

EAS 6140 - Thermodynamics of Atmospheres and Oceans

Course Information

- **Instructor** Jie He (jie.he@eas.gatech.edu)
- **Course number** EAS 6140
- **Term** Fall 2026
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Course description

Thermodynamics are inherent to the atmosphere and ocean. Winds and ocean currents owe their existence to the thermodynamic imbalance that arises from the differential heating of the Earth's surface by the sun. A key ingredient in the thermodynamic processes is water, which is able to change between three phases in Earth's climate. The formation of cloud and sea ice increases the Earth's reflectivity and cools the climate. On the other hand, water in its gaseous form has strong a greenhouse effect that acts to amplify the surface warming from increasing carbon dioxide. The thermodynamic feedbacks associated with water are key to understanding climate variability and the overall stability of the climate system.

The course closely follows Curry, J. A., & Webster, P. J. (1998). *Thermodynamics of atmospheres and oceans*.

1. State of atmosphere and ocean
 - State variables. Ideal gas law. Hydrostatic balance.
2. First and second laws of thermodynamics
 - 1st and 2nd laws. Enthalpy. Heat capacity. Entropy.
3. Thermodynamics of water
 - Molecular structure of water. Phase equilibrium. Colligative properties of water solutions.
4. Moist process in the atmosphere
 - Moist adiabatic process. Conservative properties. Aerological diagrams.
5. Nucleation and diffusional growth
 - Surface tension. Nucleation of liquid & ice. Diffusional growth. Initial sea ice growth.
6. Cloud and precipitation
 - Cloud classification. Cloud radiation. Accretional growth. Precipitating and Non-precipitating clouds. Cloud parameterization.
7. Thermohaline processes (may not offer every year)
 - Skin temperature. Mixed layer processes. Instability in the ocean interior. Deep ocean convection.

Course objectives / approved course learning outcomes

The main objective of this course is to apply thermodynamic principles to understand the role of water in the Earth's climate system. The course starts by developing the basic concepts of classical thermodynamics that are important for understanding the climate system. These basic concepts will then be applied to address major processes in the atmosphere and ocean, including cloud formation, precipitation processes and thermohaline circulation.

Required course materials

Curry, J. A., & Webster, P. J. (1998). *Thermodynamics of atmospheres and oceans*. Elsevier. ([link](#))

Grading policy and weighting

Homework: 30%

Close to the end of each chapter, 1-2 peer-reviewed papers covering specific topics will be assigned. All students are required to write a 1-page report (single space) containing a summary, thoughts, criticism, and questions about each paper. The summary portion should address the following questions: 1) What are the goals of this paper? 2) What methods/data are used? 3) What are the main findings? 4) What is the significance/implication of the paper? The paper will be discussed in class following the due date of the assignment.

Exam I, II, Final: 40%

All exams will be closed book. Exam I covers the first half of the course and Exam II covers the second half. The final exam includes the whole course. The best 2 scores (out of 3) will be used for calculating the final grade.

Project: 30%

The class project will be a literature review delivered in the form of a 5 to 10-page paper. The topic is flexible as long as it is relevant to the course. Students can pick any material mentioned in class and expand on it or discuss any topic that applies thermodynamic theories.

- Grading scale: A(90-100), B(80-89.99), C(70-79.99), D(60-69.99), F(below 60).

Attendance policy

Attendance is not monitored.

Additional criteria for successful completion of the course

Not applicable.

Academic honesty / academic integrity statement

Students in this course are expected to uphold the highest standards of academic integrity as defined by the Georgia Institute of Technology *Honor Code*. All submitted work must represent your own efforts unless collaboration is explicitly permitted.

Academic misconduct includes, but is not limited to, cheating, plagiarism, unauthorized collaboration, fabrication or falsification of data, and facilitating dishonesty by others. The use of unauthorized resources—including solution manuals, online answer repositories, or unapproved AI tools—on assignments or exams is prohibited.

Unless otherwise specified, you may discuss general approaches to coursework with peers, but all submitted work must be completed independently and written in your own words. Any external sources, including published materials or digital tools, must be properly cited.

Suspected violations will be reported to the Georgia Tech Office of Student Integrity and may result in academic and disciplinary sanctions consistent with Institute policies.

By enrolling in this course, you acknowledge your responsibility to understand and comply with these standards.

Statement about acceptable student conduct

Students in this course are expected to adhere to the standards of academic integrity and personal conduct established by the Georgia Institute of Technology. All students must comply with the policies outlined in the Student Code of Conduct and the Honor Code.

Academic misconduct—including, but not limited to, cheating, plagiarism, unauthorized collaboration, or falsification of academic records—is strictly prohibited. Any suspected violations will be reported to the Office of Student Integrity and may result in disciplinary action.

Students are also expected to contribute to a respectful and inclusive learning environment. Disruptive behavior, harassment, or discrimination of any kind will not be tolerated and will be addressed in accordance with Institute policies.

By remaining enrolled in this course, students acknowledge their responsibility to understand and comply with these expectations.

Statement about services offered through the Office of Disability Services

Georgia Tech Office of Disability Services (ODS) collaborates with students, faculty, and staff to create an inclusive learning environment for students with documented disabilities. ODS provides a range of services, including academic accommodations, consultation, and advocacy support, to ensure equal access to educational opportunities.

Students seeking accommodations must register with ODS and obtain an accommodation letter. Once approved, students are responsible for communicating their accommodation needs with the instructor in a timely manner so that appropriate arrangements can be made.

For more information about available services or to begin the registration process, please contact the Office of Disability Services directly.

Core IMPACTS statement

Not applicable.