Report_Dortmund_2022

August 8, 2022

1 0. Imports and data selection

[1]:
```
import os
import pandas as pd

import numpy as np

import matplotlib.pyplot as plt
```

[2]:
```
os.chdir('../data')
file_names = os.listdir()
```

[3]:
```
df = pd.DataFrame()
for name in file_names:
    df = df.append(pd.read_csv(f'../data/{name}'))
```

[4]:
```
df.columns
```

[4]:
```
Index(['Unnamed: 0', 'name', 'datetime', 'tempmax', 'tempmin', 'temp',
       'feelslikemax', 'feelslikemin', 'feelslike', 'dew', 'humidity',
       'precip', 'precipprob', 'precipcover', 'preciptype', 'snow',
       'snowdepth', 'windgust', 'windspeed', 'winddir', 'sealevelpressure',
       'cloudcover', 'visibility', 'solarradiation', 'solarenergy', 'uvindex',
       'severerisk', 'sunrise', 'sunset', 'moonphase', 'conditions',
       'description', 'icon', 'stations'],
      dtype='object')
```

[5]:
```
# use datetime as type
df['datetime'] = df['datetime'].astype("datetime64")

# setting the Date as index
df = df.set_index('datetime')
```

[6]:
```
# cut of the first days to have full periods of a year
_day = df.index[-1].day
_month = df.index[-1].month
_year = df.index[0].year
```

```
df = df[df.index>=f'{_year}-{_month}-{_day}']
```

[21]:
```
start_year = df.index.min().year
end_year = df.index.max().year
print('period:', start_year,'-', end_year)
```

```
period: 1993 - 2022
```

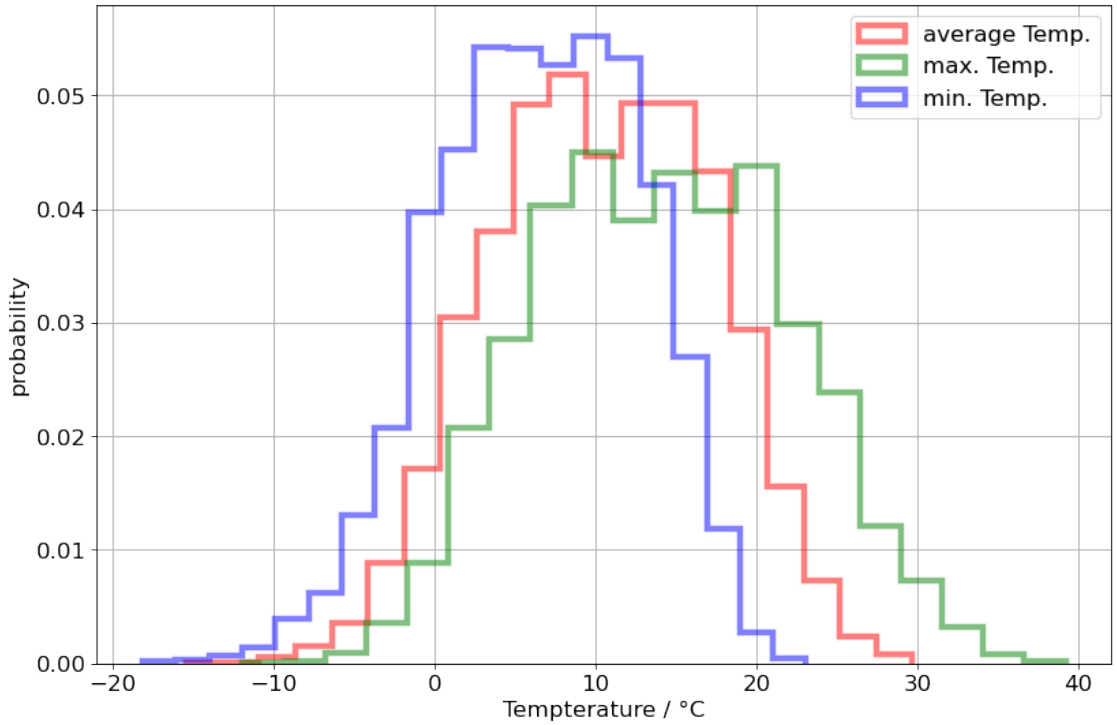
2 1. Temperature

2.1 1.1 Frequency of the daily average, max. and min. temperature

[8]:
```
# frequency of the daily average temperature, max. temp
plt.figure(figsize=(12,8), dpi=80)
plt.hist(df['temp'], bins=20, histtype='step', density=True, stacked=True,␣
 ↪color='red', linewidth=4, label='average Temp.', alpha=0.5)
plt.hist(df['tempmax'], bins=20, histtype='step', density=True, stacked=True,␣
 ↪color='green', linewidth=4, label='max. Temp.', alpha=0.5)
plt.hist(df['tempmin'], bins=20, histtype='step', density=True, stacked=True,␣
 ↪color='blue', linewidth=4, label='min. Temp.', alpha=0.5)


plt.xlabel('Tempterature / °C', fontsize=15)
plt.ylabel('probability', fontsize=15)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.grid()
plt.legend(fontsize=15)
plt.savefig(f'../figures/pdf/frequency_temp_{start_year}-{end_year}.pdf')
plt.savefig(f'../figures/png/frequency_temp_{start_year}-{end_year}.png',␣
 ↪dpi=300)

plt.show()
```



2.2 1.2 Temperature progress and the hottest/coldest days

2.2.1 Extreme days (hottest/coldest)

[9]:
```
# hottest days
df_hot = df.sort_values(by=['tempmax'], ascending=False)[['tempmax', 'tempmin',␣
↪'temp', 'moonphase']]
df_hot.head(10)
```

[9]:

datetime	tempmax	tempmin	temp	moonphase
2019-07-25	39.2	18.4	29.7	0.78
2022-07-19	37.7	13.6	26.2	0.70
2019-07-24	37.6	18.2	28.2	0.73
2002-06-18	37.1	20.9	27.5	0.28
2018-08-07	37.0	18.9	28.3	0.90
2003-08-08	36.1	21.0	28.9	0.42
2015-07-02	36.1	18.7	29.7	0.50
2003-08-07	36.0	18.3	27.7	0.37
2006-07-19	36.0	17.7	27.9	0.85
2003-08-12	36.0	19.9	28.0	0.50

[10]:
```
# coldest days
df_cold = df.sort_values(by=['tempmin'], ascending=True)[['tempmax', 'tempmin',␣
 ↪'temp', 'moonphase']]
df_cold.head(10)
```

[10]:

datetime	tempmax	tempmin	temp	moonphase
1997-01-01	-11.9	-18.1	-15.4	0.73
2021-02-12	-4.3	-17.3	-10.5	0.00
1997-01-02	-9.0	-16.2	-13.2	0.78
2009-01-07	-3.9	-16.1	-7.9	0.41
1996-12-31	-8.8	-15.7	-12.9	0.68
2021-02-13	-1.5	-15.4	-8.3	0.02
2021-02-10	-3.7	-15.2	-8.9	1.00
1993-11-07	7.0	-15.0	5.5	0.77
2012-02-07	-5.6	-14.9	-10.4	0.50
2009-12-19	-8.8	-14.9	-12.2	0.04

2.2.2 Linear Regression: Temperature

[11]:
```
ydata=df['temp'].values
xdata=np.arange(ydata.size)
```

[12]:
```
linear_temp=np.polyfit(xdata,ydata,1)  # OR coef, cov = curve_fit(lambda x,a,b:␣
 ↪a*x+b, xdata, ydata)
linear_temp_fn=np.poly1d(linear_temp)
a = linear_temp[0]
b = linear_temp[1]
print(f'Annual temp. increase: {a*360:.2f} °C')
print(f'Temp. increase all 10 years: {a*360*10:.2f} °C')
```

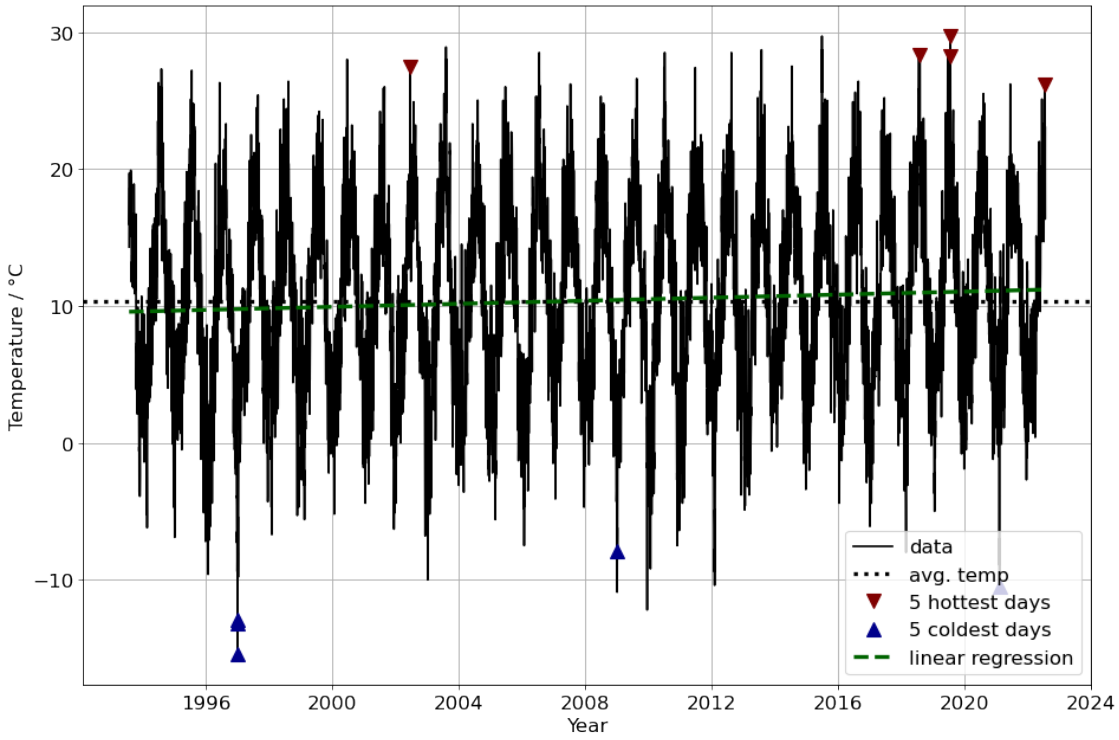
```
Annual temp. increase: 0.05 °C
Temp. increase all 10 years: 0.55 °C
```

[14]:
```
plt.figure(figsize=(12,8), dpi=80)
plt.plot(df['temp'], '-', color='black', label='data')
plt.axhline(df['temp'].mean(), linewidth=3, linestyle='dotted', color='black',␣
 ↪label='avg. temp')
plt.plot(df_hot['temp'].head(5), ' ', marker='v', markersize=10,␣
 ↪color='#800000', label='5 hottest days')
plt.plot(df_cold['temp'].head(5), ' ', marker='^', markersize=10,␣
 ↪color='#00008b', label='5 coldest days')
plt.plot([df.index[0], df.index[-1]], [b, a*ydata.size+b], color='#006400',␣
 ↪linestyle='--', linewidth=3, label='linear regression')

plt.grid()
plt.xlabel('Year', fontsize=15)
```

```
plt.ylabel('Temperature / °C', fontsize=15)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)

plt.legend(fontsize=15)
plt.tight_layout()
plt.savefig(f'../figures/pdf/temp_timeline_{start_year}-{end_year}.pdf')
plt.savefig(f'../figures/png/temp_timeline_{start_year}-{end_year}.png',␣
↪dpi=300)
plt.show()
```



2.3 1.3 Minimal, maximal and average temperature of each year

[15]:
```
max_temp_year = []
min_temp_year = []
avg_temp_year = []

for year in range(start_year, end_year+1):
    max_temp_year.append(df[(df.index>=str(year)) & (df.
↪index<=str(year+1))]['tempmax'].max()) # get max temp of the year
    min_temp_year.append(df[(df.index>=str(year)) & (df.
↪index<=str(year+1))]['tempmin'].max()) # get max temp of the year
```

```
    avg_temp_year.append(df[(df.index>=str(year)) & (df.
↪index<=str(year+1))]['temp'].max()) # get max temp of the year

len(max_temp_year)
```

[15]:
```
30
```

[16]:
```
x = np.arange(start_year, end_year+1)
```

[17]:
```
# linear regression
# max. Temperature
linear_max=np.polyfit(x,max_temp_year,1)
linear_max_fn=np.poly1d(linear_max)
print(f'Increase of daily max. Temperature in ten years {linear_max[0]*10:.2f}␣
↪°C')

# min. Temperature
linear_min=np.polyfit(x,min_temp_year,1)
linear_min_fn=np.poly1d(linear_min)
print(f'Increase of daily min. Temperature in ten years {linear_min[0]*10:.2f}␣
↪°C')

# avg. Temperature
linear_avg=np.polyfit(x,avg_temp_year,1)
linear_avg_fn=np.poly1d(linear_avg)
print(f'Increase of daily avg. Temperature in ten years {linear_avg[0]*10:.2f}␣
↪°C')
```

```
Increase of daily max. Temperature in ten years 1.26 °C
Increase of daily min. Temperature in ten years 0.52 °C
Increase of daily avg. Temperature in ten years 0.77 °C
```

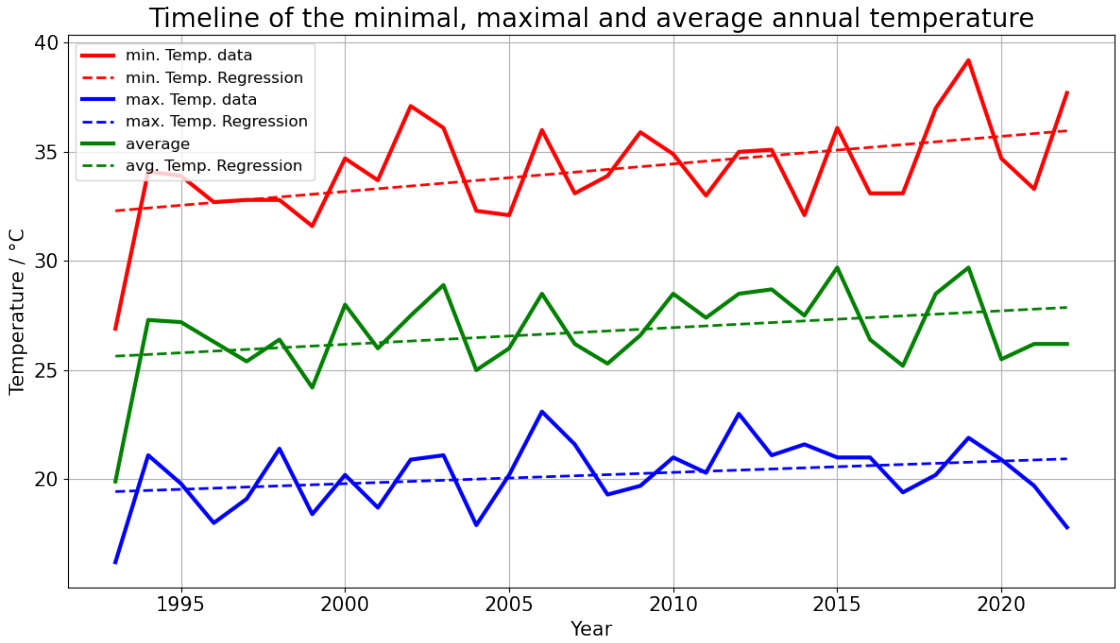
[18]:
```
plt.figure(figsize=(12,7), dpi=100)
plt.plot(x, max_temp_year, color='red', linewidth=3, label='min. Temp. data')
plt.plot(x,linear_max_fn(x), '--', color='red', linewidth=2, label='min. Temp.␣
↪Regression')

plt.plot(x, min_temp_year, color='blue', linewidth=3, label='max. Temp. data')
plt.plot(x,linear_min_fn(x), '--', color='blue', linewidth=2, label='max. Temp.␣
↪Regression')

plt.plot(x, avg_temp_year, color='green', linewidth=3, label='average')
plt.plot(x,linear_avg_fn(x), '--', color='green', linewidth=2, label='avg. Temp.
↪ Regression')

plt.grid()
plt.xlabel('Year', fontsize=15)
```

```
plt.ylabel('Temperature / °C', fontsize=15)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.title(f'Timeline of the minimal, maximal and average annual temperature',␣
 ↪fontsize=20)
plt.legend(fontsize=12)
plt.tight_layout()
plt.show()
```



3 2. Rain progress