EAS 6145 **SPRING 2011**

Syllabus

REMOTE SENSING OF THE ATMOSPHERE AND OCEANS

Instructor: Prof. Irina N. Sokolik

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Meeting Time: Mondays: 3:05-4:25 PM

Wednesdays: 3:05-4:25 PM

Meeting Place: L1175

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

What this course is about:

This course provides a foundation for understanding the physical principles of remote sensing of the atmosphere and oceans. 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 and considering passive and active remote sensing techniques. 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. The main goal of the course is to provide a broad conceptual framework for physical understanding the capability and various applications of remote sensing in studying the atmosphere and oceans.

How this course is organized:

- The course is designed as a collection of lectures, computer modeling laboratories and a research project.
- 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.

➢ **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 (see under Teaching)

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

➢ **Computer Modeling Laboratories**

will be posted at the course website and available on-line. All labs will require a written report – due in one week after the lab.

➢ **Class Research Project**

Goal is to perform an analysis and interpretation of remote sensing data in a well-defined problem. The plan of a research project must be prepared by a student but discussed with and approved by the instructor. Try to select a topic of your class project as close as possible to your research. Research projects will be presented in class.

Exams:

Two midterm exams: Exam 1: March 2 Exam 2: April 27

Grading:

Mid-term exams (2)	30%
Computer modeling labs	40%
Research project	30%

Required/additional/advanced reading:

Each lecture will provide information regarding the required, additional and advanced reading.

Required text:

1) Lecture notes and handouts
2) Selected chapters from:

   Stephens G., *Remote Sensing of the Lower Atmosphere: An Introduction.*
   Oxford Univ. Press, 1994.

   Liou, K.N., *An introduction to atmospheric radiation.*
   Academic Press, Second Edition, Chapter 7, 2002.

Recommended introductory text:

Petty G.W., *A First Course in Atmospheric Radiation.*
Sundog Publishing. Second Edition, 2006.
http://www.sundogpublishing.com/

Examples of online tutorials:

Canada Centre for Remote Sensing (CCRS) remote sensing tutorial:
http://ccrs.nrcan.gc.ca/resource/index_e.php#tutor

NASA remote sensing tutorial: http://www.fas.org/irp/imint/docs/rst/

Committee on Earth Observation Satellites (CEOS) remote sensing tutorial:
http://ceos.cnes.fr:8100/cdrom-00/astart.htm

COMET Outreach Program: http://www.meted.ucar.edu/topics_satellite.php

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

Course outline

REMOTE SENSING OF THE ATMOSPHERE AND OCEANS

1. Basics of remote sensing: introductory survey
2. The nature of electromagnetic radiation:
   Polarization. Stokes' parameters.
   Radiation laws. Blackbody emission. Brightness temperature.
3. Emission and reflection from the ocean and land surfaces
4. The composition and structure of the atmosphere. Properties of atmospheric gases, aerosols and clouds.
5. Absorption/emission by atmospheric gases and effects on remote sensing.
6. Scattering/absorption by aerosols and clouds and effects on remote sensing.
7. Principles of passive remote sensing using extinction and scattering. Scattering as a source of radiation. Multiple scattering.
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)
9. Principles of passive remote sensing using emission. Radiative transfer with emission.
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

TENTATIVE CLASS SCHEDULE FOR SPRING 2011 – revised 19 Jan.2011			
Date	**Lecture/Lab**	**Topic**	**Required reading (see Lecture notes)**
Jan 10		SCHOOL CLOSED	
Jan 12		SCHOOL CLOSED	
Jan 17		SCHOOL HOLIDAY	
Jan 19	Lecture 1.	The nature of electromagnetic radiation. Introductory survey of satellite sensor characteristics.	S 2.1-2.2
Jan 24	Lecture 2.	Polarization. Main radiation laws. Blackbody emission. Brightness temperature. Emission from ocean and land surfaces.	S 2.3-2.5; 4.4; p. 177-183
Jan 26	*Lab 1.*	*Passive microwave remote sensing of sea-ice*	
Jan 31	Lecture 3.	The composition and structure of the atmosphere. Absorption/emission by atmospheric gases and effects on remote sensing	S 1.3-1.5, 3.2.1; 3.1-3.5
Feb 2	*Lab 2.*	*Absorption by atmospheric gases*	
Feb 7	Lecture 4.	Properties of atmospheric aerosols and clouds. Rayleigh scattering. Scattering/absorption by aerosols and clouds.	S 1.6, 4.1, 4.3, 5.1-5.4, 5.6, 5.7
Feb 9	*Lab 3.*	*Modeling optical characteristics with Mie theory. Analysis of aerosol optical properties measured from ground-based and aircraft platforms.*	S 6.1
Feb 14	Lecture 5.	Principles passive remote sensing using extinction and scattering. Scattering as a source of radiation. Multiple scattering.	S 6.3, 6.4, 6.6
Feb 16	*Lab 4.*	*Retrievals of aerosol properties from passive satellite remote sensing*	
Feb 21	Lecture 6.	Applications of passive remote sensing using extinction and scattering: Aerosol retrievals. Ocean color.	S 6.3, 6.5.1, pp.177-180
Feb 23	*Lab 5.*	*Retrievals of atmospheric gases from passive remote sensing*	
Feb 28	Lecture 7.	Applications of passive remote sensing using extinction and scattering: Remote sensing of ozone in the UV region.	S 6.2.1, 6.5
Mar 2		MID-TERM EXAM I	
Mar 7	Lecture 8.	Principles of passive remote sensing using emission. Radiative transfer with emission. Measurements of precipitable water vapor. Remote sensing of sea surface temperature (SST).	S 7.1, 7.3.1, 7.3.2, 7.2, 4.5.1
Mar 9	*Lab 6.*	*Retrievals of SST*	
Mar 14	Lecture 9.	Applications of passive remote sensing using emission: Sensing of precipitation and clouds.	S 7.4 , 7.6, 6.6
Mar 16	*Lab 7.*	*Retrievals of cloud properties from passive remote sensing*	
		SPRING BREAK	
Mar 28	Lecture 10.	Principles of sounding by emission. Sounding of the temperature profile. Sounding of trace gases and air pollution	S 7.5, 7.5.4, 7.7
Mar 30	*Lab 8.*	*Atmospheric sounding*	
Apr 4	Lecture 11.	Principles of active remote sensing: Radar sensing of cloud and precipitation.	S 8.1, 8.2.1, 8.2.2,8.2.3, 8.3
Apr 6	*Lab 9.*	*Radar sensing of precipitation*	
Apr 11	Lecture 12.	Principles of active remote sensing: Lidars sensing of aerosols and clouds	S 8.4.1, 8.4.2, 8.4.3, 8.4.4
Apr 13	*Lab 10.*	*Analysis of lidar sensing*	
Apr 18		*Students' project presentation*	
Apr 20		*Students' project presentation*	
Apr 25	Lecture 13.	Course Review	
Apr 27		EXAM II	

S denotes Stephens G., *Remote Sensing of the Lower Atmosphere: An Introduction.* Oxford Univ. Press, 1994.