Text Scrapping Assignment

Precipitation is a major driver for non-point source pollutants runoff, and the impact of precipitation may vary annually, seasonally, or even monthly. For example, soil is more prone to erosion during planting seasons (March-May) when land cover is minimal. Consequently, a similar precipitation events (intensity and duration) may result in greater soil erosion during planting season as compared to the late-growing season.

Therefore, it is important to understand the precipitation pattern when evaluating the fate and transport of non-point source pollutants. The objectives of this task are:
1) To gather historical precipitation data through an open API
2) Plot daily precipitation depth for each monitoring year (2016-2018)
3) Calculate and plot monthly cumulative precipitation depth
4) Calculate and plot annual cumulative precipitation depth
5) Compare the precipitation depths between the monitoring years

In the future development, this data will be paired with nutrient concentration and loading data to identify any possible correlations.

In [1]:
```
import urllib
import urllib.parse
import json
import pandas as pd
import numpy as np
import datetime as dt
import calendar
from datetime import datetime
import pprint

pd.set_option('mode.chained_assignment', None)
```

Objective 1

To gather historical precipitation data through an open API

In[2] and [3] provided by https://github.com/ekapope/WorldWeatherOnline/tree/master/wwo_hist (https://github.com/ekapope/WorldWeatherOnline/tree/master/wwo_hist)

In [2]:
```
def extract_monthly_data(data):
    num_days = len(data)
    # initialize df_month to store return data
    df_month = pd.DataFrame()
    for i in range(num_days):
        # extract this day
        d = data[i]
        # astronomy data is the same for the whole day
        astr_df = pd.DataFrame(d['astronomy'])
        # hourly data; temperature for each hour of the day
        hourly_df = pd.DataFrame(d['hourly'])
        # this wanted_key will be duplicated and use 'ffill' to fill up the NAs
        wanted_keys = ['date', 'maxtempC', 'mintempC', 'totalSnow_cm', 'sunHour', 'uvInde
x'] # The keys you want
        subset_d = dict((k, d[k]) for k in wanted_keys if k in d)
        this_df = pd.DataFrame(subset_d,index=[0])
        df = pd.concat([this_df.reset_index(drop=True), astr_df], axis=1)
        # concat selected astonomy columns with hourly data
        df = pd.concat([df,hourly_df], axis=1)
        df = df.fillna(method='ffill')
        # make date_time columm to proper format
        # fill leading zero for hours to 4 digits (0000-2400 hr)
        df['time'] = df['time'].apply(lambda x: x.zfill(4))
        # keep only first 2 digit (00-24 hr)
        df['time'] = df['time'].str[:2]
        # convert to pandas datetime
        df['date_time'] = pd.to_datetime(df['date'] + ' ' + df['time'])
        # keep only interested columns
        col_to_keep = ['date_time', 'maxtempC', 'mintempC', 'totalSnow_cm', 'sunHour', 'uv
Index',
               'moon_illumination', 'moonrise', 'moonset', 'sunrise', 'sunset',
               'DewPointC',  'FeelsLikeC', 'HeatIndexC', 'WindChillC', 'WindGustKmph',
               'cloudcover', 'humidity', 'precipMM', 'pressure', 'tempC', 'visibility',
               'winddirDegree', 'windspeedKmph']
        df = df[col_to_keep]
        df_month = pd.concat([df_month,df])
    return(df_month)
```

In [3]:
```
#function to retrive data by date range and location
#default frequency = 1 hr
#each month costs 1 request (free trial 500 requests/key, as of 30-May-2019)
def retrieve_this_location(api_key,location,start_date,end_date,frequency):

    start_time = datetime.now()

    # create list of months, convert to month begins (first day of each month)
    list_mon_begin= pd.date_range(start_date,end_date, freq='1M')-pd.offsets.MonthBegin(1)
    # convert to Series and append first day of the last month
    list_mon_begin = pd.concat([pd.Series(list_mon_begin), pd.Series(pd.to_datetime(end_da
te,infer_datetime_format=True).replace(day=1))], ignore_index=True)
    # change the begin date to start_date
    list_mon_begin[0] = pd.to_datetime(start_date,infer_datetime_format=True)

    # create list of months, convert to month ends (last day of each month)
    list_mon_end = pd.date_range(start_date,end_date, freq='1M')-pd.offsets.MonthEnd(0)
    # convert to Series and append the end_date
    list_mon_end = pd.concat([pd.Series(list_mon_end), pd.Series(pd.to_datetime(end_date,i
nfer_datetime_format=True))], ignore_index=True)

    # count number of months to be retrieved
    total_months = len(list_mon_begin)

    # initialize df_hist to store return data
    df_hist = pd.DataFrame()
    for m in range(total_months):

        start_d =str(list_mon_begin[m])[:10]
        end_d =str(list_mon_end[m])[:10]
        print('Currently retrieving data for '+location+': from '+start_d+' to '+end_d)

        url_page = 'http://api.worldweatheronline.com/premium/v1/past-weather.ashx?key='+a
pi_key+'&q='+location+'&format=json&date='+start_d+'&enddate='+end_d+'&tp='+str(frequency)
        json_page = urllib.request.urlopen(url_page)
        json_data = json.loads(json_page.read().decode())
        data= json_data['data']['weather']
       # call function to extract json object
        df_this_month = extract_monthly_data(data)
        df_hist = pd.concat([df_hist,df_this_month])

        time_elapsed = datetime.now() - start_time
        print('Time elapsed (hh:mm:ss.ms) {}'.format(time_elapsed))
    return(df_hist)
```

In [4]:
```
# retrieving data for dates provided by user

API_key = '3bbd19dc238c4542a08213223192409'
location = '42.2422,-95.0381'
startdate = input('Enter start date as YYYY-MM-DD')
enddate = input('Enter end date as YYYY-MM-DD')
startdate = datetime.strptime(startdate, '%Y-%m-%d')
enddate = datetime.strptime(enddate, '%Y-%m-%d')
weather_data  = retrieve_this_location(API_key, location, startdate, enddate,'default')
```

```
Enter start date as YYYY-MM-DD2016-01-01
Enter end date as YYYY-MM-DD2018-12-31
Currently retrieving data for 42.2422,-95.0381: from 2016-01-01 to 2016-01-31
Time elapsed (hh:mm:ss.ms) 0:00:02.482088
Currently retrieving data for 42.2422,-95.0381: from 2016-02-01 to 2016-02-29
Time elapsed (hh:mm:ss.ms) 0:00:03.627640
Currently retrieving data for 42.2422,-95.0381: from 2016-03-01 to 2016-03-31
Time elapsed (hh:mm:ss.ms) 0:00:04.810496
Currently retrieving data for 42.2422,-95.0381: from 2016-04-01 to 2016-04-30
Time elapsed (hh:mm:ss.ms) 0:00:06.113502
Currently retrieving data for 42.2422,-95.0381: from 2016-05-01 to 2016-05-31
Time elapsed (hh:mm:ss.ms) 0:00:07.381584
Currently retrieving data for 42.2422,-95.0381: from 2016-06-01 to 2016-06-30
Time elapsed (hh:mm:ss.ms) 0:00:08.860512
Currently retrieving data for 42.2422,-95.0381: from 2016-07-01 to 2016-07-31
Time elapsed (hh:mm:ss.ms) 0:00:10.058721
Currently retrieving data for 42.2422,-95.0381: from 2016-08-01 to 2016-08-31
Time elapsed (hh:mm:ss.ms) 0:00:11.739902
Currently retrieving data for 42.2422,-95.0381: from 2016-09-01 to 2016-09-30
Time elapsed (hh:mm:ss.ms) 0:00:12.894528
Currently retrieving data for 42.2422,-95.0381: from 2016-10-01 to 2016-10-31
Time elapsed (hh:mm:ss.ms) 0:00:14.114319
Currently retrieving data for 42.2422,-95.0381: from 2016-11-01 to 2016-11-30
Time elapsed (hh:mm:ss.ms) 0:00:15.235845
Currently retrieving data for 42.2422,-95.0381: from 2016-12-01 to 2016-12-31
Time elapsed (hh:mm:ss.ms) 0:00:16.654417
Currently retrieving data for 42.2422,-95.0381: from 2017-01-01 to 2017-01-31
Time elapsed (hh:mm:ss.ms) 0:00:17.971629
Currently retrieving data for 42.2422,-95.0381: from 2017-02-01 to 2017-02-28
Time elapsed (hh:mm:ss.ms) 0:00:19.094481
Currently retrieving data for 42.2422,-95.0381: from 2017-03-01 to 2017-03-31
Time elapsed (hh:mm:ss.ms) 0:00:20.351505
Currently retrieving data for 42.2422,-95.0381: from 2017-04-01 to 2017-04-30
Time elapsed (hh:mm:ss.ms) 0:00:21.718182
Currently retrieving data for 42.2422,-95.0381: from 2017-05-01 to 2017-05-31
Time elapsed (hh:mm:ss.ms) 0:00:23.240747
Currently retrieving data for 42.2422,-95.0381: from 2017-06-01 to 2017-06-30
Time elapsed (hh:mm:ss.ms) 0:00:24.382450
Currently retrieving data for 42.2422,-95.0381: from 2017-07-01 to 2017-07-31
Time elapsed (hh:mm:ss.ms) 0:00:25.563863
Currently retrieving data for 42.2422,-95.0381: from 2017-08-01 to 2017-08-31
Time elapsed (hh:mm:ss.ms) 0:00:27.318231
Currently retrieving data for 42.2422,-95.0381: from 2017-09-01 to 2017-09-30
Time elapsed (hh:mm:ss.ms) 0:00:28.554106
Currently retrieving data for 42.2422,-95.0381: from 2017-10-01 to 2017-10-31
Time elapsed (hh:mm:ss.ms) 0:00:29.789775
Currently retrieving data for 42.2422,-95.0381: from 2017-11-01 to 2017-11-30
Time elapsed (hh:mm:ss.ms) 0:00:31.316135
Currently retrieving data for 42.2422,-95.0381: from 2017-12-01 to 2017-12-31
Time elapsed (hh:mm:ss.ms) 0:00:32.826802
Currently retrieving data for 42.2422,-95.0381: from 2018-01-01 to 2018-01-31
Time elapsed (hh:mm:ss.ms) 0:00:34.284283
Currently retrieving data for 42.2422,-95.0381: from 2018-02-01 to 2018-02-28
Time elapsed (hh:mm:ss.ms) 0:00:35.417005
Currently retrieving data for 42.2422,-95.0381: from 2018-03-01 to 2018-03-31
Time elapsed (hh:mm:ss.ms) 0:00:37.107299
Currently retrieving data for 42.2422,-95.0381: from 2018-04-01 to 2018-04-30
Time elapsed (hh:mm:ss.ms) 0:00:38.466185
Currently retrieving data for 42.2422,-95.0381: from 2018-05-01 to 2018-05-31
Time elapsed (hh:mm:ss.ms) 0:00:39.731386
Currently retrieving data for 42.2422,-95.0381: from 2018-06-01 to 2018-06-30
Time elapsed (hh:mm:ss.ms) 0:00:41.033861
Currently retrieving data for 42.2422,-95.0381: from 2018-07-01 to 2018-07-31
Time elapsed (hh:mm:ss.ms) 0:00:42.301223
```

```
Currently retrieving data for 42.2422,-95.0381: from 2018-08-01 to 2018-08-31
Time elapsed (hh:mm:ss.ms) 0:00:43.700661
Currently retrieving data for 42.2422,-95.0381: from 2018-09-01 to 2018-09-30
Time elapsed (hh:mm:ss.ms) 0:00:45.014400
Currently retrieving data for 42.2422,-95.0381: from 2018-10-01 to 2018-10-31
Time elapsed (hh:mm:ss.ms) 0:00:46.306565
Currently retrieving data for 42.2422,-95.0381: from 2018-11-01 to 2018-11-30
Time elapsed (hh:mm:ss.ms) 0:00:47.470360
Currently retrieving data for 42.2422,-95.0381: from 2018-12-01 to 2018-12-31
Time elapsed (hh:mm:ss.ms) 0:00:48.729403
Currently retrieving data for 42.2422,-95.0381: from 2018-12-01 to 2018-12-31
Time elapsed (hh:mm:ss.ms) 0:00:49.453455
```

In [5]:
```
weather_data.head()
```

Out[5]:

	date_time	maxtempC	mintempC	totalSnow_cm	sunHour	uvIndex	uvIndex	moon_illumination	moonrise
0	2016-01-01 00:00:00	-2	-9	0.0	8.7	1	0	50	12:36 AM
1	2016-01-01 03:00:00	-2	-9	0.0	8.7	1	0	50	12:36 AM
2	2016-01-01 06:00:00	-2	-9	0.0	8.7	1	0	50	12:36 AM
3	2016-01-01 09:00:00	-2	-9	0.0	8.7	1	2	50	12:36 AM
4	2016-01-01 12:00:00	-2	-9	0.0	8.7	1	2	50	12:36 AM

5 rows × 25 columns

In [6]:
```
ppt =  weather_data [['date_time','precipMM','tempC']]
ppt.head()
```

Out[6]:

	date_time	precipMM	tempC
0	2016-01-01 00:00:00	0.0	-8
1	2016-01-01 03:00:00	0.0	-8
2	2016-01-01 06:00:00	0.0	-9
3	2016-01-01 09:00:00	0.0	-6
4	2016-01-01 12:00:00	0.0	-2

In [7]:
```
# separate date and time so that daily average can be calculate using "groupby"
ppt['Date']= ppt['date_time'].dt.date
```

In [8]:
```
print(ppt.head())
print(ppt.dtypes)
```

```
            date_time precipMM tempC        Date
0 2016-01-01 00:00:00      0.0    -8  2016-01-01
1 2016-01-01 03:00:00      0.0    -8  2016-01-01
2 2016-01-01 06:00:00      0.0    -9  2016-01-01
3 2016-01-01 09:00:00      0.0    -6  2016-01-01
4 2016-01-01 12:00:00      0.0    -2  2016-01-01
date_time    datetime64[ns]
precipMM             object
tempC                object
Date                 object
dtype: object
```

In [9]:
```
# converting precip and temperature values from object to string then to interger/float
ppt['Date'] = pd.to_datetime(ppt['Date'])
ppt['precipMM'] = ppt['precipMM'].astype(float)
ppt['tempC'] = ppt['tempC'].astype(str).astype(int)
```

In [10]:
```
# calculate daily cumulative precip and average temp
daily_ppt = ppt.groupby('Date').agg({'precipMM':'sum', 'tempC':'mean'})
print(daily_ppt.head())
print(daily_ppt.dtypes)
```

```
            precipMM   tempC
Date
2016-01-01       0.0  -5.750
2016-01-02       0.0  -6.000
2016-01-03       0.1  -6.625
2016-01-04       0.1 -10.125
2016-01-05       0.0  -4.875
precipMM    float64
tempC       float64
dtype: object
```

In [11]:
```
# exporting daily ppt file as csv

export_ppt = daily_ppt.to_csv('BHL_weather_data.csv', index=True)
```

In [12]:
```
# convert Date index into column

daily_ppt.reset_index(level=0, inplace=True)
daily_ppt ['year'] = pd.DatetimeIndex(daily_ppt['Date']).year
daily_ppt ['month'] = pd.DatetimeIndex(daily_ppt['Date']).month

daily_ppt.tail()
```

Out[12]:

	Date	precipMM	tempC	year	month
1091	2018-12-27	5.6	3.750	2018	12
1092	2018-12-28	0.4	-8.500	2018	12
1093	2018-12-29	0.0	-11.375	2018	12
1094	2018-12-30	0.0	-2.750	2018	12
1095	2018-12-31	0.2	-3.000	2018	12

Objective 2

Plot daily precipitation depth for each monitoring year (2016-2018)

In [13]:
```
# split the dataset based on year
gbl = globals()

startyear = startdate.year
endyear = enddate.year
years = list(range(startyear, endyear+1))

for curr_year in years:
    year_name = str(curr_year)
    gbl['ppt_'+year_name] = daily_ppt[daily_ppt['year'] == curr_year]
    # the dataframe for each year can be called using 'ppt_YYYY'
```

In [14]:
```
# test calling 2018 dataframe using 'ppt_YYYY'

ppt_2018.head()
```

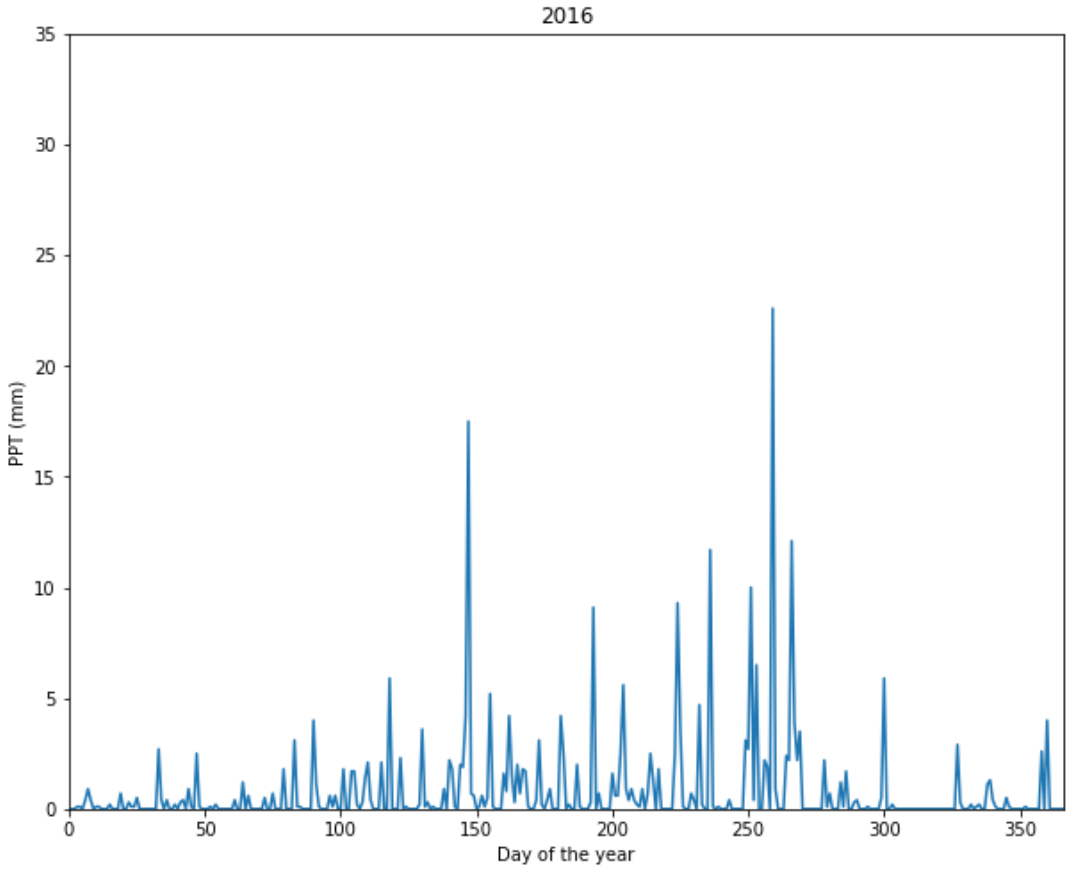
Out[14]:

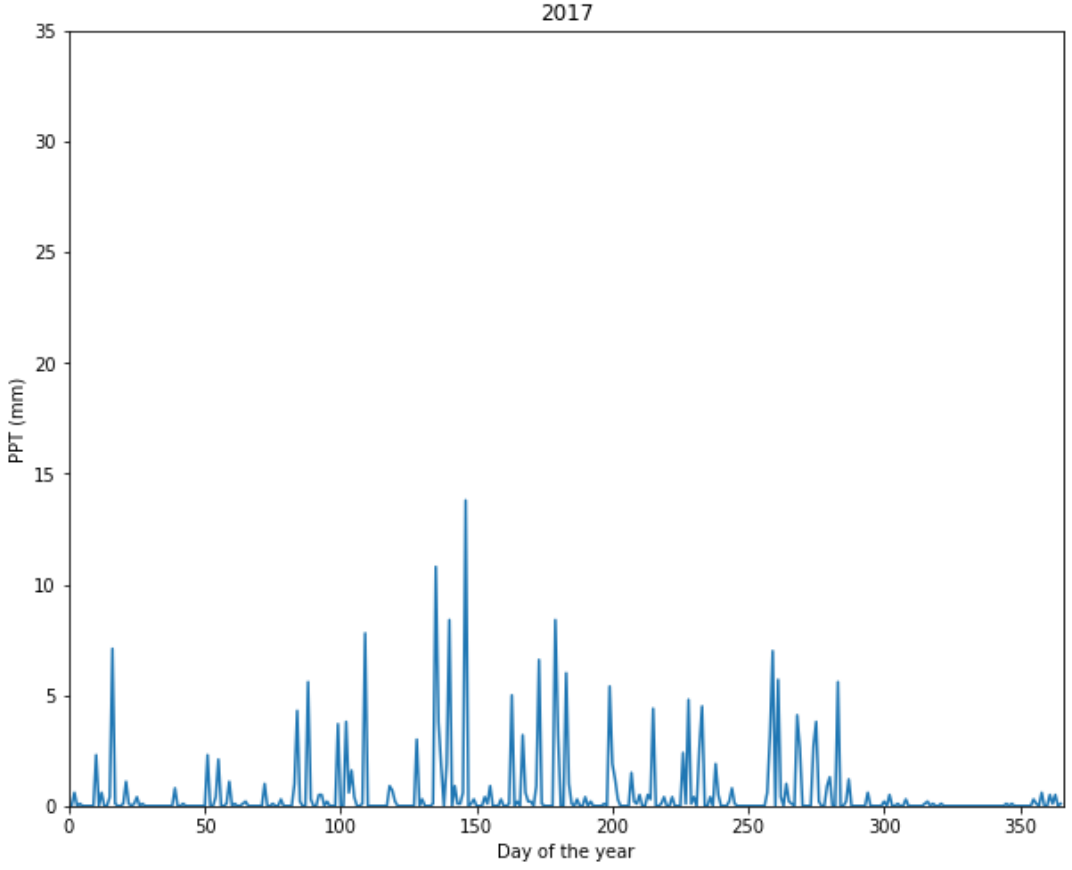
	Date	precipMM	tempC	year	month
731	2018-01-01	0.0	-27.000	2018	1
732	2018-01-02	0.0	-18.000	2018	1
733	2018-01-03	0.0	-16.375	2018	1
734	2018-01-04	0.1	-18.500	2018	1
735	2018-01-05	0.0	-17.875	2018	1

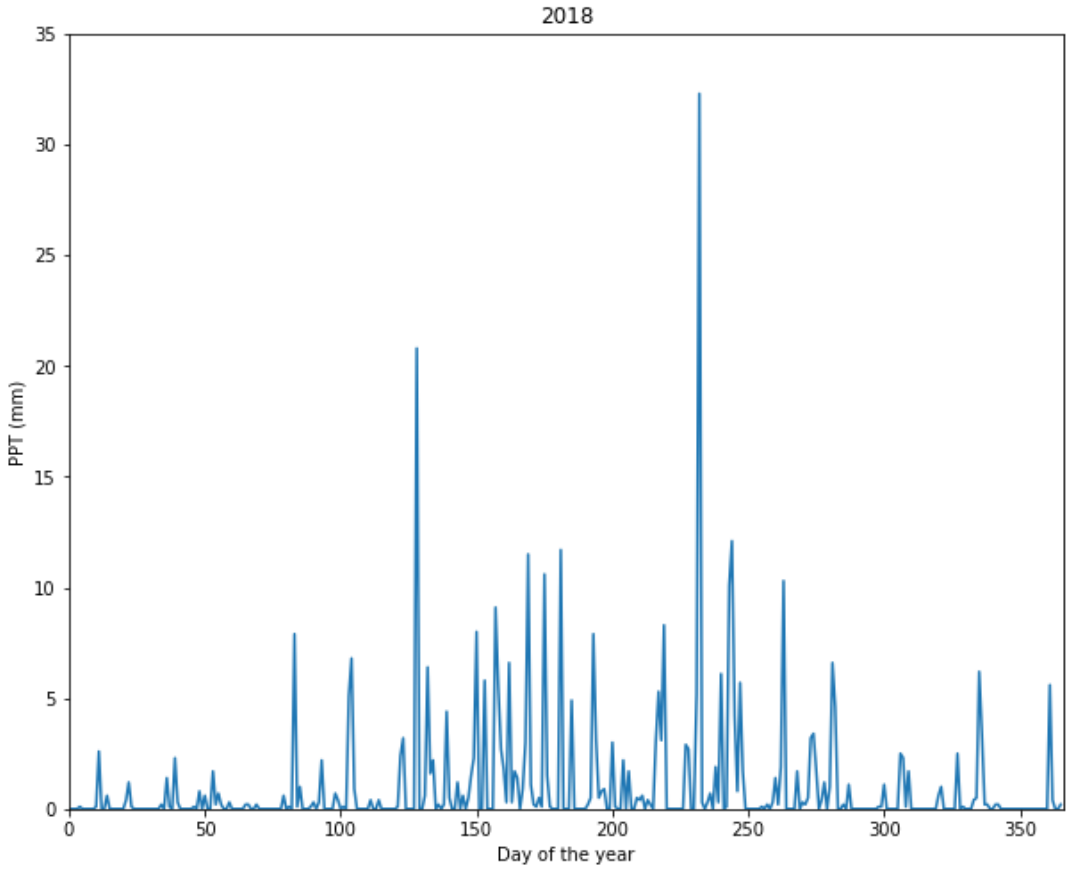
In [20]:
```
import matplotlib.pyplot as plt

# extract day of year from Date, then plot time series daily ppt
monitoring_years = (ppt_2016, ppt_2017, ppt_2018) # same comment as above, would like to a
utomate this naming
startyear = startdate.year

for df in (monitoring_years):
    df['Day_of_year'] = df['Date'].dt.dayofyear
    plt.plot(df['Day_of_year'], df['precipMM'])
    plt.title(startyear)
    plt.xlabel('Day of the year')
    plt.ylabel('PPT (mm)')
    plt.axis([0, 366, 0, 35])
    plt.show()
    startyear = startyear + 1
```


2016
PPT (mm)
Day of the year
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350


2017
PPT (mm)
Day of the year
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300
350

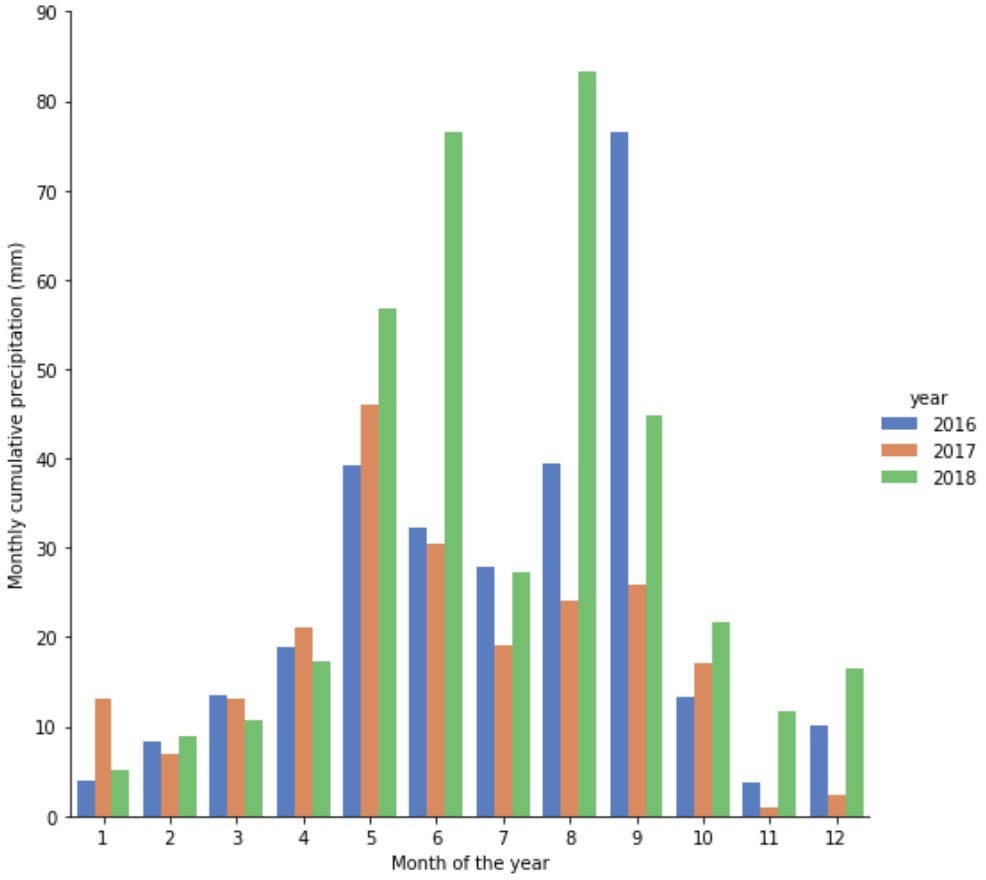


Objective 3

Calculate and plot monthly cumulative precipitation depth

In [16]:
```
import seaborn as sns

monthly_precip = pd.DataFrame(daily_ppt.groupby(['year','month']).sum()['precipMM'])
monthly_precip.reset_index(inplace=True)
monthly_plot = sns.catplot(x="month", y="precipMM", hue="year", data=monthly_precip, heigh
t=7, kind="bar", palette="muted")
plt.ylim(0,90)
plt.xlabel('Month of the year')
plt.ylabel('Monthly cumulative precipitation (mm)')
plt.show()
```



Objective 4

Calculate and plot annual cumulative precipitation depth

In [17]:
```
# calculating cumulative precip
monitoring_years = (ppt_2016, ppt_2017, ppt_2018)
# Ideally, I want to use the loop to replace the script (manually inserted dataframe name
s) above but I couldn't get it to work
# It should look something like 'ppt_'& YYYY (i.e. calling dataframes with two parts name
 fixedname+numericalname)

for df in (monitoring_years):
    df['cum_precipMM'] = df['precipMM'].cumsum()
```

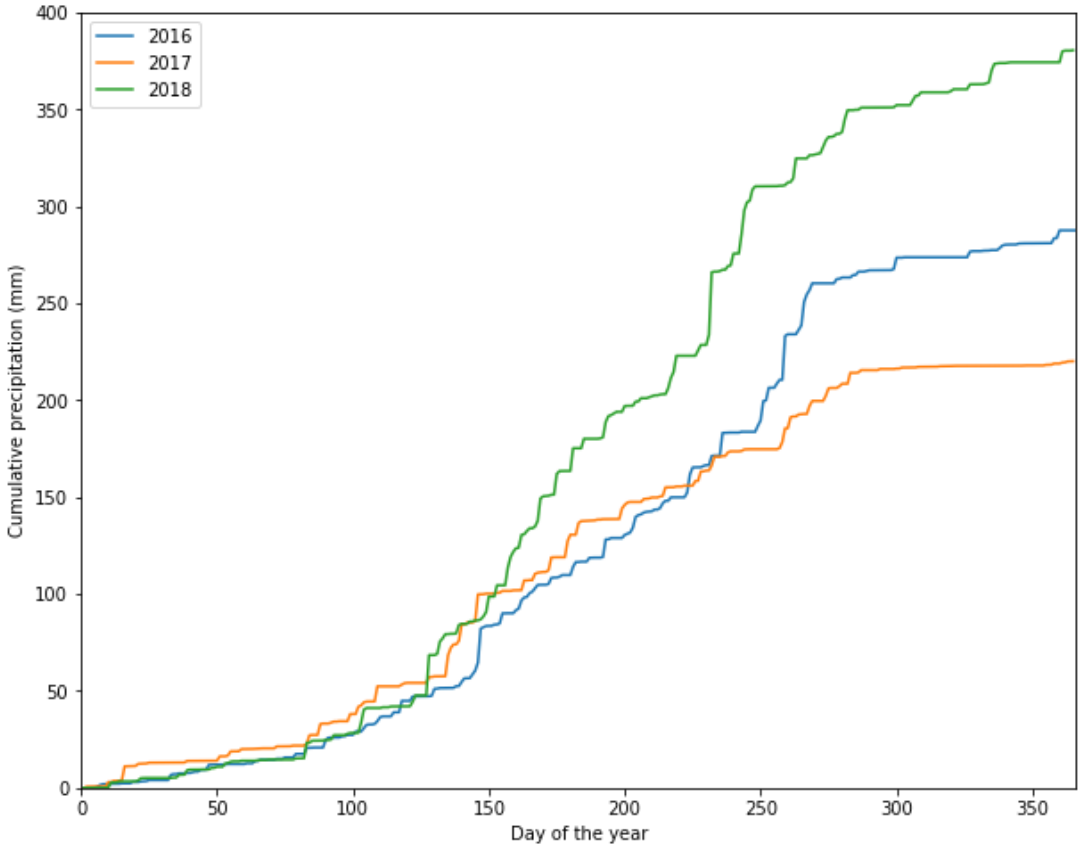
In [18]:
```
print(ppt_2016.tail())
print(ppt_2017.tail())
print(ppt_2018.tail())
```

```
          Date  precipMM  tempC  year  month  Day_of_year  cum_precipMM
361 2016-12-27       0.0 -2.000  2016     12          362         287.6
362 2016-12-28       0.0  1.375  2016     12          363         287.6
363 2016-12-29       0.0 -0.250  2016     12          364         287.6
364 2016-12-30       0.0  0.250  2016     12          365         287.6
365 2016-12-31       0.0 -1.625  2016     12          366         287.6
          Date  precipMM   tempC  year  month  Day_of_year  cum_precipMM
726 2017-12-27       0.5 -18.250  2017     12          361         219.4
727 2017-12-28       0.1 -13.000  2017     12          362         219.5
728 2017-12-29       0.5 -13.750  2017     12          363         220.0
729 2017-12-30       0.0 -21.125  2017     12          364         220.0
730 2017-12-31       0.1 -25.500  2017     12          365         220.1
           Date  precipMM   tempC  year  month  Day_of_year  cum_precipMM
1091 2018-12-27       5.6   3.750  2018     12          361         379.9
1092 2018-12-28       0.4  -8.500  2018     12          362         380.3
1093 2018-12-29       0.0 -11.375  2018     12          363         380.3
1094 2018-12-30       0.0  -2.750  2018     12          364         380.3
1095 2018-12-31       0.2  -3.000  2018     12          365         380.5
```

In [21]:
```
# cumulative precip plot
startyear = startdate.year

for df in (monitoring_years):
    plt.plot(df['Day_of_year'], df['cum_precipMM'], label = startyear)
    startyear = startyear +1

plt.rcParams["figure.figsize"] = (10,8)
plt.legend()
plt.axis([0, 366, 0, 400])
plt.xlabel('Day of the year')
plt.ylabel('Cumulative precipitation (mm)')
plt.show()
```



Objective 5

Compare the precipitation depths between the monitoring years

Discussion:
1) The time-series daily precipitation plots showed the precipitation pattern and distribution throughout the year. The precipitation pattern (especially the largest storms) can be compared with nutrient data to determine if storm events increased the nutrient export concentrations and loads. An alternative way to present the plots is to use "month" on the x-axis instead of "day of the year".
2) In relative to other months of the year, May through September received the highest amount of precipitation except for July. The nutrient export pattern also may depends on the timing of fertilizer application and crop planting, where April to May are likely to experience greater runoff from precipitation events.
3) 2018 received the highest precipitation depth, and followed by 2016 and 2017.

In [ ]: