Course title: Introduction to Climate Modelling			
Course code: NRC 122	**No. of credits: 3**	**L-T-P: 28-10-8**	**Learning hours: 42**
Pre-requisite course code and title (if any): Environmental Statistics			
Department: Energy and Environment			
Course coordinator: Dr Kamna Scahdeva	Course instructor: Mr Saurabh Bhardwaj		
Contact details: saurabh.bhardwaj@teri.res.in			
Course type: Elective	Course offered in: Semester 2		

Course Description:

On completion of this course, students should be able to understand fundamental principles of climate science depicted in the models, various types and usage of modelling activities, and basic programming required to obtain modelling skills. The lectures will lead to basic understanding of atmospheric processes, modelling framework under IPCC working papers and case studies involving usage of modelling into impact studies.

Course objectives

1. To understand the basic concepts of climate dynamics including basic forces at play and their balances and attribution.
2. To develop the conceptual understanding on forecasting techniques and their usages
3. To establish a basic understanding towards various climate modelling approaches and their differentiations.
4. To develop a theoretical perspective towards IPCC projections and working group reports.
5. To develop computational understanding on basic programming to assist towards modelling exercises.

Course content

S No	Topic	L	T	P
1.	Fundamental Forces Pressure Gradient Force, Centrifugal Force, Gravity Force, Coriolis Force	4	2	
2.	Numerical Weather Prediction (NWP) Fundamental equations of fluid motion in rotating and non-rotating fluid in different coordinate system, Principle of Weather Forecasting, General Circulation of atmosphere and Ocean	4	4	
3.	Introduction to Climate Models a. Basics of models i. Concept of Parameterizations, time-stepping and resolution b. Framework and process of model simulations c. Types of Models d. Uncertainties and sensitivity e. Case Studies	8	2	
4.	Introduction to Climate processes a. Basic understanding on Climate Sciences b. Uncertainty c. IPCC and working Group 1 projections: Global to Regional aspects d. Case Studies – illustrations	6	2	
5.	Introduction to Linux operating system and FORTRAN programming	6		8

	Total	28	10	8

Evaluation criteria

- Test 1: 20%
- Test 2: 20%
- Test 3: 60%

Learning outcomes:

After completion of this course students should be able to
1. Exhibit basic conceptual understanding on climate science and its dynamics
2. Explain the basic differences of various modelling techniques and their usage
3. Understand the IPCC projections and working group reports
4. Use basic Linux scripting and programming.

Pedagogical approach

Class room teaching with few hands-on exercises on programming

Materials

Required text

- Goosse H., Barriat P.Y., Lefebvre W., Loutre M.F. and Zunz V., Introduction to Climate Dynamics and Climate Modeling.
- James R.H. An Introduction to Dynamic Meteorology, International Geophysics Series
- Steven A. Ackerman and John A. Knox, Meteorology Understanding the Atmoshere

Suggested readings

- Geoffrey K.V. Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-scale Circulation.
- Jacobson M.Z. Fundamentals of Atmospheric Modeling.
- McGuffie K. (Henderson-Sellers A., A Climate Modelling Primer, John Wiley & Sons.
- Taylor F.W. Elementary Climate Physics.
- Washington W.M. and Parkinson C.L.Introduction to Three-dimensional Climate Modeling

Websites

- IPCC (2001 & 2007) Working Group I Report "The Physical Science Basis"

Journals

- Geophysical Research
- Global Environmental Change
- Climate Dynamics
- Current Science

Additional information (if any)

Regular Assignment and reading will be given on weekly basis

Student responsibilities

The students are expected to submit assignments in time and come prepared with readings when provided.

Course reviewers

1. Dr. Madhusoodanan M.S., Associate Professor, Amrita University.
2. Prof A K Dimri, SES, JNU