# Hurricane Landfall Predictions

**Group 2**
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SAMSI Undergraduate Modeling Workshop

# Outline

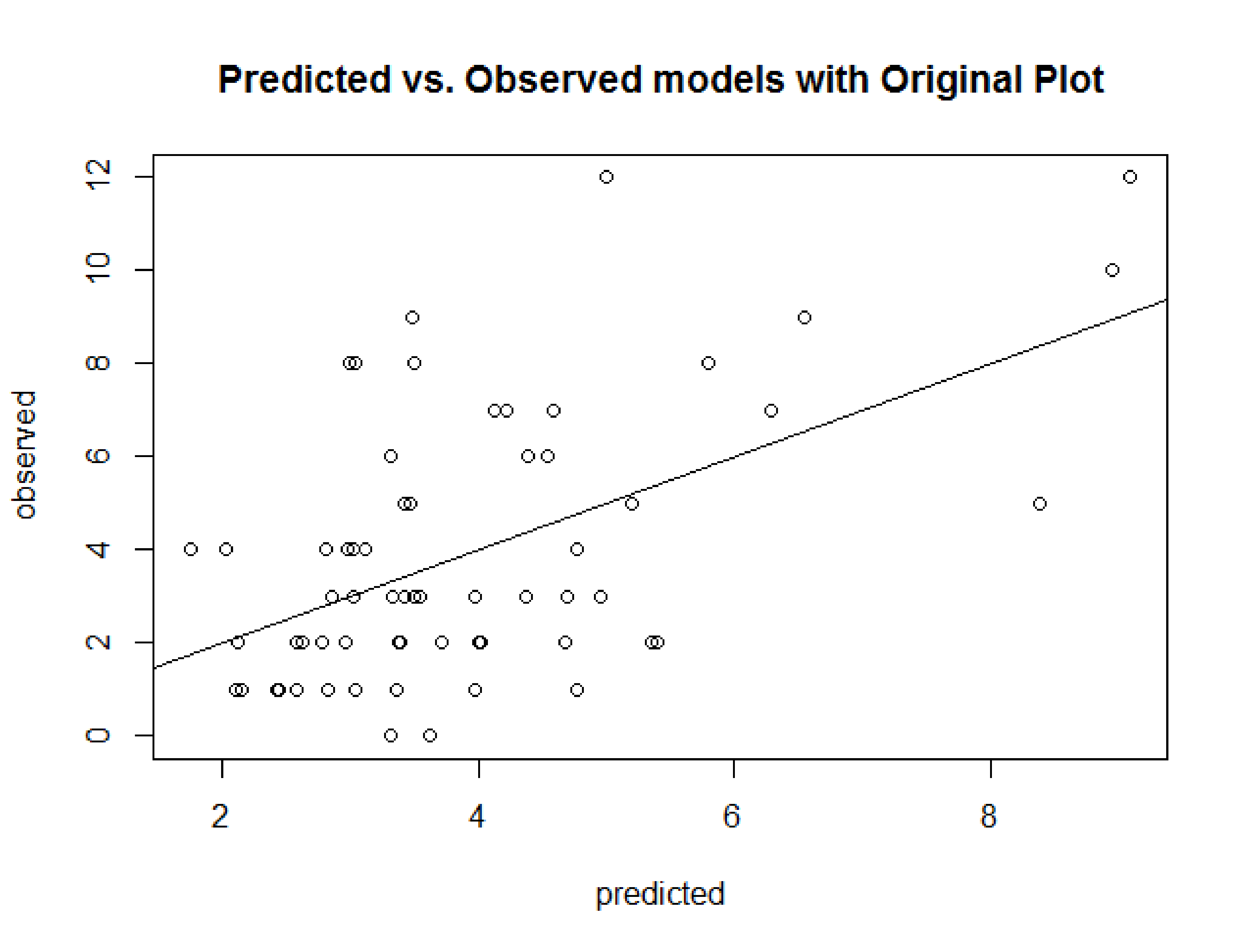
- Introduction
- Methodology
- Proposed model
- Prediction of landfalls

# Introduction

- Initially, already had predicted number of tropical cyclones
- Wanted to predict number of cyclones that make **landfall** in the U.S
- Identified covariates from data set which best predict future landfalls.

# Yearly average of covariates

- Computed yearly means of each covariate from original dataset
- Used step AIC (Poisson) to select the most predictive covariates
- Landfall Hurricanes = amo + ao + limcar + mdrsst_necp + nao + qbo + tna + whwp
- R = .543

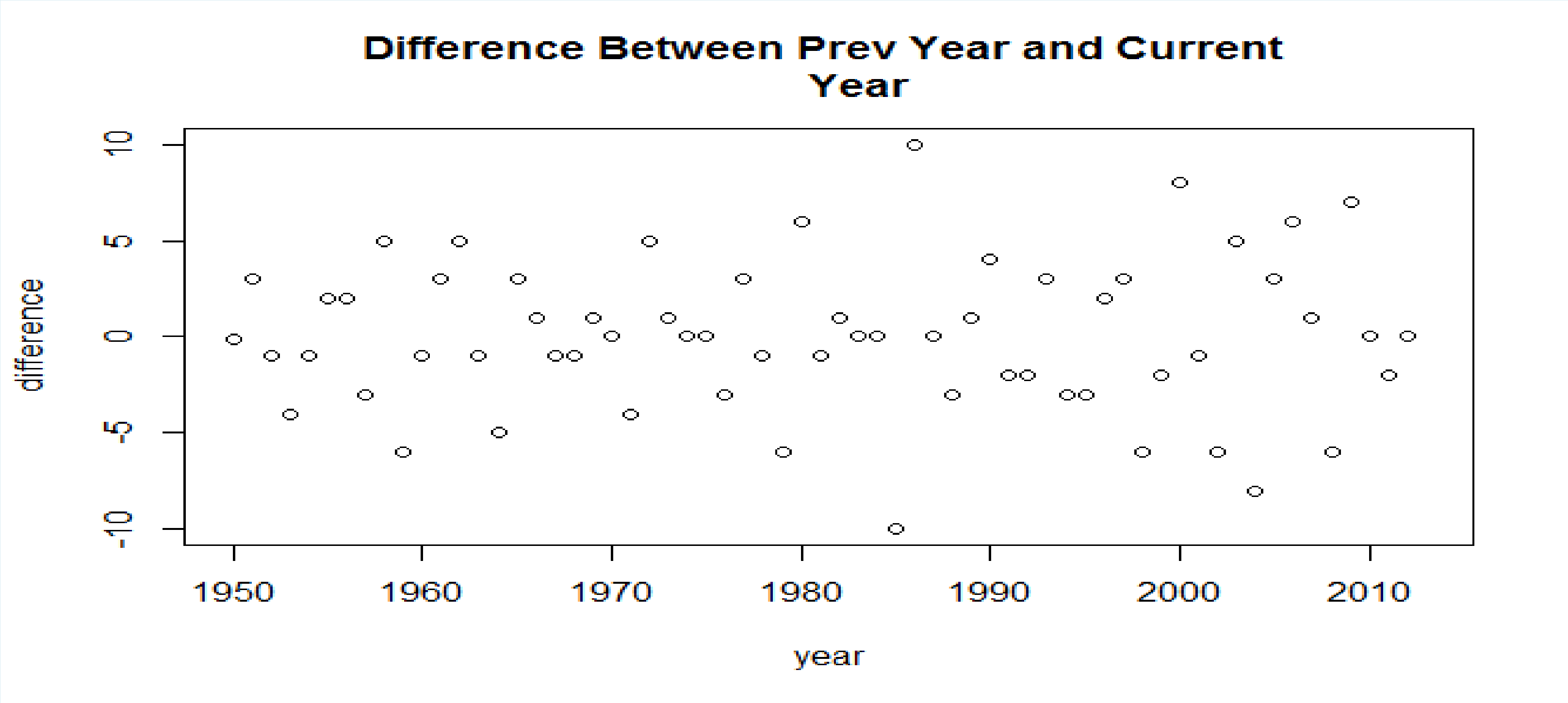

Predicted vs. Observed models with Original Plot
observed
0
2
4
6
8
10
12
2
4
6
8
predicted

# Previous year’s landfall count

- There may be dependence between yearly hurricane counts
- Previous year’s landfall count affects the subsequent year’s count
- Created new variable which reflects the number of hurricanes that made landfall in the previous year

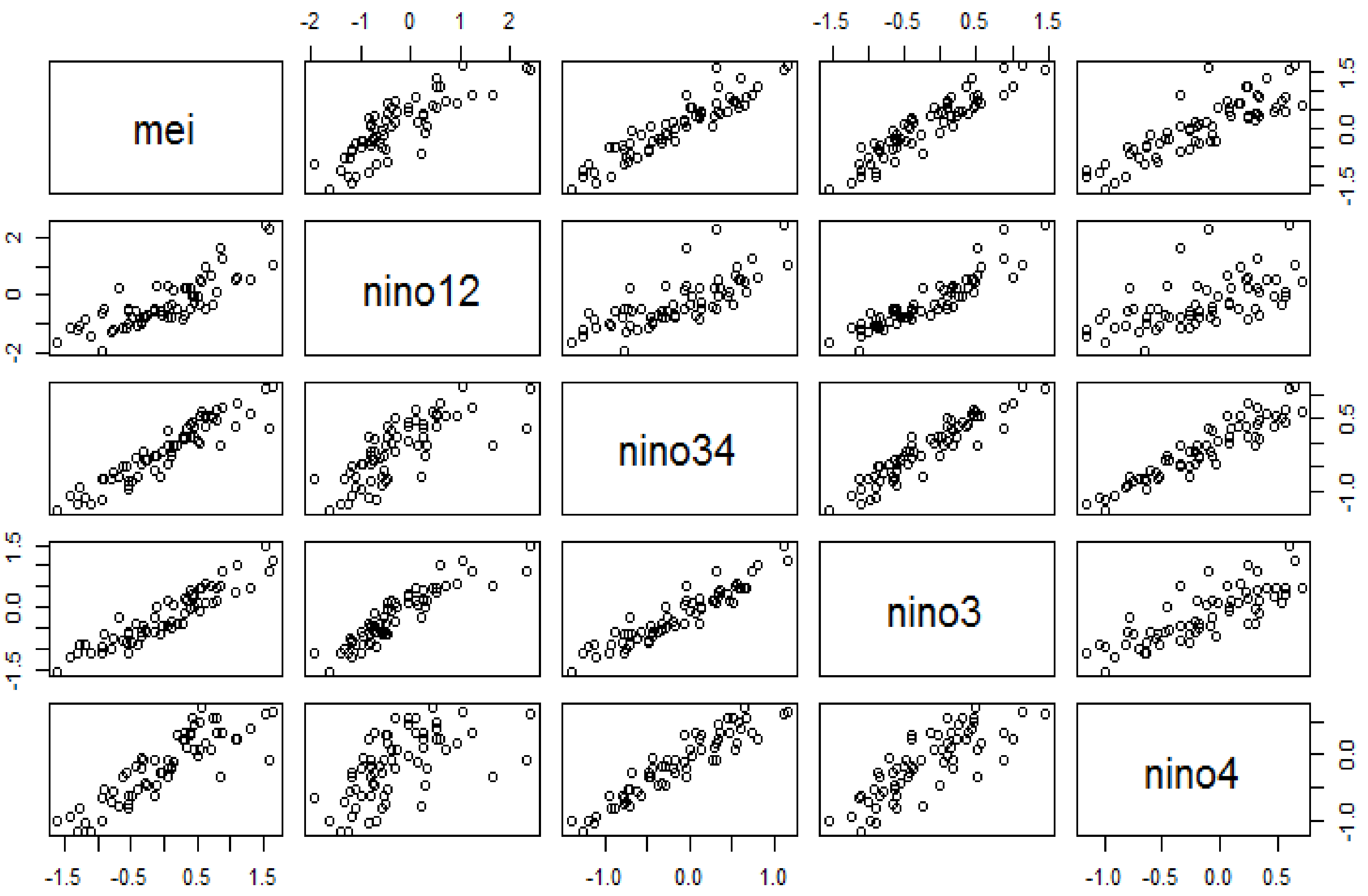
# Previous year's landfall count

- Ran step AIC with this new variable
  - This new variable was not selected as an important covariate



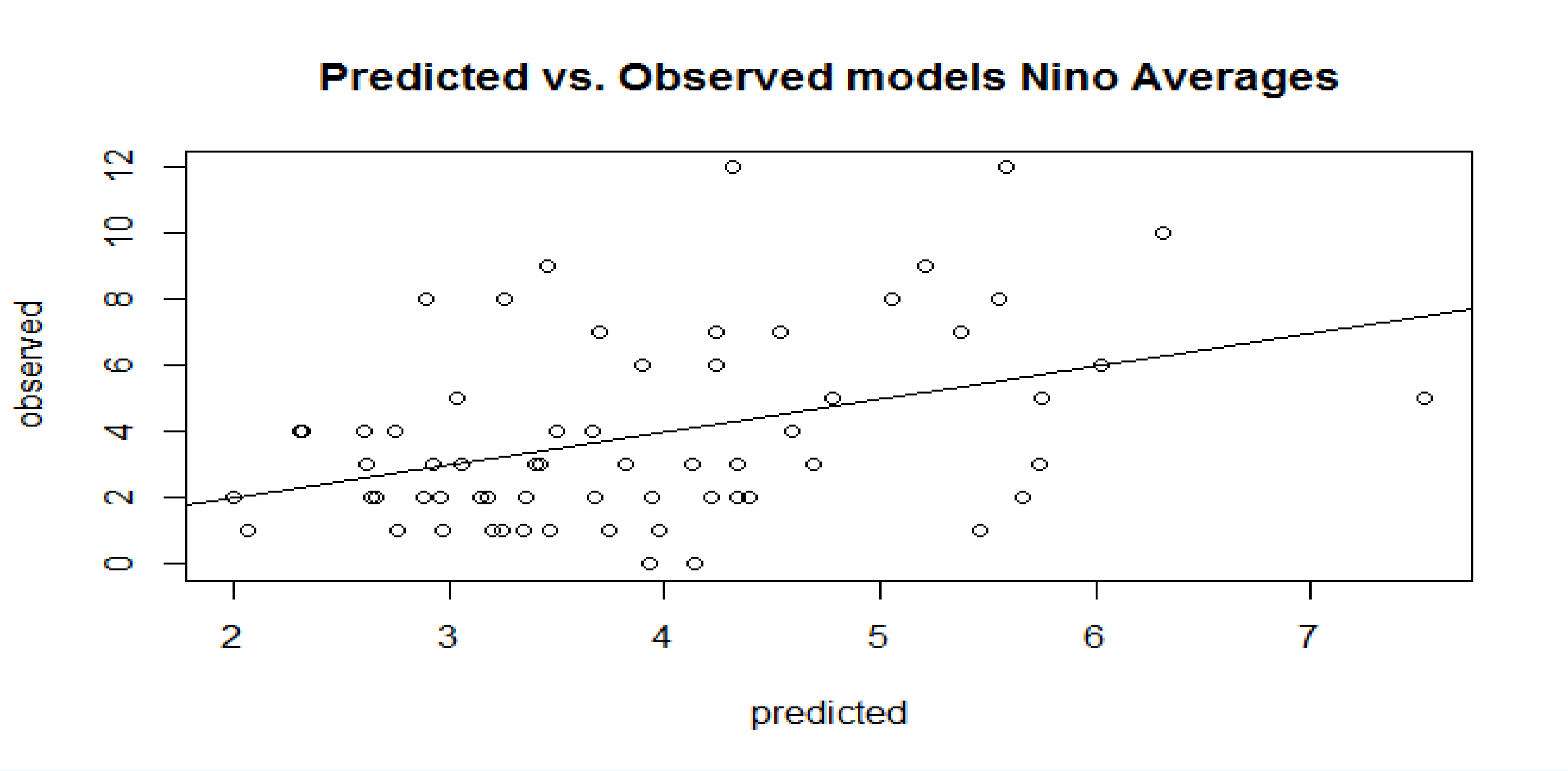
# “El Nino” Model

- Hurricanes = amo + nino12 + nino34 + nino3 + sgst + whwp + r6mh
- 3 El Nino covariates in this model


mei
nino12
nino34
nino3
nino4

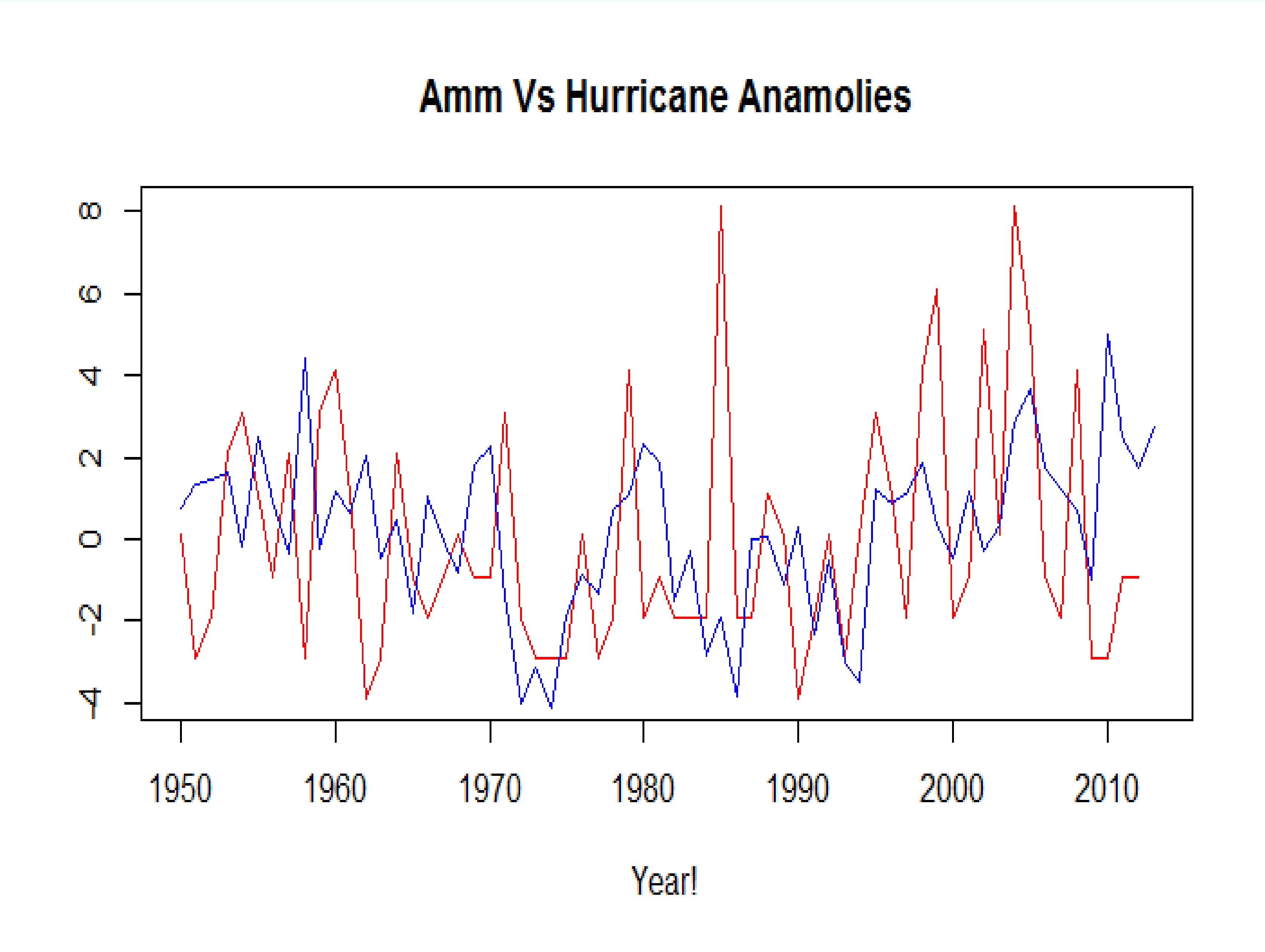
# Nino Average AIC Results

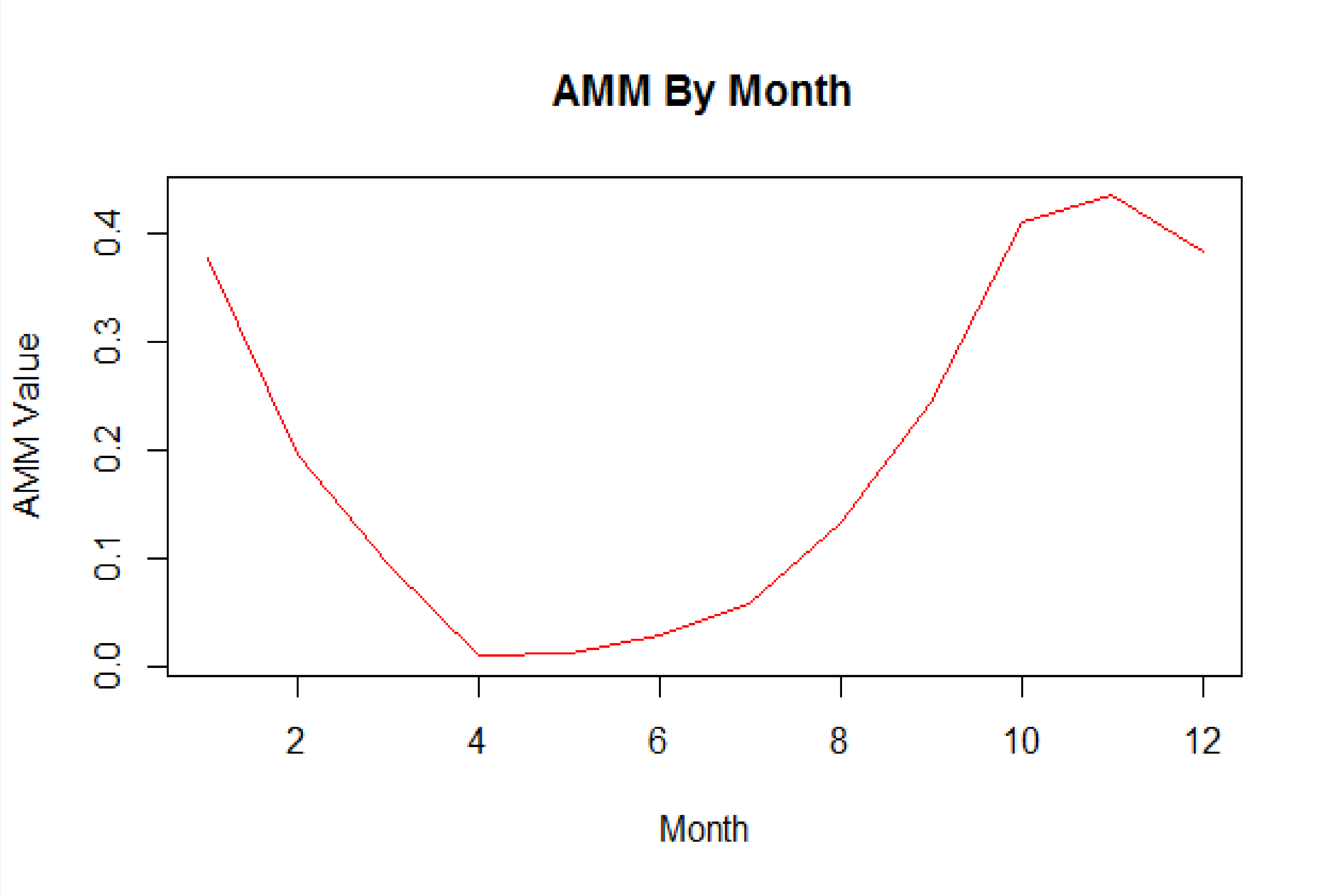
- Hurricane = amo + qbo + whwp
- R = .402



# Landfall count anomalies

- Investigated landfall count anomalies
  - The difference between actual number of landfalls per year and the average number of landfalls over the entire time period
- Sought covariates which were associated with extreme anomalies
  - Compared trends between landfall counts and individual covariates
  - 1985,1999, and 2004 : busy seasons

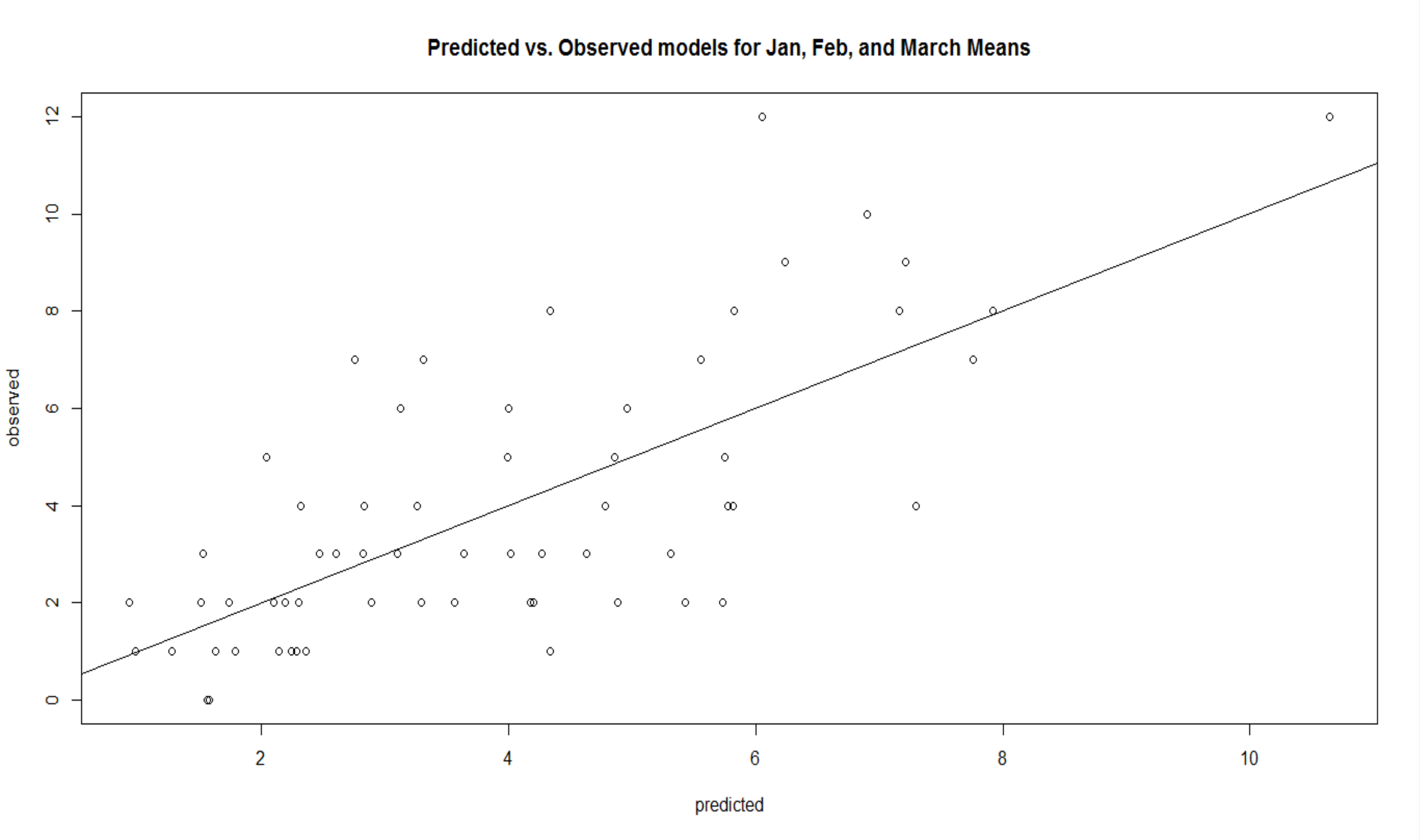

Amm Vs Hurricane Anamolies
8
6
4
2
0
-2
-4
1950
1960
1970
1980
1990
2000
2010
Year!


AMM By Month
AMM Value
0.0
0.1
0.2
0.3
0.4
2
4
6
8
10
12
Month

# Quarterly examination of data

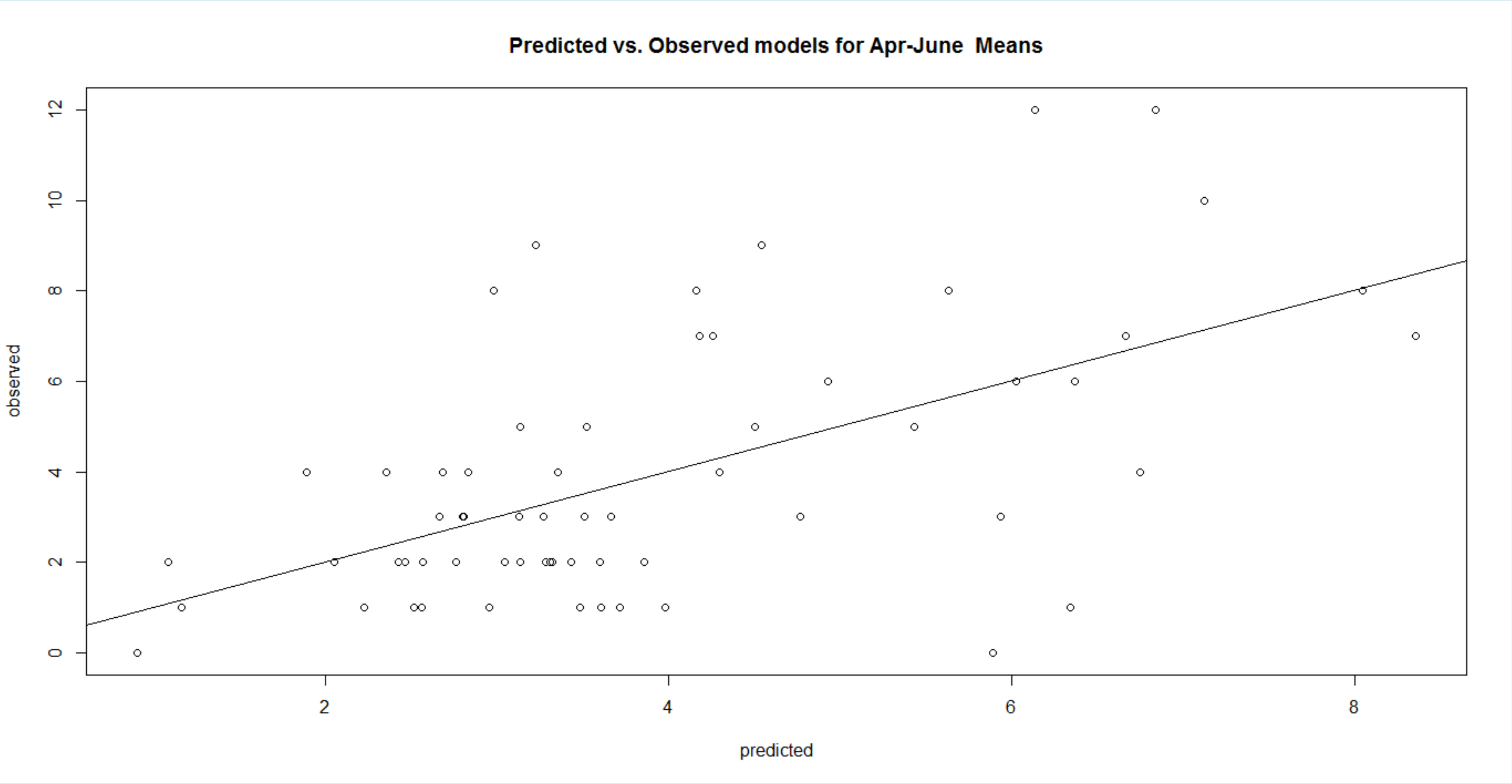
- Covariates may have varying predictive ability depending on the time of year
- Investigated the dataset by 3-month chunks using step AIC to select best covariates
  - Generated 3 models
    - January to March
    - April to June
    - July to September
    - October to December

# 1st Quarter



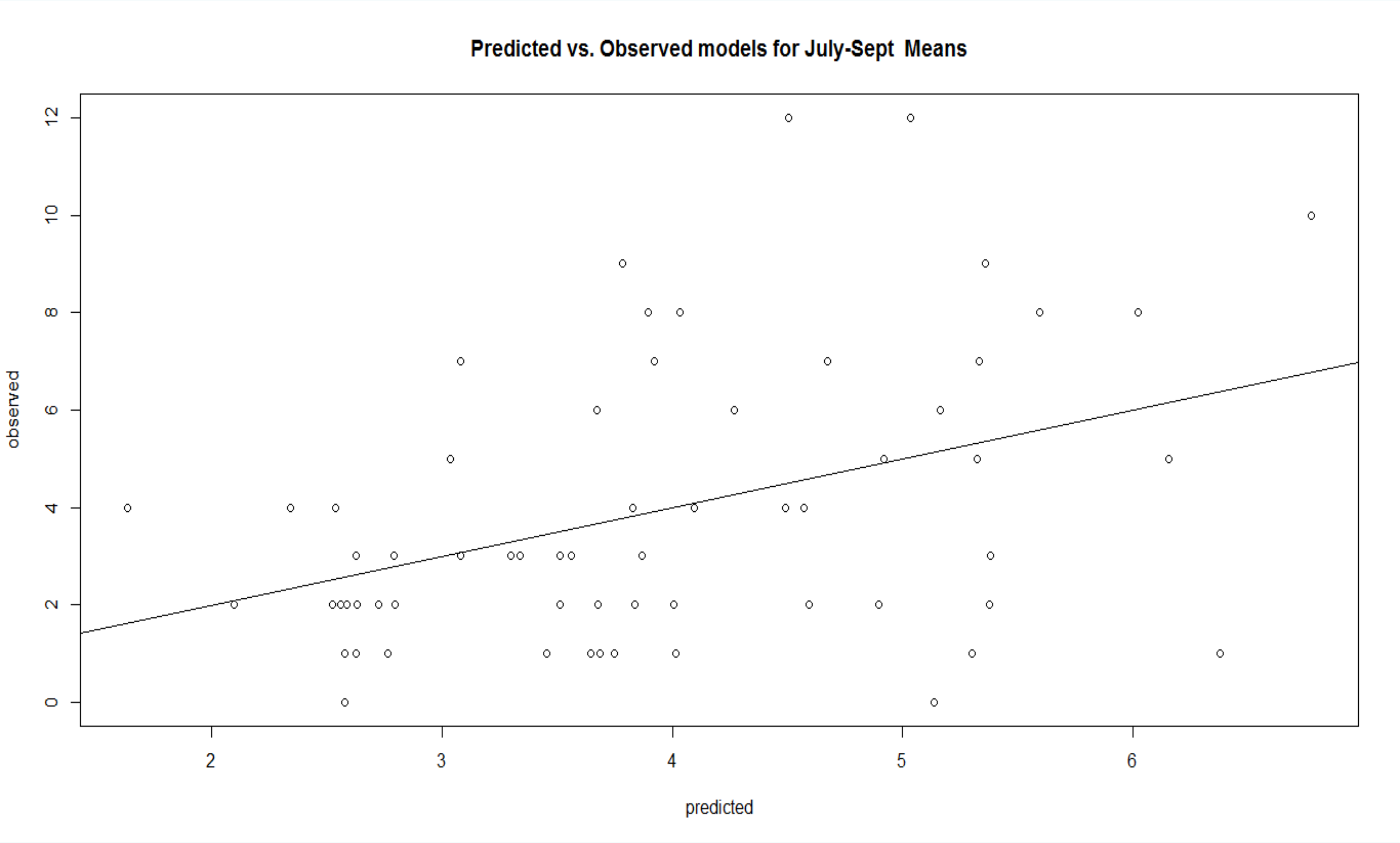

- R = .7248064

# $2^{nd}$ Quarter



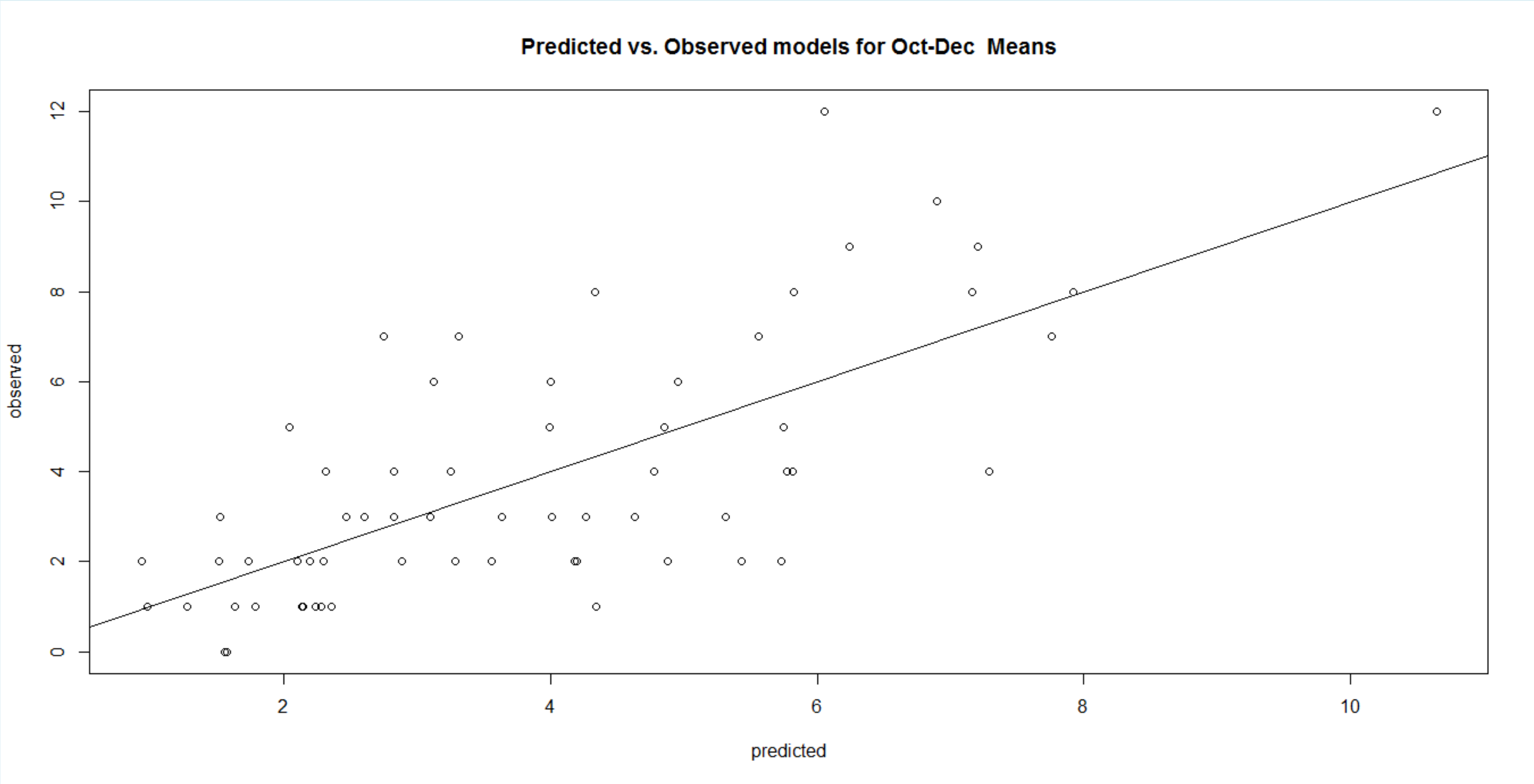

R = .5771428

# 3rd Quarter




R = .4089

# 4th Quarter




R = .777

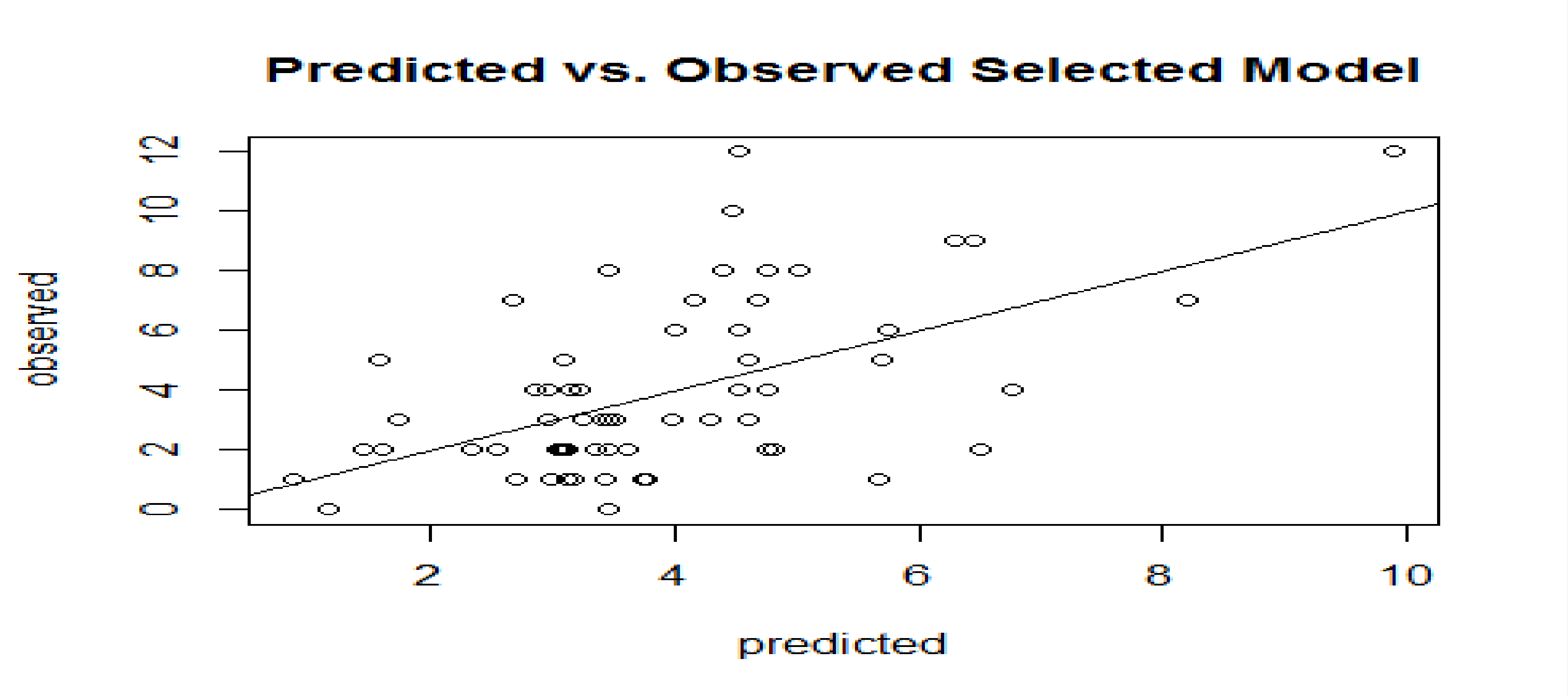
# Cross Validation

Cross-validation was used to select the best of the proposed models

| Model | CV Output |
|---|---|
| Yearly Average | 4.218075 |
| Quarter 1 | 4.638036 |
| Quarter 2 | 4.430353 |
| Quarter 3 | 4.665247 |
| Quarter 4 | 4.273530 |

# Model Selection Reasoning

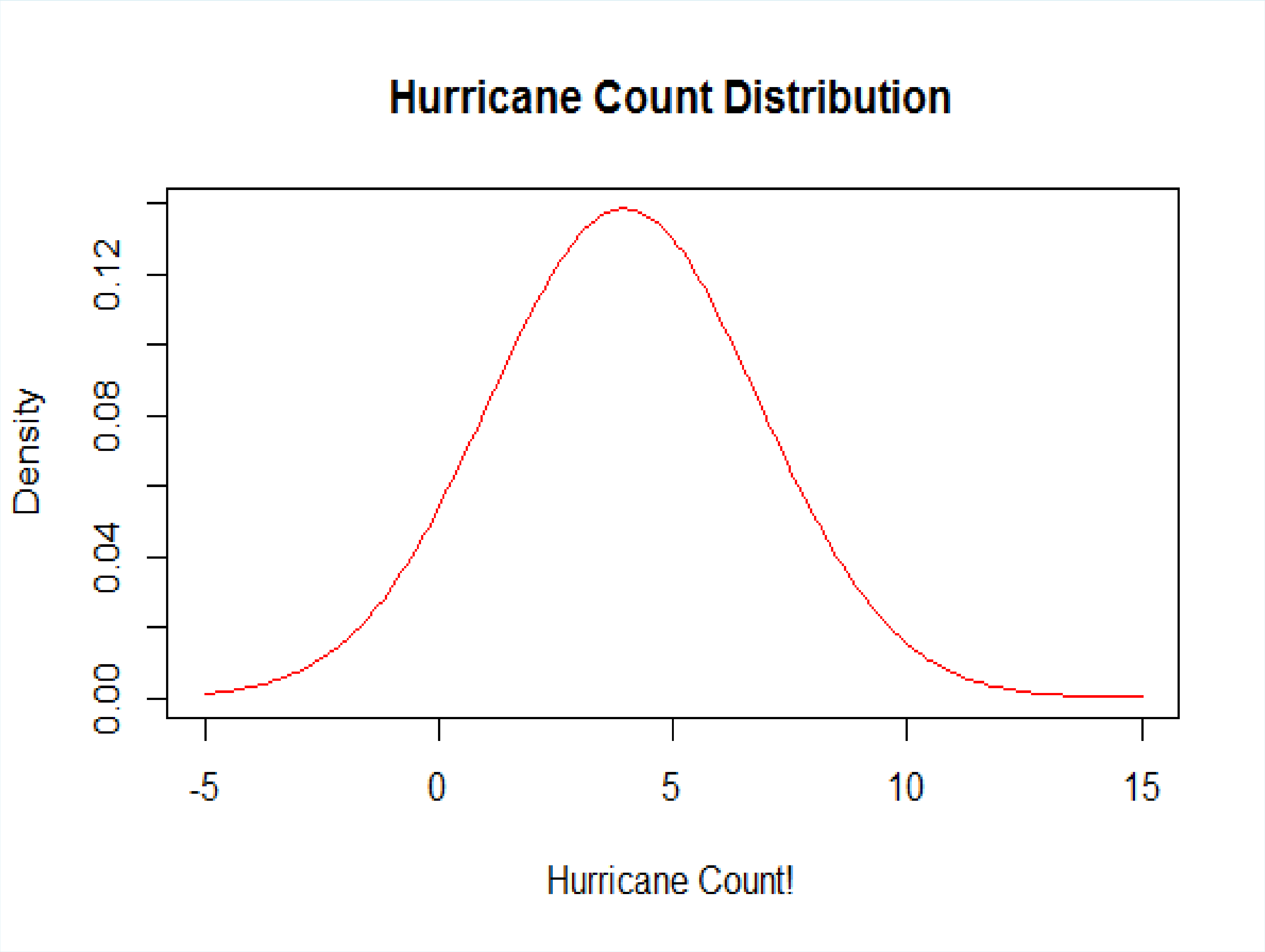
- Because of the high correlation and recent data, we chose to run the 1st quarter model.
- Only manipulation was that the AIC function gave us three of the correlated NINO values, so just selected one.



# Model Selection

- Hurricanes = amo + nin.avg + limhaw + limind + mdrslp + limind + sri
- R = .725
- Mean Predicted Hurricanes: 3.96
- Standard Deviation Hurricane Count: 2.88

| Hurricane Count | 0 | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|---|
| Probability | .074 | .107 | .135 | .151 | .549 |


Hurricane Count Distribution
Density
0.00
0.04
0.08
0.12
-5
0
5
10
15
Hurricane Count!

# Thoughts for Future Investigations

- Manipulate dataset so that data followed the course of the hurricane season (i.e. each hurricane season should begin with December of the previous calendar year)
- Investigate if selected covariates are highly dependent on human effects
- See if man made climate change is causing an increase in earthquakes
- Look at the predictions for total hurricanes and see what percentage of them reach land.
- Use different region Previous year counts.
- Compare physical theories with data collected (Warm Water, Rainfall, Shear)
- Regression techniques (weighting, interactions, smoothing, etc.)
- Look at patterns in data during specific formations of hurricanes
- Observe without extreme years,

# Conclusion

- Very Large, complex problem with lots of variables and analysis to consider, and future data to be collected
- Is man-made global warming increasing the amount of hurricanes per year?
- Signal in the Noise?