Instructor: Prof. Irina N. Sokolik
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Meeting Time: Tuesdays/Thursday: 1:35-2:55 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 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.

**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/irina/EAS8803_Fall2009/

!!!! 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
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.

➢ Exams:
Two midterm exams, but no final exam.

➢ Grading:
Mid-term exams (2) 30%
Homeworks/Numerical RT modeling 40%
Research Project 30%

Required Text:

Additional Text:
Radiation and cloud processes in the atmosphere. K.N. Liou, 1992
Absorption and Scattering of Light by Small Particles. C. Bohren and D. Huffman, 1983.
COURSE OUTLINE

1. The role of atmospheric radiation in the Earth’s energy budget, atmospheric dynamics and thermodynamics, and photochemistry.
10. Radiative heating and cooling rates and their role in the atmospheric dynamics and thermodynamics.
12. Photosynthetic active radiation (PAR) and its role in the climate system.
13. Radiation codes in regional and global atmospheric dynamical models.
# Tentative Schedule for Fall 2009

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture</th>
<th>Required Reading</th>
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<tbody>
<tr>
<td>18-Aug</td>
<td>Lecture 1</td>
<td>Introduction &amp; Logistics. Basics radiometric quantities. L02: 1.1</td>
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<tr>
<td>20-Aug</td>
<td>Lecture 2</td>
<td>The Beer-Bouguer-Lambert law. Concepts of scattering, absorption, and emission. The &quot;simple&quot; radiative transfer equation. L02: 1.1, 1.4</td>
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<tr>
<td>25-Aug</td>
<td>Lecture 3</td>
<td>Blackbody radiation. Main laws. Sun as an energy source. Solar spectrum and solar constant. L02: 1.2, 1.4.3, 2 Appendix A</td>
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<tr>
<td>27-Aug</td>
<td>Lecture 4</td>
<td>Composition and structure of the atmosphere. Basic properties of radiatively active species. L02: 3.1, 5.1 pp.169-176</td>
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<tr>
<td>1-Sep</td>
<td>Lecture 5</td>
<td>Gaseous absorption/emission: Concepts of a spectral line and a band. Line shapes. Absorption coefficient and transmittance. L02: 1.3</td>
</tr>
<tr>
<td>3-Sep</td>
<td>Lecture 6</td>
<td>Absorption by atmospheric gases in the IR, visible and UV. HITRAN spectroscopic database. L02: 4.2.1, 3.2</td>
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<tr>
<td>10-Sep</td>
<td>Lecture 8</td>
<td>Terrestrial infrared radiative transfer. Part 2: K-distribution approximations. L02: 4.3</td>
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<tr>
<td>15-Sep</td>
<td>Lecture 9</td>
<td>IR radiative transfer modeling.</td>
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<tr>
<td>22-Sep</td>
<td>Lecture 11</td>
<td>Terrestrial infrared radiative transfer. Part 4: IR radiative cooling rates. L02: 4.2.2,4.5-4.7</td>
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<tr>
<td>24-Sep</td>
<td>Lecture 12</td>
<td>IR radiative transfer modeling.</td>
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<tr>
<td>29-Sep</td>
<td>Lecture 13</td>
<td>Review for Exam 1: IR radiative transfer</td>
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<tr>
<td>1-Oct</td>
<td>Mid-term Exam 1</td>
<td></td>
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<tr>
<td>6-Oct</td>
<td>Fall Break</td>
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<tr>
<td>13-Oct</td>
<td>Lecture 15</td>
<td>Scattering. Part 2: Scattering and absorption by an ensemble of spherical particles. L02: 5.2, 3.3.2</td>
</tr>
</tbody>
</table>
15-Oct Lecture 16  Scattering: Part 3: Scattering and absorption by nonspherical particles. L02: 5.3, 5.5

20-Oct Lecture 17  Optical modeling.

22-Oct Lecture 18  Principles of multiple scattering in the atmosphere. Radiative transfer equation with multiple scattering in a plane-parallel atmosphere. L02: 3.4, 6.1


3-Nov Lecture 21  Methods for solving the radiative transfer equation with multiple scattering. Part 3. "Exact" methods (Discrete-ordinate, Adding and Monte Carlo methods). L02: 6.2. 6.3.1-6.3.4, 6.4, 6.7

5-Nov Lecture 22  Net (total) radiative heating/cooling rates. L02: 3.5, 4.5.2, 4.6.1, 4.6.2, 4.7, 8.2.4

10-Nov Lecture 23  RT modeling with multiple scattering. L02: 8.1, 8.3, 8.5, 8.6

12-Nov Lecture 24  Radiation and climate. Part 1. Radiative transfer codes in GCMs and NWPs. L02: 8.4, 8.6.3


19-Nov Lecture 26  Class project presentation

24-Nov Lecture 27  Class project presentation

26-Nov  NO CLASS: Thanksgiving

1-Dec Lecture 28  Review for Exam 2.

3-Dec  Mid-term Exam 2