

ES5007/ES7013 – Climate and Climate Change *last updated on 19 January 2022*

Lecturer:

Assoc. Prof. WANG Xianfeng (xianfeng.wang@ntu.edu.sg)

Pre-requisites:

Background in mathematics, physics, chemistry or combined science at O or H1 level, or equivalent, would be helpful but not required.

Course Structure:

PART ONE - Climate Fundamentals, Present and Future

PART TWO - Past Climate Change

Time and Venue

Lecture: Tuesday 09:30 – 12:30, **at LT26, Week 3 onwards**

Grading Policy

For ES5007 students only:

Ten quizzes (total 40%) – each week except weeks 1, 4, and 13

Final exam (60%) – **28 April 2022**

- * This is a letter-graded course.
- * All the quizzes and final are in the form of multiple-choice questions (MCQ) and closed book.
- * All the quizzes will be conducted online. Final will **be conducted in an exam hall**.

For ES7013 students only:

Ten quizzes (total 30%) – each week except weeks 1, 4, and 13

First written assignments (10%)

Final exam including 2nd written assignment (total 60%)

- * This is a letter-graded course.
- * MCQ questions in ES7013 may be different from those in ES5007.
- * Details on written assignments will be available later.
- * All the quizzes are in the form of multiple-choice questions (MCQ), closed book and conducted online.
- * Final (MCQ portion only) will **be conducted in an exam hall**.

Consultation Policy

Teaching assistants (TAs) are generally available by email.

Lecturer is available for consultation *by appointment only*.

Students are encouraged to seek clarification from TAs first before approaching the lecturer for the simple reason of low staff-to-student ratio.

Teaching Assistants:

Ms. Zhang Yilin (YILIN003@e.ntu.edu.sg)

Ms. Hu Wan-Lin (WANLIN001@e.ntu.edu.sg)

References

* All the books listed are available in the library.

* Students are recommended to read the references, but it is not compulsory to buy these books.

Basic reading

Book Title	Edition	Author	Publisher	ISBN	Year of Publication
Atmosphere, Weather and Climate	9th	Roger G. Barry, Richard J. Chorley	Routledge Taylor & Francis Group	9780415465700	2009
Earth's Climate: Past and Future	3rd	William F. Ruddiman	Freeman, W. H. & Company	9781429255257	2014
The Earth System	3rd	Lee R. Kump, James F. Kasting, Robert G. Crane	Prentice Hall	9780321597793	2010

A bit advanced reading

Book Title	Edition	Author	Publisher	ISBN	Year of Publication
Global Warming: Understanding the Forecast	2nd	David Archer	Wiley	9780470943410	2011
How to build a habitable planet	1st	Charles H. Langmuir, Wally Broecker	Princeton Press	9780691140063	2012
IPCC AR6, the Physical Science Basis, Summary for Policymakers		https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf			2021
Special Report on Global Warming of 1.5°C		https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/			2018
Special Report on Climate Change and Land		https://www.ipcc.ch/srccl/chapter/summary-for-policy-makers/			2019
Special Report on Ocean and Cryosphere in a Changing Climate		https://www.ipcc.ch/srocc/chapter/summary-for-policy-makers/			2019
Singapore National Climate Change Strategy		https://www.nccs.gov.sg/docs/default-source/publications/national-climate-change-strategy.pdf			2012
Singapore's 2nd National Climate Change Study – Climate Projections to 2100 Science Report		http://ccrs.weather.gov.sg/wp-content/uploads/2015/07/V2_Ch1_Executive_Summary.pdf			2015

Lecture Course Content

- * This outline is subject to changes as the course proceeds, while details are incrementally specified appropriate to the level of progress of the class.*
- * The lectures are demarcated by dashed lines below.*
- * All the lectures, quizzes and midterms are conducted online.*
- * There are no tutorials for this course.*
- * Consultations with teaching assistants by emails or appointments are strongly encouraged.*

References to course texts are meant as supplementary reading to the lectures. They are listed to the right of the course content. The letters/numbers following the symbol “x§” refer to the chapters in the course texts below. It is OPTIONAL to buy these books.

b§ = Atmosphere, Weather and Climate, by Roger G. Barry and Richard J. Chorley

r§ = Earth's Climate: Past and Future, by William F. Ruddiman

k§ = The Earth System, by Lee R. Kump, James F. Kasting, and Robert G. Crane

d§ = Global Warming: Understanding the Forecast, by David Archer

s§ = Summary for Policymakers, in Climate Change 2013: The Physical Science Basis
(e-copy available from <http://www.climatechange2013.org/spm>.)

Or if you are interested, the full report of IPCC Assessment Report 5, the Physical Science Basis, can be downloaded from <http://www.climatechange2013.org/report/full-report/>)

g§ = Special Report on Global Warming of 1.5°C

(e-copy available from <https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/> and the full report can be downloaded from <https://www.ipcc.ch/sr15/>.)

1. Introduction

a. Course Briefing

b. Earth's Climate

The Climate System

Atmospheric Structure & Composition

Climate Variability & Change

lecture notes

b§2.A.1-A.6, 2.C

b§2.A.7, b§13.A;

Week 2, Online Quiz-1

2. Radiation

a. Blackbody Radiation, Solar & Terrestrial
Radiation, Atmosphere-Radiation Interaction

b§3.A, 3.B.1-B.3,
b§3.C;

b. Earth's Radiation Budget, Albedo,
Radiative Heating

b§3.D

c. Horizontal Energy and Water Vapour
Transport

b§3.E

Week 3, Online Quiz-2

3. Dynamics

a. Pressure, Ideal Gas Law, Hydrostatic Balance
Atmospheric Mass Distribution

b§2.B.1

b. Atmospheric General Circulation

b§7.B-7.C

Week 4, Chinese New Year on 1 February (No Class)

Week 5, Online Quiz-3

4. Thermodynamics

a. Tropical Weather
Ocean Circulations, Eddies and Waves

b§7.D

b. Vapour Pressure and Humidity

b§2.B, 4.B.1

c. Condensation and Precipitation

b§4.D, 4.E.1-E.3

Week 6, Online Quiz-4

5. Numerical Modelling
- a. Data Sources, Numerical Models b§8.B-8.C
 - b. GCMs, Basic Scientific Principles b§8.A-8.B;
 - c. Climate Feedbacks b§13.B.2-B.3; d§7
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Week 7, Online Quiz-5

6. Global Warming & Consequences
- a. IPCC and Recent Climate Change b§13.D; s§A-D
 - b. Climate Projections b§13.E-13.G; s§E
 - c. Climate Means, Variability and Extremes *lecture notes*
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RECESS WEEK

Week 8, Online Quiz-6

7. Earth's climate in the deep time and carbon cycle
- a. Evolution of Earth's atmosphere r§4, k§10
 - b. Plate tectonics and Carbon cycle r§6, k§8
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Week 9, Online Quiz-7

8. Earth's climate in the deep time and carbon cycle
- a. The faint young Sun paradox, Snowball Earth k§11, k§12
 - b. Greenhouse to icehouse r§7, k§12
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Week 10, Online Quiz-8

9. Ice ages
- a. Pleistocene glaciations r§8, r§10
 - b. Abrupt climate change r§14, r§15
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Week 11, Online Quiz-9

10. Climate and human evolution

a. Dawn of civilization

r§16

b. Historical climate change

r§17

Week 12, Online Quiz-10

11. Anthropocene

a. Anthropogenic climate impact

r§19

b. Geo-engineering

r§20

12. Discussions on some emergent climate topics

Final exam, 28 April!
