# ESE5023 Assignment 02 Report

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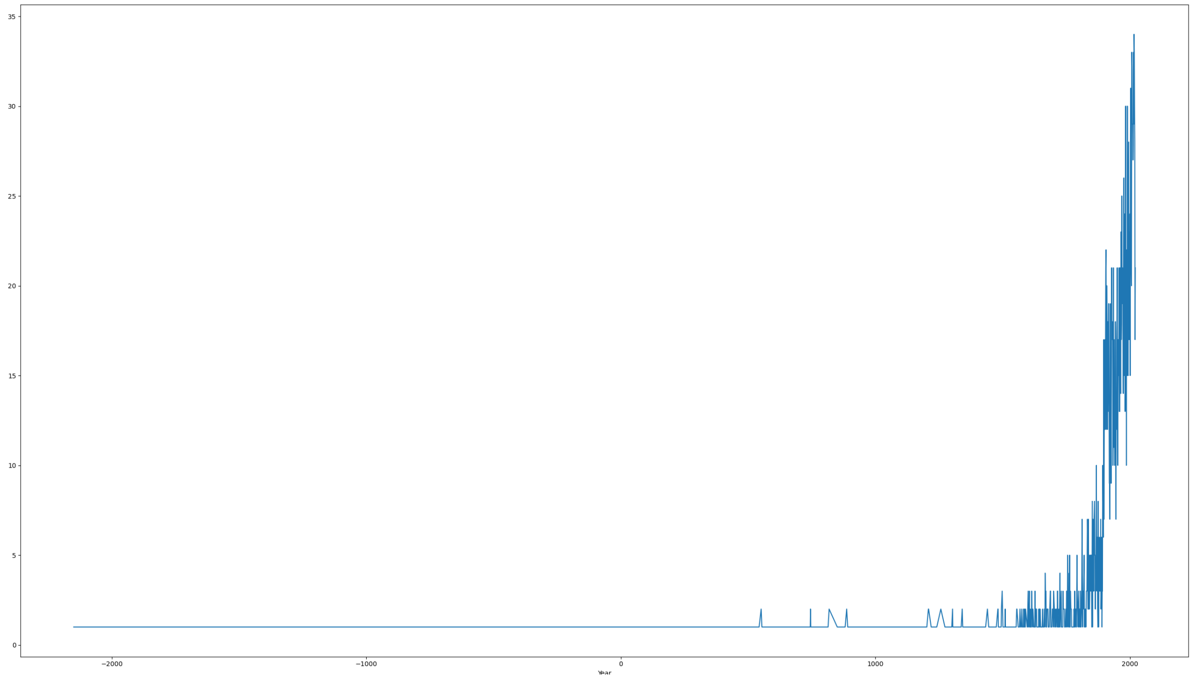
## 1. Significant earthquakes since 2150 B.C.

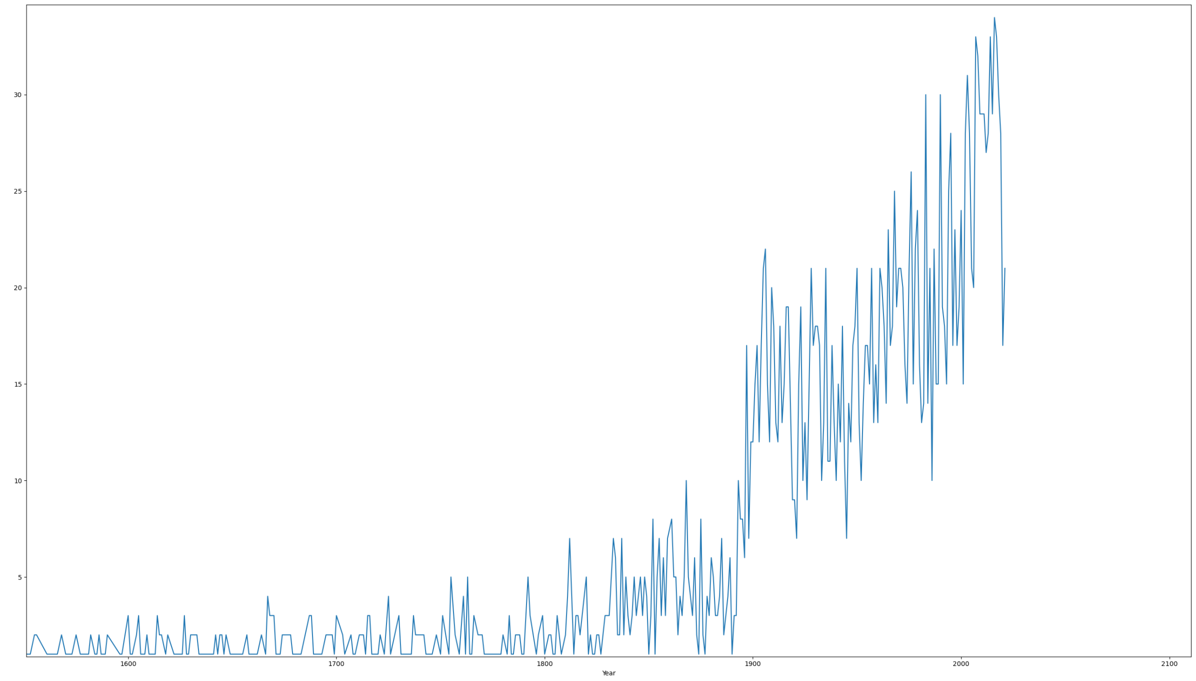
因地震而死亡的人数最高的十个国家如下：

| Country | Deaths |
|---|---|
| CHINA | 2074900.0 |
| TURKEY | 1074769.0 |
| IRAN | 1011437.0 |
| SYRIA | 439224.0 |
| ITALY | 434863.0 |
| HAITI | 323472.0 |
| AZERBAIJAN | 317219.0 |
| JAPAN | 278138.0 |
| ARMENIA | 191890.0 |
| PAKISTAN | 148764.0 |

每年地震震级≥6级的时间序列统计图如下：



放大观察1600-2020的数据：



可以发现有记录的地震次数在1900年附近发生了明显的增加，其原因应该是近代以来，人类观测与记录地震的手段和方法不断完善，因此地震记录次数明显地增加了。

按照题目要求对每个国家使用函数 CountEq_LargestEq() 后，将记录保存在文件 **mag_df.csv** 中

按降序记录每个国家地震发生总数以及最大震级地震发生的日期，绘制成如下表格：

| Country | total_eqs | maxMag_date |
|---|---|---|
| 14 | CHINA | 610 |
| 32 | JAPAN | 409 |
| 68 | INDONESIA | 399 |
| 7 | IRAN | 380 |
| 9 | TURKEY | 330 |
| 5 | ITALY | 326 |
| 51 | USA | 271 |
| 3 | GREECE | 269 |
| 65 | PHILIPPINES | 221 |
| 57 | MEXICO | 204 |
| 55 | CHILE | 198 |
| 48 | PERU | 185 |
| 15 | RUSSIA | 150 |
| 8 | INDIA | 99 |
| 72 | TAIWAN | 98 |
| 85 | PAPUA NEW GUINEA | 98 |
| 62 | COLOMBIA | 79 |
| 98 | NEW ZEALAND | 71 |
| 50 | VENEZUELA | 66 |
| 59 | ECUADOR | 64 |
| 115 | SOLOMON ISLANDS | 61 |
| 22 | AFGHANISTAN | 59 |
| 44 | ALGERIA | 57 |
| 16 | ALBANIA | 56 |
| 105 | VANUATU | 54 |
| 20 | PAKISTAN | 53 |
| 41 | CROATIA | 49 |
| 27 | FRANCE | 43 |
| 66 | USA TERRITORY | 40 |
| 71 | NICARAGUA | 39 |

| Country | total_eqs | maxMag_date |
|---|---|---|
| 63 | EL SALVADOR | 38 |
| 61 | GUATEMALA | 38 |
| 64 | COSTA RICA | 35 |
| 80 | MYANMAR (BURMA) | 33 |
| 1 | SYRIA | 33 |
| 37 | SWITZERLAND | 31 |
| 56 | AZORES (PORTUGAL) | 27 |
| 11 | SPAIN | 27 |
| 13 | PORTUGAL | 26 |
| 119 | TAJIKISTAN | 26 |
| 31 | IRAQ | 24 |
| 104 | AUSTRALIA | 24 |
| 4 | ISRAEL | 23 |
| 67 | PANAMA | 23 |
| 102 | TONGA | 22 |
| 30 | SLOVENIA | 22 |
| 107 | NEW CALEDONIA | 21 |
| 77 | ARGENTINA | 21 |
| 40 | MOROCCO | 20 |
| 73 | CANADA | 20 |
| 21 | SOUTH KOREA | 20 |
| 74 | JAMAICA | 19 |
| 109 | FIJI | 19 |
| 17 | BULGARIA | 18 |
| 52 | DOMINICAN REPUBLIC | 18 |
| 117 | KERMADEC ISLANDS (NEW ZEALAND) | 17 |
| 83 | BANGLADESH | 17 |
| 78 | HAITI | 17 |
| 36 | ICELAND | 17 |
| 39 | NEPAL | 16 |

| Country | total_eqs | maxMag_date |
|---|---|---|
| 25 | AZERBAIJAN | 16 |
| 18 | GEORGIA | 15 |
| 47 | SERBIA | 15 |
| 12 | EGYPT | 15 |
| 54 | ROMANIA | 15 |
| 6 | LEBANON | 14 |
| 10 | KYRGYZSTAN | 14 |
| 92 | SOUTH AFRICA | 14 |
| 35 | UZBEKISTAN | 14 |
| 75 | CUBA | 14 |
| 58 | HONDURAS | 13 |
| 34 | UK | 13 |
| 33 | ARMENIA | 13 |
| 23 | MACEDONIA | 12 |
| 2 | TURKMENISTAN | 11 |
| 79 | MARTINIQUE | 10 |
| 28 | KAZAKHSTAN | 10 |
| 38 | YEMEN | 10 |
| 45 | BOSNIA-HERZEGOVINA | 10 |
| 60 | MONTENEGRO | 9 |
| 53 | GERMANY | 9 |
| 97 | GUADELOUPE | 9 |
| 24 | TUNISIA | 9 |
| 69 | ETHIOPIA | 9 |
| 125 | SAMOA | 8 |
| 42 | UKRAINE | 8 |
| 121 | TANZANIA | 8 |
| 90 | TRINIDAD AND TOBAGO | 8 |
| 43 | AUSTRIA | 7 |
| 130 | SOUTH GEORGIA AND THE SOUTH SANDWICH ISLANDS | 7 |

| Country | total_eqs | maxMag_date |
|---|---|---|
| 94 | CONGO | 7 |
| 116 | MONGOLIA | 6 |
| 114 | BOLIVIA | 6 |
| 19 | CYPRUS | 6 |
| 29 | NORTH KOREA | 6 |
| 150 | POLAND | 6 |
| 132 | BRAZIL | 6 |
| 82 | ATLANTIC OCEAN | 6 |
| 81 | ERITREA | 6 |
| 127 | VIETNAM | 5 |
| 147 | BHUTAN | 5 |
| 134 | ANTARCTICA | 5 |
| 146 | RWANDA | 5 |
| 0 | JORDAN | 5 |
| 84 | HUNGARY | 5 |
| 70 | GHANA | 5 |
| 122 | MICRONESIA FED. STATES OF | 4 |
| 26 | THAILAND | 4 |
| 139 | MALAWI | 4 |
| 123 | UGANDA | 4 |
| 151 | MOZAMBIQUE | 3 |
| 149 | SAUDI ARABIA | 3 |
| 46 | SLOVAKIA | 3 |
| 142 | NETHERLANDS | 3 |
| 136 | MALAYSIA | 3 |
| 76 | ANTIGUA AND BARBUDA | 3 |
| 129 | INDIAN OCEAN | 3 |
| 128 | KENYA | 3 |
| 103 | SOUTH SUDAN | 3 |
| 88 | TOGO | 2 |

| Country | total_eqs | maxMag_date |
|---|---|---|
| 91 | CANARY ISLANDS | 2 |
| 145 | LAOS | 2 |
| 87 | SAINT LUCIA | 2 |
| 120 | CAMEROON | 2 |
| 86 | FRENCH GUIANA | 2 |
| 112 | SOLOMON SEA | 2 |
| 95 | UK TERRITORY | 2 |
| 131 | PACIFIC OCEAN | 2 |
| 108 | COTE D'IVOIRE | 2 |
| 89 | SIERRA LEONE | 1 |
| 99 | BARBADOS | 1 |
| 144 | SUDAN | 1 |
| 49 | IRELAND | 1 |
| 100 | SAINT VINCENT AND THE GRENADINES | 1 |
| 148 | BURUNDI | 1 |
| 110 | SRI LANKA | 1 |
| 106 | BRITISH VIRGIN ISLANDS | 1 |
| 152 | CZECH REPUBLIC | 1 |
| 153 | MADAGASCAR | 1 |
| 154 | ZAMBIA | 1 |
| 143 | WALLIS AND FUTUNA (FRENCH TERRITORY) | 1 |
| 137 | BELGIUM | 1 |
| 141 | BERING SEA | 1 |
| 140 | DJIBOUTI | 1 |
| 111 | URUGUAY | 1 |
| 138 | GUINEA | 1 |
| 135 | GABON | 1 |
| 113 | MONTSERRAT | 1 |
| 133 | LIBYA | 1 |
| 96 | GRENADA | 1 |

| Country | total_eqs | maxMag_date |
|---|---|---|
| 101 | FRENCH POLYNESIA | 1 |
| 93 | NORWAY | 1 |
| 126 | CENTRAL AFRICAN REPUBLIC | 1 |
| 124 | PALAU | 1 |
| 118 | KIRIBATI | 1 |
| 155 | COMOROS | 1 |

## 2. Wind speed in Shenzhen during the past 10 years

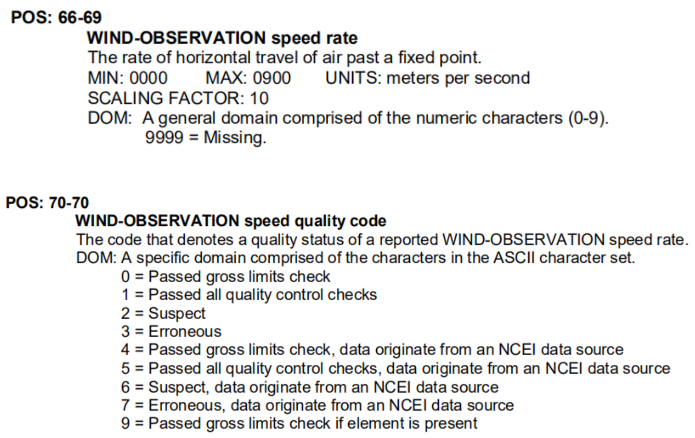
如果直接将csv文件读入会发生如下报错

```
sys:1: DtypeWarning: Columns (4,8,9,12,15,21,22,24,26,31,33,34) have mixed
types.Specify dtype option on import or set low_memory=False.
```

所以应该设置参数 low_memory=False，具体解释可见：Pandas read_csv low_memory and dtype options

```
shenzhen_windspeed = pd.read_csv("./2281305.csv", low_memory=False)
```

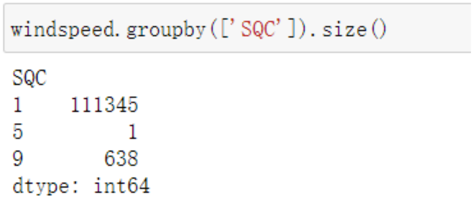
通过阅读数据集使用说明，可以知道 csv 文件的最后一列 "WND" 即是我们需要的数据，其中 "WND" 又分为 5 列数据，使用 split() 函数可以将使用 ',' 分隔的数据进行分割，我们只需要使用最后两列数据即可，分别表示的意义如下：



**POS: 66-69**
**WIND-OBSERVATION speed rate**
The rate of horizontal travel of air past a fixed point.
MIN: 0000 MAX: 0900 UNITS: meters per second
SCALING FACTOR: 10
DOM: A general domain comprised of the numeric characters (0-9).
9999 = Missing.

**POS: 70-70**
**WIND-OBSERVATION speed quality code**
The code that denotes a quality status of a reported WIND-OBSERVATION speed rate.
DOM: A specific domain comprised of the characters in the ASCII character set.
0 = Passed gross limits check
1 = Passed all quality control checks
2 = Suspect
3 = Erroneous
4 = Passed gross limits check, data originate from an NCEI data source
5 = Passed all quality control checks, data originate from an NCEI data source
6 = Suspect, data originate from an NCEI data source
7 = Erroneous, data originate from an NCEI data source
9 = Passed gross limits check if element is present

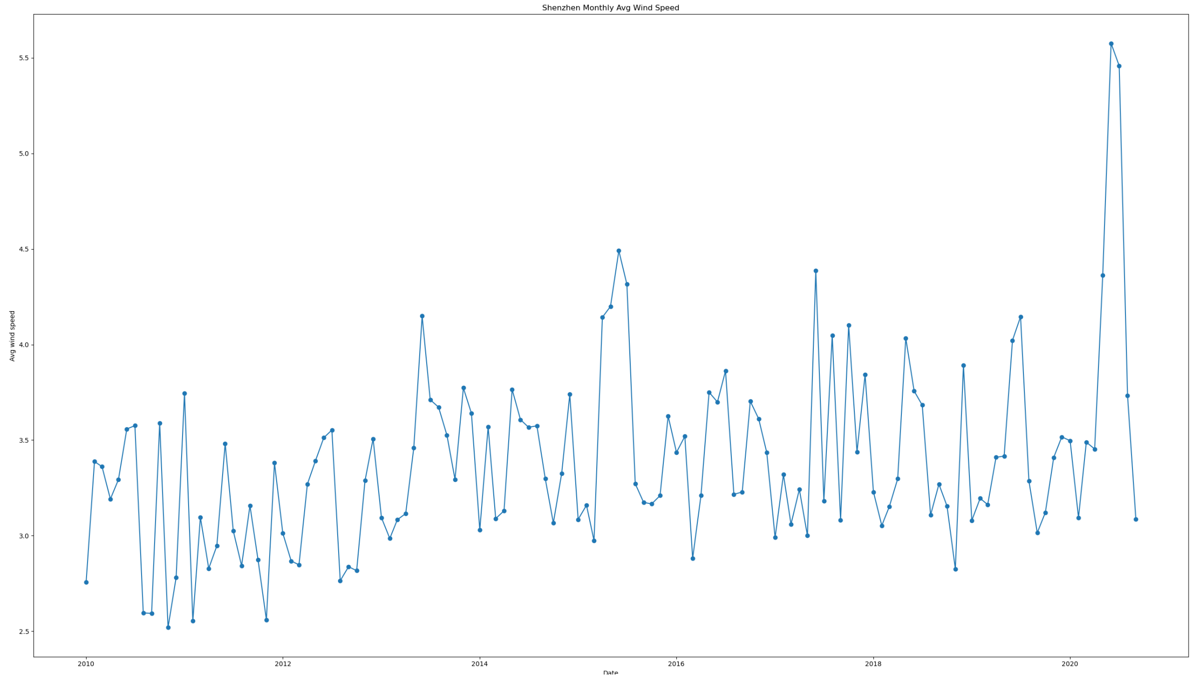
注意到 WIND-OBSERVATION speed rate 的 scale 是 10 ，所以使用的时候需要除以 10 以得到以 米/秒 为单位的数值。另外，对 quality code 做一个统计如下：



```
windspeed.groupby(['SQC']).size()
```

```
SQC
1     111345
5          1
9        638
dtype: int64
```

因此，需要对数据进行过滤，将 quality code 是 9 的数据丢弃即可，最后绘制出的图形如下：



可以观察到一个规律：每年年初以及年中（大概5-9月）的每月平均风速会较大一些

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# 3. Explore a data set

这里使用 NOAA 提供的气象数据 Climate Data Online

选择 Climate Data Online 下的 Global Summary of the Year 数据集，该数据集由大量文件（约80000个）构成，所以首先需要进行数据的拼接工作。考虑到数据集特征，使用 outer 连接方法

在拼接过程中发现，如果简单地将两个 csv 文件读入的 DataFrame 进行 merge 操作，随着操作的进行，执行速度会越来越慢，对此现象的我的解释是，每次进行 merge 操作，计算机都需要将原来庞大的 DataFrame 销毁，再生成新的更加庞大的 DataFrame，这无疑是非常耗时的，所以我使用分治的算法思想，简单的将 merge 操作分为若干区块进行，大大加快了文件合并的速度

**文件合并的代码在 PS2_3_preprocess.py 中，如果不想运行该代码（约耗时1h30min），直接使用合并后的文件 gsoy.csv 即可**

**gsoy.csv 文件体积较大，我放在了个人云盘中，连接Sustech校园网后点击链接就可以下载了 gsoy.csv 下载**

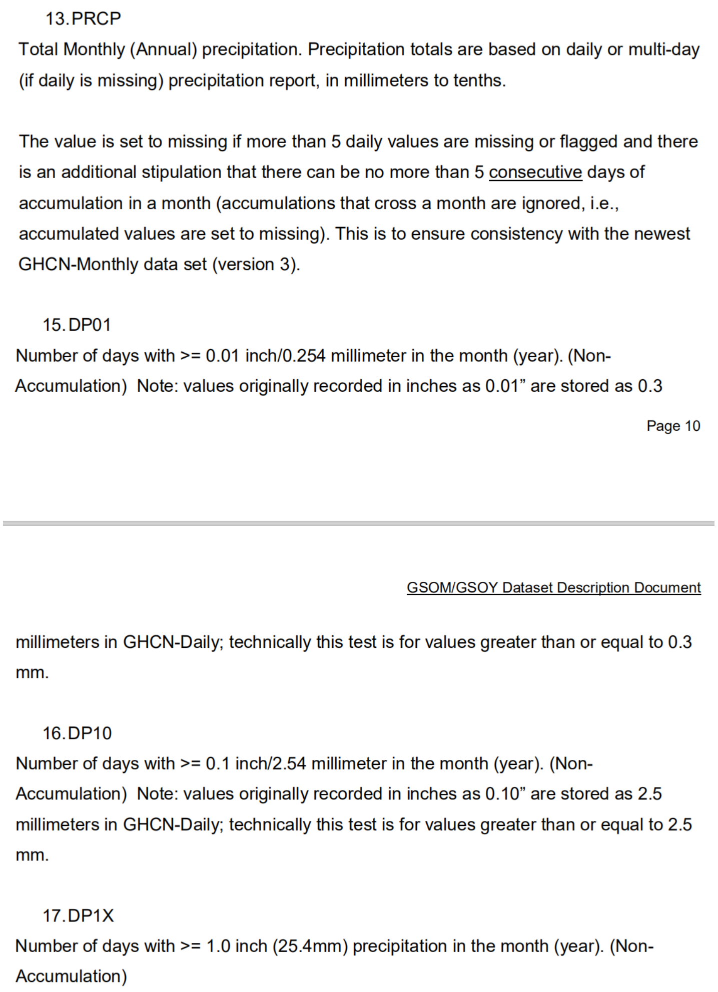
由于该数据集十分庞大，首先需要筛选出少量的数据列用于简单的分析，提取少量数据列的代码如下：

```
def extractDPData():
    df = pd.read_csv("./gsoy.csv", low_memory=False)

    dp_df = df[['STATION', 'DATE', 'LATITUDE', 'LONGITUDE', 'ELEVATION', 'NAME',
'DP01', 'DP01_ATTRIBUTES', 'DP10', 'DP10_ATTRIBUTES', 'DP1X', 'DP1X_ATTRIBUTES',
'EMXP', 'EMXP_ATTRIBUTES', 'PRCP', 'PRCP_ATTRIBUTES']]

    dp_df.to_csv('./dp_gsoy.csv')
```

提取完毕后，为了减少后续分析的运算量，便将结果直接保存在文件 **dp_gsoy.csv** 中

阅读数据集使用说明文档Dataset Description Document Global Summary of the Month/Year Dataset

我在本次 assignment 使用的数据是 DP01，DP10，DP1X 和 PRCP，其具体定义如下：



13.PRCP

Total Monthly (Annual) precipitation. Precipitation totals are based on daily or multi-day (if daily is missing) precipitation report, in millimeters to tenths.

The value is set to missing if more than 5 daily values are missing or flagged and there is an additional stipulation that there can be no more than 5 consecutive days of accumulation in a month (accumulations that cross a month are ignored, i.e., accumulated values are set to missing). This is to ensure consistency with the newest GHCN-Monthly data set (version 3).

15.DP01

Number of days with >= 0.01 inch/0.254 millimeter in the month (year). (Non-Accumulation) Note: values originally recorded in inches as 0.01" are stored as 0.3

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GSOM/GSOY Dataset Description Document

millimeters in GHCN-Daily; technically this test is for values greater than or equal to 0.3 mm.

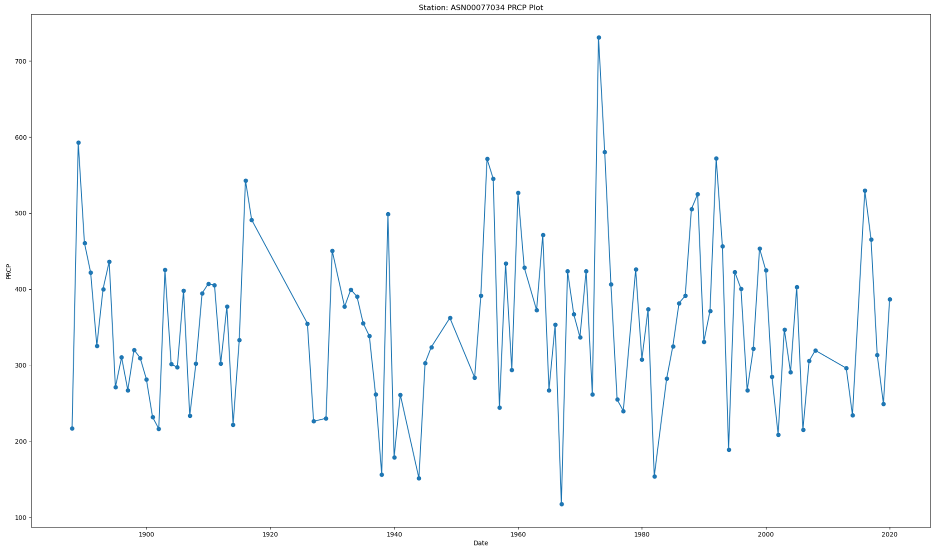
16.DP10

Number of days with >= 0.1 inch/2.54 millimeter in the month (year). (Non-Accumulation) Note: values originally recorded in inches as 0.10" are stored as 2.5 millimeters in GHCN-Daily; technically this test is for values greater than or equal to 2.5 mm.

17.DP1X

Number of days with >= 1.0 inch (25.4mm) precipitation in the month (year). (Non-Accumulation)

首先绘制站点 **ASN00077034** 的年均总降雨量折线图，这是关于时间序列的：

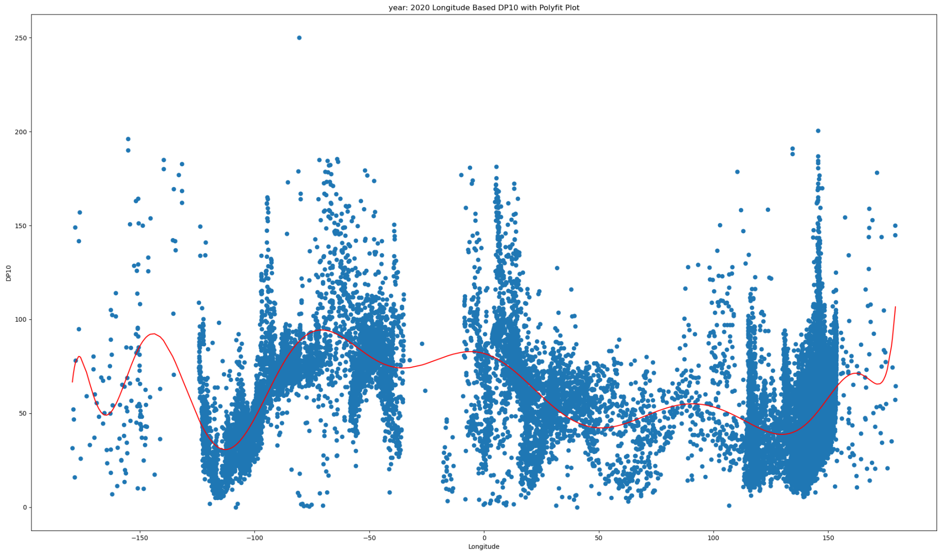


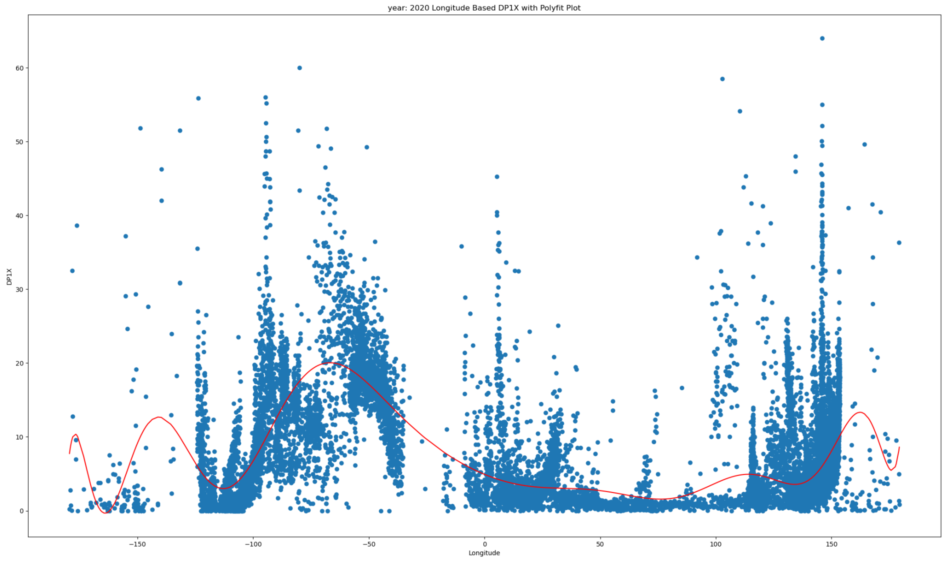
接下来我挑选了 **2020** 这一年份，分别以**经度**，**纬度**为横坐标绘制 2020 年全球各地站点统计得到的 DP10，DP1X 和 PRCP

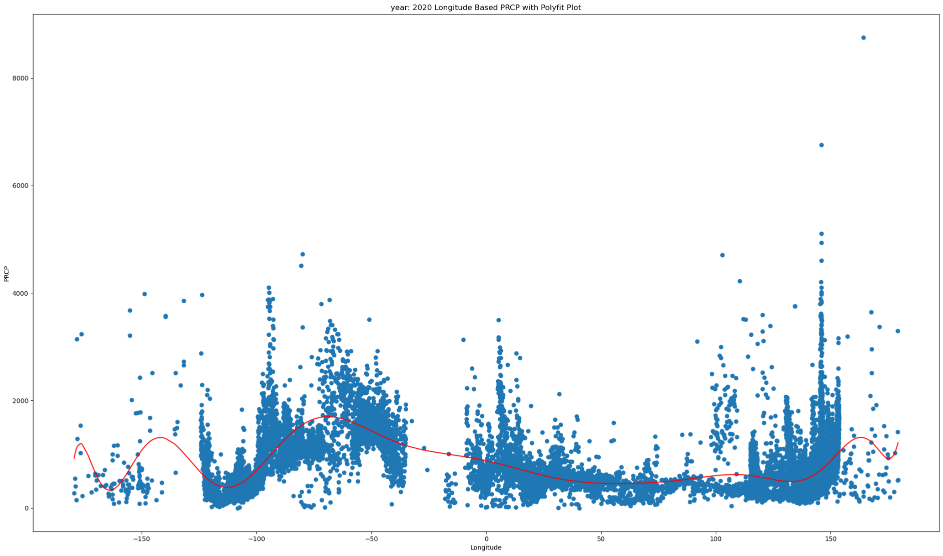
此外为了方便地观察数据趋势，我使用了 numpy 提供的多项式拟合函数（numpy.polyfit()），对数据进行了 **degree=15** 的多项式拟合

最后得到的结果如下：

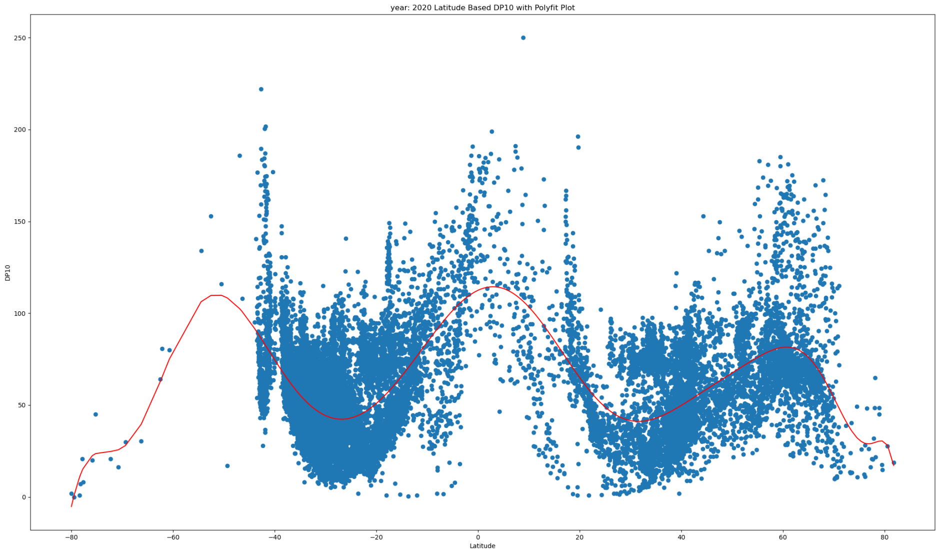
首先是以经度为基准的：

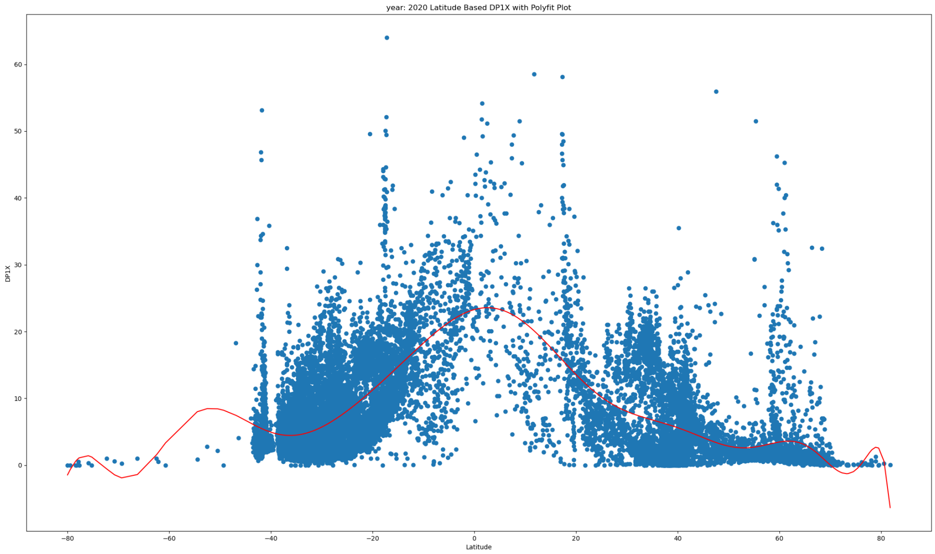


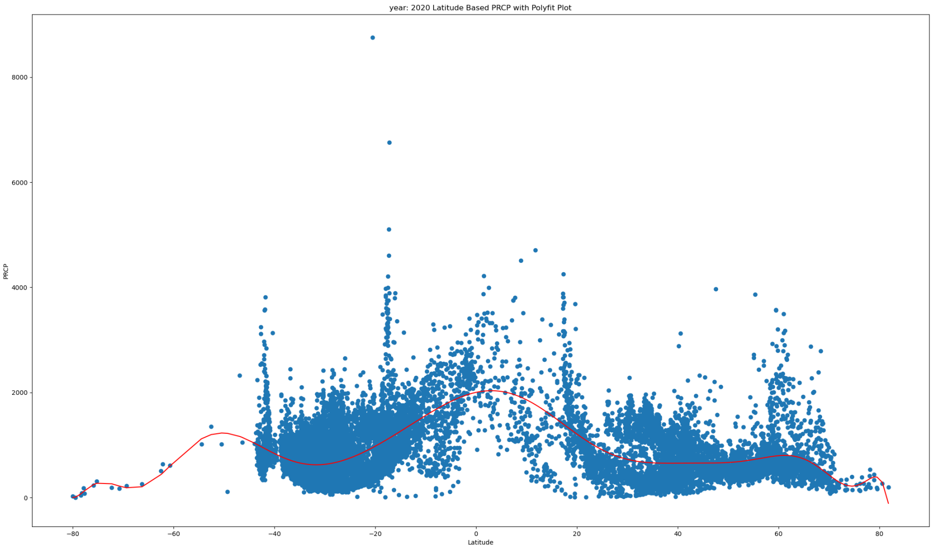




首先是以纬度为基准的：







观察上面的图像可以得到几个简单的现象规律（2020年）：

1. 大约西经40°至西经80°的区域，无论降水总量还是有大量降雨的天数（DP1X）都明显高于其他地区，该区域恰好囊括了南美洲，而南美洲拥有世界上最大的雨林生态系统，这应该可以成为该现象的可行解释之一。

2. 从纬度来看热带和南北温带全年降雨量适中的天数（DP10）都较多，大致呈现 w 的形态。如果看全年降水总量的话，赤道附近地区的降水总量则明显多于其他地区。