

Big Geospatial Data

GEOS F658: Spring 2026

Course information

Lectures: Tuesdays and Thursdays 8:45-9:45

Labs: Tuesdays and Thursdays: 9:46-11:15

Place: WRRB 004 or online

Instructor: Simon Zwieback, szwieback@alaska.edu

Office hours: Tuesdays and Thursdays, 11:15–12:00

Course type

Hybrid: In person and/or online synchronous

Course description

Analysis of large geospatial data sets and data-driven modeling for solving geoscientific problems. The class intertwines i) cloud-based processing of big vector and raster data sets from GPS surveys, models and remote sensing, and ii) predictive modeling using data science techniques such as Random Forests.

Pre-requisites

Graduate standing in science or engineering.

Previous experience with geospatial data analysis is helpful but not required. Complementary tutorials will be provided.

Course goals

The overarching goal is for the student to be able to answer applied or research-focused questions in Earth System Science using big geospatial data sets from such diverse sources as social media, remote sensing, ground-based GPS and geological surveys or atmospheric models.

The student will select, implement and critique data processing and data-driven modeling solutions to extract information from a wide range of data sets. The student will gain hands-on experience in cloud-based geospatial data analysis using Google Earth Engine. Data processing skills to be gained encompass visualization, geometric manipulation, filtering and spatiotemporal aggregations. Data-driven modeling skills include performance assessment, robust regression, and ensemble-based methods such as Random Forests.

Applications will be focused on the changing atmosphere, ocean and land surface in the Arctic, with emphasis on Alaska. They include trend analysis of snow conditions, the coupling between sea ice concentration and land surface temperatures, forecasting of weather and vegetation conditions, and changes in permafrost conditions.

Graduate learning outcomes

At the end of the course, the graduate student will be able to

- Load, query and visualize a diverse range of big geospatial data sets in Earth Engine
- Select data processing solutions amenable to processing of big data sets in the cloud
- Develop cloud-based workflows for filtering, combining and summarizing big geospatial data sets
- Design data-driven modeling workflows to solve geoscientific problems
- Draw independent conclusions from data-driven models, accounting for prediction skill, uncertainties, and previous findings

Instructional Methods

Lecture with demonstrations and discussions, labs combined with graded assignments, a case study and a capstone project.

The lectures will be partly interactive, including group-based data analyses and discussions. The labs will focus on and expand the concepts covered in the lectures, providing deeper exposure through hands-on analyses of actual data sets as well as self-directed scholarly inquiry. Lectures and labs will be online synchronous for distance delivery.

The individual project will be integrated with the final project that will be tackled jointly by all students and the instructor.

Evaluation

- Homework assignments 1-4: 40%
- Case study: 20%
- Capstone project (presentation, report, participation): 40%

Each of the four equally weighted homework (HW) assignments will be focused on one to two of the learning outcomes. The students will gain facility with the concepts introduced in class through hands-on data processing as well as by interpreting and critiquing data sets and workflows. The students are encouraged to work on the assignments in groups, but the write up must be done individually.

The graduate assignments differ fundamentally from the undergraduate assignments. Some tasks overlap with the undergraduate student assignments, primarily those focused on skill development and application of techniques learned in class. However, in addition, each graduate assignment will additionally contain a substantial self-directed component, requiring the students design experiments, conduct independent research-driven inquiry based on raw data, or compile critical reviews of the primary literature.

Each student will present a case study that showcases how Big Geospatial Data are analyzed and applied in the real world. Evaluation will be based on a 10 minute presentation and half-page write up. Graduate students are expected to critically assess an existing application and/or to contribute their own analyses.

The individual project will constitute a subtask that is part of the larger joint project, focused on changes in auefs extent in the Brooks Range in 2026. Students can propose their own or sign up for a suggested task. The joint project will vary from year to year. We will start by jointly developing a code skeleton, which the students will then individually expand and/or assess. Each student will present the findings in class at the end of the term and through a short report. The undergraduate contribution will be restricted to the testing of the code in novel conditions.

Grading criteria

A (A+: > 97%, A: 93–96%, A-: 90–92%)
B (B+: 87–89%, B: 83–86%, B-: 80–82%)
C (C+: 77–79%, C: 73–76%, C-: 70–72%)
D (C+: 67–79%, C: 63–66%, C-: > 60–62%)
F (< 60%)

Reading

Required textbooks:

1. James, Witten, Hastie and Tibshirani, An Introduction to Statistical Learning, Second Edition. The textbook is available for download from the official website. It covers the data-driven modeling modules.
2. Community Earth Engine textbook: Cloud-Based Remote Sensing with Google Earth Engine. From <https://www.eefabook.org/>

Additional tutorials and lecture notes will be provided by the instructor.

Software and technology requirements

Google Earth Engine can be run from any browser.

Course policy

Students are expected to attend and participate in the lectures.

Late assignments will be accepted with a 5% penalty per day late.

Course calendar

The course comprises five modules:

Module	Geoscientific applications
M1 Earth Engine <ul style="list-style-type: none">• Application Programming Interface (API)• Data set types• Visualization	Alaskan glaciers
M2 Data processing <ul style="list-style-type: none">• Map/reduce and filtering• Mathematical operations• Geospatial joining• Data summaries	Seasonal and interannual snow cover dynamics
M3 Basic data-driven modeling <ul style="list-style-type: none">• Linear and robust regression• Prediction performance• Interpreting results	Air temperature trends in Alaska Localized weather forecasts (model output statistics)
M4 Advanced data-driven modeling <ul style="list-style-type: none">• Model complexity trade-offs• Ensemble methods• Predictor importance	Burned area mapping Estimating tundra shrub cover
M5 Project	2026: Aufeis dynamics

Tentative schedule:

Week	Content	Evaluation	Additional information
1	M1: API		
2	M1: data types and visualization		HW1 assigned
3	M2: filtering and math. operations		
4	M2: aggregation	HW1 due	HW2 assigned
5	M3: regression		Case study selection
6	M3: prediction performance	HW2 due	HW3 assigned
7	M3: interpretation		
8	Project preview		
9	M4: ensemble methods	HW3 due	HW4 assigned
10	M4: predictor importance		
11	M5: project	HW4 due	
12	M5: project		
13	Thanksgiving		
14	M5: project wrap-up		
15	M5: presentations	Presentation, report	

Student protections statement:

The university respects and upholds the principles of due process and a fair and equitable process as specified in the Board of Regents' Policy 09.02 Student Rights and Responsibilities. For more information regarding the rights and responsibilities of students, refer to the [Office of Rights, Compliance and Accountability website](#). You are encouraged to read the Board of Regents' policy carefully to fully understand your responsibilities to our community.

We strive to create a safe and respectful environment for all members of our community. If you have questions about expectations of you as a student or believe your rights are being violated, we encourage you to reach out to the Office of Rights, Compliance and Accountability for help. UAF reserves the right to suspend, expel or take other necessary and appropriate action in cases where a student is unable or unwilling to uphold community standards and campus safety.

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 672 Rasmuson Library)
 - 1:1 tutoring ([by appointment only](#)), 6th Floor Room 677 Rasmuson Library
 - 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 102, <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, Room 206, Health, Safety & Security Bldg - same building as Fire and Police)
- 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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1692 Tok Lane
3rd floor, Constitution Hall, Fairbanks, AK 99775
907-474-7300
uaf-orca@alaska.edu