Storm Events

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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.

```
clc
clear
StormEvents2013 = importfile("StormEvents_2013.csv");
```

Reorder months

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

StormEvents2013 = 59985×23 table

...

	EpisodeID	Event_ID	State	Year	Month	Event_Type	Begin_Date_Time
1	71313	436163	NEW HAM...	2013	February	Winter Weather	2013-02-23 19:00...
2	81847	491388	NEW HAM...	2013	December	Heavy Snow	2013-12-14 21:00...
3	72356	440167	NEW HAM...	2013	March	Heavy Snow	2013-03-07 15:00...
4	78671	473492	NEW HAM...	2013	October	Strong Wind	2013-10-07 18:30...
5	71943	435880	NEW HAM...	2013	February	Heavy Snow	2013-02-08 15:00...
6	72349	437735	NEW HAM...	2013	March	Heavy Snow	2013-03-18 22:00...
7	80774	483506	NEW HAM...	2013	November	High Wind	2013-11-24 14:45...
8	81770	490913	NEW HAM...	2013	December	Heavy Snow	2013-12-17 14:00...
9	71198	427840	NEW HAM...	2013	January	High Wind	2013-01-31 08:00...

	EpisodeID	Event_ID	State	Year	Month	Event_Type	Begin_Date_Time
10	70071	420683	NEW HAM...	2013	January	Strong Wind	2013-01-20 15:00...
11	71943	435820	NEW HAM...	2013	February	Blizzard	2013-02-08 21:00...
12	75072	453900	MISSOURI	2013	June	Hail	2013-06-14 12:46...
13	75073	453904	KANSAS	2013	June	Flood	2013-06-15 14:50...
14	75073	453907	KANSAS	2013	June	Thunderstorm Wind	2013-06-15 14:50...

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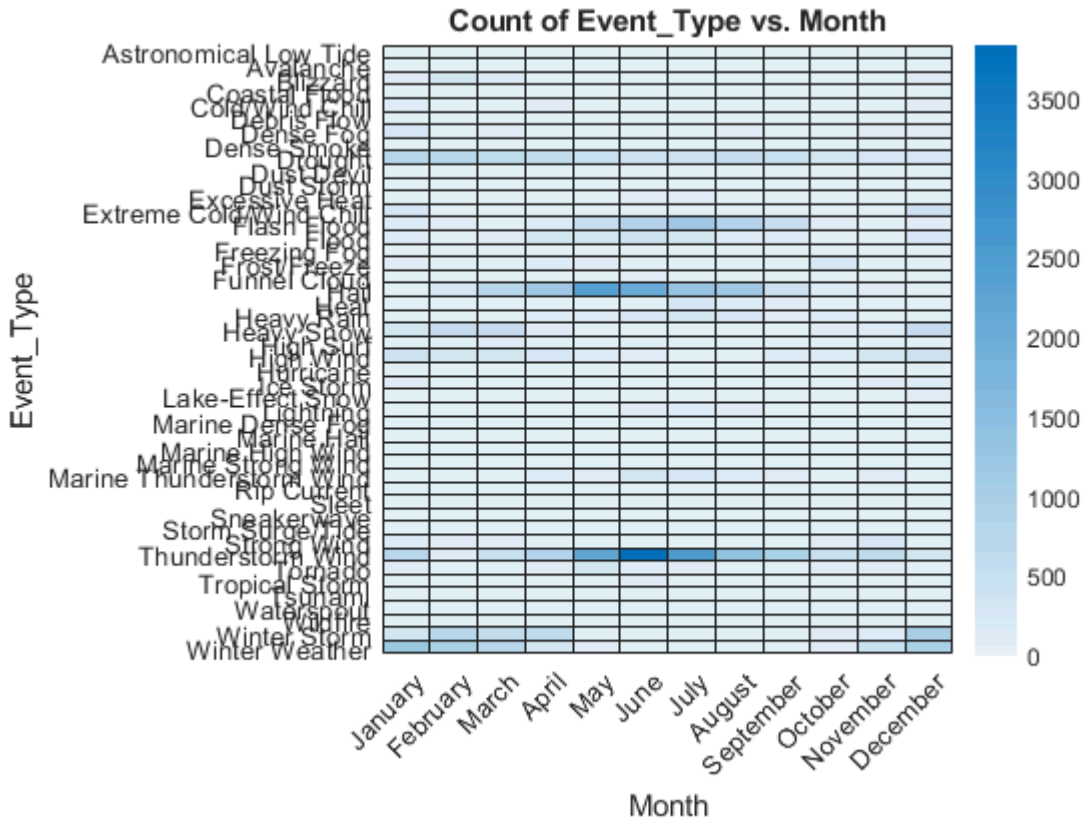
Visualize raw data

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

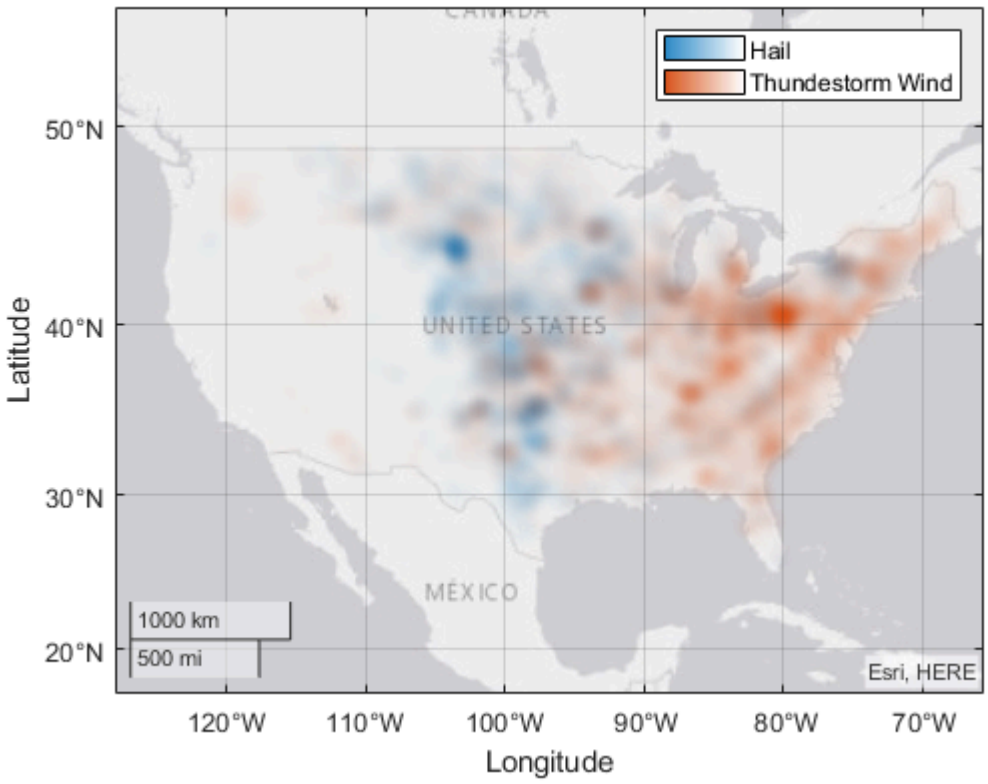
```
Hind = StormEvents2013.Event_Type=="Hail";
geodensityplot(StormEvents2013.Begin_Lat(Hind),StormEvents2013.Begin_Lon(Hind))
```

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))
legend('Hail','Thundestorm Wind')
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

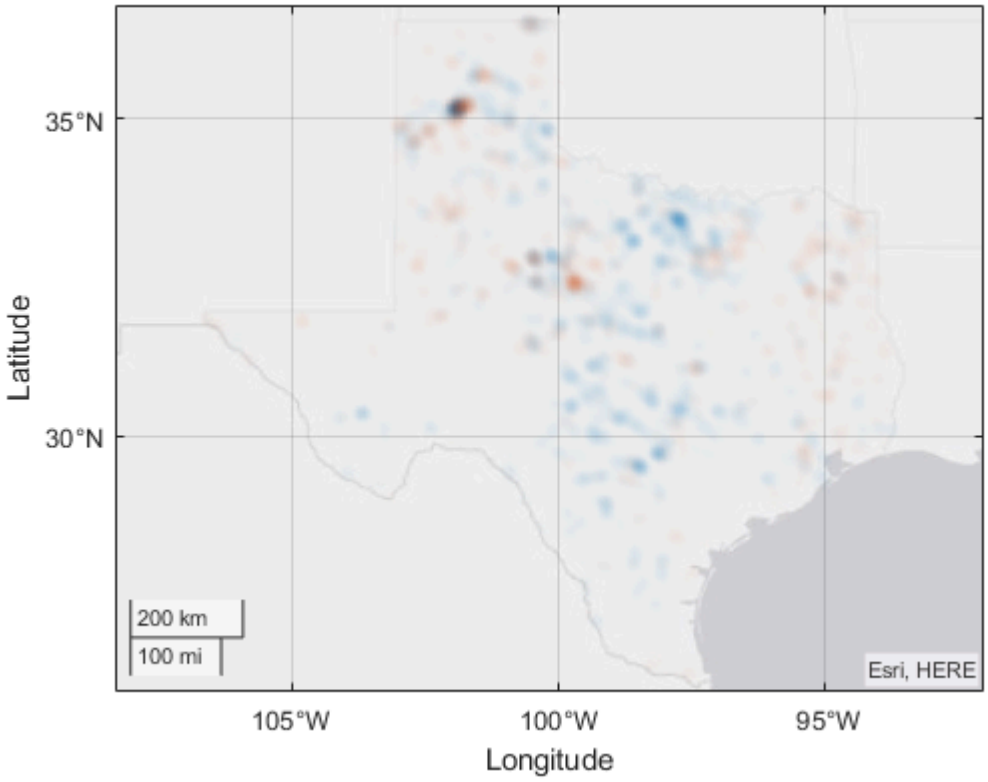
The geodenisty plot shows some potential overlapping hail and thunderstorm wind events in Texas.

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]
```

```
Lat=35.221996;
Lon=-101.831299;
```

Distance from Amarillo can be computed using the Haversine formula:

https://www.movable-type.co.uk/scripts/latlong.html

$$a = sin^2((lat1 - lat2)/2) + cos(lat1) * cos(lat2) * sin^2((lon1 - lon2)/2)$$

$$c = 2 * atan2(a^0.5, (1 - a)^0.5)$$

$$d = R * c$$

```
dLat = StormEvents2013.Begin_Lat - Lat;
dLon = StormEvents2013.Begin_Lon - Lon;
```

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, TX.

```
%dist = 8; % kilometers
dist=30
```

```
dist = 30
```

```
events = StormEvents2013((StormEvents2013.Event_Type=="Hail" | ...
    StormEvents2013.Event_Type=="Thunderstorm Wind") & ...
    StormEvents2013.Dist_m < dist,:)
```

```
events = 97×24 table
```

...

	EpisodeID	Event_ID	State	Year	Month	Event_Type	Begin_Date_Time
1	75341	455105	TEXAS	2013	May	Thunderstorm Wind	2013-05-21 07:05...
2	75341	455107	TEXAS	2013	May	Thunderstorm Wind	2013-05-21 07:02...
3	76571	462427	TEXAS	2013	June	Hail	2013-06-08 23:45...
4	76846	464013	TEXAS	2013	June	Thunderstorm Wind	2013-06-16 23:50...

	EpisodeID	Event_ID	State	Year	Month	Event_Type	Begin_Date_Time
5	76846	464015	TEXAS	2013	June	Thunderstorm Wind	2013-06-16 23:44...
6	76846	464036	TEXAS	2013	June	Thunderstorm Wind	2013-06-16 23:44...
7	76571	462400	TEXAS	2013	June	Hail	2013-06-08 20:38...
8	76846	464054	TEXAS	2013	June	Thunderstorm Wind	2013-06-16 23:44...
9	77084	465481	TEXAS	2013	June	Thunderstorm Wind	2013-06-27 22:35...
10	77084	465482	TEXAS	2013	June	Thunderstorm Wind	2013-06-27 23:08...
11	77084	465483	TEXAS	2013	June	Thunderstorm Wind	2013-06-27 23:15...
12	77084	465485	TEXAS	2013	June	Thunderstorm Wind	2013-06-27 23:19...
13	76571	462424	TEXAS	2013	June	Hail	2013-06-08 23:30...
14	77540	467843	TEXAS	2013	July	Hail	2013-07-24 19:16...

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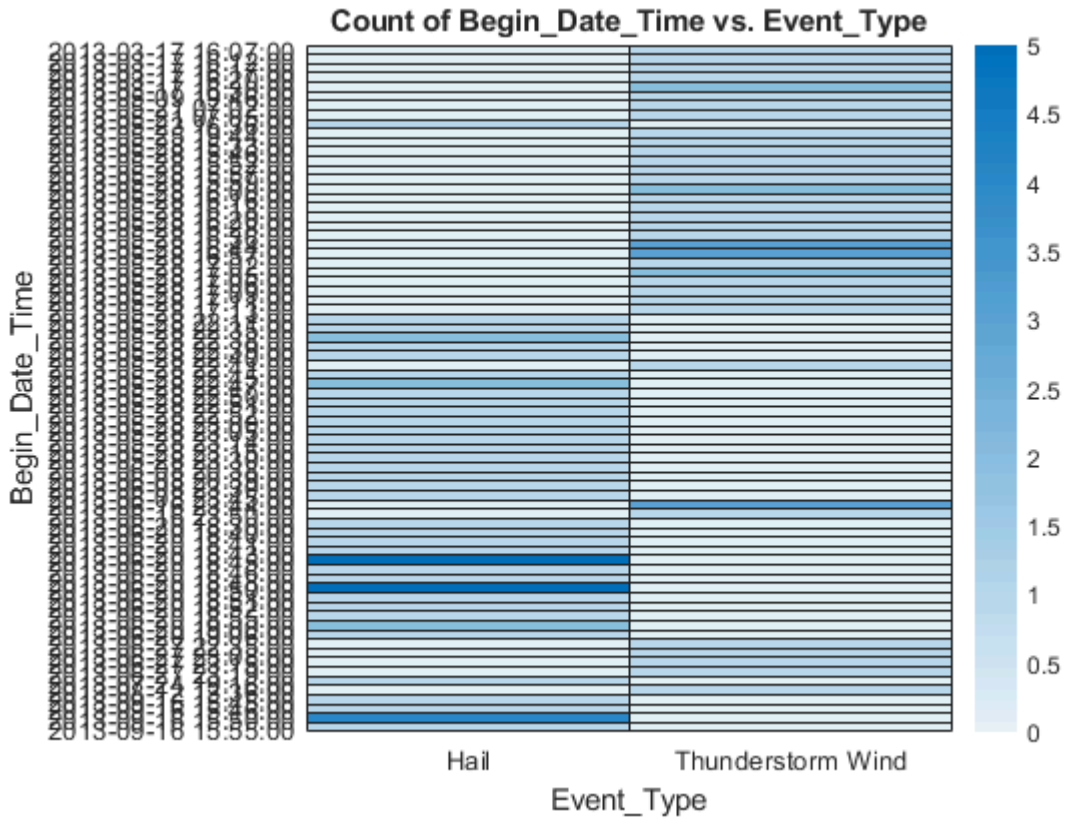
```
events.Event_Type = removecats(events.Event_Type); % remove empty categories
heatmap(events,"Event_Type","Begin_Date_Time");
```



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.Qwerty