REMOTE SENSING OF THE ATMOSPHERE AND OCEANS

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Meeting Time: Mondays: 3:05-4:25 PM L1175
   Wednesdays: 3:05-4:25 PM Computer Room L1110

Office Hours: Wednesdays 4:25-6:00 PM (or by appointment)

Lecture 1

Introduction and Logistics

Objectives:
1. What this course is about.
2. How the course is organized:
   ➢ Lectures
   ➢ Computer Modeling Laboratories
   ➢ Exams
   ➢ Class Research Project
3. Required/additional/advanced reading.
4. Grading.
5. Course outline, lecture schedule, and reading assignments.
1. What this course is about

*General definition:*

**Remote sensing** is the collection of information about an object without coming into physical contact with it.

*Definition used in this course:*

**Remote sensing** is characterization of an object based on measurements of electromagnetic radiation.

- This course provides a foundation for understanding the physical principles of remote sensing of the atmosphere and oceans.

- The main goal of the course is to build a broad conceptual framework for physical understanding the methodology and various applications of remote sensing in studying the atmosphere and oceans.

**NOTE:** This course does NOT include remote sensing of land and vegetation, image processing, or instrumentation development.

- The course is designed as a collection of lectures and computer modeling laboratories.
- The lectures focus on the fundamentals of the interactions between electromagnetic radiation and atmospheric gases, aerosols and clouds, and ocean surfaces, covering the spectrum from the ultraviolet through the microwave.
- The labs provide hands-on experience in using remote sensing data for various applications in atmospheric and oceanic sciences. Topics to be covered include aerosol and cloud property retrievals, ozone and air pollution characterization, vertical temperature and humidity profile retrievals, sea ice characterization, and retrievals of ocean color and sea surface temperature, among others.
2. How this course is organized:

> **Lectures:**

Lectures are developed to provide the most critical material and to complement the textbook.

Lecture notes will be posted (in PDF format) at the course website:

http://irina.eas.gatech.edu/EAS6145_2007.htm

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

> **Computer Modeling Laboratories**

Will be posted at the course web and available on-line

> **Exams:**

Two midterm exams:

Exam 1: February 28
Exam 2: April 30

> **Class Research Project**

**Goal** is to perform an analysis and interpretation of remote sensing data in a well-defined problem.

Plan of a research project must be prepared by a student but discussed with and approved by me. Try to select a topic of your class project as close as possible to your research.

Research project must be prepared as a web presentation.

Presentation of student’s projects is scheduled for the last week of classes.
**General guidelines for preparing your class project:**

1) Define a topic of your project by selecting a specific atmospheric or oceanic parameter and remote sensing technique(s) used to retrieve this parameter.
   
   *For instance, characterization of ozone from OMI observations.*

2) Identify and study at least 3-5 papers dealing with the selected topic.

3) Perform an original analysis of the remote sensing data in a well-defined problem.
   
   *For instance, interannual variability of O3 over the Northern America.*

4) Your paper (about 15-20 pages) should show
   - the importance of the atmospheric or oceanic parameter selected;
   - brief description of a remote sensor;
   - explanation of a retrieval algorithm;
   - results of your analysis;
   - validation of retrieved data against independent measurements and/or modeling;
   - brief summary (e.g., advantages and disadvantages of the retrieval technique, etc.)

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**3. Required/additional/advanced reading.**

**Required Text:**


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**Recommended introductory text:**

*A First Course in Atmospheric Radiation.*


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**Online tutorials:**

*Canada Centre for Remote Sensing (CCRS) remote sensing tutorial:*

http://www.ccrs.nrcan.gc.ca/ccrs/learn/learn_e.html

*NASA remote sensing tutorial:*

http://rst.gsfc.nasa.gov/Front/tofc.html
Committee on Earth Observation Satellites (CEOS) remote sensing tutorial:
http://ceos.cnes.fr:8100/cdrom-00/astart.htm

Univ. of Illinois tutorial: remote sensing for meteorology:
http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/home.rxml

Additional Text:
An introduction to atmospheric radiation.

Satellite meteorology: An Introduction.

Physical principles of remote sensing.

Introduction to the physics and techniques of remote sensing.

Remote sensing: Principles and interpretation.

NOTE: The various textbooks might have somewhat different terminology and very different notations.

4. Grading.

   Mid-term exams (2)  30%
   Computer modeling labs  40%
   Research project  30%
5. Course outline, lecture schedule, and reading assignments.

REMOTE SENSING OF THE ATMOSPHERE AND OCEANS

Outline

1. Basics of remote sensing: introductory survey
2. The nature of electromagnetic radiation:
   - Polarization. Stokes’ parameters.
3. Emission and reflection from the ocean and land surfaces
5. Absorption/emission by atmospheric gases and effects on remote sensing.
6. Scattering/absorption by aerosols and clouds and effects on remote sensing.
8. Applications of passive remote sensing using extinction and scattering:
   - Sensing of ozone in the UV region
   - Ocean color
   - Sensing of clouds and aerosols (retrieval of optical depth and particle sizes)
10. Applications of passive remote sensing using emission:
    - Sensing of sea surface temperature (SST)
    - Sensing of precipitation
    - Sensing of clouds
11. Principles of sounding by emission:
    - Sounding of the temperature profile
    - Sounding of trace gases and air pollution
12. Principles of active remote sensing: Radars and lidars
13. Applications of radars:
    - Sensing of clouds and precipitation
14. Applications of lidars:
    - Sensing of water vapor and trace gases
    - Sensing of aerosols and clouds
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<td>Logistic: Goals and structure of the course.</td>
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<td>Jan 10</td>
<td>Lecture 2.</td>
<td>Basics of remote sensing: introductory survey</td>
<td>S 1.1, 1.7, p.395-398, 426-427</td>
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<td>Lecture 3.</td>
<td>The nature of electromagnetic radiation. Polarization. Stokes’ parameters</td>
<td>S 2.1-2.4</td>
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<td>Jan 22</td>
<td>Lecture 4.</td>
<td>Radiation law. Blackbody emission. Emission and reflection from the ocean and land surfaces.</td>
<td>S 2.5; 4.4; p. 177-183</td>
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<td>Planck function and emission from the surfaces. Sea-ice detection.</td>
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<td>Lecture 5.</td>
<td>The composition and structure of the atmosphere. Absorption/emission by atmospheric gases and effects on remote sensing</td>
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<td>Properties of atmospheric aerosols and clouds. Rayleigh scattering. Scattering/absorption by aerosols and clouds.</td>
<td>S 1.6, 4.1, 4.3, 5.1-5.4, 5.6, 5.7</td>
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<td>Modeling optical characteristics with Mie theory. Analysis of aerosol optical properties measured from ground-based and aircraft platforms.</td>
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<td>Retrievals of aerosol properties from passive satellite remote sensing</td>
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<td>Lecture 8.</td>
<td>Applications of passive remote sensing using extinction and scattering: Remote sensing of ozone in the UV region</td>
<td>S 6.2.1, 6.5, pp.177-180</td>
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<td>Applications of passive remote sensing using extinction and scattering: Ocean color retrievals and atmospheric correction algorithms</td>
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<td>Principles of active remote sensing: Radar sensing of cloud and precipitation.</td>
<td>S 8.1, 8.2.1, 8.2.2, 8.2.3, 8.3</td>
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<td>Radar sensing of precipitation</td>
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<td>Principles of active remote sensing: Lidars sensing of aerosols and clouds</td>
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