

SEE8213 Climate Modeling

Course Title:	Climate Modeling
Course Code:	SEE8213
Course Duration:	One semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Prerequisites:	N/A
Precursors:	MA1201 and MA1301, or equivalent knowledge in calculus, linear algebra and complex numbers.
Equivalent Courses:	SEE6212 Climate Modeling
Exclusive Courses:	N/A

Course Aims

Nowadays, numerical models have become indispensable for studying climate dynamics. This advanced graduate course aims at introducing numerical models as tools for solving different class of problems in climate dynamics. 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)

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

- 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 (Attachment) and to the Explanatory Notes.

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)