City University of Hong Kong

Information on a Course
offered by School of Energy and Environment
with effect from Semester A in 2012 / 2013

Part I

Course Title: Climate Modeling

Course Code: SEE6212

Course Duration: One semester

Credit Units: 3

Level: P6

Medium of Instruction: English

Prerequisites: None

Precursors: MA1201 and MA1301, or equivalent knowledge in calculus, linear algrebra and complex numbers.

Equivalent Courses: SEE8213

Exclusive Courses: Nil

Part II

Course Aims

Nowadays, numerical models have become indispensable for studying climate dynamics. This advanced graduate course aims at introducing numerical models as a tool for solving different class of problems in climate dynamics, and is a follow-up of the core course in atmospheric science in the M.Sc. Energy and Environment programme. The historical development of climate models, basic numerics and models with various degrees of complexity will be considered. There will be a special topic on model simulations of the Asian climate. Overall, emphasis is given to using numerical models as an innovative method to inform our understanding of the climate system. Students will also discover and learn how to use models to interpret climate variations and climate change.

Course Intended Learning Outcomes (CILOs)

Upon successful completion of this course, students should be able to:

No.	CILOs	Weighting (if applicable)
1.	Describe the historical development of climate models	1
2.	Describe and apply the basic numerical techniques for solving equations in geophysical fluid dynamics	3
3.	Describe climate models with various degrees of complexity, and their use for tackling different class of problems in climate dynamics	2
4.	Describe the various components of a comprehensive atmosphere-ocean general circulation model, and ways of validating model simulations	2
5.	Describe and discuss the general performance of and challenges in simulating the Asian climate by general circulation models	2

Teaching and Learning Activities (TLAs)

(Indicative of likely activities and tasks designed to facilitate students' achievement of the CILOs. Final details will be provided to students in their first week of attendance in this course)

TLAs	Lectures	Group Discussion	Tutorials	Hours/week (if applicable)
CILO 1	2	-	1	3
CILO 2	10	1	2	13
CILO 3	6	1	1	8
CILO 4	6	-	1	7
CILO 5	6	1	1	8
Total (hrs)	30	3	6	39

Assessment Tasks/Activities

(Indicative of likely activities and tasks designed to assess how well the students achieve the CILOs. Final details will be provided to students in their first week of attendance in this course)

- Examination duration: 2 hrs
- Percentage of coursework, examination, etc.: 60% by coursework; 40% by exam
- Coursework consists of assignments, a mid-term test and a project

CILO No.	Assignment (%)	Mid-term test (%)	Project (%)	Exam (%)	Total (%)
CILO 1	3	2	-	5	10
CILO 2	3	7	10	10	30
CILO 3	4	6	-	10	20
CILO 4	5	-	5	10	20
CILO 5	-	-	15	5	20
Total	15	15	30	40	100

Grading of Student Achievement: Refer to Grading of Courses in the Academic Regulations for Taught Postgraduate Degrees.

The grading is assigned based on students' performance in assessment tasks/activities.

Part III

Keyword Syllabus

- Historical development of climate models-
  numerical weather prediction; atmospheric GCM; oceanic GCM; coupled models; earth system modelling
- Numerical techniques for solving GFD equations-
  Finite difference methods; spectral methods; stability; CFL criterion; shallow water system; physically insignificant fast waves; primitive equations
- Models with different degrees of complexity-
  zero-dimensional models; one-dimensional models; three-dimensional AGCM; OGCM; coupled models; ENSO models
- Components of an AOGCM and model validation-
  conservation equations (momentum, energy, water vapour, mass) and hydrostatic balance; radiation; convection; PBL; land surface; ocean; sea ice; model metrics
- Asian climate simulations-
  Asian monsoon; ISO; TC activity; monsoon-ENSO interaction; climate change projections

Recommended Reading:

- *An Introduction to Dynamic Meteorology,* J.R. Holton (Academic Press, 4th edition, 2004).
- *Global Physical Climatology,* D. L. Hartmann (Academic Press, 1994)
- *Numerical Methods for Wave Equations in Geophysical Fluid Dynamics,* D. R. Durran (Springer, 1999)
- *Climate System Modeling,* K. E. Trenberth (ed.) (Cambridge University Press, 1992)
- *Climate Models: An Assessment of Strengths and Limitations. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research* [Bader D.C., C. Covey, W.J. Gutowski, I.M. Held, K.E. Kunkel, R.L. Miller, R.T. Tokmakian and M.H. Zhang (Authors)]. (Department of Energy, Office of Biological and Environmental Research, Washington, D.C., USA, 124 pp. 2008)