**Exploring temperature and precipitation changes in Europe across the 21st Century.**

* **Abstract (100 words)**
* **Introduction – Why the topic is important. What previous work has looked at this (mini lit review)**
* **Methods**
* **Results**
* **Discussion**

**Methods**

This study makes use of various General Circulation Model (GCM) simulation outputs from the Advanced IPCC Interactive Atlas. The variables that this research focuses on is: Mean Atmospheric Temperature (degrees C) and Total Precipitation (mm/day), and how these develop throughout the 21st Century under an RCP4.5 scenario. This relies on Historical Observation data from E-OBS and model projection data from CORDEX Europe. **Why?** Before making on projections on future climate, model results from CORDEX Europe for historical observations (1981-2010) are compared against the actual historical observational data from E-OBS (1980-2015) to gather an understanding as to whether the models are able to successfully replicate observations, and whether there are any spatial biases. Once the biases are established, the changes in temperature and precipitation by the end of the century (2081-2100) simulations are compared against the baseline observations to understand how European Climate may develop across this timeframe, along with a critical analysis of the uncertainties regarding these projections. These changes are explored for an annual timescale alongside the summer months of June, July, August (JJA) and winter months of December, January and February (DJF).

**Results**

Historical Observations

When compared against the historical observations, it appears that the CORDEX Europe models consistently underestimate the mean near-surface air temperature for a large proportion of Europe annually, and in the winter and summer months (Figure 1). The greatest underestimates are visible at the Northern border of Italy (~10°E, 45°N) and the Northern regions of Norway (between ~5°E-20°E, 60°N-70°N) with a temperature difference of ~-3°C. Despite the models simulating a general cooler climate than the observations evidence, there is a clear overestimation of temperatures in the Eastern European regions (between ~10°E-40°E, 40°N-50°N) by ~2°C throughout all of the seasons considered (Fig1). Unusually, in DJF, the average temperatures are overestimated by ~1.5°C on the Eastern border of Finland (30°E, 65°N).

In terms of precipitation, the models consistently simulate wetter conditions on average across the majority of Europe by ~1mm/day, with greater precipitation rates simulated on the Northern border of Italy, for all seasons (Fig1). The annual and winter trends are relatively similar, however during JJA the model simulations underestimate average precipitation rates over small regions of Eastern Europe by ~1mm/day. (refer to p.28)

A screenshot of a graph showing the temperature of the earth

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End of the century simulations

The simulations show a consistent warming trend across Europe by the end of the century, when compared to the baseline, with the majority of warming within 2°C, however greater warming is projected in areas of Northern Europe of up to 5°C (Fig2). This appears to be consistent across annual and seasonal timescales, with the greatest warming occurring in DJF.

The trends for precipitation are not as consistent (Fig2). Across annual and seasonal scales, the Mediterranean regions show consistent drier conditions, compared to the baseline observations at the beginning of the century (Fig2) by up to 30%. In addition to this, the precipitation changes appears to be most dramatic in Northern Europe, in line with larger temperature increases, which is expected due to the increased **water capacity feedback in-line with increasing temperatures.**

On an annual timescale, areas of the UK, France and Italy appear to show no change in precipitation by the end of the century (Fig2). Interestingly, the Northern coastline of Norway appears to show no change in precipitation annually, with this extent increasing in DJF.