GEOG 172 (3 credits) Spring 2021: **Earth from Space**

Instructor:
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Office hours: 1:00pm -2:00pm Tuesday

Classes:
Lecture: 2:00pm – 3:15pm Tuesday / Thursday (LeFrak Hall TBD Room)
First Class: TBD
Last class: TBD
Final examination: TBD.

Course Objective:
In this course, students will focus on the "big question" Why are Earth observations from space critical for monitoring our changing planet? This is an introductory survey course that reviews the capabilities offered by current Earth-observing satellite missions including how satellites view the Earth, what they can observe, and what significant problems can they solve. The students will learn about methods that are used to extract meaningful information from satellite images ranging from statistical clustering to deep learning algorithms. Finally, the course will introduce various applications for satellite monitoring of sea and continental ice loss, deforestation, ocean warming, urbanization, agricultural expansion and intensification, and vegetation response to climate change, among others. The students will learn the material from lectures presented by the primary course instructor and the leading experts from the National Aeronautics and Space Administration (NASA) and the University of Maryland. They will also work independently and in groups to explore and manipulate satellite images using existing online platforms and the virtual labs at the Department of Geographical Sciences.

Learning Outcomes:
At the completion of this I-Series course, students will be able to:

1. *Identify the major questions and issues related to satellite Earth Observations. Specifically, how satellites view the Earth, what they can observe, and why they are designed to collect information that way*.
    - what ranges of electro-magnetic spectrum are particularly useful for observing different objects and processes on the Earth's surface
    - what are spatial, spectral, temporal, and radiometric resolutions of imagery means for Earth observations
    - what methods are commonly applied to satellite imagery to extract information
    - how Earth observations contribute to solving environmental and societal problems

    Lecture materials in the course will cover all major questions identified in this section as a broad overview. Additional reading assignments, primarily

covering well-researched online materials, educational videos and tutorials (primarily produced by NASA, NOAA and other international Space Agencies) will provide a broader context for the instructional materials and help students to expand on the concepts covered during the lectures.
The mastery of this learning objective will be assessed through in-class quizzes, exams, and the students' ability to generalize their knowledge of existing major issues within the context of their group project.

2. *Demonstrate an understanding of basic terms, concepts and approaches in Earth Observations*
    a. Lecture materials in the course will cover all basic terms and concepts identified in this section as a broad overview. Additional reading assignments, primarily covering well-researched online materials, educational videos and tutorials (primarily produced by NASA, NOAA and other international Space Agencies) will provide a broader context for the instructional materials and help students to expand on the concepts covered during the lectures. The mastery of this learning objective will be assessed primarily through in-class quizzes and exams.
    b. Homework exercises will involve hands-on manipulation of satellite imagery and data products through existing online platforms and through access to the virtual lab environment provided by the Department of Geographical Sciences. The homework assignments will allow students to solidify their understanding of concepts and methods for satellite Earth observation data analysis. Homework assignments will contribute 20% of the total course grade.

3. *Demonstrate an understanding of the political, social, economic and ethical dimensions of global environmental change that is made possible through satellite observations.*
   Lecture materials, guest talks, and instructional videos will build the basis for understanding the role satellite Earth Observations play in global environmental governance particularly as it is related to issues of global climate change and the political, social and economic consequences of this global change for various regions and communities within the society.
   Students' mastery of these concepts will be assessed through exam questions and their ability to discuss these issues within the scope of their group project as the justification for designing an Earth Observing system targeting a specific application of societal relevance chosen by the students.

4. *Communicate major ideas and issues through effective written presentations*
   A group project will culminate in a written group paper where students will be required to present their project following a rubric generally consistent with the outline of a scientific proposal to include:
    a. Background and Justification for the satellite Earth observing system to target an issue of societal relevance
    b. Overall Goals and Objectives of the proposed system

   c. General Technical Requirements
      i. instrument resolutions
      ii. orbital paths
      iii. proposed data products necessary to meet the goals and objectives
   d. Expected Societal Benefits

   This assignment will allow students to benefit from peer-learning and feedback in addition to practicing their writing communication skills directly.
   The written product will contribute 20% of the total grade.

5. *Articulate how this course has invited them to think in new ways about their place in the global community and global change issues*
   Students will be invited to think and discuss the potential for incorporating satellite observations in management of global environmental, political, economic, and ethical issues and how global issues are intrinsically connect Earth’s citizens into a single global community. Lecture materials, guest presentations, and additional readings will provide examples of potential use and students will be invited to comment of those during in-class quizzes. Students’ ability to articulate these issues will be further assessed through targeted exam questions and through the written component of the group project particularly within sections involving “Background and Justification” and “Expected Societal Benefits”.

At the completion of this Natural Science course, students will be able to:

1. **Demonstrate a broad understanding of scientific principles and the ways scientists in a particular discipline conduct research.**

   Demonstrate a broad understanding of computational earth observational science principles such as electro-magnetic spectrum range, spatial, spectral, temporal and radiometric resolutions, and the progression of satellite imagery methodology.

   Students will master these principles hands on homework activities, guest speakers, and lecture materials.

2. Apply quantitative, mathematical analyses to science problems.

   Earth Observations and digital image processing require quantitative analytical approaches largely based on statistical analysis of satellite imagery to obtain meaningful information from data. Homework exercises will involve quantitative manipulation of satellite imagery and data products to extract answers to scientific questions posed by the instructor. The homework assignments will allow students to practice a variety of quantitative methods involved in Earth observation data analysis. Homework assignments will contribute 20% of the total course grade.

3. Solve complex problems requiring the application of several scientific concepts.

A group project will provide students with an opportunity to synthesize knowledge acquired within this course and drawing from other disciplines to describe an optimal satellite observatory for a specific application purpose. In the development of their project, the students will need to bring together multiple core scientific concepts related to satellite Earth Observations as well as demonstrate understanding of scientific concepts related to the chosen application. The mastery of solving complex problems that require incorporation of several scientific concepts will be assessed through the written product which will contribute 20% of the total grade.

4. Look at complex questions and identify the science and how it impacts and is impacted by political, social, economic, or ethical dimensions.

Look at complex questions and identify the science and how it impacts and is impacted by political, social, and ethical dimensions of global environmental change that is made possible through satellite observations. Lecture materials, guest talks, and instructional videos will build the basis for understanding the role satellite Earth Observations play in global environmental governance particularly as it is related to issues of global climate change and the political, social and ethical consequences of this global change for various regions and communities within the society.

Students' mastery of these concepts will be assessed through exam questions and their ability to discuss these issues within the scope of their group project as the justification for designing an Earth Observing system targeting a specific application of societal relevance chosen by the students.

5. Critically evaluate scientific arguments and understand the limits of scientific knowledge.

Critically evaluate scientific arguments and understand the limits of current knowledge on earth observations for global environmental change. Through critical assigned readings, guest lectures, site visits and weekly lectures students will learn about varying approaches to monitoring and processing earth data based on time, space, region, and instrument.

Students' mastery of these concepts will be assessed through exam questions and homework submissions.

6. Communicate scientific ideas effectively.
Effectively communicate scientific ideas on computational earth observations through written assessments. Students will communicate ideas on resolutions, oribal paths, and data products for a satellive earth observation systems, and will summarize the major findings on critical peer reviewed papers relative to those systems.

Student mastery of this communication will be assessed through a culminating group paper. This assignment will allow students to benefit from peer-learning and feedback in addition to practicing their writing communication skills directly

Prerequisites:
None

Course Materials:
No text book will be required for this course. The base knowledge will be provided through an open and publicly available manual for remote sensing published online and curated by Natural Resources Canada (https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/tutorial-fundamentals-remote-sensing/9309). Additional selected readings from peer-reviewed journals, well-researched online materials, educational videos and tutorials (primarily produced by NASA, NOAA and other international Space Agencies) will be assigned.

Course materials can be accessed through Canvas: www.elms.umd.edu

Assessment:
Student learning will be assessed through a variety of assessment instruments including:

1. In class quizzes using clicker technology: in class quizzes will be employed to engage students in active classroom participation as well as to gauge their comprehension of the presented material. These quizzes will be a low-stakes assessment component and will contribute the total of 10% of the course grade.
2. Homework assignments: students will have an opportunity to manipulate satellite imagery using existing online platforms (e.g. Google Earth Engine) and software and imagery provided within the virtual labs at the Department of Geographical Sciences. The homework assignments will be completed independently throughout the semester and will contribute the total of 20% of the course grade.
3. Exams: the course will contain two mid-term exams and one final exam. The mid-term exams will be worth 15% of the course grade each and the final exam will be worth 20% of the course grade. While the exams are designed to be non-cumulative, knowledge and understanding of core concepts covered within the previous sections of the course will be required to successfully complete the exams.
4. Group project: the course will contain one group project where the students will be randomly assigned to a group of ~5 – 7 students to deliver an overview of a specific application of satellite-based observations not previously covered in detail within the course. The students within the group will be asked to deliver a paper that reviews at least 5 examples of studies published in the peer reviewed journals focused on the chosen application as well as a discussion section that describes an optimal satellite observatory for the specific application purpose

based on the summary of knowledge received in the course. The group project will be worth at 20% of the course grade.

Grading scale

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

Campus Policies

Please visit www.ugst.umd.edu/courserelatedpolicies.html for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.

Class Schedule (subject to change):

Week	Topic	Materials to Read/Watch	Homework Due
1	Earth observation defined		
1	History of remote sensing		
2	Energy sources		
2	Information domains		
3	Science on a Sphere NASA Goddard Day Visit		
3	Passive sensor systems		Homework 1 due
4	Pre-processing data		
4	Pre-processing data		
5	Biogeophysical variable extraction		
5	Biogeophysical variable extraction		
6	Image interpretation		Homework 2 due
6	Mid Term Exam 1		
7	Supervised/machine learning		
7	Deep learning (Guest expert lecture)		
8	Change detection		
8	Active sensor systems (Guest expert lecture)		Homework 3 due
9	Pre-processing data		
9	Land cover and land use		
10	Forests		
10	Agriculture (Guest expert lecture)		
11	Urbanization (Guest expert lecture)		
11	Sea ice, ice caps, glaciers (Guest expert lecture)		Homework 4 due

12	Mid Term Exam 2		
12	Surface water		
13	Sea surface temperature (Guest expert lecturer)		
13	Vegetation response to climate change		
14	Review		
14	No class, finish group project		Group project due
Finals	Final Exam		