Imperial College London

Natural Environment Research Council

2024_60_Physics_PC: Relating future jet stream changes to present-day observable variability

Supervisors: Dr Paulo Ceppi (p.ceppi@imperial.ac.uk)

Department: Department of Physics

Background:

The atmospheric circulation is characterised by "mid-latitude jet streams", belts of strong eastward winds in the middle latitudes of each hemisphere. These jet streams play a crucial role for the weather in mid-latitude regions (such as the UK), modulating the occurrence of windstorms, rainfall, cold spells and heatwaves.

Climate models predict that the jet streams will change as the climate warms, but the mechanisms of these changes are poorly understood, while climate models disagree quantitatively in their projections. The aim of the project is therefore to exploit recent advances in my group linking observable variations in the jet streams (on monthly to annual timescales) to their future changes, based on atmospheric dynamics theory.

The underlying hypothesis of the project is that climate model errors in the simulation of present-day jet variability lead to errors in the future jet response. By relating future jet stream changes to observable variations, the results will therefore provide a pathway towards reducing uncertainties in future regional climate change.

Aims and methodology:

The project involves two main aims: (1) to use objective statistical methods to characterise the variability of the different mid-latitude jet streams (e.g. in the North Atlantic, North Pacific, and Southern Hemisphere); and (2) to develop testable hypotheses to link the character of jet stream variability to its future changes. Two specific problems are of key interest for this project:

- Jet stream variability varies with region and season. Some jet streams are "shifting" (i.e. mainly move north-south) while others are "pulsing" (i.e. mainly change in strength). How these differences in variability affect the future response remains poorly understood.
- Some regions and seasons feature not just one but two mid-latitude jet streams. It is however not known how the presence of these "double jets" affects the future jet stream response.

To address these questions, the student will use atmospheric dynamics theory to interpret data from both climate models and observations. Much climate model data is already available for analysis, but the project will also involve performing additional climate model simulations to test hypotheses. The project will require developing a familiarity with statistical analysis methods and handling of large datasets in Python, or similar languages. The ultimate goal will be to provide observation-based constraints on the jet stream responses, and hence a reduction in the uncertainty in future regional climate change.