Earth Data Science & Analytics

INST208A
Spring 2020

Course Description

The world of Earth science data is complex and can be overwhelming with a wide range of data sources and formats, hefty downloads (Big Data!) and the need for complicated analytical tools. In order to make use of enormous volume of available data and geoinformation products, one has to know, where and how to search and obtain the data, how to analyze the data and extract useful information and knowledge. For example, what is the spatial distribution and temporal variation of Earth science variables (ESVs), such as temperature, precipitation, soil moisture, sea ice cover, aerosols, cloud cover, and vegetation cover? How to calculate climatology and anomalies of ESVs and identify long-term trends? What are spatial-temporal relationships between ESVs?

In this course, you will learn about the state-of-the-art Web-based tools that allow you to efficiently display and analyze a large number of datasets in a way many professionals working in the Earth science domain would. You will learn, how to visualize multiple Earth science datasets produced by NASA in a variety of ways directly on the Internet, without the need to download, manage and store them. Students will be introduced to comprehensive functions to analyze the data and generate customized maps, animations, multi-variable correlations, regional subsetting, etc. Not only will students will acquire theoretical and practical skills necessary to analyze the data, but they will also learn, how to interpret the data, extract knowledge and connect it to socio-economic information.

In particular, students will learn about main ESVs that characterize atmosphere, biosphere, cryosphere, land surface, oceans and terrestrial hydrosphere; variables' properties in terms of spatial and temporal coverage, and physical values they represent; and about visualizing ESVs to facilitate interpretation of data. Students will be introduced to comprehensive functions to analyze the geospatial data (calculating zonal statistics, histograms, spatial-temporal profiles, scatterplots, time-series) and generate customized maps, animations, multi-variable correlations, regional subsetting, etc. Students will also learn, how to relate ESVs to socio-economic data, for example assessing the impact of natural hazards on population and infrastructure (identifying flooded areas, regions of air pollution and its impact on human health); how night lights observable from space relate to economic activities and urban expansion.

The course aims to give students an authentic experience of what it means to be a professional data and research scientist through utilizing Web based analytical tools for ESVs. Therefore, in this course, you will work with real Earth science datasets and products to extract knowledge on the phenomena happening on the Earth, such as hurricanes, floods, fires, droughts, land cover land use changes, volcanic eruptions.

Dr. Sergii Skakun
skakun@umd.edu

Class Meets
Tuesdays & Thursdays
12:30 pm – 1:45 pm
ESJ # 1202

Office Hours
LeFrak Hall #1153
Tue & Thu 2:00 – 3:00 pm
and by appointment

Teaching Assistants
Na Zhang,
nzhang16@terpmail.umd.edu

Prerequisites
This course has no prerequisites.

Course Communication
All announcements will be posted on ELMS. Instructor can be contacted via ELMS or email. Please, include INST208A into the subject, when contacting by email. A guidance on writing professional emails available at ter.ps/email.

Learning Outcomes

After successfully completing this course you will be able to:

- Select, critically evaluate, and apply relevant areas of scholarship in Earth science, data analytics, and online analytical tools.
- Articulate the processes required to bring about a successful outcome from planning, modeling, preparing, critiquing, and revising Earth science data analysis study.
- By collaborating and discussing in the class, students will learn to collaborate on research projects involving Earth science data analytics. At the end of the semester, students will prepare a written report and presentation on their project, which will describe the data used, methods and obtained results.
- Connect the Earth science datasets with socio-economic information, using geoinformation datasets and analytical systems, and find patterns and correlation between them.
- Demonstrate a broad understanding of scientific principles and the ways scientists in Earth science domain conduct research with online analytical tools.
- Apply quantitative, mathematical analyses to problems in Earth science domain.
- Solve complex multi-disciplinary problems in Earth science.

Required Resources

Course website: **elms.umd.edu**, where all announcements, lectures, reading materials, and grades will be posted. The course does not have a required textbook and all materials will be provide during classes.

Campus Policies

It is our shared responsibility to know and abide by the University of Maryland's policies that relate to all courses, which include topics like:

- Academic integrity
- Student and instructor conduct
- Accessibility and accommodations
- Attendance and excused absences
- Grades and appeals
- Copyright and intellectual property

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.

Activities, Learning Assessments, & Expectations for Students

Lectures/discussions. The course will be organized around case study applications on using online analytical tools to interpret and analyze the data, including those produced by NASA. Online systems will include NASA's Worldview (https://worldview.earthdata.nasa.gov/) and Giovanni (https://giovanni.gsfc.nasa.gov/giovanni/). Each topic will consist of two parts: "Theory" and "Practice/Discussion". In the first part "Theory", students will

be given motivation and basic theoretical concepts of the subject. Students will be given information on basic definitions and notions of the Earth science variables (ESVs), overarching science questions, key NASA missions which measure ESVs, and how the data can be accessed, visualized and processed using Worldview and/or Giovanni. The instructor will also showcase an introductory data analysis, and what tasks should be performed during the "Practice/Discussion" part. In the second part, students will perform data analysis to accomplish the tasks, will have opportunity to ask questions and discuss results in the class. A short report, incorporating results of the data analysis, will be written by students with due date 10 days after the class. These assignments will be carried out by students individually, however, in-class discussions with other students are encouraged.

The complexity of the assignments will be gradually increasing as the course progresses. Students will start with basic operations of displaying and visualizing data, applying different color schemes, computing basic statistics, identifying spatial and temporal patterns, and finish with multi-source data analysis and connecting with socio-economic information. For example, the students start with searching and understanding ESVs and a range of its values, different representations and visualization of those values, identifying max/min values, inter- and intra-annual trends. Overall, there will be seven home assignments.

In addition to these home assignments, each student will work on a project (individual). The project will be on researching a scientific paper, which used Giovanni system (the list of the papers will be provided by the instructor), and repeat and extend the analysis. At the end of the course, each student will make a short presentation on the project.

Tests. There will be two tests in the course, which would test analytical skills of the students. Tests will have multiple choice and short answer questions, which should be answered by using Worldview (test 1) and Giovanni (test 2). Both tests will be open-book.

Homework assignments. There will be seven homework assignments, which will be performed individually. We start working on a home assignment in the class (second part of each topic "Practice/Discussion") through discussion of ideas and performing initial steps in completing the assignment. A corresponding report from each student will be due 10 days after that class. Templates for reports and deadlines for submitting reports will be posted in advance in ELMS.

Attendance.
Attendance to lectures is mandatory (especially second part), since class participation will be crucial to understanding the materials and performing home assignments.

Course-Specific Policies

You will need a laptop to accomplish assignments in the class. The laptop will be required during the second of the topic. Reminders will be given on ELMS.

Get Some Help!

Taking personal responsibility for you own learning means acknowledging when your performance does not match your goals and doing something about it. I hope you will come talk to me so that I can help you find the right approach to success in this course, and I encourage you to visit tutoring.umd.edu to learn more about the wide range of campus resources available to you. In particular, everyone can use some help sharpen their communication skills (and improving their grade) by visiting ter.ps/writing and schedule an appointment with the campus Writing Center. You should also know there are a wide range of resources to support you with whatever you might need (see go.umd.edu/assistance), and if you just need someone to talk to, visit counseling.umd.edu or one of the many other resources on campus.

Most services free because you have already paid for it, and **everyone needs help**… all you have to do is ask for it.

Basic Needs Security

If you have difficulty affording groceries or accessing sufficient food to eat every day, or lack a safe and stable place to live and believe this may affect your performance in this course, please visit go.umd.edu/basic-needs for information about resources the campus offers you and let me know if I can help in any way.

Names/Pronouns and Self Identifications

The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering inclusive and equitable classroom environments. I invite you, if you wish, to tell us how you want to be referred to both in terms of your name and your pronouns (he/him, she/her, they/them, etc.). The pronouns someone indicates are not necessarily indicative of their gender identity. Visit trans.umd.edu to learn more.

Additionally, how you identify in terms of your gender, race, class, sexuality, religion, and dis/ability, among all aspects of your identity, is your choice whether to disclose (e.g., should it come up in classroom conversation about our experiences and perspectives) and should be self-identified, not presumed or imposed. I will do my best to address and refer to all students accordingly, and I ask you to do the same for all of your fellow Terps.

Grades

Grades are not given, but earned. Your grade is determined by your performance on the learning assessments in the course and is assigned individually (not curved). If earning a particular grade is important to you, please speak with me at the beginning of the semester, so that I can offer some helpful suggestions for achieving your goal.

All assessment scores will be posted on the course ELMS page. If you would like to review any of your grades (including the tests), or have questions about how something was scored, please email me to schedule a time for us to meet in my office.

Late work will not be accepted for homework assignments, so please plan to have it submitted well before the scheduled deadline. Homework assignments reports must be submitted within 10 days after the second part of the topic ("Practice/Discussion"). Delayed reports will be downgraded by 50%, if submitted after the deadline, but within one week after the deadline. Reports will not be graded, if submitted one week or more after the deadline. If you are sick or physically indisposed and cannot submit your assignment on time, you must notify the instructor before the class and provide a written doctor's note when you return for you to have a chance to make up the

assignment. Any non-verifiable excuses may be denied. This policy may seem strict, but this class will move rapidly, and it is in your best interest to turn in everything on time to avoid falling irrecoverably behind.

I am happy to discuss any of your grades with you, and if I have made a mistake I will immediately correct it. Any formal grade disputes must be submitted in writing and within one week of receiving the grade.

Learning Assessments	#	Points Each	Category Total	Weight
Homework assignment	7	10	70	40%
Project	1	100	100	20%
Project presentation	1	10	10	10%
Tests	2	10	20	30%
		Total Points:	**200**	**100%**

Final letter grades are assigned based on the percentage of total assessment points earned.

Final Grade Cutoffs											
+	97.00%	+	87.00%	+	77.00%	+	67.00%				
A	94.00%	B	84.00%	C	74.00%	D	64.00%	F	<60.0%		
-	90.00%	-	80.00%	-	70.00%	-	60.00%				

Course Schedule

Week	Date	Topic	Assignment
1	28-Jan-Tue	Introduction.	
	30-Jan-Thu	UMD, NASA & Satellites.	
2	4-Feb-Tue	Basic concepts.	
	6-Feb-Thu		
3	11-Feb-Tue	Sensors & missions.	
	13-Feb-Thu		
4	18-Feb-Tue	Introduction to NASA's Worldview system. Searching and discovering datasets. Visualizing, understanding and interpreting data.	
	20-Feb-Thu		**HW1**
5	25-Feb-Tue	Building animations in NASA Worldview system.	
	27-Feb-Thu		**HW2**
6	3-Mar-Tue	Before and after: building comparisons in Worldview.	
	5-Mar-Thu		**HW3**
7	10-Mar-Tue	Summary & review.	
	12-Mar-Thu	TEST #1	
8	17-Mar-Tue	No classes: spring break.	
	19-Mar-Thu		
9	24-Mar-Tue	Introduction to NASA's Giovanni system. Searching and discovering datasets. Visualizing, understanding and interpreting data.	
	26-Mar-Thu		**HW4**
10	31-Mar-Tue	Basic mapping operations. Building histograms and area-averaged time series (temporal patterns). Importing and exporting options.	
	2-Apr-Thu		**HW5**
11	7-Apr-Tue	Building time-average maps and map animations in Giovanni.	
	9-Apr-Thu		**HW6**
12	14-Apr-Tue	Building Hovmöller diagrams (plotting meteorological data to highlight the role of waves). Deriving climatology maps. Analysis of long-term trends.	
	16-Apr-Thu		**HW7**

13	21-Apr-Tue	Summary & review.	
	23-Apr-Thu	TEST #2	
14	28-Apr-Tue	Project presentation	
	30-Apr-Thu	Project presentation	
15	5-May-Tue	Project presentation	
	7-May-Thu	Project presentation	

Homework assignments

HW	Date	Topic	Due dates for reports
1	20-Feb-Thu	Introduction to Worldview.	1-Mar-Sun
2	27-Feb-Thu	Building animations in Worldview.	8-Mar-Sun
3	5-Mar-Thu	Comparison in Worldview.	15-Mar-Sun
4	26-Mar-Thu	Introduction to Giovanni.	5-Apr-Sun
5	2-Apr-Thu	Basic operations in Giovanni.	12-Apr-Sun
6	9-Apr-Thu	Building time-average maps and map animations in Giovanni.	19-Apr-Sun
7	16-Apr-Thu	Climatology and long-term trends.	26-Apr-Sun

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.