# Instructions and learning outcomes

These are some instructor guidelines and general thoughts on the three practicals associated with this course.

## Length and setup

These practicals were run as 3-hour computer activities. I find it is best if they take place in actual computer labs, as this means the activity is not reliant on the students having their own laptops and it allows the instructors to easily interact with the students. However, as all the code is setup on MATLAB Online, it is possible to just have a regular seminar room or to do it remotely or asynchronously. I have previously had a demonstrator present for the practical as well as myself to answer questions and guide the students through the activity, with a total of 2 instructor for ~25 students and I estimate that number could go up to about 35 students easily. The activities do not take 3 hours for the majority of the students but there are always a couple that are working either more thoroughly or slowly.

## Prior programming knowledge

There is no prior programming knowledge needed, and I have taught this with students that have not taken any coding classes before. Everything is already coded, and the interaction is minimal, where the students are just required to change some numbers and observe the effects. The learning focus is on understanding Earth system processes. The exercises are currently set up in MATLAB Online as this requires the least amount of computer knowledge and cuts setup time. I found that giving the students the scripts directly leads to a lot of confusion around paths.

## Workflow

For each of the 3 practicals, the students are provided with a worksheet including general instructions, a link to the MATLAB Online repository and a list of questions that have to be answered by changing input parameter values, producing figures and thinking critically about the process at hand. The first task is always to explore the scripts given and write down inputs, outputs and think about what it is the math does. The following tasks instruct the students to alter inputs to explore the impact of the different variables and understand processes and feedbacks. The results are always in the form of visualisations – line graphs or maps – that the students have to interpret in the context of topics taught within the course.

## Assessment

The practicals themselves are not meant to be assessed. I encourage the students to include figures from practicals in their conceptual essays (also included here). It might be possible to associate an assessment with each practical but then the tasks and questions would need to be modified to be a little more in depth.

## Practical 1: Daisyworld

This is an application of the classic Daisyworld model with a modification that adds a simple greenhouse gas mechanism as implemented by [Paiva et al., 2014](https://www.sciencedirect.com/science/article/pii/S0303264714001270). Unlike more classical application of Daisyworld which look at long term planetary stability, this exercise is meant to illustrate land-atmosphere feedbacks cantering on albedo. The concept is central to many real-world climate change effects (high latitude sea ice melt, leading to accelerated temperature rise, forestation and its effects on local climate).

## Practical 2: Ecosystem carbon dynamics

This is a very simplified ecosystem model featuring the FvCB photosynthesis model and a linear biomass dependent respiration representation, leading to a broad level carbon balance. These two processes are examined under different temperature and CO2 levels, and examined in the context of the future of the terrestrial carbon cycle and potential for ecosystems to continue to take up Co2 out of the atmosphere. Basic knowledge of plant function is required for the students to interpret the results.

## Practical 3: future climate

This is a data based exercise, in which the students are presented with Earth System Model output for three different future scenarios (shared-socio economic pathways) at the end of the 21st century. The aim of the practical is to give the students first hand experience of what climate projections look like and to interrogate the variation between different regions, scenarios and models. The practical provides global maps as well as an easy way to get climate values for a given location on the globe. Students need to have a basic understanding of how we predict future climate and what Earth System Models are.