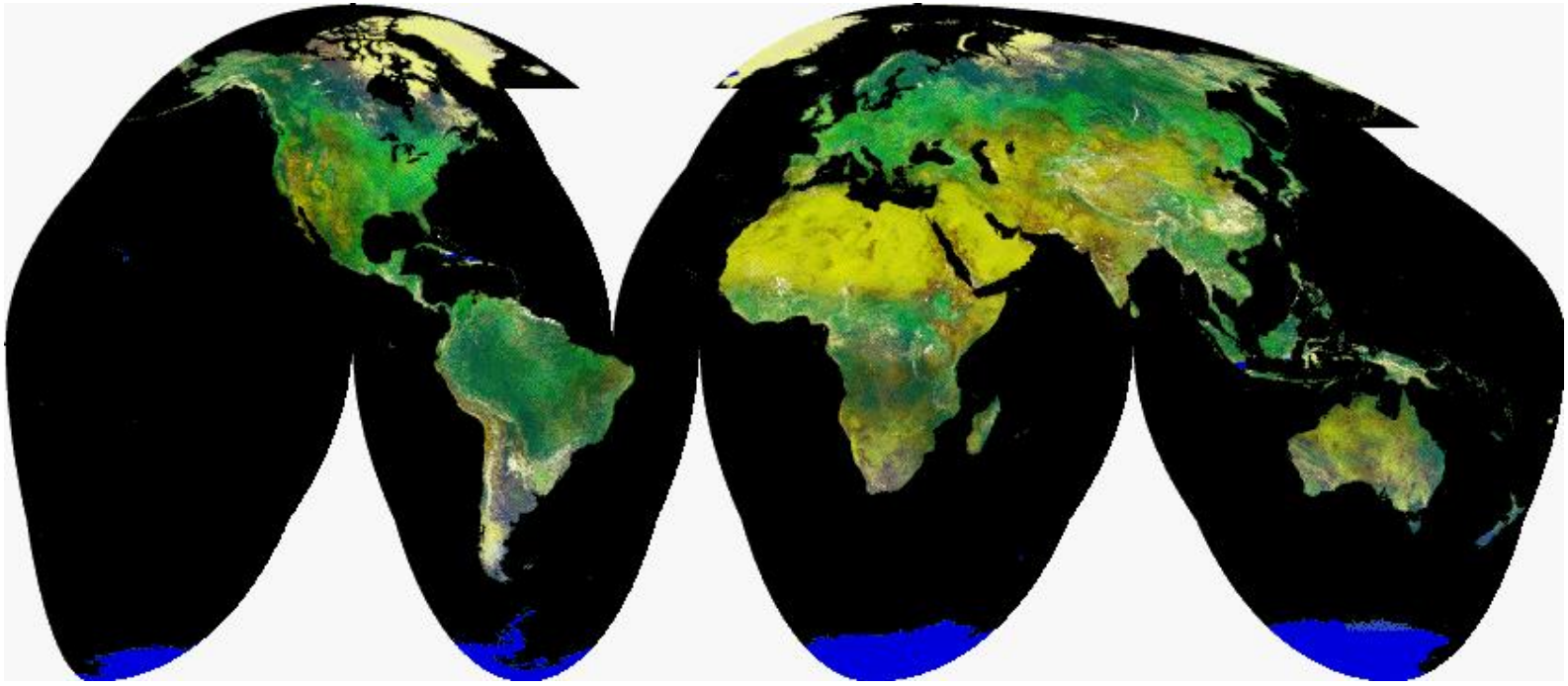
GIS4037/GIS5038C Remote Sensing

GIS 5038c (sec. 04CE) Remote Sensing of Environment
and
GIS 4037 (sec. 04CC) Digital Image Processing (Environmental Remote Sensing)

[4 Credit Hours]

Fall 2020

AVHRR 10-Day NDVI Mosaic



Instructor: Dr. Michael W. Binford

Office Hours: Zoom Meeting 2:00 p.m. - 3:00 p.m. Tuesday and Thursday or by Appointment

Office: 3131 Turlington Hall; **FALL 2020 all ONLINE, including office hours!**

Phone: (352) 392-0494; **E-mail:** mbinford@ufl.edu or via Canvas Course Communication

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 AM; Tuesdays Period 5-5 for **Grad Students,** 11:45 AM to 1:30 PM {We will have a discussion about lab schedules on the first day of class}

All classes meet SYNCHRONOUSLY AND ONLINE with Zoom Meetings. This means that you will be invited to the Zoom Meeting. Please sign on with your microphone muted and your video on.

Description: This course, taught in different sections but with lectures at the same time for undergraduate and graduate students, provides an introduction to 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. 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, WorldEye, 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 Station's 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 (4037), 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, Physics 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 conduct basic analyses of environmental systems using satellite remote sensing data and the software ENVI 5.5.

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 *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.

	Lecture Schedule (Wednesdays)	**Lab Schedule (Tuesdays: See Assignments)**	
Week	**Lecture Topic**	**Lab Topic**	**Reading**
Before Class Begins	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.)	None	NOVA Video
1 – 1, 2 September	Lecture 1: Introduction to Remote Sensing; Physics of Radiation and Remote Sensing; Color Models and Composite Imagery; full-slide pdf file of lecture.	Lab 1: Part I: Introduction to the class, the Computing Environment, Software, and Image Interpretation; Part II: Imagery on the Internet --	Ch 1, 6 (p 185-216-194)

	Actions	mostly for fun and information; Lab Intro pdf; Lab 1 Key or Rubric	
2 – 8, 9 September	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	Lab 2: Image Metadata, Stretching, Cursor Functions, Spectral Profiles. Lab_2_Introduction.pdf	Ch 5, 8
3 – 15, 16 September	Lecture 3: Orbital Characteristics, Finding Data, Importing, Preprocessing (Spectral Correction); Geometric Correction.	Lab 3: Map Composition; Contrast Stretching, 3-D Views; Key to Lab 2	Ch 2 (read carefully), 3 (read quickly), 4
4 – 22, 23 September	Lecture 4: Spectral Enhancements for Visual Analysis; Transformations and Special Indices Lecture 4 pdf file	Lab 4: Geometric Correction, Subsetting, Other Preprocessing; Key to Lab 3 GRAD STUDENTS: First draft of your Research Questions and Project Objectives due	Ch 7.
5 – 29, 30 September	Lecture 5: Classification 1: Land Cover Classes and Classification	Lab 5: Spectral Indices, Masking, Zonal Statistics	Ch. 8, Chander et al. 2009 (In Lab Data Folder)

	Lecture 5 pdf file		
6 – 6, 7 October	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	MIDTERM EXAM - IN LAB PERIOD - Download Study Guide MIDTERM EXAM KEY GRAD STUDENTS: Submit Proof of Project Data	Ch. 8
7 – 13, 14 October	Lecture 7: Change Detection and Analysis Lecture 7 pdf Lu et al. 2004. Change Detection Techniques. IJRS 25:2365-2401 Lunetta et al. 2006. Land-cover change detectin 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	Lab 6: Classification I; Key to Lab 6 GRAD STUDENTS: After feedback, finalize and resubmit your Research Questions and Project Objectives	Ch. 9, skim 10

8 – 20, 21 October	Lecture 8: Change Analysis Examples, Radiometric Correction Calculations for Image Calibration Lecture 8 pdf 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.	Lab 7: Classification II; Key to Lab 7 Crown density scale reproducible image for estimating crown density	Ch. 12
9 – 27, 28 October	Lecture 9: Hyperspectral Imagery and Analysis Lecture 9 pdf	Lab 8: Image Classification Accuracy Assessment; Change Detection & Advanced Methods All Training Samples Ever Taken for Class (MS Excel .csv format); No guarantees for accuracy.	Ch. 9, 13
10 – 3, 4 November	Lecture 10: Time Series Analysis	Lab 9: Transformations: Spectral Mixing Analysis,	Ch. 12

	Lecture 10 pdf	Tasseled Cap, Principle Components Analysis. GRAD STUDENTS: Submit completed Project Proposal	
11 – 10 November	Lecture 11: November 11 is a Holiday No Lecture on Wednesday, November 11.	Lab 10 Time Series Analysis of Imagery	Ch. 12
12 – 17, 18 November	Lecture 12: Calculations for Radiometric Correction and Thermal Analysis Lecture 12 pdf	Lab 11: Thermal Calculations and Applications Ecology's Remote-Sensing Revolution GRAD STUDENTS: Submit your Imagery Analysis Results and submit your draft paper to two of your classmates for peer evaluation.	12 – 17, 18 November
13 - 17, 18 November	Lecture 13: Other Earth Observing Missions, and maybe some extraterrestrial missions	Lab 12: GRAD STUDENTS: Course Project Peer Evaluations due back to author	Ch 13 Ch. 6 Chander et al. 2009

13 - 17, 18 November	Lecture 13: Other Earth Observing Missions, and maybe some extraterrestrial missions	Lab 12: GRAD STUDENTS: Course Project Peer Evaluations due back to author	Ch 13 Ch. 6 Chander et al. 2009
24 November	HAPPY THANKSGIVING; No Lecture This Week		
14 - 2, 3 December	Lecture 14: Other Satellites: the EO-1 System (MODIS, ASTER, HYPERION); NEON AOP	Lab 11, part 2 due today along with Lab 12. Otherwise only a work day	Chander et al. 2009
15 - 8, 9 December	Class Evaluation Lecture 15: Future Directions in Remote Sensing, other topics in Remote Sensing pdf file, 6-slide/page lecture notes. Saatchi et al. 2011. Future Directions Example Paper 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	**Digital Copies of Final Exam Questions and Answers are due today, 7 December**; Lab 13: MODIS can be turned in at the end of the lab period today; no new lab to be done (last day of classes) GRAD STUDENTS: Final Course Project Paper DUE	15 - 8, 9 December

	students. Each student will answer 10 of the questions out of the 20. Final Exam Posted X December, XX:XX PM.		
16 December - finals week. Final exam is scheduled for Wednesday, December 16, 5:30 - 7:30 PM (Undergrads) or 12:30-2:30 PM (Grad Students)	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 10E: Wednesday Dec. 16, 5:30 - 7:30 PM; for GIS5038C is Wednesday, Dec. 16 12:30 - 2:30 PM.** FINAL EXAM KEY	No labs during final period.	

THE FINE PRINT: ASSIGNMENTS, RECORDING LECTURE, ACADEMIC HONESTY, ETC.

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 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 week's lab during the lab session is not allowed). **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 (5 October - 12%) and Final (15 December - 18%) Two examinations will be given. Both exams will use short-answer, problem-solving, image interpretation, and essay questions as format. Graduate students will 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.

ASSIGNMENT – Future Directions of Remote Sensing (5%) Due in class on 3 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 2007-2011 (or else it won't be very current). The student will hand in a paper copy of the paper, IN ADDITION to a Digital version (pdf or doc is fine) as well as a 1 page (typed, single-spaced, font size 12 Times New Roman, 1" margins) describing what the novelty of the piece you selected is, what are the new developments and also include why you picked the piece and what you think of their suggestions. These summary pieces should also be emailed to me mbinford@ufl.edu, and will be shared with 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 piece. As with the Labs, no late assignments will be accepted.

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.

COVID-19 RELATED MATERIAL: Recording Lecture Sessions

Our class sessions may be audio-visually recorded for students in the class to refer back and for 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 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.

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. 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 (NOTE THAT THE STRIKETHROUGH IS FOR FALL 2020 ONLY– ~~These MUST be turned off in both lectures and labs. Also note when you are in the labs outside class time Cell phones must be off or you will be asked to leave the lab.~~

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