Report_Dortmund_2022

August 8, 2022

1 0. Imports and data selection

[148]:
```
import os
import pandas as pd

import numpy as np

import matplotlib.pyplot as plt
plt.style.use('dark_background')
```

[149]:
```
os.chdir('../data')
file_names = os.listdir()
file_names.sort()
```

[150]:
```
df = pd.DataFrame()
for name in file_names:
    df = df.append(pd.read_csv(f'../data/{name}'))
```

[151]:
```
df.columns
```

[151]:
```
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')
```

[152]:
```
# use datetime as type
df['datetime'] = df['datetime'].astype("datetime64")

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

[153]:
```
# 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}']
```

[154]:

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

```
period: 1990 - 2022
```

2 1. Temperature

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

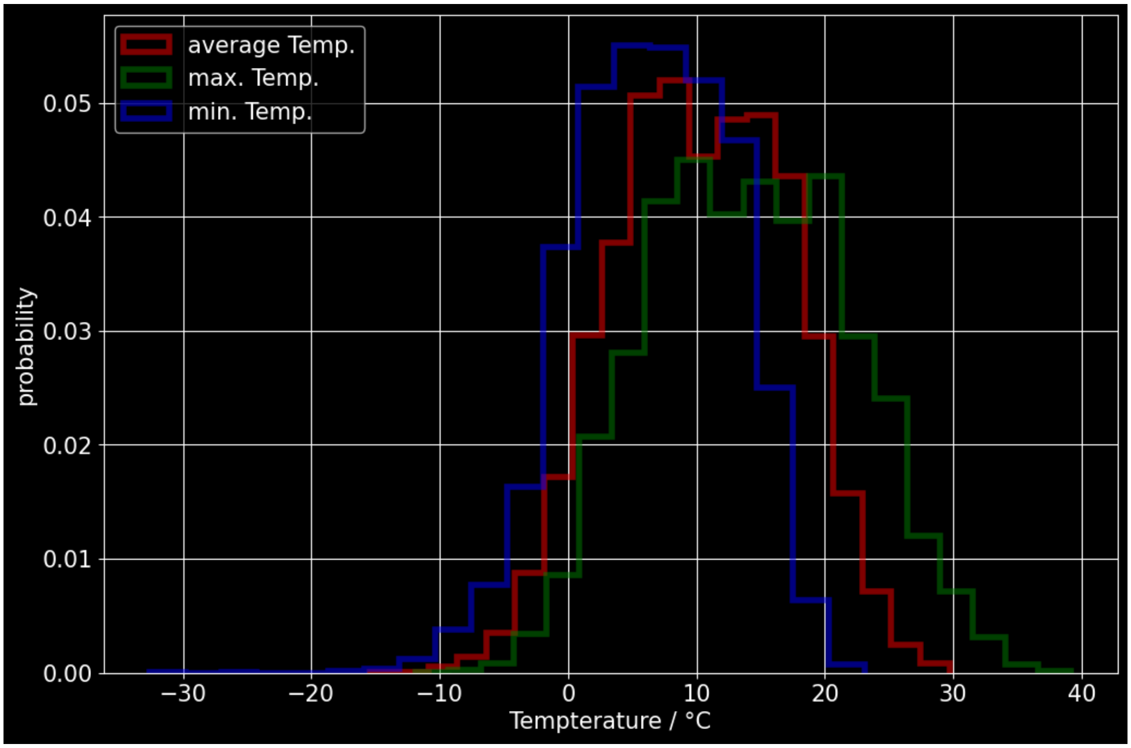
[155]:

```
# frequency of the daily average temperature, max. temp
plt.figure(figsize=(12,8), dpi=100)
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)

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

```
[156]:              tempmax  tempmin  temp  moonphase
       datetime
       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
       2015-07-02     36.1     18.7  29.7       0.50
       2003-08-08     36.1     21.0  28.9       0.42
       2003-08-12     36.0     19.9  28.0       0.50
       2003-08-07     36.0     18.3  27.7       0.37
       2019-07-26     36.0     21.9  29.4       0.83
```

[157]:

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

[157]:

```
            tempmax  tempmin  temp  moonphase
datetime
1993-01-25      7.2    -32.6   2.9       0.03
1993-01-05      6.0    -30.5  -0.9       0.44
1993-02-25      5.0    -25.9  -2.6       0.07
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
```

2.2.2 Linear Regression: Temperature

[158]:

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

[159]:

```
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: 0.04 °C
Temp. increase all 10 years: 0.38 °C
```

[160]:

```
T_mean = df['temp'].mean()
print(f'Mean annual temperature: {T_mean:.2f} °C')
```

```
Mean annual temperature: 10.40 °C
```

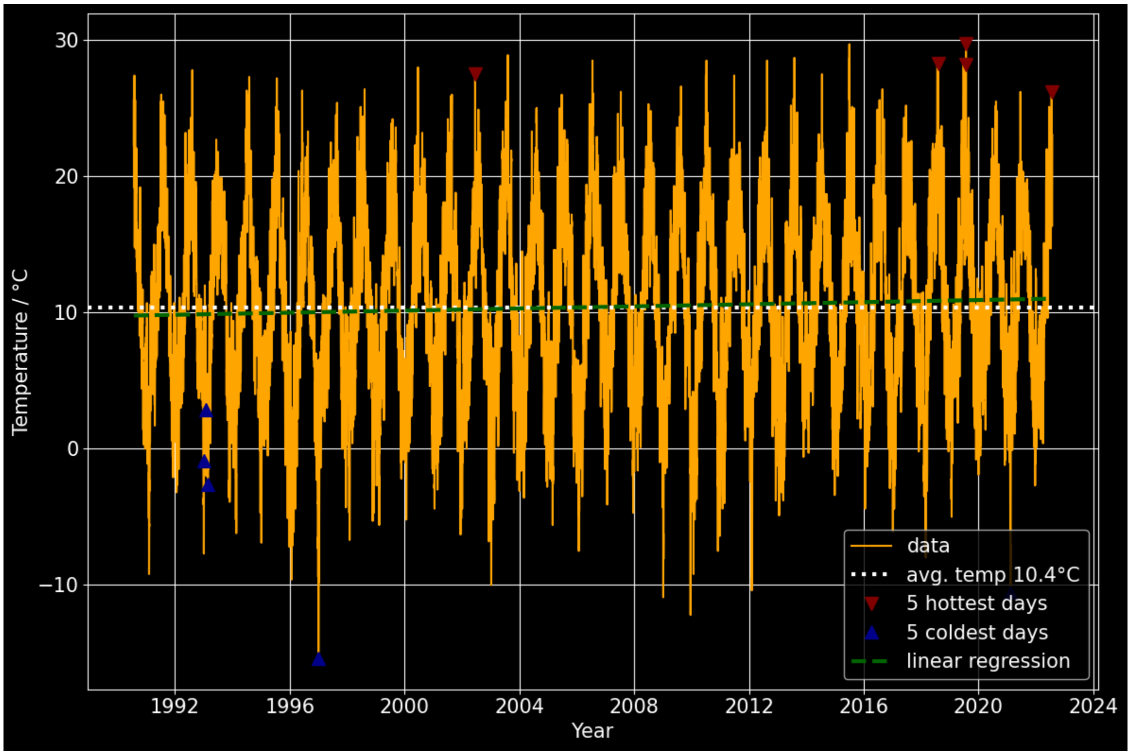
[161]:

```
plt.figure(figsize=(12,8), dpi=100)
plt.plot(df['temp'], '-', color='orange', label='data')
plt.axhline(T_mean, linewidth=3, linestyle='dotted', color='white', label=f'avg.
 ↪ temp {T_mean:.1f}°C')
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

[162]:

```
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)
```

[162]: 33

[163]:
```
x = np.arange(start_year, end_year+1)
```

[164]:
```
# 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')
```

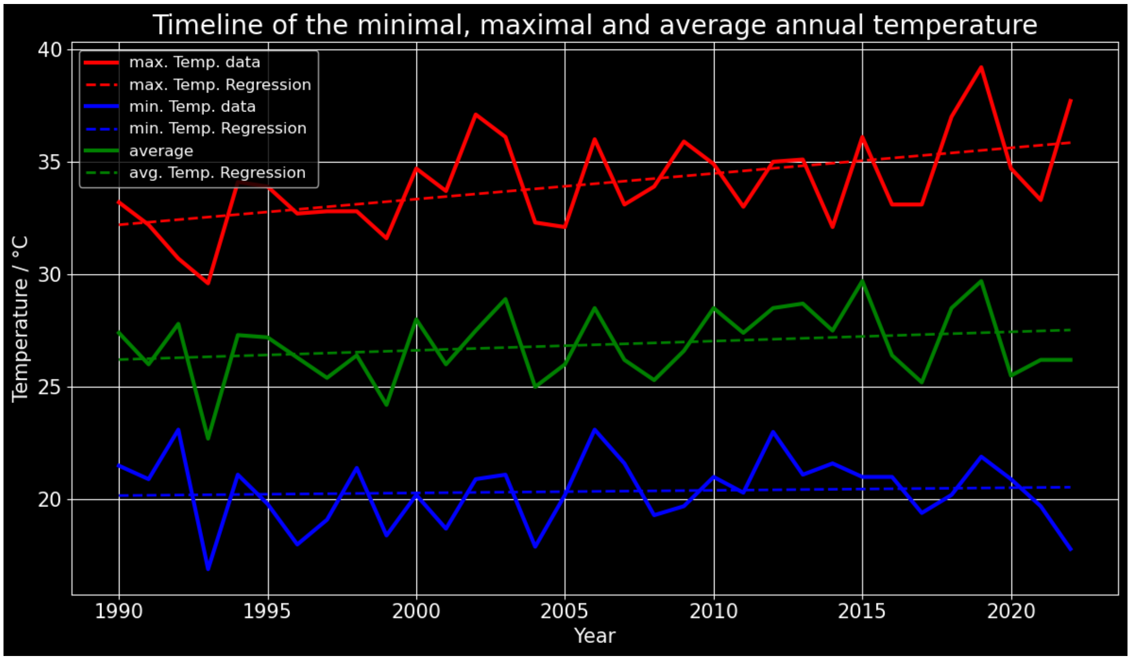
```
Increase of daily max. Temperature in ten years 1.14 °C
Increase of daily min. Temperature in ten years 0.12 °C
Increase of daily avg. Temperature in ten years 0.41 °C
```

[165]:
```
plt.figure(figsize=(12,7), dpi=100)
plt.plot(x, max_temp_year, color='red', linewidth=3, label='max. Temp. data')
plt.plot(x,linear_max_fn(x), '--', color='red', linewidth=2, label='max. Temp.␣
 ↪Regression')

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