

Course syllabus

Department of Civil Engineering, Indian Institute of Technology Madras

CE5235 - Understanding climate dynamics and its mysteries

Credit Distribution: C:9 L:3 T:0 P:0 E:0 O:6 TH:0

Course Type: Theory

Description: Familiarize students with the past climate records to signify drastic changes in the climate system and using this as a foundation explore how it challenges our understanding of climate dynamics.

Course Content: Climate change history: Definition of what is climate; physical evidences of climate change and detailed mechanism; methods used in climate reconstruction. Faint young Sun paradox: Black body radiation; Radiative equilibrium climate model; the fundamentals of greenhouse effect; climate sensitivity using climate models. Snowball Earth Climate: What is planet albedo; the importance of ice albedo feedback in climate system; relation between greenhouse and ice albedo effect; Bare Rock model; more about snowball effect. Atmospheric Dynamics: Atmospheric layers, Gas laws, hydrostatic equation, hydrostatic balance, laws of thermodynamics, radiative transfer, dynamics of atmospheric motion, geostrophic and thermal winds. Advanced meteorology: Baroclinicity and Baroclinic atmosphere, Indian summer monsoon dynamics, MJO, Rossby waves, major weather phenomenon, global circulations, introduction to climate models, tropical weather system, and wave motion theory. The dynamics of heat transport: Blackbody radiation curve of the Earth and the Sun, The greenhouse effect, Heat balance for ocean, atmosphere, and land surface, Radiative flux imbalance at top of atmosphere, bare rock model of Earth's temperature, sensible heat; latent heat; internal energy; Radiative forcing, zonal and meridional temperature variation of Earth, heat storage by climate system, hydrological cycle. Last ice age and abrupt climate change: the salt oscillator hypothesis, the wind field oscillation hypothesis.

Text Books

- Atmospheric Science, an introductory survey, Wallace and Goss, 2nd Edition, Academic Press (an imprint of Elsevier), 2006
- Global warming, David Archer, 2007, Blackwell Publication

Reference Books

- Atmospheric Chemistry and Physics: From air pollution to climate change, Seinfeld and Pandis, 2nd Edition, J. Wiley publication: 2008
- Atmospheric Thermodynamics: Elementary physics and chemistry. North and Erukhimova, Cambridge: 2008
- Chemistry of the climate system, 2nd Edition, DG Gruyter publication: 2006
- Thermodynamics, kinetics, and microphysics of clouds. Cambridge: 2008
- First principles of meteorology and air pollution, Springer publication: 2009
- Climate dynamics, Kerry H. Cook, Princeton University Press: 2013
- Mid latitude atmospheric dynamics, Jonathan E. Martin, Wiley Publication: 2006

Prerequisite: NIL