UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Te Rāngai Pūtaiao/Te Kura Matū
College of Science/School of Physical and Chemical Sciences

Ingoa Akoranga | Title of course: Environmental and climate modelling

Waehere Akoranga | Course code: PHYS330/PHYS430

15 te hua | 15 points

Ingoa Kairuruku Akoranga | Name of course co-ordinator:
Dr Laura Revell
Imēra/Waea | Email/phone contact details:
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Whakamahuki | Course Description:
This is a hands-on course in which students will learn the fundamentals of modelling the Earth's climate system via a hierarchy of models. There will be one lecture a week, in which students develop in-depth understanding of atmospheric physics, chemistry and dynamics from global to local scales. Two computer labs will be run each week, in which students learn how to use the Python programming language to handle scientific data sets, how to program their own simple models of the climate system and how to modify and run more complex models used in advanced scientific research and industrial applications. Students will learn how to evaluate spatial model output against real-world observations and appraise its feasibility. Students will learn how models are used to support decision making through geoinformatics and science in the areas of: climate change; air pollution; the ozone layer; numerical weather prediction, and its application in renewable energy and agricultural meteorology. Particular focus will be given to how these issues affect Aotearoa New Zealand. Students will gain insight into research carried out by the international climate modelling community, and how Aotearoa NZ plays an active role in this community.

The first section of this course will provide information on the radiative energy balance of the atmosphere and heat transport in the climate system and how they can be simulated using simple climate models. Supporting information on the structure of the atmosphere and radiative transfer in the atmosphere will be detailed where appropriate. Simple one-dimensional energy balance models and more complex radiative-convective models will be detailed. The second section will explore how human activities affect atmospheric composition and climate on a global scale via coupling with atmospheric chemistry and radiation. Students will understand how global climate models can be used to inform environmental policy on issues such as

climate change and the ozone layer, and run simple Lagrangian trajectory models to simulate urban air pollution. The third section will focus on understanding atmospheric boundary layer (ABL) physics and dynamics that link the synoptic climate scales to the surface climate scales. ABL parametrizations like convection, turbulence, radiation, surface-atmospheric interactions and clouds will be discussed in the context of their application and relevance to numerical weather prediction (NWP) models. Students will develop skills and knowledge that will allow them to dynamically downscale meteorological fields from the synoptic to the meso- and micro- scales and derive geospatial information from the climatic fields at relevant spatial resolutions for real world applications.

Hua Ako | Course Learning Outcomes:

1. Explain why a range of models are necessary to solve different problems, demonstrating knowledge relating to multiple scenarios based on current literature. Show how models and derived geospatial information are used to support decision making and science.
2. Identify what constitutes a functional model, and apply advanced programming skills to develop and run a range of climate models and analyse the output.
3. Synthesise mathematical and programming skills to develop a parameterisation for simple climate models.
4. Evaluate whether model output is reasonable when compared with observations and other models using advanced data analysis techniques. Explain how derived model output can be effectively communicated to affected communities.

Āhuatanga Tāura | Graduate Attributes met:

BICC1. A process of self-reflection on the nature of knowledge and norms.
BICC3. Traditional and contemporary realities of Māori society.
BICC5. The processes of colonisation and globalisation.
BICC7. Application of bicultural competence and confidence in a chosen discipline and career.
GA2. Understanding the global nature of one's discipline.
GA3. The ability to engage effectively in global and multicultural contexts.
CE3. Understanding how the skills of the subject enhances the community.
EIE1. Working effectively and professionally with diverse communities.
EIE2. Communication.
EIE3. Analytical, critical thinking and problem solving in diverse contexts.
EIE4. Digital Literacy.
EIE5. Innovation, enterprising and creativity.

Mahi ā-Ākonga | Workload (expected distribution of student hours, note 15 points = 150 hours):
60 hours of contact time (5 hours per week); i.e. one one-hour lecture per week and two two-hour computer labs per week.
7.5 hours of study per week (on average) which will consist of course reading, computer programming practice, completion of individual assessments (Assignment 1-3, below) and group work to complete the final assessment (Assignment 4).

Aromatawai | Assessment (method, weight, date due):
Assignment 1 (17%): Global climate modelling
Assignment 2 (17%): Simple climate models and energy balance models
Assignment 3 (17%): Small-scale meteorological modelling and Numerical Weather Prediction.
Assignment 4 (49%): Climate change and its implications for New Zealand.

Tuhinga | Text and Readings:

- Fundamentals of Atmospheric Modeling by Mark Z. Jacobson
- Mesoscale meteorological modelling (https://www.elsevier.com/books/mesoscale-meteorological-modeling/pielke-sr/978-0-12-385237-3)
- Parameterization Schemes, https://www.amazon.com/Parameterization-Schemes-Understanding-Numerical-Prediction/dp/0521126762

Herenga Akoranga | Academic Policies (e.g. special consideration, dishonest practice):
The School of Physical and Chemical Sciences has general policies that apply to all courses regarding such matters as Dishonest Practice, Allowed types of calculators, Marks and Grades boundaries, Late Work, Academic Liaison, Assistance for Students with Disabilities, Reconsideration of Grades, Aegrotat Applications, Missing of Tests etc. Please consult the School website for details.