Rokos Award Internship Report

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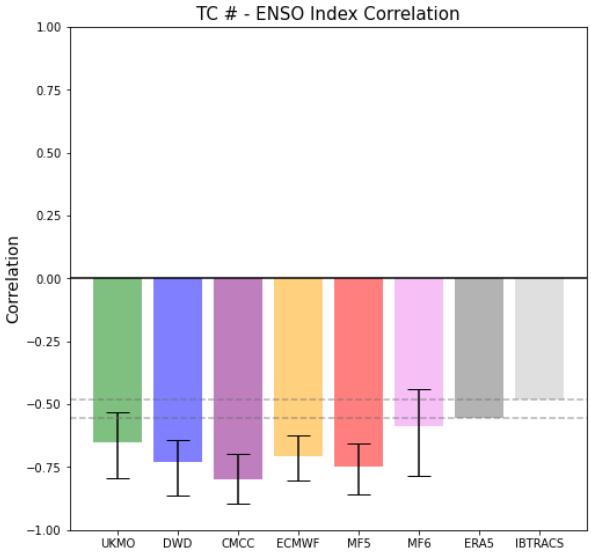
This summer, I worked in the Predictability Group in the sub-department of Atmospheric, Oceanic and Planetary Physics within the University of Oxford's Department of Physics, with supervisors Daniel Befort & Antje Weisheimer (both at Oxford), along with Joanne Camp from the Met Office and Kevin Hodges at the University of Reading. The project's aim was to evaluate forecasting skill at predicting the relationship between Atlantic hurricanes and El-Niño/La Niña (ENSO) type ocean events in the Pacific. There is a well-documented inverse relationship between Atlantic hurricane number (TC #) and Pacific sea surface temperatures (ENSO Index), however the skill of seasonal forecasts at predicting this particular relationship had not been analysed in much depth. Accurate predictions of Atlantic hurricanes are extremely important due to their large economic impact (often in billions of USD), and devastating humanitarian consequences.

Due to the COVID situation at the time, the entire project was conducted remotely, and I communicated with my supervisors regularly through weekly group meetings. Thankfully, due to the project being very coding-based, I still had a very enjoyable experience despite the lack of in-person contact. The seasonal forecast data was stored on a large server, which meant that I had to access everything remotely rather than downloading it onto my laptop. Before the internship I was not very familiar with the common practice of "ssh-ing" to access large files stored on a network, however I quickly learnt this very useful skill and became much more familiar with the features of the Terminal on my computer. Most of the data analysis was performed using Python. I was a little bit unsure about whether I had enough programming experience going in, but the coding was exactly the right difficulty. Since completing the internship, I feel much more fluent using Python for data handling.

My initial analysis showed that the overall negative correlation between TC # and ENSO Index was represented fairly well by the seasonal forecasts (6 different forecasts in colours, 2 different values of the correlation coefficient from the "real-life" data in greys). Unlike other regions of the ocean, all the forecasts for Atlantic hurricanes had the right sign of the correlation coefficient. This showed that seasonal forecasts were particularly strong in this ocean basin. However, I noticed that there was an area in the eastern Caribbean which was incorrectly modelled by almost all of the seasonal forecasts, which is an issue as there are lots of low-income islands particularly vulnerable to hurricane strikes.



After a group meeting about halfway through the internship, my supervisors steered me in the direction of looking at forecast biases to see if this could explain some of the errors. Essentially, many of the forecasts are biased towards too-cold or too-hot sea surface temperatures in the Pacific. This can have large consequences as ENSO events in this region are the largest source

of seasonal weather variability in the world. However, the results went against our expectations – instead of the forecast biases being the source of some of the problems, they did not seem to have any relationship to them entirely! Quite severe biases in the total number of hurricanes predicted or the sea surface temperatures crucially did not impact the correlation between them. This was interesting, but also slightly frustrating as the real reasons for the errors were likely a lot more complicated.

I learnt a huge amount about the climate system and seasonal forecasts during these 8 weeks, in particular about the environmental conditions which affect hurricane formation. I was really surprised to see just how different the seasonal forecasts were. The heatmap below shows the number of hurricanes predicted by each forecast in different areas around the world – the "DWD" forecast only predicts 2 or 3 per year in the important "MDR-A" region but the "MF5" forecast predicts over 15! Many of the statistical techniques I used (e.g bootstrapping) were new to me and it was nice to be able to apply those to real-life research. Discussing with my supervisors recently, I decided to try and turn my work into a short paper this winter – a process I'm really looking forward to.

I found this project immensely rewarding and would like to thank all of my supervisors for their help this summer. I would like to thank the Rokos Foundation for helping fund this internship; I had never studied this area of Physics before and it was wonderful to be in a group performing research in such an exciting area.