

**Environmental Physics**

Code: 100185  
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OT	4	2

**Contact**

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**Use of Languages**

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

**Prerequisites**

It is highly recommended to have been taken courses in basic physics and mathematics such as statistical physics, thermodynamics and integral/differential calculus.

It would help, though is not a must, some knowledge on fluid dynamics.

**Objectives and Contextualisation**

To provide those basic and necessary elements for a proper understanding of the basic processes that intervene, from the perspective of physics, in some of the main environmental problems. The subject essentially is a presentation of our current knowledge of geophysical fluids. Also some short presentations will be provided about other areas of physics relevant in environmental issues such as turbulence, energy efficiency, etc.

**Competences**

- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Develop critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others
- Develop independent learning strategies
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Generate innovative and competitive proposals for research and professional activities.
- Plan and perform, using appropriate methods, study, research or experimental measure and interpret and present the results.
- Respect the diversity and plurality of ideas, people and situations

- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Using appropriate methods, plan and carry out a study or theoretical research and interpret and present the results
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project
- Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

## Learning Outcomes

1. Analyse the evolution in actual emissions of CO<sub>2</sub> (and other greenhouse gases) in relation to measures or containment policies adopted over recent decades and, in case of mismatch, propose viable alternative measures.
2. Apply the physics of fluids in rotating systems to the study of geophysical fluid dynamics.
3. Assessing the environmental impacts of different energy sources used, their financial cost and the risks associated with their use. Critically evaluate their use depending on the circumstances and factors applicable in every situation.
4. Based on the more general set of equations governing the physics of fluids, obtain their realization in the field of geophysical fluids.
5. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
6. Compare the relative importance of each of the terms involved in the Navier-Stokes equations and assess their importance according to the process or system to be studied.
7. Critically analyse the different spatial and temporal scales involved in a problem and make the corresponding simplifications for the differential equations governing the process.
8. Critically evaluate the implications that recent advances in paleoclimatology have on our understanding of medium-term evolution in the climate system.
9. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
10. Develop independent learning strategies.
11. Evaluate the different variables involved in the situation analysed, in addition to their relative magnitude, and obtain a rough estimate of the results that may subsequently be obtained following a detailed and rigorous analysis.
12. Generate innovative and competitive proposals for research and professional activities.
13. Produce energy-balance models for the climate system in order to make predictions on temperature evolution, and compare the results with measurements obtained in recent decades.
14. Relate the molecular structure of certain atmospheric compounds with climate-system response to anthropogenic or natural actions.
15. Respect diversity in ideas, people and situations.
16. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
17. Use the basic principles of thermodynamics in the energy-efficiency analysis of certain energy-generation processes in addition to in the study of the Earth's global energy balance.
18. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
19. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
20. Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals

## Content

### 1 Atmosphere and hydrosphere

- 1.1 The climate system. Radiation transport and energy balance
- 1.2 The Greenhouse effect
- 1.3 The ozone layer
- 1.4 The atmosphere and ocean's thermal structure. Atmosphere and ocean parameters. State equations. Adiabatic processes. Potential temperature. Stability.
- 2. Ocean and atmosphere dynamics
  - 2.1 Basic equations
  - 2.2 Rotation effects. Geostrophic flow
  - 2.3 Circulation and vorticity
  - 2.4 Ekman layer
  - 2.5 Barotropic waves. Planetary waves

## Methodology

Theoretical lectures to introduce some basic concepts.

Practical sessions to solve those exercises that have been previously handed to the student.

Students will give an oral exposition based on scientific publications.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Exercises resolution sessions	16	0.64	10, 12, 18, 19
Theoretical sessions	33	1.32	
Type: Autonomous			
Student personal work	93	3.72	18, 19

## Assessment

A first partial exam covering the contents studied until then. It is mainly theoretical: 30%

An oral presentation on a topic related to environmental physics: 30%

The second partial exam includes a multiple-choice test, which covers all the contents of the course, plus some practical exercises: 40%

In order to be able to participate in the recovery examination the student have to:

- a) have done at least the two partial exams
- b) have obtained a minimum of 3 out of 10 in the overall of the tests carried out

The final mark would be split into 70% by the recovery exam plus 30% by the oral presentation.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First partial examination	30 %	2.5	0.1	1, 8, 3, 13, 16, 14
Oral expositions	30 %	0.5	0.02	5, 10, 9, 20, 12, 16, 15, 18, 19
Recovery examination	70 %	2.5	0.1	7, 1, 2, 8, 3, 11, 6, 13, 4, 16, 14, 17
Second partial examination	40 %	2.5	0.1	7, 2, 11, 6, 4, 17

## Bibliography

### Elementary

B. Cushman-Roisin, Introduction to Geophysical Fluid Dynamics, Prentice Hall, 1994

S.Pond, G.L.Pickard, Introductory Dynamical Oceanography, Butterworth, 1997

J.M.Wallace i P.V. Hobbs, Atmospheric Science, Academic Press, New York, 1977

John Houghton, The Physics of Atmospheres, 3rd ed. Cambridge University Press, 2002

C.D. Ahrens, Meteorology today (7th ed.), Brooks/ColePacific Grove, 2003

### Advanced

S. P. Arya, Introduction to micrometeorology, Academic Press, 1988

S. P. Arya, Air pollution. Meteorology and dispersion, Oxford University Press, New York, 1999

E. Boeker, R. van Grondelle, Environmental Physics, Wiley, London 1999

E. Boeker, R. van Grondelle, Environmental Science, Wiley, Chichester 2001

G.S. Campbell, J. M. Norman, An introduction to Environmental Biophysics, Springer, 1998.

W. Cotton, R. A. Pielke, Human Impacts on Weather and Climate, Cambridge, 1995.

S. Eskinazi, Fluid Mechanics and Thermodynamics of our Environment, Academic Press, 1975.