

## **ATS 632: Interpreting Satellite Observations of Atmospheric Composition**

Monday: 10:00-10:50 AM, 101 ATS

Wednesday: 10:00-10:50 AM, ATS 3<sup>rd</sup> floor teaching lab (lab open until 1 PM)

*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. The teaching lab is reserved for 3 hours on Wednesdays (10 AM - 1 PM). The instructor will be present for at least the first hour on Wednesday to provide guidance and assistance. Students will be evaluated on the basis of weekly lab assignments, and a final project. Lab assignments are due in the following weekly-lecture class. Late assignments will not be accepted; 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 2019

Week	Lecture Topic	Laboratory Exercise
1/21 – 1/25	No Class – University Holiday on Monday 1/21 Emily at Aura Science Team Meeting Wednesday 1/23	
1/28 - 2/1	Introduction to Satellite Observations of Composition (two lectures during week 2)	
2/4 – 2/8	High Level overview Lecture of Optimal Estimation Theory	Student led discussions of <i>Duncan et al.</i> [2014], <i>Vijayraghavan et al.</i> [2008], <i>Martin</i> [2008], and <i>Streets et al.</i> [2013]
2/11 – 2/15	Thermal Infrared Measurements Part 1: TES O <sub>3</sub> /PAN/CO Observations	Laboratory Exercise 1: Comparing retrieved ozone data from TES with in situ observations
2/18 – 2/22	Thermal Infrared Measurements Part 2: Guest Lecture by Meritt Deeter on MOPITT CO (NCAR)	Note: EVF likely at ASDC Meeting in Langley Laboratory Exercise 2: Plotting profiles and maps of CO Measurements
2/25 – 3/1	Thermal Infrared Measurements Part 3: TES NH <sub>3</sub> Observations	Laboratory Exercise 3: Plotting the Spatial Distribution of TES NH <sub>3</sub> over the U.S.
3/4 – 3/8	UV-Visible Measurements Lecture Part 1	Laboratory Exercise 4: Formaldehyde from OMI and Airmass Factors
3/11 – 3/15	UV-Visible Measurements Lecture Part 2	Laboratory Exercise 5: GOME-2 NO <sub>2</sub> over North America and East Asia
3/18 – 3/22	Spring Break	
3/25– 3/29	TEMPO Lecture	Laboratory Exercise 6: Synthetic TEMPO measurements of ozone and NO <sub>2</sub>
4/1 – 4/5	Satellite Measurements of Aerosols Lecture Part 1	Laboratory Exercise 7: Exploring Dust Distributions over West Asia using OMI and GOME-2: Aerosol Products
4/8 – 4/12	Satellite Measurements of Aerosols Overview Lecture Part 2	Laboratory Exercise 8: MODIS Global Aerosol Climatology
4/15 – 4/19	Complementary MODIS and VIIRS satellite datasets Lecture	Laboratory Exercise 9: Fires from Space (EVF Visiting Berkley – Lab will be rescheduled for Friday afternoon)

4/22 – 4/26	MISR Overview Lecture: Observational principles, data products and applications	Laboratory Exercise 10: Identifying Layers of Smoke and Dust with CALIPSO or CATS  (EVF in Boulder for WE-CAN Meeting – Lab will be rescheduled for Friday afternoon)
4/29 – 5/3	Future of satellite observations Lecture	Laboratory Exercise 11: Exploring the Capabilities of NASA Worldview ( <a href="https://worldview.earthdata.nasa.gov">https://worldview.earthdata.nasa.gov</a> ) & the Community Intercomparison Suite ( <a href="http://www.cistools.net">http://www.cistools.net</a> )
5/6 – 5/10	No Class due to GEOS-Chem Users Meeting and FRAPPE/DISCOVER-AQ Science Team Meetings: Class Time to be used for Final Project Preparation	
5/13 – 5/17	Final Project Poster Presentations will be scheduled on either Monday 5/13 or Tuesday 5/14 depending on student exam schedules	

*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.