Climate Systems Science: CLIM3001

Schedule and timetable: See pages 5-6

School of BEES, Faculty of Science
Session 2, 2021
UOC: 6
Prerequisites: CLIM2001 or PHYS2801 or GEOS2711 or MATH2241

Course Coordinators: Dr Anna Ukkola and Prof Steven Sherwood
Climate Change Research Centre
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Course material will be posted in Moodle
https://moodle.telt.unsw.edu.au/login/index.php

Lectures:
held online – zoom links appear on page 5 below.

Labs:
held face-to-face and online – zoom links appear on page 5 below.

Course summary:

Climate science incorporates aspects of atmospheric science, oceanography, hydrology, biology, chemistry and physics. An understanding of the observations of and interactions between the Earth's carbon cycle, hydrological cycle and key chemical species is key to understanding the mechanisms that underpin climate and in particular climate change. This course will build on students existing understanding of these separate disciplines and present an integrative multi-disciplinary approach to understanding the key drivers of the Earth's climate as well as how these drivers are measured and incorporated into mathematical models of climate. Theoretical understanding gained in lectures will be explored in practical sessions using a range of simplified statistical and climate models that will allow students to appreciate the strengths and weaknesses of the assumptions inherent in each modelling approach. By allowing students to understand the myriad of feedbacks and complex interactions between components of the climate system, this course provides the foundation for interpreting climate model projections and understanding the key sources of uncertainty in climate prediction. These are essential prerequisites for research in this area and invaluable skills for graduates looking to apply their knowledge in the university sector, government or private business.

Course aims:

This course aims to give students an understanding of the key systems that control the Earth's climate, how they interact, as well the uncertainties associated with direct climate observation and future climate modelling. Students will have an appreciation of the range of observational data products that allow us to understand climate processes, including uncertainties associated with sampling and representativeness. Students will also develop

an understanding of how climate models are built, executed and evaluated against observations. Through this, students will gain the skills required to critically interpret climate model projections and understand key aspects of the uncertainties associated with those projections.

Student learning outcomes:

Learning outcomes are the skills and capabilities we hope this course will help you to attain i.e. what we have in mind while we're teaching. They include the ability to:

1. Identify the limits of inference for a given observed climate data product e.g. spatial or temporal scales, sampling uncertainty and representativeness, or noise levels.
2. Describe primary pathways of the carbon cycle, including photosynthesis, autotrophic and heterotrophic respiration and ocean solubility, as well as the conditions that enhance or restrict them and climate feedback mechanisms that may affect these.
3. Detail a range of key climate feedback mechanisms, as well as how these are likely to have affected the Earth's palaeoclimate.
4. Identify common representations of atmospheric, oceanic and terrestrial processes within current generation state-of-the-art climate models.
5. Identify aspects of future climate projections that deserve higher or lower confidence and recognise the sources of uncertainty in such projections including downscaling techniques.
6. Perform experiments using simple and complex models of the climate system and present results

Reading material

"Introduction to Climate Dynamics and Climate Modelling". By Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre and V. Zunz. Online textbook available at http://www.climate.be/textbook/. Further reading material may be prescribed for each week on Moodle, predominantly from online material. Please check Moodle regularly as updates to the reading list may be posted throughout the course.

There is a list of useful general references below.
http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html
https://www.publish.csiro.au/book/6558/
https://www.science.org.au/files/userfiles/learning/documents/climate-change-r.pdf

Lecture slides and recordings: We will make lecture slides and recordings available ASAP after each lecture. Lecture slides are not intended as a comprehensive representation of material covered in lectures and therefore are in no way a substitute for lecture attendance and effective note taking. They are made available simply to help structure and supplement students' notes.

Assessment

Assessment grading is as shown in the table below. Full details of assessments, including assessment criteria submission and details of feedback, will be made available on Moodle.

Activity	Contribution
First 7 tutorials	30%
Last 5 tutorials (including presentation)	20%
Final Exam	50%

More information about the assessable tasks above:

- Tutorials will mostly be computer-based but will also include some theoretical problems. It is expected that you will not be able to complete the tutorials tests within class time and will therefore be expected to spend some additional time completing assignments outside of class time. You should hand in your tutorial assignments by the beginning of the following week's tutorial. Assignments will be marked and handed back to you by the Thursday tutorial of the following week.
- The last 4 weeks of tutorials involve learning how to run a low resolution fully coupled climate model. Each person will be given a different 'experiment' to run and in the last tutorial you will be expected to give a 10 minute presentation on the results to the rest of the class and the lecturers. You will be marked on your understanding of the problem and how you contextualise your topic and the clarity and delivery of your presentation.
- The final examination will contain short and longer answer questions, to test your ability to synthesise several aspects of the course material.

Academic misconduct will not be tolerated in any form in this course. Substantiated instances of cheating or plagiarism may result in a failure grade. Please investigate http://www.lc.unsw.edu.au/plagiarism/ if you are in any way unsure of what constitutes plagiarism.

Help

The learning centre can offer personalised, confidential help with writing and a range of other academic skills. Contact them at http://www.lc.unsw.edu.au/student.html or call 9385 2060. UNSW Counselling offers a free and confidential service to students. Find out more at https://www.counselling.unsw.edu.au/ or call 9385 5418.

Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or http://www.studentequity.unsw.edu.au/content/default.cfm?ss=0). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

Grievance policy

Should you wish make a complaint regarding this course, the UNSW Grievance Policy can be found at http://www.gs.unsw.edu.au/policy/documents/studentcomplaintproc.pdf and the procedure for the resolution of complaints about student experiences at the University can

be found at https://my.unsw.edu.au/student/atoz/Complaints.html. In all cases you should first try to resolve any issues with the course coordinator (contact details above). If this is unsatisfactory, you should contact the Director of the Climate Change Research Centre (Prof. Katrin Meissner K.Meissner@unsw.edu.au). If this in turn is not satisfactory, you can contact the Associate Dean (Education). The University Counselling Services can also offer advice on any grievances (9385 5418 or counselling@unsw.edu.au).

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CLASSES:
Lecture/Lab: Mondays 3:00 – 5:00pm
Lectures: Tuesdays 4:00pm – 6:00pm
Lecture / Lab: Thursdays 3:00pm – 5:00pm

All **lectures** will be **online** on zoom: connect here: https://unsw.zoom.us/j/91036488322
All **labs** will be in **D26 G29 and online** on zoom: https://unsw.zoom.us/j/91036488322

			Lecture / Lab Topic
Week 1	Monday 31st May 3 – 5pm	**Anna Ukkola + Matt England**	Course introduction & Ocean's Role in Climate
	Tuesday 1st June 4 – 6pm	**Lisa Alexander**	Point-based measurement systems, scaling issues and statistics of climate
	Thursday 3rd June 3 – 5pm	**Lisa Alexander**	In situ observations and scaling issues (lab)
Week 2	Monday 7th June 3 – 5pm	**Laurie Menviel**	Palaeoclimate, climate forcings, Milankovitch theory and palaeo proxies
	Tuesday 8th June 4 – 6pm	**Jason Evans**	Principles of remote sensing applications
	Thursday 10th June 3 – 5pm	**Laurie Menviel**	Palaeoclimate Ice sheets (lab)
Week 3	Monday 14th June 3 – 5pm	**No class**	
	Tuesday 15th June 4 – 6pm	**Veronique Lago**	Planetary energy budget; radiation, fluxes
	Thursday 17th June 3 – 5pm	**Anna Ukkola**	Remote sensing (lab)
Week 4	Monday 21st June 3 – 5pm	**Veronique Lago**	Energy balance modelling (lab)
	Tuesday 22nd June 4 – 6pm	**Steven Sherwood**	Chaos and turbulence
	Thursday 24th June 3 – 5pm	**David Hutchinson**	Idealised ENSO modelling (lab)
Week 5	Monday 28th June 3 – 5pm	**No class**	
	Tuesday 29th June 4 – 6pm	**Nina Ridder**	The carbon cycle, ocean chemistry and acidification, feedbacks and tipping points
	Thursday 1st July 3 – 5pm	**Nina Ridder**	Carbon cycle modelling (lab)

Week 6	Mon 5th July – Fri 9th July	**No classes**	**Mid-session break**
Week 7	Monday 12th July 3 – 5pm	**Tim Raupach**	Coupled modelling with MK3L – 1. Intro (lab)
	Tuesday 13th July 4 – 6pm	**Sami Rifai**	Terrestrial carbon and water cycles
	Thursday 15th July 3 – 5pm	**Sami Rifai / Jon Page**	Modelling the photosynthetic response to environmental conditions (lab)
Week 8	Monday 19th July 3 – 5pm	**Tim Raupach**	Coupled modelling with MK3L – 2. Expts (lab)
	Tuesday 20th July 4 – 6pm	**Andy Pitman**	Global Climate Models: History and hierarchies of climate models, atmosphere and land-surface models
	Thursday 22nd July 3 – 5pm	**Matt England**	Global Climate Models: Ocean and cryosphere
Week 9	Monday 26th July 3 – 5pm	**Tim Raupach**	Coupled modelling with MK3L – 3. Expts (lab)
	Tuesday 27th July 4 – 6pm	**Jason Evans**	Regional climate modelling, statistical and dynamical downscaling
	Thursday 29th July 3 – 5pm	**Gab Abramowitz**	Model evaluation metrics & uncertainty estimation
Week 10	Monday 2nd Aug 3 – 5pm	**Tim Raupach**	Coupled modelling MK3L – 4. Synthesis (lab)
	Tuesday 3rd Aug 4 – 6pm	**No class**	
	Thursday 5th Aug 3 – 5pm	**Tim Raupach / Steven Sherwood**	Final presentations (lab) *Coupled modelling with MK3L*
Week 11	Monday 9th – Thursday 12th Aug	**No classes**	**Study leave**
Exam period	13th -26th Aug. Date TBC	**Exams**	**Exams**