The Hong Kong University of Science and Technology

Ocean and Climate Change

OCES 4001

3 Credits

Pre-requisites: OCES 2003 and OCES 2001

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Course Description

This course is about Earth's climate system with a heavy focus (as the course title indicates) upon the role ocean plays within this system and the interactions between ocean and atmosphere.

As a 4000-level course, the material will be a bit quantitative, involving some doable calculations; these calculations serve to build up conceptual understanding. In certain (but not all) lectures, such as that about how ocean gains momentum from atmosphere, calculus symbols will be quoted alongside their physical meaning explicitly affixed. However, calculus is not a target -- conceptual understanding is.

The course takes on a physical oceanography flavor, plus certain amount of biogeochemistry. Students are expected to have taken OCES 2003 upon enrolling in this one. Fundamental oceanographic concepts such as Coriolis force and geostrophic balance will be quoted frequently. These concepts will be briefly recapped but will not be covered as thoroughly as in OCES 2003 or OCES 2001. Students are therefore encouraged to review such prior knowledge via their OCES 2003 and OCES 2001 course materials.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Interpret the role of ocean plays in Earth's climate.

2. Demonstrate a solid understanding of physical or biogeochemical processes shaping Earth's climate.

3. Explain why and how ocean and atmosphere are a coupled, interacting system.

4. Explain the fundamental principles governing oceanic and atmospheric variability in association with climate changes at different temporal and spatial scales.

5. Evaluate evidence for past and future climate changes.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

All assignments and the final take-home exam will be released and thus should be submitted, ideally as PDF files, via Canvas.

Answers to all assignments should be written in full sentences, yet no answer should occupy more than half a page. Excess answers lead to lower marks. For questions involving calculations, please show detailed working/derivation steps; answers involving numbers should retain up to 2 decimal places (e.g. write 123.45 instead of 123.5).

Assessment Task	Contribution to Overall Course grade (%)	Due date
Assignment 1	10%	*
Assignment 2	10%	*
Assignment 3	10%	*
Assignment 4	10%	*
Final take-home exam	45%	*
Attendance and in-class quizzes	15%	Continuous

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

[add to/delete table as appropriate]

Assessed Task	Mapped ILOs	Explanation
All assignments	ILO1, ILO2, ILO3, ILO4	Each of the assignments will be designed via a long, essay-type question, which is composed several sub-questions with increasing level of requirement on the ILOs. Students achieving more ILOs will get higher marks for each. Lectures on paleoclimate will be covered in the final part of this course and thus will not constitute the four assignments.
Final take-home exam	ILO3, ILO4, and ILO5	The final take-home exam serves as a major assignment but with compact period for completion. It will focus on the high-level and new content covered in this course, specifically ocean-atmosphere coupling and paleoclimate.

Attendance and in-class quizzes	ILO1, ILO3, ILO5	Class attendance for participating discussions about oceanographic concepts in the big picture of Earth's climate (ILO1), extended concepts of air-sea interaction and ocean-atmosphere coupling (ILO3), and new scientific knowledge (ILO5)

Grading Rubrics

Each of the four assignments will be marked out of 10 points, designed with 4-5 sub-questions within a single essay-type question. Among the sub-questions of each assignment, 1-2 will be challenging by design, requiring not just familiarity with knowledge covered in class, but also application of relevant knowledge to a broader or more general scenario. While each assignment will provide two weeks for completion, students are highly encouraged to start doing it as early as possible.

The final take-home exam follows a similar procedure but is composed of more essay-type questions and requires a more compact period for completion. Answers to each of the question will be constrained to a certain number of full sentences for discussions, but questions involving calculations will require detailed working/derivation steps. Students are expected to hit the key points via discussions, and to write down the key working steps for calculations. The marking scheme will be standardized with reference answer keys, each of which accounts for 0.5-1.0 point for marking.

A total of 25 lectures will be delivered throughout the semester. Attendance will be recorded in two ways: in-class sign-up on the students' name list and in-class quiz responses. A student missing one of these lectures will not incur attendance mark reduction; yet students missing up to two or more lectures without a good rationale (e.g. medical conditions or personal urgence) will receive lower marks in attendance.

Final Grade Descriptors:

[As appropriate to the course and aligned with university standards]

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance (> 85% in final mark)	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance (70% - 85% in final mark)	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance (55% - 69%)	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass (46% - 54%)	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.

F	Fail (<45%)	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

The use of Generative AI in assignments is permitted with proper acknowledgement. However, students should note that all assignments and the take-home exam will be designed in a way that would prevent constructive or useful support from any AI tool.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include a breakdown of mark and specific comments on the knowledge gap in students' answers. Reference answers with marking schemes will be provided after the submission due dates. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

All assignments and the final take-home exam will allow for unlimited re-submissions prior to the due dates/times for submission but will not accept re-submission thereafter.

Required Texts and Materials

No textbook is strictly needed for this course. All content will be covered via instructors' course slides and hand-out materials.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

[Optional] Additional Resources

• Kris Karnauskas, Physical Oceanography and Climate, Cambridge University Press, 2020.

• Kevin E. Trenberth, The Changing Flow of Energy through the Climate System, Cambridge University Press, 2022.

• John Marshall and R. Allen Plumb, Atmosphere, Ocean and Climate Dynamics, Academic Press, 2007.

• John M. Wallace and Peter V. Hobbs, Atmospheric Science, Academic Press, 2nd Ed., 2006.

• Gerold Siedler (Ed.), Stephen M. Griffies (Ed.), John Gould (Ed.), and John A. Church (Ed.), Ocean Circulation and Climate, Academic Press, 2nd Ed., 2013.