ATS 632: Interpreting Satellite Observations of Atmospheric Composition

Monday: 11:30 AM - 12:30 PM MT, 121 ATS West
Monday: 1:00-2:50 PM MT, 121 ATS West
Instructor: Prof. Emily Fischer
Office Location: ATS 203
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Office Hours: By Appointment

Course Description: This course will provide a broad theoretical and practical overview of satellite observations of atmospheric composition. Students will be introduced to the theoretical foundations of satellite composition retrievals of both gases and aerosols, and the associated strengths and weaknesses of commonly used atmospheric products. The class will focus on the interpretation and application of these datasets. Practical laboratory exercises will expose students to products and analysis tools. Course material will include discussion of solar-backscatter techniques (*e.g*., TOMS, GOME, SCIAMACHY, OMI, MODIS, MISR), thermal infrared emission retrievals (*e.g.,* MOPITT, TES, IASI), and lidar measurements (*e.g.,* CALIPSO, CATS). Additional satellite products of interest for atmospheric composition, such as fire counts, will also be discussed.

Course Learning Objectives: Upon completion of this class students will

1. Have developed the programming skills necessary to manipulate these datasets
2. Have developed the analytical skills to interpret these measurements and their uncertainties
3. Be able to apply these datasets to scientific inquiry regarding the spatial and temporal variability of atmospheric composition.

Pre-requisites: Students are expected to have a familiarity with the basics of atmospheric radiation (pre-requisite ATS 622 or equivalent) and atmospheric chemistry (pre-requisite ATS 621 or equivalent), which will not be covered in this class. In addition, students are expected to have a basic familiarity with programming. Students are free to use their language of choice (*e.g.,* Matlab, IDL, IGOR, R, Python) for assignments. However, the instructor will only be providing major programming assistance in Matlab and minor assistance in IDL.

Course Structure and Grading Criteria: The course will consist of a weekly lecture following by a weekly computer lab associated with a weekly assignment. Assignments will familiarize students with different data products. Students will be evaluated on the basis of weekly lab assignments that begin in week 4, and a final project. Lab assignments are due in the following weekly-lecture class. The grade for the lab portion of the course will be calculated by dropping the lowest grade. The final project will be an in-class poster presentation the final week of class. For the project, students will showcase how satellite data can be used in the context of their research, and show an example of working with an additional dataset. Poster layout will follow the guidelines for effective scientific posters in *Trees, Maps and Theorems: Effective Communication for Rational Minds.* Grades are weighted as follows: Lab Assignments: 75% Final Presentation: 25%

Tentative Schedule for Spring 2020

Week	Lecture Topic	Laboratory Exercise
1/25 – 1/29	Introduction to Satellite Observations of Composition (Essentially 3 introductory lectures during week 2 class time – no class in week 1 due to MLK Holiday on Monday 1/18)	
2/1 – 2/5	High Level overview Lecture of Optimal Estimation Theory: Guest Lecture by Chris O'Dell	Student led discussions of select papers
2/8 – 2/12	Thermal Infrared Measurements Part 1: TES O_3/PAN/CO Observations, Guest Lecture by Vivienne Payne	Laboratory Exercise 1: Comparing retrieved ozone data from TES with in situ observations
2/15 – 2/19	Thermal Infrared Measurements Part 2: MOPITT CO (NCAR) Guest Lecture by Merritt Deeter	Laboratory Exercise 2: Plotting profiles and maps of CO Measurements
2/22 – 2/26	Thermal Infrared Measurements Part 3: TES NH_3 Observations	Laboratory Exercise 3: Plotting the Spatial Distribution of TES NH_3 over the U.S.
3/1 – 3/5	UV-Visible Measurements Lecture Part 1	Laboratory Exercise 4: Formaldehyde from OMI and Airmass Factors
3/8 – 3/12	UV-Visible Measurements Lecture Part 2	Laboratory Exercise 5: GOME-2 NO_2 over North America and East Asia
3/15 – 3/19	TEMPO Lecture	Laboratory Exercise 6: Synthetic TEMPO measurements of ozone and NO_2

3/22– 3/26	Satellite Measurements of Aerosols Lecture Part 1	Laboratory Exercise 7: Exploring Dust Distributions over West Asia using OMI and GOME-2: Aerosol Products
3/29 – 4/2	Satellite Measurements of Aerosols Overview Lecture Part 2	Laboratory Exercise 8: MODIS Global Aerosol Climatology
4/5 – 4/9	Complementary MODIS and VIIRS satellite datasets Lecture	Laboratory Exercise 9: Fires from Space
4/12 – 4/16	CSU Spring Break	
4/19 – 4/23	MISR Overview Lecture: Observational principles, data products and applications	Laboratory Exercise 10: Identifying Layers of Smoke and Dust with CALIPSO or CATS
4/26 – 4/30	Future of satellite observations Lecture	Laboratory Exercise 11: Exploring the Capabilities of NASA Worldview (https://worldview.earthdata.nasa.gov) & the Community Intercomparison Suite (http://www.cistools.net)
5/3 – 5/7	Final Project Poster Presentations will be scheduled sometime this week, likely on 5/3 unless the group would like additional time.	

Statement on Academic Integrity: This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf) and the Student Conduct Code (http://www.conflictresolution.colostate.edu/conduct-code). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.