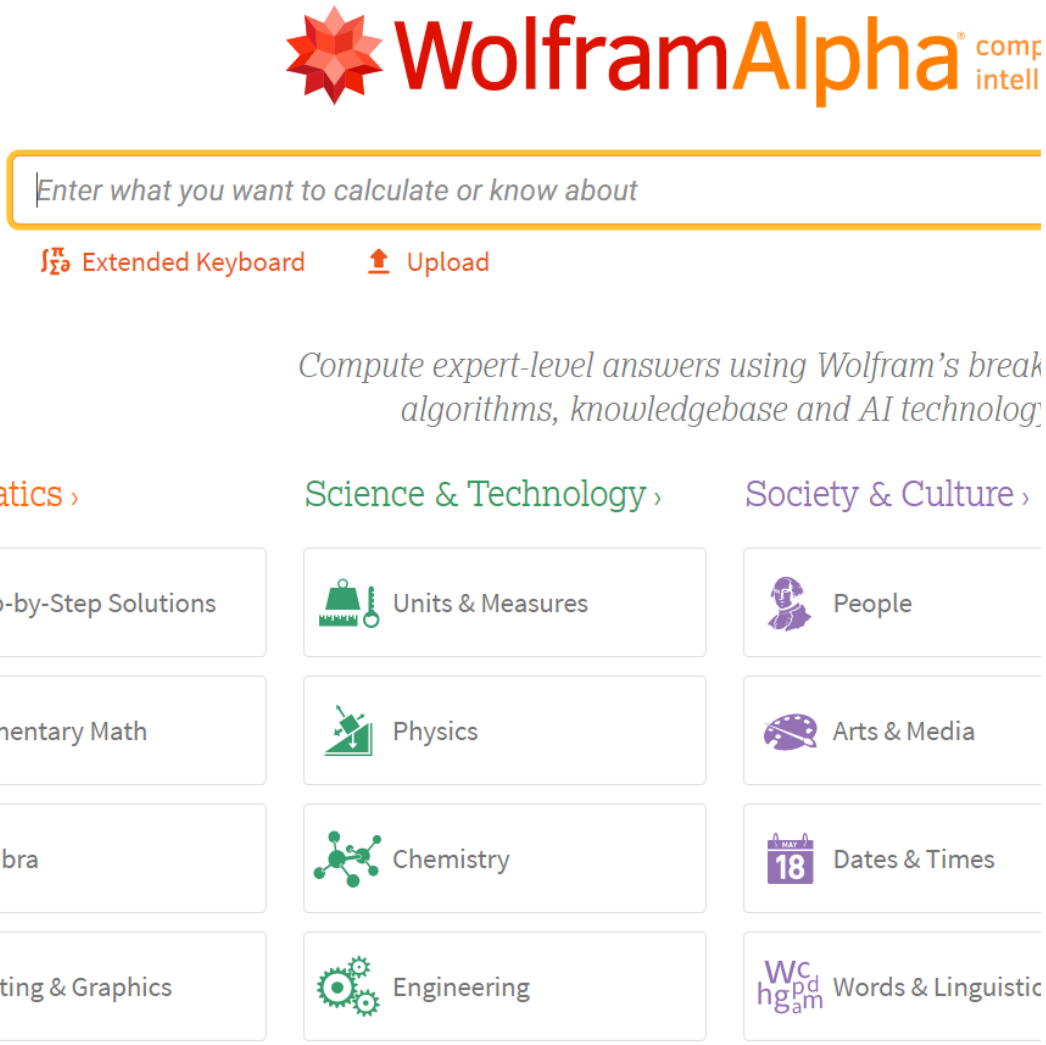
Seminarium POB 6.1, 17 III 2021

Co Wolfram|Alpha i Mathematica wiedzą o zmianach klimatu i jak można je zastosować do gromadzenia i analizowania danych klimatycznych?

Ryszard Walentyński
Katedra Mechaniki i Mostów

Wolfram|Alpha



Wolfram|Alpha

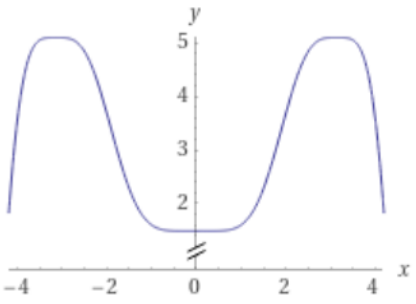
integrate x^2 sin^3 x dx

Extended Keyboard Upload Exa

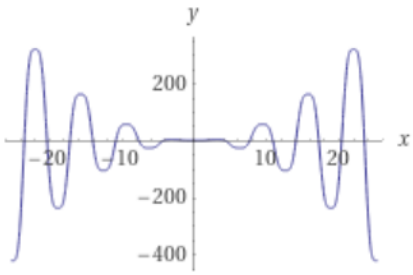
Indefinite integral:

$$\int x^2 \sin^3(x)\,dx =$$
$$\frac{1}{108}\left(-81\left(x^2-2\right)\cos(x)+\left(9x^2-2\right)\cos(3x)-6x\left(\sin(3x)-27\sin(x)\right)\right) + \text{constant}$$

Plots of the integral:



(*x* from −4.2 to 4.2)



(*x* from −25.1 to 25.1)

Globalne ocieplenie

In[28]:= **global warming**

Assuming "global warming" is referring to global climate studies | Use as
referring to physical effect or a music work or a music album or a word or a climatology topic instead

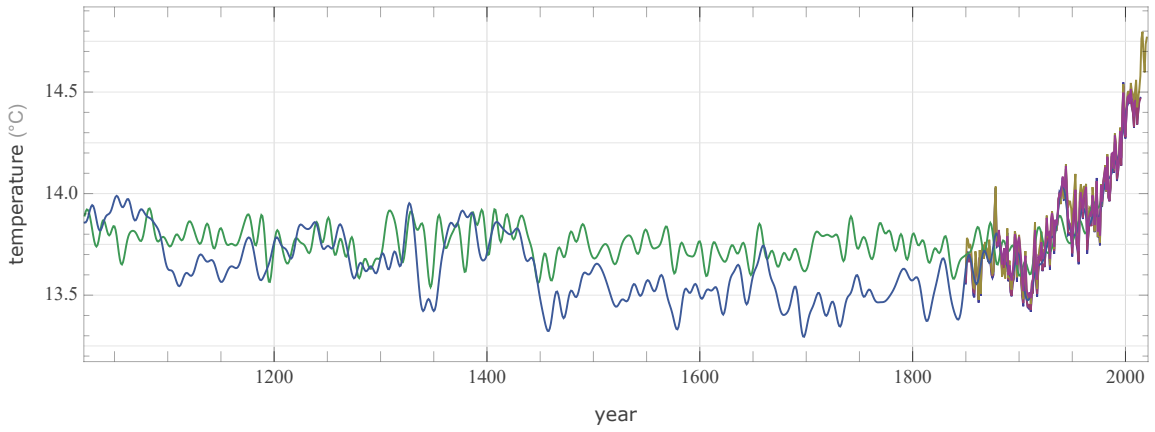
Input interpretation:

global climate studies

Results:

Temperature | Annual | All models | Last 1000 yr | Show non-metric

History:



Description: Hide details

study	description	year
HadCRUT3GL	instrumental HadCRUT3 data from the Hadley Centre and the Climate Research Unit	2006
HadCRUT3vGL	instrumental HadCRUT3v data from the Hadley Centre and the Climate Research Unit	2006
HadCRUT4GL	instrumental HadCRUT4 data from the Hadley Centre and the Climate Research Unit	2012
Mann2003a	historical records, ice cores, lake sediments, shells, tree rings (reconstruction) global mean surface reconstruction based on multi-proxy data	2003
Mann2008f	corals, historical records, ice cores, lake sediments, speleothem, tree rings (reconstruction) 2,000 year hemispheric and global surface temperature reconstructions: global, land and ocean, error-in-variables method	2008
NCDCGL	instrumental global surface temperature anomalies from the National Oceanic and Atmospheric Administration/National Climatic Data Center	2008

Trends:

Trends:

study	linear trend
HadCRUT3GL	(0.47 ± 0.16) °C/century
HadCRUT3vGL	(0.47 ± 0.16) °C/century
HadCRUT4GL	(0.53 ± 0.17) °C/century
Mann2003a	(0.00 ± 0.08) °C/century
Mann2008f	(−0.01 ± 0.19) °C/century
NCDCGL	(0.57 ± 0.13) °C/century

Statistics:

study	min	mean	max	range
HadCRUT3GL	13.4 °C (1911)	13.9 °C (1850 to 2014)	14.5 °C (1998)	1.1 °C (1850 to 2014)
HadCRUT3vGL	13.4 °C (1911)	13.8 °C (1850 to 2014)	14.5 °C (1998)	1.1 °C (1850 to 2014)
HadCRUT4GL	13.5 °C (1911)	13.9 °C (1850 to 2020)	14.8 °C (2016)	1.3 °C (1850 to 2020)
Mann2003a	13.5 °C (1347)	13.8 °C (1022 to 1980)	14 °C (1980)	0.5 °C (1022 to 1980)
Mann2008f	13.3 °C (1698)	13.7 °C (1022 to 2006)	14.5 °C (2006)	1.2 °C (1022 to 2006)
NCDCGL	13.5 °C (1911)	13.9 °C (1880 to 2009)	14.5 °C (2005)	1 °C (1880 to 2009)

WolframAlpha

Lokalne dane pogodowe

In[29]:= **Gliwice Dec 14th 1963**

Input interpretation:

12:00 am | Saturday, December 14, 1963 in Gliwice, Slaskie

Date formats: More formats/calendars

1963–12–14 (year–month–day)

Time difference from today (Tuesday, March 16, 2021):

57 years 3 months 2 days ago

2987 weeks 3 days ago

20 912 days ago

57.25 years ago

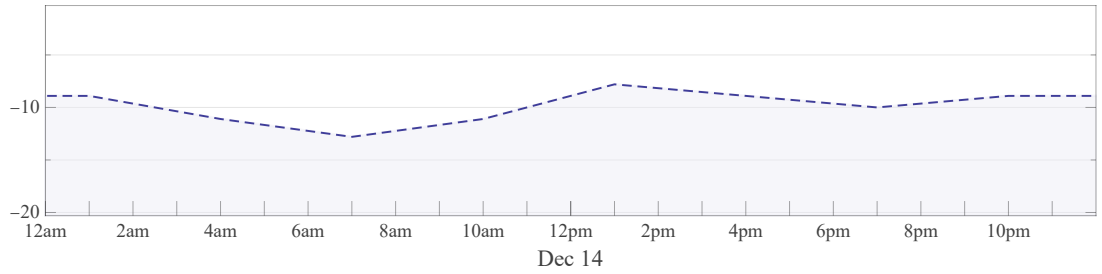
Time in 1963: More

348th day

50th week

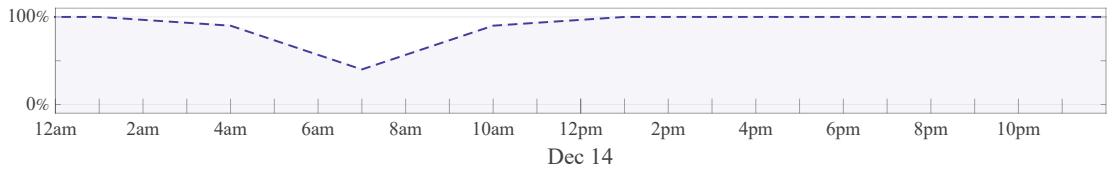
Weather for 1963–12–14: Show non–metric

Temperature:



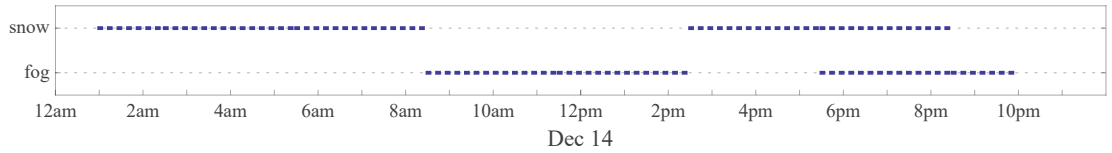
low: –13 °C	average: –10 °C	high: –8 °C
Sat, Dec 14, 7:00am		Sat, Dec 14, 1:00pm

Cloud cover:



overcast: 57.1% (12 hours) | clear: 0% (0 minutes)

Conditions:



snow: 64.3% (13.5 hours) | fog: 50% (10.5 hours)

Daylight information for December 14, 1963 in Gliwice, Poland: More

sunrise	7:37 am CET
sunset	3:42 pm CET
duration of daylight	8 hours 5 minutes

Phase of the Moon: Large image

waning crescent moon

Observances for December 14, 1963 (Poland):

(no official holidays or major observances)

Events on December 14, 1963: Show anniversaries

death of Dinah Washington (singer, etc.)

City center elevation:

223 meters

WolframAlpha

Klimat lokalny

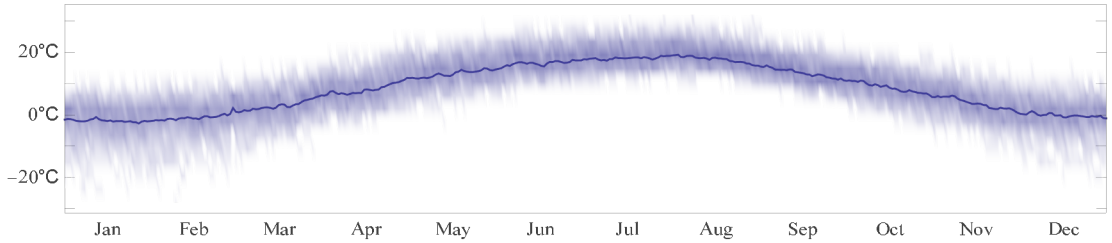
In[30]:= **climate Gliwice**

Input interpretation:

climate	Gliwice, Poland

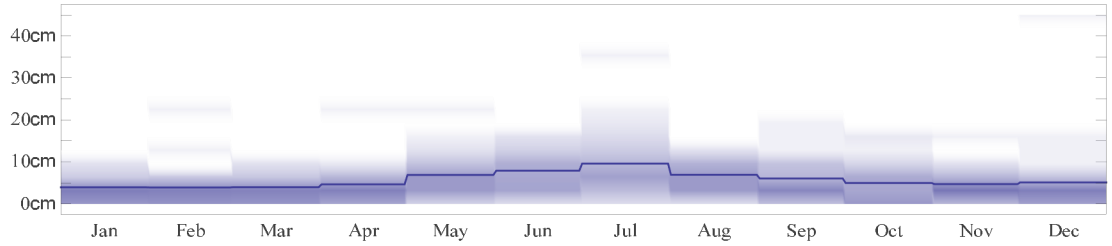
Result for Gliwice, Slaskie, Poland: Show non-metric More

Temperature distribution:



(1952–2021 data)

Precipitation distribution:



(1952–2021 data, 1 month totals, with water equivalent of snow)

Weather station information: Show non-metric More

name	EPKT (Katowice International Airport)
relative position	34 km ENE (from center of Gliwice)
relative elevation	81 meters (above center of Gliwice)

+ Units

Satellite image »

WolframAlpha

In[32]:= **temperature in Gliwice 1952 to 2021**

Input interpretation:

temperature	Gliwice, Poland
	1952 to 2021

Result:

Show non-metric

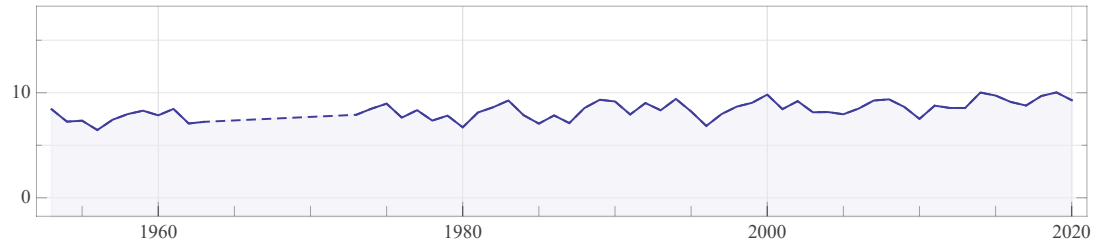
(−31 to 37) °C (average low: 2 °C | average high: 12 °C)
(1952 to 2021)

History:

Show non-metric Less

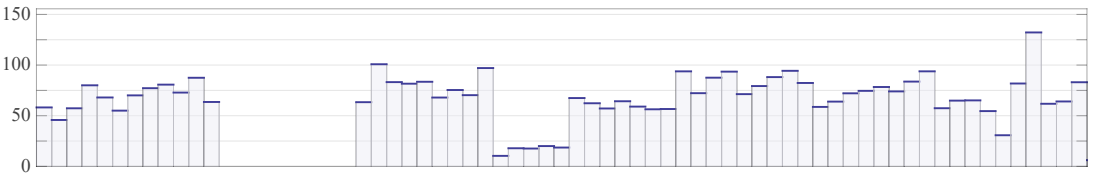
Temperature:

(yearly means)



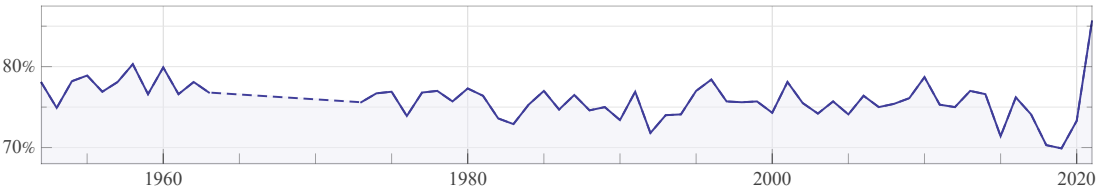
low: −31 °C 1987	average high: 33 °C average low: −20 °C	high: 37 °C 2013

Annual precipitation amount:



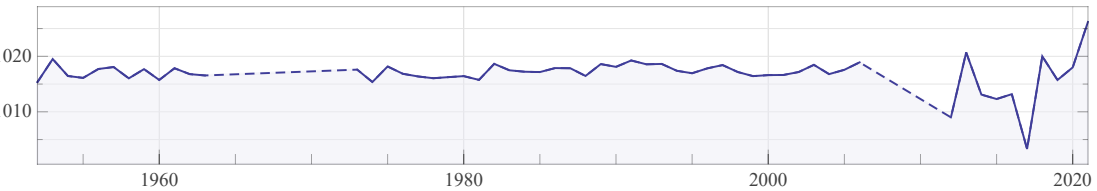
maximum: 130 cm
2017

Humidity:



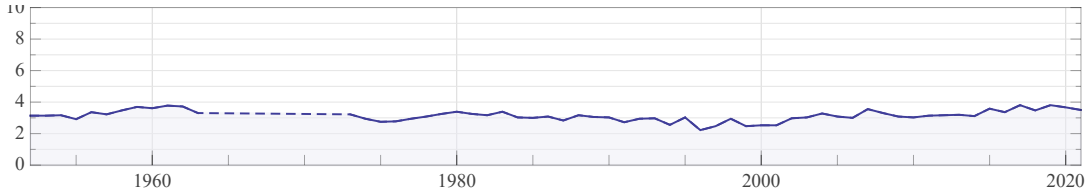
average: 76%

Pressure:



average: 1017 hPa

Wind speed:



average: 3 m/s	high: 26 m/s 2008

Weather station information:

Show non-metric More

name	EPKT (Katowice International Airport)
relative position	34 km ENE (from center of Gliwice)
relative elevation	81 meters (above center of Gliwice)

+ Units

Satellite image »

Weather station comparisons:

Show non-metric

	position	elevation	min	average	max
EPKM	27 km ESE	277 m	−31 °C	8 °C	37 °C
LKMT	79 km SSW	256 m	−29 °C	9 °C	37 °C
EPKK	84 km ESE	237 m	−30 °C	8 °C	38 °C

(sorted by distance and inferred reliability)

+ Units

WolframAlpha

In[33]:= **temperature in Gliwice May 15th 1999 to May 30th 1999**

Input interpretation:

temperature	Gliwice, Poland
	Saturday, May 15, 1999 to Sunday, May 30, 1999

Result:

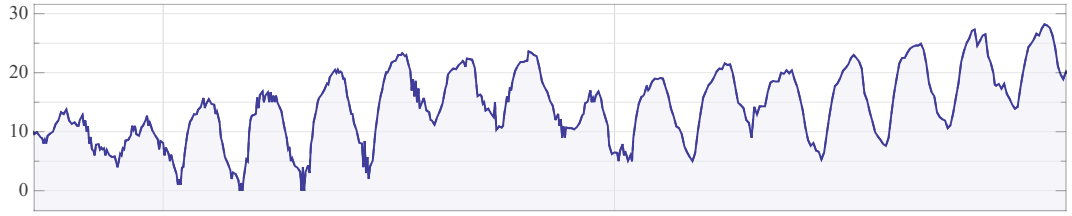
Show non-metric

(0 to 28) °C (average low: 6 °C | average high: 21 °C)
(Saturday, May 15, 1999 to Sunday, May 30, 1999)

History:

Week | Show non-metric Less

Temperature:

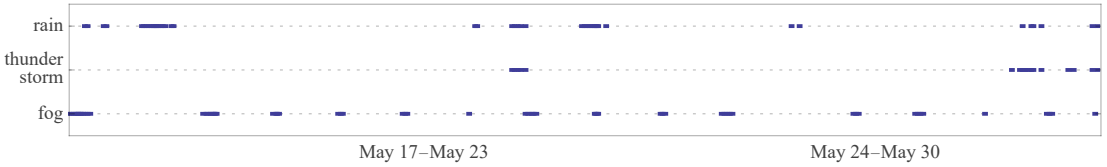


low: 0 °C	average high: 21 °C	high: 28 °C
Wed, May 19, 4:30am, ...	average low: 6 °C	Sun, May 30, 4:00pm

Cloud cover:

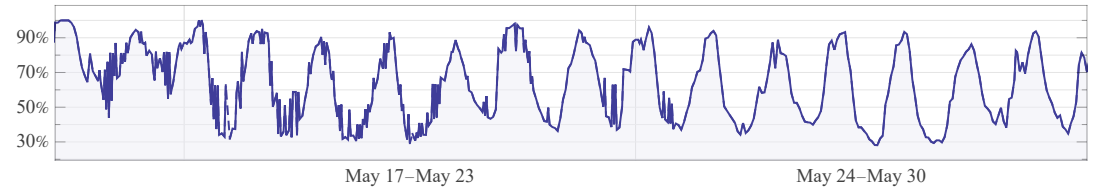
clear: 18.6% (2.5 days) | overcast: 5.5% (17.5 hours)

Conditions:



fog: 14.8% (2 days) | rain: 11.1% (1.5 days) | thunderstorm: 4.7% (15 hours)

Humidity:

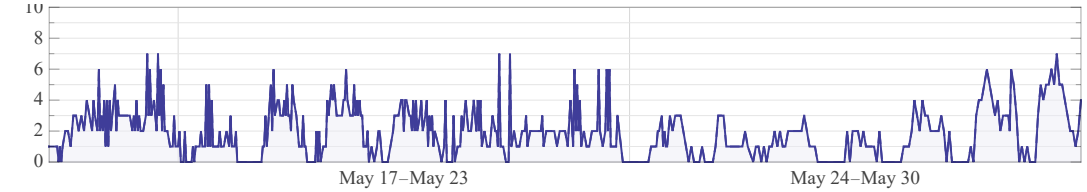


low: 28%	average high: 94%	high: 100%
Thu, May 27, 6:00pm	average low: 36%	Sat, May 15, 2:00am, ...

Pressure:

low: 1006 hPa	average: 1019 hPa	high: 1029 hPa
Fri, May 21, 9:00am		Wed, May 19, 5:00am

Wind speed:



low: 0 m/s	average: 2 m/s	high: 7 m/s
Sun, May 30, 7:00am, ...		Sun, May 16, 12:30pm, ...

Incident sunlight intensity:

Weather station information:

Show non–metric More

name	EPKT (Katowice International Airport)
relative position	34 km ENE (from center of Gliwice)
relative elevation	81 meters (above center of Gliwice)

+ Units

Satellite image »

Weather station comparisons:

Show non–metric

	position	elevation	min	average	max
EPKM	27 km ESE	277 m	0 °C	16 °C	28 °C
LKMT	79 km SSW	256 m	1 °C	16 °C	28 °C
EPKK	84 km ESE	237 m	3 °C	16 °C	27 °C

(sorted by distance and inferred reliability)

+ Units

WolframAlpha

Publikacja we współpracy zagranicznej

MATEC Web of Conferences **313**, 00037 (2020) https://doi.org/10.1051/matecconf/202031300037
DYN-WIND'2020

Example of analysis of climatic data series with respect to the testing of reinforcement concrete corrosion in a climate chamber

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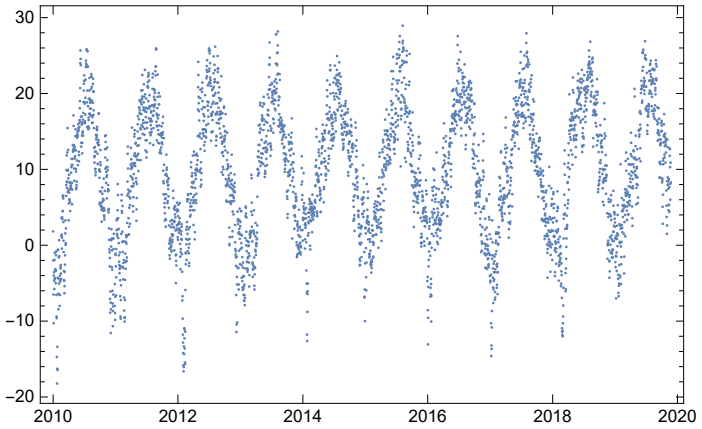
[1]VSB – Technical University of Ostrava, Faculty of Civil Engineering, Department of Structural Mechanics, Ludvíka Podéště 1875/17, 708 33 Ostrava-Poruba, Czech Republic
[2]Silesian University of Technology, Faculty of Civil Engineering, Department of Mechanics and Bridges, ul. Akademicka 5, pok. 124, 44-100 Gliwice, Poland

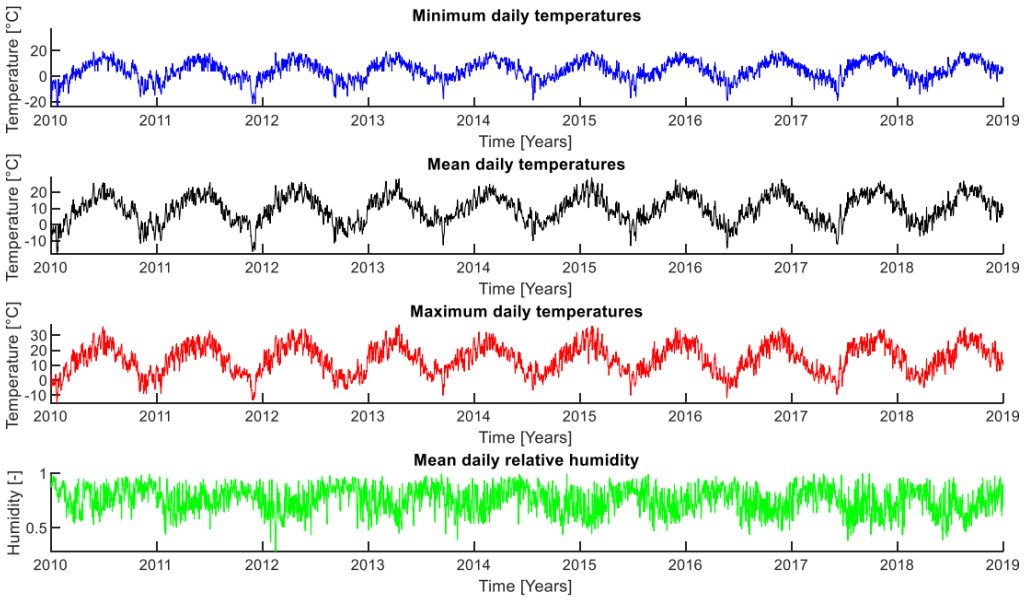
```
In[1]:= meantemp = WeatherData[ Ostrava CITY ,
          dane pogodowe
        "MeanTemperature", {{2010, 1, 1}, {2019, 11, 23}, "Day"}]
```

```
Out[1]= TimeSeries[ Time: 01 Jan 2010 to 23 Nov 2019
                    Data points: 3573 ]
```

```
In[2]:= mtplot = DateListPlot[meantemp, Joined -> False]
          wykres listy dat          połączone  fałsz
```

Out[2]=




Minimum daily temperatures
Temperature [°C]
20
0
-20
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Time [Years]
Mean daily temperatures
Temperature [°C]
20
10
0
-10
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Time [Years]
Maximum daily temperatures
Temperature [°C]
30
20
10
0
-10
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Time [Years]
Mean daily relative humidity
Humidity [-]
1
0.5
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Time [Years]

Analiza ocieplenia klimatu w Gliwicach

Aquiring data about mean year temperature in Gliwice

In[34]:=
```
WolframAlpha["Gliwice temperature 1900 to 2021",
 {{"TemperatureChart:WeatherData", 1}, "TimeSeriesData"}]
```

zapytaj WolframAlpha

dane pogodowe

Out[34]=

{1953, 1, 1}	8.42 °C
{1954, 1, 1}	7.25 °C
{1955, 1, 1}	7.34 °C
{1956, 1, 1}	6.45 °C
{1957, 1, 1}	7.43 °C
{1958, 1, 1}	7.97 °C
{1959, 1, 1}	8.29 °C
{1960, 1, 1}	7.85 °C
{1961, 1, 1}	8.46 °C
{1962, 1, 1}	7.07 °C
{1963, 1, 1}	7.23 °C
{1973, 1, 1}	7.9 °C
{1974, 1, 1}	8.48 °C
{1975, 1, 1}	8.96 °C
{1976, 1, 1}	7.63 °C
{1977, 1, 1}	8.34 °C
{1978, 1, 1}	7.35 °C
{1979, 1, 1}	7.82 °C
{1980, 1, 1}	6.71 °C
{1981, 1, 1}	8.12 °C
{1982, 1, 1}	8.62 °C
{1983, 1, 1}	9.26 °C
{1984, 1, 1}	7.86 °C
{1985, 1, 1}	7.06 °C
{1986, 1, 1}	7.84 °C
{1987, 1, 1}	7.11 °C
{1988, 1, 1}	8.55 °C
{1989, 1, 1}	9.33 °C
{1990, 1, 1}	9.17 °C
{1991, 1, 1}	7.93 °C
{1992, 1, 1}	9.02 °C
{1993, 1, 1}	8.33 °C
{1994, 1, 1}	9.41 °C
{1995, 1, 1}	8.22 °C
{1996, 1, 1}	6.84 °C
{1997, 1, 1}	7.97 °C
{1998, 1, 1}	8.68 °C
{1999, 1, 1}	9.04 °C
{2000, 1, 1}	9.82 °C
{2001, 1, 1}	8.44 °C
{2002, 1, 1}	9.2 °C
{2003, 1, 1}	8.14 °C

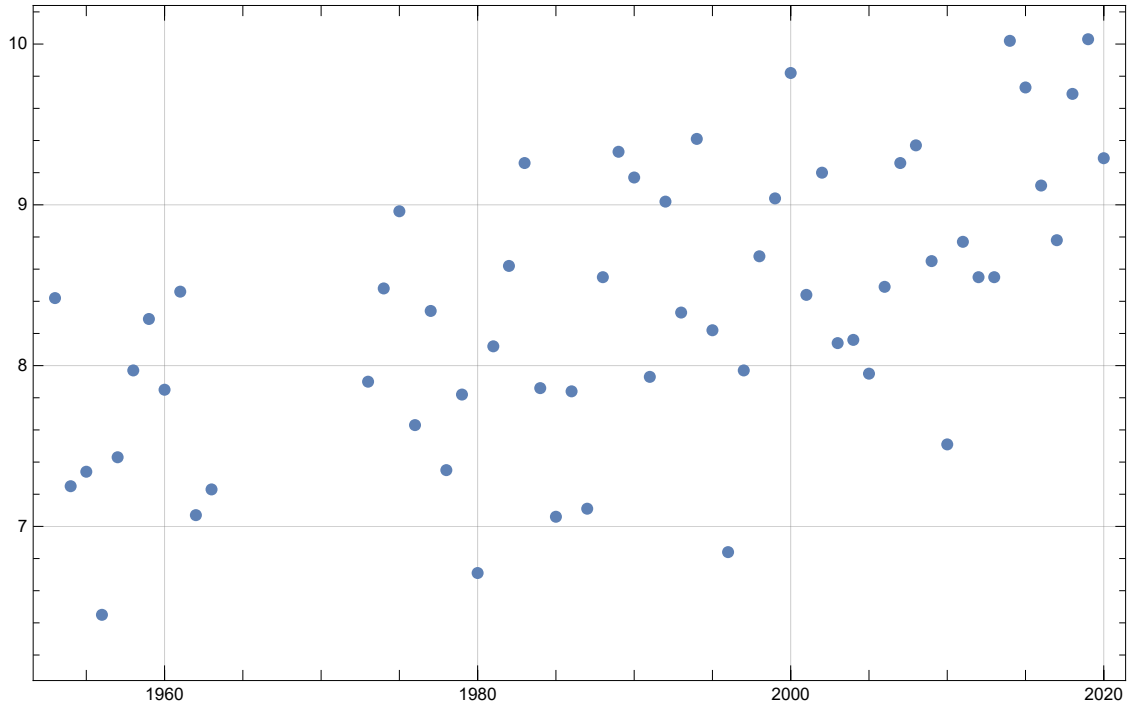
{2003, 1, 1}	8.14 °C
{2004, 1, 1}	8.16 °C
{2005, 1, 1}	7.95 °C
{2006, 1, 1}	8.49 °C
{2007, 1, 1}	9.26 °C
{2008, 1, 1}	9.37 °C
{2009, 1, 1}	8.65 °C
{2010, 1, 1}	7.51 °C
{2011, 1, 1}	8.77 °C
{2012, 1, 1}	8.55 °C
{2013, 1, 1}	8.55 °C
{2014, 1, 1}	10.02 °C
{2015, 1, 1}	9.73 °C
{2016, 1, 1}	9.12 °C
{2017, 1, 1}	8.78 °C
{2018, 1, 1}	9.69 °C
{2019, 1, 1}	10.03 °C
{2020, 1, 1}	9.29 °C

In[18]:=
```
ts = TimeSeries[WolframAlpha["Gliwice temperature 1900 to 2021",
    {{"TemperatureChart:WeatherData", 1}, "TimeSeriesData"}] /. Quantity[a_, b_] → a]
```
szereg czas… | zapytaj WolframAlpha | dane pogodowe | ilość w jednostkach

Out[18]= TimeSeries [ Time: 01 Jan 1953 to 01 Jan 2020 Data points: 59]

In[19]:=
```
plotts = DateListPlot[ts, Joined → False, GridLines → Automatic]
```
wykres listy dat | połączone | fałsz | linie siatki | automatyczny

Out[19]=



Fitting nonlinear model

In[20]:=
```
nlm = NonlinearModelFit[ts, a x^2 + b x + c, {a, b, c}, x]
```
znajdź nieliniowy model

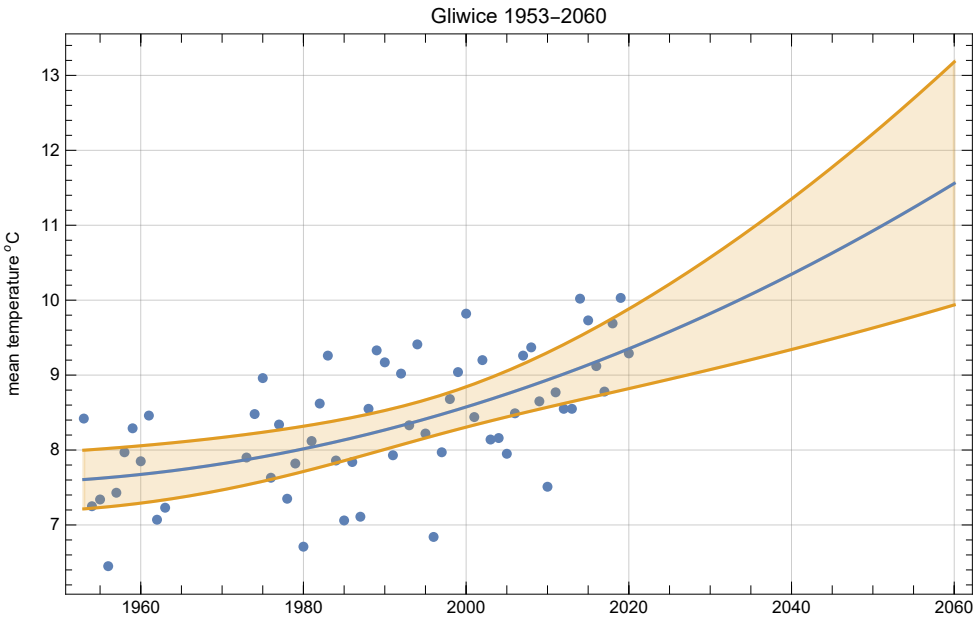
Out[20]=
```
FittedModel[7.95681 - 6.66891 × 10^-10 x + 2.73347 × 10^-19 x^2]
```

Defining 99% confidence bands

In[21]:=
```
bands99[x_] := nlm["MeanPredictionBands", ConfidenceLevel → .99];
```
poziom zaufania

In[22]:=
```
pl = Show[DateListPlot[ts, Joined → False, GridLines → Automatic,
  PlotLabel → "Gliwice 1953-2060", FrameLabel → "mean temperature °C"], Plot[
  {nlm[x], bands99[x]}, {x, AbsoluteTime[{1953, 1, 1}], AbsoluteTime[{2060, 1, 1}]},
  Filling → {2 → {1}}], PlotRange → {All, Automatic}]
```
pokaż | wykres listy dat | połączone | fałsz | linie siatki | automatyczny | etykieta grafiki | etykieta ramki | stała | wykres | czas bezwzględny | czas bezwzględny | wypełnienie | zakres wykresu | ws··· | automatyczny

Out[22]=



In[23]:=
```
city = "Gliwice"
```

Out[23]=
```
Gliwice
```

In[24]:=
```
tsm = TimeSeriesModelFit[ts, "SARIMA"]
```
szukaj modelu szeregu czasowego

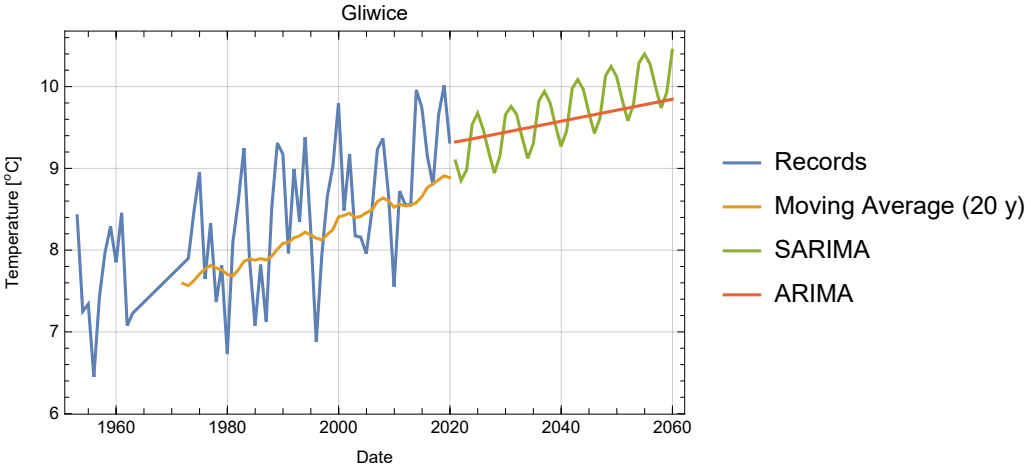
Out[24]=
```
TimeSeriesModel[Family: SARIMA
Order: {{1, 0, 0}, {1, 1, 2}6}]
```

In[25]:=
```
tsma = TimeSeriesModelFit[ts, "ARIMA"]
```
szukaj modelu szeregu czasowego

Out[25]=
```
TimeSeriesModel[Family: ARIMA
Order: {1, 1, 1}]
```

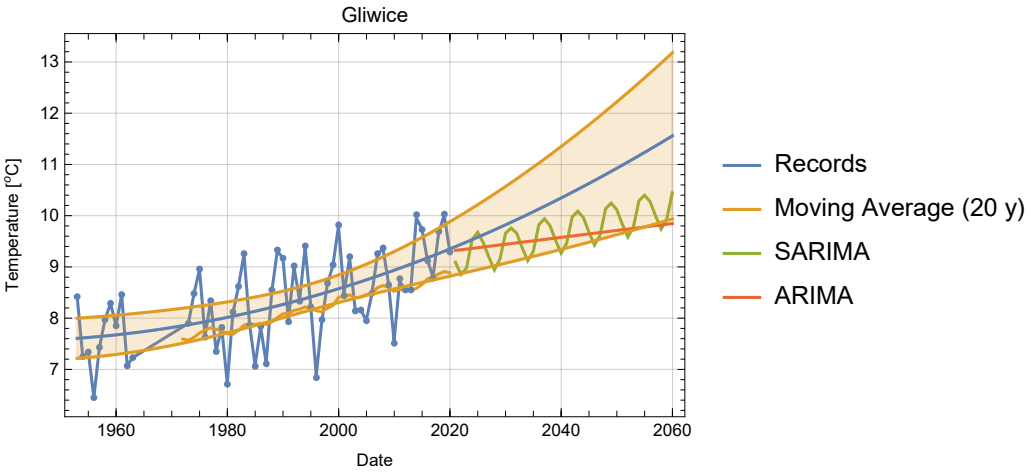
In[26]:=
```
DateListPlot[{tsm["TemporalData"], MovingAverage[tsm["TemporalData"], 20],
  TimeSeriesForecast[tsm, {40}], TimeSeriesForecast[tsma, {40}]},
 GridLines → Automatic, PlotRange → All, PlotLabel → city,
 FrameLabel → {"Date", "Temperature [°C]"},
 PlotLegends → {"Records", "Moving Average (20 y)", "SARIMA", "ARIMA"}]
```
wykres listy dat | dane czasowe | średnia ruchoma | dane czasowe | prognoza wartości szeregu czasowego | prognoza wartości szeregu czasowego | linie siatki | automatyczny | zakres wykresu | ws··· | etykieta grafiki | etykieta ramki | stała | legenda dla grafik

Out[26]=

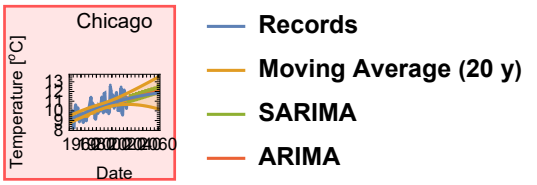


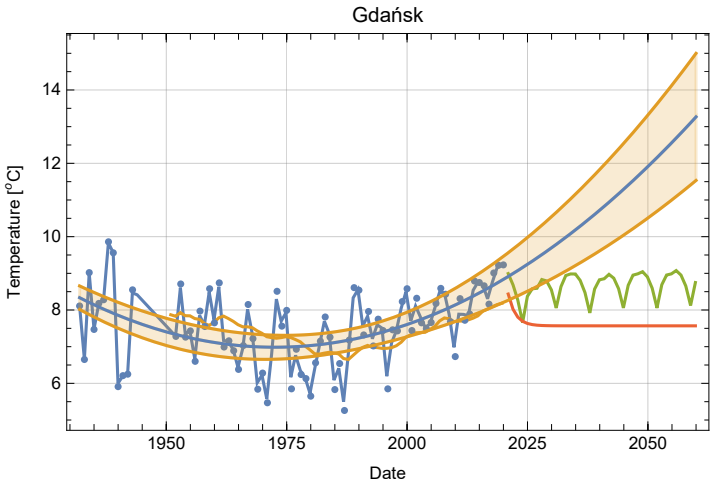
In[27]:=
```
Show[%, pl, PlotRange → All]
```
pokaż | zakres wykresu | wszys

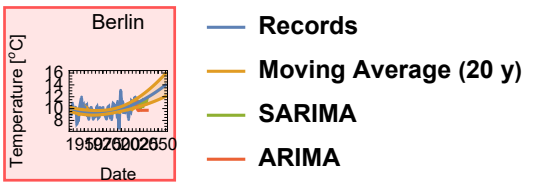
Out[27]=

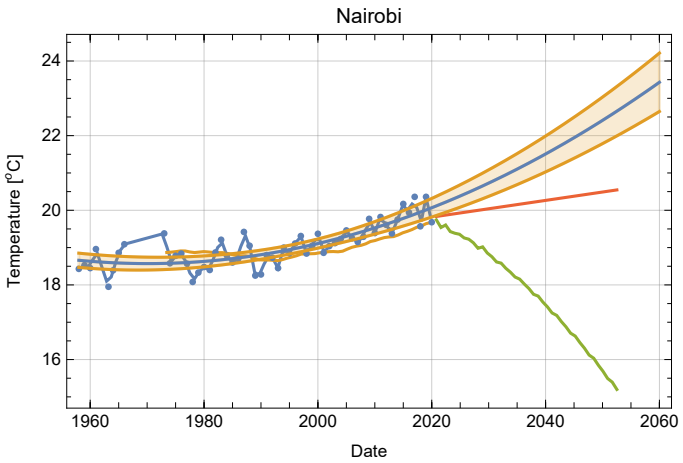


Inne miasta świata









Raspberry Pi

Czy Wolfram|Alpha potrafi udzielić odpowiedzi na każde pytanie?

In[35]:= **What do men want?**

Input interpretation:

What do men want?

Response:

Why don't you ask them?

WolframAlpha

Dziękuję za uwagę

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