UAB
Universitat Autònoma de Barcelona

Environmental Physics

Code: 100185
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500097 Physics	OT	4

PROVISIONAL

Contact

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

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

Finally, some more practical issues based on environmental radioactivity will be introduced, namely the basics on radioactive tracers as a means to evaluate environmental processes with examples from hydrology, atmospheric sciences and oceanography.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- 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

- 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
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Plan and perform, using appropriate methods, study, research or experimental measure and interpret and present the results.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- 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 CO2 (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 convolution techniques for obtaining the spectrum of neutron fields detected through spectrometer measurements.
3. Apply the physics of fluids in rotating systems to the study of geophysical fluid dynamics.
4. 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.
5. Based on the more general set of equations governing the physics of fluids, obtain their realization in the field of geophysical fluids.
6. 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.
7. 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.
8. Critically analyse the different spatial and temporal scales involved in a problem and make the corresponding simplifications for the differential equations governing the process.
9. Critically evaluate the implications that recent advances in paleoclimatology have on our understanding of medium-term evolution in the climate system.
10. 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.
11. Explain the explicit or implicit code of practice of one's own area of knowledge.
12. Identify situations in which a change or improvement is needed.
13. Identify the social, economic and environmental implications of academic and professional activities within one's own area of knowledge.
14. 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.
15. Relate the molecular structure of certain atmospheric compounds with climate-system response to anthropogenic or natural actions.
16. Solve differential equations associated to decay chains.
17. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
18. 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.

19. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
20. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
21. 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. 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

3. Environmental radiaoactivity: isotopic tracers

3.1 Nuclear stability

3.2 Environmental origin of the stable and radioactive nuclides

3.3 How to use radioactive tracers in environmental processes

3.4 Some examples of radioactive tracers as used in environmental processes

Activities and Methodology

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

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.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First partial examination	30 %	2.5	0.1	1, 2, 4, 8, 9, 12, 14, 15, 16
Oral expositions	30 %	0.5	0.02	6, 11, 13, 17, 19, 20, 21
Recovery examination	70 %	2.5	0.1	
Second partial examination	40 %	2.5	0.1	3, 5, 7, 8, 10, 18

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

An oral presentation on a topic related to environmentañl 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.

There will NOT be exam to improve the final qualification.

Those students who have not completed any of the partials nor the oral presentation will have a "Not evaluable" final grade.

Single evaluation

Students who have taken advantage of the single assessment modality must take a final test that will consist of a theory exam in which they must develop a topic and answer a series of short questions. Next, you will have to do a problem test where you will have to solve a series of exercises similar to those that have been worked on in the classroom. When you have finished, you will deliver the work chosen and done during the course. There will not be, however, oral presentation. These tests will be carried out on the same day, time and place as the tests of the second part of the continuous assessment modality. The student's grade will be the weighted average of the three previous activities, in which the theory exam will account for 30% of the grade, the problems exam for 40% and the work report presented for 30%. If the final mark does not reach 5, the student has another opportunity to pass the subject through the recovery exam that will be held on the date set by the coordination of the degree. In this test it will bepossible to recover 70% of the mark corresponding to theory and problems. The work reported part is not recoverable.

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

Raymond T. Pierrehumbert, Principles of planetary climate, Cambridge UniverssityPress, 2010

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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.

K. N. Liou, An introduction to atmospheric radiation, Academic Press, 2002 **

References marked with a double asterisk are the most relevant for the course.

Software

No specific software will be used.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	second semester	afternoon

(TE) Theory	1	Catalan	second semester	afternoon