**ESU22001 Climate Science**

**Practical 3**

**Future climates**

**Aim**

Earth system models are our main tools for predicting the future of the climate. They are giant computer programs, with hundreds of thousands lines of code, that run on supercomputers and require terabytes of storage. In this practical you will explore the output from two different models (UK-ESM and MPI-ESM), under four shared socio-economic pathways (SSP1-2.6, SSP2=4.5, SSP3-7.0, SSP5-8.5) in the year 2100. You will be looking at temperature, precipitation and sea ice cover. The aim of this exercise is to understand what we predict the climate to be in 2100 and where the uncertainties in these predictions come from.

**Workflow**

Go to <https://drive.mathworks.com/sharing/25e56297-23ff-4f5d-8f54-b0e5d01937a2> then add the folder to your MATLAB Drive: click the Add to my Files button and select Copy Folder. MATLAB Drive adds the folder to your files and opens the Files view. You must be logged in with your MathWorks account to add a shared folder to your files. If you now go to the MATLAB Online window you should be able to see the files on the left hand side. The files in this folder are: two .m files associated with the practical task, and two .m files that read the data (you don’t need to look at these), three .m files that make your figures pretty (Brewermap, see below) as well as the paper on future scenarios downloadable from Blackboard.

The workflow here is a bit different from the previous two practicals. We are working with data rather than a model directly, so it is a lot more about plotting and extracting information from the data. You can change the model, the variable and the SSP scenario. You will see three maps: historical, 2100 and the differences between the two. At the bottom of the script you can also display the values for one specific location – currently set to Dublin, you can find lat/lon coordinates for your desired place through Google.

Some MATLAB functions you might find useful:

* mean gets the arithmetic mean of a variable – if you type mean(clim\_var(:)) in the console (not the script) you will get the mean global value
* max, min and median work similarly for the respective statistics

Don’t hesitate to ask questions, both if MATLAB gives you errors and if you are usure about the scientific interpretation.

|  |
| --- |
| **Explore how SSPs are defined** |
| Look through the O’Neil et al. paper – what are the main differences between the different SSPs? What are the differences in emissions? Make sure you understand what we would expect from each scenario. We covered this in lectures. |
| Explore changes in climate compared to present day conditions globally |
| Run practical3\_task1.m. Which regions have the highest/lowest changes in temperature and precipitation? What’s the average? What are the extremes? |
| Set ssp to different scenarios. How do the patterns change? Is it a linear change? Is it the same change in all regions of the globe? |
| Switch between the two different models. Are the predictions the same everywhere? Are the differences the same in all areas of the globe? Are they the same between the three variables? |
| Explore changes in climate compared to present day conditions locally |
| Run practical3\_task3.m. Rather than displaying maps, this script pulls out values for individual locations on the globe. Try out a few different locations when you’re answering these questions. The spatial resolution of the data is 1.25o latitude by 1.85o longitude, so locations that are very close together will give you the same value. |
| What are the predicted values of temperature and precipitation at your chosen locations under different SSPs? Are the differences between SSPs similar at all locations? |
| What are the predicted values for temperature and precipitation at your chosen locations in the two models? Are the differences between SSPs similar at all locations? |

**A note on colourmaps**

This practical uses colourmaps – a way to display a range of numerical values as colour. This is a very common way to display global data in earth system science. It is also a very common way to make figures illegible to all or some people and frequently make ugly figures. Here I am using a custom set of colourmaps meant to be both visible and pretty. However, all eyes are different. If you cannot see or do not like the colours I have chosen you can choose your own. Type brewer\_view in the MATLAB command line and see what’s available. You can then change the colourmap used on lines 39, 45 or 51 of practical3.m