

Climate Systems Science: CLIM3001

Course Coordinator: A/Prof Lisa Alexander and Prof Matthew England
Climate Change Research Centre
Level 4, Matthews Building
l.alexander@unsw.edu.au m.England@unsw.edu.au

Lecture Times: Mondays 11am-1pm [in CCRC seminar room – 4th Floor Mathews Building]

Tutorial Times: Thursdays 9am-11am [in BioScience G29]

Consultation Times: By appointment (email please).

Course material will be posted in Moodle
<https://moodle.telt.unsw.edu.au/login/index.php>

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

<http://www.csiro.au/resources/Climate-Change-Book.html>

<http://www.science.org.au/reports/climatechange2010.pdf>

Lecture slides: we will try to make lecture slides available in time for assessments on the material they cover, but cannot guarantee this. 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.

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 5 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 (A/Prof. Katrin Meissner K.Meissner@unsw.edu.au). If this in turn is not satisfactory, you can contact the Associate Dean (Education), A/Prof Chris Tisdell (9385 6792 or cct@unsw.edu.au). The University Counselling Services can also offer advice on any grievances (9385 5418 or counselling@unsw.edu.au).

Table 1: Lecture and tutorial outline**Lectures Mondays 11am-1pm; Tutorials Thursdays 9am-11am**

Dates 2018		Lecturer	Topic	Tutorial	Tutors
Overview: The climate system and observations				Thursdays 9-11	
Week 1	26 th Feb	Prof Matthew England	Course introduction: outline, lectures, pracs, assessment	No tutorial	
Week 2	5 th March	Dr Zoe Thomas	Palaeoclimate, climate forcings, Milankovitch theory and palaeo proxies	Ice sheets	Dr Zoe Thomas
Week 3	12 th March	A/Prof Lisa Alexander	Point-based measurement systems, scaling issues and statistics of climate	In situ observations and scaling issues	A/Prof Lisa Alexander
Week 4	19 th March	Prof Jason Evans	Principles of remote sensing applications	Remote sensing	Earl Duran
Energy budget, water and carbon cycles, chaos					
Week 5	26 th March	Dr Laurie Menviel	The carbon cycle, ocean chemistry and acidification, feedbacks and tipping points	Carbon cycle modelling	Dr Laurie Menviel
Mid Semester Break 30th March – 8th April					
Week 6	9 th April	Dr Ryan Holmes	Planetary energy budget; radiation, fluxes	Energy balance modelling	Stefan Contractor
Week 7	16 th April	Prof Steve Sherwood	Idealised models to study particular phenomena, chaos and initial conditions, ocean applications	Idealised ENSO modelling	Dr Ryan Holmes
Week 8	23 rd April	Dr Mark Decker	Hydrological cycle Land-atmosphere interaction and surface fluxes	Land-surface modelling	Dr Mark Decker
Models and modelling					
Week 9	30 th April	Dr Sarah Perkins-Kirkpatrick	Global Climate Models: History and hierarchies of climate models, atmosphere and land-surface models	Coupled modelling with MK3L	Dr Veronique Lago
Week 10	7 th May	Dr Paul Spence	Global Climate Models: Ocean and cryosphere	Coupled modelling with MK3L	Dr Veronique Lago
Week 11	14 th May	Dr Sarah Perkins-Kirkpatrick	Regional climate modelling, statistical and dynamical downscaling	Coupled modelling with MK3L	Dr Veronique Lago
Model evaluation and uncertainties					
Week 12	21 st May	Dr Gab Abramowitz TBC	Model evaluation metrics & uncertainty estimation	Coupled modelling with MK3L	Dr Veronique Lago
Week 13	28 th May	Prof Matthew England	The ocean's role in climate: from seasons to millennia	Student presentations	Prof Matthew England