# Highlights of Findings from the Uintah Basin Ozone Study: Preliminary Update from 2013 Field Study

Ozone concentrations in excess of the current national ambient air quality standard (NAAQS) have been measured in the Uintah Basin during winter inversion periods when the ground is covered by snow. The UBOS aims to identify the emissions and photochemical processes that cause elevated winter ozone concentrations, and to identify the most effective strategies to reduce winter ozone. Presented here are the interim findings from UBOS 2013, which are drawn from preliminary analyses of data and results and will be updated in the coming months. A final report for UBOS 2013 is currently under preparation and planned for completion by December 2013.

Key findings from UBOS 2013 are summarized below:

**I. Air Quality**

- Maximum 8-hour average ozone concentrations measured at Ouray reached 142 ppb during the December 2012 – March 2013 winter study, exceeding the NAAQS (75 ppb) by 89%. Monitored values in the major population centers were greater than the NAAQS on a total of 22 days at Vernal and 29 days at Roosevelt. These observations are in sharp contrast to the 2012 winter study, when 8-hour average ozone levels did not exceed 63 ppb.
- There were seven multi-day elevated ozone episodes which were separated by periods of ozone levels below the NAAQS. Individual ozone episodes ranged from 3 to nearly 15 days in length.
- Ozone concentrations within the basin are not influenced to any significant extent by transport of ozone or precursors from outside of the Basin, or by the Bonanza Power Plant.
- Elevated ozone coincided with elevated levels of volatile organic compounds (VOC) and nitrogen oxides ($NO_x$), which are the primary chemical precursors of ozone.

**II. Meteorology**

- Elevated winter ozone in the Uintah Basin only occurs with snow cover, which causes a strong temperature inversion, trapping a layer of cold air within the basin.
- Reflection of sunlight from the snow surface significantly increases the total solar radiation in the atmosphere and thus the rate of ozone formation.
- Complex patterns of light winds within the Basin appear to produce an east-west “sloshing” of air, that contributes to intra-basin mixing of ozone and ozone precursors.

**III. Chemistry**

- Chemical reactions during these winter episodes differ greatly from summer ozone formation in urban areas. Nitrous acid (HONO) and formaldehyde were found to be the biggest contributors to the reactive chemical intermediates (radicals) that drive ozone formation in the Uintah Basin.
- Uncertainties remain regarding the likely impact of $NO_x$ and VOC emission controls:
  1. Analysis of 2012 data (when elevated ozone did not occur) suggests that ozone formation was VOC limited, i.e. VOC reductions would produce ozone reductions, but $NO_x$ reductions might be

counterproductive. Further analysis of 2013 conditions is needed to determine if this was also true during the 2013 episodes or if the concentration of radicals increased to the point where $NO_x$ controls start to become effective.

2. The effectiveness of $NO_x$ controls will also be impacted by the extent to which relatively unreactive nitrogen species (nitrates) are being recycled back into reactive $NO_x$ by chemical reactions in snow and on particles in the atmosphere.
3. Measurements made during 2013 suggest that VOC reactions in the snow may contribute to ozone in the air just above the snow surface.

- Oxidation of aromatic VOCs (including toluene and xylene) is an important source of radicals. Thus, VOC control measures focused on these species will be particularly effective.

**IV. Emissions**

- Inventory data specific to the winter ozone season are needed as emissions from some oil and gas sources have large seasonal variations.
- Additional information is needed on methanol use and its contamination, if any, by formaldehyde.
- VOC emissions from storage tanks, fugitive emissions, venting, blowdowns and other intermittent events need to be more carefully quantified in future inventories.

**V. Recommendations for Future Analyses**

- Two areas of particular importance for additional field data collection and analysis are:
  1. Improved measurements of HONO concentrations and related chemicals.
  2. Development of a comprehensive and accurate winter emission inventory for the Basin.

**VI. Implications for Control Strategies**

- Elevated ozone levels are only observed during winter inversion periods; episodic or seasonal controls may be a useful component of a management strategy for the Basin.
- Reductions in emissions of highly reactive VOCs such as aromatics will be beneficial. Ozone response to $NO_x$ reductions is more complex and requires further study.
- Reducing formaldehyde would be an effective way to reduce ozone but it is not yet clear which sources of formaldehyde are most important.
- Uncertainty in HONO sources makes it difficult to predict how responsive ozone will be to reductions in both VOC and $NO_x$ emissions.

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