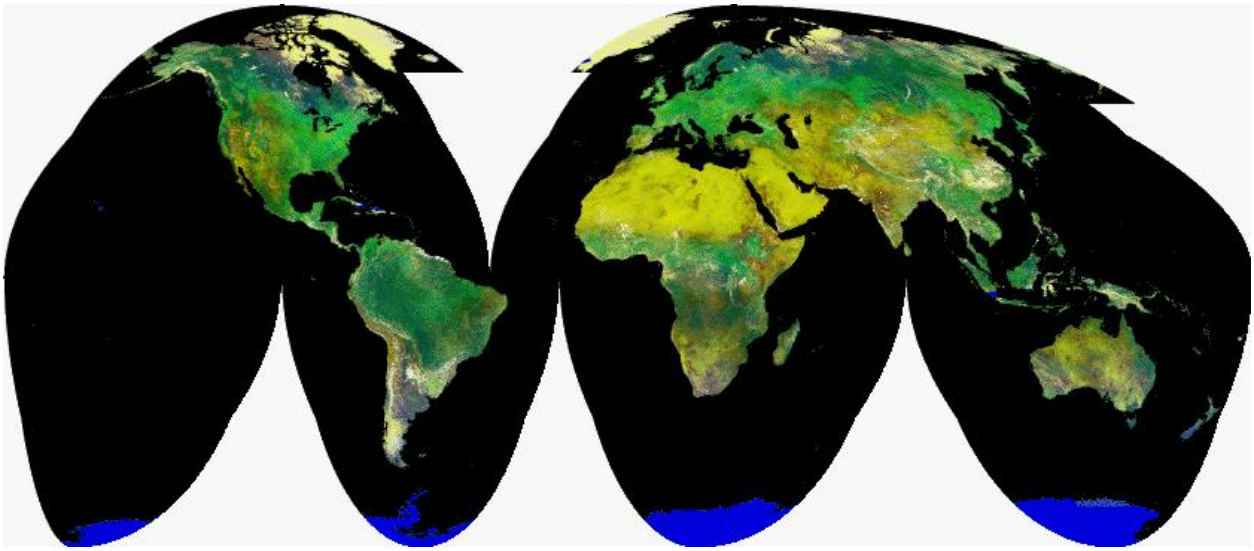
GIS4037/GIS5038C Remote Sensing

GIS 5038c (sec. RS50) Remote Sensing of Environment
and
GIS 4037 (sec. DI40 and DIUF) Digital Image Processing (Environmental Remote Sensing)

4 Credit Hours

Fall 2021

AVHRR 10-Day NDVI Mosaic



Instructor: Dr. Michael W. Binford

Online Office Hours (In Person and Online): 2:00 p.m. - 3:00 p.m. Wednesday and 1:00 p.m. - 2:00 p.m. Thursday or by Appointment

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Phone: (352) 392-0494 (Geography Front Office); **E-mail:** mbinford@ufl.edu

Course Website: Log in to CANVAS at https://elearning.ufl.edu

Required Textbook: Jensen, J.R. 2016. Introductory Digital Image Processing: A Remote Sensing Approach. Prentice-Hall, Saddle River, NJ. 544 pages.

Recommended Textbook: Jensen, J.R. 2007. Remote Sensing of the Environment: An Earth Resources Perspective. Prentice-Hall. Upper Saddle River, NJ.

Required Equipment and Materials:

Class Meetings - All Students: Lectures Wednesday Period 3-4, 9:35 – 11:30; **Laboratory:** Tuesdays Period 3-4 for **Undergraduate Students**, 9:35 - 11:30; Tuesdays Period 5 - 6 for **Grad Students,** 11:45 - 1:30 {**NOTE THAT** We will have a discussion about class schedules on the first day of class, August 24}

All classes meet IN-PERSON and SYNCHRONOUSLY ONLINE with Zoom Meetings. This means that you will either be in the Lab or Classroom, and/or log on to the Zoom Meeting. Please sign on with your microphone and your video **on** so you can be acknowledged. You can turn off your microphone and video when I start to record the meeting. The lectures and lab introductions will be recorded and posted.

Description: This course, taught in different sections but with lectures at the same time for undergraduate and graduate students, introduces the use of remotely sensed data in environmental applications. Remote sensing is the science of acquiring data using the measurement of electromagnetic radiation by techniques that do not require actual contact with the object or area being observed. Most environmental applications of remote sensing use instruments carried on satellites or piloted or unpiloted aircraft. The different sensors used to collect this information, and the interpretation techniques vary quite widely, and are being developed at an astounding rate. In this course, we will focus on the interpretation and applications of data from spaceborne imaging systems (eg: Landsat MSS, Landsat TM, Landsat ETM+, Landsat OLI, Quickbird, IKONOS, MODIS, ASTER, SeaWIFS, HYPERION, SPOT, AVHRR). Newer airborne sensors, e.g. the National Ecological Observatory Network's (NEON) Airborne Observation Platform (AOP), the EU's Sentinal satellites, the International Space Stations such as GEDI, OCO-1 and -2, and ECOSTRESS will be described late in the course but we will not have labs that work with their data.

Prerequisites: Senior Standing (GIS4037), Graduate Standing (GIS5038c), or Permission of Instructor. Facility with operations in MS Windows, College-level Statistics or Quantitative Analysis in Geography and College-level Algebra are required, basic courses in Ecology or other Environmental Sciences and Physics are recommended. A prior course in GIS would be helpful, but is not required. Likewise, this course would give students an advantage in a GIS course.

OBJECTIVES OF THE COURSE:

1. Introduce students to the basic concepts, data, analytical methods, and software of satellite remote sensing as applied to environmental systems, e.g. geomorphologic studies, classification of land cover and habitat, landscape analysis, land-cover/land-use change analysis, ecosystem pattern and process analysis, landscape monitoring, etc.

2. At the end of the class, students will be able to:

A. ask project or research questions that can be answered with RS data,

B. conduct basic analysis of environmental systems using satellite remote sensing data and the software ENVI 5.6 to answer the project or research questions,

C. teach yourself new software functions,

D. read and implement methods presented in peer-reviewed and technical literature,

E. generally be independent scientists and technicians with beginning expertise in remote sensing.

3. The course will provide a learning environment in which students will learn to teach themselves new software functions, read and implement methods presented in the peer-reviewed and technical literature, and generally be independent scientists and technicians with beginning expertise in remote sensing.

Basis of Grade: 90-80-70-60; A-B-C-D (with 88-90, 78-80, etc. earning +, 90-92, 80-82, etc. earning minus grades except C- which is 68-70)

Activity	%
Laboratory Exercises	65%
Midterm Examination	12%
Final Exam	18%
Future Directions in RS	5%

Graduate Students: Term Project 20% with Lab Exercises worth 45%.

Note that the official University of Florida grades and grading policies for undergraduates are found at https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/ (Links to an external site.). Grades and Grading policies for graduate students are found in lower part of the page of https://catalog.ufl.edu/graduate/regulations/#text (Links to an external site.).

COURSE SCHEDULE

(NOTE THAT THIS SCHEDULE IS ALWAYS TENTATIVE, EXCEPT FOR EXAM DATES AND OTHER DEADLINES, AND WILL BE REVISED CONSTANTLY. CHECK BACK OFTEN.)

Lectures

In the list below readings are indicated for Jensen (2016) *Introductory Digital Image Processing: A Remote Sensing Perspective.* Students are responsible for reading these materials on their own initiative, and the lack of mention of a reading in class does not mean that the chapter does not have to be read before class time.

	Lab Schedule (Tuesdays)	Lecture Schedule (Wednesdays)	
Week	**Lab Topic**	**Lecture Topic**	**Jensen (2016) Reading**
Before Class Begins	None	Watch NOVA Video "Earth from Space" https://florida.pbslearningmedia.org/resource/nvfb-sci-earthspace/wgbh-nova-earth-from-space-full-length-broadcast/ (Links to an external site.)	NOVA Video
1 – 24, 25 August	Lab 1: Part I: Introduction to the class, the Computing Environment, Software, and Image Interpretation; Part II: Imagery on the Internet -- mostly for fun and information; Lab Intro pdf; Lab 1 Intro Recording	Lecture 1: Introduction to Remote Sensing; Physics of Radiation and Remote Sensing Full-slide pdf file of lecture. Zoom Recording of the lecture	Ch 1, 6 (p 185-216-194)

2 – 31 August, 1 September	Lab 2: Image Metadata, Stretching, Cursor Functions, Spectral Profiles. Lab_2_Introduction.pdf Lab 2 Intro Recording	Lecture 2: Multispectral Instruments (sensors) and Platforms (satellites, aircraft, and UAV); Mapping; Wulder paper on Current Status of Landsat Program lecture_2_2019_satellites_sensors.pdf Lecture 2 Recording	Ch 5, 8
3 – 7, 8 September	Lab 3: Map Composition; Contrast Stretching, 3-D Views; Lab 3 Introduction.pdf GRAD STUDENTS: First draft of your Research Questions and Project Objectives due	Lecture 3: Orbital Characteristics, Finding Data, Importing, Preprocessing (Spectral Correction); Geometric Correction. Lecture 3 Recording	Ch 2 (read carefully), 3 (read quickly), 4
4 – 14, 15 September NOTE: September 16 is the scheduled launch day for Landsat 9.	Lab 4: Topographic Modeling; Preprocessing: Geometric Correction, Subsetting, Other Preprocessing; Lab 4 Introduction.pdf GRAD STUDENTS: You can turn in the Research Questions this week - my mistake in the syllabus.	Lecture 4: Spectral Enhancements for Visual Analysis; Transformations and Special Indices AND Landsat 9 (see https://landsat.gsfc.nasa.gov/landsat-9 (Links to an external site.)) Lecture 4 pdf file Lecture 4 Recording	Ch 7.

5 – 21, 22 September	Lab 5: Spectral Indices, Masking, Zonal Statistics Lab 5 short intro pdf Watch Dr. Southworth's short lecture on the basis of this lab. (Links to an external site.)	Lecture 5: Classification 1: Land Cover Classes and Classification Lecture 5 pdf file Florida Land Use and Cover Classification System (FLUCCS) manual	Ch. 9, Chander et al. 2009 for calibration plus Chastain et al. 2019 for updates
6 –28, 29 September	Lab 6: Classification I Lab 6 Introduction pdf file Lab 6 Introduction Recording GRAD STUDENTS: Submit Proof of Project Data	Lecture 6: Classification 2: Supervised Classification & Accuracy; Change Detection; Lecture 6 pdf Foody 2002 paper on classification accuracy assessment. Lu and Weng 2007 paper on improving classifications	Ch. 9

7 – 5, 6 October*	Lab 7 Introduction pdf Lab 7 Intro Recording (Links to an external site.) Lab 7: Classification II: Training Samples CIPEC Training Sample Form CIPEC Explanations GRAD STUDENTS: After feedback, finalize and resubmit your Research Questions and Project Objectives	Lecture 7: Change Detection and Analysis Lecture 7 pdf Lecture 7 Recording (Links to an external site.) Lu et al. 2004. Change Detection Techniques. IJRS 25:2365-2401 Lunetta et al. 2006. Land-cover change detection using multi-temporal MODIS NDVI data. Rem. Sens. Env. 105:142-154. Zhu, Z. 2017. Change detection using landsat time series: A review of frequencies, preprocessing, algorithms, and applications. ISPRS J. Photogramm. Rem. Sense. 130:370-384	Ch. 12, skim 10

8 – 12, 13 October	MIDTERM EXAM - IN LAB PERIOD - Download Study Guide MIDTERM EXAM KEY	Lecture 8: Change Analysis Examples, Radiometric Correction Calculations for Image Calibration Lecture 8 pdf Lecture Recording Lu et al. 2004 Int. J. Remote Sensing Change Detection Paper Paper by Barsi et al. on atmospheric correction; Atmospheric Correction Web Site (NASA) Example output from Atmospheric Correction Web Site. Links to Radiometric and Atmospheric Correction Spreadsheets for Landsat 5 TM and Landsat 7 ETM+	Ch. 12
9 – 19, 20 October	Lab 8 Introduction Lab 8 Introduction Recording 1 Lab 8 Introduction Recording 2 Lab 8: Image Classification Accuracy Assessment; Change Detection & Advanced Methods Lab 8 Questions	Lecture 9: Advanced Transformations: Spectral Mixing Analysis, Tasseled Cap, Principle Components Analysis Lecture 9 pdf Lecture 9 Recording	Ch. 9, 13

10 – 26, 27* October	Lab 9: Transformations: Spectral Mixing Analysis, Tasseled Cap, Principle Components Analysis. Lab 9 Questions Lab 9 Introduction GRAD STUDENTS: Submit completed Project Proposal	Lecture 10: Hyperspectral Imagery and Analysis Lecture 10 pdf Lecture 10 Recording	Ch. 12
11 – 2, 3 November	Lab 10 Hyperspectral Analysis Lab 10 Questions Lab 10 Introduction Lab 10 Intro Recording (GIS4037)	Lecture 11: Time Series Analysis Lecture 11 pdf Lecture 11 Recording	Ch. 12

	Lab 10 Intro Recording (GIS5038C)		
12 – 9, 10 November	Lab 11: Time Series Analysis Lab 11 Questions Lab 11 Introduction pdf Lab 11 Intro Recording GIS4037 Lab 11 Intro Recording GIS5038C Reading: Ecology's Remote-Sensing Revolution GRAD STUDENTS: Submit your Imagery Analysis Results and submit your draft paper so two of your classmates can write a peer evaluation.	Lecture 12: Calculations for Radiometric Correction and Thermal Analysis; plus more about MODIS and other EOS (Earth Observing System) instruments Lecture 12 Recording 2018 NAS-NRC Decadal Survey for Earth Science Remote Sensing 2021 NASA Budget Book	

13 - 16, 17 November	Lab 12: Thermal Calculations and Applications Lab 12 Questions Lab 12 Introduction pdf Lab 12 Introduction Recording GRAD STUDENTS: Course Project Peer Evaluations due back to author	Lecture 13: Survey of Other Earth Observation Systems; NASA Budget pdf file pdf file, 6-slide/page lecture notes. Lecture 13 Recording Part 1; Part 2 2021 Bibliography on "Future Directions" "Remote Sensing" Google.Scholar search - first 140 hits.	Ch 13 Ch. 6 Chander et al. 2009
14 - 23 November	Lab 13: MODIS Data and Animations Lab 13 Questions Julian Date Calendar Lab 13 Introduction Lab 13 Introduction Recording	November 24 is a holiday; no lecture	Chander et al. 2009
15 - 30 November, 1 December	no required lab to be done Lab 14 OPTIONAL FOR EXTRA CREDIT: NEON AOP DATA ANALYSIS GRAD STUDENTS: Final Course Project Paper DUE	Lecture 14: The National Ecological Observatory Network and the Airborne Observation Platform. Class Evaluation	

7, 8 December	**Digital Copies of Final Exam Questions and Answers are due today, 7 December** No New Labs During Last Week	Lecture 15: Future Directions in Remote Sensing, other topics in Remote Sensing Open Day for Possible Catch-up. Every year one or more lectures may be interrupted by some emergency such as hurricanes. This session will be available to allow for postponements or for new issues arising during the semester. NOTE ABOUT FINAL EXAM: Each student will submit 5 questions with answers. The exam will consist of 20 questions selected from all the questions submitted by students. Each student will answer 10 of the questions out of the 20. Final Exam download; Posted XX December, XX:XX AM	

16 December - finals week. Final exam is scheduled for Wednesday, December 13, 10:00 AM to 12:00 Noon (Undergrads) or Dec. 14, 7:30-9:30 AM (Grad Students)	No Labs during Final Period	Final Exam. The written answers will be due at the end of the time when the university has scheduled the final exam for the class. **Exam Schedule for GIS 4037 is Monday, Dec. 13 at 10:00 AM to 12:00 noon; for GIS5038C is Tuesday, Dec. 14 at 7:30 - 9:30 AM.** So, undergraduate students must turn in the completed exam by noon on Monday of finals week and graduate students must turn in the completed exam by 9:30 on Tuesday. FINAL EXAM KEY	

*Dr. Binford will be out of town, but labs will be led by a TA and the lecture will be a video recording and can be watched at any time.

THE FINE PRINT: ASSIGNMENTS

WEEKLY LABS = 65% of grade. Individual exercises in the lab manual will be posted online each week. You should create a file of the labs for yourself. Labs are frequently quite complex and much of each exercise will need to be completed outside of laboratory periods. Thirteen lab exercises (plus one optional lab for extra credit) are planned and these will take you from basic introductory tasks through intermediate and some more advanced remote sensing techniques. You are given 1 week to complete each lab and all labs must be handed with the answers printed and references given, at the beginning of the next lab period (completing a previous weeks lab during the lab session is not allowed – you will fall behind if you do this). **Late labs will not be accepted** and a grade of 0 will be recorded. If you have a legitimate reason for missing a lab the absence MUST be documented, e.g., you are in a car wreck, then I need to see the accident report, a death in the family, I need to see the obituary and service times. Labs are critical to this class and it is easy to fall behind. It is to prevent this that I am so strict about not accepting late labs. You have been warned, **if it is late you receive a ZERO!** Labs are an integral part of the learning procedure in this course and are timed to coincide with the appropriate lectures and reading materials. As such they comprise a significant proportion of your grade and should be taken very seriously.

EXAMS - Midterm (13 October - 12%) and Final (13 or 134December - 18%) Two examinations will be given. Both exams will use short-answer, problem-solving, image interpretation, and essay questions as format. Graduate students may have additional questions to answer. Make-up exams are not given unless written proof/documentation of the emergency which caused you to miss the exam is given.

Future Directions of Remote Sensing (5%) Due in before your final exam dates in December. For this assignment each student must find a research paper or other literature which they feel is an example or discussion of the Future Direction in the field of Remote Sensing. The piece must have been published in 2016-2021 (or else it won't be very current). The student will hand in a digital version of the paper (pdf is fine) as well as a 1-page paper (typed, single-spaced, font size 12 Times New Roman, 1" margins) describing the novelty of the piece you selected, what are the new developments, and also include why you picked the piece and what you think of the paper's suggestions. These summary pieces should be uploaded on the assignments page, and will be posted for all class members. Additional details will be given out in class but this is so you are aware of this assignment, can plan for it in terms of time, and can also keep an eye out for a suitable article.

OPTIONAL NEON-AOP LAB The National Ecological Observatory Network (NEON) collects airborne remote sensing data (Hyperspectral Imager, LiDAR, and RGB Imagery) every other year for each of 81 sites across the United States including Alaska, Hawaii, and Puerto Rico with its Airborne Observatory Platform (AOP). These data are freely available to the world. The lab will be posted during the last week of class. It is not required but if you complete the lab (and give me feedback on how the lab works for you) you will have 100 points added to your total lab score.

EXTRA CREDIT LAB. Many students have data or questions associated with their thesis, dissertation, or work-related activity. The last two lab periods will be devoted to work on, and presentations of, projects that are derived from outside the class. If you conduct and present a good project, your numeric grade will be increased by 12%. Thus, the extra credit project is equal in value to the mid-term exam. You may not, however, choose to do a project and neglect the exam. The exam is still required. Discuss this project with the instructor early in the semester so that I can approve your extra work. You must have the extra credit lab approved by the instructor before the mid-term exam.

LECTURE SECTIONS WILL BE RECORDED

Our class sessions will be audio-visually recorded for students in the class to refer back and for UFO enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are attending the course online, please log on with your camera on so that I can see you. You may turn off your camera when I start to record the session. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not

willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

COURSE EVALUATION BY STUDENTS

From the GatorEvals Course Evaluation System Web site: "Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/ (Links to an external site.). Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/ (Links to an external site.). Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/ (Links to an external site.)."

ACADEMIC HONESTY

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code specifies a number of behaviors that are in violation of this code and the possible sanctions. Click here to read the Honor Code (Links to an external site.). Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Cell phones MUST be turned off during in-person lectures.

Both class lecture and lab are mandatory if you wish to succeed in this course.