GE-305: Introduction to Remote Sensing of the Earth and Environment

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Course Description

An exploration of methods of remote sensing used in modern observations of Earth processes. The physical principles of remote sensing will be introduced within the context of key Earth systems such as the atmosphere, the cryosphere, and the terrestrial and ocean biospheres. We will explore topics such as vegetation cycles, weather observations, the atmospheric ozone layer, and digital elevation model development. Laboratory work and student projects will include manipulation and interpretation of remote imagery to classify ground cover, detect environmental change, and observe spatial and temporal patterns in Earth processes. 4 credits, 3 hours lecture/3 hours lab per week. Prerequisites are: GE-101 (or concurrent enrollment in GE-101) and ID-210 (or approved GIS course); or permission of the instructor.

Class Meetings

Lecture: 11:15-12:10, Mon/Wed/Fri, 3 hours total per week
Lab: 2:10-5:10, Tuesday, 3 hours total per week

Learning Goals

Studies of modern Earth system processes have been fundamentally altered over the last several decades by the developent of satellite remote sensing technology, which now allows us to remotely observe Earth's crust, ocean, atmosphere, and biosphere. Our focus in this class will be on regional and global-scale observations of Earth system processes acquired from airborne or orbiting sensors in space. Some of the data analysis techniques we will learn are equally applicable to aerial observations, however. Prerequisites are a basic understanding of Earth systems and geographic principles, and familiarity with GIS software. Students completing this course will be able to:

- Understand principles and major applications of modern techniques for regional and global-scale, remote sensing of the Earth
- Access, manipulate, and interpret remotely-sensed imagery
- Understand the uncertainties and limitations of remote observations
- Use remote-sensing data to infer rates, fluxes, and spatial patterns in Earth system processes
- Be able to formally communicate scientific research results orally and in writing, including correct attribution of imagery and data sources

Course format

Lectures and labs: Our one-hour lecture periods will consist of a combination of lecture and in-class activities. The first two-thirds of the course will include self-contained, weekly lab activities whose goals are 1) to give you the skills you need to design and carry out your final projects during the last month of the course, and 2) to introduce you to some of the applications of remote sensing in Earth science. Lab write-ups will be due the Monday following each Tuesday lab. Beginning in the second week after spring break, lab periods will be devoted to work on your final projects.

Final project: A major part of the coursework will consist of your final class project, in which you will use satellite observations to test a hypothesis or answer a question about Earth system processes. The specific area of focus is flexible, so you can explore a topic that is most relevant to you, but you will first need to articulate your hypothesis and research plan in a project proposal, on which I will provide feedback. You may work alone on your final project, or you may work together with one fellow student. Of course, I will expect projects undertaken by teams of two to require twice the effort of a solo project, and all "Group work" guidelines discussed below will apply.

Homework: Homework will be assigned approximately once a week and may include problems, online research tasks, or questions about reading assignments. Homework is intended to give you practice applying concepts learned in lecture, and to provide early feedback on your understanding of the material.

Textbook: **Lavender and Lavender, *Practical Handbook of Remote Sensing*, CRC Press, 2016.** Other readings will be provided as necessary.

Class Policies

Attendance: As with any class, attendance and active participation are key. When you are absent or unprepared, it not only impacts your own learning experience, but also that of your classmates. I will strive to be on time and prepared for every class, and I expect the same from all students. If you are late once or twice it's OK, but please enter quietly and find a seat quickly. If you are sick, please rest and recover – but also inform me ahead of your absence. Unless you have a true emergency (for which I will expect documentation), a quick email ahead of class is all it takes. If I excuse your absence, I will still expect you to turn in any written assignment that was due, and make up any missed in-class work. Beginning with your 2nd *unexcused* absence, a 4% penalty to your final grade per unexcused absence will apply, plus a zero for any work due that day. Unavoidable conflicts must be cleared with me well in advance.

Electronic Devices: Electronic devices and cell phones are allowed in class as long as they *do not distract you or those around you.* This means, for example, that cell phones must be silenced, and laptops used only for activities immediately relevant to this class (e.g., note-taking, data analysis, or when the class is actively researching a topic online). This policy, in which electronic devices are present but silent and unobtrusive, reflects the norms of the professional world that you will enter after you graduate. However, if I notice that you or your neighbors are distracted by your device(s), I reserve the right to restrict their use by everyone, for the remainder of the semester. Electronic devices and cell phones are not allowed during quizzes or exams.

Access and Office Hours: I am available for drop-in meetings during my posted office hours. If you are unable to meet during those times, you are welcome to make an appointment with me at a mutually convenient time. The best ways to set a meeting are to catch me in class or email me. You can also reach me by calling my office. I respond to student messages as quickly as possible, and you can expect a response to e-mail requests typically within 48 hours and often much sooner.

Academic Integrity: Plagiarism, cheating, and other violations of academic integrity will not be tolerated, and will result in consequences in accordance with the Skidmore College Student Handbook, https://www.skidmore.edu/student_handbook/honor-code.php. When writing any kind of academic document, sources of information, including internet sources, must be properly cited, in accordance with the Skidmore College Honor Code. Detailed instructions regarding citation conventions are available from the Library.

Group work: You may work with classmates on homework assignments, but *the individual work you turn in must be your own*. If you work with others, you must note somewhere on the assignment who your study partners were. During the semester, there may be occasions where I will ask you to work on an assignment as part of a group. After you present or hand in a group assignment, I will ask each group member for a brief, written evaluation of their own and their team members' contributions to the effort. There may also be occasions where I ask you to work individually without collaboration, and in these cases working with others would constitute an academic integrity violation. I will be clear about my expectations in all cases.

Students with disabilities. If you are a student with a disability and believe you need academic accommodations in this or any class you must make requests for such accommodation to Meg Hegener, the Coordinator for Students with Disabilities. You will also need to provide documentation which verifies the existence of a disability in support of your request. Accommodations must be approved in advance of exams to allow time to make any supporting arrangements. For further information and assistance with this process, call 580-8150, or stop by Student Academic Services in Starbuck.

> *Color vision deficiency*: If you don't have normal color vision, please let me know, even if you do not normally request accommodations in your other classes.

Grading Breakdown

Final project

- Proposal: 5%
- Progress report meeting: 5%
- Final presentation: 10%
- Written report: 20%

Final Project Total: 40%

Mid-term Exams (2): 25%

Labs (7): 20%

Class participation and homework: 15%

Schedule (continued on next page, and subject to change!)

Week	Lecture (MWF)	Lab (T)	Major assignments due
Jan. 22-25	Introduction; Electromagnetic spectrum, solar radiation, and observing platforms	No lab	
Jan. 28-Feb. 1	Reflectance, absorption, scattering, and sensor resolution	#1: Introduction to multiband imagery and software packages	
Feb. 4-8	Map projections, georeferencing, and atmospheric correction	#2: Land cover (digital processing: spatial resolution and image classification)	Lab #1 due Mon Feb. 4
Feb. 11-15	Visible reflectance applications: vegetation, land cover	#3: Mapping sea-ice in the Arctic	Lab #2 due Mon Feb. 11
Feb. 18-22	Visible reflectance applications: Aquatic systems	#4: The global biosphere, or "When is spring coming?"	Lab #3 due Mon. Feb. 18 **In-class mid-term exam, Fri. Feb. 22**
Feb. 25-Mar. 1	Data transformation, change detection	#5: Land use change	Lab #4 due Mon. Feb. 25
Mar. 4-8	Introduction to the atmosphere: radiative transfer, major gases, and the ozone layer	#6: The ozone hole	Lab #5 due Mon. Mar 4 *Project proposal due Fri. Mar. 8*
Mar. 11-15	Spring Break		
Mar. 18-22	Atmospheric gas absorption, clouds, and weather	#7: Volcanoes and hyperspectral imagery	Lab #6 due Mon. Mar. 18
Mar. 25-29	Introduction to thermal imaging, thermal inertia, and temperature observation	Work on projects*	Lab #7 due Mon. Mar. 25
Apr. 1-5	Passive microwave remote sensing and polarization	Work on projects*; one-on-one progress report meetings during lab	*Project progress meetings Thurs. Apr. 2, during lab*
Apr. 8-12	Active microwave remote sensing, RADAR, LIDAR overview	Work on projects*	**In-class mid-term exam, Fri. Apr. 12**
Apr. 15-19	Field trip data analysis and interpretation*	Work on projects*	
Apr. 22-26	Additional topics and applications (e.g., other planets; careers in remote sensing and geospatial analysis)	Final presentations	*Final presentations during last lab period*
Apr. 29-30	Wrap-up	***Final project report due by end of final exam period: Monday May 6, noon***	

* One lab period and 2-3 lecture periods during the second half of the semester will be devoted to a field trip to the Hudson and Mohawk Rivers, where we will make radiometric observations of suspended

sediment loading. Timing will be dependent on spring ice thaw and on the Landsat overpass schedule (below). Other lab and lecture topics during this time period may be shifted around a bit to accommodate.

Landsat 8 overpasses – Path 14, Row 30 on cycle day 16
Fri Mar. 29
Sun. Apr 14
Tue. Apr. 30

Landsat 7 overpasses – Path 14, Row 30 on cycle day 8
Thu. Mar. 21
Sat. Apr. 6
Mon. Apr. 22

Landsat overpass calendars: http://landsat.usgs.gov//tools_L8_acquisition_calendar.php
http://landsat.usgs.gov//tools_L7_acquisition_calendar.php

Sentinel-2A overpass information: https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-2/acquisition-plans