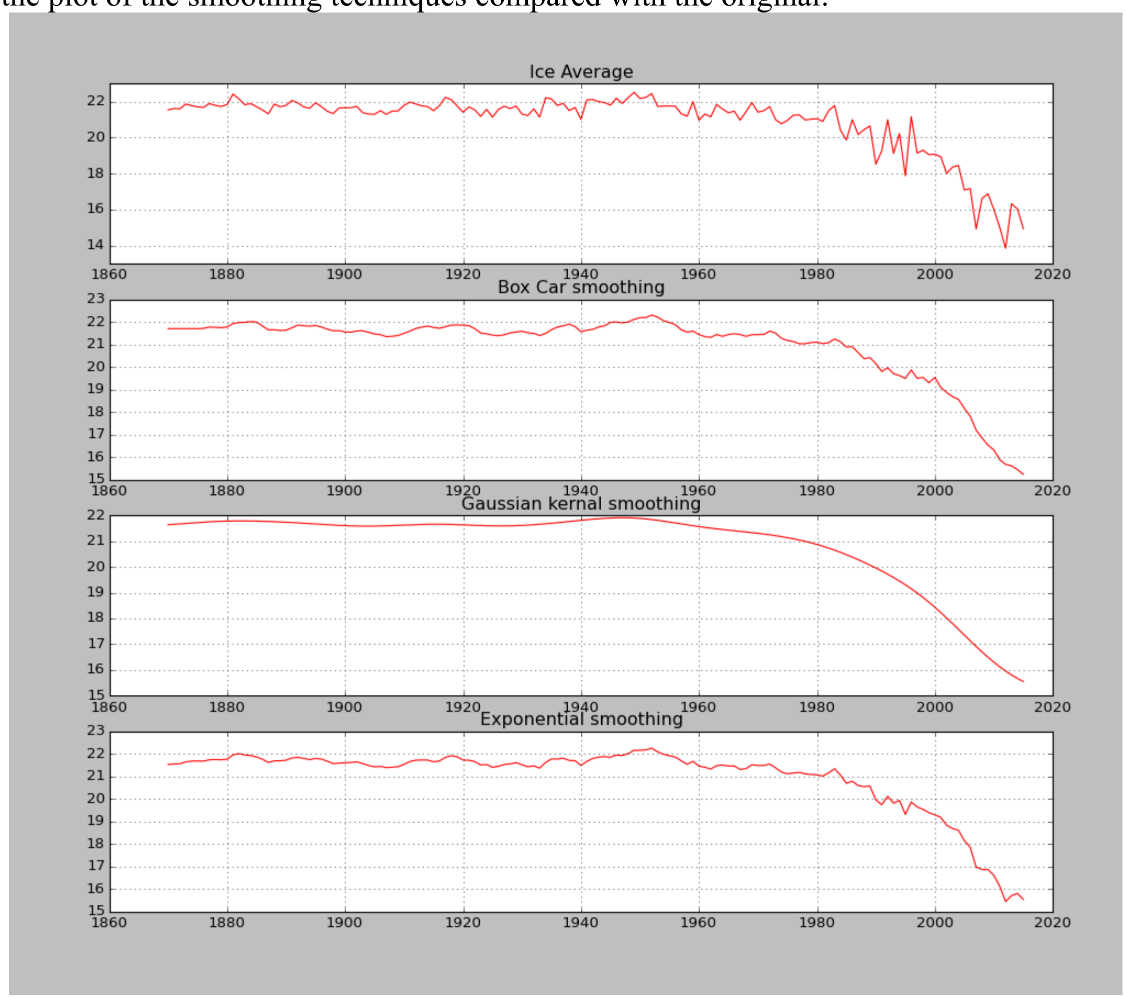
Wells Bishop
Lab 5
Physics 391
December 7th, 2015

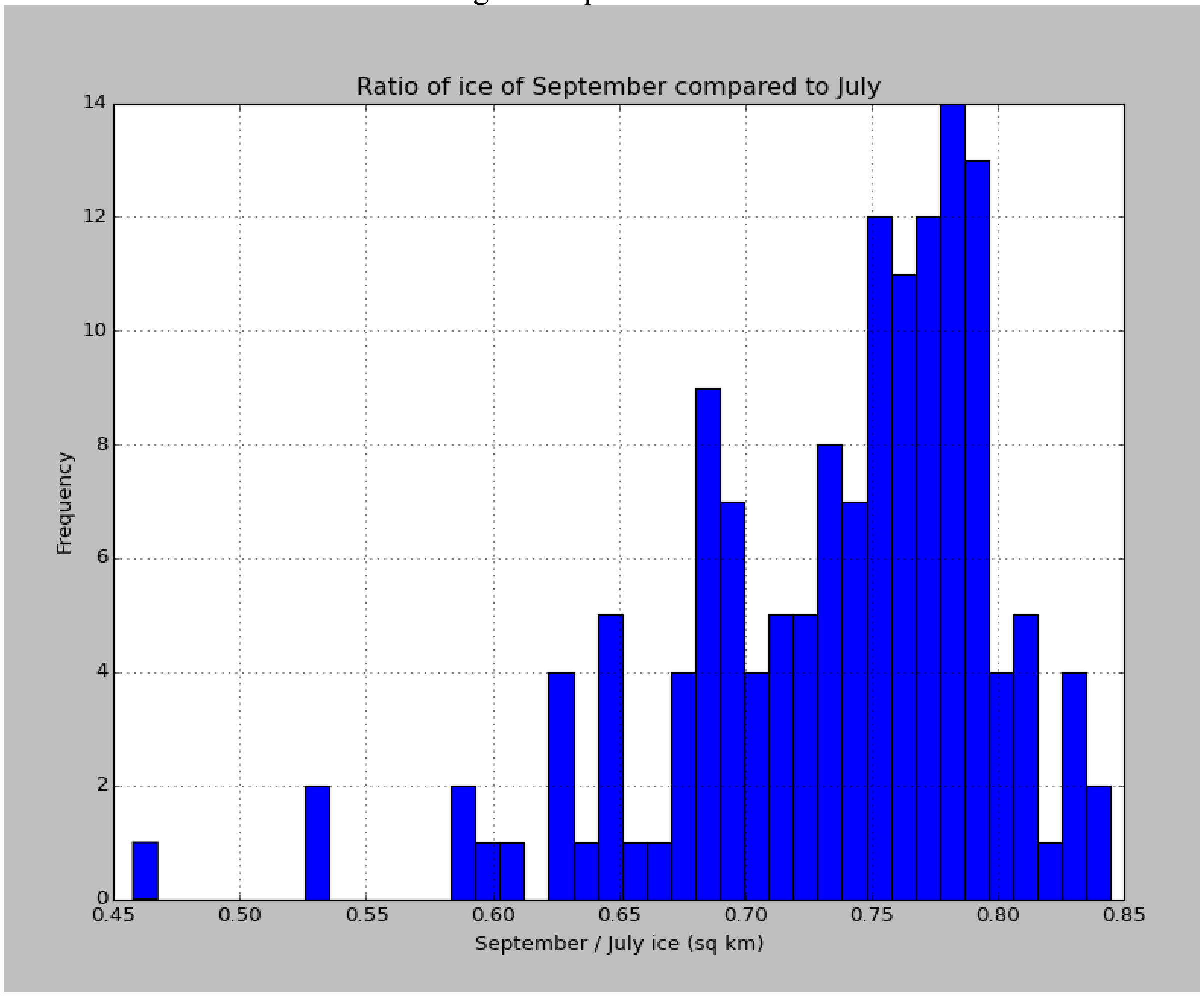
<u>Arctic Ice</u>

This lab was designed to test how well we can read real data and use it in meaningful ways. First we smoothed the data using various techniques designed to reduce the noise and flatten the data to understand the overall trend. Second, we looked for two periods of cooling before 1975 and looked at how these features can be understood. And finally we looked at the most recent satellite data (after 1979), and deduced when the Arctic would no longer have ice, it's a lot sooner than you think.

We used three methods of smoothing for our noisy data: moving boxcar average takes the average of a few data points around it and replaces the current point with that value. By moving the averaging box across my data with a 5 point width, I get a much smoother curve. The Gaussian kernel smoothing technique replaces every point with a Gaussian that influences all the points around it. I used the built in Gaussian kernal function in scipy and found that it smooths my function too much, it reduces most of the peaks and points of interest to a very consistent line. The last in an exponential smooth which smooths each point based off the last point, and a smoothing factor A. This smoothing factor is between 1 and 0 and greatly changes how much it does its job. I went with A=0.3 to get some smoothing similar to the moving boxcar, but not enough to completely destroy all the relevant data. Here is the plot of the smoothing techniques compared with the original:

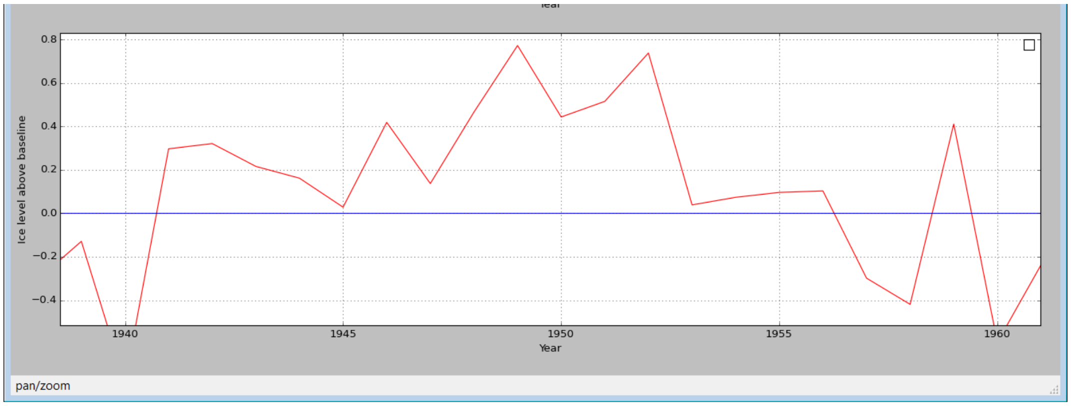


I found that the Gaussian kernal smoothing reduces the noise so much that it seems to destroy some of the important information along with it. This is why I went with the exponential smoothing techniques because it has the smoothing constant that is able to be varied depending on how much smoothing is needed. I find this to be the best smoothing technique of the three.

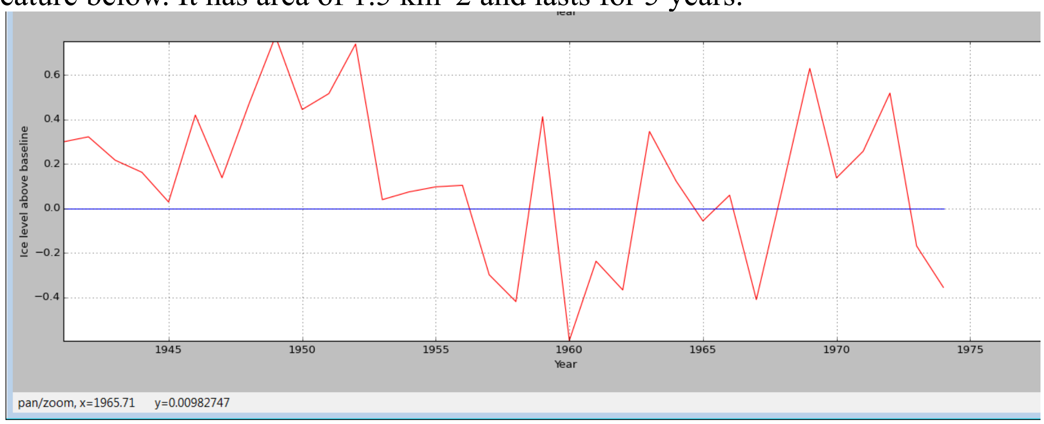


The histogram above shows us the ratio of ice in the month of September compared to July. From this graph we notice a few things. Firstly, there is always less ice in September then July as the ratio never gets above 1. This graph could be represented as a Poisson distribution with a mean of 0.73. There are also a few years when there is a lot of ice melting. There are 6 years where over 40% of the ice melts in the summer. The mean ratio of the last 15 years was 0.61, meaning that the greatest changes in sea ice have been since the turn of the century.

There are supposedly two periods before 1975 of much colder weather and by subtracting a baseline out of our data we are able to see these 'features'. I noticed one feature from 1941-1956 of seemingly much more sea ice than normal.

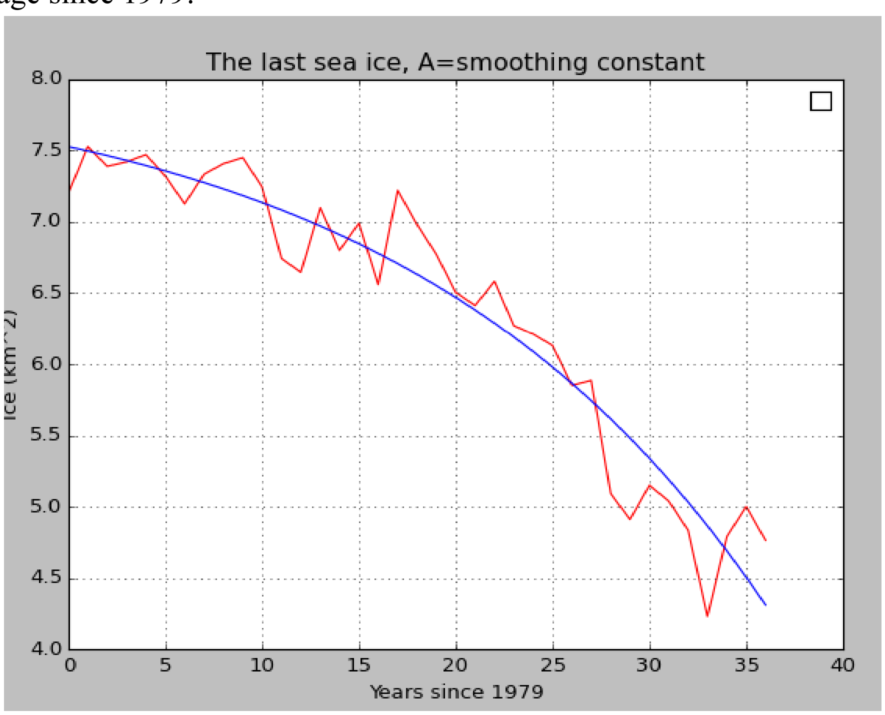


This is my first feature with the baseline subtracted and has an area of 4.6 km^2 and lasts for 15 years. This was by far the most distinct feature of my data. The next feature in from 1968-1973 and is the rightmost feature below. It has area of 1.5 km^2 and lasts for 5 years.



These features were not quite as distinct as I was hoping they would be and it was hard to decide what constitutes a feature. I did my best to pick the most distinct ones.

The last part was to analyze the data from 1979 on and project when all the ice would be gone. I used an exponential smooth with a smoothing constant of A=0.5 to first smooth the data, and then fit an exponential decay trend line. From the parameters of the exponential function I was able to find the x-intercept that would correspond to the year with 0 ice coverage. The graph below shows my trend line for ice coverage since 1979:



I found that with this particular fit we would run out of ice in 2029. By varying the smoothing constant, I found the year that we would run out of ice would be between 2028 and 2032. This gives me the year of 2030 ± 2 that we will have no Arctic ice left.

This is a very scary number to be left with. Without the ice cap to reflect sunlight away from Earth it could result in a runaway greenhouse effect from the ocean absorbing much more light and energy. Unfortunately, most of the proposals to reduce emissions and temperature rising will not have much effect in 15 years. In 20-30 years we will hopefully be much more environmentally conscious, but it could be too late if our the ice cap is already gone.