



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Earth Systems and Climate Change Mechanism

2627-2-E3304M013

Aims

The course provides students with the fundamental concepts of climate science and Earth System Science, focusing on the Earth as an interconnected system composed of interacting physical, chemical, and biological components. It introduces the main mechanisms governing the climate system — including Earth's energy balance, radiative forcing, atmospheric and ocean circulation, climate feedbacks, and the greenhouse effect — together with the key processes linking the geosphere, hydrosphere, cryosphere, biosphere, and anthroposphere. The course aims to provide students with the conceptual and analytical tools needed to interpret climate change processes, critically assess scientific information, and understand environmental change from an integrated Earth-system perspective.

Contents

The course is organized into two integrated modules of 3 ECTS credits each:

Module 1 – Climate Change Mechanisms (3 ECTS)

Module 2 – Geo, Bio, Cryo, Hydro and Atmosphere (3 ECTS)

Together, the two modules provide an interdisciplinary introduction to climate science and Earth System Science, combining the physical mechanisms of climate change with a systems-based understanding of the interactions among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere.

Detailed program

Module 1 – Climate Change Mechanisms (3 ECTS)

This module introduces the physical basis of the climate system and climate change science. It covers the fundamental properties of the atmosphere, ocean, and cryosphere; the Earth's energy balance; radiative transfer; the greenhouse effect; radiative forcing; atmospheric and ocean circulation; climate feedbacks; tipping points; sea level rise; and uncertainty in climate projections. The module also introduces students to the interpretation of IPCC reports and to the scientific basis of current global warming.

Module 2 – Geo, Bio, Cryo, Hydro and Atmosphere (3 ECTS)

This module introduces the Earth as a complex system composed of interacting geosphere, hydrosphere, biosphere, atmosphere, and cryosphere components. It focuses on the hydrological cycle, water resources and water balance, surface water and groundwater systems, glacier retreat and mountain water resources, biogeochemical cycles, and the impacts of climate change on water availability, droughts, floods, ecosystems, human health, infrastructure, and environmental sustainability.

Prerequisites

None

Teaching form

Module 1 – Climate Change Mechanisms (3 ECTS): 24 hours in person that include 4 hours of interactive teaching with experiments.

Module 2 – Geo, Bio, Cryo, Hydro and Atmosphere (3 ECTS): 24 hours of lectures

Textbook and teaching resource

“Global warming science: A quantitative introduction to climate change and its consequences”, by E. Tziperman, Princeton Press, ISBN: 9780691228792,
<https://press.princeton.edu/books/paperback/9780691228792/global-warming-science>

Slides from the instructors will also be provided, containing additional online resources to support the learning.

Semester

First semester

Assessment method

There will be no interim evaluation.

The final evaluation consists of a set of 12 multiple-choice questions and 6 open questions that cover the topics of

both modules of the course. The exam session will last two hours.

The following level of judgment is applied in relation to the following parameters:

Conceptual knowledge and understanding ability
Ability to apply knowledge and understanding
Communication and argumentative skills
Learning, self-assessment and self-regulation ability

Grade < 18

Knowledge and Understanding: The student is not able to identify the core concepts and the right answers to the questions. The connections between the concepts are fragmented and poorly supported by theoretical knowledge.

Ability to apply knowledge and understanding: The student identifies only some relevant elements in a phenomenon, without being able to integrate them into an organic analysis.

Communication and argumentation skills: In the open questions, the student is not able to elaborate a correct argument, lacking logical flow with numerous inaccuracies.

Learning, self-assessment and self-regulation skills: The student is able to reconstruct only some aspects of his/her learning.

Grade 18-22

Knowledge and Understanding: The student identifies a minimal number of relevant concepts. The connections between the concepts are basic and weakly supported by theoretical understanding.

Ability to apply knowledge and understanding: The student is able to integrate a sufficient number of concepts into an organic analysis, despite having some deficiencies.

Communication and argumentation skills: In the open questions, the student uses the correct technical language with a minimal clear structure in the explanation. In the writing, there are still some mistakes.

Learning, self-assessment and self-regulation skills: The student is able to reconstruct all fundamental aspects of his/her learning, with some inaccuracies.

Grade 23-27

Knowledge and Understanding: The student demonstrates an in-depth understanding of the subject. The explanations are well-structured and supported by an adequate use of theoretical references.

Ability to apply knowledge and understanding: The student precisely identifies the essential elements of a phenomenon. The application of knowledge occurs with a methodological rigor that is not always solid.

Communication and argumentative skills: In the open questions, the student develops a coherent and well-organized argument, demonstrating good mastery of language and a solid logical-argumentative structure.

Learning, self-assessment and self-regulation skills: The student analyzes his/her learning path in a clear and structured way, highlighting significant relationships between the different stages and demonstrating a good capacity for critical reflection.

Grade 28-30

Knowledge and Understanding: The student demonstrates a complete mastery of concepts, articulating complex connections and providing exhaustive explanations. Theoretical references are used with relevance and rigor.

Ability to apply knowledge and understanding: The student demonstrates an advanced ability to analyze a phenomenon, identifying and interpreting all the salient elements in an exhaustive manner. The application of knowledge occurs with methodological rigor, supported by a solid and articulated argument.

Communication and argumentative skills: In the open questions, the student develops a solid and articulated argument, with a rigorous logical structure and a high level of textual coherence. The writing is fluid and well-structured.

Learning, self-assessment and self-regulation skills: The student demonstrates an advanced ability to self-reflect, developing an articulated and in-depth analysis of his/her own learning. The connections between formative experiences and theoretical concepts are clear, coherent and rigorous.

Office hours

Contact the instructors.

Sustainable Development Goals

SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION
