Exploration of 2013 Storm Events

Table of Contents

Introduction

The data file contains a list of weather events that occurred in the United States in 2013. The events have been categorized by type and the state in which they occurred. There is also information about

- damage costs
- number of resulting injuries
- location of some of the events

```
StormEvents2013 = importStormEvents("StormEvents_2013.csv");

% Reorder months
month = ["January","February","March","April","May","June","July","August","September","October
StormEvents2013.Month = reordercats(StormEvents2013.Month,month)
```

```
StormEvents2013 = 59985×18 table
```

...

	State	Month	Event_Type	Begin_Date_Time	Timezone	End_Date_Time
1	NEW HAM...	February	Winter Weather	02/23/2013 1...	EST-5	02/25/2013 ...
2	NEW HAM...	December	Heavy Snow	12/14/2013 2...	EST-5	12/15/2013 ...
3	NEW HAM...	March	Heavy Snow	03/07/2013 1...	EST-5	03/09/2013 ...
4	NEW HAM...	October	Strong Wind	10/07/2013 1...	EST-5	10/07/2013 ...
5	NEW HAM...	February	Heavy Snow	02/08/2013 1...	EST-5	02/09/2013 ...
6	NEW HAM...	March	Heavy Snow	03/18/2013 2...	EST-5	03/19/2013 ...
7	NEW HAM...	November	High Wind	11/24/2013 1...	EST-5	11/24/2013 ...
8	NEW HAM...	December	Heavy Snow	12/17/2013 1...	EST-5	12/18/2013 ...
9	NEW HAM...	January	High Wind	01/31/2013 0...	EST-5	01/31/2013 ...
10	NEW HAM...	January	Strong Wind	01/20/2013 1...	EST-5	01/20/2013 ...
11	NEW HAM...	February	Blizzard	02/08/2013 2...	EST-5	02/09/2013 ...
12	MISSOURI	June	Hail	06/14/2013 1...	CST-6	06/14/2013 ...
13	KANSAS	June	Flood	06/15/2013 1...	CST-6	06/15/2013 ...
14	KANSAS	June	Thunderstorm...	06/15/2013 1...	CST-6	06/15/2013 ...

	State	Month	Event_Type	Begin_Date_Time	Timezone	End_Date_Time
15	KANSAS	June	Thunderstorm...	06/15/2013 1...	CST-6	06/15/2013 ...
16	KANSAS	June	Thunderstorm...	06/15/2013 1...	CST-6	06/15/2013 ...
17	KANSAS	June	Thunderstorm...	06/15/2013 1...	CST-6	06/15/2013 ...
18	KANSAS	June	Thunderstorm...	06/15/2013 1...	CST-6	06/15/2013 ...
19	TEXAS	June	Drought	06/01/2013 0...	CST-6	06/30/2013 ...
20	TEXAS	June	Drought	06/01/2013 0...	CST-6	06/30/2013 ...
21	HAWAII	March	High Surf	03/21/2013 0...	HST-10	03/22/2013 ...
22	HAWAII	March	High Surf	03/21/2013 0...	HST-10	03/22/2013 ...
23	HAWAII	March	High Surf	03/21/2013 0...	HST-10	03/22/2013 ...
24	COLORADO	November	Winter Storm	11/20/2013 1...	MST-7	11/25/2013 ...
25	COLORADO	November	Heavy Snow	11/20/2013 1...	MST-7	11/24/2013 ...
26	TEXAS	May	Drought	05/01/2013 0...	CST-6	05/31/2013 ...
27	KANSAS	June	Hail	06/16/2013 1...	CST-6	06/16/2013 ...
28	ILLINOIS	April	Flood	04/19/2013 0...	CST-6	04/30/2013 ...
29	ILLINOIS	April	Flood	04/16/2013 0...	CST-6	04/30/2013 ...
30	ILLINOIS	April	Flood	04/19/2013 0...	CST-6	04/30/2013 ...
31	ILLINOIS	April	Flood	04/19/2013 0...	CST-6	04/30/2013 ...
32	MONTANA	May	High Wind	05/23/2013 1...	MST-7	05/23/2013 ...
33	TENNESSEE	May	Thunderstorm...	05/21/2013 1...	EST-5	05/21/2013 ...
34	TENNESSEE	May	Thunderstorm...	05/21/2013 1...	EST-5	05/21/2013 ...
35	TENNESSEE	May	Thunderstorm...	05/21/2013 1...	EST-5	05/21/2013 ...
36	TENNESSEE	May	Thunderstorm...	05/21/2013 1...	EST-5	05/21/2013 ...
37	TENNESSEE	May	Hail	05/21/2013 1...	EST-5	05/21/2013 ...
38	TENNESSEE	May	Hail	05/21/2013 1...	EST-5	05/21/2013 ...
39	MICHIGAN	May	Hail	05/30/2013 1...	EST-5	05/30/2013 ...
40	MICHIGAN	May	Hail	05/30/2013 1...	EST-5	05/30/2013 ...
41	MICHIGAN	May	Hail	05/30/2013 1...	EST-5	05/30/2013 ...
42	MICHIGAN	May	Hail	05/30/2013 1...	EST-5	05/30/2013 ...
43	WYOMING	May	High Wind	05/30/2013 1...	MST-7	05/31/2013 ...
44	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...
45	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...
46	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...
47	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...
48	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...

	State	Month	Event_Type	Begin_Date_Time	Timezone	End_Date_Time
49	TEXAS	May	Drought	05/01/2013 0...	CST-6	05/31/2013 ...
50	MARYLAND	May	Flash Flood	05/23/2013 1...	EST-5	05/23/2013 ...
51	MARYLAND	May	Flash Flood	05/23/2013 1...	EST-5	05/23/2013 ...
52	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
53	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
54	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
55	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
56	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
57	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
58	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
59	MARYLAND	June	Tornado	06/13/2013 1...	EST-5	06/13/2013 ...
60	VIRGINIA	June	Flash Flood	06/18/2013 1...	EST-5	06/18/2013 ...
61	VIRGINIA	June	Flash Flood	06/18/2013 2...	EST-5	06/18/2013 ...
62	VIRGINIA	June	Flash Flood	06/17/2013 2...	EST-5	06/17/2013 ...
63	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
64	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
65	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
66	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
67	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
68	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
69	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
70	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
71	MICHIGAN	May	Thunderstorm...	05/30/2013 1...	EST-5	05/30/2013 ...
72	MONTANA	May	Hail	05/25/2013 1...	MST-7	05/25/2013 ...
73	MONTANA	May	Hail	05/25/2013 2...	MST-7	05/25/2013 ...
74	IOWA	May	Winter Weather	05/01/2013 1...	CST-6	05/02/2013 ...
75	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
76	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
77	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
78	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
79	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
80	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
81	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
82	VIRGINIA	August	Dense Fog	08/12/2013 0...	EST-5	08/12/2013 ...

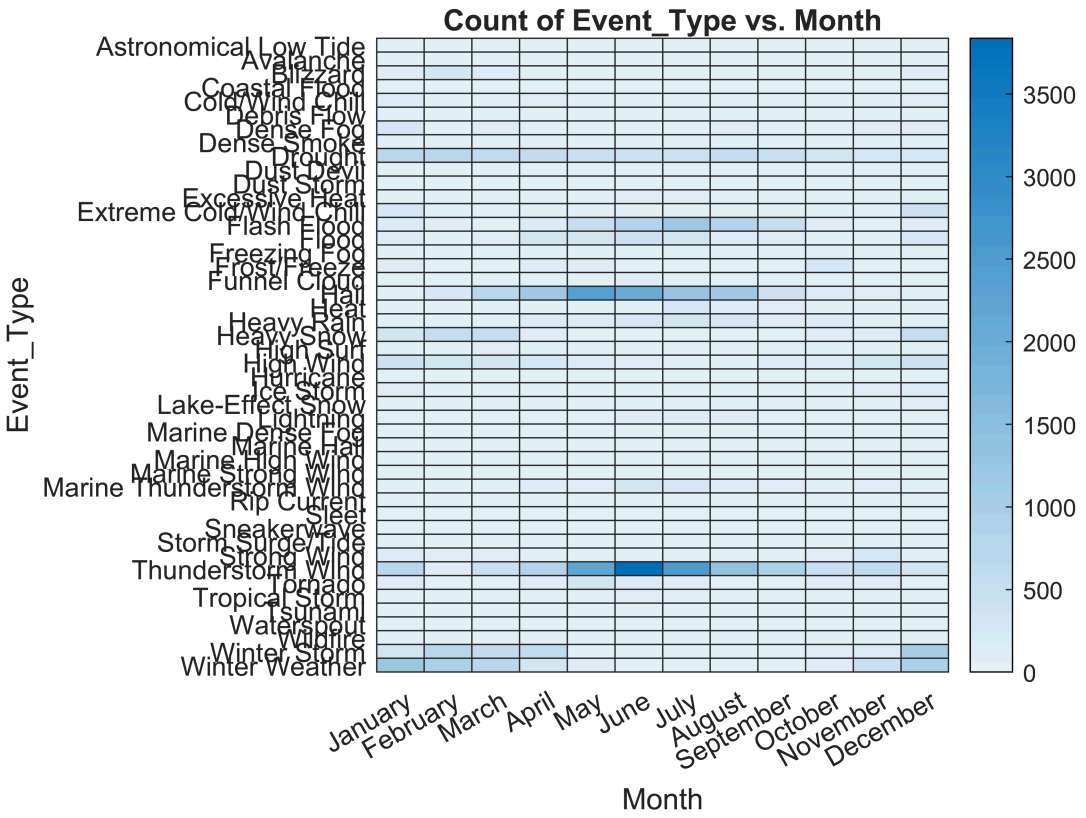
	State	Month	Event_Type	Begin_Date_Time	Timezone	End_Date_Time
83	VIRGINIA	August	Dense Fog	08/12/2013 0...	EST-5	08/12/2013 ...
84	VIRGINIA	August	Dense Fog	08/12/2013 0...	EST-5	08/12/2013 ...
85	VIRGINIA	August	Dense Fog	08/12/2013 0...	EST-5	08/12/2013 ...
86	VIRGINIA	August	Dense Fog	08/12/2013 0...	EST-5	08/12/2013 ...
87	VIRGINIA	August	Dense Fog	08/11/2013 2...	EST-5	08/12/2013 ...
88	TENNESSEE	May	Thunderstorm...	05/22/2013 1...	EST-5	05/22/2013 ...
89	VIRGINIA	May	Thunderstorm...	05/22/2013 1...	EST-5	05/22/2013 ...
90	NEBRASKA	May	Hail	05/18/2013 2...	CST-6	05/18/2013 ...
91	KANSAS	May	Thunderstorm...	05/08/2013 1...	CST-6	05/08/2013 ...
92	KANSAS	May	Thunderstorm...	05/08/2013 1...	CST-6	05/08/2013 ...
93	KANSAS	May	Hail	05/08/2013 1...	CST-6	05/08/2013 ...
94	KANSAS	May	Thunderstorm...	05/08/2013 1...	CST-6	05/08/2013 ...
95	KANSAS	May	Thunderstorm...	05/08/2013 1...	CST-6	05/08/2013 ...
96	KANSAS	May	Hail	05/08/2013 2...	CST-6	05/08/2013 ...
97	KANSAS	May	Hail	05/08/2013 2...	CST-6	05/08/2013 ...
98	LAKE ST...	May	Marine Thund...	05/31/2013 1...	EST-5	05/31/2013 ...
99	LAKE HU...	May	Marine Thund...	05/11/2013 1...	EST-5	05/11/2013 ...
100	MISSOURI	April	Hail	04/10/2013 1...	CST-6	04/10/2013 ...

⋮

Visualize raw data

Create a heat map to look at the frequency of each event type by month.

```
% Count of events by type and month
heatmap(StormEvents2013,"Month","Event_Type");
```

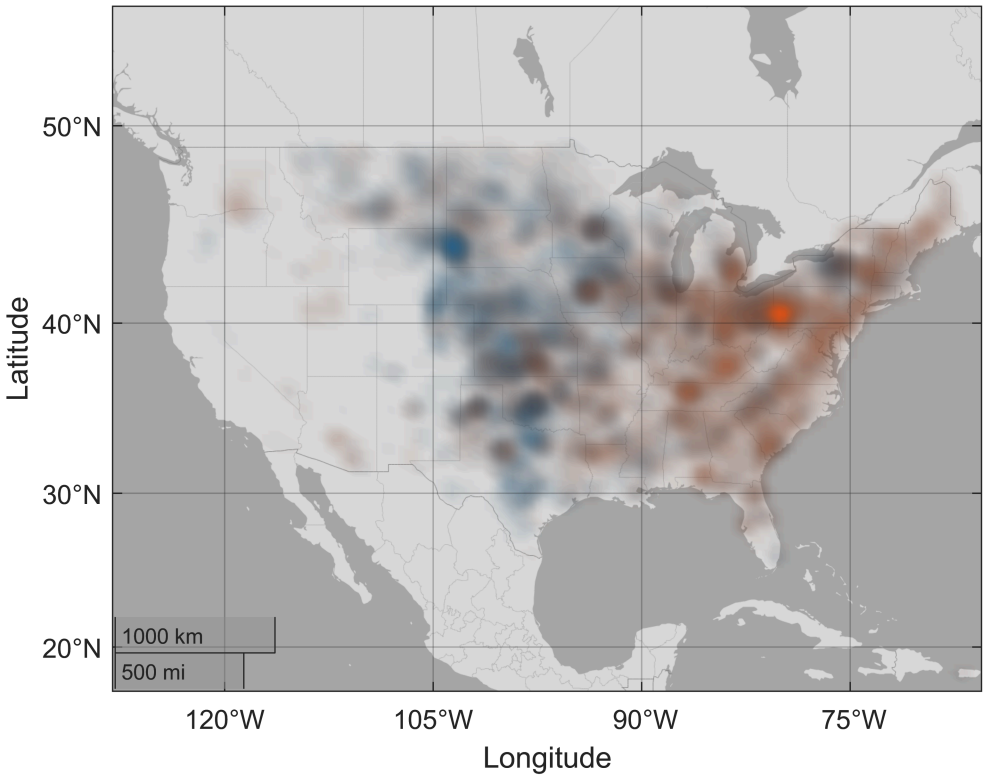


Explore Hail and Thunderstorm Wind

There is a higher occurrence of Hail and Thunderstorm Wind in the summer months. Further analysis will see if there is a relationship between these two events.

```
% Creating a new plot - geodensity
Hind = StormEvents2013.Event_Type=="Hail";
geodensityplot(StormEvents2013.Begin_Lat(Hind),StormEvents2013.Begin_Lon(Hind))
% Just show continental US
geolimits([17.0 55.2],[-128.0 -65.6])

% Add Thunderstorm Wind to see if they are related.
hold on
TWind = StormEvents2013.Event_Type=="Thunderstorm Wind";
geodensityplot(StormEvents2013.Begin_Lat(TWind),StormEvents2013.Begin_Lon(TWind))
hold off
```



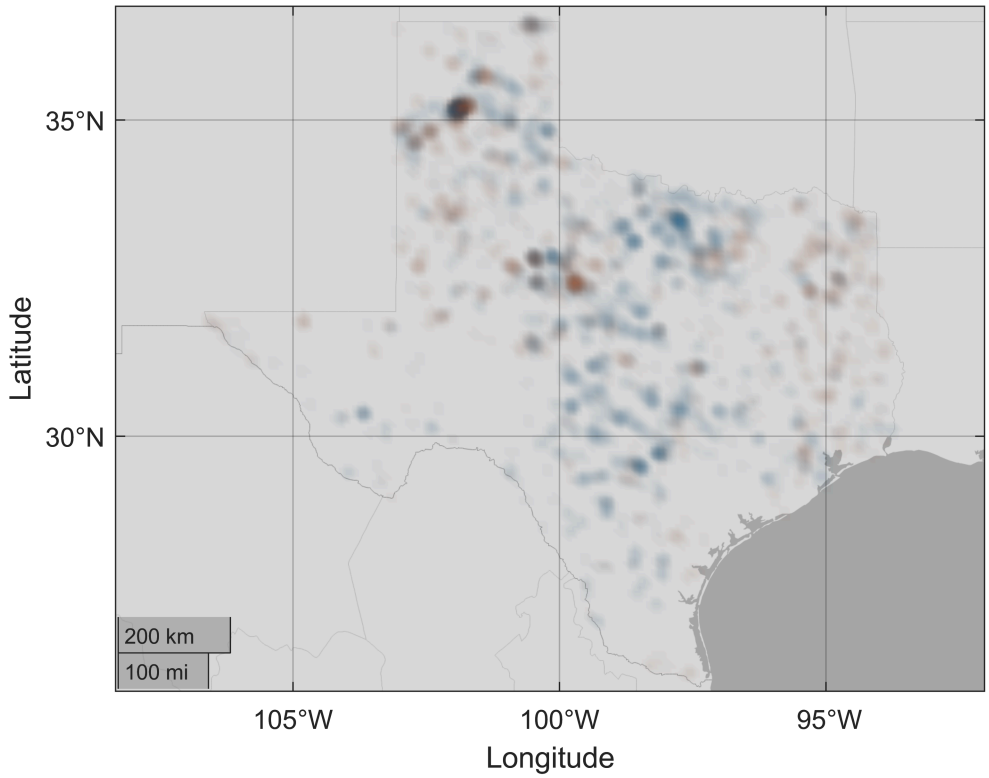
When looking across all states, there does not appear to be a relationship between hail and thunderstorm wind. Hail appears to be concentrated in the central United States while thunderstorm wind is concentrated in the eastern United States. However, there still may be some storms where both events occurred. Looking at events in a single state may show this.

Texas

The geodenisty plot shows some potential overlapping hail and thunderstorm wind events in Texas.

```
% Creating a new plot - geodensity
Hind = StormEvents2013.Event_Type=="Hail" & StormEvents2013.State=="TEXAS";
geodensityplot(StormEvents2013.Begin_Lat(Hind),StormEvents2013.Begin_Lon(Hind))

% Add Thunderstorm Wind to see if they are related.
hold on
TWind = StormEvents2013.Event_Type=="Thunderstorm Wind" & StormEvents2013.State=="TEXAS";
geodensityplot(StormEvents2013.Begin_Lat(TWind),StormEvents2013.Begin_Lon(TWind))
hold off
```



While it appears most of the events are unrelated, some of the events do overlap. The large concentration at the top is near Amarillo, Texas. Looking at that cluster of events may show a relationship.

Amarillo, TX

Both hail and thunderstorm wind events contain latitude and longitude values. Use this to select events that occurred within a specified distance of Amarillo. The coordinates for Amarillo, TX were obtained online.

```
amarilloTX = [35.221996 -101.831299]; % [latitude longitude]
```

Distance from Amarillo can be computed using the Haversine formula:

$$a = \sin^2\left(\frac{\Delta \text{lat}}{2}\right) + \cos(\text{lat}_1) \cdot \cos(\text{lat}_2) \cdot \sin^2\left(\frac{\Delta \text{lon}}{2}\right)$$

$$c = 2 \cdot \text{atan2}(\sqrt{a}, \sqrt{(1-a)})$$

$$d = R \cdot c$$

```
dLat = StormEvents2013.Begin_Lat - amarilloTX(1);
dLon = StormEvents2013.Begin_Lon - amarilloTX(2);

% Haversine formula
R = 6371; % earth's radius, kilometers
a = sind(dLat/2).^2 + cosd(StormEvents2013.Begin_Lat).*cosd(StormEvents2013.End_Lat).*sind(dLor
c = 2*atan2(sqrt(a),sqrt(1-a));

% Add distance to data table
```

```
StormEvents2013.Dist_m = R*c; % kilometers
```

Select all hail and thunderstorm wind events that occurred within 8 km (~5 miles) of Amarillo.

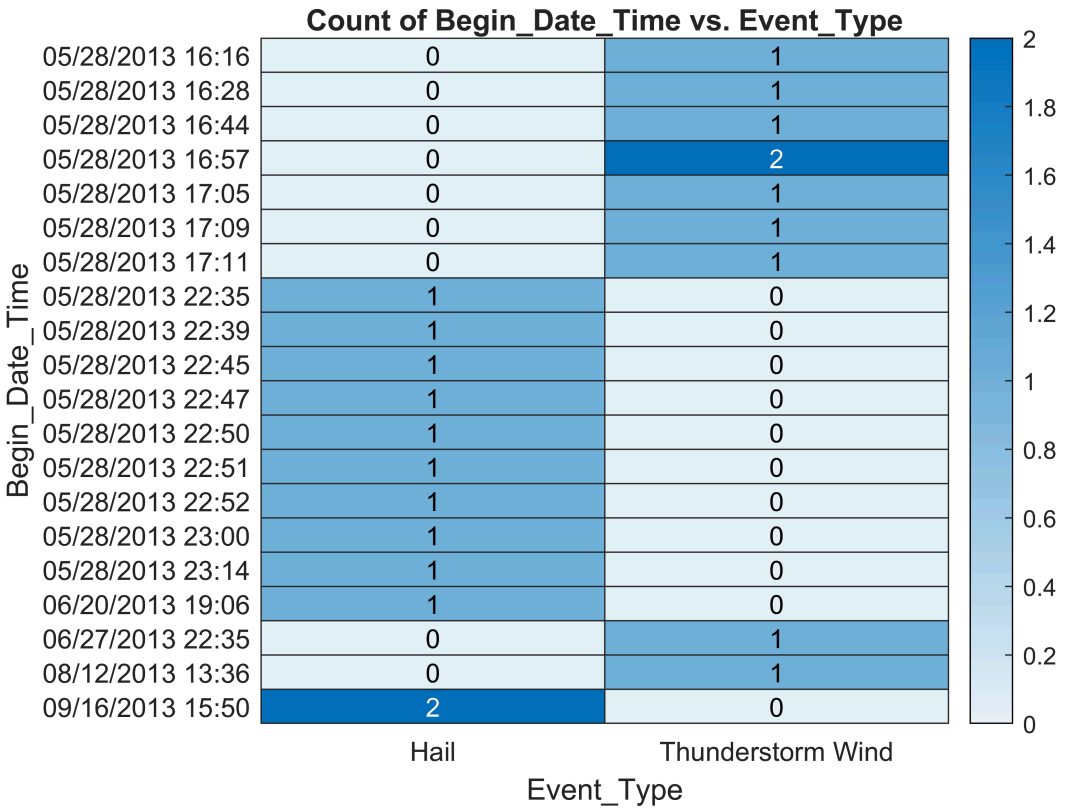
```
dist = 8; % kilometers
amarillo = StormEvents2013((StormEvents2013.Event_Type=="Hail" | ...
    StormEvents2013.Event_Type=="Thunderstorm Wind") & ...
    StormEvents2013.Dist_m < dist,:)
```

amarillo = 22×19 table

...

	State	Month	Event_Type	Begin_Date_Time	Timezone	End_Date_Time
1	TEXAS	June	Thunderstorm...	06/27/2013 2...	CST-6	06/27/2013 ...
2	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
3	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
4	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
5	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
6	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
7	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
8	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
9	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
10	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
11	TEXAS	May	Hail	05/28/2013 2...	CST-6	05/28/2013 ...
12	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
13	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
14	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
15	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
16	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
17	TEXAS	June	Hail	06/20/2013 1...	CST-6	06/20/2013 ...
18	TEXAS	September	Hail	09/16/2013 1...	CST-6	09/16/2013 ...
19	TEXAS	September	Hail	09/16/2013 1...	CST-6	09/16/2013 ...
20	TEXAS	August	Thunderstorm...	08/12/2013 1...	CST-6	08/12/2013 ...
21	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...
22	TEXAS	May	Thunderstorm...	05/28/2013 1...	CST-6	05/28/2013 ...

```
amarillo.Event_Type = removecats(amarillo.Event_Type); % remove empty categories
heatmap(amarillo,"Event_Type","Begin_Date_Time");
```



So far, the analysis has only used location to identify a potential relationship between hail and thunderstorm wind events. However, the events must also occur around the same time to be related. Since the number of events has been reduced by the filtering, the simplest way of visualizing location and date is with a heatmap of event type and date.

Conclusion

The main contributing factor in the formation of hail is wind. It would therefore be reasonable to expect some relationship between hail and thunderstorm wind events. This preliminary investigation into these two events would suggest that, at least in this data set, there is not a strong relationship.

A comparison of the events by concentration shows most hail events occur in the central United States while most thunderstorm wind events occur in the east. There are exceptions, but it is necessary to look at individual storms to identify potential relationships.

One such storm was found to hit the Amarillo, Texas area on May 28, 2013. Eight thunderstorm wind events were recorded between 16:16 and 17:11. Then starting at 22:35, nine hail events were recorded, with the last one starting at 23:14.

Additional work is necessary to determine if the thunderstorm wind events did in fact contribute to the hail events.