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.

Part 1 of the course (weeks 1-3) will focus on learning how to handle climate model data with the Python programming language and working in Jupyter notebooks.
Lecturer: Professor Adrian McDonald.

Part 2 (weeks 4-6) will focus on the radiative energy balance of the atmosphere and heat transport in the climate system using simple climate modelling. Supporting information on the structure of the atmosphere and radiative transfer will be detailed where appropriate. The Finite

Amplitude Impulse Response (FaIR) simple climate model will be used to explore how human activities affect atmospheric composition and climate on a global scale.
Lecturer: Professor Dave Frame.

Part 3 (weeks 7-9) will focus on modelling air pollution chemistry on city-wide scales. The AtChem2 model will be used to explore the influences of air pollution policies on air quality, with a particular focus on nitrogen oxides, volatile organic compounds and tropospheric ozone. Students will understand how models are used to inform environmental policy.
Lecturer: Dr Catherine Hardacre.

Part 4 (weeks 10-12) will focus on basic oceanographic principles and how they are reflected in the global ocean models. The data analysis will focus on analysing the existing model output with Python and Jupiter notebooks. Lecturer: Dr Alena Malyarenko.

**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 and completion of individual assignments.

**Aromatawai | Assessment (method, weight, date due):**

- Weekly lab work (20%): As advised by the lecturer

- Assignment 1 (20%): Handling climate model data sets in Python, due end of week 4
- Assignment 2 (20%): Simple climate modelling, due start of week 7
- Assignment 3 (20%): Air pollution modelling, due end of week 10
- Assignment 4 (20%): Handling ocean model output in Python, due end of week 12

**Tuhinga | Suggested texts:**

- Fundamentals of Atmospheric Modeling by Mark Z. Jacobson
- Robert Stewart - "Introduction to Physical Oceanography" https://open.umn.edu/opentextbooks/textbooks/20 (open access)
- Neil C. Wells - "The Atmosphere and Ocean : A Physical Introduction" - UC Library - https://libcat.canterbury.ac.nz/Record/1999945

**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.