PHY 2505S
ATMOSPHERIC RADIATIVE TRANSFER AND REMOTE SOUNDING
Spring Term, 2020
"JOURNAL CLUB" PRESENTATION/DISCUSSION FACILIATION

You will be responsible for presenting a journal article related to the course material (chosen from the list below) and leading a class discussion of this paper. These presentations will be during the term (a two-hour slot outside class time, at a time TBA in late March/early April). You will be evaluated on how you present your paper and lead the discussion on it and on how you participate in discussion of the other papers.

PRESENTATION AND DISCUSSION GUIDELINES:

You will have 20 minutes for your presentation and discussion. In the first ~10 minutes (no more than half of the time), you will present a summary/synthesis of the results of the paper and provide any background necessary for the class to have a clear understanding of the article. In the rest of your time (~10 minutes), you will lead a discussion of the paper focusing on the aspects that relate to the course.
You should include in your presentation and discussion:

- What is the motivation for this study?
  - What was new and why was it published?
  - What is next step or implication for this work?
- Highlight the radiative transfer and/or remote sounding aspects of the work
  - How does this relate to what we have learned in the course?
  - What are the advantages and challenges of using this technique?
  - Can these results be obtained by another method?
- Remember to formulate some questions for the class to help lead the discussion part

MARKING:

Marks (15% of course total) will be given for content and comprehension of material, clarity, presentation method and use of diagrams or other aids. For the discussion component, marks will be given for your ability to lead the discussion of your paper and to provide topics and questions to facilitate this discussion. You will also be graded on your participation in the discussions of the other papers.

PAPERS TO BE PRESENTED:

- Ding, J., et al. (2018), Maritime NOx emissions over Chinese seas derived from satellite observations. Geophys. Res. Lett., 45, 2031–2037, https://doi.org/10.1002/2017GL076788.
- Franco, B., Clarisse, L., Stavrakou, T., Müller, J.-F., Pozzer, A., Hadji-Lazaro, J., et al. (2019). Acetone atmospheric distribution retrieved from space. Geophysical Research Letters, 46, 2884–2893, https://doi.org/10.1029/2019GL082052.
- Hakkarainen, J., Ialongo, I., and Tamminen, J. (2016), Direct space-based observations of anthropogenic CO_2 emission areas from OCO-2, Geophys. Res. Lett., 43, 11,400-11,406, https://doi.org/10.1002/2016GL070885.
- Strahan, S. E., & Douglass, A. R. (2018), Decline in Antarctic ozone depletion and lower stratospheric chlorine determined from Aura Microwave Limb Sounder observations. Geophysical Research Letters, 45, 382–390, https://doi.org/10.1002/2017GL074830.

- Warner, J. X., et al. (2017), Increased atmospheric ammonia over the world's major agricultural areas detected from space, Geophys. Res. Lett., 44, 2875–2884, https://doi.org/10.1002/2016GL072305.
- Zhu, L., et al. (2015), TES observations of the interannual variability of PAN over Northern Eurasia and the relationship to springtime fires, Geophys. Res. Lett., 42, 7230–7237, https://doi.org/10.1002/2015GL065328.

ABSTRACTS OF PAPERS:

- Ding, J., et al. (2018), Maritime NO_x emissions over Chinese seas derived from satellite observations. Geophys. Res. Lett., 45, 2031–2037, https://doi.org/10.1002/2017GL076788.

By applying an inversion algorithm to NO_x satellite observations from Ozone Monitoring Instrument, monthly NO_x emissions for a 10 year period (2007 to 2016) over Chinese seas are presented for the first time. No effective regulations on NO_x emissions have been implemented for ships in China, which is reflected in the trend analysis of maritime emissions. The maritime emissions display a continuous increase rate of about 20% per year until 2012 and slow down to 3% after that. The seasonal cycle of shipping emissions has regional variations, but all regions show lower emissions during winter. Simulations by an atmospheric chemistry transport model show a notable influence of maritime emissions on air pollution over coastal areas, especially in summer. The satellite-derived spatial distribution and the magnitude of maritime emissions over Chinese seas are in good agreement with bottom-up studies based on the Automatic Identification System of ships.

- Franco, B., Clarisse, L., Stavrakou, T., Müller, J.-F., Pozzer, A., Hadji-Lazaro, J., et al. (2019). Acetone atmospheric distribution retrieved from space. Geophysical Research Letters, 46, 2884–2893, https://doi.org/10.1029/2019GL082052

As one of the most abundant oxygenated volatile organic compounds in the atmosphere, acetone (CH3C[O]CH3) influences atmospheric oxidants levels and ozone formation. Here we report the first unambiguous identification of acetone from the nadir-viewing satellite sounder Infrared Atmospheric Sounding Interferometer (IASI). Via a neural network-based retrieval approach that was previously applied to the retrieval of other weak absorbers, we obtain daily global acetone retrievals. A first intercomparison with independent measurements is conducted. As the retrieval method is computationally fast, it allowed the full reprocessing of the 2007–2018 IASI time series. Analysis of the retrieved global product and its seasonality suggests that emissions of acetone and precursors from the terrestrial biosphere at Northern Hemisphere middle and high latitudes are the main contributors to the atmospheric acetone abundance, more than year-round oxidation of anthropogenic isoalkanes. Remarkably, biomass burning does not appear to be a strong global source of acetone.

- Hakkarainen, J., Ialongo, I., and Tamminen, J. (2016), Direct space-based observations of anthropogenic CO_2 emission areas from OCO-2, Geophys. Res. Lett., 43, 11,400-11,406, https://doi.org/10.1002/2016GL070885.

Anthropogenic CO2 emissions from fossil fuel combustion have large impacts on climate. In order to monitor the increasing CO2 concentrations in the atmosphere, accurate spaceborne observations—as available from the Orbiting Carbon Observatory-2 (OCO-2)—are needed. This work provides the first direct observation of anthropogenic CO_2 from OCO-2 over the main pollution regions: eastern USA, central Europe, and East Asia. This is achieved by deseasonalizing and detrending OCO-2 CO_2 observations to derive CO_2 anomalies. Several small isolated emission areas (such as large cities) are detectable from the anomaly maps. The spatial distribution of the CO_2 anomaly matches the features observed in the maps of the Ozone Monitoring Instrument NO_2 tropospheric columns, used as an

indicator of atmospheric pollution. The results of a cluster analysis confirm the spatial correlation between CO_2 and NO_2 data over areas with different amounts of pollution. We found positive correlation between CO_2 anomalies and emission inventories. The results demonstrate the power of spaceborne data for monitoring anthropogenic CO_2 emissions.

- Strahan, S. E., & Douglass, A. R. (2018), Decline in Antarctic ozone depletion and lower stratospheric chlorine determined from Aura Microwave Limb Sounder observations. Geophysical Research Letters, 45, 382–390, https://doi.org/10.1002/2017GL074830.

Attribution of Antarctic ozone recovery to the Montreal protocol requires evidence that (1) Antarctic chlorine levels are declining and (2) there is a reduction in ozone depletion in response to a chlorine decline. We use Aura Microwave Limb Sounder measurements of O_3, HCl, and N_2O to demonstrate that inorganic chlorine (Cl_y) from 2013 to 2016 was 223 ± 93 parts per trillion lower in the Antarctic lower stratosphere than from 2004 to 2007 and that column ozone depletion declined in response. The mean Cl_y decline rate, ~0.8%/yr, agrees with the expected rate based on chlorofluorocarbon lifetimes. N_2O measurements are crucial for identifying changes in stratospheric Cl_y loading independent of dynamical variability. From 2005 to 2016, the ozone depletion and Cl_y time series show matching periods of decline, stability, and increase. The observed sensitivity of O_3 depletion to changing Cl_y agrees with the sensitivity simulated by the Global Modeling Initiative chemistry transport model integrated with Modern Era Retrospective Analysis for Research and Applications 2 meteorology.

- Warner, J. X., et al. (2017), Increased atmospheric ammonia over the world's major agricultural areas detected from space, Geophys. Res. Lett., 44, 2875–2884, https://doi.org/10.1002/2016GL072305.

This study provides evidence of substantial increases in atmospheric ammonia (NH3) concentrations (14 year) over several of the worlds major agricultural regions, using recently available retrievals from the Atmospheric Infrared Sounder (AIRS) aboard NASA's Aqua satellite. The main sources of atmospheric NH3 are farming and animal husbandry involving reactive nitrogen ultimately derived from fertilizer use; rates of emission are also sensitive to climate change. Significant increasing trends are seen over the U.S. (2.61% yr1), the European Union (EU) (1.83% yr1), and China (2.27%yr1). Over the EU, the trend results from decreased scavenging by acid aerosols. Over the U.S., the increase results from a combination of decreased chemical loss and increased soil temperatures. Over China, decreased chemical loss, increasing temperatures, and increased fertilizer use all play a role. Over South Asia, increased NH3 emissions are masked by increased SO2 and NOx emissions, leading to increased aerosol loading and adverse health effects.

- Zhu, L., et al. (2015), TES observations of the interannual variability of PAN over Northern Eurasia and the relationship to springtime fires, Geophys. Res. Lett., 42, 7230–7237, https://doi.org/10.1002/2015GL065328.

Peroxyacetyl nitrate (PAN) plays an important role in atmospheric chemistry through its impact on remote oxidant and nitrogen budgets. PAN is formed rapidly in boreal fire plumes through the oxidation of short-lived volatile organic compounds in the presence of nitrogen oxide radicals. Here we present new satellite observations of PAN from the Tropospheric Emission Spectrometer (TES) over northern Eurasia for April 2006–2010. We observe large interannual variability in TES PAN observations, and we show that fires are one source of this variability using (1) Moderate Resolution Imaging Spectroradiometer Mean Fire Radiative Power observations and (2) Hybrid Single-Particle Lagrangian Integrated Trajectory backward trajectories. We also show that cold springtime temperatures and enhanced vertical mixing in the lower free troposphere over northeastern Eurasia likely played a role in the detection of PAN from TES in April 2006 in this region.