ATMOSPHERIC RADIATIVE TRANSFER – Fall 2005

EAS 8803

Instructor: Prof. Irina N. Sokolik
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Meeting Time: Tuesdays: 3:05-4:25 PM
Thursdays: 3:05-4:25 PM

Meeting place: L1175

Office hours: by appointment

What this course is about.

The atmospheric radiative transfer is central to understanding the workings of the 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 surface. Topics to be covered include the radiative balance at the surface, radiative forcing at the top of the atmosphere, radiative heating/cooling rates, actinic fluxes, methods for solving the one- and three-dimensional radiative transfer, radiation codes in regional and global atmospheric dynamical models, among others.

Prerequisites: EAS Remote Sensing classes or prior experience in radiative transfer are required. This is an advanced graduate level course.

How this course is organized:

- **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/EAS_Fall2005.htm

!!!! Please review lecture materials before coming to the class.

- **Homework assignments**

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

- **Class research project**

Goal is 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. A written report is required by the end of the term.

- **Exams:**

Two midterm exams, but no final exam.

- **Grading:**

Mid-term exams (2)	30%
Homeworks	30%
Research Project	40%

Required Text:

K.N. Liou *An Introduction to Atmospheric Radiation*, 2002.

Additional Text:

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.

Atmospheric transmission, Emission, and Scattering. Kyle, 1991.

COURSE OUTLINE

1. The role of atmospheric radiation in the Earth's energy budget, atmospheric dynamics and thermodynamics, and photochemistry.
2. The nature of solar and thermal IR atmospheric radiation. Concepts of scattering, absorption, and emission.
3. Basic radiometric quantities. Main radiation laws. Blackbody radiation.
4. Sun as an energy source. Solar spectrum and solar constant.
5. Gaseous absorption and emission. Concepts of a spectral line and a band. Band models. Absorption by atmospheric gases in IR, visible, and UV regions.
6. Interaction of electromagnetic radiation with aerosol and cloud particles. Single-scattering by spherical and non-spherical particles. The nature of light absorption by particulate matter. Lorenz-Mie theory.
7. Fundamentals of the thermal IR radiative transfer. Line-by-line approach. Correlated K-distribution approximation.
8. Principles of multiple scattering. Methods for solving the radiative transfer equation with multiple scattering and absorption (Two-stream and Eddington's approximations, Discrete-ordinates method, Adding method, Monte Carlo). Radiative transfer with polarization.
9. Earth's energy balance. Direct and indirect radiative forcings. Radiation budget at the surface. Radiative feedbacks.
10. Radiative heating and cooling rates.
11. Actinic fluxes. Basics of photochemistry.
12. Radiation codes in regional and global atmospheric dynamical models.