```
#import libraries
#Library Imports
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import sklearn.model_selection
import sklearn.neighbors
import scipy.stats
import numpy as np
from matplotlib.animation import FuncAnimation
from matplotlib.animation import PillowWriter
import math

import mpl_toolkits.basemap
import scipy.stats
import seaborn
import sklearn.model_selection
import sklearn.neighbors

#Loading Data
S_O_20 = pd.read_csv("Earthquake_2020_9_2020_10_filtered.csv")
N_D_20 = pd.read_csv("Earthquake_2020_11_2020_12_filtered.csv")
J_F_21 = pd.read_csv("Earthquake_2021_1_2021_2_filtered.csv")
M_A_21 = pd.read_csv("Earthquake_2021_3_2021_4_filtered.csv")
M_J_21 = pd.read_csv("Earthquake_2021_5_2021_6_filtered.csv")
J_A_21 = pd.read_csv("Earthquake_2021_7_2021_8_filtered.csv")
S_O_21 = pd.read_csv("Earthquake_2021_9_2021_10_filtered.csv")
N_D_21 = pd.read_csv("Earthquake_2021_11_2021_12_filtered.csv")
J_F_22 = pd.read_csv("Earthquake_2022_1_2022_2_filtered.csv")
M_A_22 = pd.read_csv("Earthquake_2022_3_2022_4_filtered.csv")
M_J_22 = pd.read_csv("Earthquake_2022_5_2022_6_filtered.csv")
J_A_22 = pd.read_csv("Earthquake_2022_7_2022_8_filtered.csv")

# Creating Sets for Pictures
set1 = [S_O_20, N_D_20, J_F_21]
set2 = [N_D_20, J_F_21, M_A_21]
set3 = [J_F_21, M_A_21, M_J_21]
set4 = [M_A_21, M_J_21, J_A_21]
set5 = [M_J_21, J_A_21, S_O_21]
set6 = [J_A_21, S_O_21, N_D_21]
set7 = [S_O_21, N_D_21, J_F_22]
set8 = [N_D_21, J_F_22, M_A_22]
set9 = [J_F_22, M_A_22, M_J_22]
set10 = [M_A_22, M_J_22, J_A_22]

Set1 = pd.concat(set1)
Set2 = pd.concat(set2)
Set3 = pd.concat(set3)
Set4 = pd.concat(set4)
Set5 = pd.concat(set5)
```

```
Set6 = pd.concat(set6)
Set7 = pd.concat(set7)
Set8 = pd.concat(set8)
Set9 = pd.concat(set9)
Set10 = pd.concat(set10)

Dictionary = dict()
Dictionary = { 1: Set1, 2:Set2, 3:Set3, 4:Set4, 5:Set5, 6:Set6,
7:Set7, 8:Set8, 9:Set9, 10:Set10 }

#Storing the clusters
#Store the center of the clusters
#Store the average distance from center of the cluster
#Store the average magnitude of the values in the cluster


#Create Test Subject
PDataset = Set1.iloc[1:10,:]
print(PDataset)


def Center(x):
    meanLat = x['latitude'].mean()
    meanLong = x['longitude'].mean()
    return meanLat, meanLong

#sqrt(lat^2 + long^2)
#Get cluster one values and run this
#Did this since its computationally faster than trying to find the
area and if it
# increases the cluster is growing if it decreases the cluster size is
shrinking



def DistCenter(x):
    distance = 0
    LatDist = x['latitude'].var()
    LongDist = x['longitude'].var()
    distance =  LatDist + LongDist
    return distance

def MagPerCL(x):
    return(x['mag'].mean())
```

	time	latitude	longitude	depth	mag
1	2020-09-01T00:36:59.811Z	38.003900	-118.2358	6.60	3.40
2	2020-09-01T01:39:34.960Z	36.394333	-120.4370	9.19	2.87
3	2020-09-01T02:25:49.130Z	42.370000	-118.4440	8.45	3.52
4	2020-09-01T05:51:36.757Z	38.179800	-117.8634	9.20	3.30

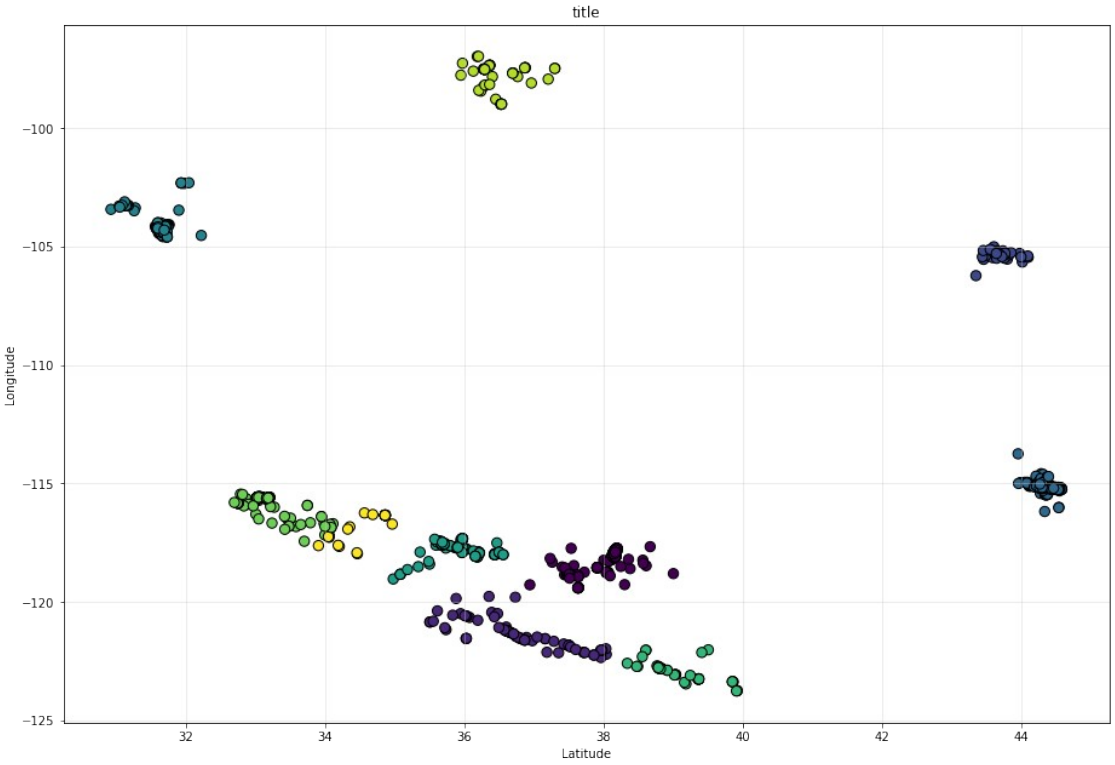
```
5  2020-09-01T08:51:26.458Z  38.175900  -117.8014   5.80  2.80
6  2020-09-01T09:08:48.644Z  43.779900  -107.6074  10.00  2.80
7  2020-09-01T16:56:23.593Z  38.200200  -117.7724  10.00  2.50
8  2020-09-01T18:59:44.436Z  43.801700  -105.5253   0.00  3.30
9  2020-09-01T20:02:10.047Z  44.477200  -115.2000  13.23  3.20

#--------------DBSCAN Clustering------------------#
import sklearn
from sklearn.cluster import DBSCAN
from sklearn.neighbors import NearestNeighbors
from collections import Counter
from sklearn.preprocessing import StandardScaler

#.25 = eps, 64 = minsamples DEFAULT

def dbscan(dataset, epsilon, minsamples):
    dbscan_data = dataset[['latitude','longitude']]
    dbscan_data = dbscan_data.values.astype('float32', copy = False)
    dbscan_data_scaler = StandardScaler().fit(dbscan_data)
    dbscan_data = dbscan_data_scaler.transform(dbscan_data)

    model1 = DBSCAN(eps=epsilon, min_samples=minsamples,
metric='euclidean').\
    fit(dbscan_data)

    outliers_df = dataset[model1.labels_ == -1]
    num_clusters = len(set(model1.labels_))

    clusters_df = [dataset[model1.labels_ == n] for n in
range(num_clusters)]

    colors = model1.labels_
    color_clusters = colors[colors != -1]
    color_outliers = 'white'
    clusters1 = Counter(model1.labels_)
    return clusters_df

def dbscanplot(dataset, epsilon, minsamples):
    dbscan_data = dataset[['latitude','longitude']]
    dbscan_data = dbscan_data.values.astype('float32', copy = False)
    dbscan_data_scaler = StandardScaler().fit(dbscan_data)
    dbscan_data = dbscan_data_scaler.transform(dbscan_data)
    #return dbscan_data
    model1 = DBSCAN(eps=epsilon, min_samples=minsamples,
metric='euclidean').\
    fit(dbscan_data)
    #return model1
    outliers_df = dataset[model1.labels_ == -1]
    clusters_df = dataset[model1.labels_ != -1]
    #return model1.labels_
```

```
    colors = model1.labels_
    color_clusters = colors[colors != -1]
    color_outliers = 'white'
    clusters1 = Counter(model1.labels_)
    print(clusters1)
    #print(dataset[model1.labels_ == -1].head())
    print('number of clusters: {}'.format(len(clusters1)-1))
    dbscan_plot(clusters_df,color_clusters)

def dbscan_plot(cluster,cluster_colors):
    fig = plt.figure()
    ax = fig.add_axes([.2,.2,2,2])
    ax.scatter(cluster['latitude'], cluster['longitude'],
    c = cluster_colors, edgecolors = 'black', s = 70)
    ax.set_xlabel('Latitude', fontsize=10)
    ax.set_ylabel('Longitude', fontsize=10)
    plt.title('title',fontsize=12)
    plt.grid(which='major',color='#cccccc', alpha=0.45)
    plt.show()


#print(dbscan(Set1, .15, 50))

#-------------finds hotspots using d1 and d2 thresholds-----------#

d1 = 200
d2 = 80

# find hotspots with high density threshold
def findHighHotspots(dataset):
    df = dbscan(dataset, .15, 50)
    clusters_df = pd.DataFrame()
    for n in range(len(df)):
        n_cluster = df[n]
        if n_cluster.shape[0] >= d1:
            clusters_df = clusters_df.append(n_cluster)
    return clusters_df

#print(findHighHotspots(Set1))
#dbscanplot(findHighHotspots(Set1), .15, 50)

def findMediumHighHotspots(dataset):
    df = dbscan(dataset, .15, 50)
    clusters_df = pd.DataFrame()
    for n in range(len(df)):
        n_cluster = df[n]
        if n_cluster.shape[0] < d1 and n_cluster.shape[0] >= d2:
            clusters_df = clusters_df.append(n_cluster)
    return clusters_df
```

```
#print(findMediumHighHotspots(Set1))
#dbscanplot(findMediumHighHotspots(Set1), .15, 50)

#-------------------Pipeline------------------#

#What do I want this pipleine to do
#For each cluster in image
#Output center an

#d distance from Center of the cluster

#Generate 10 images
#And then make animation of the 10 images
        # clustered_df = dbscan(DataFrame, .25, 64)

def pipeline(Dict, epi, mins):
    for key,DataFrame in Dict.items():
        print("Set ",key)
        cluster_list = dbscan(DataFrame,epi, mins)
        print("Set ", key, " information")
        print("Number of hotspots :" , len(cluster_list)-1)
        size = len(cluster_list)-1
        for i in range(size):
            print("Hotspot Center (Lat, Long): ",
Center(cluster_list[i]))
            print("Spread of Hotspot (Var of Lat and Long pts of the
hotspot)", DistCenter(cluster_list[i]))
            print("Avg Magnitude of Earthquakes in the hotspot: ",
MagPerCL(cluster_list[i]))

        dbscanplot(DataFrame,epi, mins)

        #Plot into basemap
        #Justin this is for u

pipeline(Dictionary, .15,35)
```

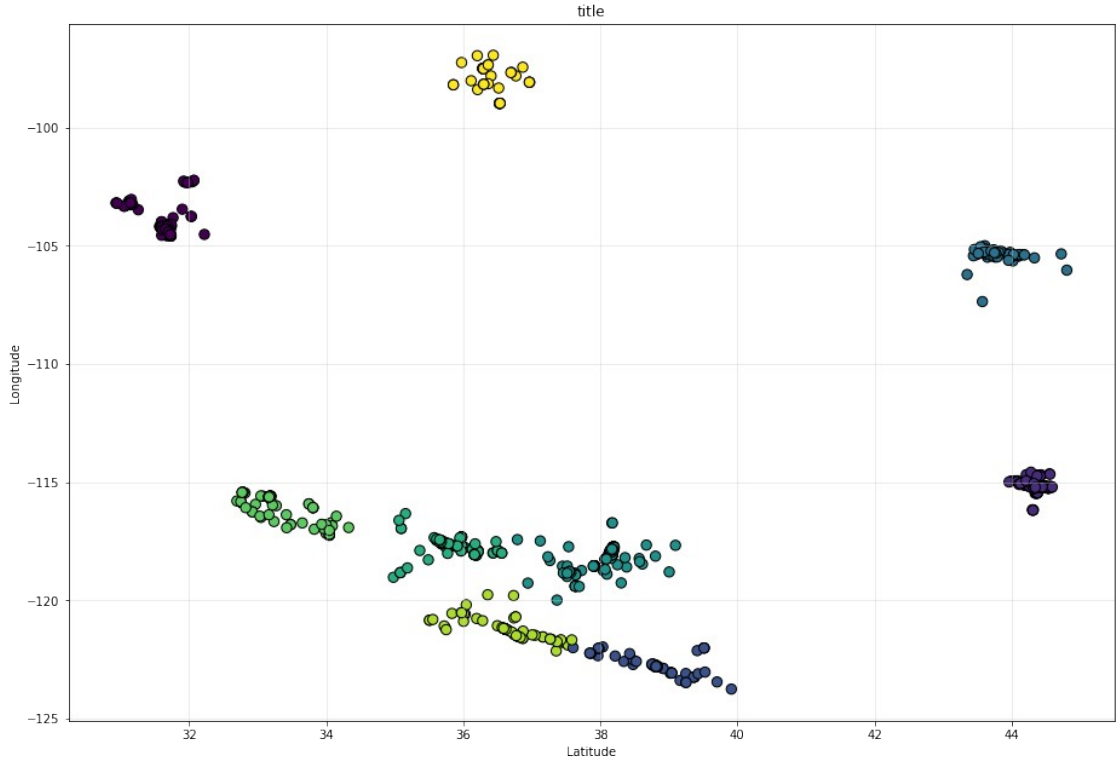
```
Set  1
Set  1  information
Number of hotspots : 10
Hotspot Center (Lat, Long):  (38.08898145013772, -118.12192369146013)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.18877081764650575
Avg Magnitude of Earthquakes in the hotspot:  2.936914600550964
Hotspot Center (Lat, Long):  (36.8140347978022, -121.36532235054949)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.734654768058884
Avg Magnitude of Earthquakes in the hotspot:  2.87142857142857
Hotspot Center (Lat, Long):  (43.72617234042554, -105.35486382978722)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
```

0.05992874527289512
Avg Magnitude of Earthquakes in the hotspot: 3.1765957446808506
Hotspot Center (Lat, Long): (44.34409155555554, -115.1288653333334)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.0518846448373015
Avg Magnitude of Earthquakes in the hotspot: 2.8026666666666693
Hotspot Center (Lat, Long): (31.632328328051965, -104.14499092987015)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.25442646425767707
Avg Magnitude of Earthquakes in the hotspot: 2.8129870129870134
Hotspot Center (Lat, Long): (35.935903919999994, -117.81007450941176)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.2861802469261798
Avg Magnitude of Earthquakes in the hotspot: 2.9465882352941177
Hotspot Center (Lat, Long): (39.12125892857143, -122.97928866249995)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.33903123114204137
Avg Magnitude of Earthquakes in the hotspot: 2.927142857142858
Hotspot Center (Lat, Long): (33.109698864393934, -115.70279444621217)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.1531262500923589
Avg Magnitude of Earthquakes in the hotspot: 2.960454545454546
Hotspot Center (Lat, Long): (36.4855121209091, -97.8293992425)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.44934139581276505
Avg Magnitude of Earthquakes in the hotspot: 2.9065909090909092
Hotspot Center (Lat, Long): (34.55199332800001, -116.817054672)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4733348770544138
Avg Magnitude of Earthquakes in the hotspot: 2.9128000000000003
Counter({0: 363, -1: 300, 7: 264, 3: 225, 4: 154, 1: 91, 5: 85, 6: 56,
2: 47, 8: 44, 9: 25})
number of clusters: 10



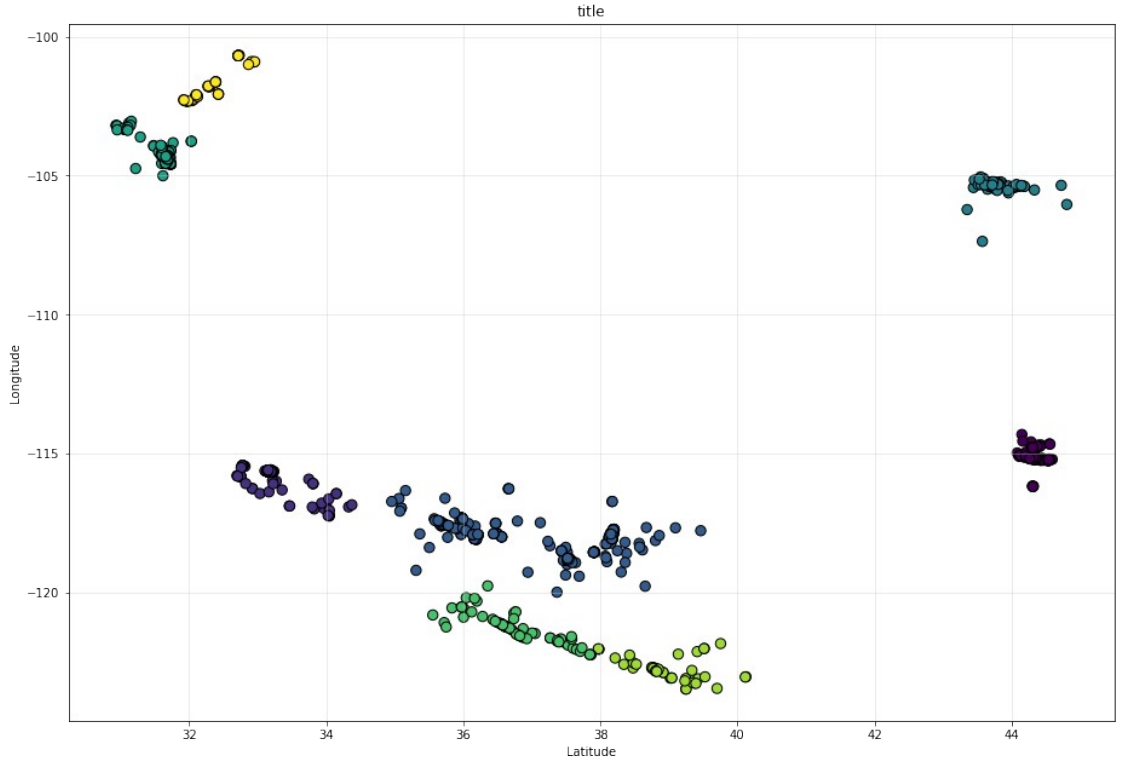
Set 2
Set 2 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (31.637276037393605, -104.13126792340427)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.33672549101732313
Avg Magnitude of Earthquakes in the hotspot: 2.8218085106382986
Hotspot Center (Lat, Long): (44.34132731707317, -115.12713902439026)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.05606705056288844
Avg Magnitude of Earthquakes in the hotspot: 2.7907317073170734
Hotspot Center (Lat, Long): (38.81768841014494, -122.74644927391307)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.39421373518658126
Avg Magnitude of Earthquakes in the hotspot: 2.926376811594203
Hotspot Center (Lat, Long): (43.79216060606059, -105.38524090909088)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.16120036149417244
Avg Magnitude of Earthquakes in the hotspot: 3.134848484848485
Hotspot Center (Lat, Long): (38.08205753440231, -118.13007676530619)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.22658363115053465
Avg Magnitude of Earthquakes in the hotspot: 2.94466472303207
Hotspot Center (Lat, Long): (35.85954059615383, -117.73059187948719)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.34936014542669513
Avg Magnitude of Earthquakes in the hotspot: 2.943717948717949

Hotspot Center (Lat, Long): (33.25071138414634, -116.02733333536585)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5201549871361556
Avg Magnitude of Earthquakes in the hotspot: 2.970365853658536
Hotspot Center (Lat, Long): (36.63540540135134, -121.21278603918923)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.42466698798594293
Avg Magnitude of Earthquakes in the hotspot: 2.874054054054055
Hotspot Center (Lat, Long): (36.41849047542856, -97.97207142828573)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4324955006533462
Avg Magnitude of Earthquakes in the hotspot: 2.906571428571429
Counter({-1: 344, 4: 343, 1: 205, 0: 188, 6: 82, 5: 78, 7: 74, 2: 69,
3: 66, 8: 35})
number of clusters: 9

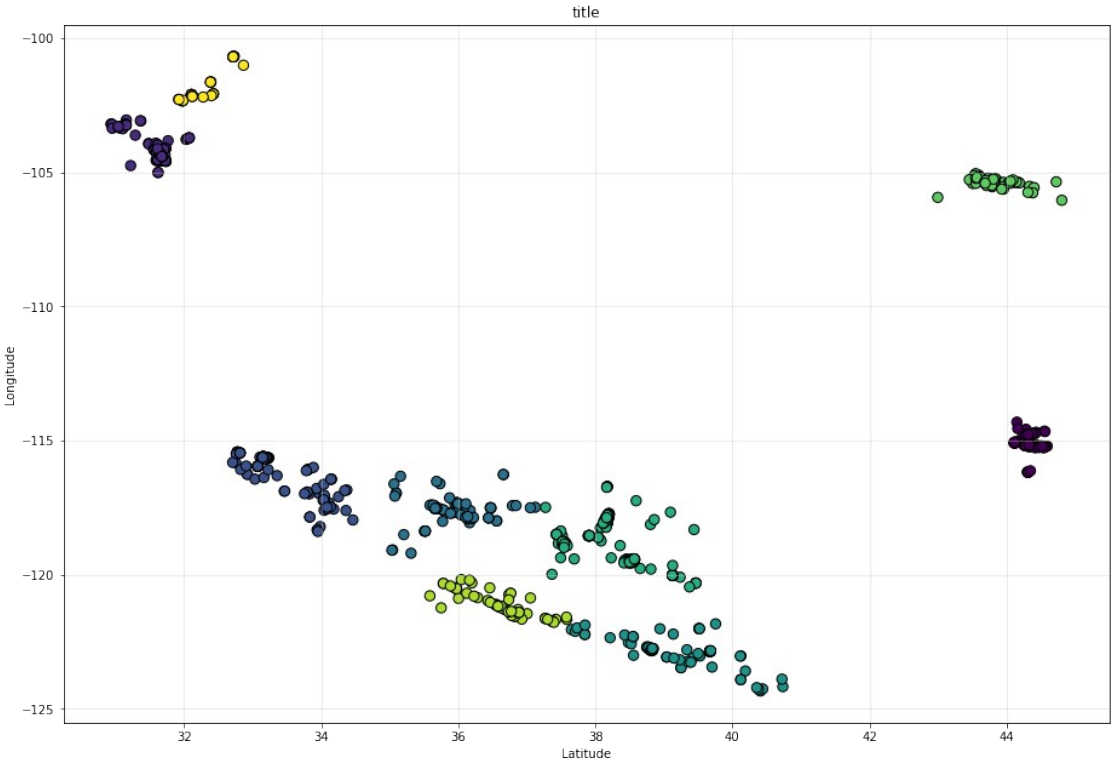


Set 3
Set 3 information
Number of hotspots : 8
Hotspot Center (Lat, Long): (44.337147107437985, -115.11412644628096)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.08517593264049589
Avg Magnitude of Earthquakes in the hotspot: 2.7900826446280993
Hotspot Center (Lat, Long): (33.18998127285713, -115.76388936333332)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.21349509968542107
Avg Magnitude of Earthquakes in the hotspot: 2.9813366666666656

```
Hotspot Center (Lat, Long):  (37.31875416969697, -118.00635440833331)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
1.4135708408780967
Avg Magnitude of Earthquakes in the hotspot:  2.913333333333335
Hotspot Center (Lat, Long):  (43.791298529411755, -105.38621911764699)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.15546448917910455
Avg Magnitude of Earthquakes in the hotspot:  3.13235294117647
Hotspot Center (Lat, Long):  (31.621828206206896, -104.26983983534481)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.13189842165864618
Avg Magnitude of Earthquakes in the hotspot:  2.8530172413793102
Hotspot Center (Lat, Long):  (36.75960822467533, -121.27383550000002)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5271422535555996
Avg Magnitude of Earthquakes in the hotspot:  2.872727272727274
Hotspot Center (Lat, Long):  (38.9504632779661, -122.7654152542373)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.3473416037844518
Avg Magnitude of Earthquakes in the hotspot:  2.924067796610168
Hotspot Center (Lat, Long):  (32.3485529153846, -101.68493266666667)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.48450233978010404
Avg Magnitude of Earthquakes in the hotspot:  2.8435897435897433
Counter({-1: 367, 2: 264, 4: 232, 1: 210, 0: 121, 5: 77, 3: 68, 6: 59,
7: 39})
number of clusters: 8
```

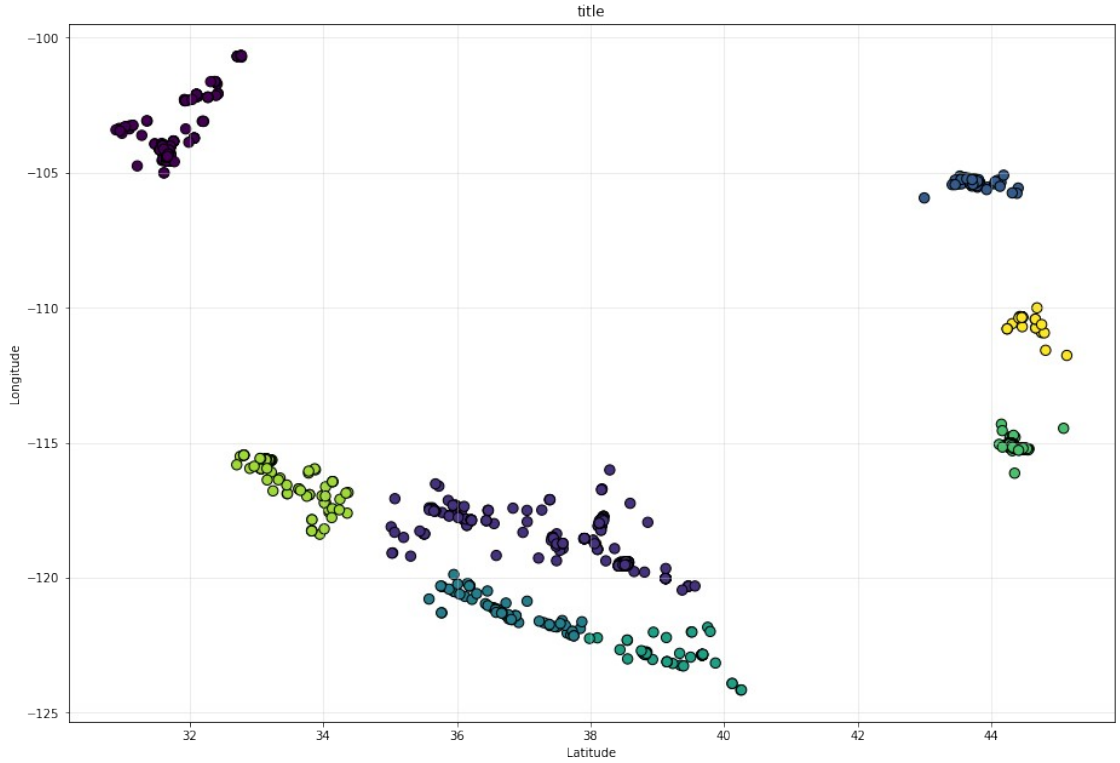


Set 4
Set 4 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (44.34340520833333, -115.13849895833334)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.10900163112938634
Avg Magnitude of Earthquakes in the hotspot: 2.794791666666665
Hotspot Center (Lat, Long): (31.623772782086625, -104.25142816417325)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.14489113805841683
Avg Magnitude of Earthquakes in the hotspot: 2.846850393700789
Hotspot Center (Lat, Long): (33.27890912169811, -115.93555786037737)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5550574339709006
Avg Magnitude of Earthquakes in the hotspot: 2.973871226415092
Hotspot Center (Lat, Long): (35.91877666, -117.60610999857147)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5615224596805518
Avg Magnitude of Earthquakes in the hotspot: 2.8975714285714282
Hotspot Center (Lat, Long): (39.22442535312499, -122.86724652500006)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.7138950598675153
Avg Magnitude of Earthquakes in the hotspot: 2.8752083333333336
Hotspot Center (Lat, Long): (38.406456718407966, -119.1468745358209)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6330142515072914
Avg Magnitude of Earthquakes in the hotspot: 2.914577114427857
Hotspot Center (Lat, Long): (43.813922972972975, -105.37083513513512)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.10608267615883007
Avg Magnitude of Earthquakes in the hotspot: 3.141891891891892
Hotspot Center (Lat, Long): (36.611446972727265, -121.1158560590909)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4092196822961718
Avg Magnitude of Earthquakes in the hotspot: 2.8786363636363643
Hotspot Center (Lat, Long): (32.31994629028571, -101.73171412857143)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4831479863615099
Avg Magnitude of Earthquakes in the hotspot: 2.8314285714285723
Counter({5: 402, -1: 338, 1: 254, 2: 212, 0: 96, 4: 96, 6: 74, 3: 70,
7: 66, 8: 35})
number of clusters: 9



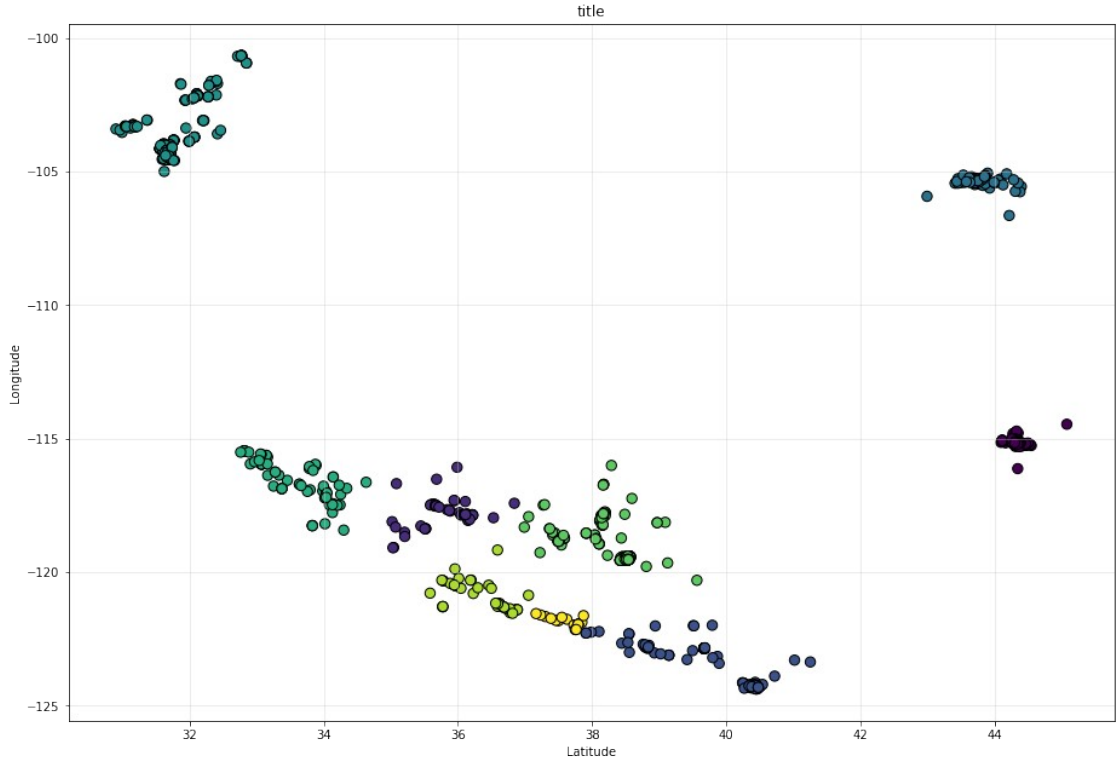
Set 5
Set 5 information
Number of hotspots : 8
Hotspot Center (Lat, Long): (31.73020885652819, -103.90363779643911)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.9031016467362282
Avg Magnitude of Earthquakes in the hotspot: 2.860830860534128
Hotspot Center (Lat, Long): (38.06040349999999, -119.00211246344539)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
1.5371140744659821
Avg Magnitude of Earthquakes in the hotspot: 2.9146848739495748
Hotspot Center (Lat, Long): (43.76031967213115, -105.3665344262295)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.07853694923497274
Avg Magnitude of Earthquakes in the hotspot: 3.1114754098360646
Hotspot Center (Lat, Long): (36.712871431428574, -121.19012856714286)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6918407375537633
Avg Magnitude of Earthquakes in the hotspot: 2.980714285714285
Hotspot Center (Lat, Long): (39.23076535131579, -122.84017324736841)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.41973149735916493
Avg Magnitude of Earthquakes in the hotspot: 2.8718421052631595
Hotspot Center (Lat, Long): (44.3411125, -115.10726057692305)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.050931239826363335
Avg Magnitude of Earthquakes in the hotspot: 2.8423076923076924

Hotspot Center (Lat, Long): (33.29608243300492, -115.95417618817737)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5473993175223523
Avg Magnitude of Earthquakes in the hotspot: 2.9746832512315273
Hotspot Center (Lat, Long): (44.52842570571429, -110.54198856285717)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.15861575173989806
Avg Magnitude of Earthquakes in the hotspot: 2.758
Counter({1: 476, 0: 337, -1: 288, 6: 203, 5: 104, 4: 76, 3: 70, 2: 61, 7: 35})
number of clusters: 8

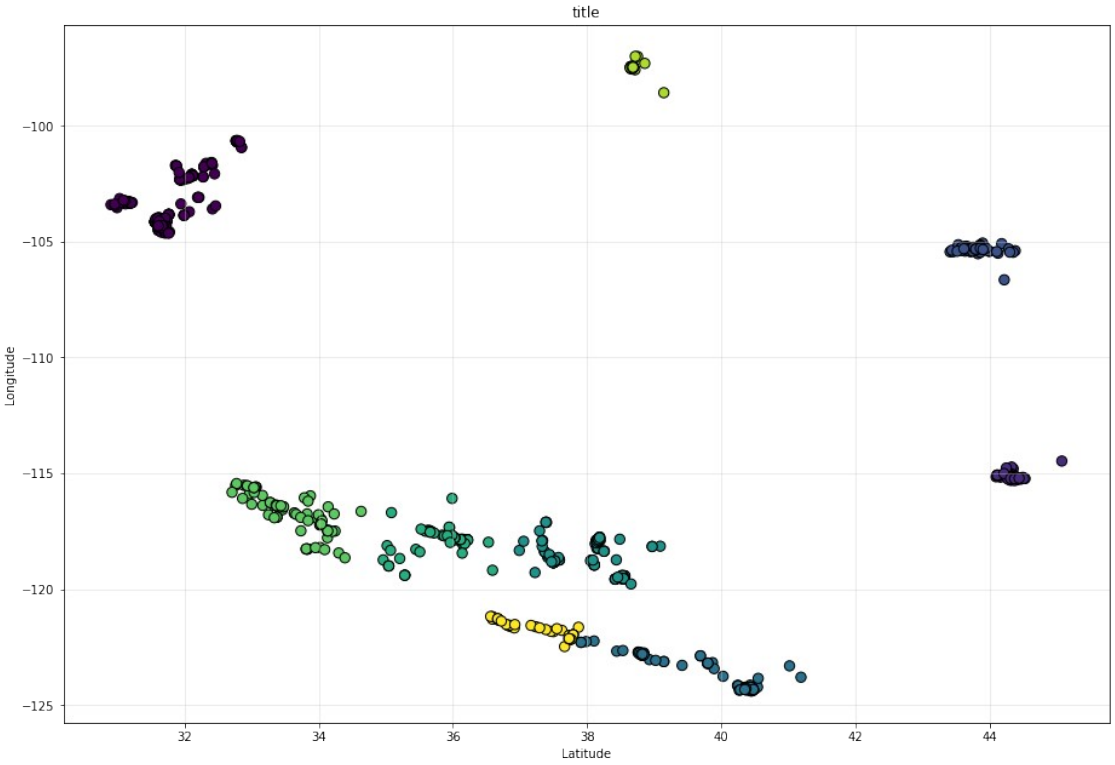


Set 6
Set 6 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (44.32994479999999, -115.1357)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.0324343415251615
Avg Magnitude of Earthquakes in the hotspot: 2.8152000000000004
Hotspot Center (Lat, Long): (35.8141314076923, -117.79846154423078)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4446784404807957
Avg Magnitude of Earthquakes in the hotspot: 2.90096153846154
Hotspot Center (Lat, Long): (39.786670238571446, -123.50978452499996)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
1.157967067401669
Avg Magnitude of Earthquakes in the hotspot: 2.876142857142856

```
Hotspot Center (Lat, Long):  (43.777121126760555, -105.3765929577465)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.10471237263983896
Avg Magnitude of Earthquakes in the hotspot:  3.0619718309859154
Hotspot Center (Lat, Long):  (31.729243531558858, -103.87660032088236)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.8918640853200254
Avg Magnitude of Earthquakes in the hotspot:  2.8641176470588277
Hotspot Center (Lat, Long):  (33.575821257971015, -116.57873188115937)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.8768786278315039
Avg Magnitude of Earthquakes in the hotspot:  2.9234782608695657
Hotspot Center (Lat, Long):  (38.396342302902355, -119.2000781865436)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.4940117689598391
Avg Magnitude of Earthquakes in the hotspot:  2.9034828496042184
Hotspot Center (Lat, Long):  (36.37756521956521, -120.91562680869563)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.43037381858668977
Avg Magnitude of Earthquakes in the hotspot:  3.0017391304347836
Hotspot Center (Lat, Long):  (37.625140352631576, -121.86930701052628)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.08382883355809109
Avg Magnitude of Earthquakes in the hotspot:  2.886315789473684
Counter({6: 379, 4: 340, -1: 333, 2: 140, 0: 125, 3: 71, 5: 69, 1: 52,
7: 46, 8: 19})
number of clusters: 9
```

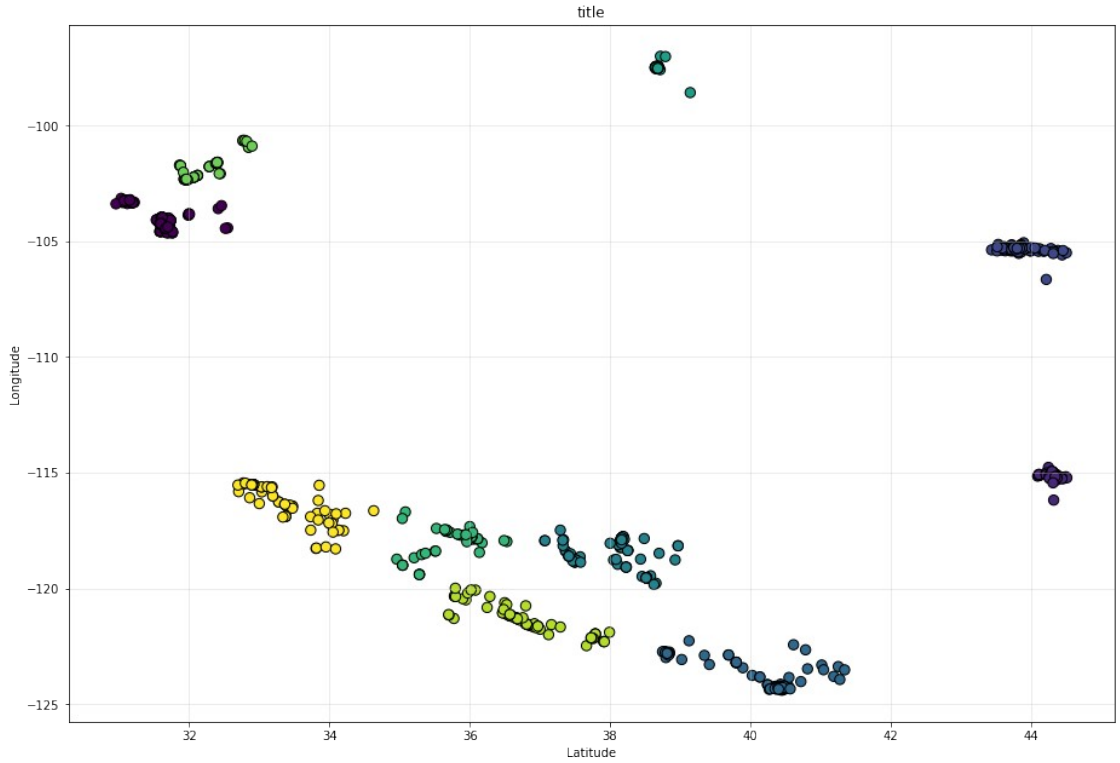


Set 7
Set 7 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (31.732645041597788, -103.85673751542703)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.9779330010933533
Avg Magnitude of Earthquakes in the hotspot: 2.88512396694215
Hotspot Center (Lat, Long): (44.327380165289256, -115.12937190082648)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.02297303230716255
Avg Magnitude of Earthquakes in the hotspot: 2.810743801652893
Hotspot Center (Lat, Long): (43.79238904109589, -105.34792602739726)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.07810136016362232
Avg Magnitude of Earthquakes in the hotspot: 3.0547945205479436
Hotspot Center (Lat, Long): (39.871750666400004, -123.72850533519998)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
1.1267110591107812
Avg Magnitude of Earthquakes in the hotspot: 2.880559999999999
Hotspot Center (Lat, Long): (38.090803186029405, -118.50162916470586)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.7077573774302276
Avg Magnitude of Earthquakes in the hotspot: 2.947573529411764
Hotspot Center (Lat, Long): (35.79005555555556, -117.95671296481484)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5777623044055575
Avg Magnitude of Earthquakes in the hotspot: 2.860555555555555
Hotspot Center (Lat, Long): (33.60536714927537, -116.79906521594204)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.9481015525159961
Avg Magnitude of Earthquakes in the hotspot: 2.9108695652173915
Hotspot Center (Lat, Long): (38.69263999999999, -97.4902575)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.050321537275641086
Avg Magnitude of Earthquakes in the hotspot: 2.9074999999999998
Hotspot Center (Lat, Long): (37.210695126829265, -121.67795121463412)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.35334004144387104
Avg Magnitude of Earthquakes in the hotspot: 2.920975609756097
Counter({0: 363, -1: 288, 4: 136, 3: 125, 1: 121, 2: 73, 6: 69, 5: 54,
8: 41, 7: 40})
number of clusters: 9



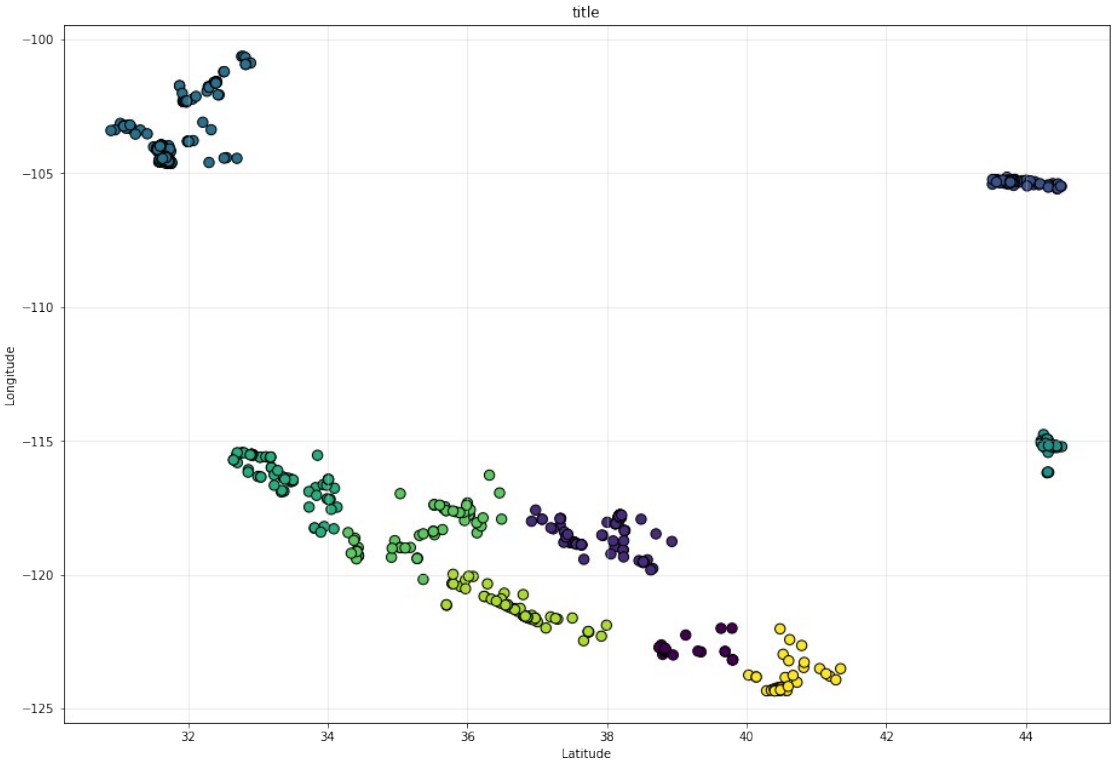
Set 8
Set 8 information
Number of hotspots : 10
Hotspot Center (Lat, Long): (31.63586017864079, -104.25796340744338)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.12963302899049145
Avg Magnitude of Earthquakes in the hotspot: 2.869255663430425
Hotspot Center (Lat, Long): (44.3238576923077, -115.16837307692305)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.02986694576423566
Avg Magnitude of Earthquakes in the hotspot: 2.7512820512820504
Hotspot Center (Lat, Long): (43.84070860215053, -105.34720860215056)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.08228467311126683
Avg Magnitude of Earthquakes in the hotspot: 3.04516129032258
Hotspot Center (Lat, Long): (40.06576208625953, -123.79974809312976)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.9320756843167861
Avg Magnitude of Earthquakes in the hotspot: 2.88854961832061
Hotspot Center (Lat, Long): (38.07579166538463, -118.43005833173076)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6052985870834684
Avg Magnitude of Earthquakes in the hotspot: 2.943942307692309
Hotspot Center (Lat, Long): (38.68796097560975, -97.49617560975611)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.04766328782926831
Avg Magnitude of Earthquakes in the hotspot: 2.870731707317073

Hotspot Center (Lat, Long): (35.72189629999999, -117.98836666888892)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5579673149088289
Avg Magnitude of Earthquakes in the hotspot: 2.8397777777777784
Hotspot Center (Lat, Long): (32.22000434590908, -101.83536686818184)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.3977074069256269
Avg Magnitude of Earthquakes in the hotspot: 2.913636363636364
Hotspot Center (Lat, Long): (36.79239801940299, -121.32158955223878)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.7888328849354449
Avg Magnitude of Earthquakes in the hotspot: 2.8707462686567164
Hotspot Center (Lat, Long): (33.41858457164179, -116.40265671940301)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.9080142488351204
Avg Magnitude of Earthquakes in the hotspot: 2.9268656716417922
Counter({0: 309, -1: 280, 3: 131, 4: 104, 2: 93, 1: 78, 8: 67, 9: 67, 6: 45, 7: 44, 5: 41})
number of clusters: 10



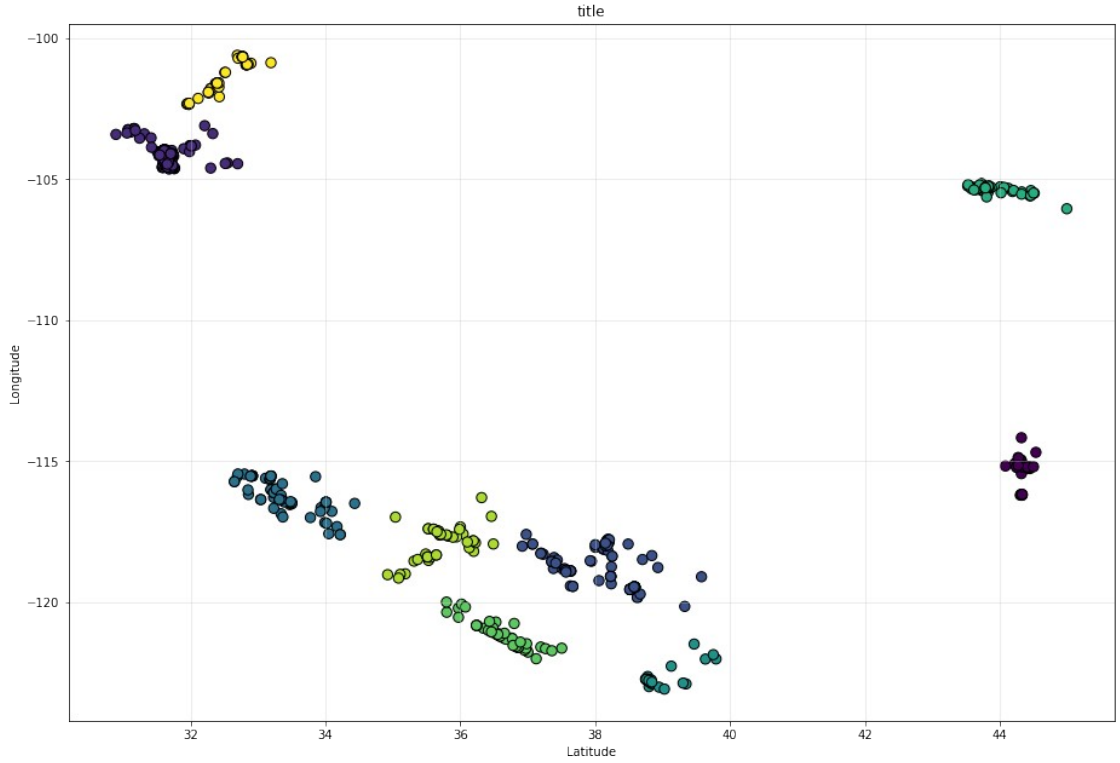
Set 9
Set 9 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (38.979057973913044, -122.77898912826083)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.16959196904697443
Avg Magnitude of Earthquakes in the hotspot: 2.8528260869565223

Hotspot Center (Lat, Long): (38.00217155779817, -118.47465993853211)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6003301510926173
Avg Magnitude of Earthquakes in the hotspot: 2.947798165137613
Hotspot Center (Lat, Long): (43.85385061728396, -105.34193827160487)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.0676555301728394
Avg Magnitude of Earthquakes in the hotspot: 3.069135802469135
Hotspot Center (Lat, Long): (31.720676313358027, -103.96799785432091)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.8126315917875708
Avg Magnitude of Earthquakes in the hotspot: 2.8464792569876587
Hotspot Center (Lat, Long): (44.33712790697676, -115.22743488372093)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.0874401629568102
Avg Magnitude of Earthquakes in the hotspot: 2.695348837209302
Hotspot Center (Lat, Long): (33.34608570428572, -116.34329048000001)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.8445259919215343
Avg Magnitude of Earthquakes in the hotspot: 2.9198571428571425
Hotspot Center (Lat, Long): (35.35404010144927, -118.33017101739131)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
1.0812376225300646
Avg Magnitude of Earthquakes in the hotspot: 2.9539130434782606
Hotspot Center (Lat, Long): (36.69081217777778, -121.24728836031744)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6232492983471991
Avg Magnitude of Earthquakes in the hotspot: 2.8696825396825396
Hotspot Center (Lat, Long): (40.57405127948718, -123.88653846666665)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.42273032675890876
Avg Magnitude of Earthquakes in the hotspot: 2.782820512820513
Counter({3: 405, -1: 253, 1: 109, 2: 81, 5: 70, 6: 69, 7: 63, 0: 46,
4: 43, 8: 39})
number of clusters: 9



Set 10
Set 10 information
Number of hotspots : 9
Hotspot Center (Lat, Long): (44.33228863636364, -115.2508272727273)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.18402460585095193
Avg Magnitude of Earthquakes in the hotspot: 2.7227272727272727
Hotspot Center (Lat, Long): (31.657693495090914, -104.25385493688316)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.09830641433560745
Avg Magnitude of Earthquakes in the hotspot: 2.8323520300883147
Hotspot Center (Lat, Long): (38.09713455504587, -118.7885030577981)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.6957456595291815
Avg Magnitude of Earthquakes in the hotspot: 2.8679816513761462
Hotspot Center (Lat, Long): (33.34683574202899, -116.16875362608697)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.5418055736977663
Avg Magnitude of Earthquakes in the hotspot: 2.9194202898550743
Hotspot Center (Lat, Long): (38.923666664285705, -122.69621031666664)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.17393405694739555
Avg Magnitude of Earthquakes in the hotspot: 2.872619047619048
Hotspot Center (Lat, Long): (43.862703125, -105.3535078125)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.09753014802331342
Avg Magnitude of Earthquakes in the hotspot: 3.0687499999999996

```
Hotspot Center (Lat, Long):  (36.62591346346154, -121.1533205115384)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.3565367142505669
Avg Magnitude of Earthquakes in the hotspot:  2.8648076923076924
Hotspot Center (Lat, Long):  (35.711483708888885, -117.90081037333334)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.494166487504578
Avg Magnitude of Earthquakes in the hotspot:  3.043777777777776
Hotspot Center (Lat, Long):  (32.48181931553193, -101.44366039574469)
Spread of Hotspot (Var of Lat and Long pts of the hotspot)
0.376078143831026
Avg Magnitude of Earthquakes in the hotspot:  2.894010026468085
Counter({1: 385, -1: 298, 2: 109, 3: 69, 5: 64, 6: 52, 8: 47, 7: 45,
0: 44, 4: 42})
number of clusters: 9
```

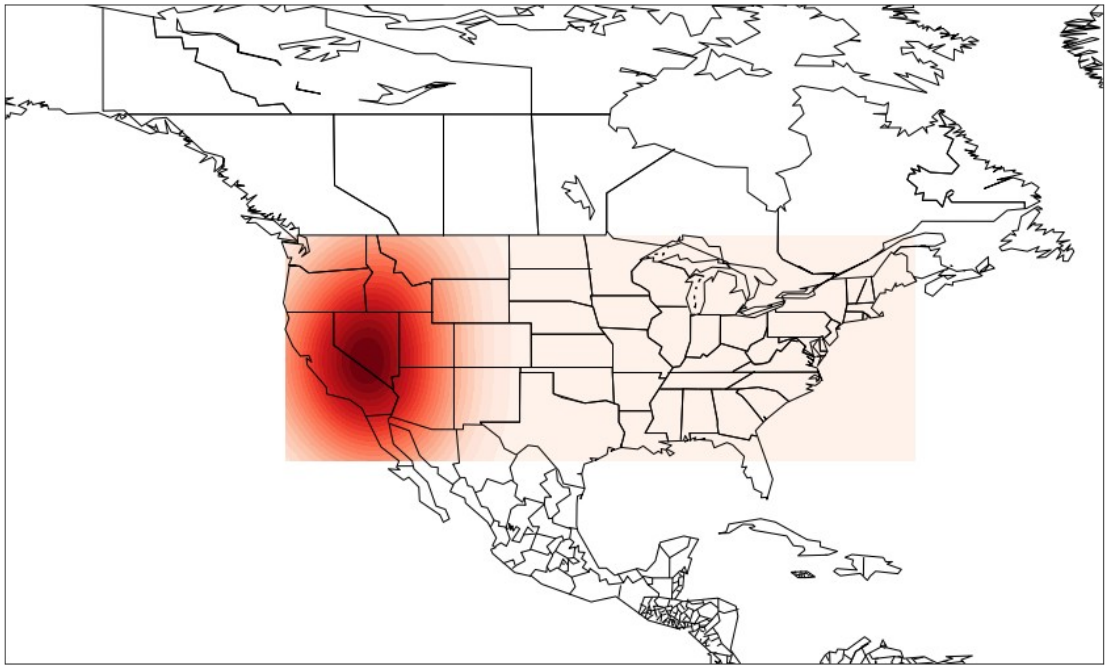



```
# set up the data grid for the contour plot

hotspot1_Set1 = findHighHotspots(Set1)

ktest = hotspot1_Set1[['latitude', 'longitude']]

xgrid = np.sort(list(hotspot1_Set1['longitude']))
ygrid = np.sort(list(hotspot1_Set1['latitude']))
x, y = np.meshgrid(xgrid, ygrid)
print("X Grid Component:\n{}\n".format(x))
print("Y Grid Component:\n{}\n".format(y))
```

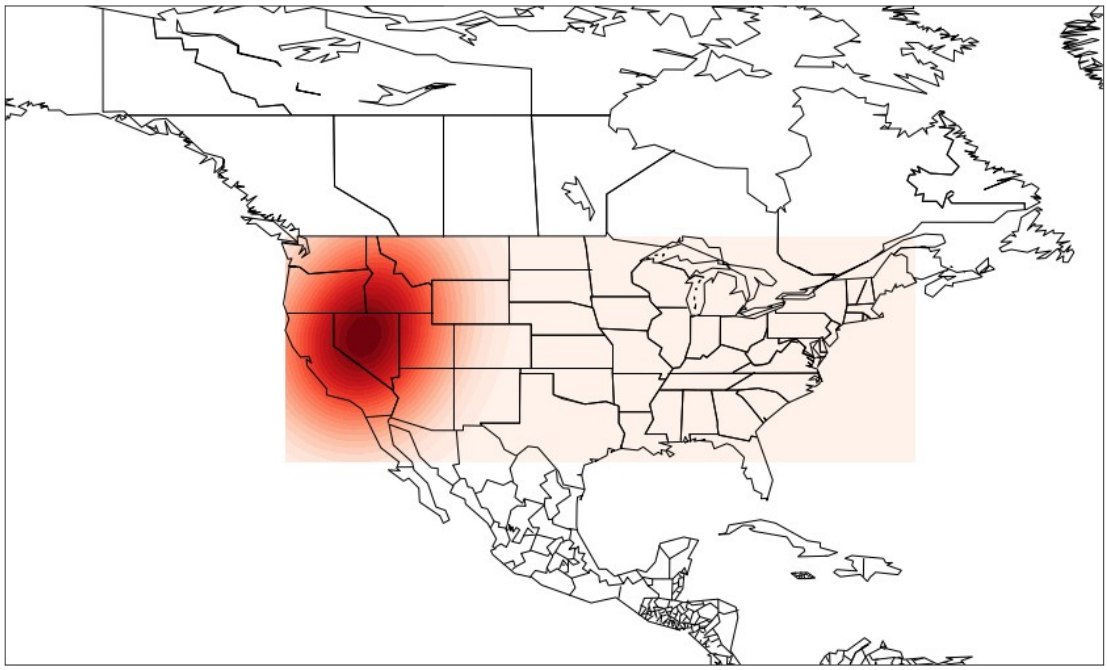
```
xy = np.vstack([y.ravel(), x.ravel()]).T

#----------HOTSPOT1 MAP SETUP-----------------#

def mapSetUp1(dataset):
    # set up the data grid for the contour plot #
    hotspot2 = findHighHotspots(dataset)
    ktest2 = hotspot2[['latitude', 'longitude']]

    xgrid2 = np.sort(list(dataset['longitude']))
    ygrid2 = np.sort(list(dataset['latitude']))
    x2, y2 = np.meshgrid(xgrid2, ygrid2)
    #print("X Grid Component:\n{}\n".format(x2))
    #print("Y Grid Component:\n{}\n".format(y2))

    xy2 = np.vstack([y2.ravel(), x2.ravel()]).T
    # run kernel density estimation for hotspot 2 #
    kde2 = sklearn.neighbors.KernelDensity(
        bandwidth=5,
        metric='minkowski',
        kernel='gaussian',
        algorithm='ball_tree'
    )
    kde2.fit(ktest2.values)

    # fit the trained model on the xy grid #
    log_density2 = kde2.score_samples(xy2)
    density2 = np.exp(log_density2)
    density2 = density2.reshape(x2.shape)
    #print("Shape of Density Values:\n{}\n".format(density2.shape))

    return x2, y2, density2

#---------------visualize the results for Hotspot 1----------------#
#PS takes a while to run
def visualizeMap(dataset):
    fig15 = plt.figure(figsize=(15, 15))


    the_map = mpl_toolkits.basemap.Basemap(
        projection='cyl',
        llcrnrlat=10, urcrnrlat=70,
        llcrnrlon=-150,urcrnrlon=-50,
        resolution='c'
    )

    the_map.drawcoastlines(linewidth=1)
    the_map.drawcountries(linewidth=1)
    the_map.drawstates(linewidth=1)
```

```
    """
    #turns polygons into points
    for i in hotspot1_Set1:
    the_map.scatter(hotspot1_Set1['longitude'],
hotspot1_Set1['latitude'], latlon = True, s = 50, c = 'red')
    """

    hotspot_vals =  mapSetUp1(dataset)
    levels = np.linspace(0, hotspot_vals[2].max(), 25)
    plt.contourf(hotspot_vals[0], hotspot_vals[1], hotspot_vals[2],
levels=levels, cmap=plt.cm.Reds)

    plt.show()

######################start of high hotspot######################

visualizeMap(Set1), visualizeMap(Set2)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



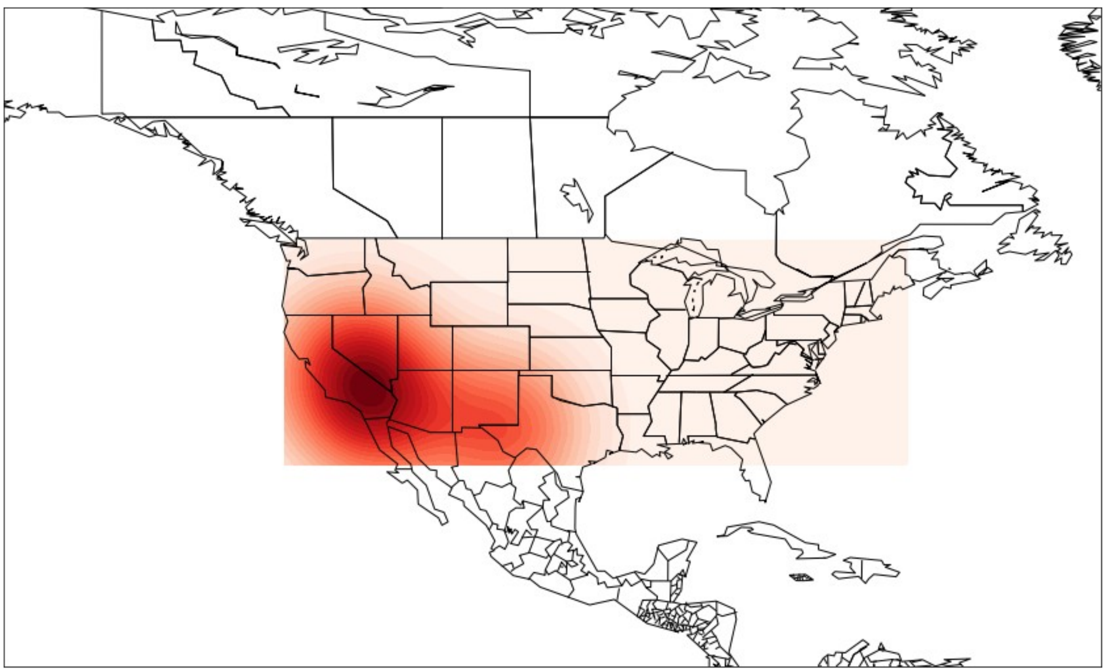
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



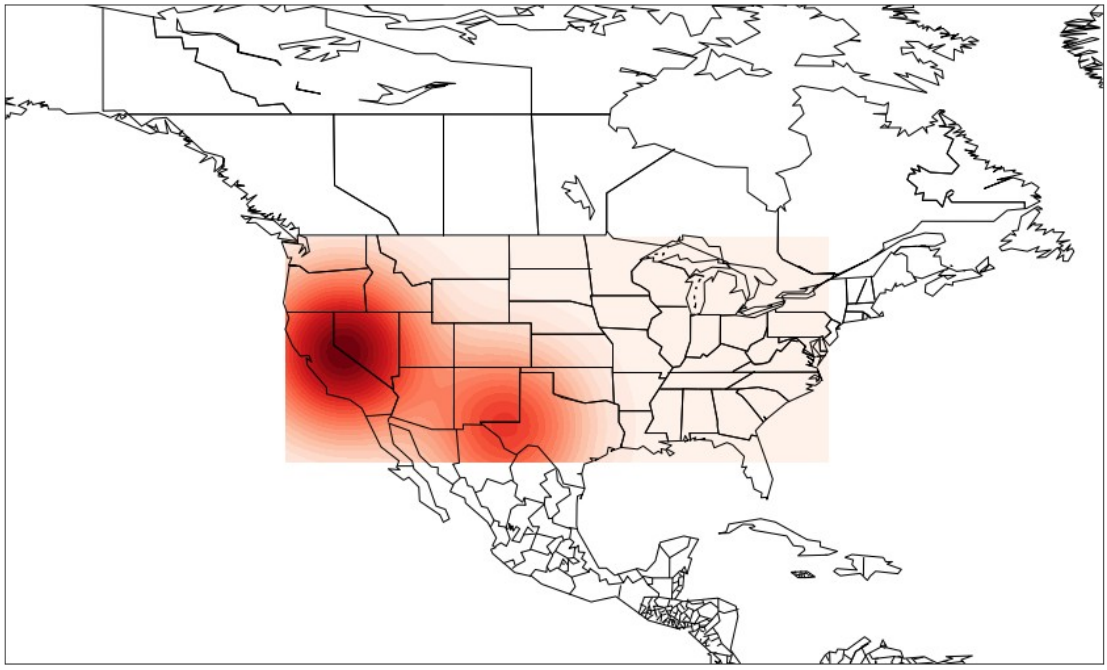
```
(None, None)
```

```
visualizeMap(Set3), visualizeMap(Set4)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



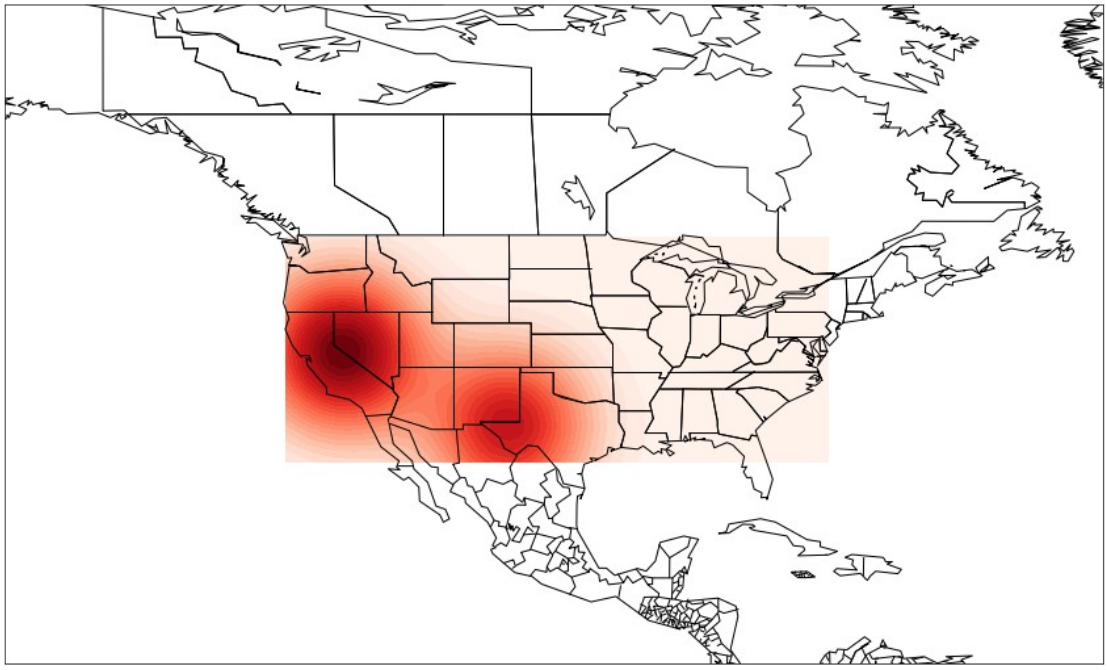
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



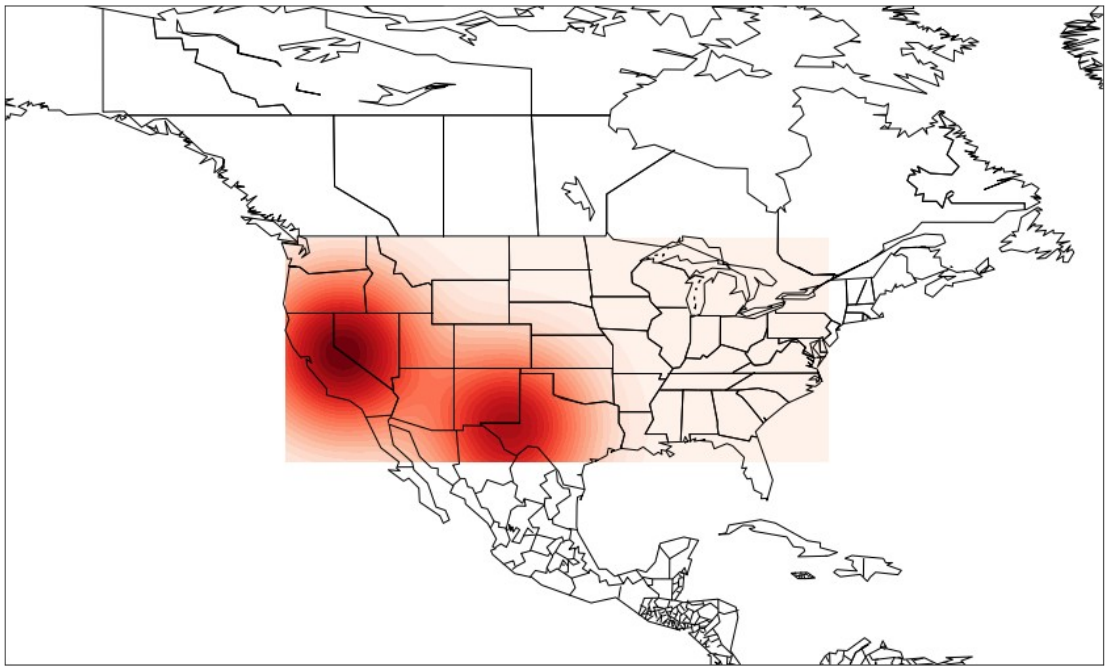
```
(None, None)
```

```
visualizeMap(Set5), visualizeMap(Set6)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



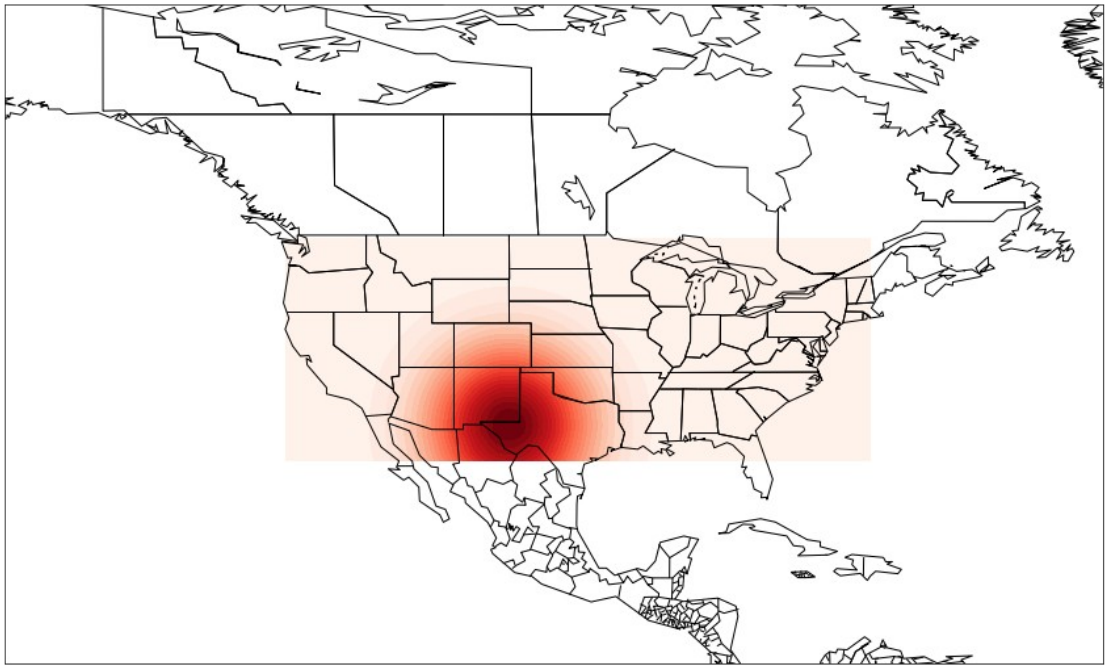
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



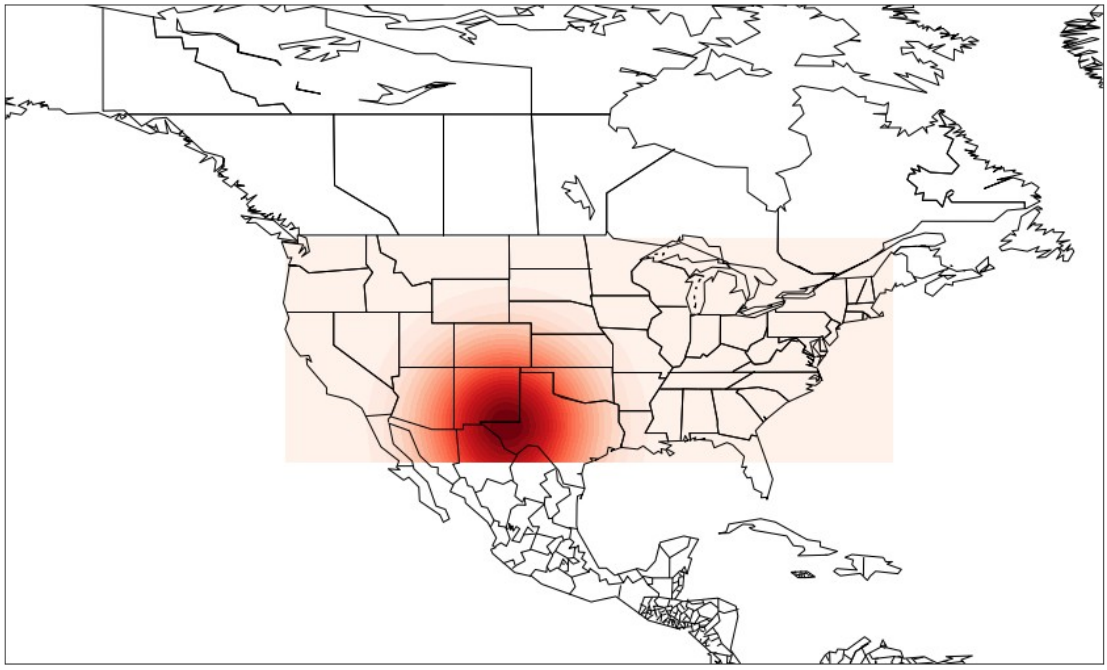
```
(None, None)
```

```
visualizeMap(Set7), visualizeMap(Set8)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



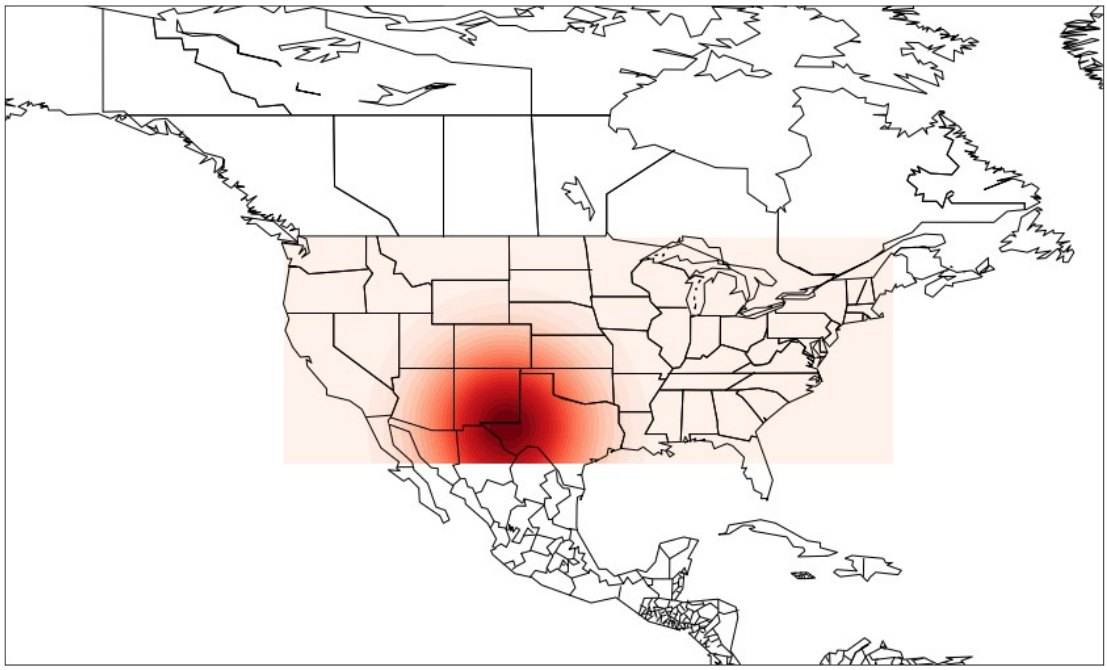
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



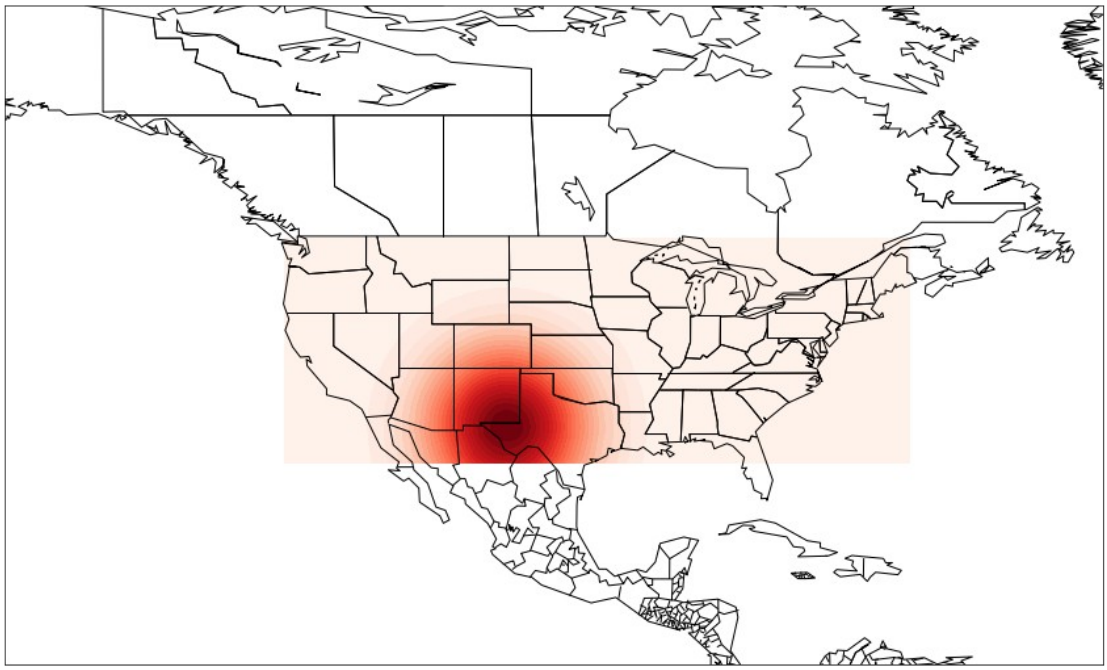
```
(None, None)
```

```
visualizeMap(Set9), visualizeMap(Set10)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:13:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



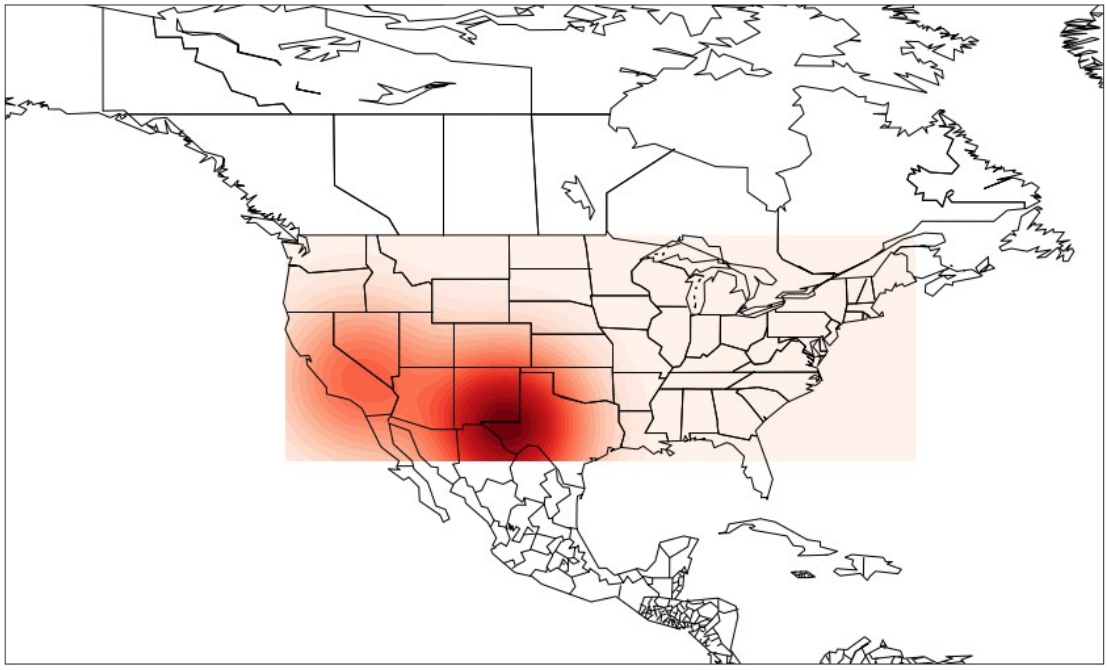
```
(None, None)
```

```
##########################start of medium high
hotspot#########################
```

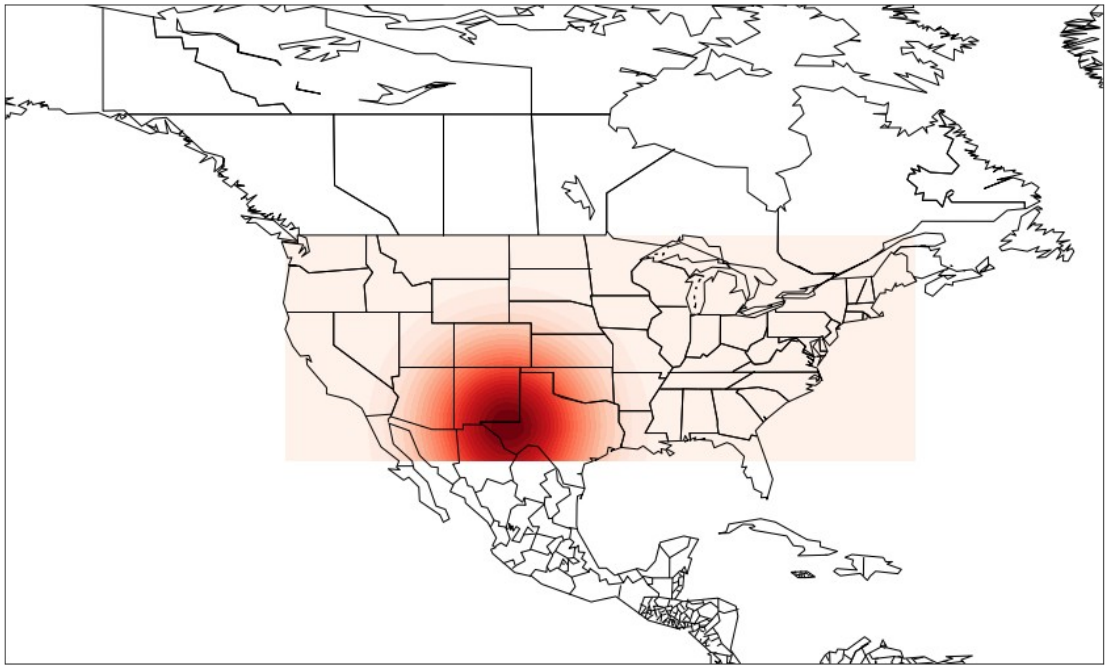
```
def mapSetUp2(dataset):
    # set up the data grid for the contour plot #
    hotspot2 = findMediumHighHotspots(dataset)
    ktest2 = hotspot2[['latitude', 'longitude']]

    xgrid2 = np.sort(list(dataset['longitude']))
    ygrid2 = np.sort(list(dataset['latitude']))
    x2, y2 = np.meshgrid(xgrid2, ygrid2)
    #print("X Grid Component:\n{}\n".format(x2))
    #print("Y Grid Component:\n{}\n".format(y2))

    xy2 = np.vstack([y2.ravel(), x2.ravel()]).T
    # run kernel density estimation for hotspot 2 #
    kde2 = sklearn.neighbors.KernelDensity(
        bandwidth=5,
        metric='minkowski',
        kernel='gaussian',
        algorithm='ball_tree'
    )
    kde2.fit(ktest2.values)
```

```
    # fit the trained model on the xy grid #
    log_density2 = kde2.score_samples(xy2)
    density2 = np.exp(log_density2)
    density2 = density2.reshape(x2.shape)
    #print("Shape of Density Values:\n{}\n".format(density2.shape))

    return x2, y2, density2

#--------------visualize the results for Hotspot 2--------------#
#PS takes a while to run
def visualizeMap2(dataset):
    fig15 = plt.figure(figsize=(15, 15))
    fig15.suptitle(
        """
        Density Estimation:
        Location of Earthquakes within the US
        With Magnitude >= 2.5
        """,
        fontsize=16
    )

    the_map = mpl_toolkits.basemap.Basemap(
        projection='cyl',
        llcrnrlat=10, urcrnrlat=70,
        llcrnrlon=-150,urcrnrlon=-50,
        resolution='c'
    )

    the_map.drawcoastlines(linewidth=1)
    the_map.drawcountries(linewidth=1)
    the_map.drawstates(linewidth=1)

    """
    #turns polygons into points
    for i in hotspot1_Set1:
    the_map.scatter(hotspot1_Set1['longitude'],
hotspot1_Set1['latitude'], latlon = True, s = 50, c = 'red')
    """

    hotspot_vals =  mapSetUp2(dataset)
    levels = np.linspace(0, hotspot_vals[2].max(), 25)
    plt.contourf(hotspot_vals[0], hotspot_vals[1], hotspot_vals[2],
levels=levels, cmap=plt.cm.Reds)

    plt.show()


visualizeMap2(Set1),visualizeMap2(Set2)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



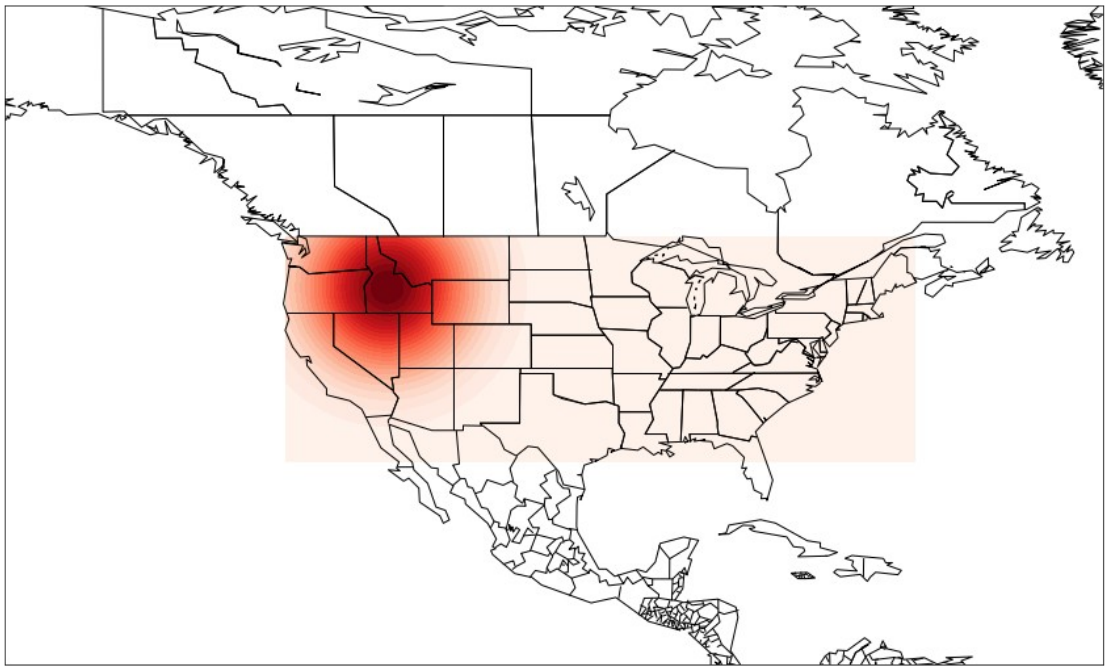
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



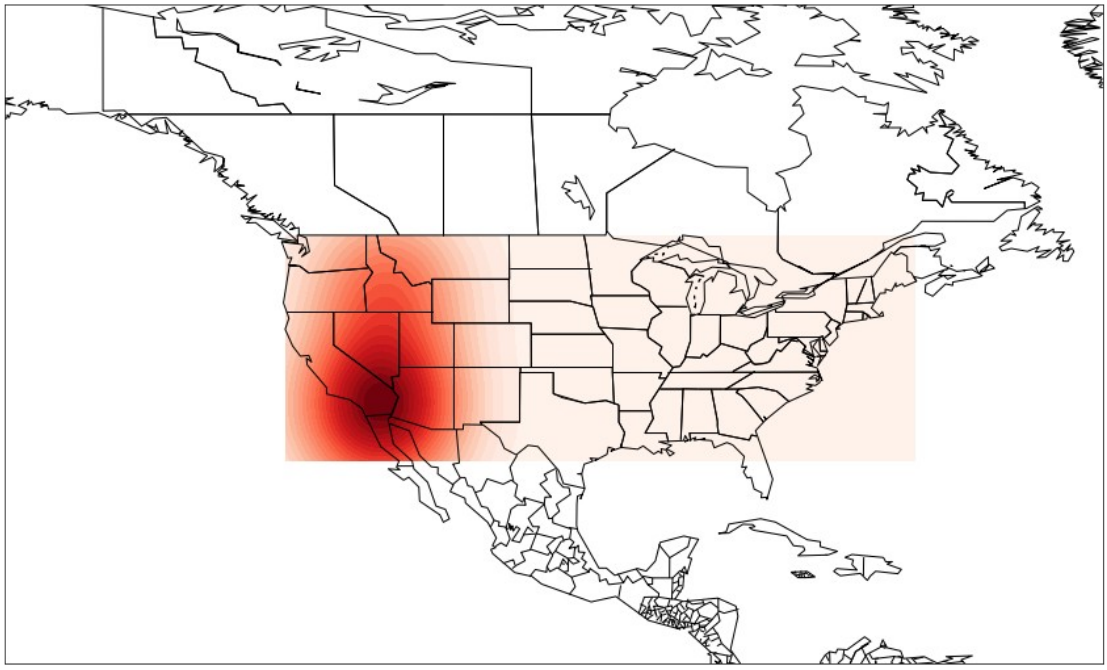
```
(None, None)
```

```
visualizeMap2(Set3),visualizeMap2(Set4)
```

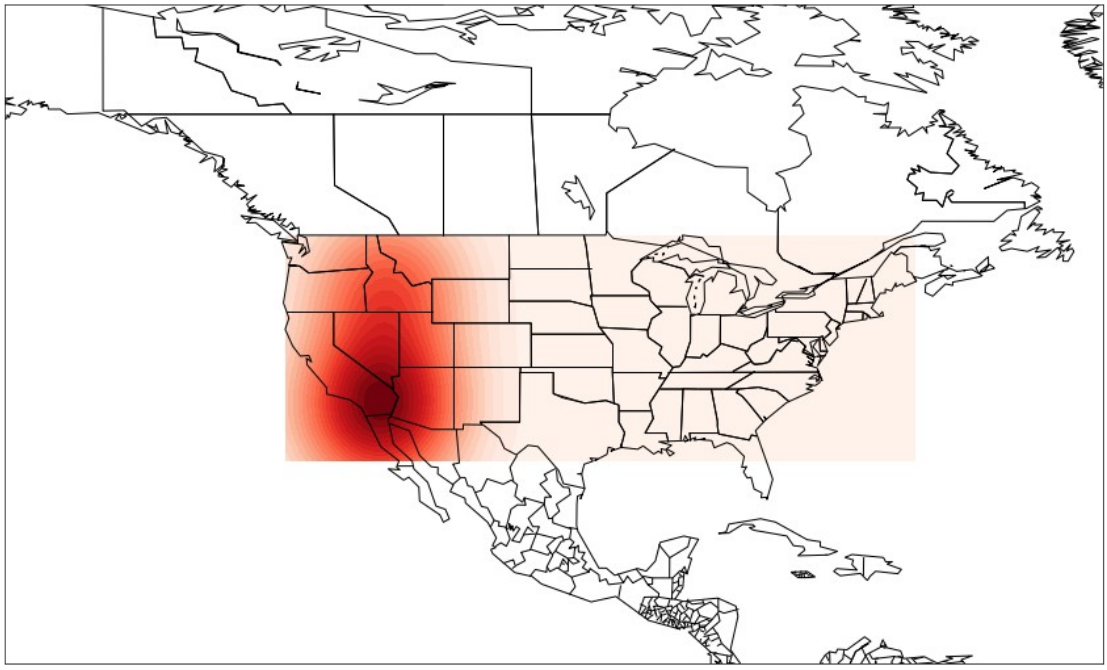
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



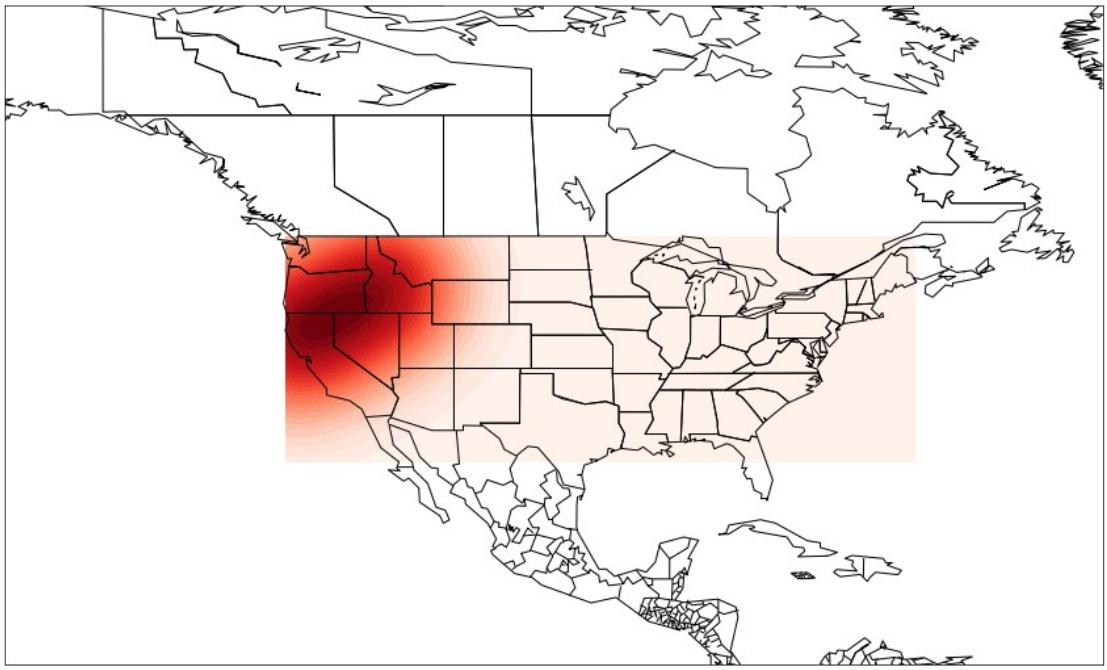
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



```
(None, None)

visualizeMap2(Set5),visualizeMap2(Set6)

C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



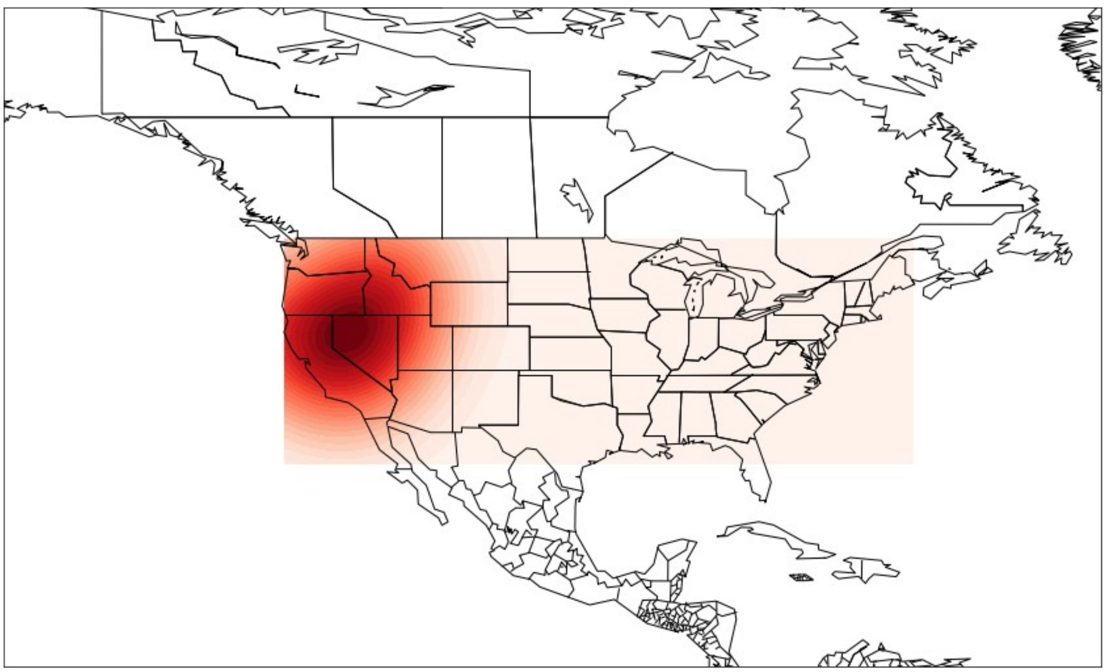
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



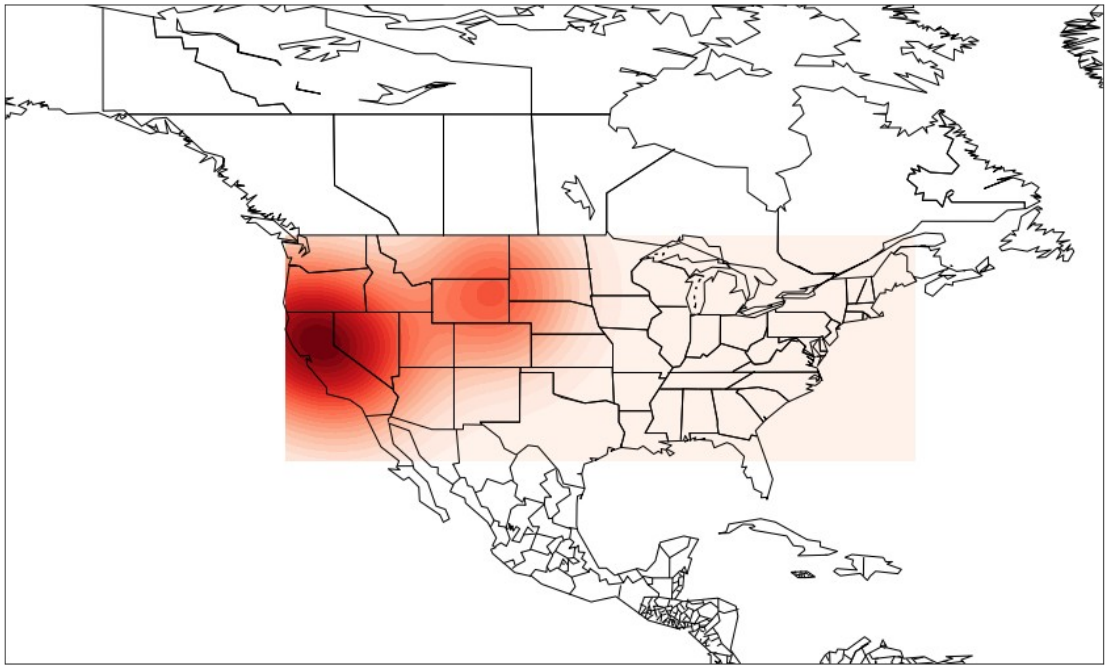
```
(None, None)
```

```
visualizeMap2(Set7),visualizeMap2(Set8)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



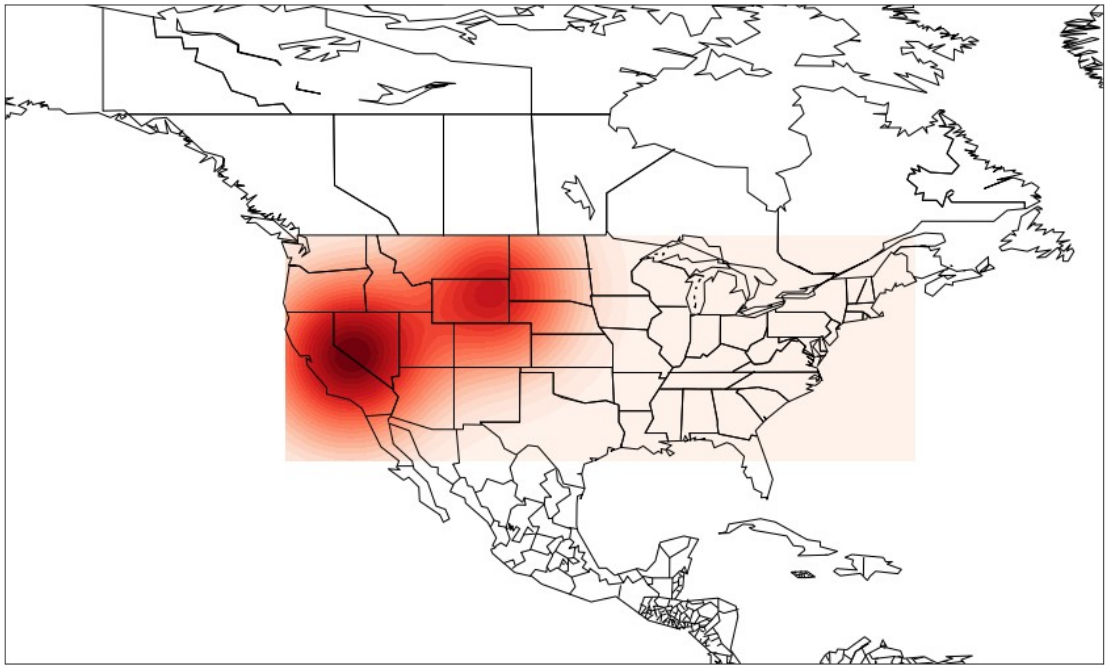
```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



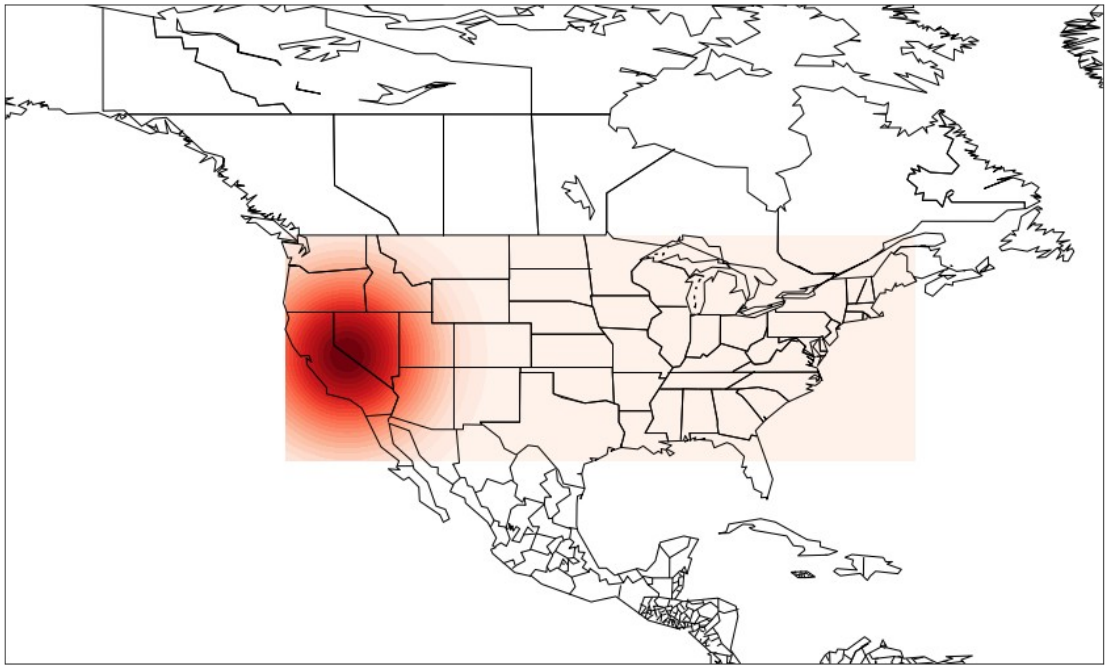
```
(None, None)
```

```
visualizeMap2(Set9),visualizeMap2(Set10)
```

```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



```
C:\Users\saima\AppData\Local\Temp\ipykernel_17300\2750432586.py:25:
FutureWarning: The frame.append method is deprecated and will be
removed from pandas in a future version. Use pandas.concat instead.
  clusters_df = clusters_df.append(n_cluster)
```



```
(None, None)
```