Highlights of Findings from the Uinta Basin Ozone Study: Preliminary Update from 2014 Field Study

Ozone concentrations in excess of the current national ambient air quality standard (NAAQS) have been measured in the Uinta Basin during winter inversion periods when the ground is covered by snow. The Uinta Basin Ozone Study (UBOS) aims to identify the emissions, meteorological and photochemical processes that cause elevated winter ozone concentrations, and to identify the most effective strategies to reduce winter ozone. Results from detailed scientific measurements made in the Uinta Basin during the winters of 2011-2012, 2012-2013 were summarized in previous Highlights of Findings and accompanying detailed reports (http://www.deq.utah.gov/locations/U/uintahbasin/problem.htm). Additional measurements targeted at areas of remaining uncertainty were conducted during January – March 2014. Results from this most recent field campaign both confirm findings from the prior two years and provide important additional contributions to our understanding of the emissions, meteorology and atmospheric chemistry associated with winter ozone episodes. Major findings drawn from preliminary analyses of the 2014 data are described below.

Air Quality and Meteorological Conditions during UBOS 2014

- Conditions favorable for ozone formation occurred at times during the December 2013 – March 2014 winter ozone season. Eight-hour average ozone concentrations exceeded the level of EPA's ambient air quality standard (75 ppb) at seven different locations within the Uinta Basin; Ouray experienced the most exceedance days (17).
- The most severe high ozone episodes of the winter occurred in December: the maximum 8-hour average concentration of the season (102 ppb) was recorded at Dinosaur National Monument on 18 December and concentrations in excess of 75 ppb were observed at several locations within the Basin during mid and late December. Additional episodes occurred in January and early February. As in previous years, the episodes were associated with snow cover and strong inversions. Lack of snow cover precluded the occurrence of any episodes after early February.
- While ozone episodes captured by the intensive field study measurements during January and February were shorter and peak ozone concentrations were lower than episodes during the 2013 field study, conditions were nevertheless representative of typical winter ozone events.

Key Findings

- A primary focus of UBOS 2014 was further evaluation of the relative contributions of different sources of the reactive chemical intermediates (radicals) that drive ozone formation during winter episodes. Understanding the contributions of different sources to the radical budget is a key step in the development of effective emission controls for ozone reduction. Results from UBOS 2013 showed that the primary chemical drivers of winter ozone formation in the Uinta Basin differ greatly from summer ozone formation in urban areas but left unanswered a key question about the importance of a particular radical source, nitrous acid (also known as HONO). Measurements made during UBOS 2014 confirmed the unique nature of winter ozone formation mechanisms. By comparing results from five different HONO measurement techniques and making HONO

measurements over a wider range of elevations within the polluted atmospheric boundary layer, researchers showed that HONO does not appear to be a major source of radicals during the winter episodes. Instead, results from the 2014 measurements confirmed that formaldehyde and other aldehydes are the dominant radical sources. These compounds are both directly released from various emission sources and form in the atmosphere from directly emitted volatile organic compounds (VOCs) such as those contained in oil and raw natural gas. Aromatic VOCs (including toluene and xylene), while less abundant than other VOC species in the Basin, are also particularly important sources of radicals.

- New "box model" simulations of ozone formation chemistry based on data collected at the Horsepool study site confirmed earlier analyses indicating that ozone formation at this location is sensitive to VOC reductions, i.e. VOC reductions would result in ozone reductions. These results also suggest that NO_x reductions, either by themselves or in conjunction with VOC reductions, would lead to ozone reductions at Horse Pool. While providing an important reference point, these box model results do not take into account spatial variations in emissions and the mixing of emissions from different sources (among other factors) and thus do not provide an assessment of the expected impact of basin-wide VOC or NOx emission reductions on ozone levels sufficiently robust to allow formulation of a comprehensive regulatory control strategy. Nevertheless, this result provides support for on-going VOC reduction measures and is an important contribution to the overall "weight of evidence" guiding control strategy design.

Next Steps

- UBOS 2014 researchers identified a number of questions which require further investigation. The major recommendation with respect to future field studies is that additional measurements should be collected to compare radical sources in the western basin (where oil production dominates) with those that have been collected at Horsepool (where natural gas production dominates) so as to better characterize the influence of oil production sources on ozone episodes.
- Several different government and university groups are continuing to develop and evaluate inventories of pollutant emissions in the Basin. Discrepancies between current emission estimates and observed pollutant concentrations have been noted and are being further investigated by these groups. The Utah Division of Air Quality is working with the Western Energy Alliance to update the inventory of emissions from oil and gas operations in the Basin. Recently enacted reporting and permitting regulations are also expected to generate data contributing to future improvements in the inventory. Research efforts are underway at Utah State University to better quantify emissions of formaldehyde (an important ozone precursor).
- Full scale three-dimensional computer model simulations of winter ozone episodes are under development by the Utah Division of Air Quality, EPA, BLM, University of Utah, Utah State University and NOAA. A number of areas in which model improvements are needed have been identified and work is continuing. The State of Utah has also committed $300,000 towards development of improved emissions data and models for evaluation of winter ozone control strategies.
- These findings will be updated in the coming months. A final report for UBOS 2014 is currently under preparation and planned for completion by December.