



Wintertime Air Quality Impacts from Oil and Natural Gas Drilling Operations in the Bakken Formation Region

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Oil and natural gas extraction has dramatically increased in the last decade in the United States due to the increased use of unconventional drilling techniques which include horizontal drilling and hydraulic fracturing. The impact of these drilling activities on local and regional air quality in oil and gas basins across the country are still relatively unknown, especially in recently developed basins such as the Bakken shale formation. This study is the first to conduct a comprehensive characterization of the regional air quality in the Bakken region. The Bakken shale formation, part of the Williston basin, is located in North Dakota and Montana in the United States and Saskatchewan and Manitoba in Canada. Oil and gas drilling operations can impact air quality in a variety of ways, including the generation of atmospheric particulate matter (PM), hazardous air pollutants, ozone, and greenhouse gas emissions. During the winter especially, PM formation can be enhanced and meteorological conditions can favor increased concentrations of PM and other pollutants.

In this study, ground-based measurements throughout the Bakken region in North Dakota and Montana were collected over two consecutive winters to gain regional trends of air quality impacts from the oil and gas drilling activities. Additionally, one field site had a comprehensive suite of instrumentation operating at high time resolution to gain detailed characterization of the atmospheric composition. Measurements included organic carbon and black carbon concentrations in PM, the characterization of inorganic PM, inorganic gases, volatile organic compounds (VOCs), precipitation and meteorology. These elevated PM episodes were further investigated using the local meteorological conditions and regional transport patterns. Episodes of elevated concentrations of nitrogen oxides and sulfur dioxide were also detected. The VOC concentrations were analyzed and specific VOCs that are known oil and gas tracers were used to investigate the sources of high PM and other pollutants. Specifically, the low ratio of iso-pentane to n-pentane indicated consistent regional influence from oil and gas emissions. Finally, a source apportionment study using the VOC and other gas phase measurements was conducted to gain a better understanding of how the oil and gas drilling operations impact the air quality in the Bakken formation region.