Air Quality Impacts of Oil and Gas Development

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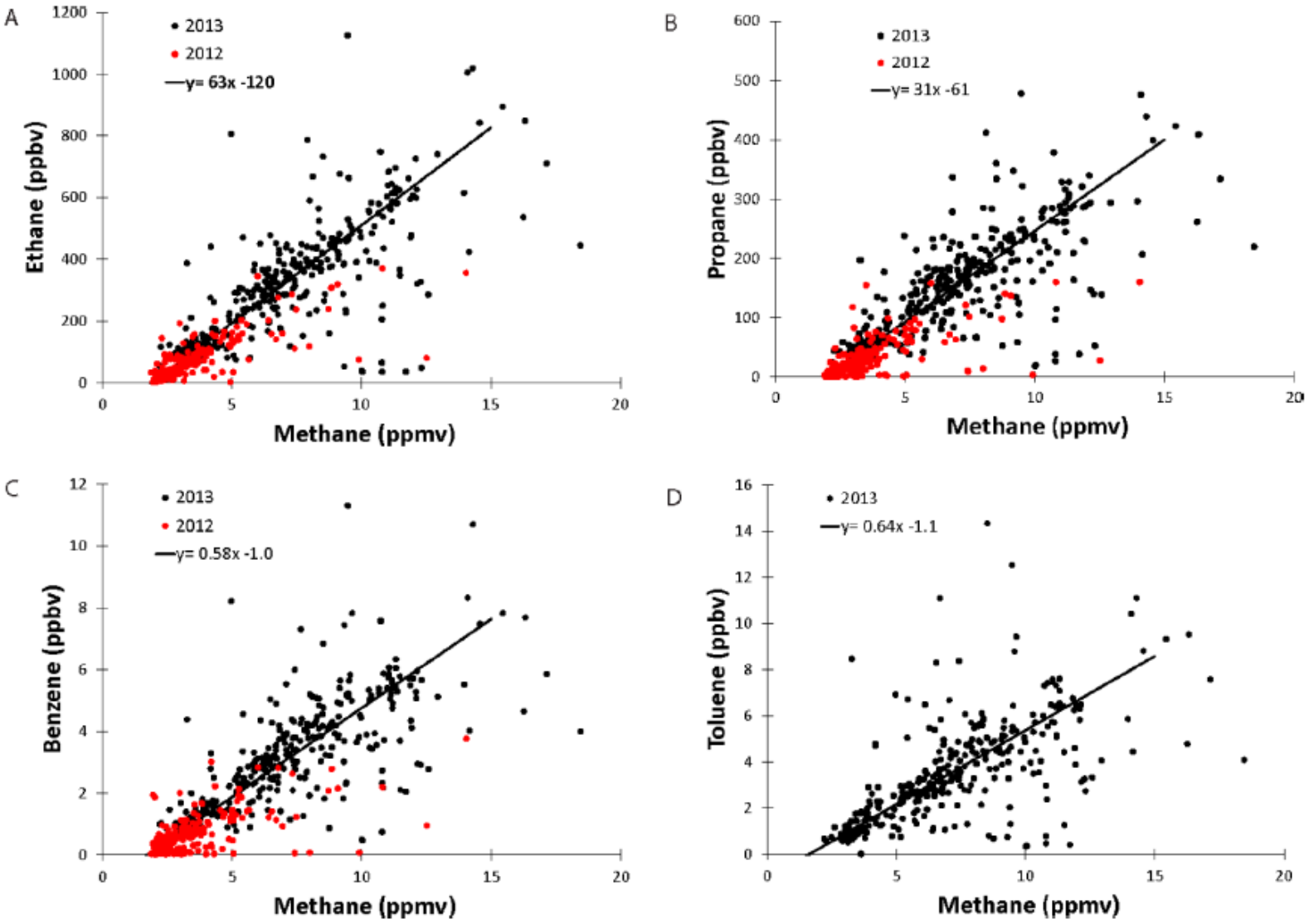
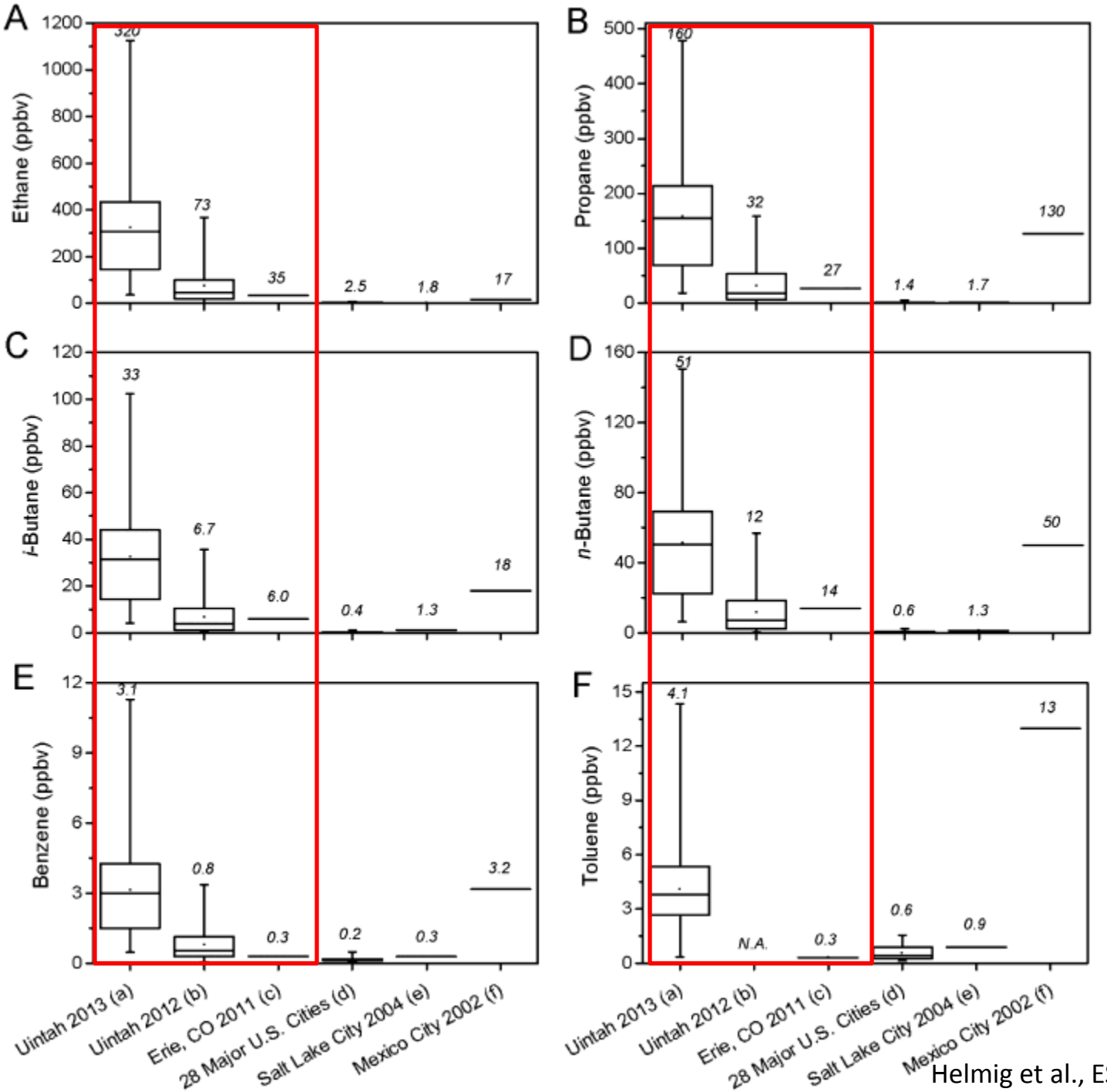
Emission Sources of Oil and Gas Development

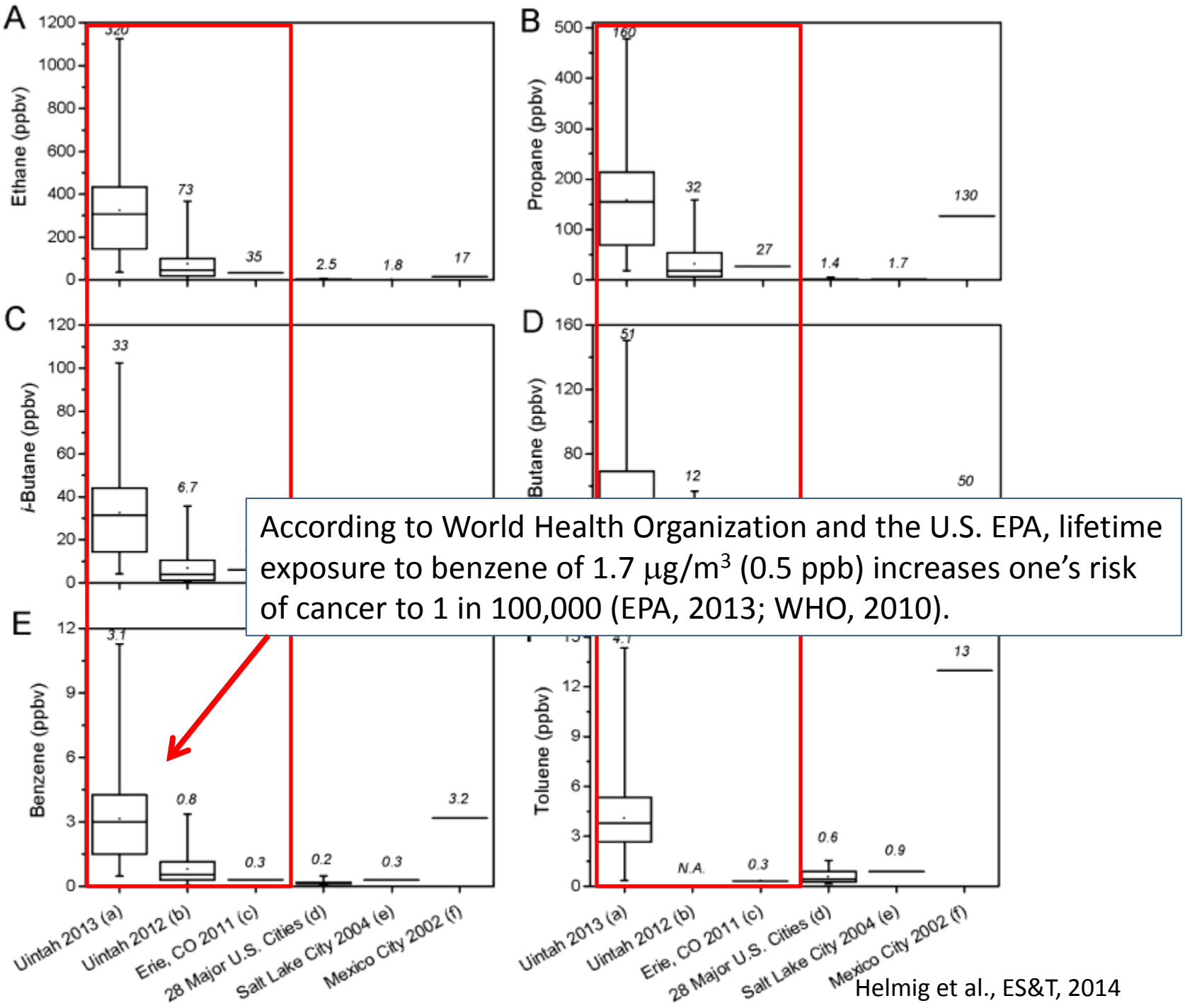
Uintah Basin Methane – VOC Relationships



Helmig et al., ES&T, 2014



Helmig et al., ES&T, 2014



According to World Health Organization and the U.S. EPA, lifetime exposure to benzene of 1.7 μg/m^3 (0.5 ppb) increases one's risk of cancer to 1 in 100,000 (EPA, 2013; WHO, 2010).

Helmig et al., ES&T, 2014

Table 2. Comparison of UBWOS 2012 and 2013 NMHC Surface Data Results with the Estimated NMHC Regional Atmospheric Background Mole Fractions

compound	Uintah 2012 (n = 233) min – max avg (std dev) (ppbv)	Uintah 2013 (n = 327) min – max average (std dev) (ppbv)	regional background 40°N, Jan 20–Feb 20 (ppbv)	enhancement factor: Uintah 2012/2013 vs background
ethane	2.04–367	36–1125		
	74 (79)	323 (196)	1.8	41/179
propane	1.07–158	19–478		
	33 (35)	158 (93)	0.77	42/205
iso-butane	0.19–36	4.2–102		
	6.8 (7.6)	33 (20)	0.14	49/236
n-butane	0.37– 57	6.3 - 151		
	12 (13)	51 (30)	0.24	50/213
iso-pentane	0.11–29	0.98–69		
	5.5 (6.3)	22 (14)	0.10	54/220
n-pentane	0.098–29	2.4–60		
	5.0 (5.8)	20 (11)	0.06	83/333
n-hexane	0.047–14	1.2–2.5		
	2.1 (2.3)	11 (6.5)	n.a.	n.a.

Helmig et al., ES&T, 2014

Highly Elevated Atmospheric Levels of Volatile Organic Compounds in the Uintah Basin, Utah

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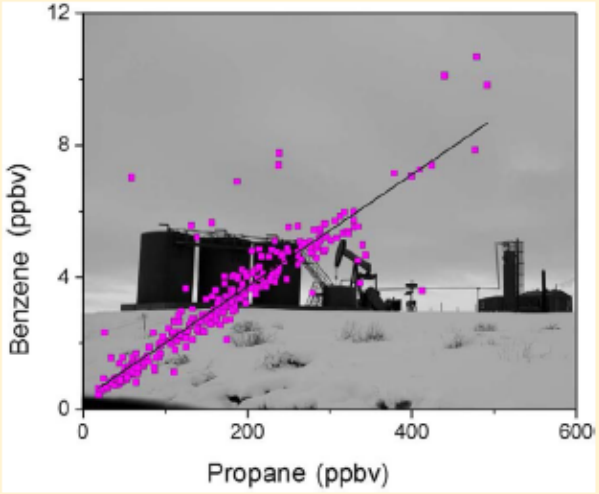
Supporting Information

ABSTRACT: Oil and natural gas production in the Western United States has grown rapidly in recent years, and with this industrial expansion, growing environmental concerns have arisen regarding impacts on water supplies and air quality. Recent studies have revealed highly enhanced atmospheric levels of volatile organic compounds (VOCs) from primary emissions in regions of heavy oil and gas development and associated rapid photochemical production of ozone during winter. Here, we present surface and vertical profile observations of VOC from the Uintah Basin Winter Ozone Studies conducted in January–February of 2012 and 2013. These measurements identify highly elevated levels of atmospheric alkane hydrocarbons with enhanced rates of C_2–C_5 nonmethane hydrocarbon (NMHC) mean mole fractions during temperature inversion events in 2013 at 200–300 times above the regional and seasonal background. Elevated atmospheric NMHC mole fractions coincided with build-up of ambient 1-h ozone to levels exceeding 150 ppbv (parts per billion by volume). The total annual mass flux of C_2–C_7 VOC was estimated at 194 ± 56 × 10^6 kg yr^{-1}, equivalent to the annual VOC emissions of a fleet of ~100 million automobiles. Total annual fugitive emission of the aromatic compounds benzene and toluene, considered air toxics, were estimated at 1.6 ± 0.4 × 10^6 and 2.0 ± 0.5 × 10^6 kg yr^{-1}, respectively. These observations reveal a strong causal link between oil and gas emissions, accumulation of air toxics, and significant production of ozone in the atmospheric surface layer.



Environ. Sci. &Technol., 2014

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Total non-Methane VOC

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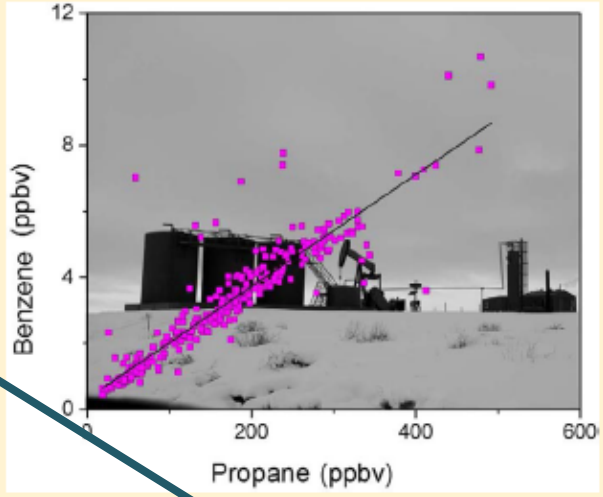


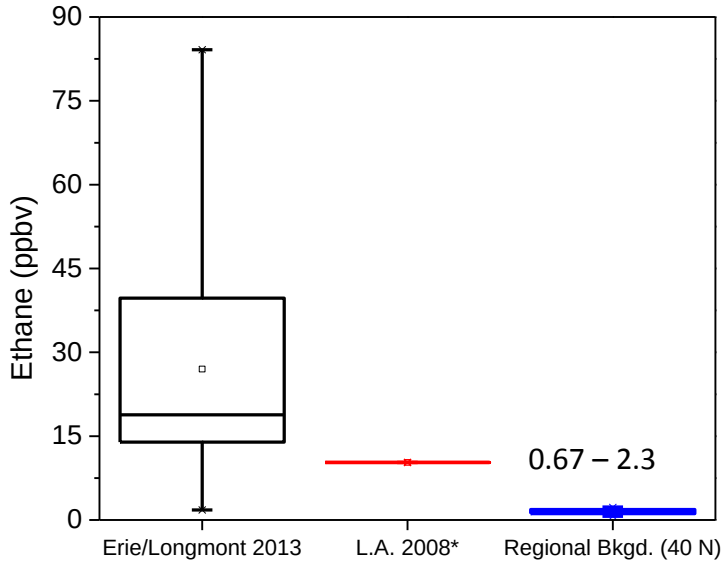
Benzene

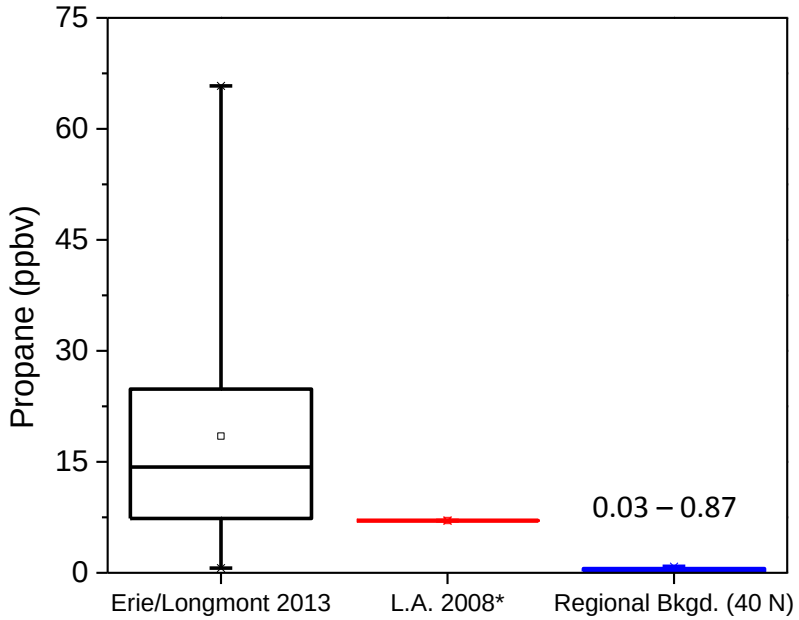
50 x

Environ. Sci. &Technol., 2014

2013 Erie, CO, Air Quality Study

(Thompson et al., Elementa, in press)





*Warnecke et al., 2012

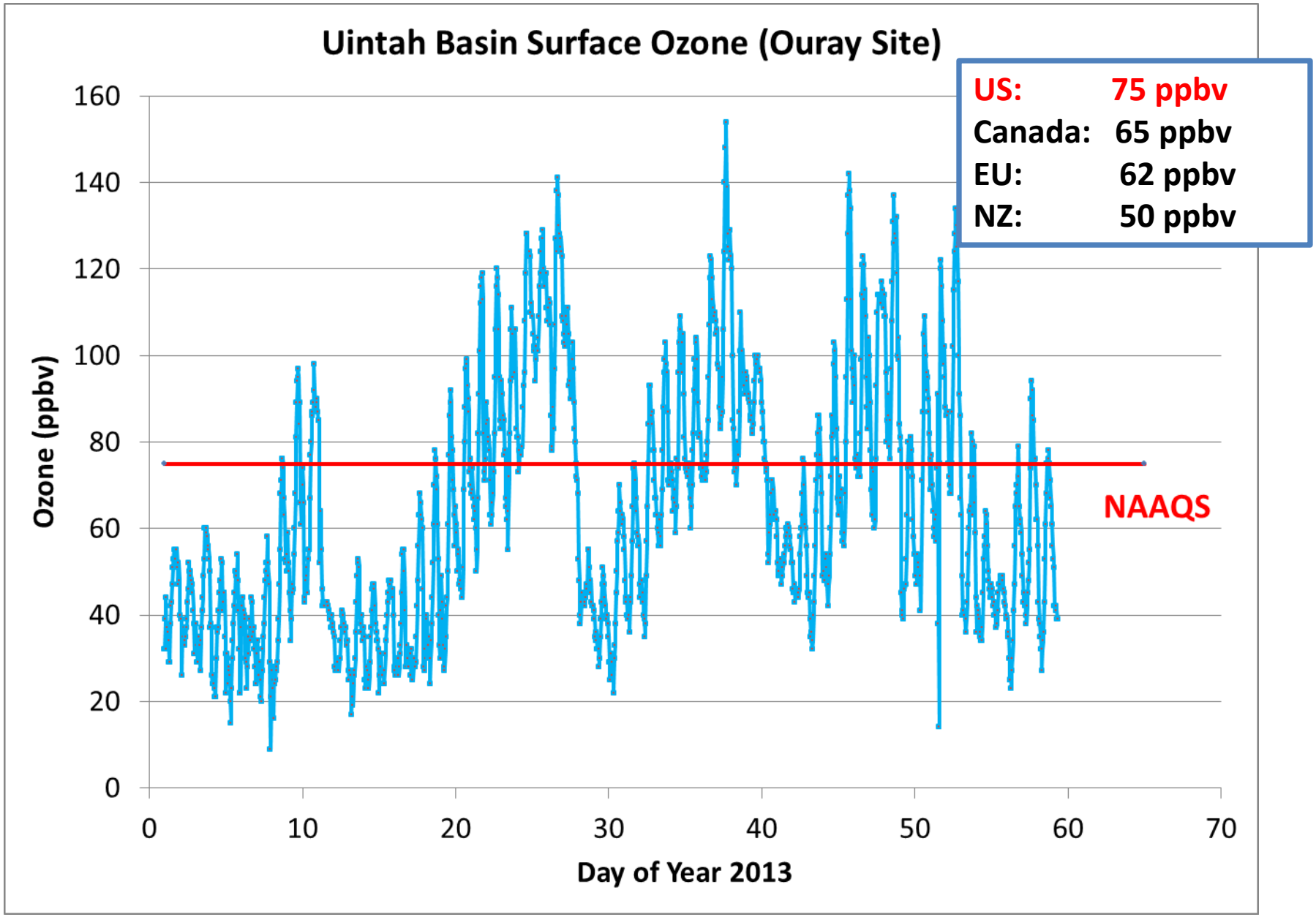
Surface Ozone - Elevated Levels can cause:

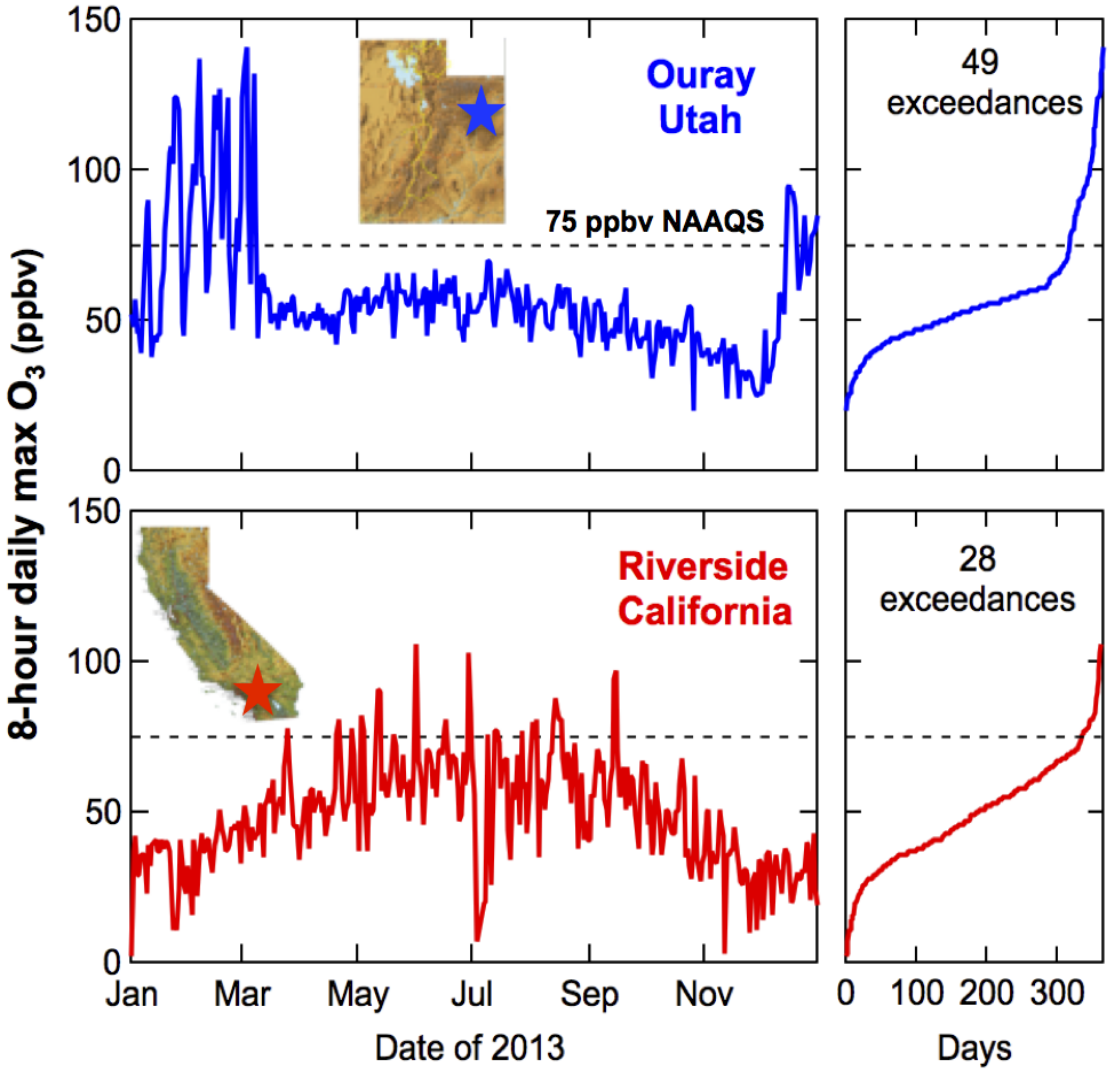
- Shortness of breath
- Chest pain when inhaling deeply
- Wheezing and coughing
- Increased susceptibility to respiratory infections
- Inflammation of the lungs and airways
- Increased risk of asthma attacks

….. (American Lung Association)

→ Increased risk of death

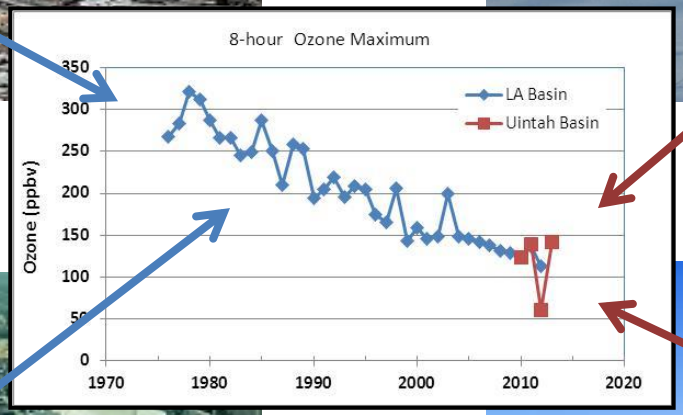
~ 0.9% increase in mortality for 10 ppbv increase in ozone (Bell et al., Epidemiology, 2005; Ito et al., Epidemiology 2005) -> Thousands of people die in US prematurely every year due to elevated ozone.


Uintah Basin Surface Ozone (Ouray Site)
US: 75 ppbv
Canada: 65 ppbv
EU: 62 ppbv
NZ: 50 ppbv
NAAQS
Ozone (ppbv)
Day of Year 2013
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
70

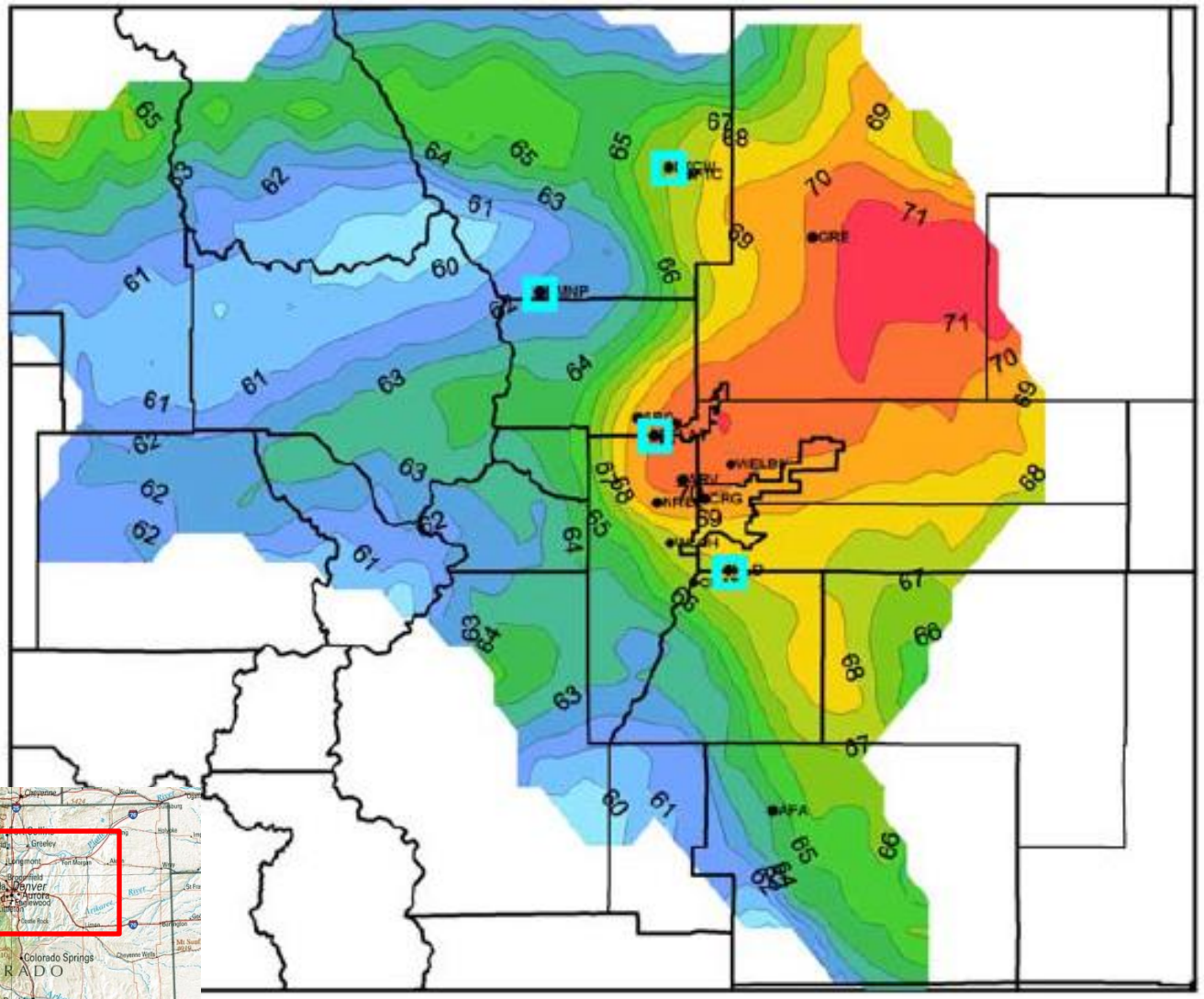


Edwards et al., Nature, 2014

Los Angeles – Uintah Basin Comparison

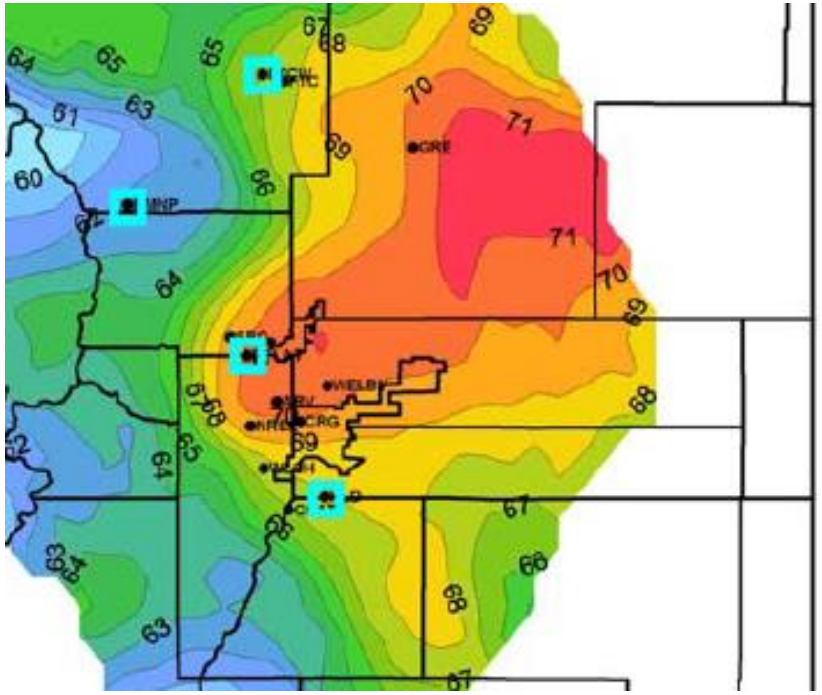


Back Trajectory Model Analysis of Ozone NAAQS Exceedances at Four Colorado Front Range Monitoring Sites

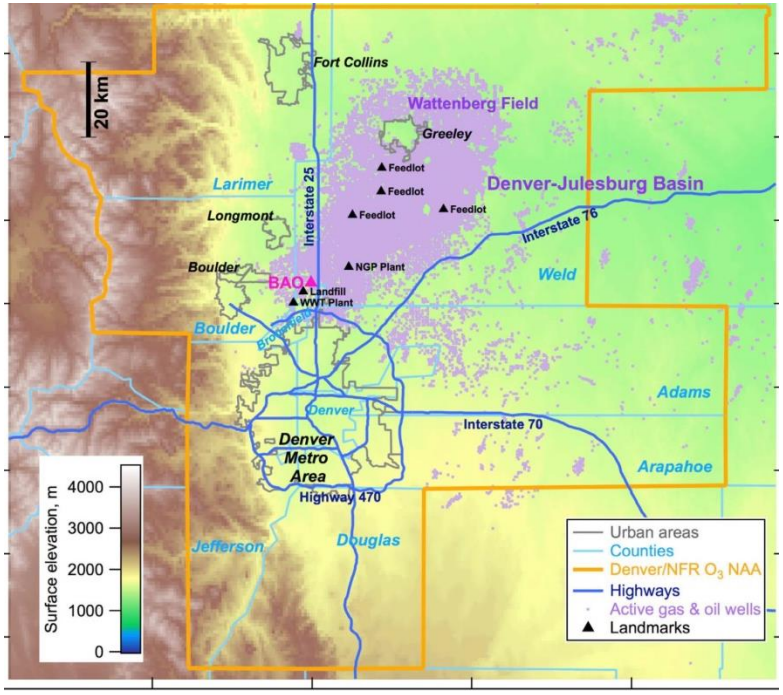


Ozone State Implementation Plan, CDPHE, 2008

Spatial Relationship between Ozone NAAQS Exceedance Air Transport Region and Oil and Gas Production Region in the Colorado Front Range



Ozone State Implementation Plan, CDPHE, 2008



Active Oil and Gas Wells

Air Quality Impacts of Oil and Gas Development
Summary

- Highly Elevated Levels of Volatile Organic Compounds in Ambient Air in Oil and Gas Development Regions

- Levels of Aromatic Compounds (Benzene) Exceed Recommended Health Thresholds

- VOC Emissions from Oil and Gas Operations play a major Role in Photochemical Ozone Production and Exceedance of the Ozone National Ambient Air Quality Standard