560 test question 3

# Introduction

There has been a lot of work around hurricanes and what will happen as our climate changes - warms. What we know is number of hurricances is not really chaning (get reference). (add counts of named storms, hurricanes, major, and intense)

In some cases it appears that there might be some increases in intensity (ar15 and new climate report) but The focus os this paper will be to demonstate that the winds are getting just a bit more intense for intense hurricanes.

I want to look at two differen measurements of intensity for storms Accul (ACE) (get refence). ref to noaa website showing calculation paramets and wikipedia calulations Show acce fomration.

The second measurement we will use is max winds for meters per second.(ref) which is used in many studies as Lifetime Maxuimom Intensity (LMI). As a note There are potential issues wuth hurricane data specilfically with how it was collected pre and post satetlaite error (date ?) (add ref) because of these issues I will look at the entire history but the conclusions will be drawn on post stateliate and speciacally after the dovak technique was developed (add ref). This does post some issues with how limiting the historical record. There is ecvendce the dovark technique has some underestimates in the early 1980 (ref landsea).

for both ACE and LMI i will look at four types of storms named storms, used by ace (noaa ref) defined as Subtropical storms, Tropical Storms, and Hurricanes all with winds greator than 39 mph. Hurricanes, Majpr Hurricanes category 3 or greator, and Intense Hurricanes category 4 or greator.

Many research proejcts focuse on more recent trends late 80;s rearly 90s to early 2010's

# Methodology

Note: To follow along with R code please download the code () and run the r script .R. This will install the packages, functions, and load the datasets I am using.

The basis for all our work will be getting data from Hurdat2 data from NOAA. The hurdat2 data is reanalyixed and fixed for accuracy (<http://www.aoml.noaa.gov/hrd/hurdat/hurdat_pub.html> ref) so it should be fairly accurate, althought the latest year (2017) we not be availlable until 2018. First we need to calculate both ace and LMI. for non math people that formula can be expreses as where hurr\_obs is the data frame containing all hurricane observations (hurdata2 - ref )

#only use named storms defined as Subtropical storms, Tropical Storms, and Hurricanes  
#ace\_subset <- subset(hurr\_obs, hurr\_obs$status\_code == 'SS' | hurr\_obs$status\_code == 'HU' | hurr\_obs$status\_code == 'TS')  
  
  
#winds 39 MPH or greator (some Subtropical storms do not meet this)  
#ace\_subset <- subset(ace\_subset, ace\_subset$wind\_mph > 39)  
  
#max wind every 6 hours tarting at 0000  
#ace\_subset <- subset(ace\_subset, ace\_subset$time == '0000' | ace\_subset$time == '0600' | ace\_subset$time == '1200' | ace\_subset$time == '1800')  
  
#square the the max wind in knots  
#ace\_subset$wind\_knts\_sq <- ace\_subset$wind\_knts^2  
  
#sum the squared winds  
#sum\_wind\_knots <- aggregate(x=ace\_sub$wind\_knts\_sq, by=list(ace\_sub$storm\_id, ace\_sub$year),FUN=sum, na.rm=TRUE, na.action=NULL)  
  
#multiple by 10 to -4 power.   
#storm\_ace$ace <- 10^-4\*(storm\_ace$x)

and calculation LMI as max winds for meters per second. (add formula). using our data this can be expresed as

#hurr\_obs$wind\_meters\_per\_second <- as.numeric(as.numeric(hurr\_obs$wind\_knts) \* 0.5144)

then will get the total storm ace and lmi. Show plots four columns nammed, hur, maj, int

two rows history 1975+

also calculate the yearly totals and we see the same thing.

we also want to see how the effects that max wind m/s and ace have in each indivual year. we are expecting some very slight increases in intense hurricanes as we move foward in time. then we take the log on the max wind meters per second. So we I will use linear regresion to asses wether this true.

# Discussion

The preousi fuigures give us some insight into the possiblity that intense tropial systems are becoming more intense. This however does not provide us with any statistcal evidence.

To look into the idea the max wind speeds are indeed increasing slightly we are using the max wind as m/s. m/s is used in numerouse studies (ref). To see how this is chaning of the years I am converting the the years to a factor, in R then using the log of the maximum wind m/s of the storm. then assuming the standard error fits the output we can chart the coef or slope to see how each year is changing. Similar to what we did with >>>?

I wnat to look at the yearly totals and indivual stroms to see differences

(add charts of scatter yearly and storm with r) (and for history and 1975+)

there seems to be large step drop with coef around 1968, this is about the time of satelite obs started so I can only assume this is due to changes in data collection. I have nto been able to find any research that metions this. This would be a good topic for futuure resarch...

Looking at 1975 plus we say a definite uptick and clear patter upwards. This shows soem clear indications that indeed storms seem to gettting more intense even if it is small whhich is what we would expect. each storm should be gettiting just a bit mroe intese. especuall intense storms. this verifies what we observerd in the simple yearyly fgiures.

With ace we should not have to do any log nor use the coeffiences. ACE is and index that measures hte total intensity so it is arleady normailzied and ready for comapreis.

(add charts of scatter for yearly and strom with r)

again we see a very clear trend updwards which suppports our inital hyothesis.

There are some issue that I encountered look at historical ace or amx wind we see ig step are ound 1968. This is probably dioe

# Conclusion

Looking at data avaulable the re appears to be a somewhat clear small trend updwards in winds and storm intensity expresssed as ACE. the trends seem small and have low correlation but in this case that makes sense we are expecting a very small increase. there are many varrrables that things that determine hwo tropical sytems develop and intensify. global warming is not a big culprit in this but it appears that it's possible there are other studies that show a poleward shift with tropical systems (ref) but not a lot in intensity.

SOme things that should cause hestiation to say for sure, is the there us research indicating a cycle to tropiucal developement (ef) so with smaller time frame of 1980 - 2016 we coudl be witnessing one of these cycles so there is probably the need to re-look at this later. infact the step down we see in the coeffients could be one of these cycles so we could be picking up one of these as noise.

a seocnd caution, is I am using simple regriosn. many of the resrarch into intesnity of tropical systems uses quadratic regresion to find the extreemes (ref). This beyond the scope of this work.

# Refrences

# appendix: Reproducable Research with R and Github