Climate and Climate Change (250653)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria de Projectes i de la Construcció (EPC) Departament de Projectes d'Enginyeria (PE)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA AMBIENTAL (pla 2014)
Course	2025/26

Main teaching language at each group

- Group 10Q1 Spanish (Q1)

Faculty

Responsible Faculty: Maria Gonçalves Ageitos
Faculty: Jose M. Baldasano Recio, Maria Gonçalves Ageitos

Objectives of Education

CE01 - Apply scientific concepts to environmental problems and their correlation with technological concepts.
CE02 - Analyze systems, environmental problems and their resolution using models and evaluate them.
CE03 - Acquire basic skills of laboratory work and identify the methods and instrumentation for the determination of parameters relevant to the analysis of environmental problems.

Very aware of the structure of land, water and artificial ecosystems and their interactions.
Meet the ecology and the cycling of elements.
Meet the major environmental problems globally.
Analyzes energy bases, stoichiometric and kinetic of different processes.
Modeling process and quantifies the performance and efficiency of systems.
Determines the basis of environmental hazards to human health and ecosystems.
Apply material balances and energy to environmental problems.
Interprets water-rock and water - air interactions using thermodynamic and kinetic methods.
Meet the pollutants and identify their impact.
Learn the basics of how the atmosphere and applies them in maintaining air quality.
Learn the basics of climate and discusses the implications of current climate change.
Conceptualized an environmental problem described by equations and poses analytical or numerical solution.
Identifies the codes you need to solve a problem as conceptualized.
Recognizes the spatial and temporal scales required to resolve the problem.
Is familiar with solutions to problems relating to dynamical systems.
Learn about simple solutions to problems advection- dispersion - reaction.
Recognizes the existence of uncertainty in the parameters of the equations and is capable of performing an uncertainty analysis and sensitivity.
Learn methods for information and action on various parameters or variables.
Understand that any measure inherently carries an associated error and is able to work with them.
It is critical to the values reported by others when the measurement method is not specified.
He has worked in the laboratory measurement of some parameters of environmental interest.

Description of the climate system and its components.
The atmosphere, oceans, cryosphere, land surface and biosphere.
The balance of power: land-atmosphere.

The hydrological and carbon cycles.
History of climate change: causes and mechanisms.
Internal climate variability.
Evolution of Earth's climate.
Modelling the climate system.
Components of a climate model.
Evaluation of results.
The climate system response to a disturbance.
Influences of human activities on climate and climate change.

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Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	25.5 h	56.67 %
	Medium group	9.75 h	21.67 %
	Laboratory classes	9.75 h	21.67 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

1.Description of the climate system and its components

The atmosphere
Composition and temperature
General circulation of the atmosphere
Precipitation

Exercises and practical work

2 The atmosphere, oceans, cryosphere, land surface and biosphere

The ocean
* Composition and properties
* Oceanic circulation
* Temperature and salinity
The cryosphere
* Components of the cryosphere
* Properties of the cryosphere
The land surface and the terrestrial biosphere
Exercises and practical work

3.The energy balance: land-atmosphere

The energy balance of the Earth
* The heat balance at the top of the atmosphere: a global view
* The "greenhouse"
* today insolation at the top of the atmosphere
* The heat balance at the top of the atmosphere: geographical distribution
* Heat storage and transport
* Heat balance at the surface
Exercises and practical work

4.The hydrological and carbon cycles

The hydrological cycle
The carbon cycle
* General information
* Ocean Carbon Cycle
* Terrestrial Carbon Cycle
Exercises and practical work

13 Assessment

5.History climate change: causes and mechanisms

History of Climate Change: causes and mechanisms

6 Internal climate variability

Internal climate variability
* El Niño-Southern Oscillation
* North Atlantic Oscillation
* The Southern Annular Mode
Exercises and practical work

7 Evolution of the Earth's climate

The climate since the Earth's formation
* Precambrian climate
* Phanerozoic climate
* Cenozoic climate
The last million years: glacial interglacial cycles
* Variations in orbital parameters and insolation
* The orbital theory of paleoclimates
* Glacial-interglacial variations in the atmospheric CO2 concentration
The Holocene and the last 1000 years
* The current interglacial
* The last 1000 years
* The last century
Exercises and practical work

8 Modelling the climate system

Modelling the climate system
Introduction
* What is a climate model?
* Types of models
* Models of energy balance
* Models intermediate complexity
* The general circulation models
Exercises and practical work

9 Components of a climate model

Components of a climate model
* Atmosphere

* Ocean
* Sea ice
* Land surface
* Marine biogeochemistry
* Ice sheets
* Coupling between the models of systems components to Earth
Numerical solution of the equations
* Consistency, stability and convergence
* The time and space discretizations using finite difference
Exercises and practical work

10. Analysis and evaluation of results

Checking the validity of the models
* Verification, validation, test
* Evaluate the performance of the model
Exercises and practical work

11. The response of the climate system to a perturbation

The climate system response to a disturbance
Climate and climate change response
* The concept of radiative forcing
* equilibrium response of the climate system - a definition of feedback
* Transient response of the climate system
Direct physical assessments
* Steam water gradient feedback and comments
* Rretroalimentación Clouds
* Evaluations Cryospheric
Exercises and practical work

12 Influences of human activities on climate and of climate change on ecosystems and human activitie

Influences of human activities on climate and climate change.
. Emissions
. Land use changes
. Ecosystems

Activities

Performing a case study

Dedication

10h

Teaching Methodology

The course consists of 3 hours a week of classes in a classroom.
The 2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.
The 1 hour is devoted to solving practical problems with greater interaction with the students. The objective of these practical work and exercises is to consolidate the general and specific learning objectives.
Support material in the form of detailed teaching plan is used by: content, program of learning and assessment activities conducted and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The course grade will be obtained from continuous assessment scores and corresponding practical work. Continuous assessment consists in several activities, both individually and in group, of additive and formative characteristics, carried out during the course (in the classroom and beyond).
The evaluation tests consist of a part with basic issues and questions about concepts associated with the learning objectives of the course with in terms of knowledge or understanding concepts, and a set of exercises for understanding and application.
The teaching takes place according to the following criteria:
NF = r*NE +(1-r)*NAC r = 0,5
NAC = q*NAEP +(1-q)*NACET q = 0,5

NF: Final Note
NE: Exam Note
NAC: Note from continuous assessment
NAEP: Note teachings practical assessment (works, presentations, etc.)
NACET: Note continued evaluation of the theoretical teachings (test, etc.)

Test Rules

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Office Hours

Constantly available via email: jose.baldasano@upc.edu

Bibliography

Basic

- Goosse, H. Climate system dynamics and modelling. New York, NY: Cambridge University Press, 2015. ISBN 9781107445833.
- Archer, D. Global warming: understanding the forecast. 2nd ed. Hoboken, N.J.: Wiley, 2008. ISBN 0470943416.

Complementary

- Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press, 2014. ISBN 9781107661820.