GESM-150: CIVILIZATION AS A GLOBAL GEOSYSTEM

Spring Semester, 2023

Units: 4
Term—Day—Time: Spring 2023, Tues & Thurs, 09:30-10:50 (Lecture); Thurs 1:00 - 2:50 (Lab)
Location: ZHS 118 (Lecture) and ZHS B65 (Lab)

Instructor: Thomas H. Jordan
Office: ZHS-267
Office Hours: Tues & Thurs, 8:00-9:00 am, and by appointment
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Course Description

Welcome to GESM-150, *Civilization as a Global Geosystem*. In this course, we will examine how civilization—the collective sum of all human activities—has grown into a global geosystem that is changing Earth's surface environment at a phenomenal rate. We will show how the main components of the Earth system interact to produce the climate we live in today. We will investigate the geologic record of climate change and discuss the key role of the carbon cycle in regulating climate. We will survey the energy resources that fuel our economy and examine how our future use of those resources will affect our environment. Our main focus will be on three of the most serious forms of anthropogenic global change: global warming, ocean acidification, and loss of biodiversity. We will explore how geoscientists are observing these changes and combining data with models of the Earth system to predict future changes. We shall see that reducing the impacts of anthropogenic global change, and adapting to its consequences, will require concerted worldwide actions on an unprecedented scale.

Learning Objectives

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

1.1 Describe key aspects of geoscience that relate it to, and distinguish it from, other sciences such as physics, chemistry, and biology.
1.2 Illustrate how the scientific method has been used to develop theories of Earth's shape and structure.
1.3 Compare the chemical compositions of Earth's crust, mantle and core in terms of their most abundant elements.
1.4 Recall Earth's age and some key events in the evolution of life that stand out in the geologic record.
1.5 Describe how geologists establish the relative and absolute ages of events in Earth's history.

1.6 Locate within the layered Earth system the global geosystems that explain climate, plate tectonics, and the geomagnetic field.
1.7 Describe the evidence for seafloor spreading as a mechanism for continental drift.
1.8 Classify plate boundaries as divergent, convergent or transform, and describe how plate boundary processes contribute to natural hazards.
2.1 Recognize the major climate zones of today's world from annual variations in temperature and precipitation.
2.2 Identify each major component of the climate system and describe how the transport of energy and mass within and between these components affects climate zonation.
2.3 Explain the greenhouse effect in terms of radiation balance and feedbacks within the climate system.
2.4 Describe how the climate changes over the short term during the El Niño–Southern Oscillation and over the long term during glaciations.
2.5 Identify the signatures of Milankovitch cycles in the Pleistocene glacial record.
2.6 Describe the fluxes of water, carbon and nutrients between parts of the Earth system as biogeochemical cycles
2.7 Quantify the carbon cycle in terms of the flux of carbon between the atmosphere and the other principal carbon reservoirs.
3.1 Explain how the demographic transition lowers population growth while increasing population size
3.2 Understand how the impact of civilization on the Earth system qualifies it as a global geosystem.
3.3 Categorize our natural resources as renewable and nonrenewable, and differentiate energy reserves from energy resources.
3.4 Describe the geological processes that form fossil fuels and quantify the energy available from their reserves.
3.5 Evaluate the question: When will civilization run out of oil?
3.6 Compute the carbon intensities of fossil fuels from the energy they produce and the carbon dioxide they emit, and use carbon intensities to compute the changes in carbon flux from changes in energy production.
3.7 Quantify the relative contributions of alternative energy resources to energy production, and estimate their potential to satisfy future energy needs.
3.8 Project the worldwide growth of energy consumption by geographic region and fuel type.
4.1 Show how international policy agreements successfully limited damage to Earth's ozone layer.
4.2 Explain why scientists can assert with high confidence that fossil-fuel burning is increasing the atmospheric concentration of carbon dioxide.
4.3 Compare the anthropogenic increase in carbon dioxide to its natural variability over the past 800,000 years.
4.4 Catalog the main types of anthropogenic global change and describe their main effects on the atmosphere, hydrosphere, cryosphere, and lithosphere.
4.5 Use scenarios developed by the Intergovernmental Panel on Climate Change to project greenhouse gas concentrations, increases in the average surface temperature, and sea-level rise.
4.6 Describe how the absorption of atmospheric carbon dioxide into sea water causes ocean acidification.
4.7 Assess the potential effects of anthropogenic global change on the biosphere, and evaluate the possibility that the beginning of the Anthropocene epoch will be marked by a mass extinction.
4.8 Illustrate with specific examples changes in our energy production and usage that could stabilize carbon emissions to their current rates.
4.9 Investigate new technologies for reducing carbon pollution and geoengineering climate change

Prerequisite(s):

None

Co-Requisite(s):

Students enrolled in Civilization as a Global Geosystem Lecture (section 35471D) should also be enrolled in Civilization as a Global Geosystem Laboratory (section 35475D).

Course Information

Mode of teaching will be in-person. This syllabus outlines the course contacts, requirements, and schedule. Additional information will be posted on Blackboard during the semester.

Communication

Announcements, lecture presentations, assignments, etc. will be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

Students are expected to be proficient in using Blackboard. Students will require a hand calculator (e.g., on smartphone or personal computer) to do some of the laboratory and examination exercises.

Students will be asked to use the desktop version of Google Earth software, available for free at https://www.google.com/earth/versions/. Instructions on the use of Google Earth will be provided in the laboratory sessions.

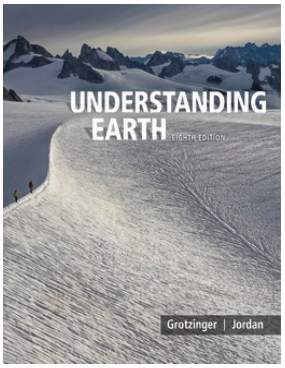
USC technology rental program

We realize that the coursework requires access to technology that not all students possess. If you need resources to successfully participate in your classes, such as a laptop or internet hotspot, you may be eligible for the university's equipment rental program. To apply, please submit an application.

USC Technology Support Links

Zoom information for students
Blackboard help for students
Software available to USC Campus

Required Materials



Understanding Earth (8th edition), J. Grotzinger and T. H. Jordan, W.H. Freeman, 2020. Most assigned readings will come from Chapters 1, 2, 12, 13, 14 of this edition. You can rent or buy the textbook from many booksellers. The publisher is Macmillan Learning, which lists access options at:
https://www.macmillanlearning.com/college/us/product/Understanding-Earth/p/131905532X
Please note that earlier editions of *Understanding Earth* do not contain much of the material covered in the class and therefore will not substitute for the 8th edition. If you have difficulty accessing the 8th edition, please contact the instructor or TA.

Google Earth Pro: This is the desktop version of Google Earth software, available for free at https://www.google.com/earth/versions/. Please download and install it ahead of the lab component of the course.

Optional Materials

Optional study materials that are recommended in the lectures will be posted on Blackboard.

Assignments

All assignments will be posted on Blackboard. Students will be asked to complete three types of assignments:

Reading assignments: Weekly readings from *Understanding Earth* are posted in the Course Schedule below. You are expected to complete the readings assigned for each class session *before* that session, and you should be prepared to ask and answer questions about the readings during the session.

Laboratory assignments: Worksheets describing the laboratory exercises, as well as the context of the exercises, will be posted on Blackboard in advance of the Thursday laboratory session. You are expected to read the worksheet before you attend the laboratory session. Students should submit their completed lab assignments by the start of lecture on the Tuesday following the laboratory.

Homework: Occasionally, the Instructor or Teaching Assistant (TA) will assign readings or exercises to be completed by the students within one week. These assignments will not be graded, but they will help the students understand the course materials. Questions about the homework will be encouraged in the class sessions. Questions on the homework will be included in the mid-term and final exams.

Course Schedule: A Weekly Breakdown

Week	Lecture & Discussion Topics	Learning Objectives & Readings	Laboratory
1	Tu 1/10: Introduction Th 1/12: Geoscience and the Scientific Method	LO: 1.1, 1.2 Ch 1, pp. 1-5	No lab first week
2	Tu 1/17: Discovery of a Layered Earth Th 1/19: Overview of Geologic Time	LO: 1.3, 1.4 Ch 1, 6-11, 16-18	Lab 1: Measuring geologic time
3	Tu 1/24: The Earth System Th 1/26: Global Geosystems	LO: 1.5, 1.6 Ch 1, pp. 12-16	Lab 2: Conceptualizing geosystems
4	Tu 1/31: Plate Tectonics Th 2/2: Climate System	LO: 1.7, 1.8, 2.1, 2.2 Ch 2, pp. 23-43 Ch 12, pp. 337-345	Lab 3: Plate tectonics
5	Tu 2/7: Greenhouse Effect Th 2/9: Midterm Exam #1	LO: 2.3,2.4 Ch 12, pp. 345-348	Lab 4: Climate zones
6	Tu 2/14: Natural climate variability Th 2/16: Carbon Cycle	LO: 2.5, 2.6, 2.7 Ch 12, pp. 348-359	Lab 5: Radiation balance and the Greenhouse effect
7	Tu 2/21: Human Perturbations to Carbon Cycle Th 2/23: Human Population Growth	LO: 3.1, 3.2 Ch 12, pp. 365-369	Lab 6: Natural climate variability
8	Tu 2/28: Environmental Impact of Civilization Th 3/2: Fossil-Fuel Resources 1	LO: 3.3, 3.4, 3.5, 3.6 Ch 13, pp. 369-381	Lab 7: Biogeochemical cycles
9	Tu 3/7: Fossil-Fuel Resources 2 Th 3/9: Alternative Energy Resources	LO: 3.7, 3.8 Ch 13, pp. 381-391	Lab 8: Human population growth
10	Tu 3/14: Spring break – no class Th 3/16: Spring break – no class	None	No lab
11	Tu 3/21: The Keeling Curve Th 3/23: Midterm Exam #2	LO: 4.1,4.2 Ch 14, pp.393-395	Lab 9: Computing carbon intensities & footprints
12	Tu 3/28: Anthropogenic Global Change Th 3/30: Projecting Global Change	LO: 4.3, 4.4 Ch 14, pp. 395-405	Lab 10: The Keeling curve
13	Tu 4/4: Climate Change Th 4/6: Sea-Level Rise	LO: 4.5 Ch 14, pp. 405-408	Lab 11: Projecting climate change
14	Tu 4/11: Ocean Acidification Th 4/13: Biodiversity Loss: 6th mass extinction?	LO: 4.6, 4.7 Ch 14, pp. 408-412	Lab 12: Sea-level rise & ocean acidification
15	Tu 4/18: Decarbonizing the Energy System Th 4/20: Negative Emission Technologies & Geoengineering	LO: 4.8 Ch 14, pp. 412-421	Lab 13: Managing the carbon crisis
16	Tu 4/25: Adapting to Global Change Th 4/27: Course Review	LO: 4.9	No lab last week

Tu 5/9: Final Exam (8-10 am)

Grading Breakdown

Laboratories: The material covered in the laboratory sessions is closely coordinated with the material introduced in the readings and class sessions. The purpose of the laboratories is to deepen your understanding of the course material by focusing on specific concepts and practical problems. The laboratory exercises will often involve questions that have no definitive or easy answers.

Laboratory sessions will begin on Thursday, January 19th; no labs will be held during the first and last weeks of classes. Lab exercises can be downloaded from Blackboard. Students should upload to Blackboard responses to lab exercises in pdf format by 5:00 pm PST on the Monday following the lab. The Teaching Assistant will grade all lab work; the Instructor will intervene only in the case of conflicts.

Quizzes: Approximately 6 timed quizzes will be given at unscheduled times during lecture periods throughout the term. The cumulative quiz score, up to 15 grade points, will be computed for each student by dropping the student's lowest quiz score. All quizzes and exams will be open-book, but most students find that the rapid pace of a timed quiz limits book consultation and puts a premium on preparation. The best preparation will be your participation in the class and laboratory sessions and your attention to the reading assignments.

Examinations: The three examinations will evaluate student comprehension of the lecture and textbook material:

- *Midterm Exam 1* will be given at 09:30, Thursday, Feb 9. It will cover the lectures and reading assignments from Jan 11th to Feb 3rd.
- *Midterm Exam 2* will be given at 09:30, Thursday, Mar 23. It will cover the lectures and reading assignments from Feb 8th to Mar 10th.
- The *Final Exam* will be given at 08:00, Tuesday, May 9. It will be a *comprehensive examination*, covering all lectures and reading assignments throughout the term, but a special emphasis will be placed on the material in lectures given after Midterm Exam 2.

All exam questions will be objective (true/false or multiple choice). To do well on the exams, you should attend the classes and laboratories faithfully, take notes, read the assigned materials, and review the lectures and lab worksheets. PDF versions of the lecture slides will be posted on Blackboard.

Missed examinations: *If you have to miss an examination because of illness or an academic conflict, you must inform the instructor by email in advance, and provide documentation.* Make-ups of examinations will, in general, NOT be permitted except for extraordinary circumstances. In the case of a missed midterm, where a reasonable excuse exists, the midterm may be waived with a score assigned that reflects the average of your work done on the other two exams.

Maximum Scoring for Each Grade Element

Student grades are based on the cumulative score of 100 grade points summed over five graded elements: laboratory work, quizzes, two mid-term exams, and a final exam. The maximum number of points that can be earned for each element is given in the following table:

Graded Element	% of Grade
Laboratory Assignments	30
In-Class Quizzes	15
Midterm Exam 1	15
Midterm Exam 2	15
Final Exam	25
Total	100

Grading Scale

Each student will receive a final letter grade based on their cumulative score. Score ranges that determine the letter grades will not be based on the numerical scores of other students in this class; that is, we won't "grade on a

curve". Instead, final letter grades will be based on the Instructor's and TA's assessment of the student's *learning accomplishment* measured by the numerical grades. We associate letter-grade categories with the following learning accomplishments, measured by demonstrated understanding:

A: Mastered the course material
B: Achieved a good understanding of most course material
C: Demonstrated a minimally adequate understanding of most course material
D: Demonstrated an inadequate understanding of most course material
F: Failed to demonstrate a minimal understanding of most course material

Communication Policy

To communicate with the instructor outside of class or office hours, email the instructor from your USC email account. In the subject line, indicate the course number and your full name. Simple questions will be answered by email, but for more complex discussions students may be instructed to visit office hours. Email will be answered within 24 hours.

On-line classroom norms and Zoom etiquette

When attending on-line classes via Zoom, students will be expected to enter each Zoom session with cameras on and microphones muted, unless an exception is granted due to personal circumstances. Students for whom attending on-camera will be difficult should contact the instructors ahead of class. All classes held on Zoom will be recorded.

Sharing of course materials outside of the learning environment

USC policy prohibits sharing of any synchronous and asynchronous course content outside of the learning environment.

Residential and Hybrid Streaming Model Courses

The latest COVID-19 testing and health protocol requirements for on campus courses can be found on the USC COVID-19 resource center website.

Disability Services

All students, including those with disabilities or other conditions, have an equal right to access the complete experience of this course, and to have their learning assessed fairly. Students whose ability to learn may be improved by disability-related accommodations are strongly encouraged to contact the office of Disability Services and Programs (DSP; https://dsp.usc.edu/). DSP can work with you to determine what accommodations might be helpful, and can arrange these without needing to disclose your condition to your instructors. To ensure accommodations can be provided, affected students are expected to:

- Register with DSP early at the beginning of each semester
- Maintain timely communication with DSP (respond to email questions, requests for meetings, etc.)
- Forward the accommodation letter provided by DSP to the course instructors as soon as possible

DSP is open Monday-Friday, 8:30-5:00. The office is in Student Union 301 and the phone number is (213) 740-0776.

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.