3.015 Chemical characterization of gas-phase organic compound emissions from unconventional fossil fuel operations and their impact on regional atmospheric composition and air quality.

Presenting Author:
Drew Gentner, Dept. of Chemical and Environmental Engineering, Yale University, drew.gentner@yale.edu

Co-Authors:
Roger Sheu, Dept. of Chemical and Environmental Engineering, Yale University
Aurelie Marcotte, Dept. of Chemical and Environmental Engineering, Yale University
Jessica Gilman, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Brian Drollette, Dept. of Chemical and Environmental Engineering, Yale University
Desiree Plata, Dept. of Chemical and Environmental Engineering, Yale University
Joost de Gouw, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Carsten Warneke, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Brian Lerner, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Abigail Koss, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Bin Yuan, NOAA Earth System Research Laboratory; Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Emily Fischer, Department of Atmospheric Science, Colorado State University
Delphine Farmer, Department of Chemistry, Colorado State University
Ilana Pollack, Department of Atmospheric Science, Colorado State University
Mark Omara, Dept. of Mechanical Engineering, Carnegie Mellon University
Xiang Li, Dept. of Mechanical Engineering, Carnegie Mellon University
Albert Presto, Dept. of Mechanical Engineering, Carnegie Mellon University
Allen Robinson, Dept. of Mechanical Engineering, Carnegie Mellon University
Shao-Meng Li, Air Quality Research Division, Environment Canada
John Liggio, Air Quality Research Division, Environment Canada

Abstract:

With technological growth and the development of unconventional fossil fuel resources, the volume of oil and gas extracted from basins across North America has

grown dramatically over the past 5-10 years. This has had significant, observable effects on ambient air quality, including enhancements in ozone and secondary organic aerosol (SOA) formation, but the extent of emissions across the volatility range of gas-phase organic compounds remains uncertain. Using offline analysis and a survey of gas-phase organic compound samples from a mix of laboratory, ground site, mobile lab, and aircraft platforms; we examine the magnitude and detailed chemical composition of emissions and ambient concentrations of volatile organic compounds (VOCs), intermediate-volatility organic compounds (IVOCs), semivolatile organic compounds (SVOCs).

Offline samples of compounds with 7 or more carbon atoms are collected on custom adsorbent traps and analyzed using a thermal desorption-gas chromatography system connected to both a very-high resolution, chemical ionization, tandem mass spectrometer and an electron ionization quadrupole mass spectrometer. The sampled complex mixtures of organic compounds are comprehensively speciated by carbon number and compound class, with resolution of major isomers. We present these results in an intercomparison across several North American basins with a varying mix of shale oil and shale gas operations. We also present the results of a laboratory experiment that realistically simulates the processing of oil sands, which has been shown to cause SOA formation downwind of extraction and processing operations in Alberta. We compare the distribution of chemical compound classes and volatility across all measured sources with a preliminary assessment of their relative potential for SOA and ozone formation.