COURSE SYLLABUS
ATS 737 Satellite Observations of the Atmosphere and Earth

Credits: 3

Instructor Information

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Office Hours: Wednesdays 1-2 PM , or by appointment
Communication Policy: Responses to emails will be provided within 48 hr

Class Meets: ACRC Room 212B M/W **11:00 AM - 12:15 PM**

NOTE: This is a **3-credit-hour** class. Instead of holding three 50 min lectures (e.g., M/W/F) we do a 2 lecture format with extended lecture time (75 min/each) as described above. There will be a ~5 min break near the mid-point of these lectures.

Prerequisites for Course

Graduate-level Atmospheric Radiation (e.g., ATS 622), Graduate-level Atmospheric Remote Sensing (e.g., ATS 652), or the express consent of Instructor. Any graduate student in physical sciences, engineering or mathematics is qualified to take the course. Students are expected to have a basic familiarity with scientific programming languages. Students are free to use their language of choice (e.g., MATLAB, IDL, FORTRAN-90/95, R, Python) for assignments. However, the instructor / class support team can provide minor assistance in FORTRAN-90, IDL and Python.

Course Description & Objectives

This course delves into the exciting topic of meteorological satellites, beginning with the basic theory and laws that govern satellite orbits, and reviewing the underpinning principles of radiative transfer that enable remote sensing of the earth/atmosphere system. We explore different kinds of satellite instrumentation and their unique abilities to sense key properties of this system, and hone our interpretation of satellite imagery as related to various meteorological and environmental phenomena. The course takes a historical perspective on the field (which is still relatively new) and extends into the modern-era of operational and research-grade systems, and consider the role of the satellite platform in addressing the pressing questions of weather/climate observation and prediction.

Learning Outcomes (See Course Schedule for Lecture Alignment)

Upon the completion of this course, students will be able to:

1. Recount the history of meteorological satellites
2. Describe basic satellite orbits and compute them from first principles of Newton's Laws and Keplerian Theory

3. Relate fundamental principles of radiative transfer theory to the application of satellite remote sensing
4. Understand how satellite instruments measure electromagnetic radiation to infer the composition of various constituents of the earth/atmosphere system, including:
    a. Imagery interpretation and physically based enhancements
    b. Temperature and Moisture
    c. Winds
    d. Clouds and Aerosols
    e. Precipitation
    f. Earth's radiation budget and climate
    g. As a tool in supporting various research topics (class projects)
5. Understand how satellites are used in operational weather forecasting
6. Design a satellite observing system to meet a specific science objective
7. Anticipate the future of meteorological satellites vis-à-vis priorities of our field

In addition to lectures on the core topics of satellite meteorology, experts from the field will be invited as guest lecturers to provide additional background and examples of specific research and operational pursuits leveraging satellite observations—providing students with a well-rounded, multi-dimensional perspective.

Assignments' Description & Alignment with Course Objectives

The main assignments will involve an exercise to apply the basic orbital theory learned in the first part of the course to a practical problem, review of selected scientific papers, chapter updates to the Kidder and Vonder Haar text, and a **Class Project**.

Class Project: Each student will develop their own topic idea, based on their interests. Topics must deal with some aspect of meteorological satellite remote sensing of Earth's environment. Topics related to a student's ongoing thesis or dissertation work are allowed in some cases and where applicable, but must demonstrate a significant and novel effort. Project proposals are due in February and will be reviewed by the instructor to ensure project criteria are met. Students will make a science poster and write-up of their project due near the end of the semester. Details be discussed in class.

Course Schedule – Alignment of Course Topics, Learning Outcomes, and Assignments/Assessments

DATE	TOPIC/SUB-TOPIC	LEARNING OUTCOMES ALIGNMENT (Referring to list above)	READINGS/ ASSIGNMENTS/ ASSESSMENTS
W 22 Jan	1 Course Overview and Introductions	--	--
M 27 Jan	2 Class Project Discussion	--	K&V Ch 1
W 29 Jan	3 Satellite Orbital Theory 1: Governing Principles	2	K&V Ch 2
M 3 Feb	4 Satellite Orbital Theory 2: Types of Orbits	2	--
W 5 Feb	5 Satellite Orbital Theory 3: Positioning/Tracking/Navigation	2	--
M 10 Feb	6 Satellite Orbits Workshop	2	HW1 Assigned

	GUEST: Stan Kidder		(Due Fri 28 Feb)
W 12 Feb	7 History of Met Satellites GUEST: Tom Vonder Haar	1	K&V Ch1
M 17 Feb	8 Radiative Transfer Review 1: Basic Laws & Equations	3	K&V Ch 3
W 19 Feb	9 Radiative Transfer Review 2: Scatt/Abs/Reflectance and Sun	3	--
M 24 Feb	10 Satellite Instrumentation 1: Resolution & Calibration	4	K&V Ch 4
W 26 Feb	11 Satellite Instrumentation 2: NOAA Operational Programs	4	--
M 3 Mar	12 Satellite Imagery 1: Atmos Params, Imagery Interpretation	4a	K&V Ch 5, Bader HW2 Assigned (Due Fri 14 Mar)
W 5 Mar	13 Satellite Imagery 2: Surface Params, Imagery Enhancement	4a	--
M 10 Mar	14 Atmospheric Composition 1: Temperature Soundings	4b	K&V Ch 6
W 12 Mar	15 Atmospheric Composition 2: Moisture Soundings **GUEST:** John Forsythe	4b	--
17-21 Mar	**Spring Break (No Class)**	--	--
M 24 Mar	16 Clouds	4d	K&V Ch 8
W 26 Mar	17 Winds 1: Multi-sensor	4c	K&V Ch 7 HW3 Assigned (Due Fri 11 Apr)
M 31 Mar	18 Winds 2: Optical Flow **GUEST:** Jason Apke	4c	--
W 2 Apr	19 Tropical Cyclones **GUEST:** Kate Musgrave	4d, 5	--
M 7 Apr	20 Aerosols	4d	--
W 9 Apr	21 Precipitation	4e	K&V Ch 9
M 14 Apr	22 Earth's Radiation Budget	4f	K&V Ch10
W 16 Apr	23 Satellite Training **GUEST:** Bernie Connell & Jorel Torres	5	--
M 21 Apr	24 Severe Wx and Forecaster Applications of Sat Imagery **GUEST:** Dan Bikos & Bill Line	5	--
W 23 Apr (Field Trip)	NWS Cheyenne WFO Arrive 12:30, Depart ~ 3:00	5	--
M 28 Apr	25 *Science of the Night* Low-Light Visible Sensing	6	--
W 30 Apr	26 *The Future:* NextGen Satellite Programs; GeoXO **GUEST:** Dan Lindsey	6,7	K&V Ch 11
M 5 May (Field Trip)	Lockheed Martin Deer Creek Arrive 1:30, Depart ~ 4:30	6,7	--
W 7 May	**Class Project Poster Presentations**	--	Location: CIRA Commons
M 12 May (Finals Week)	**Class Project Reports Due (No Final Exam)**	--	--

Textbook / Course Readings

Required Text:

Satellite Meteorology, an Introduction (Kidder and Vonder Haar (K&V), Academic Press)
https://www.amazon.com/Satellite-Meteorology-Introduction-Stanley-Kidder/dp/0124064302

https://www.elsevier.com/books/satellite-meteorology/kidder/978-0-08-057200-0

Optional Text:

Images in Weather Forecasting (Bader et al., Cambridge)
https://www.amazon.com/Images-Weather-Forecasting-Practical-Interpreting/dp/0521451116

https://www.abebooks.co.uk/book-search/title/images-in-weather-forecasting/author/bader/

NOTE: we have a couple copies you can borrow/share

Other Topical Readings (Suggested or Assigned):

To be provided

Course Materials & Equipment

N/A

Participation/Behavioral Expectations

This course will be taught in-person, but in the event of unanticipated hybrid format delivery modes, please review the core rules of netiquette for some guidelines and expectations on conduct expectations in an online learning environment.

Course Policies (late assignments, make-up exams, etc.)

As a student enrolled in this course, one of your responsibilities is to submit course work by the due dates listed. With that said, I take my role as your instructor very seriously. I care about how well you do in this course and that you have a satisfying, rewarding experience. As such, it is my commitment to you to respond individually to the work you submit in this class and to return your work in a timely manner. Smaller assignments will be returned within 1 week and major assignments will be returned within 2 weeks. If, due to unforeseeable circumstances, the grading of your work takes longer than the times I have listed here, I will keep you informed of my progress and make every effort to return your work with feedback as soon as I can.

Grading Policy

GRADE	RANGE
A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

ASSIGNMENT	GRADE POINTS	GRADE PERCENTAGE
Attendance, Discussion and Participation	20	20%
Homework / Assignments	30	30%
Class Project: Science Poster	20	20%
Class Project: Final Report	30	30%
Total:		**100 %**

Academic Integrity & CSU Honor Pledge

This course will adhere to the CSU Academic Integrity/Misconduct policy as found in the General Catalog and the Student Conduct Code.

Academic integrity lies at the core of our common goal: to create an intellectually honest and rigorous community. Because academic integrity, and the personal and social integrity of which academic integrity is an integral part, is so central to our mission as students, teachers, scholars, and citizens, I will ask that you please affirm the CSU Honor Pledge as part of completing your work in this course. Any violations will result in a grading penalty for this course and a report to the Office of Conflict Resolution and Student Conduct Services.

Important Semester Dates

Spring Semester – 2023

Spring Semester - 2025

January 1	Wednesday: Holiday - University Offices Closed
January 20	Monday: Holiday - University Offices Closed
January 21	Tuesday: Classes Begin
January 24	Friday: End Restricted Drop
January 26	Sunday: End Add Without Override
January 27	Monday: Add With Override Begins Today
February 5	Wednesday: Census; Registration Closes (end of period for adding courses - last day for dropping courses without record entry, changes in grade option, and tuition and fee adjustment)
February 11	Tuesday: Founder's Day
March 15	Saturday: Spring Recess Begins - No Classes Next Week
March 24	Monday: Classes Resume
April 18	Friday: End Course Withdrawal Deadline; Repeat/Repair Deadline
May 9	Friday: Classes End; Semester Withdrawal Deadline
May 12-16	Monday-Friday: Final Exams
May 16	Friday: Commencement
May 20	Tuesday: Grades Due

Student resources for inside and outside the classroom

We want you to be able to fully participate in the learning experience. Student resources for food, financial, and housing security; transportation; child care; health care; violence; and immigration issues are compiled at basicneeds.colostate.edu.

An additional list of student resources, which includes information on learning/accommodation resources, mental-health resources, student case management, and religious observances is at the following link and QR code: https://col.st/2FA2g