Modeling of Atmospheric Methane and Ozone in the Uintah Basin, UT: The Role of Oil and Gas Emissions, Chemistry and Transport

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There is a growing concern about increasing methane and other Volatile Organic Compound (VOC) emissions due to rapid development of the oil and gas production across the United States. The Uintah Basin Winter Ozone Study (UBWOS) field campaigns took place in the winters of 2011-12 and 2012-13 in the Uintah Basin in Utah, which has a large number of oil and gas wells. Intensive measurements conducted by the NOAA/ESRL researchers were designed to characterize the meteorology and chemistry over the basin.

In this study, we present methane and ozone simulations for the UBWOS at high spatial resolution using the Weather Research & Forecasting-Chemisty model that uses two anthropogenic emissions inventory datasets. The first emission data set (bottom-up) is based on the U.S. Environmental Protection Agency National Emissions Inventory-2011 (version 1) emission inventory's gas and oil sector for the basin. Emissions of nitrogen oxides and VOCs in the second inventory (top-down) are constructed using the UBWOS measurements. The aircraft and tethersonde measurements conducted by Global Monitoring Division during the UBWOS are extensively used in this study to evaluate the 3D distribution of modeled meteorological and chemical variables. Comparisons of the model results with the surface and aircraft measurements show greater underestimates of mixing ratios of methane and other VOCs in the simulation with the bottom-up inventory than the case when the top-down inventory is used. The photochemistry modeling using the emission datasets reveals that the top-down emissions allow the model to capture the high ozone episodes quite well. In contrast, the simulation case using the bottom-up inventory is not able to reproduce any of the observed high ozone concentrations in the basin.

We show the role of photochemical and deposition processes in driving the high ozone concentrations in the basin. In addition, the role of advection and vertical mixing of gas species within and out of the basin focusing the winter of 2013 will be discussed.

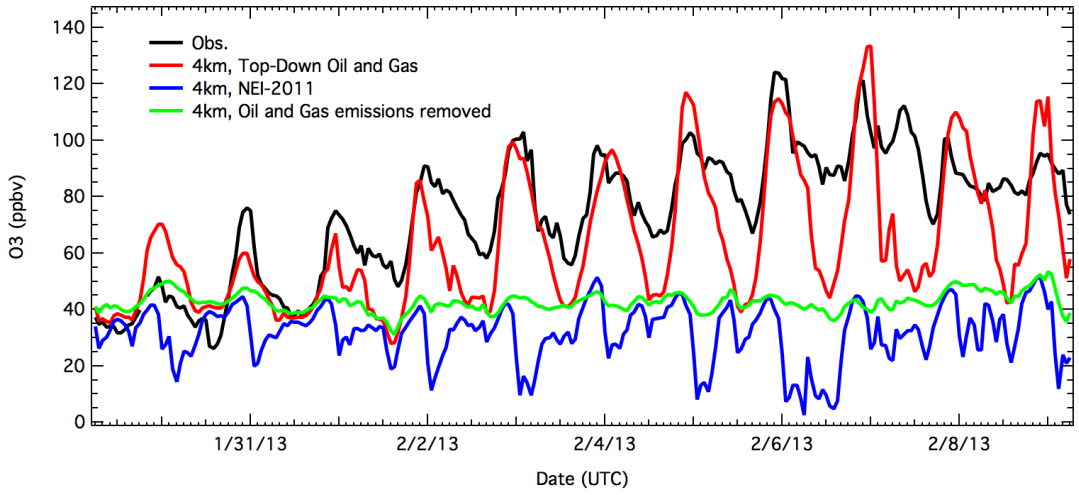

Figure 1. Time series of the observed and modeled ozone mixing ratios at the Horse Pool surface site during winter of 2013. Three modeled cases with different anthropogenic emission cases are shown.