Georgia Institute of Technology

ATMOSPHERIC RADIATIVE TRANSFER

Instructor – Professor Irina N. Sokolik

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Office hours: by appointment, or 2 hours before each class

Recommended Textbook:
K.N. Liou An Introduction to Atmospheric Radiation, 2002 (Second Edition).
Additional sources:
Course website
A First Course in Atmospheric Radiation. Petty G.W., Second Edition, 2006.
Radiation and cloud processes in the atmosphere. K.N. Liou, 1992
Atmospheric Radiation: Theoretical basis. R.M. Goody and Y. L. Yung, 1989
Radiative Transfer in the Atmosphere and Ocean. G. E. Thomas and K. Stamnes, 1999.
Absorption and Scattering of Light by Small Particles. C. Bohren and D. Huffman, 1983.

Grading:
Computer modeling laboratories – 40%, exam - 20%, and class project 40%

Attendance:
all students must attend each class. Special permission to not attend any class is required in advance by contacting instructor. The Institute Absence policy is available at: www.catalog.gatech.edu/rules/4/

Prerequisites:
None
Goals:
The atmospheric radiative transfer is central to understanding the workings of the Earth's climate system. This course covers the physical principles, quantitative analysis, and numerical modeling of atmospheric radiation and its interaction with atmospheric constituents (gases, aerosol, and clouds) and the land and ocean surfaces. The topics to be covered include the radiative balance at the surface, radiative forcing at the top of the atmosphere, radiative heating/cooling rates and their role in the atmospheric dynamics and thermodynamics, actinic fluxes, PAR, methods for solving the one- and three-dimensional radiative transfer, radiation codes in regional and global atmospheric dynamical models, among others.

Learning Objectives:
This course will provide the fundamentals of radiative transfer processes in the earth atmosphere, as well as, atmospheres of other planets. The interaction of the electromagnetic radiation with clouds, aerosol and gases will be addressed, including their optical properties. The broad spectral range will be considered, covering the UV, solar, infrared, and microwave radiation.

Overview:
Fundamentals of interaction of atmospheric constituents with the electromagnetic radiation, including absorption and scattering processes by atmospheric gases, aerosols, and cloud.

Decription:

- **Lectures:**

Lectures are developed to provide the most critical material and to complement a class textbook. Lecture notes will be posted (in PDF format) at the course website: http://irina.eas.gatech.edu/EAS8803_SPRING2018/

- **Homework assignments and computer modeling laboratories**

will include problem solutions, radiative transfer numerical modeling, radiation data analysis, and literature review.

- **Class research project**

The goal will be to perform the radiative transfer modeling and interpretation of the results in a well-defined problem. This will involve learning how to run a radiative transfer code selected for the project. Class project presentation is required at the end of the term.

- **Exam:**

One midterm exam

Academic Integrity:
Academic dishonesty will not be tolerated. This includes cheating, lying about course matters, plagiarism, or helping others commit a violation of the Honor Code. Some exams (when specifically announced in class) allow the use of self-prepared supporting information (one sheet of paper, either typed or handwritten, could be double-sided); no other support materials are allowed at tests. Plagiarism includes reproducing the words of others without both the use of quotation marks and citation. Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at www.honor.gatech.edu.

Learning Accommodations:
If needed, we will make classroom accommodations for students with documented disabilities. These accommodations must be arranged in advance and in accordance with the Office of Disability Services (http://disabilityservices.gatech.edu).

Schedule of Topics:

Week 1:	Introduction The multiple roles of radiation: Introductory survey
Week 2:	Basic radiometric quantities. The Beer-Bouguer-Lambert law. Concepts of extinction (scattering plus absorption) and emission. Schwarzschild's equation. Blackbody radiation. Main radiation laws. Sun as an energy source. Solar spectrum and solar constant. Translation initiation
Week 3:	Composition and structure of the Earth's atmosphere.

	Basic properties of gases, aerosols, and clouds that are important for radiative transfer modeling. Basics of gaseous absorption/emission. Line shapes.
Week 4:	Absorption spectra of atmospheric gases in the IR, visible and UV regions. Terrestrial infrared radiative processes. Part 1: Line-by-line (LBL) method for solving IR radiative transfer.
Week 5:	Terrestrial infrared radiative processes. Part 2: Absorption band models. Terrestrial infrared radiative processes. Part 3: K-distribution approximation.
Week 6:	Terrestrial infrared radiative processes. Part 4: IR radiative heating/cooling rates. SBDART modeling
Week 7:	Light scattering and absorption by atmospheric particulates. Part 1: Principles of scattering. Main concepts: elementary wave, polarization, Stokes matrix, and scattering phase function. Rayleigh scattering. Light scattering and absorption by atmospheric particulates. Part 2: Scattering and absorption by spherical particles.
Week 8:	Light scattering and absorption by atmospheric particulates. Part 3: Scattering and absorption by nonspherical particles. Optical modeling using Mie theory.
Week 10	Principles of multiple scattering in the atmosphere. Radiative transfer equation for diffuse solar radiation. Single scattering approximation. Modeling of radiativ transfer through the atmosphere using SBDART.
Week 11:	Methods for solving the radiative transfer equation with multiple scattering. Part 1: Two-stream approximations Methods for solving the radiative transfer equation with multiple scattering. Part 2: Inclusion of surface reflection and emissivity. Exact methods: Discrete-ordinate, Adding-doubling, and Monte Carlo.
Week 12:	Total radiative heating/cooling rates. Radiation and climate. Simple climate models.
Week 13	Radiative forcing of gases, aerosols and, clouds. Course review.
Week 14	Problem solution examples. Take home exam.
Week 15:	Class Project Presentations
Final Week	Class Papers due