GEOS F422
Geoscience Applications of Remote Sensing

Spring 2025, 3 credits
In person or online synchronous
Lecture: Tue/Thu 09:00-10:00, room: WRRB 004/online
Lab: Tue/Thu 10:00-11:30, room: WRRB 004/online

Instructor: Simon Zwieback
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Office Hours: Tue/Thu 11:30-12:30, or by appointment

Course Description

Remote sensing and its applications to geologic, environmental and physical sciences. Includes physical principles, digital image processing and hands-on project experience using satellite images for mapping and change detection. Course is not available for audit.

Pre-requisites

PHYS F124X or PHYS F212X, or permission of instructor.

Course Content

The first third of the course provides a general overview of remote sensing, introducing applications of societal relevance, the history of the field, and basic physical principles. We discuss the foundations of image interpretation, focusing on aerial images and multispectral observations (Landsat program). We will analyze these images using remote sensing software packages, drawing on a range of data sources and scientific disciplines.
The second third is centered on a range of imaging modalities, including imaging spectroscopy, light detection and ranging (LiDAR), and microwave systems. The idea is to provide an overview of the measurement principle, common sensors and data

sources, and image processing techniques. Case studies and hands-on labs will showcase real-world applications and convey practical image analysis skills.
In the final third of the course, we will investigate geoscientific applications of remote sensing. We will adopt a domain-science perspective and appraise the contribution of remote sensing to scientific questions relating to geohazards, hydrology, etc. An independent project gives students an opportunity to study an applied problem of their choice.

Student Learning Outcomes

After completing the course, you will be able to

- Quantitatively describe electromagnetic radiation using radiometric concepts and radiation laws
- Contrast spectral signatures and identify the underlying physical phenomena
- Perform and appraise atmospheric corrections of visible and infrared remote sensing observations
- Identify suitable remote sensing techniques, data, and algorithms to answer a given geoscientific question
- Extract information from remote sensing data using state-of-the-art analysis techniques and assess the quality of the results

In contrast to the graduate students, undergraduate students are not expected independently to design remote sensing solutions.

Course Readings/Materials

Textbooks:

- Sabins, F. F. and Ellis, J. M. Remote Sensing Principles, Interpretation, and Applications. Fourth Edition Waveland Press, 2020 (Recommended)
- Jensen, J. R. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. 2007. (Alternative)

Additional readings

Additional readings will be posted on Canvas.

Software

All necessary software tools will be available through the computing facilities of the remote sensing computer lab in WRRB 004 or via the university's Virtual Private Network (VPN). Upon request, you will be provided with swipe card access to WRRB 004.

Instructional Methods:

Lecture and lab: The course comprises 2 hours of lecture and 3 hours of lab each week. Distance students will be able to join remotely via Zoom. The lectures will be partly interactive, including group-based image analyses and discussions. Participation in the discussions is required. We will flip the classroom for one week, i.e. the students will be completely in charge of lecture and lab. The labs will focus on remote sensing data processing and analysis using software packages such as ENVI. Lectures and labs will be online synchronous for distance delivery.

Assignments: Students will complete (approximately) bi-weekly homework assignments. The assignments are tightly integrated into the labs.
Term project: The term project addresses an applied problem in remote sensing. The selection of the application is at the student's discretion, upon consultation with the instructor. Each student will give an outline presentation mid-semester and give a PICO (Present Interactive COntent) presentation at the end of the semester. The students are expected to:

- Provide a compelling rationale for their project and identify a specific objective
- Identify a suitable data set
- Analyze the data set to achieve the objective

Evaluation:

There will be 5 assignments throughout the semester. The one with the lowest score will be dropped. All assignments are closely aligned with the learning outcomes, allowing the student to build a broad skill set in remote sensing data processing, analysis, and interpretation.
There will be a single quiz about the foundations of remote sensing.
Participation credit will be based on the quality and frequency of the student's contribution to group discussions, image interpretation, etc.
Evaluation of the project will be based on the project outline presentation; design and clarity of the PICO flash talk and interactive poster; the question and answer session; and the intrinsic merit of the presented work (e.g., compelling interpretation, critical discussion of limitations).

Course policies

Attendance: All students are expected to attend and participate in all classes and labs. Active participation in class (e.g., group discussions) forms part of the grade. Should reasons emerge that prevent a course participant from attending a lecture or lab, they should consult with the instructor in advance.
Late submission: Unless arrangements are made with the instructor prior to the due date, work that is submitted late will be penalized 10% per day past the deadline.
Independent work: Students are welcome to discuss the assignments with one another. However, the write-up must be individual work. The take-home quiz must be tackled individually.

Grading:

The course grade will be a weighted average of the absolute scores obtained in:

- Assignments: 48%
- Quiz: 12%

- Participation: 5%
- Project: 35%

The final weighted scores (in percent) will be translated to letter grades (with +/-) as follows:

A+ = 97-100% A = 93-96% A– = 90-92%
B+ = 87-89% B = 83-86% B– = 80-82%
C+ = 77-79% C = 73-76% C– = 70-72%
D+ = 67-69% D = 63-66% D– = 60-62%
F = 60% or below

I follow the University of Alaska Fairbanks Incomplete Grade Policy, which states that the letter “I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) the majority of work in a course but for personal reasons beyond the students control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an ”I" grade.

Tentative course calendar

Week	Topics	Labs	Due
1	Introduction	Remote sensing images	
2	Principles	Calculations	
3	Take-home quiz / Interpretation	Image interpretation	Take-home quiz
4	Aerial imagery	Aerial imagery (A1)	
5	Multispectral I	Change detection (A2), project meetings	
6	Multispectral II	Multispectral analysis (A3)	A1
7	Thermal infrared	A2 presentations, project meetings	A2
8	Topographic mapping & LiDAR	LiDAR (A4)	A3
9	Spring break		
10	Microwave	Project outline talk	Project outline talk
11	Image processing	Image processing (A5)	A4
12	Hyperspectral & Applications I	Hyperspectral	
13	Applications II	Flipped classroom	A5
14	Applications III	Project meetings	PICO draft
15	PICO presentations		PICO

Student protections statement: UAF embraces and grows a culture of respect, diversity, inclusion, and caring. Students at this university are protected against sexual harassment and discrimination (Title IX). Faculty members are designated as responsible employees which means they are required to report sexual misconduct. Graduate teaching assistants do not share the same reporting obligations. For more information on your rights as a student and the resources available to you to resolve problems, please go to the following site: https://catalog.uaf.edu/academics-regulations/students-rights-responsibilities/.

Disability services statement: I will work with the Office of Disability Services to provide reasonable accommodation to students with disabilities.

ASUAF advocacy statement: The Associated Students of the University of Alaska Fairbanks, the student government of UAF, offers advocacy services to students who feel they are facing issues with staff, faculty, and/or other students specifically if these issues are hindering the ability of the student to succeed in their academics or go about their lives at the university. Students who wish to utilize these services can contact the Student Advocacy Director by visiting the ASUAF office or emailing asuaf.office@alaska.edu.

Student Academic Support:
Communication Center (907-474-7007, uaf-commcenter@alaska.edu, Student Success Center, 6th Floor Room 677 Rasmuson Library)
Writing Center (907-474-5314, uaf-writing-center@alaska.edu, Student Success Center, 6th Floor Room 677 Rasmuson Library)
UAF Math Services (907-474-7332, uaf-traccloud@alaska.edu)
Drop-in tutoring, Student Success Center, 6th Floor Room 677 Rasmuson Library)
1:1 tutoring (by appointment only), Chapman 210
Online tutoring (by appointment only) available
https://www.uaf.edu/dms/mathlab/, available at the Student Success Center
Developmental Math Lab (Gruening 406, https://www.uaf.edu/deved/math/)
The Debbie Moses Learning Center at CTC (907-455-2860, 604 Barnette St, Room 120, https://www.ctc.uaf.edu/student-services/student-success-center/)
For more information and resources, please see the Academic Advising Resource List https://www.uaf.edu/advising/students/index.php

Student Resources:
Disability Services (907-474-5655, uaf-disability-services@alaska.edu, 110 Eielson Building)
Student Health & Counseling [free counseling sessions available] (907-474-7043, https://www.uaf.edu/chc/appointments.php, Whitaker Building 2nd floor)
Office of Rights, Compliance and Accountability (907-474-7300, uaf-orca@alaska.edu, 3rd Floor, Constitution Hall)

Associated Students of the University of Alaska Fairbanks (ASUAF) or ASUAF Student Government (907-474-7355, asuaf.office@alaska.edu, Wood Center 119)

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For more information, contact:
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