

# Aircraft and Tethered Balloon Measurements in the Uinta Basin in Winter 2013

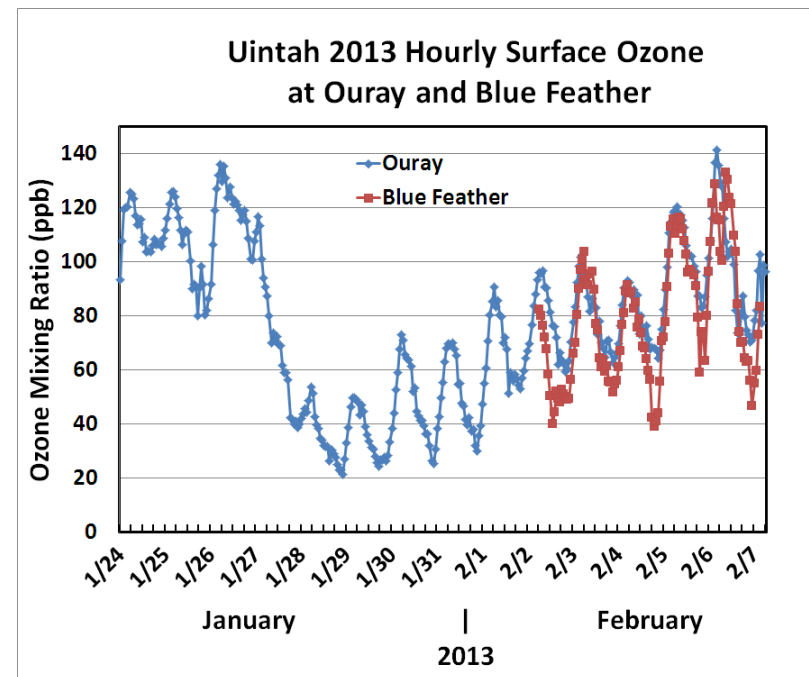
S. Oltmans, R. Schnell, A. Karion, B. Johnson, G. Petró, C. Sweeney, P. Cullis, E. Hall, A. Jordan, S. Wolter, D. Neff, B. Miller, S. Montzka, C. Sterling, A. McLure-Begley  
CIRES and NOAA/ESRL/GMD

**Seven Flights on January 31, February  
1, 2, 4, 5, 6, and 7**

**Continuous measurements of O<sub>3</sub>, CH<sub>4</sub>,  
CO, CO<sub>2</sub>, NO<sub>2</sub>, T, RH**

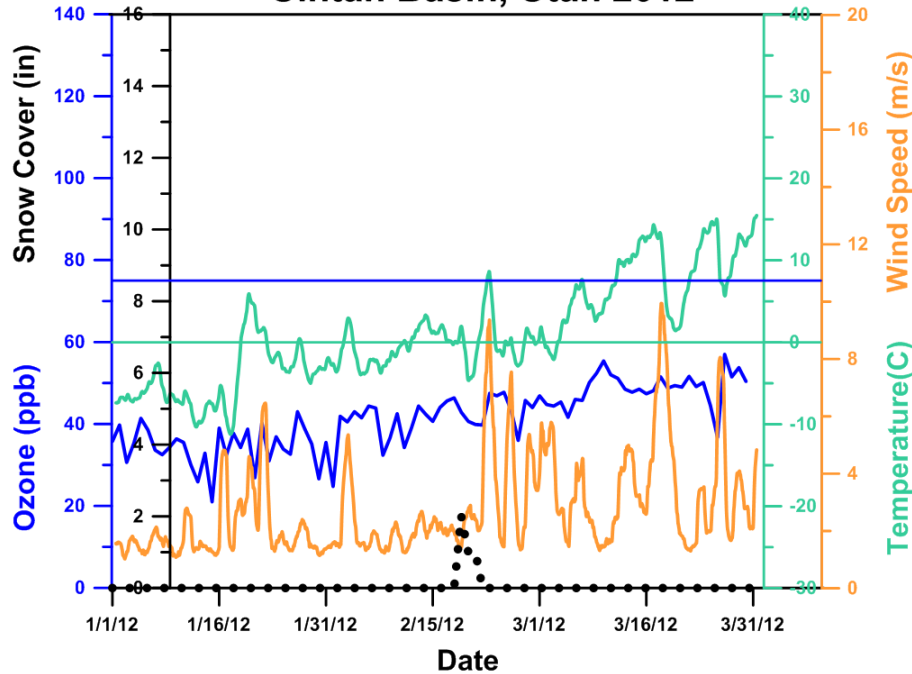
**12 Flask samples per flight measuring  
~50 constituents including several VOCs**

**Tethered Balloon Ozonesondes from  
3 sites with multiple profiles (~350)**

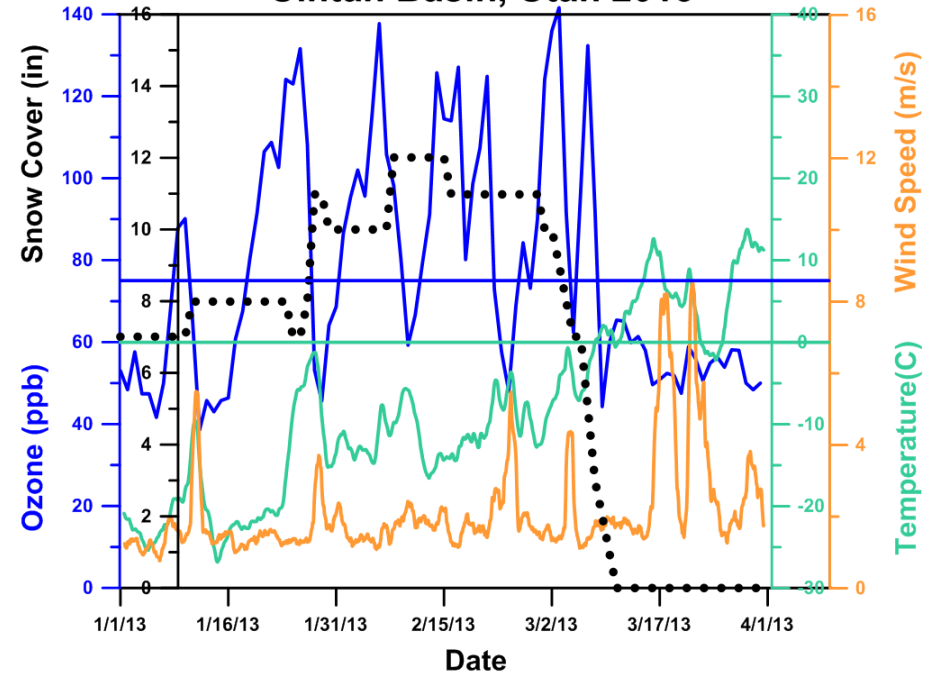


# Ozone in the Uinta Basin of Utah in Winter 2012 and 2013

## Uintah Basin, Utah 2012



## Uintah Basin, Utah 2013



What is the difference?

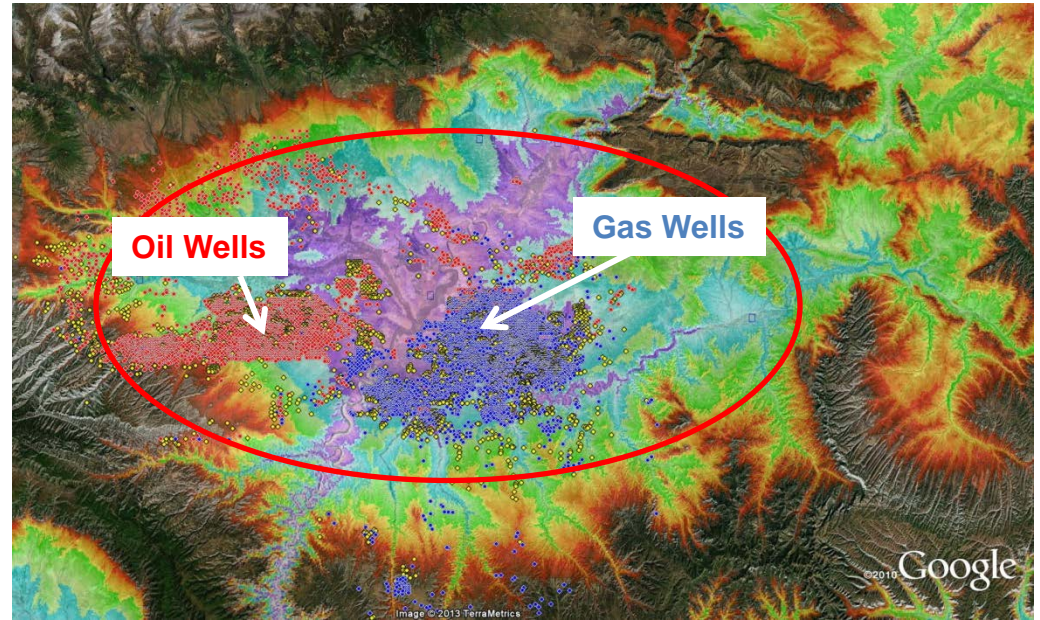


**What is the role of snow cover?**

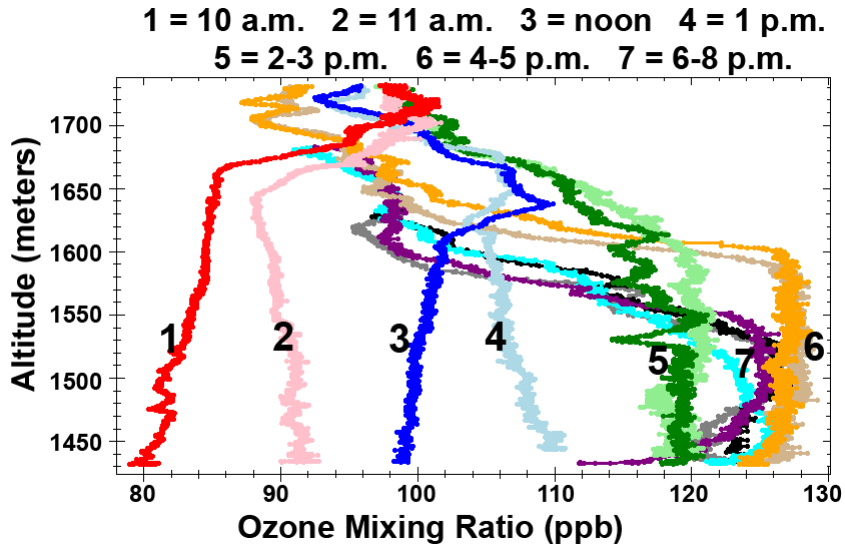
- Produces strong temperature inversions giving a shallow, confined boundary layer.
- High albedo of the surface essentially doubles the UV available for photochemistry.
- Heterogeneous chemistry on snow surfaces?

# What is Unique About the Unita Basin of Utah?

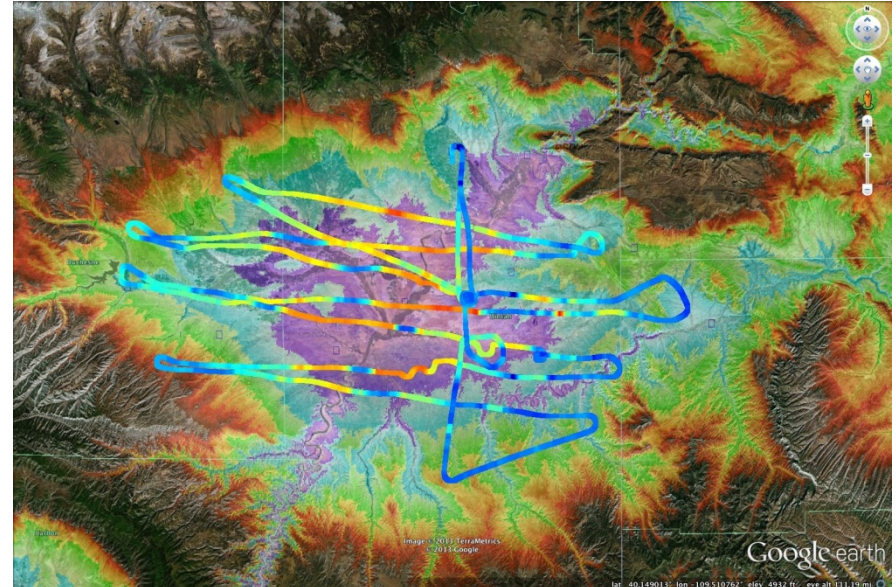
- Confined topography
- Intense oil and gas exploration and extraction
- Active oil and gas processing facilities
- Persistent winter snow cover!



# Ozone in the Unita Basin of Utah in Winter 2012 and 2013



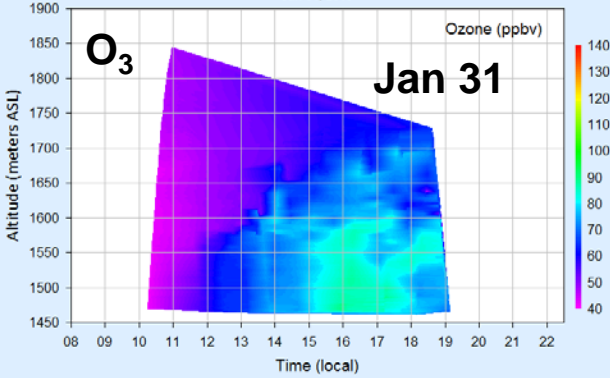
Ozone profiles through the day at Ouray on February 5, 2013



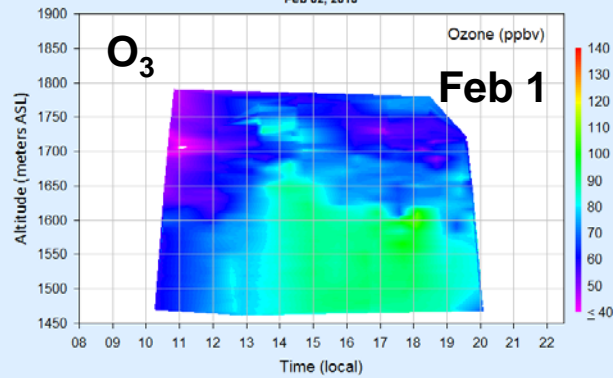
Ozone across the basin on Feb. 2

# Tethered Balloon Profiles at Fantasy Canyon

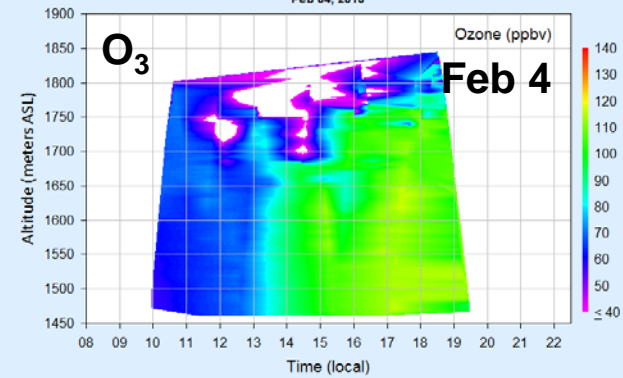
Fantasy Canyon  
Jan 31, 2013



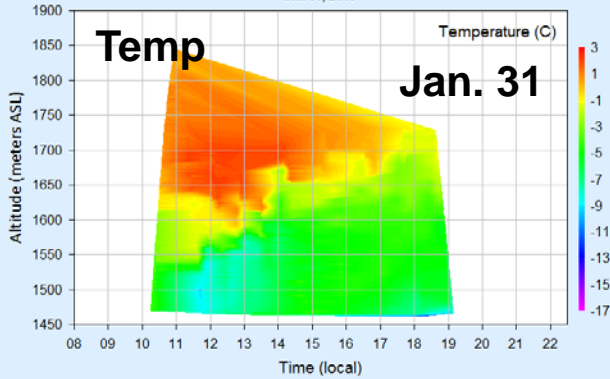
Fantasy Canyon  
Feb 02, 2013



Fantasy Canyon  
Feb 04, 2013

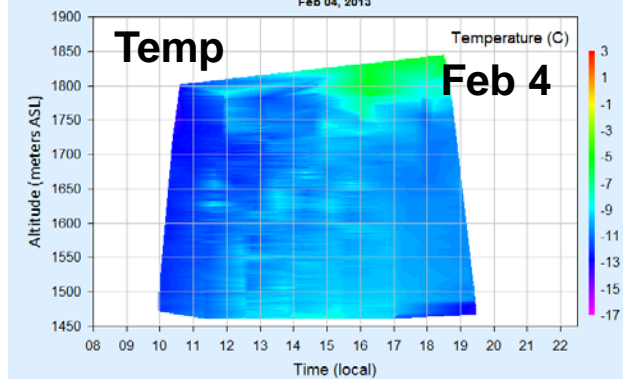


Fantasy Canyon  
Jan 31, 2013

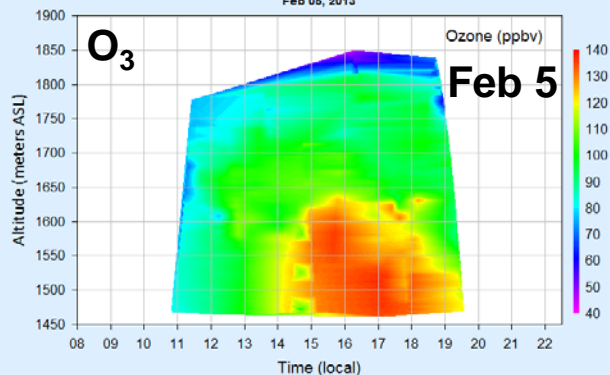


**Increase of ozone amount  
and vertical extent  
with time**

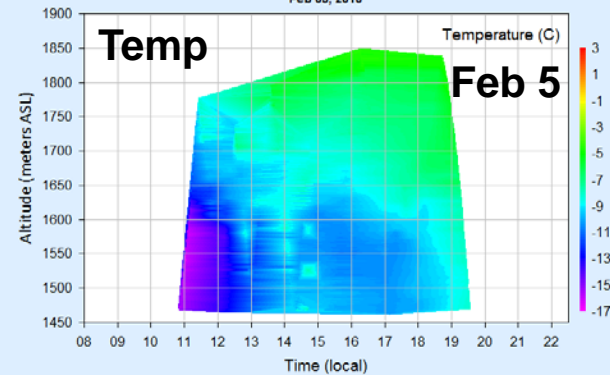
Fantasy Canyon  
Feb 04, 2013



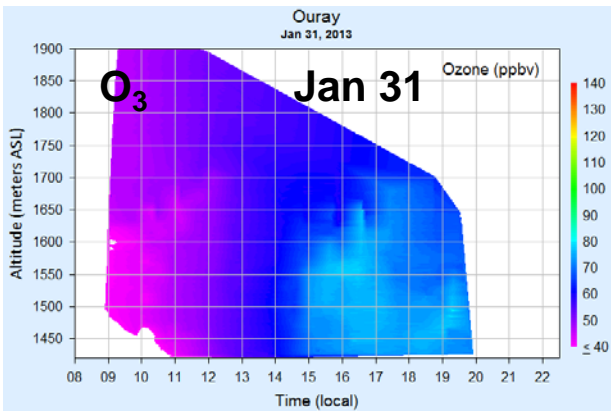
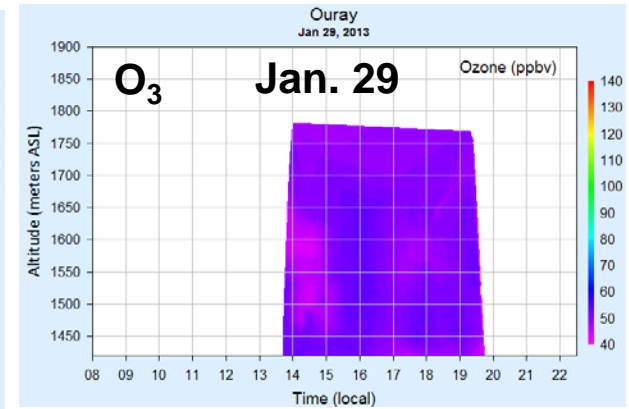
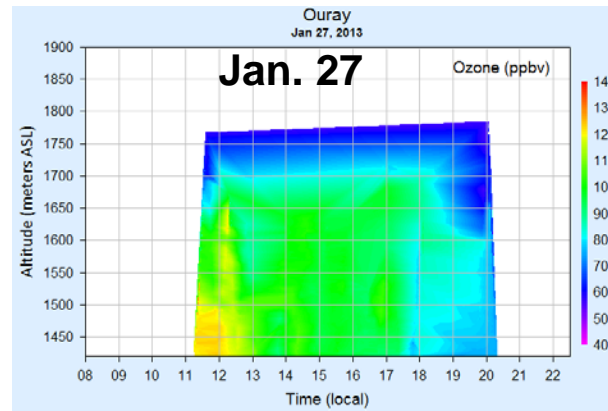
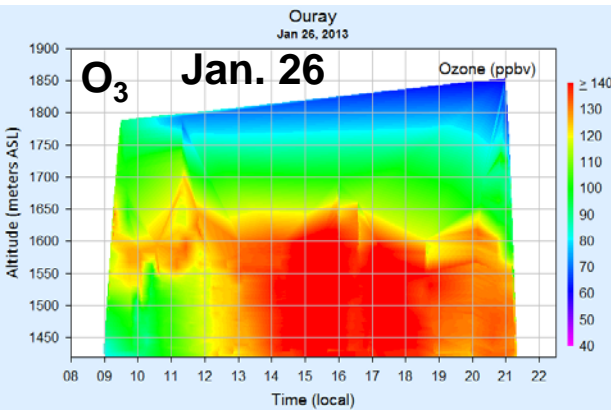
Fantasy Canyon  
Feb 05, 2013



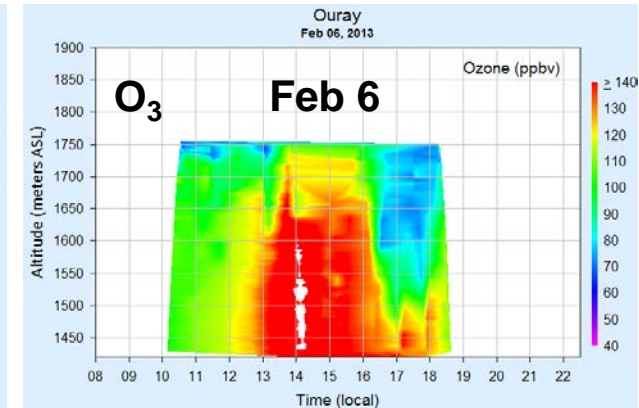
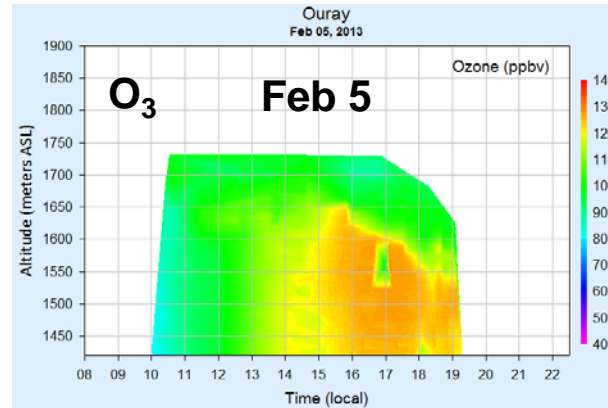
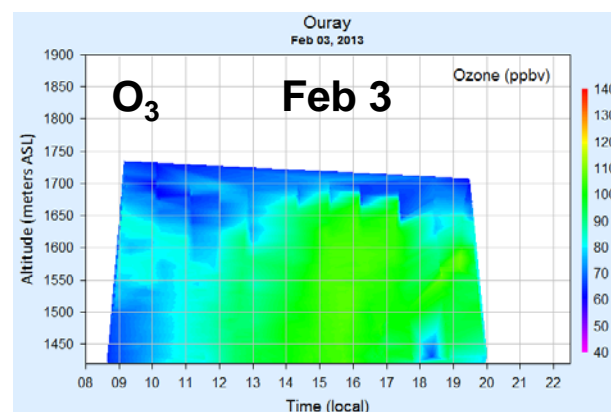
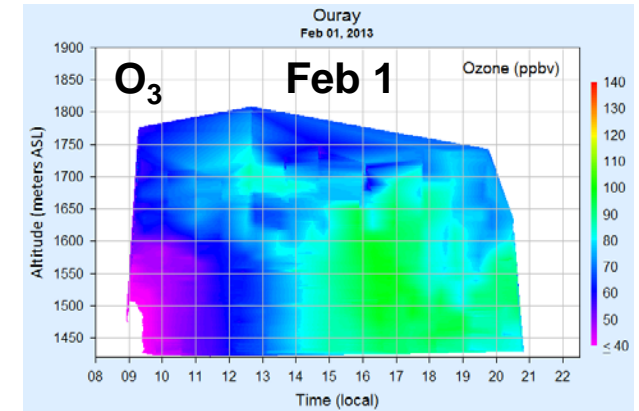
Fantasy Canyon  
Feb 05, 2013



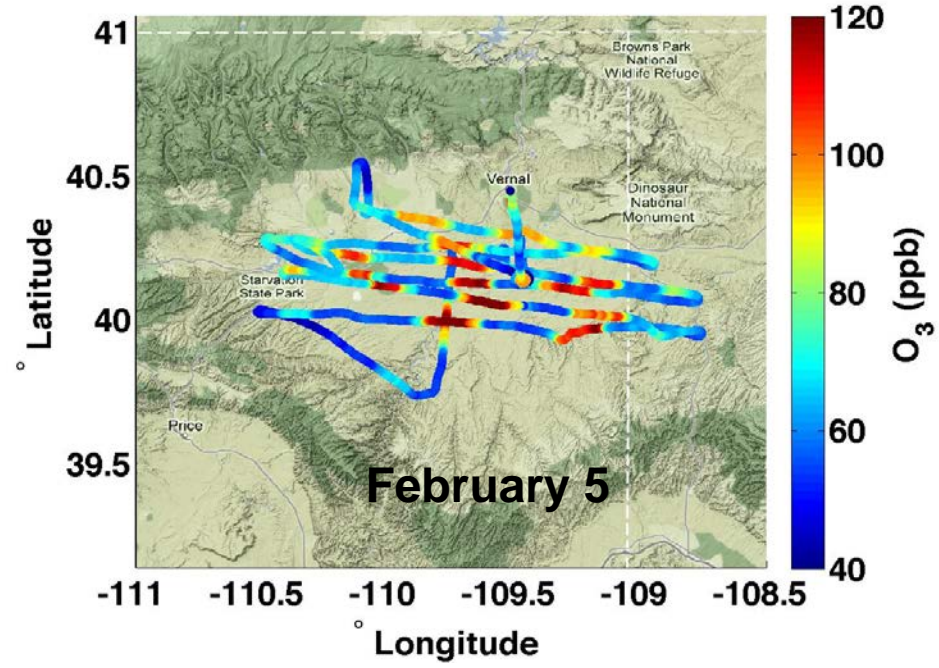
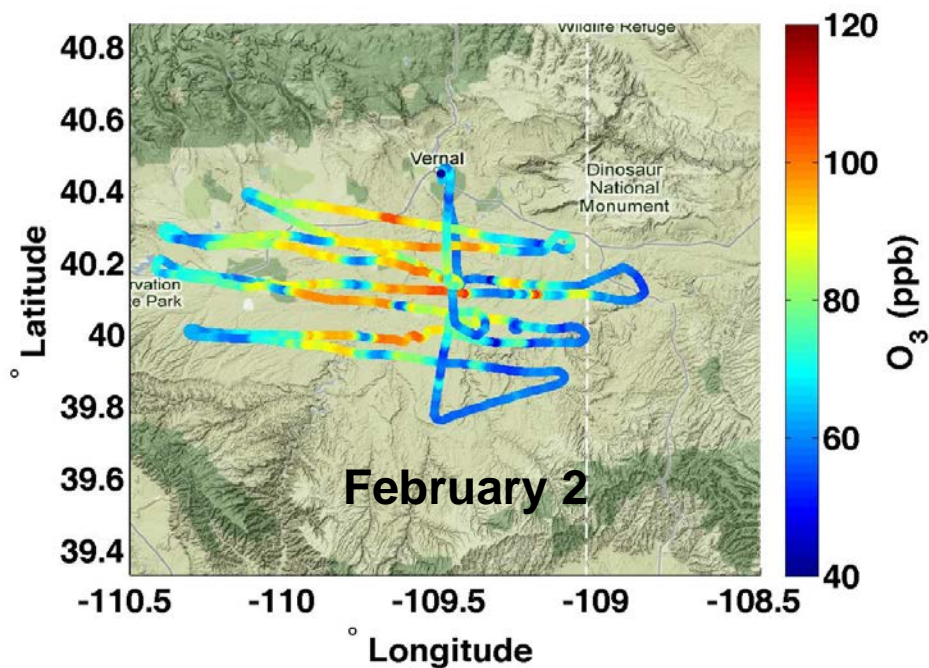
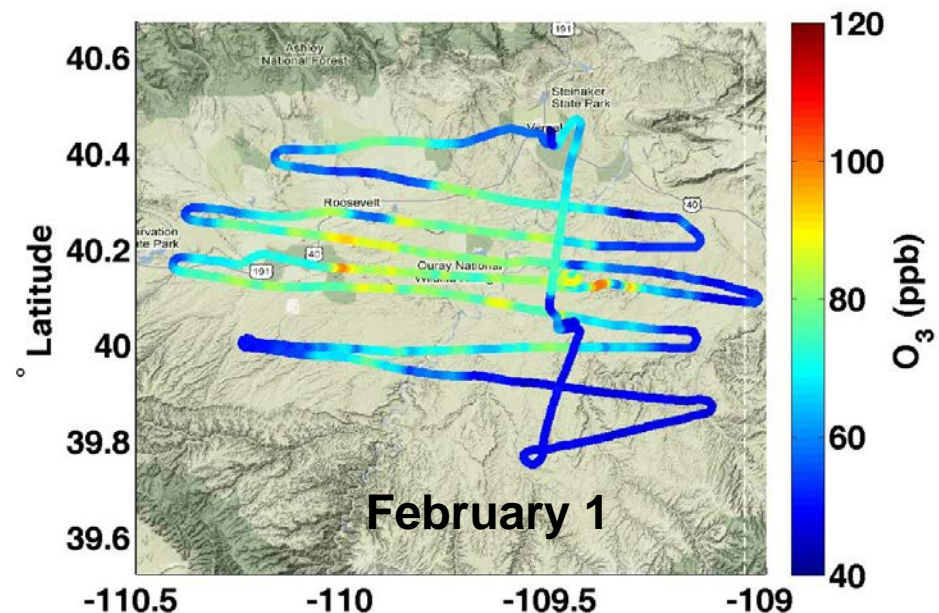
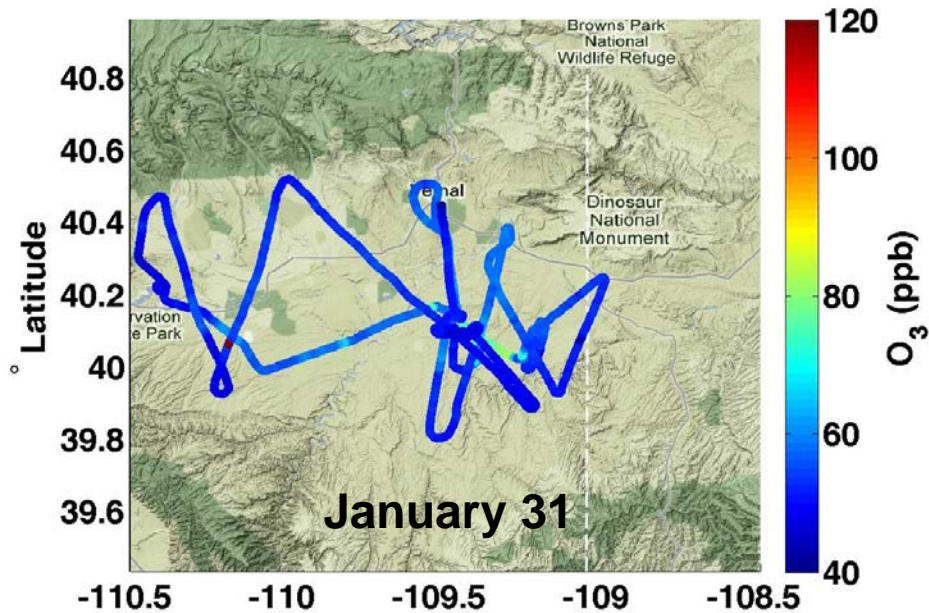
# Tethered Balloon Profiles at Ouray



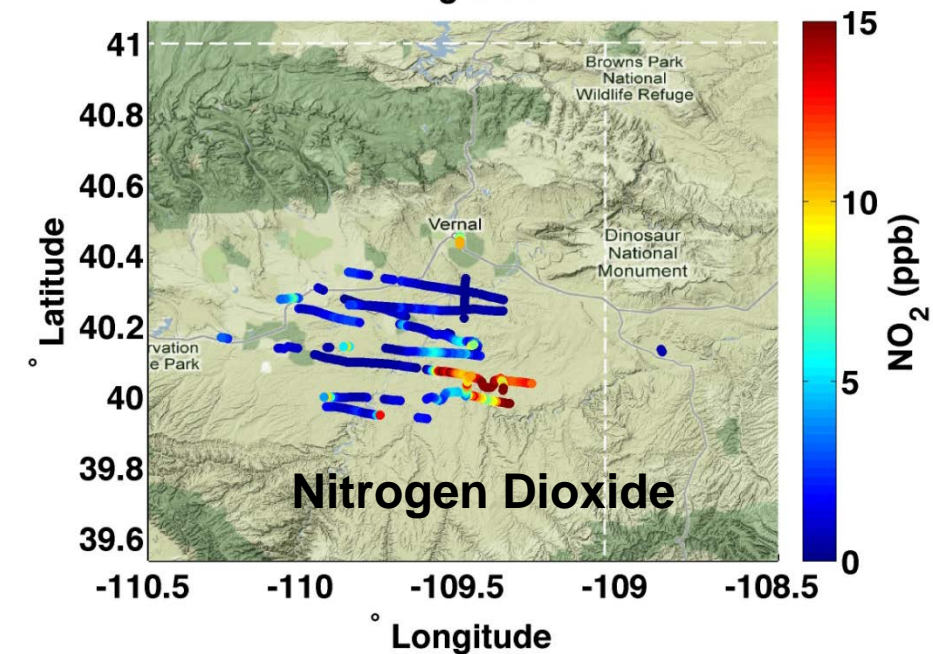
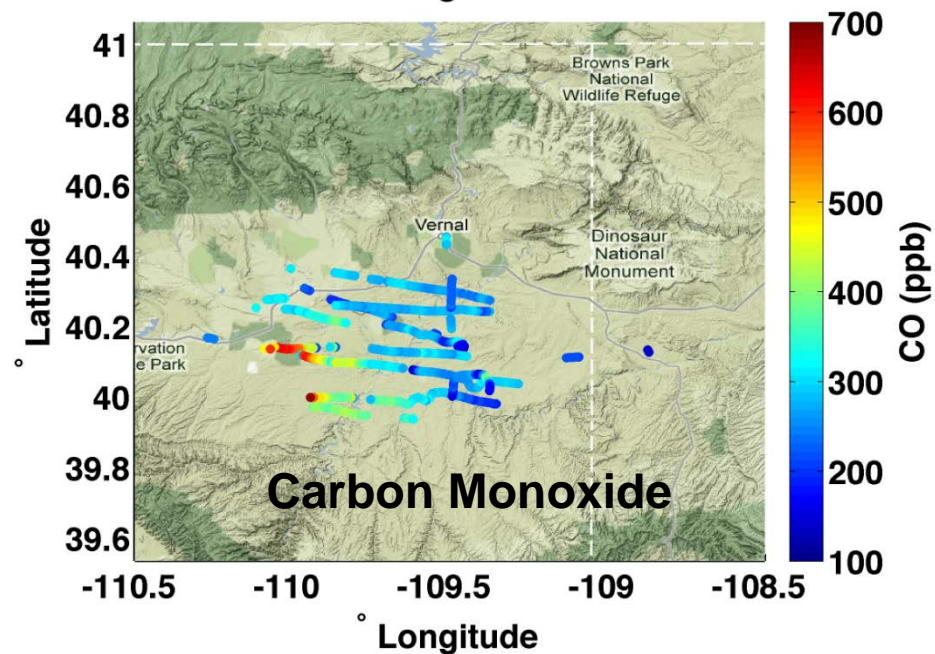
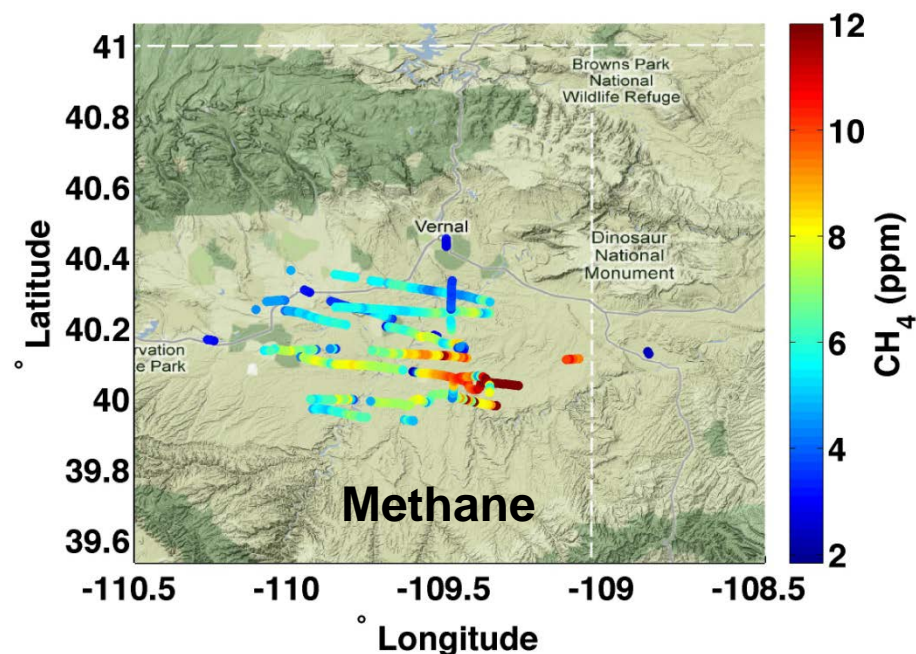
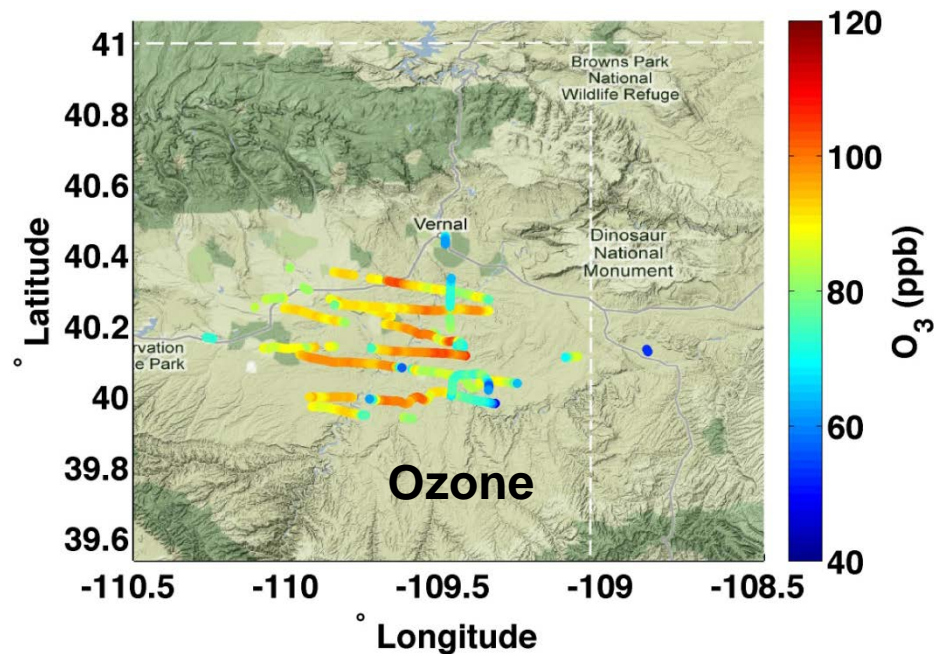
**End of an event (Jan. 29)  
and the beginning of the  
next event (Jan. 31)**



# Ozone across the basin on Jan. 31, Feb. 1, 2, and 5



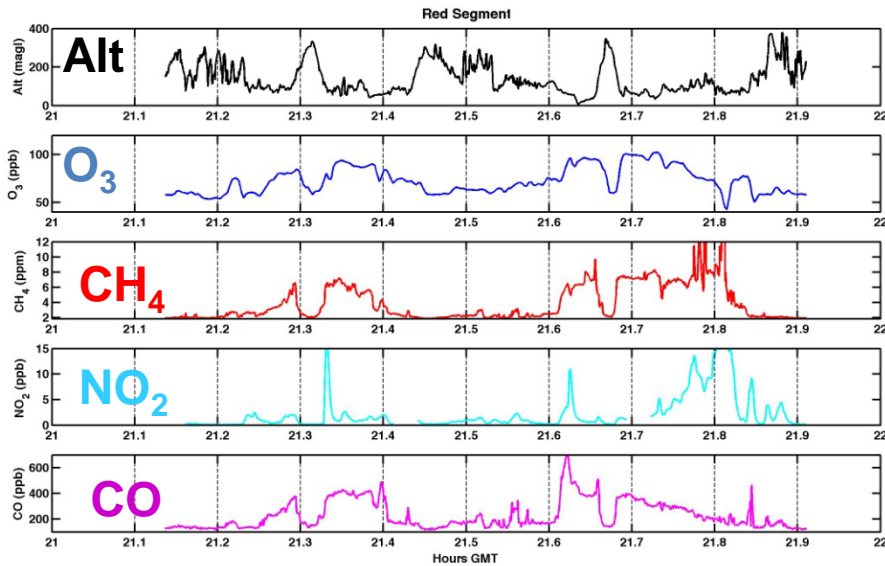
# O<sub>3</sub>, CH<sub>4</sub>, CO, and NO<sub>2</sub> below 1650 masl on Feb. 2



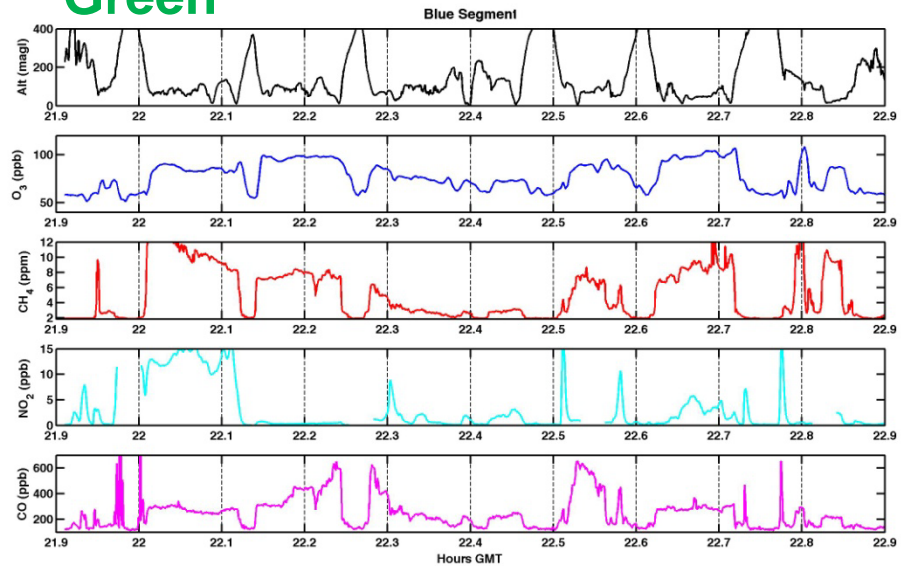


# O<sub>3</sub>, CH<sub>4</sub>, NO<sub>2</sub> and CO time series on Feb. 2

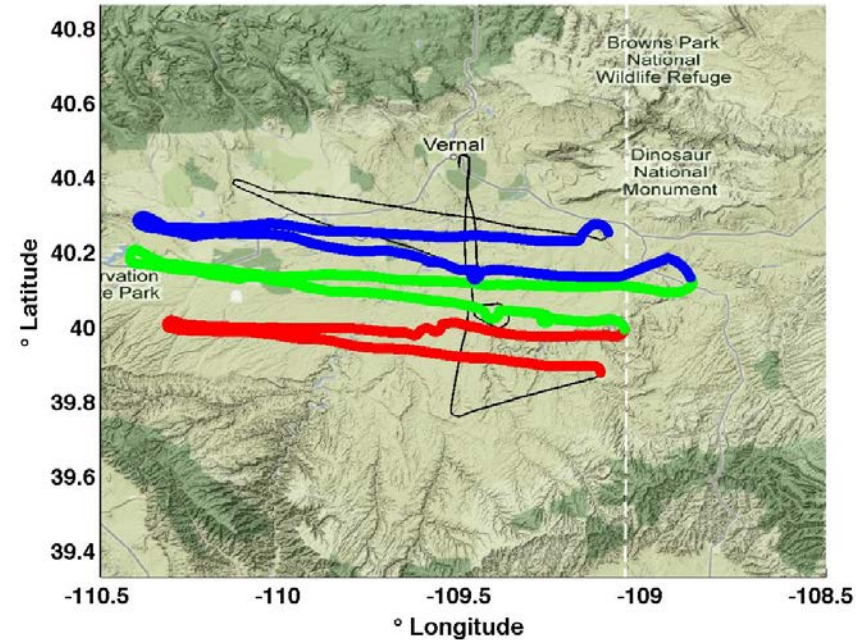
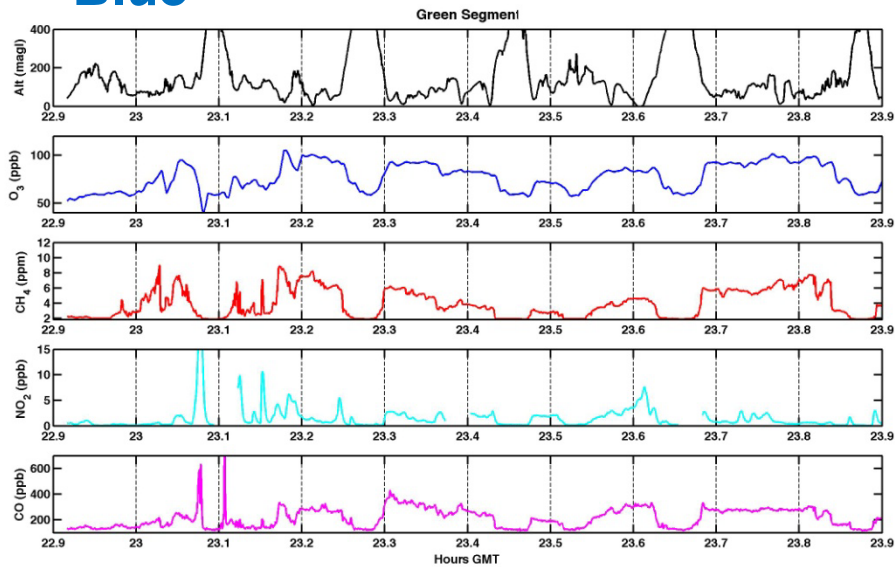
Red



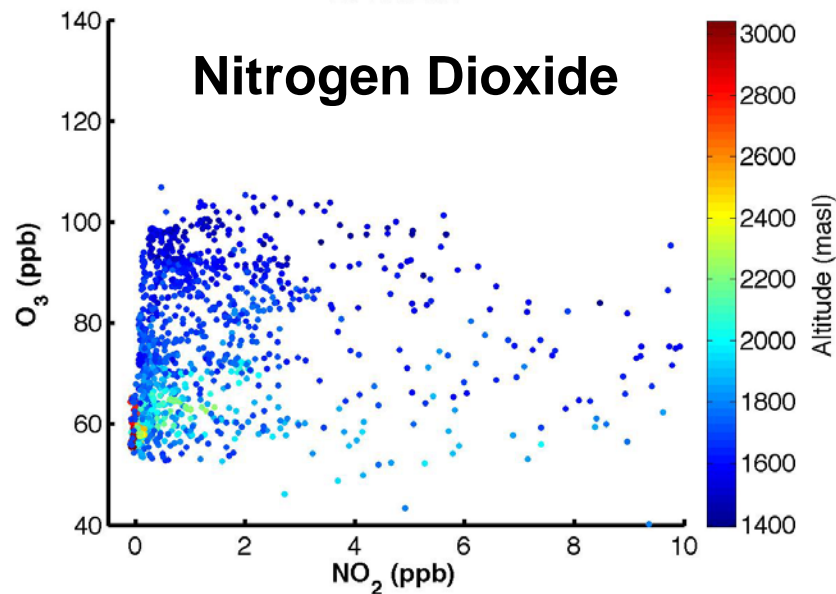
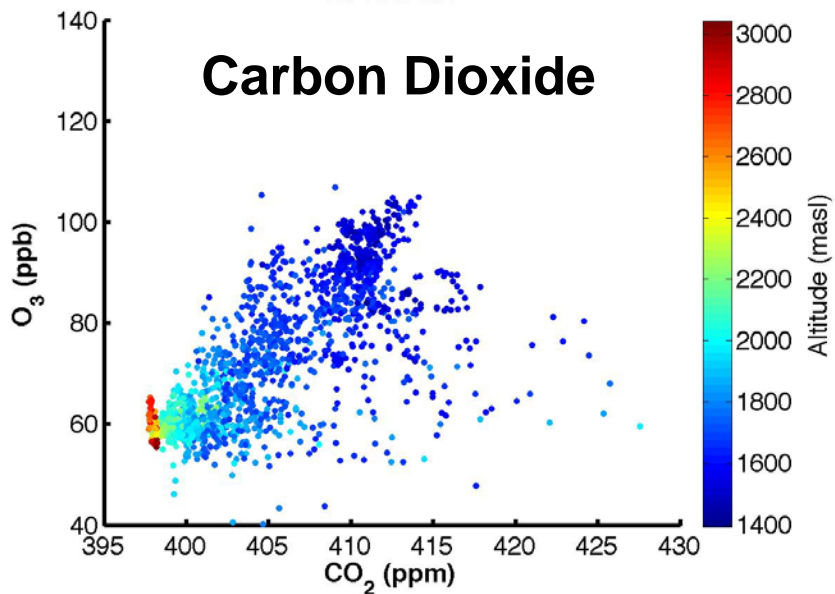
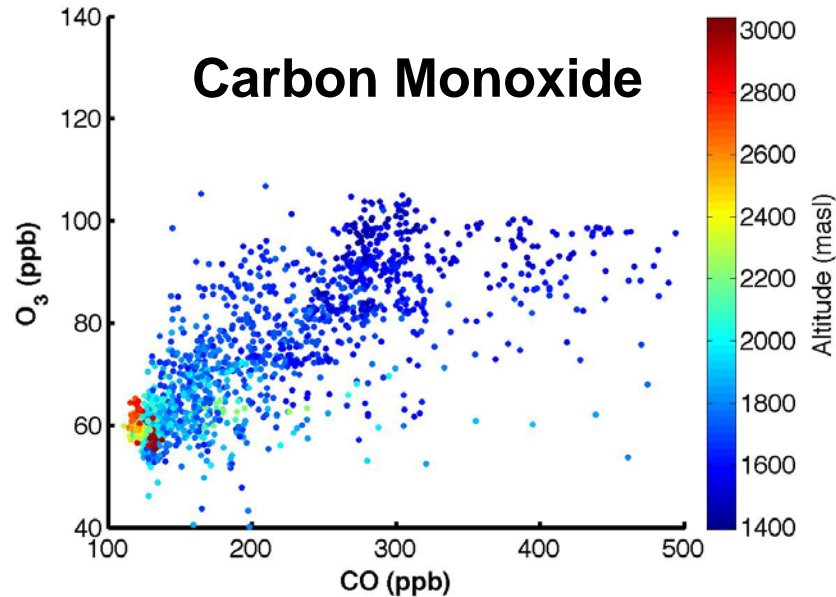
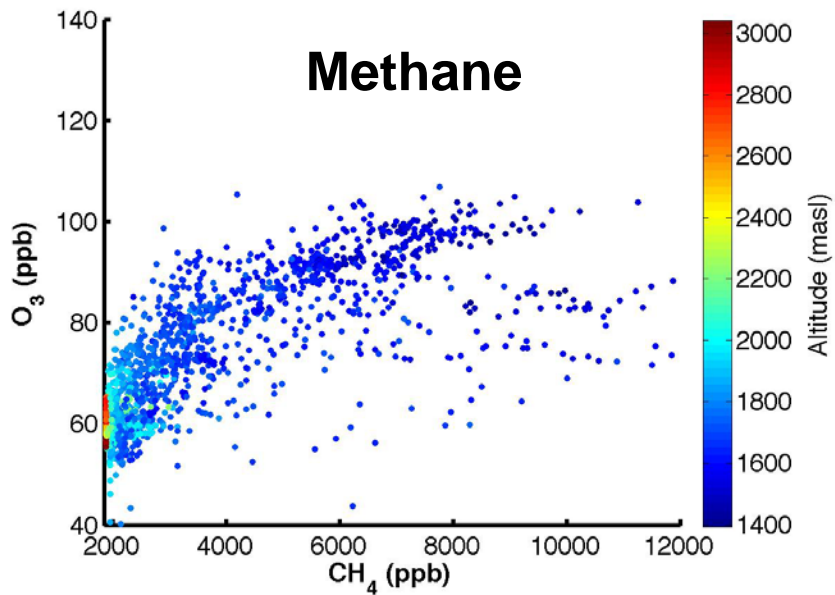
Green



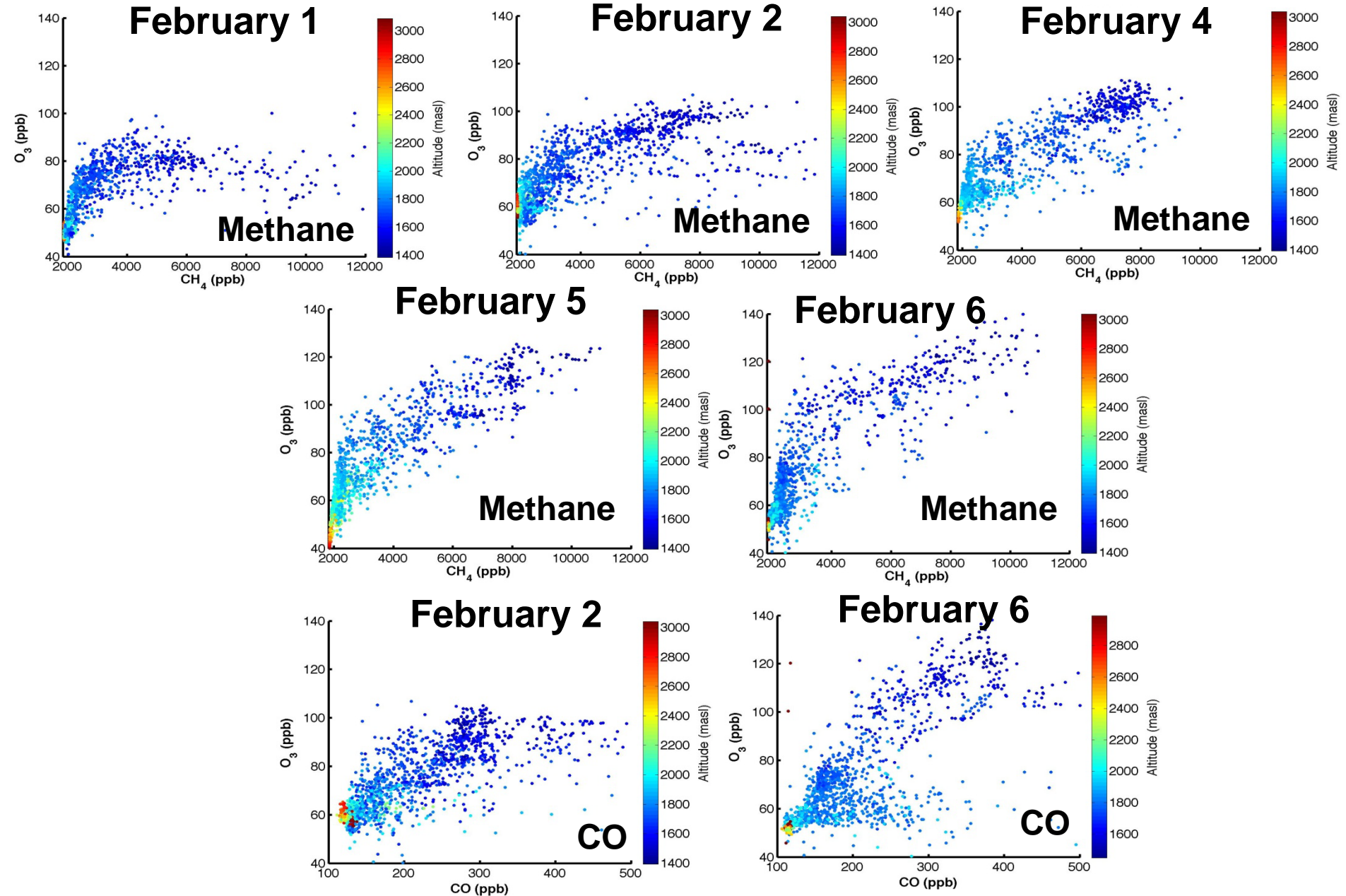
Blue



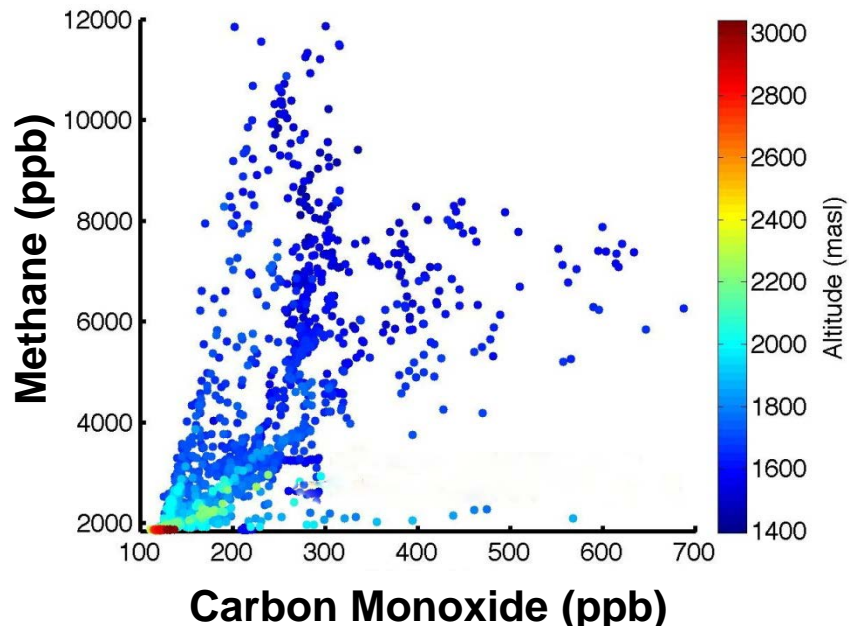
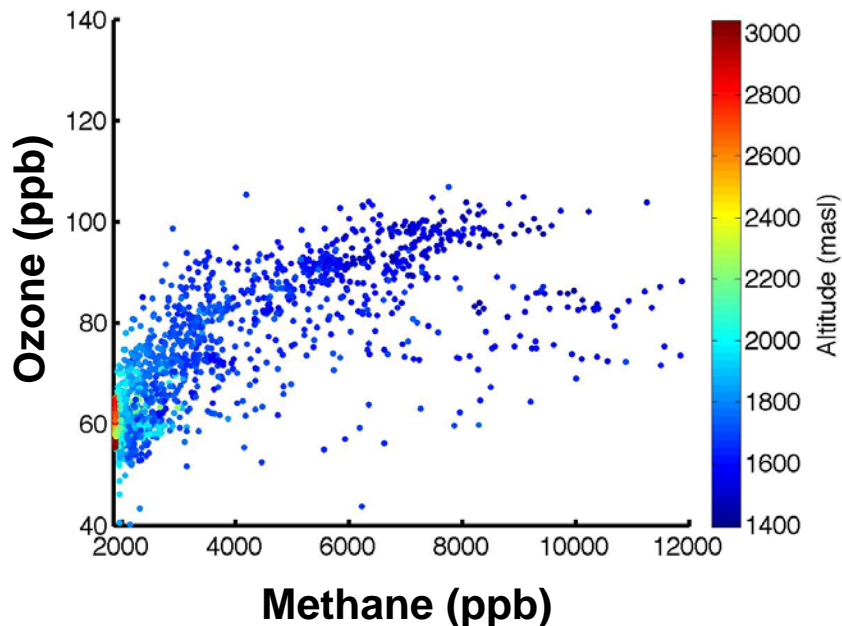
# Correlation of O<sub>3</sub> with CH<sub>4</sub>, CO, NO<sub>2</sub>, and CO<sub>2</sub> on Feb. 2



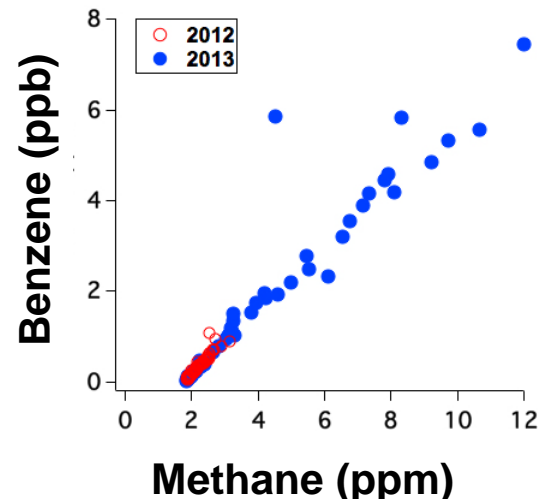
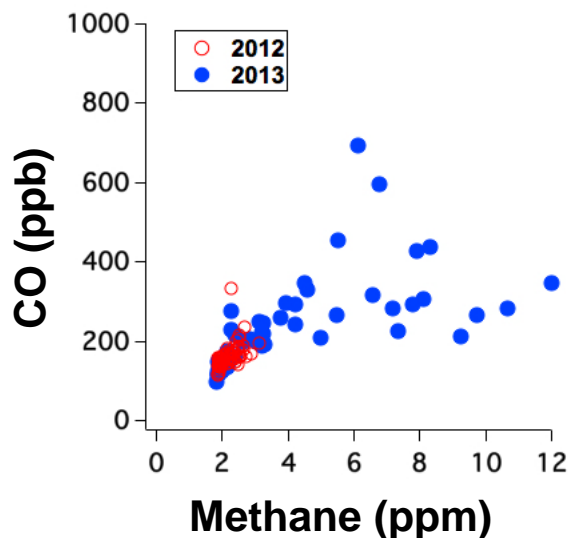
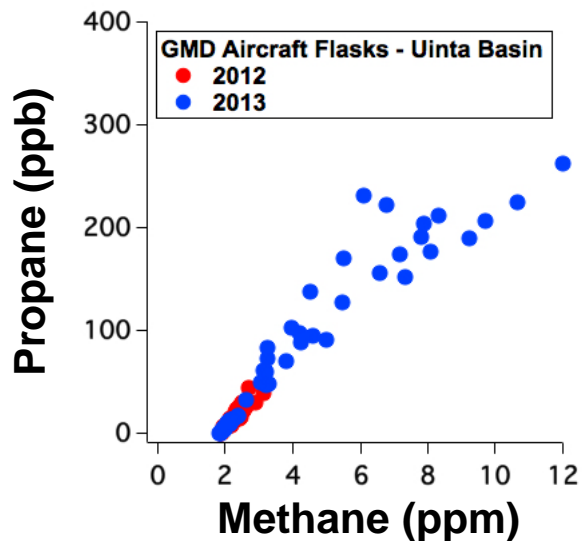
# Correlation of O<sub>3</sub> with CH<sub>4</sub> and with CO on Feb. 1, 2, 4, 5, 6



# Correlation of O<sub>3</sub> with CH<sub>4</sub> and CO with CH<sub>4</sub> on Feb. 2



## Aircraft flask samples.



# Conclusions

- **The tethered sonde and aircraft data provide an unparalleled set of data for understanding the vertical and spatial characteristics of winter high ozone events in the Uinta Basin of Utah.**
- **There is a continued buildup in ozone through a high ozone episode that is seen across the basin which fills the layer to the top of the shallow boundary layer.**
- **There is a strong correlation between methane and ozone through the basin. Ozone is also correlated with CO.**
- **The levels of methane and hydrocarbons are extremely high.**
- **The aircraft data identify the precursor emission hot spot in the gas field but high ozone is seen well away from this source.**