Wintertime Distributed Ozone Measurements in Utah's Uintah Basin during UBWOS 2012

#0224

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1) Introduction

❖ **Ozone (O_3)**

- EPA designated O_3 as a primary pollutant, current National Ambient Air Quality Standard (NAAQS) is 75 ppb as an 8-hr average
- No significant direct O_3 source, formed in atmosphere through photochemical reactions

$$VOC + NO_x + h\nu \rightarrow O_3 + other\ \ products$$

- Generally considered a summertime pollutant associated with large metropolitan areas

❖ **O_3 in rural Intermountain West during winter months**

- NAAQS O_3 exceedences observed during winter months in the rural Upper Green River Basin of Wyoming beginning in 2005 (Schnell et al., 2009; Stoeckenius and Ma, 2010)
- Studies have suggested 5 important factors: relatively high elevation, snow cover, low daytime inversion heights, light winds, and abundant precursors (oil/gas development)
- Conditions listed above for the UGRB exist in the Uintah Basin of Utah
- High ground level O_3 values detected during Winter 2009-10 in the Uintah Basin
- Winter 2010-2011 Uintah Basin study looked at spatial and temporal distribution of O_3, (Martin et al., 2011)
  - 16 O_3 monitoring sites, weighted towards population centers
  - 1-hr average values as high as 149.0 ppb recorded in 2010 (Fig. 1)
  - High O_3 observed only during stagnant inversion periods with snow cover
  - 25 days with 8-hr average O_3 NAAQS exceedences in center of Basin
  - Basin perimeter sites recorded few exceedences if any

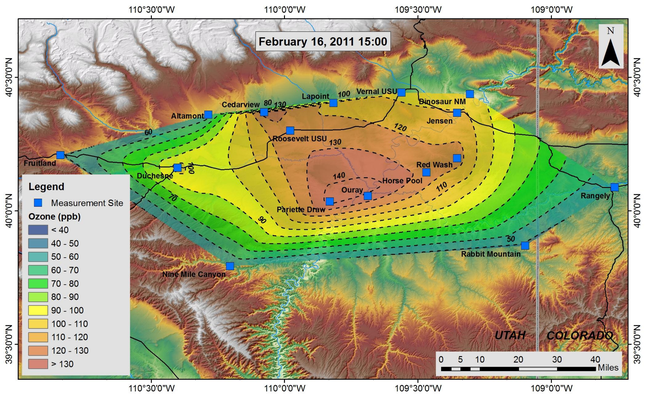

Figure 1. Period of maximum ozone concentrations during the Winter 2010-11 study showing the highest intensity area in the center of the Basin and much lower values at the perimeter.

- **Uintah Basin Winter O_3 2012 Study**
  - Objective: Obtain measurements to provide detailed understanding of the spatio-temporal distribution of ozone, precursors, and surface meteorology in the Basin.
  - This poster presents the distributed O_3 measurements
  - See presentations in Sessions A21J, A23B, and A23H for other results of study

2) Methodology

❖ **Distributed O_3 measurements made from December 2011 to March 2012**

❖ **Sample locations**

- 19 sites established as part of this study, examples in Fig. 2
  - 2B Technologies Model 205 monitors (FEMs) deployed at 12 sites
  - Portable Ozone Monitoring Systems (POMS), which included a Model 202 or 205 O_3 monitor from 2B Technologies, deployed at 7 sites
  - Logged 1, 5, or 60 minute averages
  - 2 week service schedule to download data and check calibration
- 11 other sites operated by UT Division of Air Quality, Golder Associates, Bureau of Land Management, National Park Service, U.S. Forest Service, Tetratech, and Meteorological Solutions, Inc.

Figure 2. Pictures of three O_3 monitoring sites during the Uintah Basin Winter 12 study. Note the lack of snow in the middle picture, taken in February 2012. The other pictures were taken in December 2011.

3) Results

❖ **Hourly Average O_3**

- Elevated O_3 levels observed in 2011 (Fig. 3a) did not occur during 2012 study (Fig. 3b)
- Winter 2012 had little to no snow and no persistent temperature inversions
- Daily maximum O_3 levels were uniform throughout the Basin, suggesting good daytime mixing
- Highest hourly average O_3 in winter 2012 was 65.8 ppb in mid-March (Fig. 4)

❖ **8-hr Average O_3**

- No exceedences of 8-hr O_3 occurred in 2012 (Fig. 5)
- Highest 8-hr average value was 62.9 ppb

❖ **Highest Period of O_3**

- Time series of March 8-11 shows uniform daily maximums at all sites (Fig. 6)
- Nighttime decreases are not uniform across the sites
- Greatest decreases seen in population centers (Vernal, Roosevelt, Duchesne), likely due to local sources of NO
- Lower elevation areas also exhibited nighttime titration, with a 24-hr time lag relative to population centers
- High elevation sites (Little Mountain, Mountain Home) exhibited little to no diurnal trend
- Average diurnal patterns over March 8-11 calculated for each site
- Large spatial differences exist in measured levels during early morning at sunrise (Fig. 7a)
- Mid-afternoon levels were fairly homogeneous throughout the Basin (Fig. 7b)
- Differencing the mid-afternoon and early morning averages highlights areas with most ozone chemistry during the period (Fig. 7c)

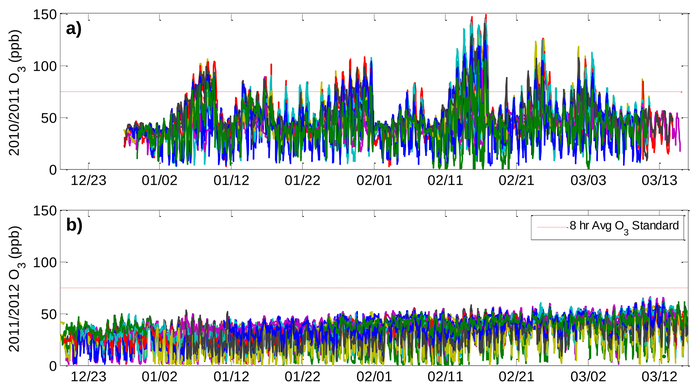

Figure 3. Observed 1-hr average O_3 in the Uintah Basin at a) 16 sites during the winter 2010/2011 study and b) 30 sites during the winter 2011/2012 study.

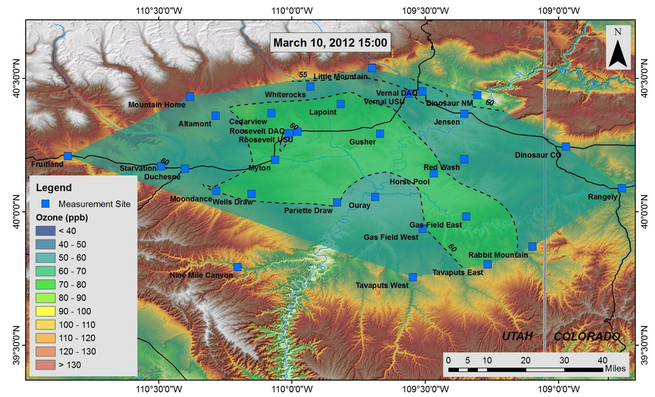

Figure 4. Highest 1-hr average O_3 concentrations during the Winter 2012 study.

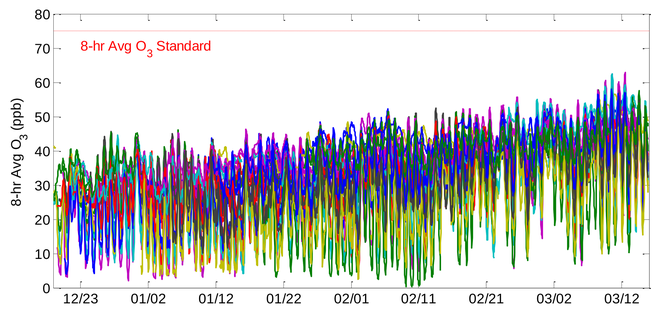

Figure 5. Time series of calculated 8-hr averages for the Winter 2012 study.

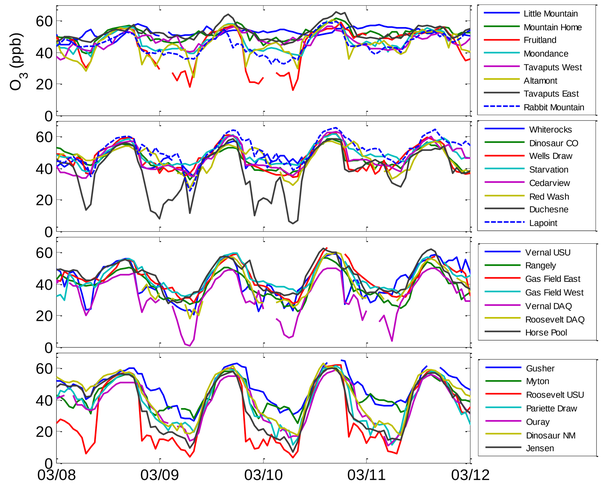

Figure 6. Time series of observed O_3 levels during March 8-11, 2012, organized by increasing elevation from bottom to top.

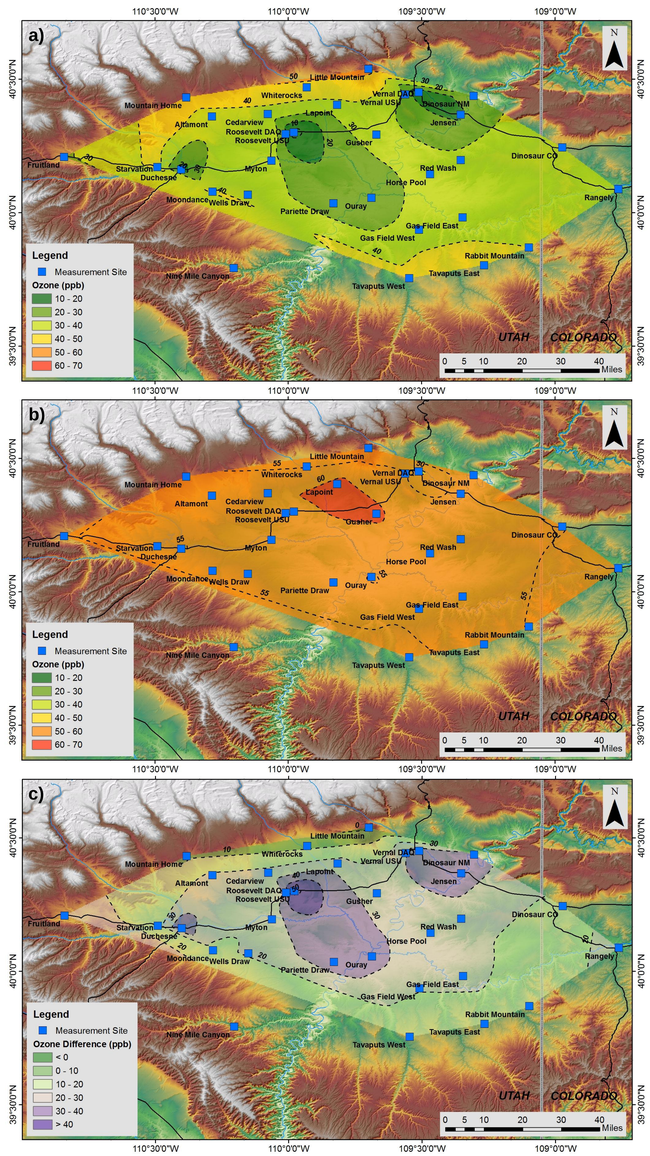

Figure 7. Spatial distribution of O_3 based on diurnal averages for March 8-11, 2012 a) around sunrise, b) in mid-afternoon, and c) the difference between the two times.

4) Conclusions

❖ **High O_3 levels were not measured during the Uintah Basin Winter Ozone Study 2012**

❖ **Little to no snow cover existed, no persistent temperature inversions occurred**

❖ **Daily maxima were fairly uniform (range ≤ 10 ppbv) across the Basin**

❖ **Nighttime titration observed in population centers and low elevation areas**

5) Acknowledgments

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6) References

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