smještaj OŠ prof. Franje Viktora Šignjara Virje iOŠ Vladimir Nazor Virovitica

Table 2. Geographical position of Primary school prof. Franjo Viktor Šignjar, Virje and Primary school Vladimir Nazor, Virovitica

|  |  |  |  |
| --- | --- | --- | --- |
| **Naziv škole** | **Mjesto** | **Geografski smještaj** | **Google maps pozicija škola** |
| OŠ prof. Franje Viktora Šignjara | Virje | N 46.065195°E 16.996357°134,0 mn/v |  |
| OŠ Vladimir Nazor Virovitica | Virovitica | N 45.829120 °E 17.384264°78,7 mn/v |  |

1. **Prikaz i analiza podataka**

Prikupljene podatke prikazali smo tablično i grafički po mjesecima te ih međusobno usporedili. Za obradu podataka koristili smo program Excel.

Iz izmjerenih podataka izračunali smo za GLOBE postaje u Virju i Virovitici :

1. Srednje dnevne temperature zraka (formula T sredD = (T max + T min) / 2)
2. Srednje dnevne mjesečne temperature zraka (funkcija AVERAGE)
3. Srednje dnevne godišnje temperature zraka (funkcija AVERAGE)
4. Apsolutne maksimalne mjesečne i godišnje temperature zraka (funkcija MAX)
5. Srednje maksimalne mjesečne i godišnje temperature zraka (funkcija AVERAGE)
6. Broj toplih dana (Tmax >= 25 °C) (funkcija COUNTIF)
7. Broj vrućih dana (Tmax >= 30°C) (funkcija COUNTIF)
8. Apsolutne minimalne mjesečne i godišnje temperature zraka (funkcija MIN)
9. Srednje minimalne mjesečne i godišnje temperatura zraka (funkcija AVERAGE)
10. Broj hladnih dana (Tmin < 0,0 °C) (funkcija COUNTIF)
11. Broj studenih dana (Tmax < 0,0 °C) (funkcija COUNTIF)
12. Apsolutnu razliku srednje dnevne temperature zraka (funkcija ABS)
13. Srednju dnevnu mjesečnu i godišnju apsolutnu razliku temperatura (funkcija AVERAGE)

Kod računanja srednjih mjesečnih temperatura uzimali smo broj dana u kojima je bilo mjerenja.

Slika1. Srednja dnevna temperatura (°C) u Virju i Virovitici za razdoblje od 1.1.2014. do 31.12.2018.

Figure1. Daily average temperature (daily mean air temperature) (°C) in Virje and Virovitica in the period period from 1st January 2014 to 31st December 2018

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Slika 2. Srednje dnevne mjesečne temperature zraka (°C) u Virju i Virovitici za razdoblje od siječnja 2014. do prosinca 2018.

Figure 2 Average air temperature–monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 3. Apsolutna razlika srednjih dnevnih mjesečnih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od siječnja 2014. do prosinca 2018.

Figure 3 Absolute difference in average air temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 4. Srednje maksimalne mjesečne temperature zraka (°C) u Virju i Virovitici za razdoblje od siječanja 2014. do prosinca 2018.

Figure 4 Average maximum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 5. Apsolutna razlika srednjih maksimalnih mjesečnih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od siječanja 2014. do prosinca 2018.

Figure 5. Absolute difference in average maximum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 6. Srednje minimalne mjesečne temperature zraka (°C) u Virju i Virovitici za razdoblje od siječanja 2014. do prosinca 2018.

Figure 6. Average minimum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 7. Apsolutna razlika srednjih minimalnih mjesečnih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od siječanja 2014. do prosinca 2018.

Figure 7. Absolute difference in average minimum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 8. Srednje dnevne godišnje temperature zraka (°C) u Virju i Virovitici za razdoblje od 2014. do 2018.

Figure 8 Average air temperature–yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Slika 9. Apsolutna razlika srednjih dnevnih godišnjih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od 2014. do 2018.

Figure 9. Absolute difference in average air temperature –yearly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Slika 10. Srednje maksimalne godišnje temperature zraka (°C) u Virju i Virovitici za razdoblje od 2014. do 2018.

Figure 10 Average maximum temperature – yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Slika 11. Apsolutna razlika maksimalnih godišnjih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od 2014. do 2018

Figure 11. Absolute difference in average maximum temperature –yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Slika 12. Srednje minimalne godišnje temperature zraka (°C) u Virju i Virovitici za razdoblje od 2014. do 2018.

Figure 12 Average minimum temperature – yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Slika 13. Apsolutna razlika srednjih minimalnih godišnjih temperatura (°C) između mjernih postaja u Virju i Virovitici za razdoblje od 2014. do 2018.

Figure 13. Absolute difference in average minimum temperature –yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

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Tablica 3. Apsolutne minimalne i maksimalne godišnje temperature za Virje i Viroviticu i njihove apsolutne razlike za razdoblje od 2014. do 2018.

Table 3. Absolute minimum and maximum temperature – yearly in Virje and Virovitica and absolute difference in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Godina | Apsolutna minimalna godišnja temperatura Virje | Apsolutna minimalna godišnja temperatura Virovitica | Apsolutna maksimalna godišnja temperatura Virje | Apsolutna maksimalna godišnja temperatura Virovitica | Apsolutna razlika apsolutne minimalne temperature | Apsolutna razlika apsolutne maksimalne temperature |
| 2014 | -13,0 | -14,0 | 37,0 | 37,0 | 1,0 | 0,0 |
| 2015 | -15,5 | -14,0 | 36,0 | 36,5 | 1,5 | 0,5 |
| 2016 | -8,0 | -12,0 | 34,0 | 35,0 | 4,0 | 1,0 |
| 2017 | -14,0 | -18,0 | 36,0 | 39,0 | 4,0 | 3,0 |
| 2018 | -18,0 | -17,0 | 35,0 | 34,0 | 1,0 | 1,0 |

Tablica 4. Broj toplih i vrućih dana u Virju i Virovitici i apsolutna razlika u broju toplih i vrućih dana za razdoblje od 2014. do 2018.

Table 4. Number of warm and hot days in Virje and Virovitica and absolute difference in number of warm and hot days in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Godina | Broj toplih dana Virje | Broj toplih dana Virovitica | Broj vrućih dana Virje | Broj vrućih dana Virovitica | Apsolutna razlika broja toplih dana | Apsolutna razlika broja vrućih dana |
| 2014 | 83 | 69 | 24 | 16 | 14 | 8 |
| 2015 | 110 | 91 | 49 | 42 | 19 | 7 |
| 2016 | 99 | 115 | 24 | 33 | 16 | 9 |
| 2017 | 96 | 99 | 43 | 54 | 3 | 11 |
| 2018 | 111 | 131 | 32 | 50 | 20 | 18 |

Tablica 5. Broj hladnih i studenih dana u Virju i Virovitici i apsolutna razlika u broju hladnih i studenih dana za razdoblje od 2014. do 2018.

Table 5 Number of cold and freezing days in Virje and Virovitica and absolute difference in number of cold and freezing days in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Godina | Broj hladnih dana Virje | Broj hladnih dana Virovitica | Broj studenih dana Virje | Broj studenih dana Virovitica | Apsolutna razlika broja hladnih dana | Apsolutna razlika broja studenih dana |
| 2014 | 36 | 71 | 8 | 12 | 35 | 4 |
| 2015 | 81 | 82 | 4 | 5 | 1 | 1 |
| 2016 | 68 | 77 | 9 | 9 | 9 | 0 |
| 2017 | 71 | 75 | 22 | 19 | 4 | 3 |
| 2018 | 73 | 78 | 8 | 16 | 5 | 8 |

1. **Rasprava i zaključci**

Iz grafikona na slikama 2,3,4,5,6 i 7 vidljivo je da su apsolutne razlike za srednju dnevnu , maksimalnu i minimalnu mjesečnu temperaturu u granicama od 5°C (oko 3°C) osim minimalne mjesečne temperature za mjesec siječanj 2018. koja iznosi 5,4°C. Kontrolom podataka i usporedbom naših podatak sa podacima DHMZ-a postaja u Đurđevcu i Virovitici uočili smo da se podaci OŠ Vladimir Nazor Virovitica u sedam dana razlikuju od podataka DHMZ-a Virovitica za više od 10°C što pripisujemo krivom očitavanju.

Iz grafikona na slikama 8,9,10,11,12 i 13 vidljivo je da su apsolutne razlike za srednju dnevnu , maksimalnu i minimalnu godišnju temperaturu u granicama od 5°C (čak su manje od 2°C) .

Iz tablice 3 vidimo da se apsolutne razlike između apsolutnih minimalnih i maksimalnih temperatura u rasponu od 0°C do 4°C.

U tablicama 4 i 5 koji prikazuju broj toplih, vrućih, hladnih i studenih dana vidimo da se apsolutne razlike kreću od nula dana za broj studenih dana u 2016. godini do čak 35 hladnih dana u 2014. godini.

Iz svega prikazanog zaključili smo da su apsolutne razlike u granicama od 5°C i time potvrdili našu hipotezu.

1. **Izvori**
* Janja Milković, GLOBE program- meteorologija, Zagreb, ožujak 2004, Kontrola i osnovna statistička obrada podataka
* <https://vis.globe.gov/GLOBE/> podaci za Virje i Viroviticu za razdoblje 1.1.2014. do

31.12.2018.

* <https://www.google.hr/maps?hl=hr&tab=wl> -google maps pozicije škola

**Statistical interpretation of air temperature and comparison of school data from Virovitica and**

**Virje, January 2014 - December 2018**

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**Summary**

The aim of the research was to compare measured temperatures in Virje and Virovitica. We were interested in differences between mean daily, mean monthly and mean annual temperatures as well as mean maximum and minimal monthly and annual temperatures.We wanted to find out is there a correspondence between absolute minimal and maximum annual temperature as well as between the number of warm, hot, cold and freezing days. We have used the data of GLOBE stations for the period between 1 January 2014 to 31 December 2018 and controlled them with the data of a Croatian Meteorological and Hydrological Service. The hypothesis is that absolute differences in temperatures will range up to 5 °C and according to the data processing it is obvious that the differences are in the range of up to 5 °C which confirms our hypothesis.

Table 1. Number of measurements at GLOBE stations of Primary school prof. Franjo Viktor Šignjar, Virje and Primary school Vladimir Nazor, Virovitica in the period from 1st January 2014 to 31st December 2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name of school** | **Name of town** | **Number of possible measurements** | **Number of measurements** | **Percent** |
| Primary school prof. Franje Viktora Šignjara | Virje | 1826 | 1658 | 91% |
| Primary school Vladimir Nazor Virovitica | Virovitica | 1826 | 1755 | 96% |

Table 2. Geographical position of Primary school prof. Franjo Viktor Šignjar, Virje and Primary school Vladimir Nazor, Virovitica

|  |  |  |  |
| --- | --- | --- | --- |
| **Name of school** | **Name of town** | Geographical position | **Google maps position of school** |
| Primary school prof. Franje Viktora Šignjara | Virje | N 46.065195°E 16.996357°134,0 mn/v |  |
| Primary school Vladimir Nazor Virovitica | Virovitica | N 45.829120 °E 17.384264°78,7 mn/v |  |

The collected data we presented in tables and graphs by month and compare them with each other. We used Excel to process the data.
From the measured data, we calculated:

1. Daily average temperature (T sredD = (T max + T min) / 2)
2. Average air temperature–monthly (function AVERAGE)
3. Average air temperature– yearly (function AVERAGE)
4. Absolute maximum temperature - monthly and yearly (function MAX)
5. Average maximum temperature –monthly and yearly (function AVERAGE)
6. Number of warm days (Tmax >= 25 °C) (function COUNTIF)
7. Number of hot days (Tmax >= 30°C) (function COUNTIF)
8. Absolute minimum temperature - monthly and yearly (function MIN)
9. Average minimum temperature –monthly and yearly (function AVERAGE)
10. Number of cold days (Tmin < 0,0 °C) (function COUNTIF)
11. Number of freezing days (Tmax < 0,0 °C) (function COUNTIF)
12. Absolute difference for Daily average temperature (function ABS)

Figure1. Daily average temperature (daily mean air temperature) (°C) in Virje and Virovitica in the period period from 1st January 2014 to 31st December 2018

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Figure 2 Average air temperature–monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 3 Absolute difference in average air temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 4 Average maximum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 5. Absolute difference in average maximum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 6. Average minimum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 7. Absolute difference in average minimum temperature –monthly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 8 Average air temperature–yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Figure 9. Absolute difference in average air temperature – yearly (°C) in Virje and Virovitica in the period from January 2014 to December 2018

Figure 10 Average maximum temperature – yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Figure 11. Absolute difference in average maximum temperature –yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Figure 12 Average minimum temperature – yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

Figure 13. Absolute difference in average minimum temperature – yearly (°C) in Virje and Virovitica in the period from 2014 to 2018

.

Table 3. Absolute minimum and maximum temperature – yearly in Virje and Virovitica and absolute difference in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Absolute minimum temperature – yearly in Virje | Absolute minimum temperature – yearly in Virovitica | Absolute difference of absolute minimum temperature | Absolute maximum temperature – yearly in Virje | Absolute maximum temperature – yearly in Virovitica | Absolute difference of absolute maximum temperature |
| 2014 | -13,0 | -14,0 | 1,0 | 37,0 | 37,0 | 0,0 |
| 2015 | -15,5 | -14,0 | 1,5 | 36,0 | 36,5 | 0,5 |
| 2016 | -8,0 | -12,0 | 4,0 | 34,0 | 35,0 | 1,0 |
| 2017 | -14,0 | -18,0 | 4,0 | 36,0 | 39,0 | 3,0 |
| 2018 | -18,0 | -17,0 | 1,0 | 35,0 | 34,0 | 1,0 |

Table 4. Number of warm and hot days in Virje and Virovitica and absolute difference in number of warm and hot days in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Number of warm days in Virje | Number of warm days in Virovitica | Absolute difference in number of warm days  | Number of hot days in Virje | Number of hot days in Virovitica | Absolute difference in number of hot days  |
| 2014 | 83 | 69 | 14 | 24 | 16 | 8 |
| 2015 | 110 | 91 | 19 | 49 | 42 | 7 |
| 2016 | 99 | 115 | 16 | 24 | 33 | 9 |
| 2017 | 96 | 99 | 3 | 43 | 54 | 11 |
| 2018 | 111 | 131 | 20 | 32 | 50 | 18 |

Table 5 Number of cold and freezing days in Virje and Virovitica and absolute difference in number of cold and freezing days in the period from 2014 to 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Number of cold days in Virje | Number of cold days in Virovitica | Absolute difference in number of cold days  | Number of freezing days in Virje | Number of freezing days in Virovitica | Absolute difference in number freezing days  |
| 2014 | 36 | 71 | 35 | 8 | 12 | 4 |
| 2015 | 81 | 82 | 1 | 4 | 5 | 1 |
| 2016 | 68 | 77 | 9 | 9 | 9 | 0 |
| 2017 | 71 | 75 | 4 | 22 | 19 | 3 |
| 2018 | 73 | 78 | 5 | 8 | 16 | 8 |

The graphs in Figures 2,3,4,5,6 and 7 show that the absolute differences for the average daily, maximum and minimum monthly temperatures are within 5 ° C (about 3 ° C).

The graphs in Figures 8,9,10,11,12 and 13 show that the absolute differences for the average daily, maximum and minimum annual temperatures are within 5 ° C (even less than 2 ° C).
From Table 3 we can see that the absolute differences between the absolute minimum and maximum temperatures range from 0 ° C to 4 ° C.
In Tables 4 and 5, which show the number of warm, hot, cold and freezing days, we see that the absolute differences range from zero days for the number of cold days in 2016 to as many as 35 cold days in 2014.
From all the above, we concluded that the absolute differences were within the limits of 5 ° C and thus confirmed our hypothesis.

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* Janja Milković, GLOBE program- meteorologija, Zagreb, mart 2004, Kontrola i osnovna statistička obrada podataka
* <https://vis.globe.gov/GLOBE/> podaci za Virje i Viroviticu za razdoblje 1.1.2014. do

31.12.2018.

* <https://www.google.hr/maps?hl=hr&tab=wl> -google maps pozicije škola