Investigation of Floods (EDAV Proj.2)

Team - Awesome

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Project Description

In this project, we will analysis the global floods records from 1985 to 2008. Specifically, we will invesitgate the floods patterns over time, floods distribution across continent, causes of floods and relation between floods and air pressure.

Floods Patterns Over Time

First, to have a basic idea about world floods records, we show historical floods in a world map.

Generally speaking, there is no apparent geographical pattern about happened floods in this static map. So we built a dynamic map based on the time when floods began. We want to find out when and where floods happened frequently.

The dynamic map is available here.

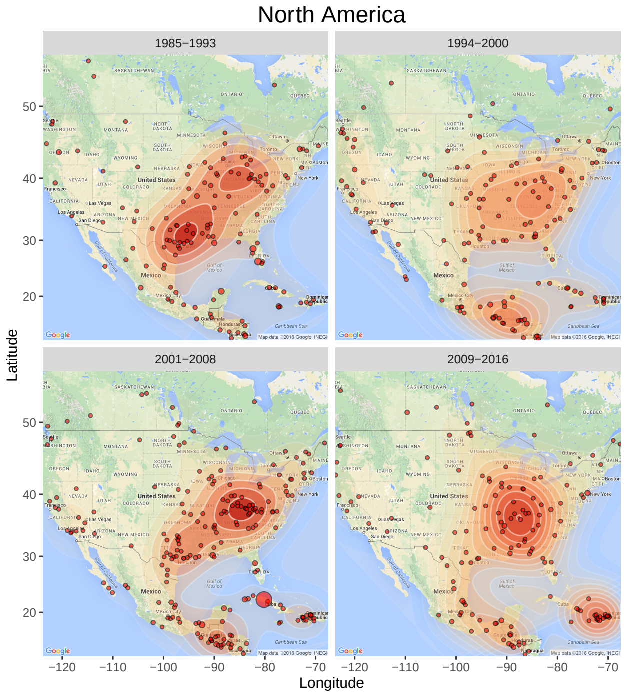
From this dynamic map, it seems like that a time pattern exists, which means that the number of floods varied in different time periods. We are curious about this, and we believe that there must be a facotr or some factors influencing the number of floods. So we have the following analysis.

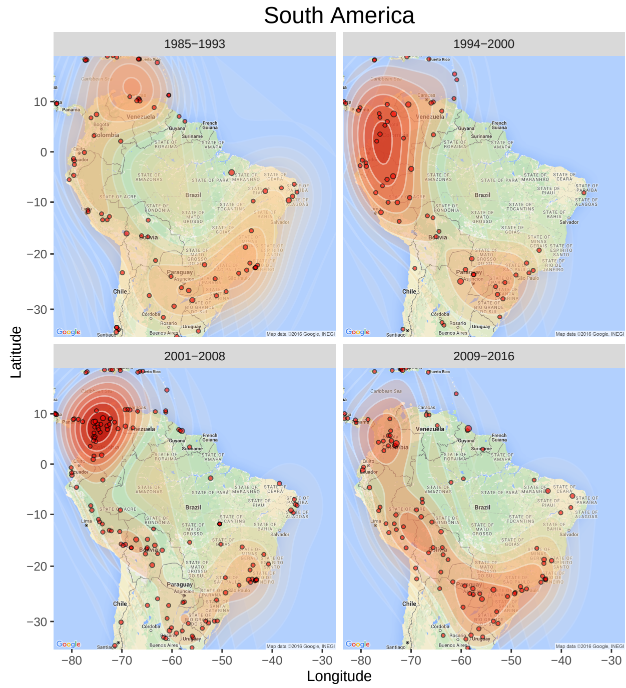
Floods by Continent

As a next step in the analysis, we look at the distribution of floods across the different continents throughout time. The goal is to identify possible patterns, and address questions such as:

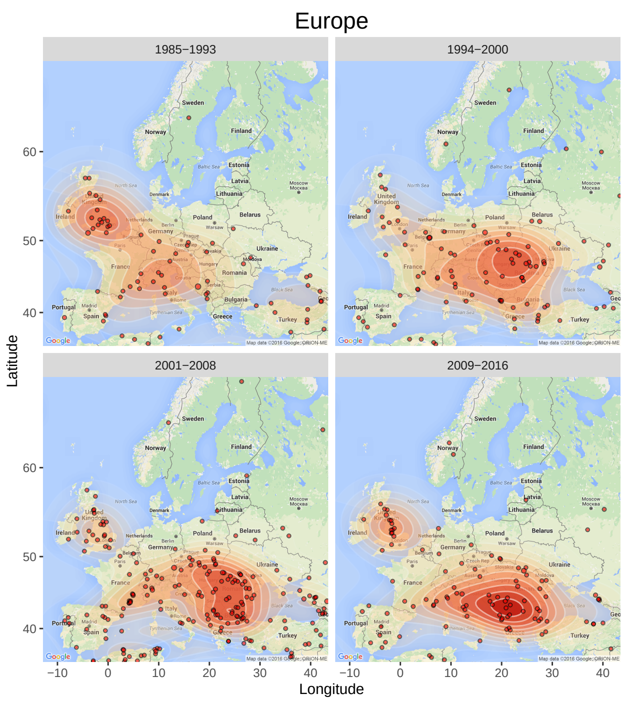
- Have floods concentrated on particular continents during specific periods?
- For any given continent, have there been more disastrous times in terms of floods and displacement?
- Within continents, which regions are more susceptible to disasters caused by floods?

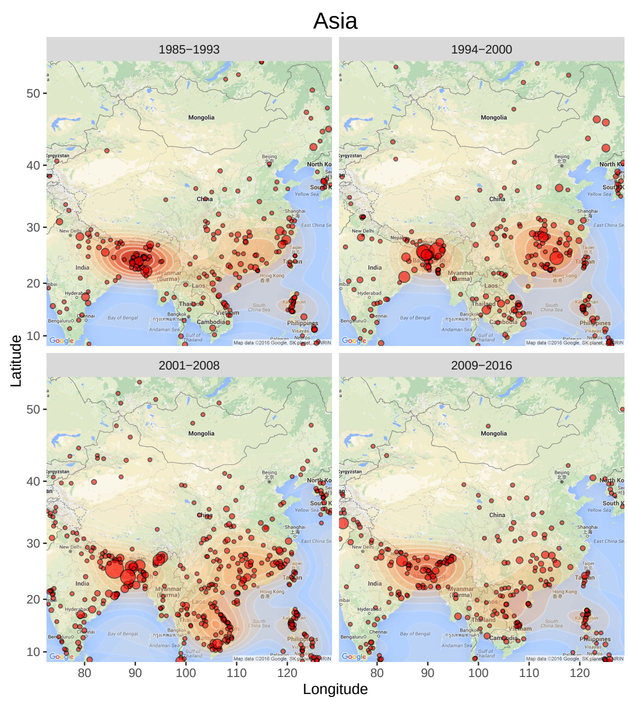
To do this, we will divide the data into 4 roughly equally sized time periods: 1985-1993, 1994-2000, 2001-2008, 2009-2016. We will then produce plots for each continent during these periods, highlighting the flood events that occurred with their size indicating their total impact as measured on a scale that depends on displacement. A contour plot will also help us identify where clusters of these events occurred.





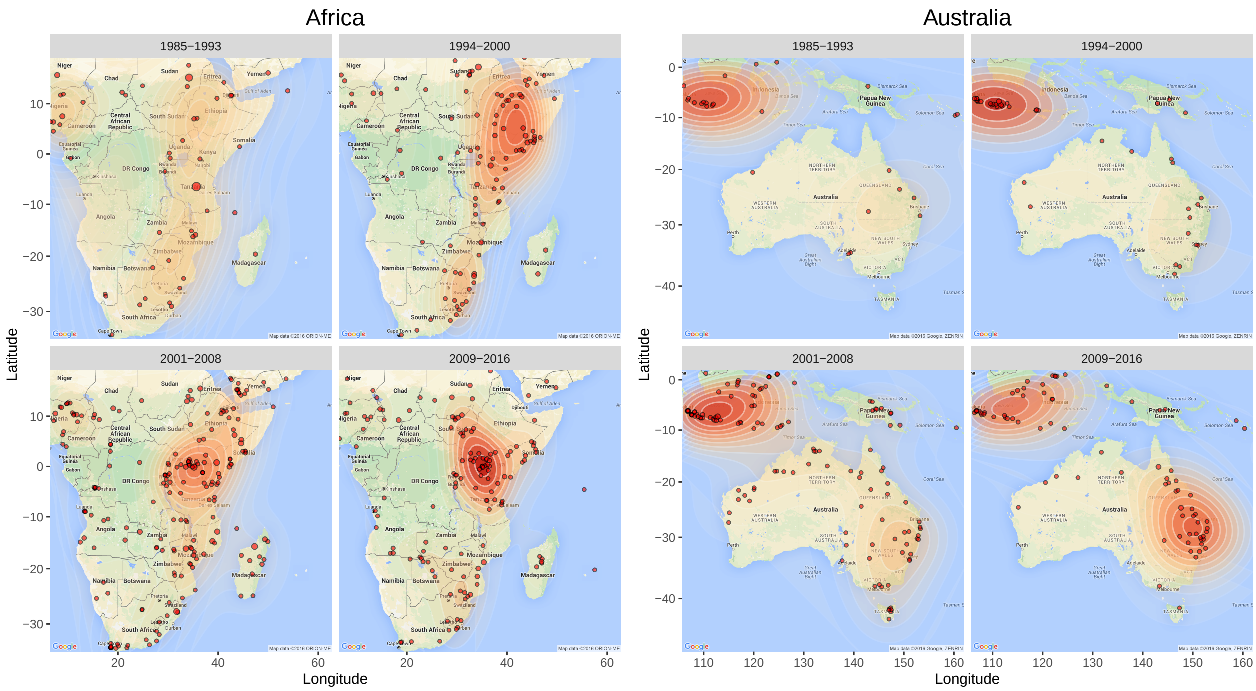
Interestingly on North America the majority of the events are concentrated on the east coast, while South America shows the opposite pattern. Some regions that are constantly affected by floods are the U.S. Mid-West, the Yucatan Peninsula, and the region that encompasses Colombia and Ecuador. Cuba, being an island, is also highly susceptible to these kind of natural disasters, with a large-displacement event occurring on during the 2000's.





Turning to Europe, we notice that starting on the 1900's the Balkan Peninsula became constantly impacted by flood disasters. The United Kingdom, due to its geographical position, is also exposed to a greater number of floods, although it had a relatively stable period throughout the second half of the 90's. We notice that displacement is generally low on this continent.

The story on Asia is considerably different to what we have seen so far: floods are a frequent phenomena on the east coast of India, with China and the South-East region being constantly affected as well. Displacement tends to be generally higher, which could be explained both by the frequency of the events and by the civil planning required to handle them, although more investigation is required on the latest.



Moving now to Africa, we see again the pattern of more floods occurring on the western coast. Displacement does not seems to be so prevalent, although this could be due to more inefficient bookkeeping? We also identify Kenya and Tanzania as 2 regions that are particularly prone to these disasters.

Finally looking at Australia we notice that, although it is a continent with a large surface of contact with water, floods are not so prevalent. The clusters we observe correspond to the neighboring Indonesia and Malaysia, which are particularly succeptible.

Distribution by main cause / death : top floods causes , different from cause of deaths

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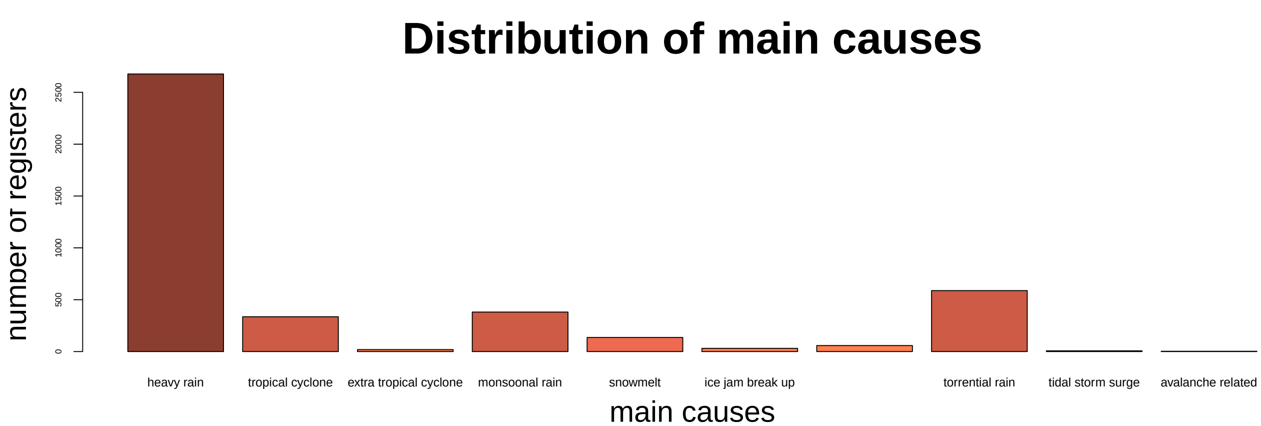
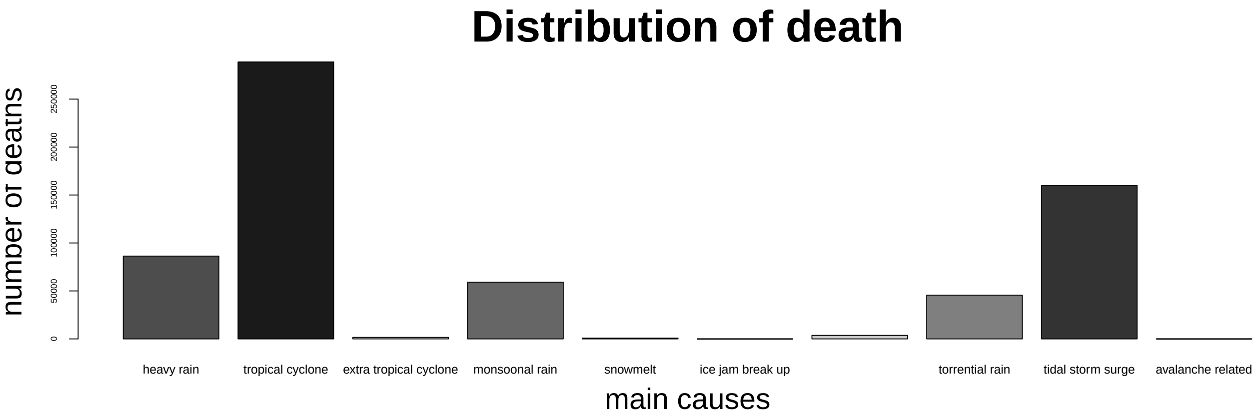


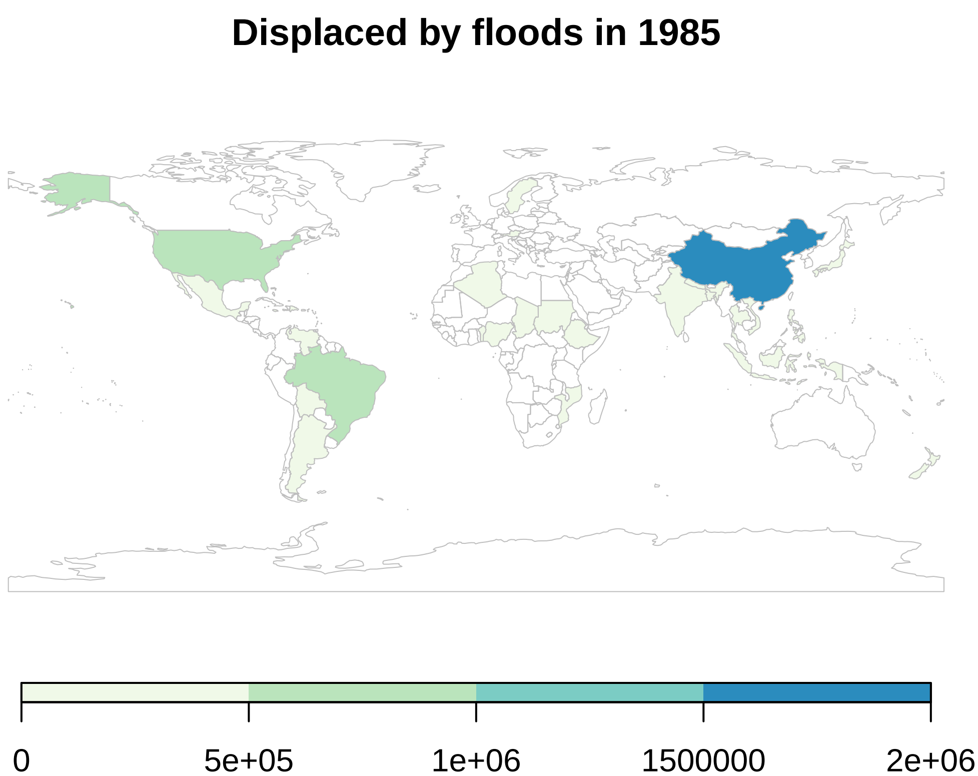
Next, we did some analysis of main causes and death. From the distribution of main causes, we found "heavy rain" is the primary main cause of floods, over 2500 registers of floods are caused by heavy rain, which is much higher than any other causes.



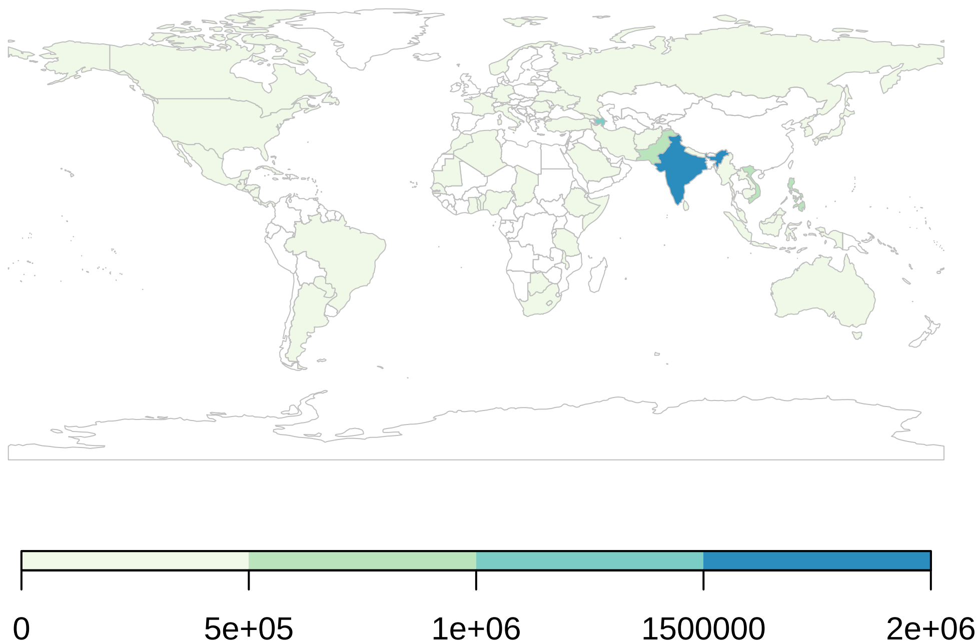
However, although "tropical cyclone" and "tidal storm surge" have only around 500 registers, respectively, they were the main causes of death. After ordering the top 10 registers which have the most number of death, 5 of the top 10 registers are caused by these two natural disasters. Compared to the death caused by "heavy rain", less than 100000 people died in floods caused by "heavy rain", although it's the primary main cause of floods.

Displacement

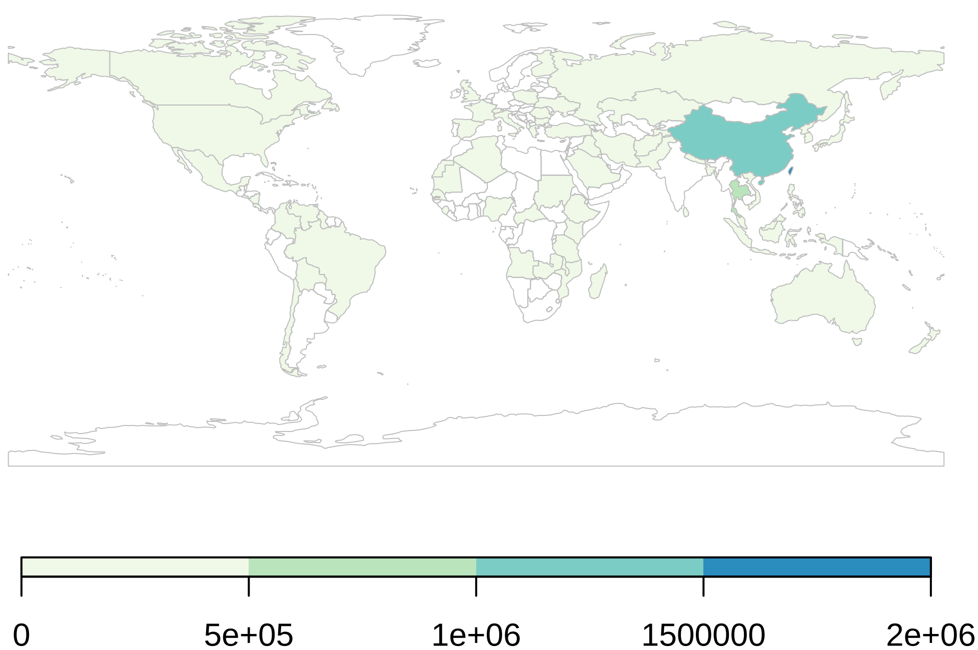
We also wanted to look at how floods affect displacement globally. We are using subset data of countries and respective number of people displaced. In order to get a broad understanding of displacement over time, the graphs have been generated for every 10 years i.e. the number of people displaced has been mapped for the years 1985, 1995, 2005 amd 2015.

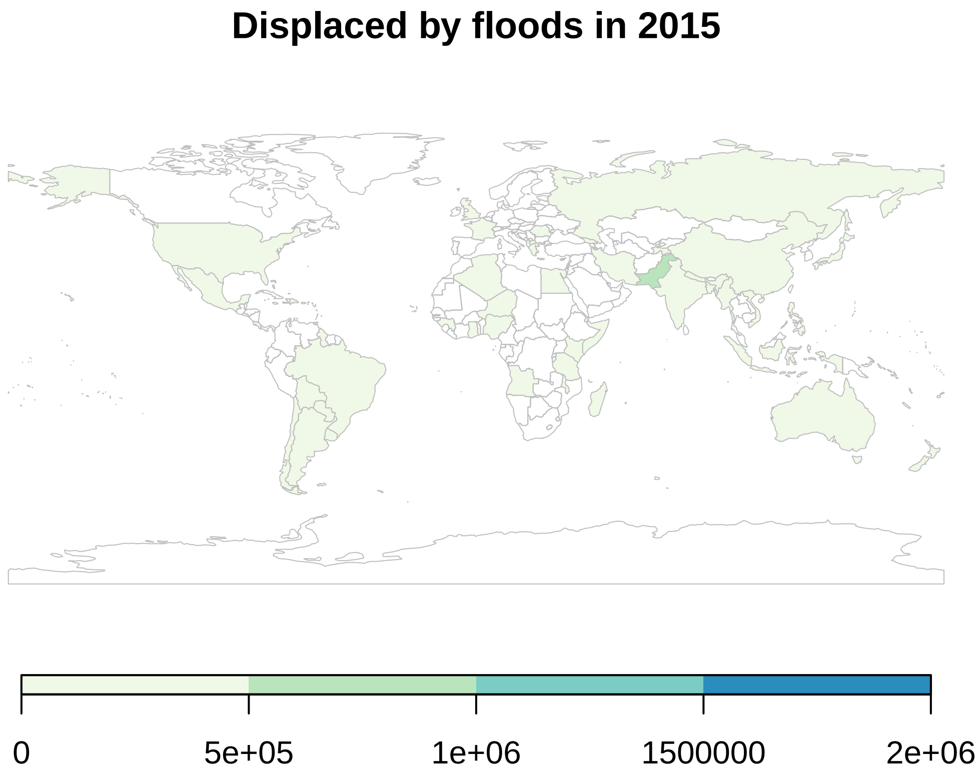


Displaced by floods in 1995



Displaced by floods in 2005

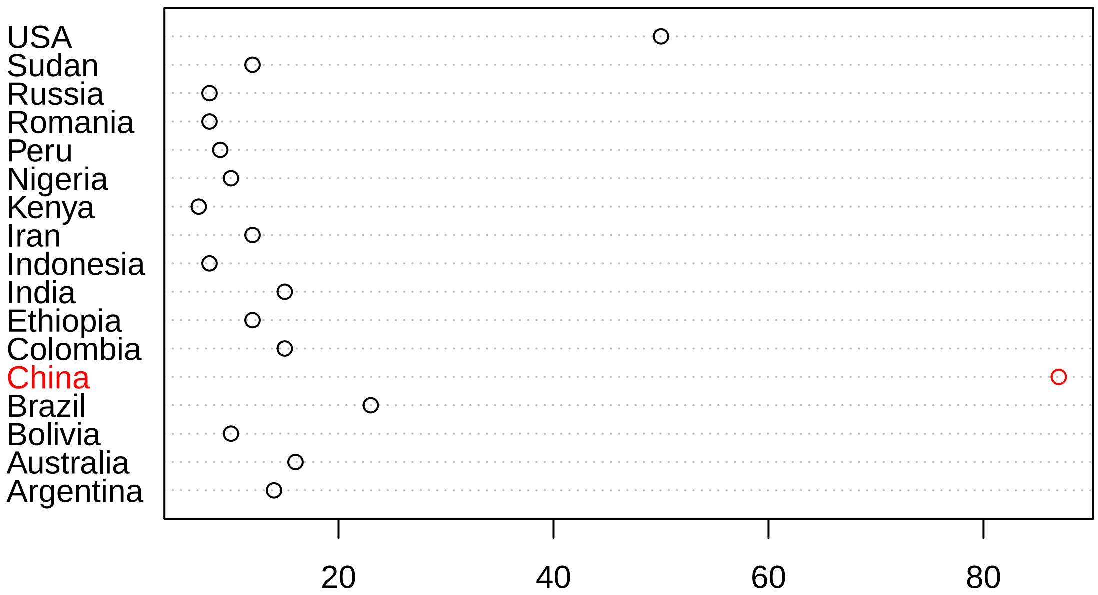




From the plots above, we find: + Several regions in African continent have minimal displacement. This may be sttributed to no floods in those regions. This is supported by the finding that the African countries where people got displaced match the countries that had floods. However, it can't be ruled out that lack of record keeping may be a possible reason.
+ Asia has significant displacement. One of the factors is potentially the highest population density in Asia.

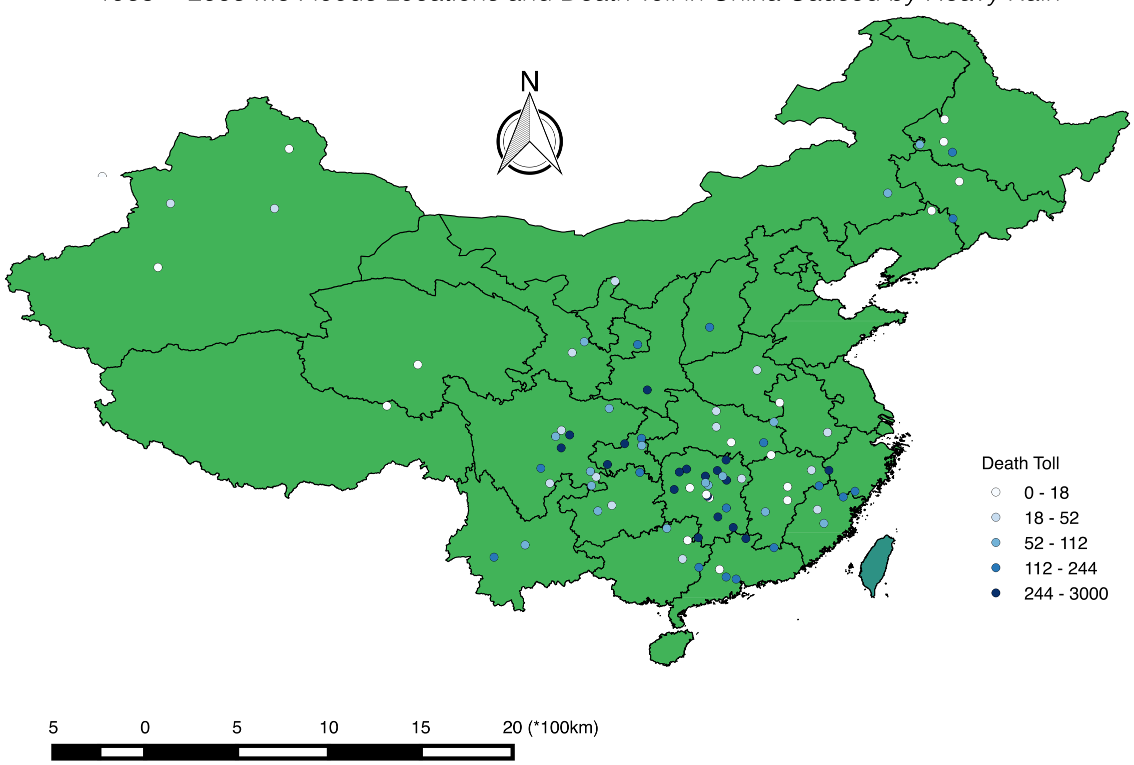
M6 Floods Caused by Heavy Rain

From previous analysis, we found that heavy rain is the reason which caused the largest number of floods. Here, we researched on the floods caused by heavy rain that had a level of M6. We count the occurence of M6 level floods at each countries from 1985 to 2008. The countries with the largest 20 occurence are displayed in the following dotchart. From the plot, we can see that in the time period 1985 to 2008 China and USA have much more M6 floods than other countries. We then analysised the M6 floods in China.



plot (1) number of M6 floods 1985~2008

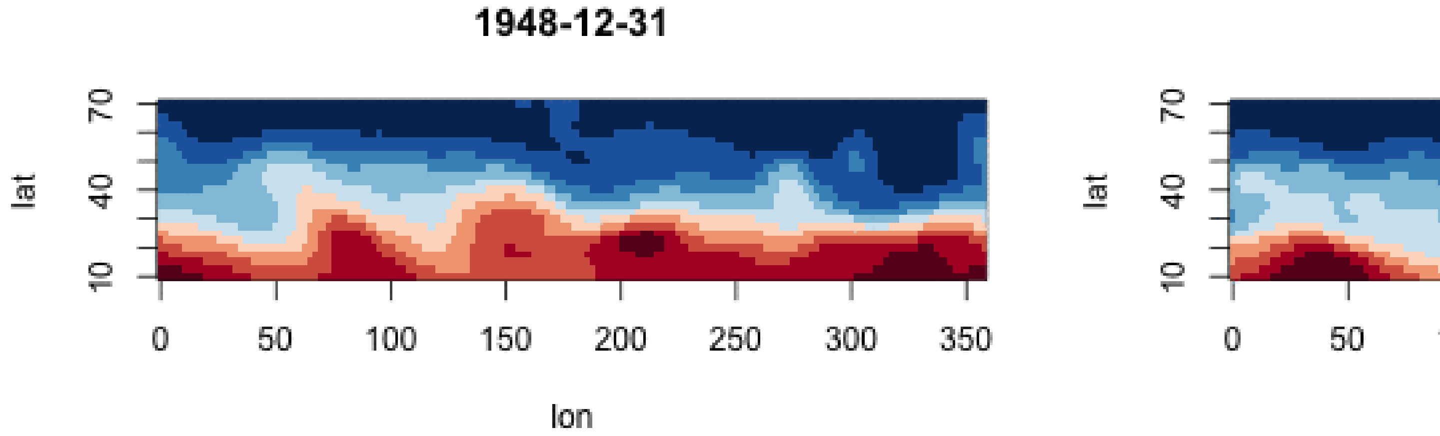
1985 ~ 2008 M6 Floods Locations and Death Toll in China Caused by Heavy Rain

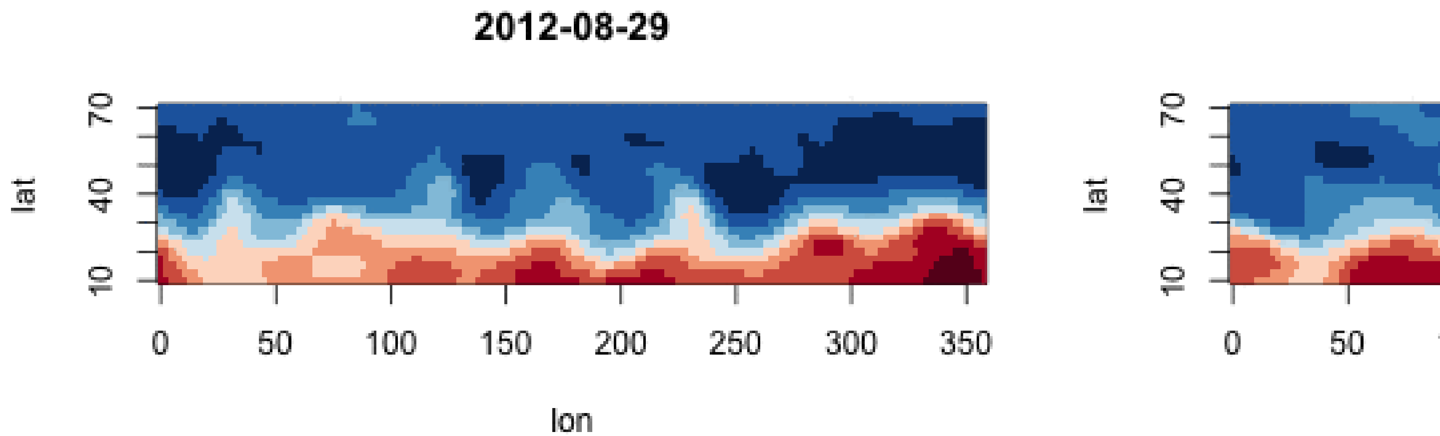


In this plot, we plotted all the floods locations with a level at least M6 happened in China from 1985 to 2015 with the death toll. As we can the most deadly floods happened in Hunan province.

How Preassure Data Related to Floods

As final part of our analysis, we will look at how preassure levels relate to floods and their intensity, if this relationship exists. First, it would be interesting to see how preassure levels vary over time, and investigate if the levels exhibit some patterns across the different coordinates. The plots below show this information, for selected time periods.



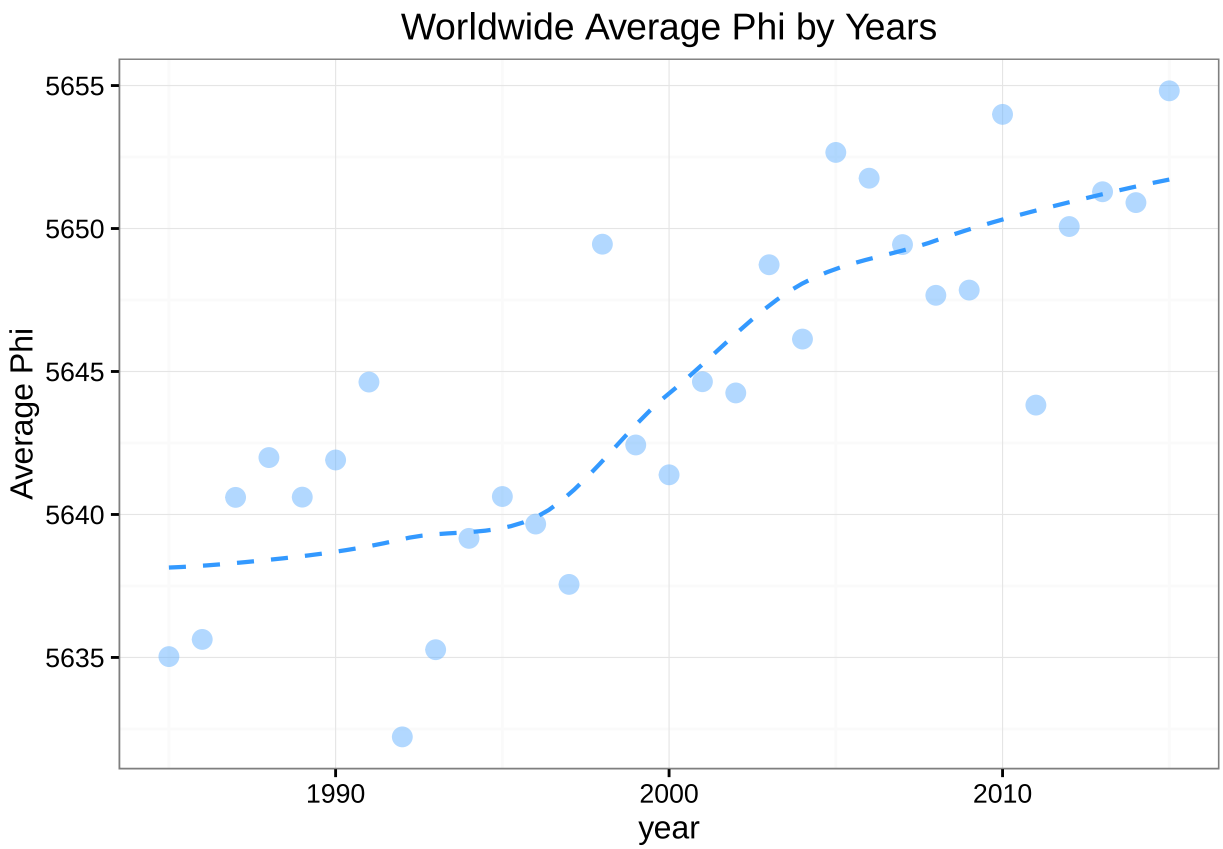


We see that although the pressure levels don't change throughout these different time periods, they do exhibit some seasonality and higher concentration on the latitudes closer to the equator. The plots below provide more information on how these patterns evolve.

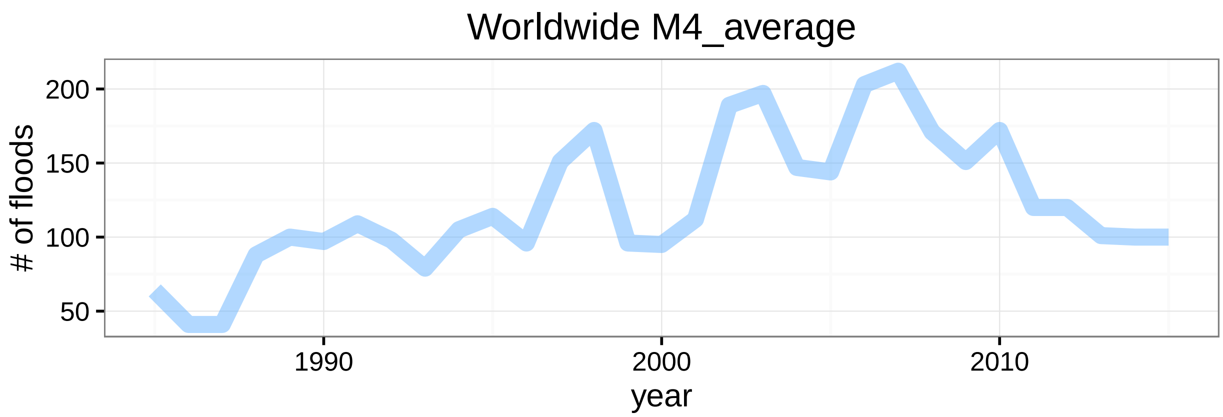
We gather daily gridded geopotential height data(phi) from http://iridl.ldeo.columbia.edu/SOURCES/.NOAA/.NCEP-NCAR/.CDAS-1/.DAILY/.Intrinsic/.PressureLevel/, which has the longitude 0E to 2.5W and latitude 70N to 10N.

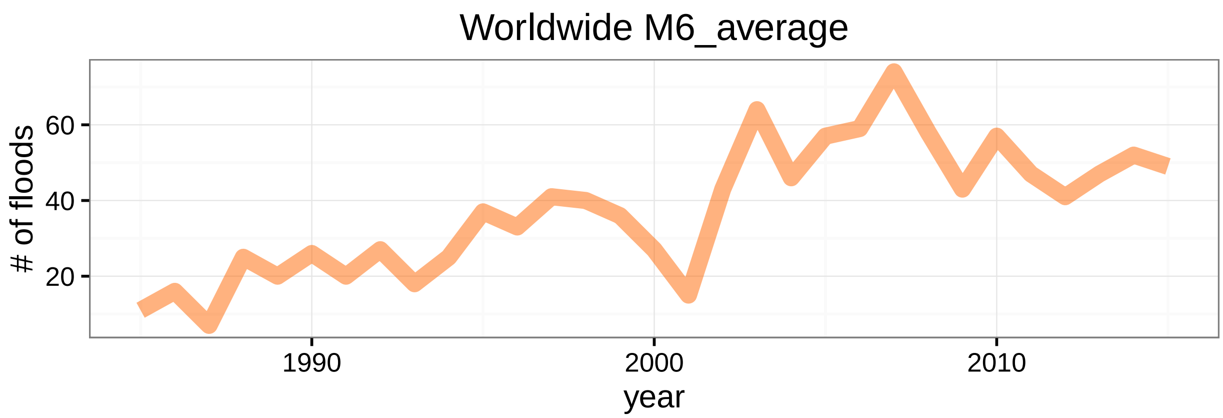
According to location, we combined phi data and floods data together. Since we only have phi data's latitude from N10 to N70, we take floods data's subset to analyze.

In the following parts, we will research the relationship between phi and the number of floods in different latitude regions, which are worldwide, N10-N35, and N35-N70.



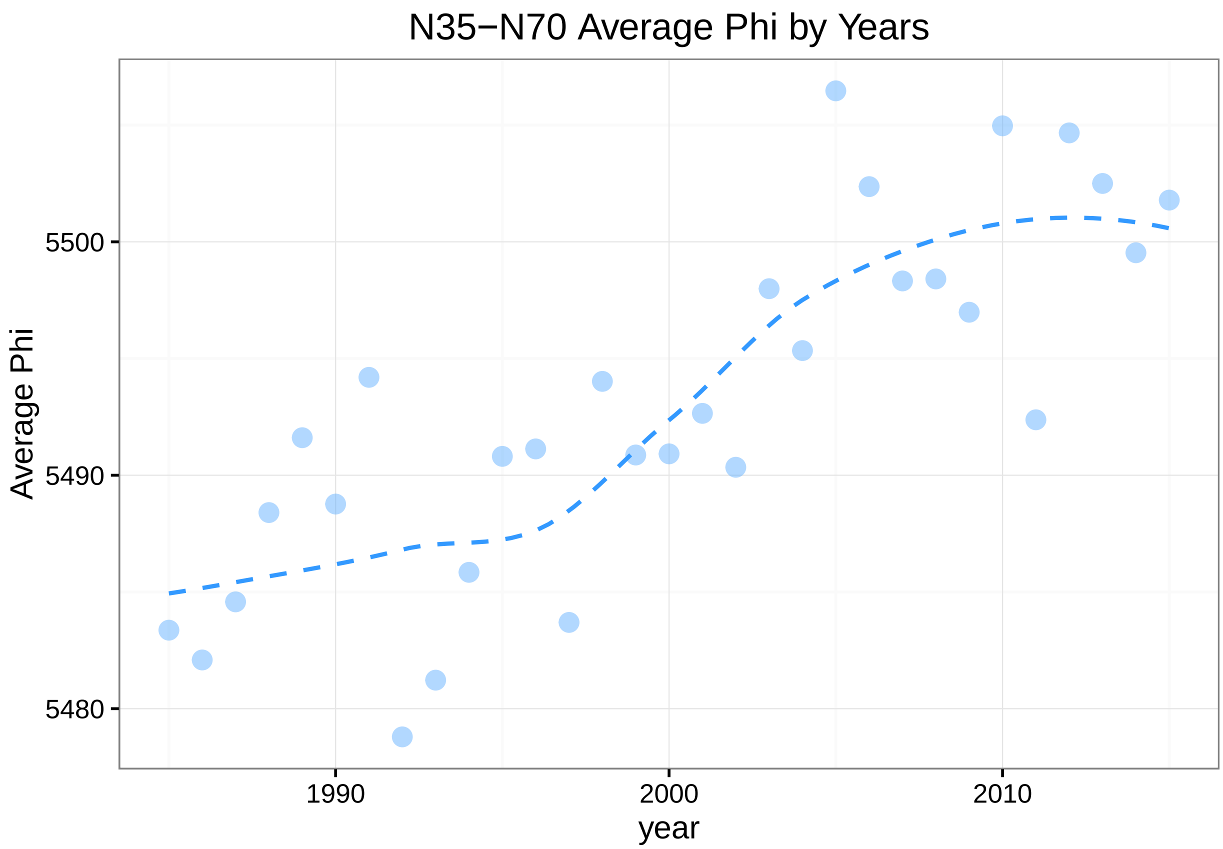
We plot the average phi through years with the dashed smooth line. Aligned X-axis, ave_phi is increasing. Does the number of floods share a same trend? We then plot twos figures to show that based on different types of magnitude, extreme (M>6) and large (M>4).



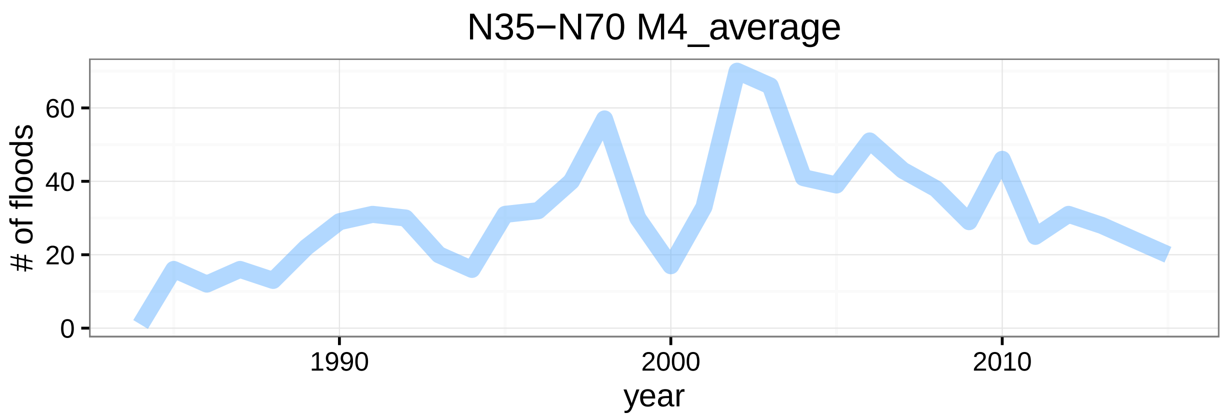


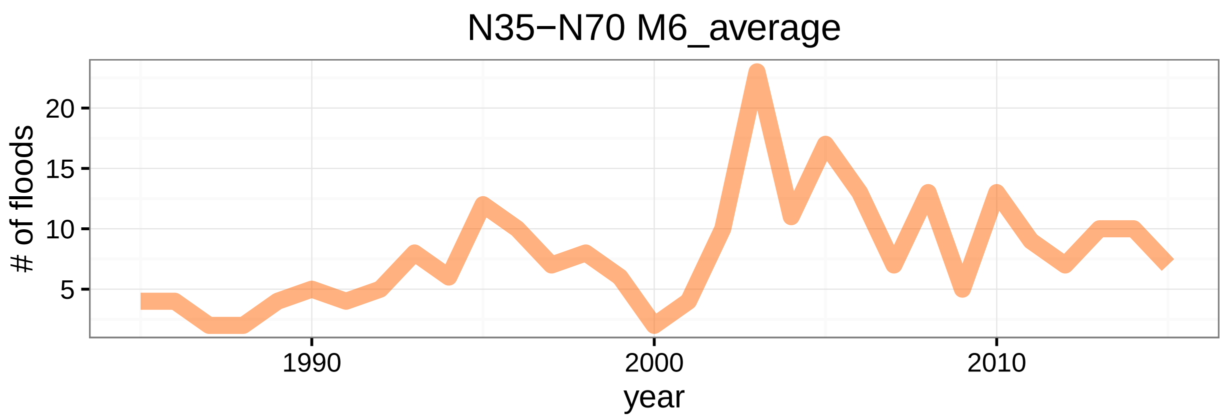
The results show that M4 and M6 are increasing with periodicity and some variances, but after 2010, M4 has a tendancy of decreasing, while M6 still keeps in a high leverl.

Then we look at the results in middle and high latitude regions (N35-N70).



We see a same tendency as worldwide, but with less magnitude (the lowest worldwide average phi is around 5600, but the lowest N35-N70 Average Phi is around 5400).

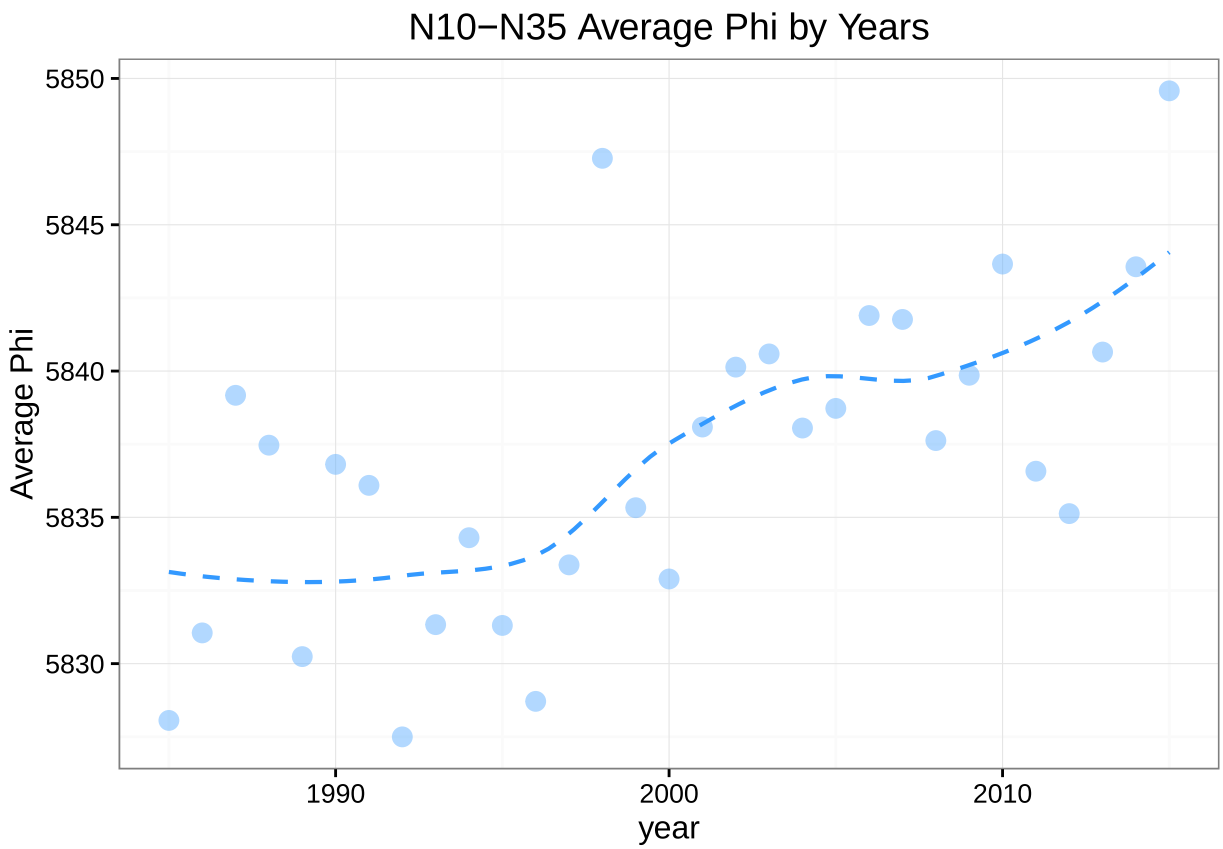




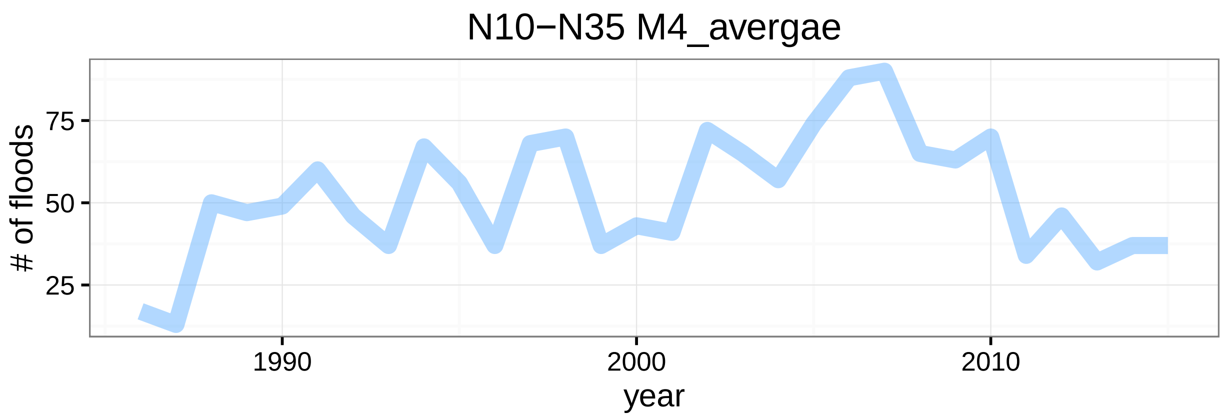
Same as average phi, the number of either magnitude type floods in N35-N70 has similar tendency and periodicity as worldwide's.

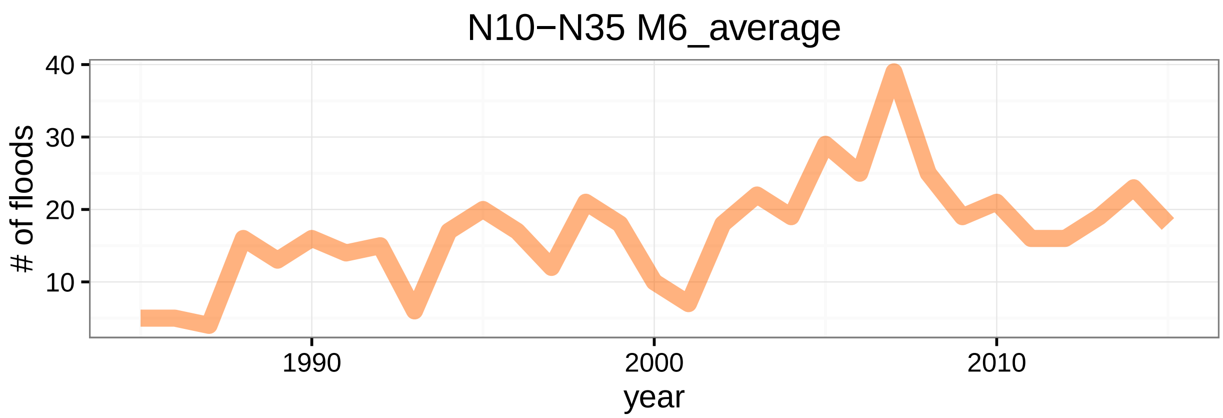
The results also show that M4 and M6 in N35-N70 have larger fluctuations, especially in recent years.

After that, we'll see the results in N10-N35 region.



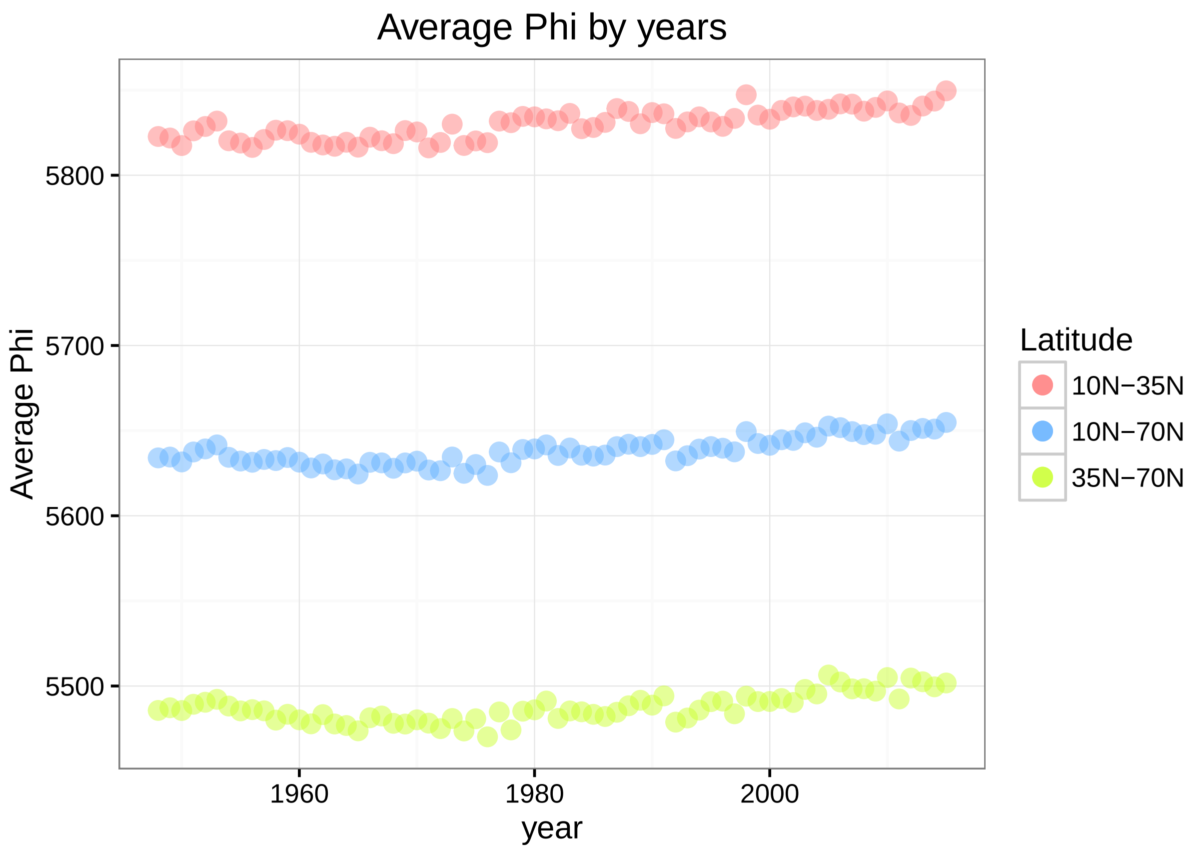
We see a same tendency as worldwide and N35-N70, but with bigger magnitude (the lowest N10-N35 average phi is around 5800).

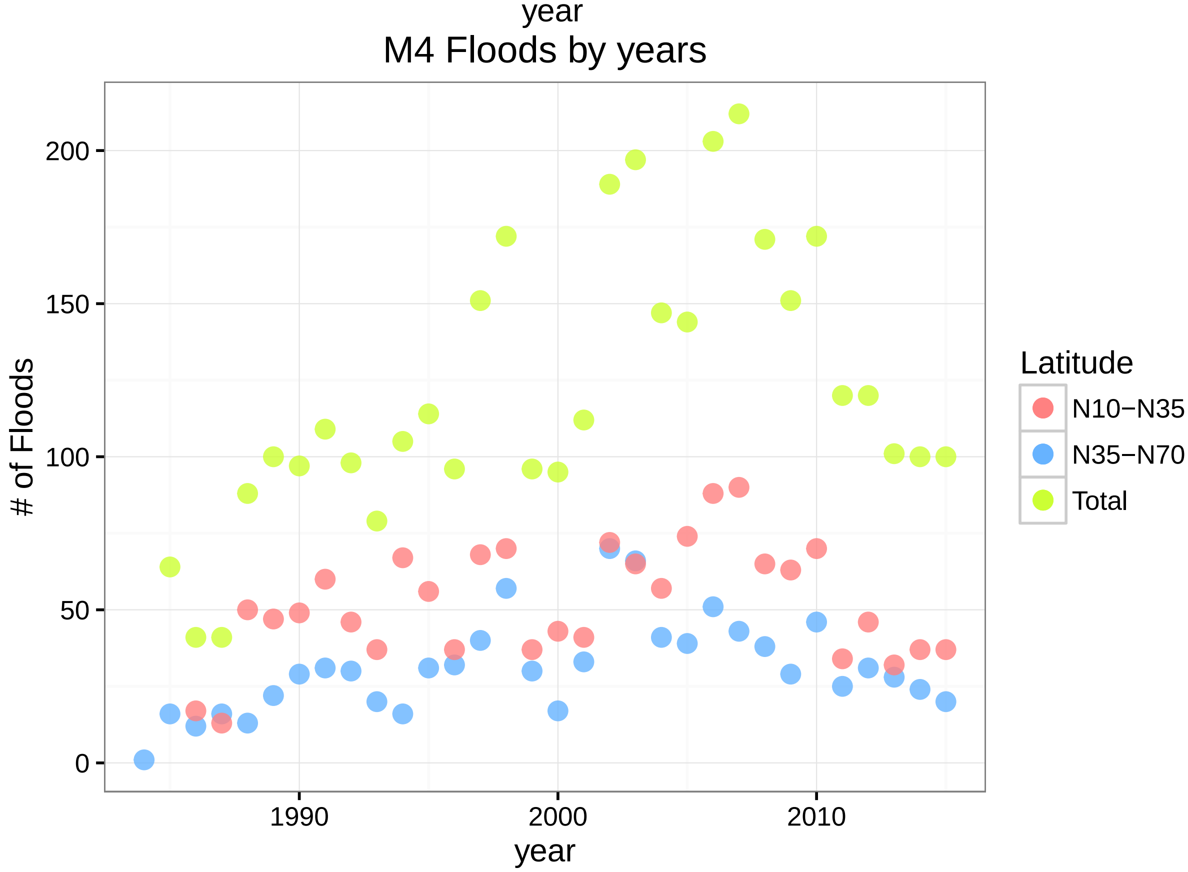


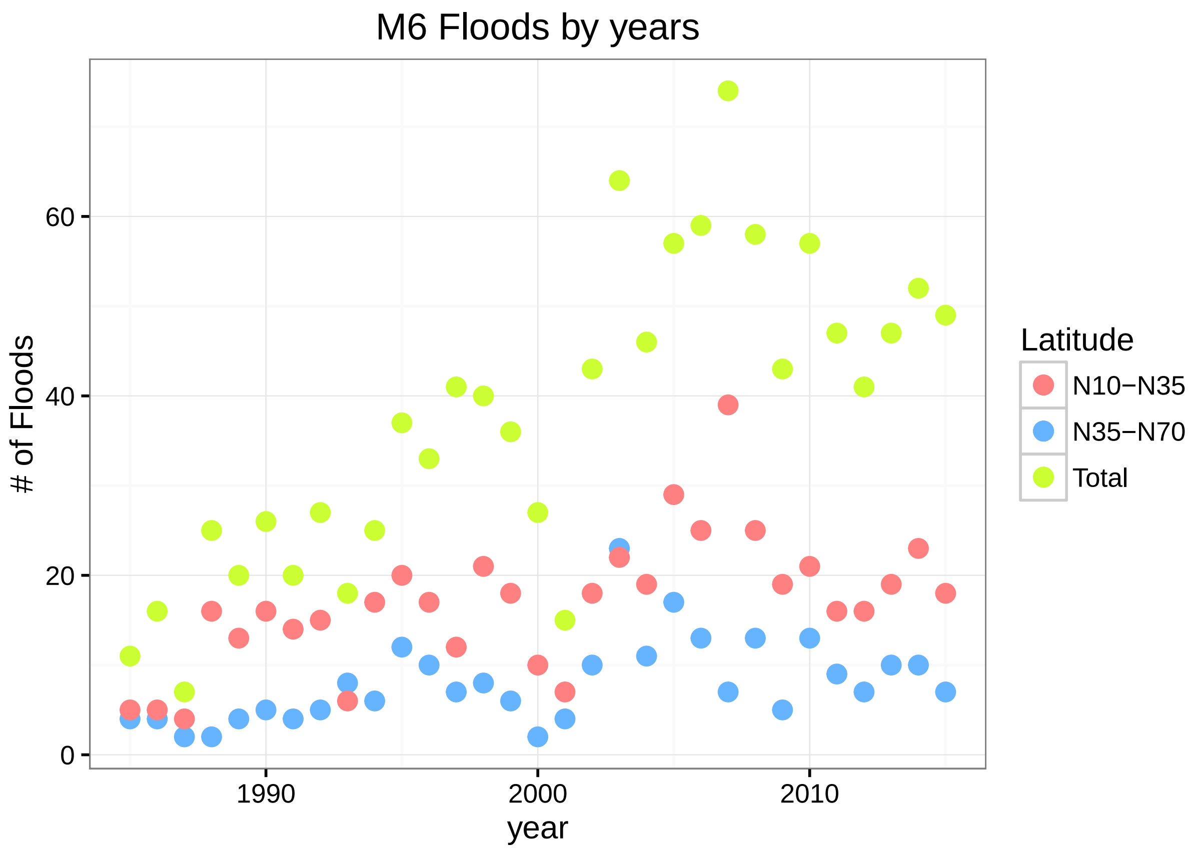


The number of either magnitude type floods in N10-N35 has similar tendency and periodicity as in N35-N70 but is more than N35-N70's, which is consistent with the results from average phi.

Last but not least, we plot all three subgroups together in one figure, to give a straightforward comparison.


Average Phi by years
Average Phi
5800
5700
5600
5500
1960
1980
2000
year
Latitude
10N−35N
10N−70N
35N−70N

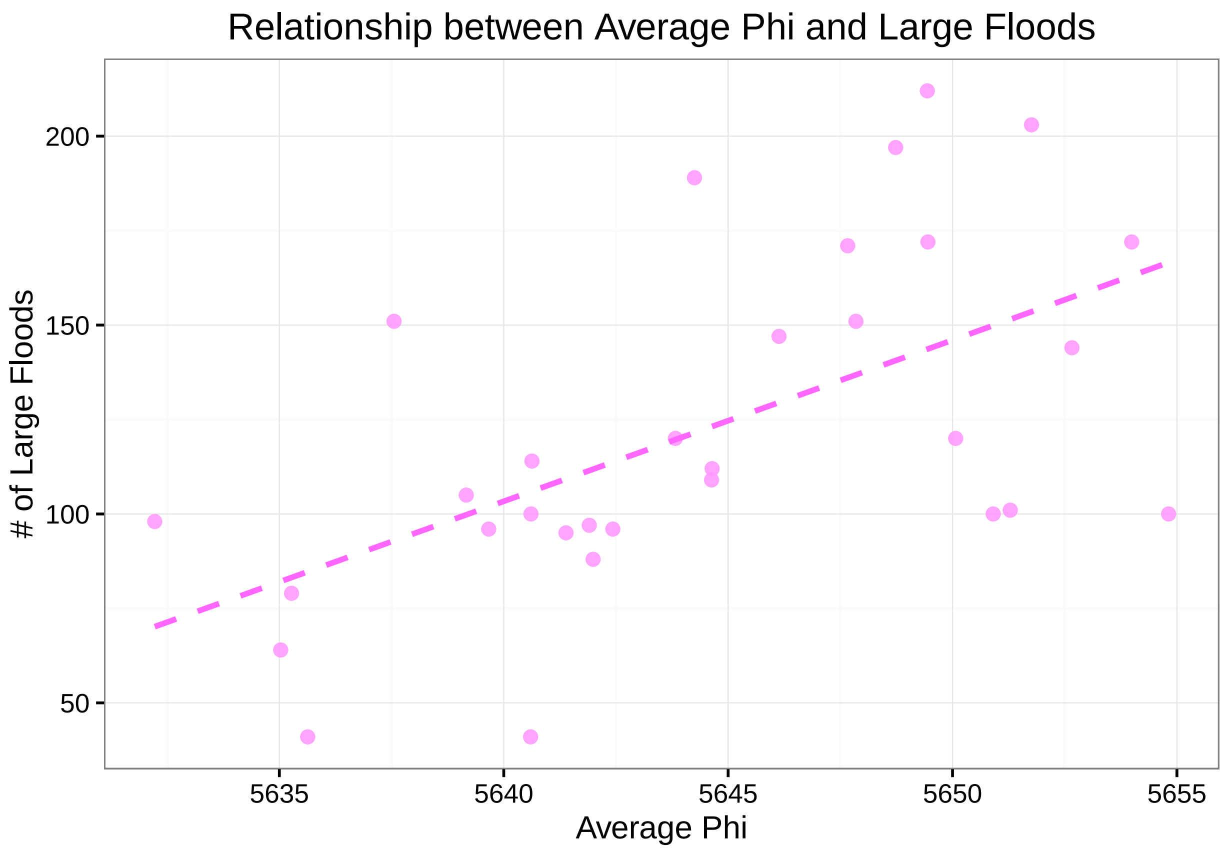

M4 Floods by years
# of Floods
200
150
100
50
0
1990
2000
2010
year
Latitude
N10−N35
N35−N70
Total

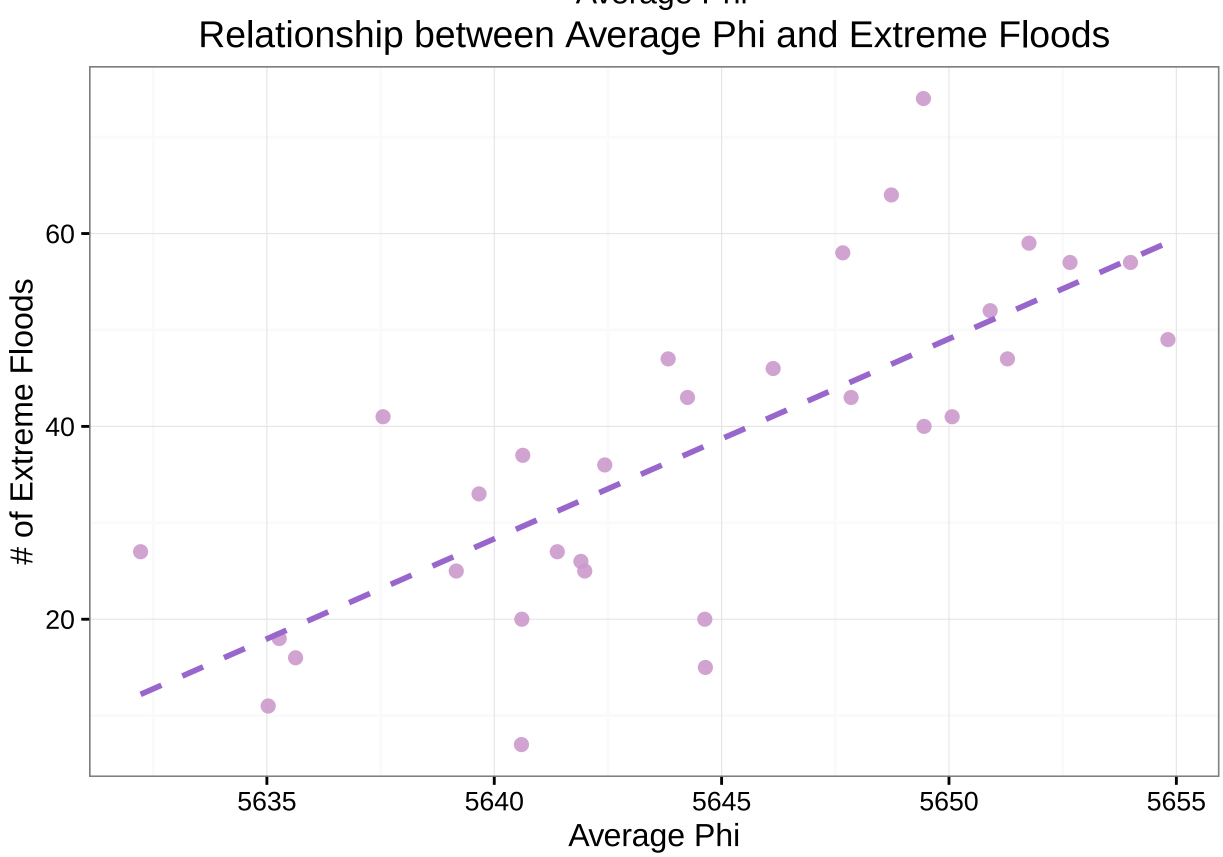


Based on above plots, we can see that total annual floods have an apparent periodicity. Large floods and extreme floods share a similar trend. And different latitude regions have various patterns, either in average phi or in the number of floods.

What should be concerned is that we are in a dangerous time period now, because in 2015, large floods seem to touch the bottom of its periodicity. Maybe there would be more floods in 2016.

Here comes the relationship between phi and the number of floods.





The dashed line is a fiited line from linear regression. We can see apparent positive relationships between average phi and the number of floods whether or not floods are extreme or large.

For different types of floods, most points in extreme floods concentrate on the fitted line, while in large floods, there are more outliers existing. In lower average phi level, the number of large floods could be better explained by linear regression than in higher average phi level. Maybe linear regression is better at explaining the relationship between average phi and the number of extreme floods.