Cloud Computing Project on Big Data Analysis

By Piyush Sanghi (M12952017)

The project will perform Data analysis and processing using Map reduce processing in python. It will use the data from GHNC Daily: ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt. It has records of data from 2000 to 2019 which contains maximum and minimum temperatures recorded with station ID's.

In particular, the processing obtains the following results:
• Average TMIN, TMAX for each year excluding abnormalities or missing data
• Maximum TMAX, Minimum TMIN for each year excluding abnormalities or missing data
• 5 hottest, 5 coldest weather stations for each year excluding abnormalities or missing data
• Hottest and coldest day and corresponding weather stations in the entire dataset

I chose MapReduce because it is scalable, flexible, fast and have parallel processing. And it is easy to exclude abnormalities in MapReduce. I run the mapper and reducer files in Hadoop cluster and the output is saved in a text file, which helped in analysis.

All the values are scaled by 10 for easy and better analysis.

Result:

Year	Avg TMAX	Avg TMIN	Max TMAX	Min TMIN
2000	175.584	44.308	522	-578
2001	178.747	47.923	528	-528
2002	177.229	46.549	533	-472
2003	177.099	48.628	533	-500
2004	174.506	49.095	517	-533
2005	177.660	49.805	539	-550
2006	180.773	50.854	528	-528
2007	178.219	49.0073	539	-539
2008	170.096	40.739	528	-578
2009	168.693	43.365	533	-566
2010	171.517	47.261	517	-533
2011	172.469	46.054	511	-517
2012	183.914	53.481	537	-544
2013	167.314	43.001	539	-528
2014	168.439	43.849	522	-500
2015	177.230	53.536	556	-528
2016	179.074	55.107	539	-469
2017	176.645	52.811	528	-520
2018	171.321	49.453	528	-478
2019	73.031	-36.554	417	-494

Here you can see some abnormality in 2019 data as the year is still not complete. Hence it has less temperatures when compared to other years as the it will be winter during the start of the year. So we cannot really consider this into any analysis.

On observing other data we can see that 2006 had the most higher average of Tmax which tells that it was a hotter year when compared with other years, though other years had more hot hottest day. 2008 had the coldest average .

Hottest Day	2015-02-13	StationID USR0000HKAU
Coldest Day	2000-01-01	StationID USC00501684

5 hottest and coldest stations year wise:

Year	Hottest stations	Coldest stations
2000	['USC00042319', 'USW00003104', 'USR0000AHAV', 'USC00021050', 'USC00024761']	['USC00505644', 'USC00509313', 'USW00026440', 'USC00501684', 'USC00508140']
2001	['USC00042319', 'USR0000AHAV', 'USC00024829', 'USC00021050', 'USR0000CMOJ']	['USS0051R01S', 'USR0000ABCA', 'USC00504567', 'USC00508470', 'USW00026508']
2002	['USR0000CMOJ', 'USC00042319', 'USC00265846', 'USC00044297', 'USR0000CCOR']	['USR0000ABEV', 'USC00503212', 'USS0050S01S', 'USC00501684', 'USW00026533']
2003	['USC00021050', 'USR0000CMEA', 'USR0000AHAV', 'USC00029376', 'USC00042319']	['USC00509869', 'USW00026533', 'USS0050S01S', 'USR0000AKIA', 'USS0051R01S']
2004	['USW00053139', 'USC00042319', 'USR0000AHAV', 'USC00021050', 'USC00261371']	['USC00501684', 'USS0045010S', 'USC00502568', 'USW00026412', 'USC00503009']
2005	['USW00023179', 'USC00042319', 'USR0000CMOJ', 'USW00053139', 'USC00029376']	['USW00026412', 'USC00509869', 'USC00502568', 'USC00501684', 'USC00509313']
2006	['USR0000CMOJ', 'USC00044259', 'USW00053139', 'USC00042319', 'USC00029376']	['USS0051R01S', 'USC00501492', 'USR0000ACHL', 'USR0000ABEV', 'USR0000ASEL']
2007	['USC00042319', 'USC00264480', 'USR0000CMOJ', 'USC00021050', 'USW00053139']	['USR0000ACHL', 'USC00502607', 'USC00501684', 'USW00026422', 'USS0045R01S']
2008	['USC00261371', 'USC00042319', 'USC00024761', 'USC00044297', 'USW00053139']	['USC00501684', 'USS0045R01S', 'USR0000ACHL', 'USR0000ABEV', 'USC00501492']
2009	['USR0000CSQU', 'USC00042319', 'USR0000CMOJ', 'USW00053139', 'USR0000CBUU']	['USC00509313', 'USC00502101', 'USR0000ACHL', 'USR0000AEAG', 'USC00501684']
2010	['USC00021050', 'USR0000AHAV', 'USR0000CBUU', 'USC00042319', 'USR0000CMOJ']	['USS0051R01S', 'USR0000ACHL', 'USC00502101', 'USS0045R01S', 'USC00501684']
2011	['USR0000CCAA', 'USC00042319', 'USW00053139', 'USR0000CBUU', 'USC00022782']	['USC00509869', 'USC00501492', 'USC00501684', 'USR0000AFYK', 'USS0051R01S']
2012	['USW00053139', 'USR0000AHAV', 'USC00021050', 'USS0005N23S', 'USC00042319']	['USS0051R01S', 'USC00503212', 'USC00504210', 'USC00503165', 'USR0000AFYK']
2013	['USW00053139', 'USW00004134', 'USR0000AHAV', 'USC00044297', 'USC00042319']	['USS0051R01S', 'USS0045R01S', 'USC00501684', 'USC00502339', 'USR0000AFYK']
2014	['USC00028396', 'USC00020672', 'USC00042319', 'USR0000CBUU', 'USW00053139']	['USS0045R01S', 'USR0000ACOA', 'USR0000AFYK', 'USC00501684', 'USS0048V01S']
2015	['USW00053139', 'USR0000CBUU', 'USW00003104', 'USC00045502', 'USC00042319']	['USW00026533', 'USC00509314', 'USS0041P07S', 'USC00501684', 'USC00502339']
2016	['USC00042319', 'USW00023179', 'USC00040924', 'USW00053139', 'USR0000CBEV']	['USS0041P07S', 'USR0000ACHL', 'USC00501684', 'USR0000AFYK', 'USS0045R01S']
2017	['USW00053139', 'USC00021050', 'USW00023179', 'USC00046386', 'USC00042319']	['USR0000ASLC', 'USS0045004S', 'USS0051R01S', 'USW00026529', 'USC00503585']
2018	['USC00021050', 'USW00003104', 'USR0000AHAV', 'USW00023179', 'USC00042319']	['USR0000AKAV', 'USR0000ANOR', 'USW00096406', 'USW00026529', 'USC00501684']
2019	['USW00012907', 'USW00022010', 'USC00417624', 'USC00415048', 'USR0000TFAL']	['USC00211840', 'USW00096406', 'USC00218618', 'USC00501684', 'USC00509891']

Link to GITHUB:
https://github.uc.edu/sanghiph/cloud_project_2

Code:

Mapper.py

```python
#!/usr/bin/env python

import sys
import csv


# input comes from STDIN (standard input)
file = csv.reader(sys.stdin)
for line in file:
    # remove leading and trailing whitespace
    # line = line.strip()
    if line[5] == "" and line[4] != "P" and line[6] != "" and (line[2] ==
'TMAX' or line[2] == 'TMIN') and line[3] != -9999:
        print '%s\t%s\t%s\t%s' % (line[1], line[0], line[2], line[3])
```

Reducer.py

```python
#!/usr/bin/env python

from operator import itemgetter
import sys

tmax = 0
tmin = 0
maxtmx = 0
mintmn = 999999
tmaxct = 0
tminct = 0
currentyear = None
year = None
element = None
value = 0
date = None
stationid = None
hottestweatherstationsids = []
```

```python
coldestweatherstationsids = []
hottestweatherstationsvalues = []
coldestweatherstationsvalues = []
hottestvalue = 0
coldestvalue = 999999
hottestday = None
coldestday = None
hottestdaystationid = None
coldestdaystationid = None

for line in sys.stdin:

    line = line.strip()

    date, stationid, element, value = line.split('\t', 3)
    year = str(date)[:4]

    try:
        value = int(value)
    except ValueError:
        continue

    if currentyear is None:
        currentyear = year

    if year == currentyear:
        if element == "TMAX":
            tmax += value
            if value > maxtmx:
                maxtmx = value
            tmaxct += 1

        elif element == "TMIN":
            tmin += value
            if value < mintmn:
                mintmn = value
            tminct += 1

        if value > hottestvalue:
            hottestvalue = value
            hottestdaystationid = stationid
            hottestday = date
```

```python
            if value < coldestvalue:
                coldestvalue = value
                coldestdaystationid = stationid
                coldestday = date

            if len(hottestweatherstationsids) < 5:
                hottestweatherstationsids.append(stationid)
                hottestweatherstationsvalues.append(value)
            else:
                minhottestvalue = min(hottestweatherstationsvalues)
                if minhottestvalue < value and stationid not in
hottestweatherstationsids:
                    for idx, i in enumerate(hottestweatherstationsvalues):
                        if i == minhottestvalue:
                            hottestweatherstationsvalues[idx] = value
                            hottestweatherstationsids[idx] = stationid
                            break

            if len(coldestweatherstationsids) < 5:
                coldestweatherstationsids.append(stationid)
                coldestweatherstationsvalues.append(value)
            else:
                maxcoldestvalue = max(coldestweatherstationsvalues)
                if maxcoldestvalue > value and stationid not in
coldestweatherstationsids:
                    for idx, i in enumerate(coldestweatherstationsvalues):
                        if i == maxcoldestvalue:
                            coldestweatherstationsvalues[idx] = value
                            coldestweatherstationsids[idx] = stationid
                            break
        else:
            print '%s' % currentyear
            print 'Average TMAX\t%s\t' % (tmax * 1.0 / tmaxct)
            print 'Average TMIN\t%s\t' % (tmin * 1.0 / tminct)
            print 'Max TMAX\t%s\t' % maxtmx
            print 'Min TMIN\t%s\t' % mintmn
            print 'Hottest Weather Stations\t%s' % hottestweatherstationsids
            print 'Coldest Weather Stations\t%s' % coldestweatherstationsids

            currentyear = year
            tmax = 0
            tmin = 0
            maxtmx = 0
```

```python
            mintmn = 999999
            tmaxct = 0
            tminct = 0
            hottestweatherstationsids = []
            hottestweatherstationsvalues = []
            coldestweatherstationsids = []
            coldestweatherstationsvalues = []
            if element == "TMAX":
                tmax = value
                maxtmx = value
                tmaxct = 1

            elif element == "TMIN":
                tmin = value
                mintmn = value
                tminct = 1

            if value < coldestvalue:
                coldestvalue = value
                coldestdaystationid = stationid
                coldestday = date

            if value > hottestvalue:
                hottestvalue = value
                hottestdaystationid = stationid
                hottestday = date

    if year == currentyear:
        print '%s' % currentyear
        print '%s\tAverage TMAX\t%s\t' % (currentyear, (tmax * 1.0 / tmaxct))
        print '%s\tAverage TMIN\t%s\t' % (currentyear, (tmin * 1.0 / tminct))
        print '%s\tMax TMAX\t%s\t' % (currentyear, maxtmx)
        print '%s\tMin TMIN\t%s\t' % (currentyear, mintmn)
        print '%s\tHottest Weather Stations\t%s' % (currentyear,
hottestweatherstationsids)
        print '%s\tColdest Weather Stations\t%s' % (currentyear,
coldestweatherstationsids)
        print '\n'
        print 'Hottest Day\t%s\t - StationID\t%s' % (hottestday,
hottestdaystationid)
        print 'Coldest Day\t%s\t - StationID\t%s' % (coldestday,
coldestdaystationid)
```

Log file:

sanghiph@hadoop-gate-0:~$ hadoop jar /usr/hdp/current/hadoop-mapreduce-client/hadoop-streaming.jar -file /home/sanghiph/mapper.py -mapper /home/sanghiph/mapper.py -file /home/sanghiph/reducer.py -reducer /home/sanghiph/reducer.py -input /user/tatavag/weather -output /tmp/piyush_project/output_111

19/04/30 16:32:24 WARN streaming.StreamJob: -file option is deprecated, please use generic option -files instead.

packageJobJar: [/home/sanghiph/mapper.py, /home/sanghiph/reducer.py] [/usr/hdp/3.1.0.0-78/hadoop-mapreduce/hadoop-streaming-3.1.1.3.1.0.0-78.jar] /tmp/streamjob3140126933421747507.jar tmpDir=null

19/04/30 16:32:25 INFO client.RMProxy: Connecting to ResourceManager at hdfs-0-3.eecscluster/192.168.200.103:8050

19/04/30 16:32:25 INFO client.AHSProxy: Connecting to Application History server at hdfs-0-0.eecscluster/192.168.200.100:10200

19/04/30 16:32:25 INFO client.RMProxy: Connecting to ResourceManager at hdfs-0-3.eecscluster/192.168.200.103:8050

19/04/30 16:32:25 INFO client.AHSProxy: Connecting to Application History server at hdfs-0-0.eecscluster/192.168.200.100:10200

19/04/30 16:32:26 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /user/sanghiph/.staging/job_1549995810963_3702

19/04/30 16:32:26 INFO mapred.FileInputFormat: Total input files to process : 20

19/04/30 16:32:26 INFO mapreduce.JobSubmitter: number of splits:39

19/04/30 16:32:26 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1549995810963_3702

19/04/30 16:32:26 INFO mapreduce.JobSubmitter: Executing with tokens: []

19/04/30 16:32:26 INFO conf.Configuration: found resource resource-types.xml at file:/etc/hadoop/3.1.0.0-78/0/resource-types.xml

19/04/30 16:32:27 INFO impl.YarnClientImpl: Submitted application application_1549995810963_3702

19/04/30 16:32:27 INFO mapreduce.Job: The url to track the job: http://hdfs-0-3.eecscluster:8088/proxy/application_1549995810963_3702/

19/04/30 16:32:27 INFO mapreduce.Job: Running job: job_1549995810963_3702

19/04/30 16:42:58 INFO mapreduce.Job: Job job_1549995810963_3702 running in uber mode : false

19/04/30 16:42:58 INFO mapreduce.Job: map 0% reduce 0%

19/04/30 16:43:08 INFO mapreduce.Job: map 1% reduce 0%

19/04/30 16:43:09 INFO mapreduce.Job: map 9% reduce 0%

19/04/30 16:43:10 INFO mapreduce.Job: map 12% reduce 0%

19/04/30 16:43:11 INFO mapreduce.Job: map 13% reduce 0%

19/04/30 16:43:12 INFO mapreduce.Job: map 20% reduce 0%

19/04/30 16:43:13 INFO mapreduce.Job: map 24% reduce 0%

19/04/30 16:43:14 INFO mapreduce.Job: map 25% reduce 0%

19/04/30 16:43:15 INFO mapreduce.Job: map 31% reduce 0%

19/04/30 16:43:16 INFO mapreduce.Job: map 34% reduce 0%

19/04/30 16:43:17 INFO mapreduce.Job: map 39% reduce 0%

```
19/04/30 16:43:18 INFO mapreduce.Job:  map 46% reduce 0%
19/04/30 16:43:19 INFO mapreduce.Job:  map 49% reduce 0%
19/04/30 16:43:20 INFO mapreduce.Job:  map 50% reduce 0%
19/04/30 16:43:23 INFO mapreduce.Job:  map 53% reduce 0%
19/04/30 16:43:25 INFO mapreduce.Job:  map 54% reduce 0%
19/04/30 16:43:26 INFO mapreduce.Job:  map 56% reduce 0%
19/04/30 16:43:27 INFO mapreduce.Job:  map 59% reduce 0%
19/04/30 16:43:28 INFO mapreduce.Job:  map 63% reduce 0%
19/04/30 16:43:29 INFO mapreduce.Job:  map 66% reduce 7%
19/04/30 16:43:30 INFO mapreduce.Job:  map 72% reduce 7%
19/04/30 16:43:31 INFO mapreduce.Job:  map 75% reduce 7%
19/04/30 16:43:32 INFO mapreduce.Job:  map 81% reduce 8%
19/04/30 16:43:33 INFO mapreduce.Job:  map 89% reduce 8%
19/04/30 16:43:34 INFO mapreduce.Job:  map 93% reduce 8%
19/04/30 16:43:35 INFO mapreduce.Job:  map 94% reduce 14%
19/04/30 16:43:36 INFO mapreduce.Job:  map 97% reduce 14%
19/04/30 16:43:37 INFO mapreduce.Job:  map 99% reduce 14%
19/04/30 16:43:38 INFO mapreduce.Job:  map 100% reduce 16%
19/04/30 16:43:41 INFO mapreduce.Job:  map 100% reduce 19%
19/04/30 16:43:44 INFO mapreduce.Job:  map 100% reduce 25%
19/04/30 16:43:47 INFO mapreduce.Job:  map 100% reduce 29%
19/04/30 16:43:50 INFO mapreduce.Job:  map 100% reduce 33%
19/04/30 16:43:53 INFO mapreduce.Job:  map 100% reduce 35%
19/04/30 16:43:56 INFO mapreduce.Job:  map 100% reduce 37%
19/04/30 16:43:59 INFO mapreduce.Job:  map 100% reduce 39%
19/04/30 16:44:02 INFO mapreduce.Job:  map 100% reduce 41%
19/04/30 16:44:05 INFO mapreduce.Job:  map 100% reduce 43%
19/04/30 16:44:08 INFO mapreduce.Job:  map 100% reduce 44%
19/04/30 16:44:11 INFO mapreduce.Job:  map 100% reduce 46%
19/04/30 16:44:14 INFO mapreduce.Job:  map 100% reduce 48%
19/04/30 16:44:17 INFO mapreduce.Job:  map 100% reduce 50%
19/04/30 16:44:20 INFO mapreduce.Job:  map 100% reduce 52%
19/04/30 16:44:23 INFO mapreduce.Job:  map 100% reduce 53%
19/04/30 16:44:26 INFO mapreduce.Job:  map 100% reduce 55%
19/04/30 16:44:30 INFO mapreduce.Job:  map 100% reduce 57%
19/04/30 16:44:33 INFO mapreduce.Job:  map 100% reduce 59%
19/04/30 16:44:36 INFO mapreduce.Job:  map 100% reduce 60%
19/04/30 16:44:39 INFO mapreduce.Job:  map 100% reduce 62%
19/04/30 16:44:42 INFO mapreduce.Job:  map 100% reduce 63%
19/04/30 16:44:45 INFO mapreduce.Job:  map 100% reduce 65%
19/04/30 16:44:48 INFO mapreduce.Job:  map 100% reduce 67%
19/04/30 16:45:00 INFO mapreduce.Job:  map 100% reduce 68%
19/04/30 16:45:15 INFO mapreduce.Job:  map 100% reduce 69%
19/04/30 16:45:27 INFO mapreduce.Job:  map 100% reduce 70%
19/04/30 16:45:39 INFO mapreduce.Job:  map 100% reduce 71%
19/04/30 16:45:54 INFO mapreduce.Job:  map 100% reduce 72%
```

19/04/30 16:46:06 INFO mapreduce.Job: map 100% reduce 73%
19/04/30 16:46:18 INFO mapreduce.Job: map 100% reduce 74%
19/04/30 16:46:30 INFO mapreduce.Job: map 100% reduce 75%
19/04/30 16:46:43 INFO mapreduce.Job: map 100% reduce 76%
19/04/30 16:46:55 INFO mapreduce.Job: map 100% reduce 77%
19/04/30 16:47:08 INFO mapreduce.Job: map 100% reduce 78%
19/04/30 16:47:20 INFO mapreduce.Job: map 100% reduce 79%
19/04/30 16:47:32 INFO mapreduce.Job: map 100% reduce 80%
19/04/30 16:47:44 INFO mapreduce.Job: map 100% reduce 81%
19/04/30 16:47:56 INFO mapreduce.Job: map 100% reduce 82%
19/04/30 16:48:11 INFO mapreduce.Job: map 100% reduce 83%
19/04/30 16:48:23 INFO mapreduce.Job: map 100% reduce 84%
19/04/30 16:48:35 INFO mapreduce.Job: map 100% reduce 85%
19/04/30 16:48:47 INFO mapreduce.Job: map 100% reduce 86%
19/04/30 16:48:59 INFO mapreduce.Job: map 100% reduce 87%
19/04/30 16:49:14 INFO mapreduce.Job: map 100% reduce 88%
19/04/30 16:49:26 INFO mapreduce.Job: map 100% reduce 89%
19/04/30 16:49:38 INFO mapreduce.Job: map 100% reduce 90%
19/04/30 16:49:50 INFO mapreduce.Job: map 100% reduce 91%
19/04/30 16:50:06 INFO mapreduce.Job: map 100% reduce 92%
19/04/30 16:50:21 INFO mapreduce.Job: map 100% reduce 93%
19/04/30 16:50:33 INFO mapreduce.Job: map 100% reduce 94%
19/04/30 16:50:45 INFO mapreduce.Job: map 100% reduce 95%
19/04/30 16:51:00 INFO mapreduce.Job: map 100% reduce 96%
19/04/30 16:51:12 INFO mapreduce.Job: map 100% reduce 97%
19/04/30 16:51:25 INFO mapreduce.Job: map 100% reduce 98%
19/04/30 16:51:37 INFO mapreduce.Job: map 100% reduce 99%
19/04/30 16:51:49 INFO mapreduce.Job: map 100% reduce 100%
19/04/30 16:56:58 INFO mapreduce.Job: Job job_1549995810963_3702 completed successfully
19/04/30 16:56:58 INFO mapreduce.Job: Counters: 54
        File System Counters
                FILE: Number of bytes read=3529152647
                FILE: Number of bytes written=7067760664
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=4212255521
                HDFS: Number of bytes written=5981
                HDFS: Number of read operations=122
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Launched map tasks=39
                Launched reduce tasks=1
                Data-local map tasks=36
                Rack-local map tasks=3

```
            Total time spent by all maps in occupied slots (ms)=3091705
            Total time spent by all reduces in occupied slots (ms)=5162290
            Total time spent by all map tasks (ms)=618341
            Total time spent by all reduce tasks (ms)=516229
            Total vcore-milliseconds taken by all map tasks=618341
            Total vcore-milliseconds taken by all reduce tasks=516229
            Total megabyte-milliseconds taken by all map tasks=3165905920
            Total megabyte-milliseconds taken by all reduce tasks=5286184960
      Map-Reduce Framework
            Map input records=111989663
            Map output records=111174068
            Map output bytes=3306804505
            Map output materialized bytes=3529152875
            Input split bytes=4446
            Combine input records=0
            Combine output records=0
            Reduce input groups=7045
            Reduce shuffle bytes=3529152875
            Reduce input records=111174068
            Reduce output records=144
            Spilled Records=222348136
            Shuffled Maps =39
            Failed Shuffles=0
            Merged Map outputs=39
            GC time elapsed (ms)=40151
            CPU time spent (ms)=1650040
            Physical memory (bytes) snapshot=99114266624
            Virtual memory (bytes) snapshot=252894973952
            Total committed heap usage (bytes)=108920307712
            Peak Map Physical memory (bytes)=2583347200
            Peak Map Virtual memory (bytes)=6252642304
            Peak Reduce Physical memory (bytes)=3802456064
            Peak Reduce Virtual memory (bytes)=10713088000
      Shuffle Errors
            BAD_ID=0
            CONNECTION=0
            IO_ERROR=0
            WRONG_LENGTH=0
            WRONG_MAP=0
            WRONG_REDUCE=0
      File Input Format Counters
            Bytes Read=4212251075
      File Output Format Counters
            Bytes Written=5981
19/04/30 16:56:58 INFO streaming.StreamJob: Output directory: /tmp/piyush_project/output_111
```

Output:

sanghiph@hadoop-gate-0:~$ hadoop fs -cat /tmp/piyush_project/output_111/*
2000
Average TMAX   175.584256706
Average TMIN   44.3082903296
Max TMAX   522
Min TMIN   -578
Hottest Weather Stations   ['USC00042319', 'USW00003104', 'USR0000AHAV',
'USC00021050', 'USC00024761']
Coldest Weather Stations   ['USC00505644', 'USC00509313', 'USW00026440', 'USC00501684',
'USC00508140']
2001
Average TMAX   178.747558648
Average TMIN   47.9238293819
Max TMAX   528
Min TMIN   -528
Hottest Weather Stations   ['USC00042319', 'USR0000AHAV', 'USC00024829',
'USC00021050', 'USR0000CMOJ']
Coldest Weather Stations   ['USS0051R01S', 'USR0000ABCA', 'USC00504567',
'USC00508470', 'USW00026508']
2002
Average TMAX   177.229975514
Average TMIN   46.5490911032
Max TMAX   533
Min TMIN   -472
Hottest Weather Stations   ['USR0000CMOJ', 'USC00042319', 'USC00265846',
'USC00044297', 'USR0000CCOR']
Coldest Weather Stations   ['USR0000ABEV', 'USC00503212', 'USS0050S01S',
'USC00501684', 'USW00026533']
2003
Average TMAX   177.099600803
Average TMIN   48.6285186518
Max TMAX   533
Min TMIN   -500
Hottest Weather Stations   ['USC00021050', 'USR0000CMEA', 'USR0000AHAV',
'USC00029376', 'USC00042319']
Coldest Weather Stations   ['USC00509869', 'USW00026533', 'USS0050S01S',
'USR0000AKIA', 'USS0051R01S']
2004
Average TMAX   174.506802106
Average TMIN   49.0952521104
Max TMAX   517
Min TMIN   -533
Hottest Weather Stations   ['USW00053139', 'USC00042319', 'USR0000AHAV',
'USC00021050', 'USC00261371']

Coldest Weather Stations   ['USC00501684', 'USS0045O10S', 'USC00502568',
'USW00026412', 'USC00503009']
2005
Average TMAX   177.660982462
Average TMIN   49.8054192201
Max TMAX   539
Min TMIN   -550
Hottest Weather Stations   ['USW00023179', 'USC00042319', 'USR0000CMOJ',
'USW00053139', 'USC00029376']
Coldest Weather Stations   ['USW00026412', 'USC00509869', 'USC00502568', 'USC00501684',
'USC00509313']
2006
Average TMAX   180.773615979
Average TMIN   50.8548743305
Max TMAX   528
Min TMIN   -528
Hottest Weather Stations   ['USR0000CMOJ', 'USC00044259', 'USW00053139',
'USC00042319', 'USC00029376']
Coldest Weather Stations   ['USS0051R01S', 'USC00501492', 'USR0000ACHL',
'USR0000ABEV', 'USR0000ASEL']
2007
Average TMAX   178.219864159
Average TMIN   49.0736120122
Max TMAX   539
Min TMIN   -539
Hottest Weather Stations   ['USC00042319', 'USC00264480', 'USR0000CMOJ',
'USC00021050', 'USW00053139']
Coldest Weather Stations   ['USR0000ACHL', 'USC00502607', 'USC00501684',
'USW00026422', 'USS0045R01S']
2008
Average TMAX   170.09655467
Average TMIN   40.7394844915
Max TMAX   528
Min TMIN   -578
Hottest Weather Stations   ['USC00261371', 'USC00042319', 'USC00024761', 'USC00044297',
'USW00053139']
Coldest Weather Stations   ['USC00501684', 'USS0045R01S', 'USR0000ACHL',
'USR0000ABEV', 'USC00501492']
2009
Average TMAX   168.693988733
Average TMIN   43.3658121143
Max TMAX   533
Min TMIN   -556
Hottest Weather Stations   ['USR0000CSQU', 'USC00042319', 'USR0000CMOJ',
'USW00053139', 'USR0000CBUU']

Coldest Weather Stations ['USC00509313', 'USC00502101', 'USR0000ACHL', 'USR0000AEAG', 'USC00501684']
2010
Average TMAX   171.51778809
Average TMIN   47.2613962352
Max TMAX   517
Min TMIN   -533
Hottest Weather Stations ['USC00021050', 'USR0000AHAV', 'USR0000CBUU', 'USC00042319', 'USR0000CMOJ']
Coldest Weather Stations ['USS0051R01S', 'USR0000ACHL', 'USC00502101', 'USS0045R01S', 'USC00501684']
2011
Average TMAX   172.46933642
Average TMIN   46.0545355887
Max TMAX   511
Min TMIN   -517
Hottest Weather Stations ['USR0000CCAA', 'USC00042319', 'USW00053139', 'USR0000CBUU', 'USC00022782']
Coldest Weather Stations ['USC00509869', 'USC00501492', 'USC00501684', 'USR0000AFYK', 'USS0051R01S']
2012
Average TMAX   183.914808379
Average TMIN   53.4819231631
Max TMAX   537
Min TMIN   -544
Hottest Weather Stations ['USW00053139', 'USR0000AHAV', 'USC00021050', 'USS0005N23S', 'USC00042319']
Coldest Weather Stations ['USS0051R01S', 'USC00503212', 'USC00504210', 'USC00503165', 'USR0000AFYK']
2013
Average TMAX   167.31434867
Average TMIN   43.0010399546
Max TMAX   539
Min TMIN   -528
Hottest Weather Stations ['USW00053139', 'USW00004134', 'USR0000AHAV', 'USC00044297', 'USC00042319']
Coldest Weather Stations ['USS0051R01S', 'USS0045R01S', 'USC00501684', 'USC00502339', 'USR0000AFYK']
2014
Average TMAX   168.439429894
Average TMIN   43.8491942761
Max TMAX   522
Min TMIN   -500
Hottest Weather Stations ['USC00028396', 'USC00020672', 'USC00042319', 'USR0000CBUU', 'USW00053139']

Coldest Weather Stations ['USS0045R01S', 'USR0000ACOA', 'USR0000AFYK', 'USC00501684', 'USS0048V01S']

2015
Average TMAX   177.23014761
Average TMIN   53.5361682807
Max TMAX   556
Min TMIN   -528
Hottest Weather Stations ['USW00053139', 'USR0000CBUU', 'USW00003104', 'USC00045502', 'USC00042319']
Coldest Weather Stations ['USW00026533', 'USC00509314', 'USS0041P07S', 'USC00501684', 'USC00502339']

2016
Average TMAX   179.074322175
Average TMIN   55.1074627805
Max TMAX   539
Min TMIN   -469
Hottest Weather Stations ['USC00042319', 'USW00023179', 'USC00040924', 'USW00053139', 'USR0000CBEV']
Coldest Weather Stations ['USS0041P07S', 'USR0000ACHL', 'USC00501684', 'USR0000AFYK', 'USS0045R01S']

2017
Average TMAX   176.64585266
Average TMIN   52.8118997978
Max TMAX   528
Min TMIN   -520
Hottest Weather Stations ['USW00053139', 'USC00021050', 'USW00023179', 'USC00046386', 'USC00042319']
Coldest Weather Stations ['USR0000ASLC', 'USS0045O04S', 'USS0051R01S', 'USW00026529', 'USC00503585']

2018
Average TMAX   171.321408178
Average TMIN   49.4530738941
Max TMAX   528
Min TMIN   -478
Hottest Weather Stations ['USC00021050', 'USW00003104', 'USR0000AHAV', 'USW00023179', 'USC00042319']
Coldest Weather Stations ['USR0000AKAV', 'USR0000ANOR', 'USW00096406', 'USW00026529', 'USC00501684']

2019
2019   Average TMAX   73.0315200726
2019   Average TMIN   -36.5548757831
2019   Max TMAX   417
2019   Min TMIN   -494
2019   Hottest Weather Stations ['USW00012907', 'USW00022010', 'USC00417624', 'USC00415048', 'USR0000TFAL']

2019   Coldest Weather Stations   ['USC00211840', 'USW00096406', 'USC00218618', 'USC00501684', 'USC00509891']

Hottest Day   20150213   - StationID   USR0000HKAU
Coldest Day   20000101   - StationID   USC00501684