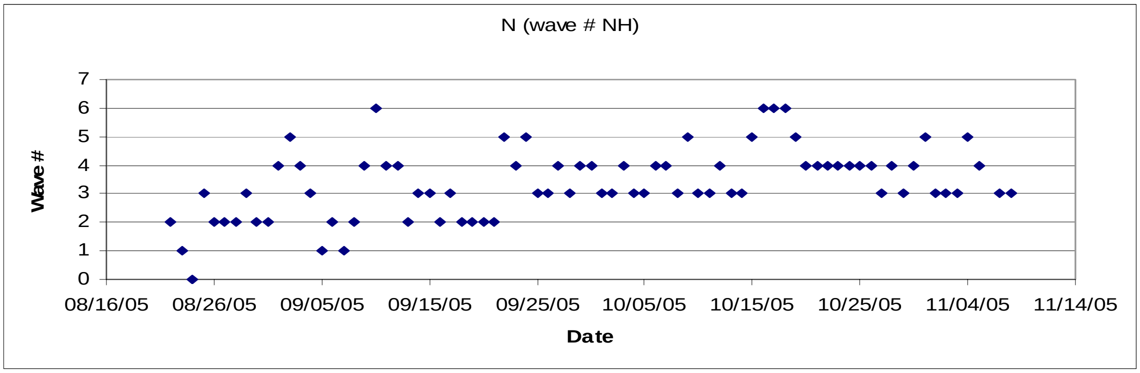
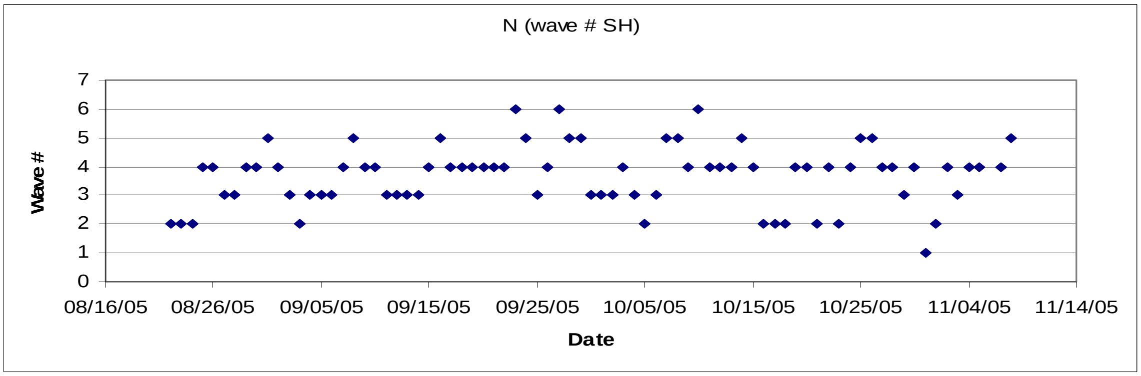
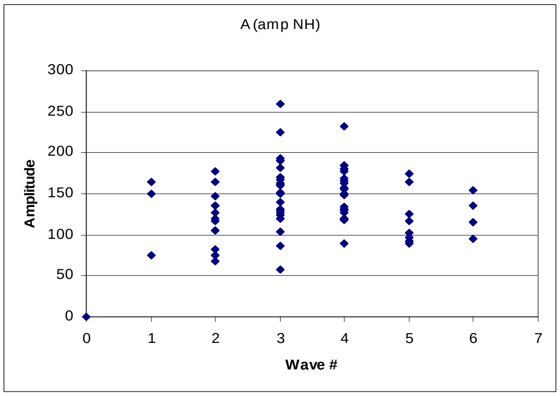
Heather Moser, Mindy Pearson, and Jacob Williams
Mteor 454 Wave Project 2005

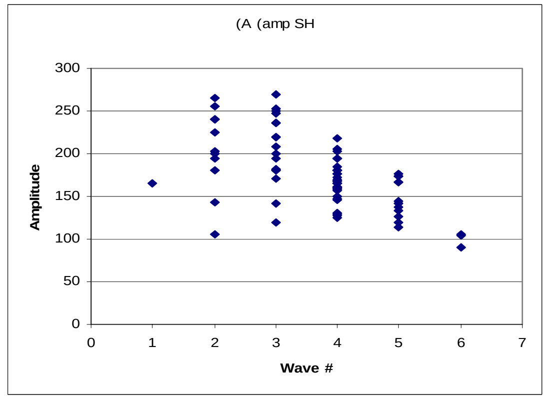
1. Wave patterns appear to move at around 8-15 longitudinal degrees per day, with a few outliers either moving slightly faster or slightly slower. Looking at the hemispheres separately may show different ranges, since speeds tend to be slightly higher in the Southern Hemisphere.
2.
   a. In the NH it appears that the dominant wavenumber increases from 2 to 3 & 4. In the SH it is clear that the dominant wavenumber is 4 throughout the data set. In both hemispheres there are persistent periods with frequent shifts from the dominant wavenumber of +/- 1. Synoptic scale waves last for about 7 days; the persistent periods in our data lasted on average 9 days in the NH and 7 days in the SH.



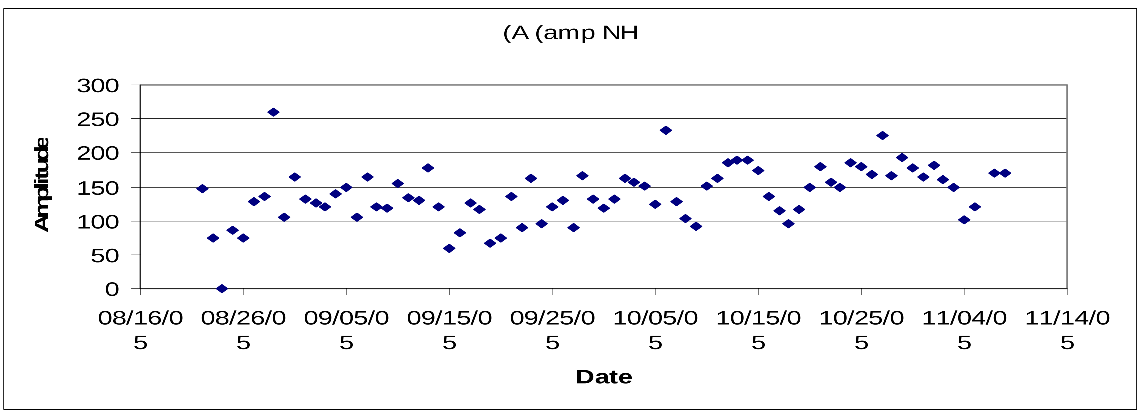


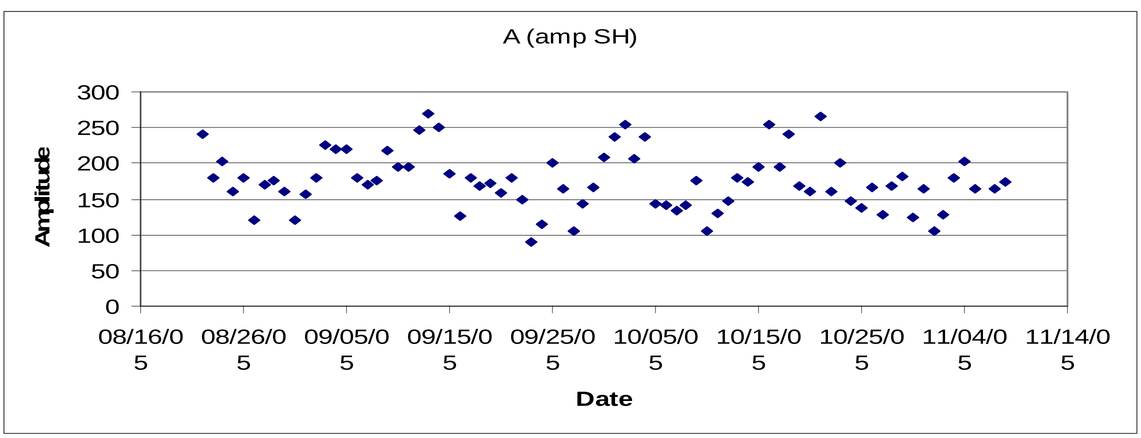
   b. When comparing the wavenumber verses the amplitude there are similar trends between the NH and the SH. In general as the wavenumber increased the amplitude decreased. The NH had the largest amplitudes with a wavenumber of 3 and as the wavenumber increased from there the amplitude decreased. The reason for the decrease in amplitude as the wavenumber increased is due to changes in energy within the wave. With more wavenumbers there seems to be less kinetic energy per wave and that causes smaller amplitude.





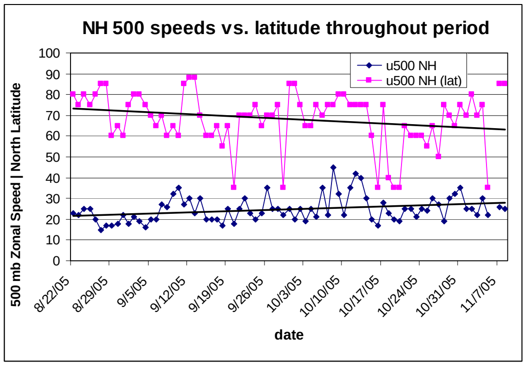
3. The data shows that there are episodes of growth in the amplitude for both hemispheres. On average, in the NH, it took about 3-4 days for a wave to reach max amplitude. The amplitude would increase by 30% for many NH waves. In the SH the amplitude took about 4 days to reach its max amplitude and would increase by 84% on average.

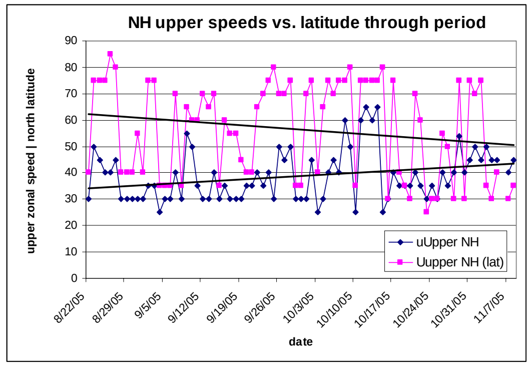


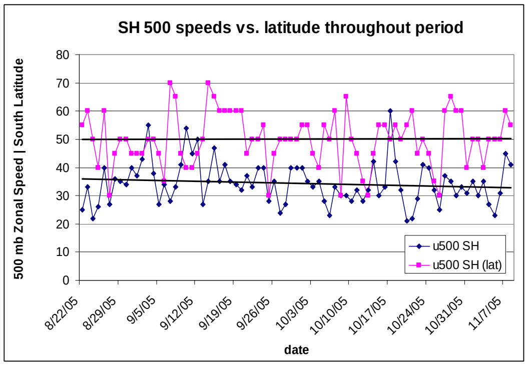


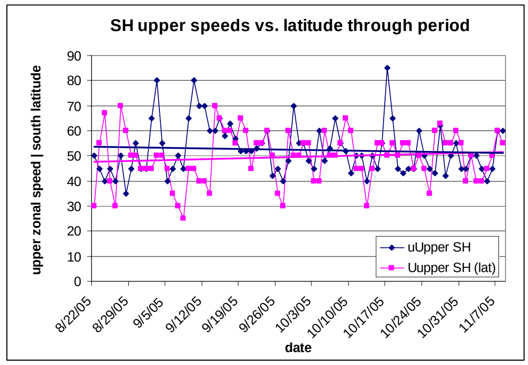
4. Looking at the figures below, there does seem to be a slight correlation between increasing speeds and decreasing latitude in the Northern

Hemisphere, while the Southern Hemisphere only shows a decreasing trend in speeds.







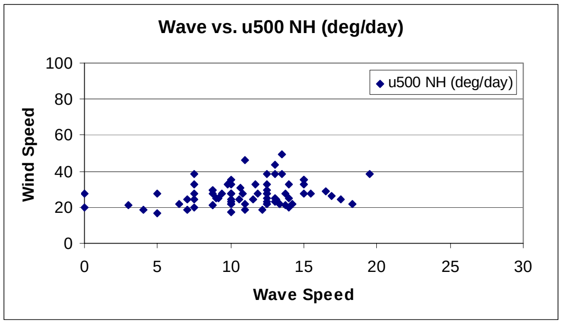


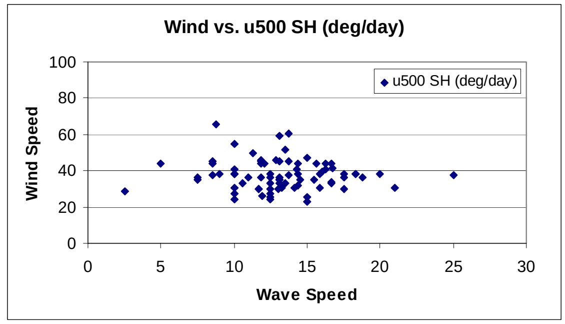
5.

a. Waves in the northern hemisphere move counterclockwise around the pole at about 11 degrees per day, while the waves in the southern hemisphere rotate clockwise and are faster at around 13 degrees per day. If the waves were to stay intact, a complete trip around a latitude circle would take about 32.7 days for the northern hemisphere and 27.7 days for the southern hemisphere.

Since the speeds are overall averages for several months of data, the two degree per day increase of speed in the southern hemisphere is notably faster than movement in the northern hemisphere. This could be because the distance of waves from the pole is much shorter in the Southern Hemisphere, thus a degree of distance is much shorter for waves to travel. The large difference in spread of the waves out from the poles for the two hemispheres may make our units of speed inappropriate for analysis since the degree is not a uniform distance at every latitude.

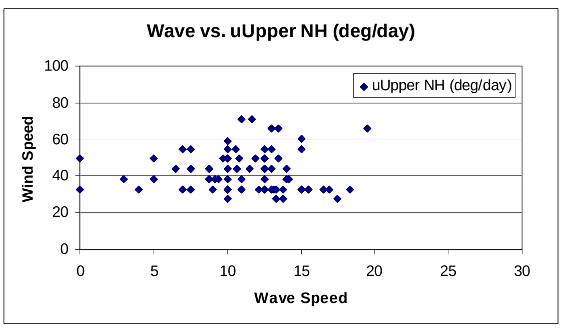
b. 500 mb winds:

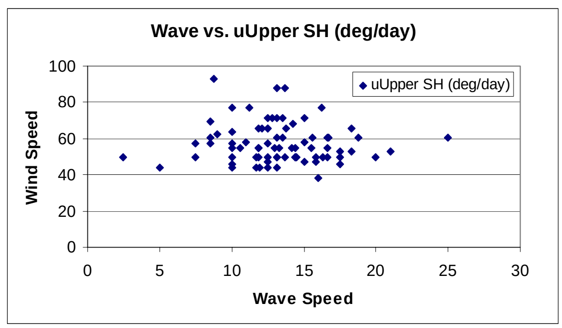




The 500 mb zonal wind speeds appear in the above scatter plots to be higher than the wave speed in every day of data that we took. Taking an average ratio of the two shows that in the Northern Hemisphere the 500 speeds are about 2.5 times higher than the wave speeds and about 3.2 times higher in the Southern Hemisphere. This finding supports Rossby wave theory in that the westward propagation of planetary waves would serve to work against the zonal wind and slow down the eastward movement of wave patterns, hence making waves appear to move slower than the mean zonal wind.

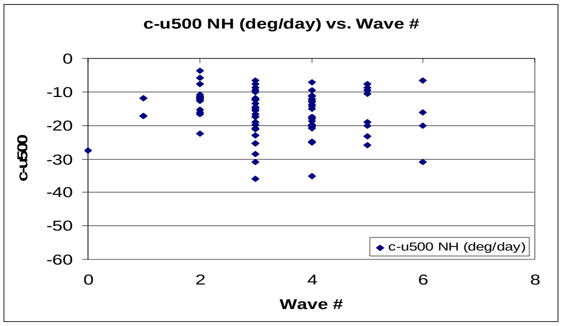
300-150 mb winds:

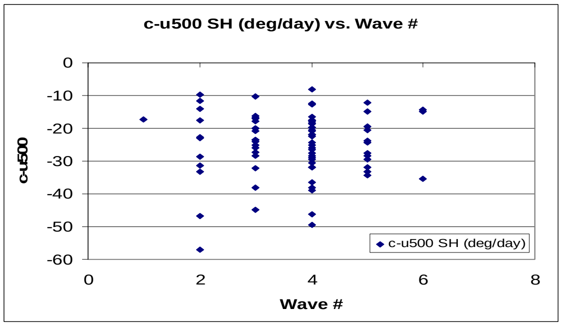




Similar relationships exist with respect to the 300-150 mb zonal wind and wave speeds (shown in the two figures above) but with higher ratios of difference. However, compared to the 500 mb speeds, there seems to be a much more variable relationship between Uupper and wave speed aloft. The plots are much more scattered, possibly indicating that Uupper is not as good a predicting factor for wave speed as U500 might be. As far as why this is the case, I think the occurrence of jet streaks and higher velocities within the jet stream tend to work into the data while those higher winds really are not related to the speed of the larger wave pattern.

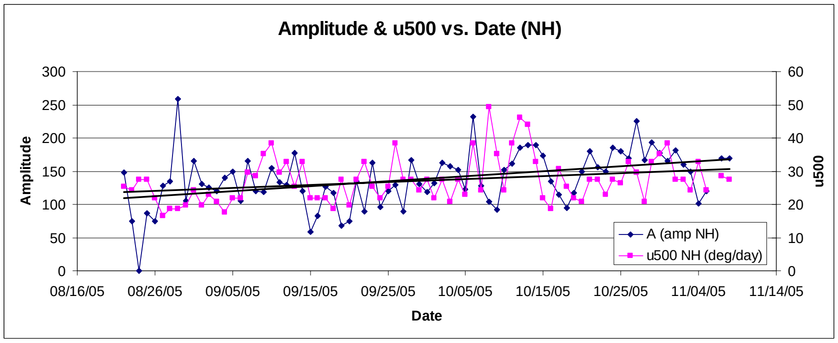
c.

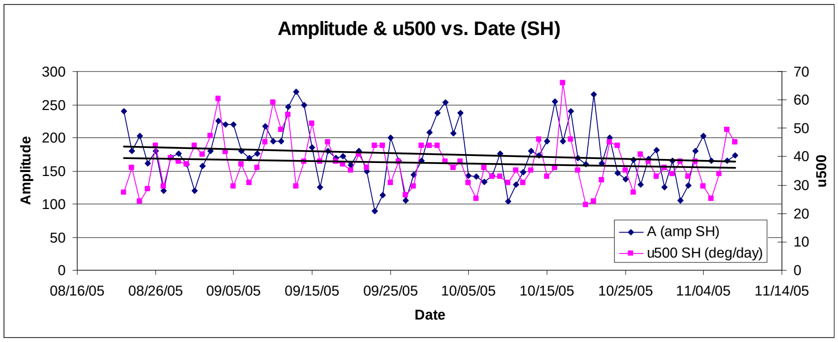




There really is no prevailing trend between wave speeds and wavenumbers. The two hemispheres do seem to have more common wavenumber modes as is shown by more points being plotted for wavenumbers 3 and 4 in both cases, but there is a wide range of speeds associated with each number. Rossby wave theory indicates that planetary wave phase speed should be inversely proportional to the square of the wavenumber. Assuming this is true, we should be seeing a very obvious trend of decreasing wave speed with increasing wavenumber, but that is not showing up at all in our data. Squaring the wavenumber data does not seem to emphasize any trend either. Since Rossby wave theory is based on a barotropic environment and the real environment is baroclinic, there may be some factors affecting our data that aren't part of the Rossby theory.

6. Amplitude and zonal winds at 500 mb seem to have a directly proportional relationship (both increasing over time in the Northern Hemisphere and decreasing in the Southern hemisphere), and they appear to change at about the same rate, although that could be an artifact of the graph since the two variables are of different scales.





Overall

The Rossby Wave Theory explains that there are longwave flow patterns in the upper air flow. Rossby waves are known to have seasonal changes from the summer to winter. Winter patterns tend to have longer wavelengths and stronger winds. Our observations have some agreement with the Rossby Theory. Our data shows distinct changes in wavenumbers and zonal wind speeds. Zonal winds appear to be stronger in the fall and winter season for both hemispheres. Something that could be added to improve our model is to add a temperature variable. Movement of arctic air might help illustrate amplitude changes.