This week’s practical is about solar radiation.

Background

Before you start
You *must* read the install notes on https://github.com/UCL-EO/geog0133/blob/main/Install.md before the session and set up a way for you to access the notes. Whilst binder might be the easiest (and is what I will use in the session), remember that the results are not persistent (ie not saved and will not be there the next time you open a session), so this might not be what you want for the sessions. That said, you *can* leave and re-load notebooks in a session (see the ‘cloud’ buttons`).

Plan of the week: Teamwork!
You have been allocated to a group of 3-5 people in Teams (A to E) and should have received notification of this from Teams. You are expected to work together on this practical throughout the week, and discuss what you are doing with each other in the group. You should have a range of skills and backgrounds in your group, so make use of those perspectives. I would suggest that you try to hold a group meeting before the Wednesday session, if possible, so you can get to know each other better.

At the end of the week (Friday) all groups must present a slideshow (eg ppt) to discuss findings. Try to phrase this in terms of what you have learnt (compare what you knew before, with what you now know).

I would suggest you allocate one person as ‘coordinator’ to help prompt inputs from different people and be the keeper of the main ppt file for the show. If someone takes that role on, then the presentation should probably be given by other members of the group on the Friday. You can decide your own ways of running the groups, but you want to make sure that everyone contributes. You might assign other people to particular roles, or decide to all do the same thing and meet back to discuss. I leave it to you, but will be visiting each group during the sessions to see how you are getting on and to provide any advice.

Teething problems
Ive not run a session in this way before, so its possible there will be some teething problems about how we connect and how you work together. Ive planned it as well as I can, but we might need to change some things as we go along if we find that some parts work and others don’t. I am happy

to recieve suggestions from you all.

Python and use of the notebooks

Much of the practical is developed as some text, followed by some Python code for running and/or plotting datasets. At least one person in each group will have had experience of using these notebooks and Python before, so they should be able to provide some technical help. I have tried to design the work so that, with basic knowledge of any high-level programming (such as R or Matlab, if not Python) you should be able to understand what the codes are doing, and adapt them to your purposes. I understand that not everyone will have used Python, but if not, this is an opportunity for you to see how transferable the computing skills you have learned really are!

Purpose of the practical

The purpose of the practical is for you to gain an understanding of the equations and factors relating to the calculation of incident PAR at the Earth land surface. For you to assess your learning, you might like to answer the quiz below before (and after) you start the sessions. Most of your learning will be based around computer experiments. It is trivial to run the experiments, what you need to put time and effort into is in thinking about what they tell you and what the implications are for Terrestrial Carbon budgets.

Mostly, you will be looking with patterns of variation, so think through and discuss what the implications of those might be. You should be experimenting with changing the conditions of experiments (e.g. changing latitude) to look at effects.

Pay attention to the magnitudes of IPAR as well though, not just the patterns. You might be able to relate those some considerations of photosynthesis.

The main tool you have for this is the Python function solar_model():

solar_model(secs, mins, hours, days, months, years, lats, longs, julian_offset='2000/1/1')

A function that calculates the solar zenith angle (sza, in degrees), the Earth-Sun distance (in AU), and the instantaneous downwelling solar radiation in mol(photons) per square meter per second for a set of time(s) and geographical locations.

You also have access to the the CRU climate dataset for recent years.

You might find the AR5 Chapter 2 document
https://www.ipcc.ch/site/assets/uploads/2017/09/WG1AR5_Chapter02_FINAL.pdf
Useful for reading, especially with regard to any comments relating to solar radiation trends (and temperature, though that is more complex).

Before you start the practicals, you may find it useful to attempt the following quiz as a group. You don't need to get everything right - rather it is to measure what you know before doing the practical and any reading. You might also find the following table on some upper and lower temperature values for some types of plants helpful (we will do more detail of that sort in the follow-up practical, but there is no harm in getting used to these ideas now)

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Table 2. Default values of PFT-specific parameters for leaf biochemistry and photosynthesis.

		Broadleaf tree	Needleleaf tree	C_3 grass	C_4 grass	Shrub
k	Extinction coefficient for PAR	0.50	0.50	0.50	0.50	0.50
α (mol CO_2 [mol PAR photons]$^{-1}$)	Quantum efficiency	0.08	0.08	0.12	0.060	0.08
ω	Leaf scattering coefficient for PAR	0.15	0.15	0.15	0.17	0.15
f_{dr}	Dark respiration coefficient	0.015	0.015	0.015	0.025	0.015
r_g	Growth respiration coefficient	0.25	0.25	0.25	0.25	0.25
n_0 (kg N [kg C]$^{-1}$)	Top leaf Nitrogen concentration	0.046	0.033	0.073	0.060	0.060
n_{rl}	Ratio of Nitrogen concentrations in roots and leaves	1.00	1.00	1.00	1.00	1.00
n_{sl}	Ratio of Nitrogen concentrations in stem and leaves	0.10	0.10	1.00	1.00	0.10
T_{low} (°C)	Lower temperature parameter	0.0	−10.0	0.0	13.0	0.0
T_{upp} (°C)	Upper temperature parameter	36.0	26.0	36.0	45.0	36.0

Quiz
What is IPAR?
Why is it important for considering Terrestrial Carbon budgets?
What is an AU? And why is it a useful unit in the calculation of IPAR
What units do we measure IPAR in?
What factors control the amount of solar radiation arriving at the Earth?
How do these vary over the year?
What are solar cycles and how do they affect IPAR?
Why do we have seasons on Earth?
Define the following terms: equinox, solstice.
When do these occur?
What is so special (in the context of IPAR) about the arctic/antarctic circles and the topics of cancer and Capricorn?
How do clouds affect ipar at the Earth surface?

What is the relationship between diurnal patterns of ipar and temperature? What factors affect this?
What is the CRU climate dataset and how is it generated? Why is it an important dataset?