ATS 681: Interpreting Satellite Observations of Atmospheric Composition

Tuesday: 1:00-1:50 PM, 212B ACRC
Thursday: 1:00-4:00 PM, ERC lab (lab open until 4pm)
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). 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 computer lab in ERC is reserved for 3 hours on Thursday afternoons (1-4 PM). The instructor will be present for the first hour on Thursday 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%

Topic Schedule for Spring 2017

Week	Lecture Topic	Laboratory Exercise
1/16 – 1/20	Introduction to Satellite Observations of Composition (two lectures during week 1)	
1/23 - 1/27	No Class – AMS Meeting Time will be rescheduled later in the semester after the series of guest lectures.	
1/30 – 2/3	High Level overview of Inverse Methods: Guest Lecture by Chris O'Dell (CIRA)	Student led discussions of *Duncan et al.* [2014], *Vijayraghavan et al.* [2008], *Martin* [2008], and *Streets et al.* [2013]
2/6 – 2/10	Thermal Infrared Measurements Part 1: Guest Lecture by Vivienne Payne on TES O_3/PAN/CO Observations (JPL)	Comparing retrieved ozone data from TES with in situ observations
2/13 – 2/17	Thermal Infrared Measurements Part 2: Guest Lecture by Meritt Deeter on MOPITT CO (NCAR)	Plotting profiles and maps of CO Measurements
2/20 – 2/24	Thermal Infrared Measurements Part 3: Guest Lecture by Juliet Zhu on TES NH_3 Observations (CSU)	Plotting the Spatial Distribution of TES NH_3 over the U.S. **Emily is on travel this week.*
2/27 – 3/3	Part 1: Differential Optical Absorption Spectroscopy (TOMS, GOME, SCIAMACHY, OMI)	Comparison of GOME and SCIAMACHY NO_2 for East Asia
3/6 – 3/10	Part 2: Differential Optical Absorption Spectroscopy (TOMS, GOME, SCIAMACHY, OMI) *Potential Guest lecture*	Formaldehyde and NO_2 from OMI: Airmass Factors OR OMI SO_2 Applied to Volcanoes
3/13 – 3/17	Spring Break	
3/20 – 3/24	Aerosol Measurements (TOMS AI)	TOMS and OMI Aerosol Index (AI) Products
3/27 – 3/31	Cloud-Aerosol Lidar Measurements (CALIPSO)	CALIOP Lidar Data applied to dust and smoke plumes
4/3 – 4/7 *time change	MODIS and the Remote Sensing of Clouds and Aerosols from Space: Guest Lecture by Michael King on Monday 4/3 2-3PM	Emily in DC for a meeting – Lab is open, but Emily will not be there. Lab is focused on MODIS AOD
4/10 – 4/14	Complementary MODIS satellite datasets	MODIS Fire Counts
4/17 – 4/21	MISR Overview: Observational principles, data	MISR Plume Heights

	products and applications	
4/24 – 4/28	Future of satellite observations	Exploring the Capabilities of NASA Worldview (https://worldview.earthdata.nasa.gov) & the Community Intercomparison Suite (http://www.cistools.net)
5/1 – 5/5	No Class due to GEOS-Chem Users Meeting and FRAPPE/DISCOVER-AQ Science Team Meetings: Class Time to be used for Final Project Preparation	
Final Exam Period	Final Project Presentations	

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.