DC3 Deep Convective Clouds and Chemistry

Source Characterization

– E. Apel, N. Blake, R. Hornbrook, T. Campos, C. Farris, Sorooshian, T. Shingler….

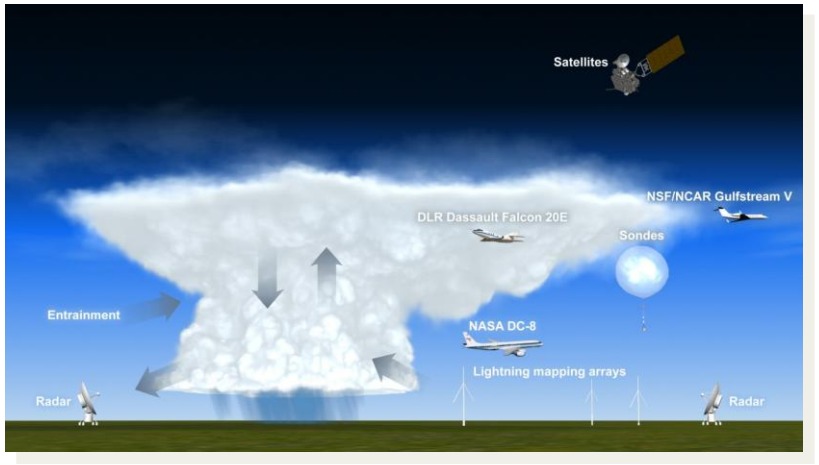
Prediction: Expect to find large variations in surface emissions

CO: lower NOx, higher VOC/CO
OK: Anthropogenic NOx/VOC/CO
low – intermediate biogenic VOCs
Alabama: higher than others

McKeen – emission inventories incl. MEAGAN

Species	Colorado	Oklahoma	Alabama
NO_x	7.73	6.93	12.5
CO	42.3	29.6	60.8
VOC	14.4	8.08	13.2
Biogenic C_5H_8	1.90	10.5	21.8

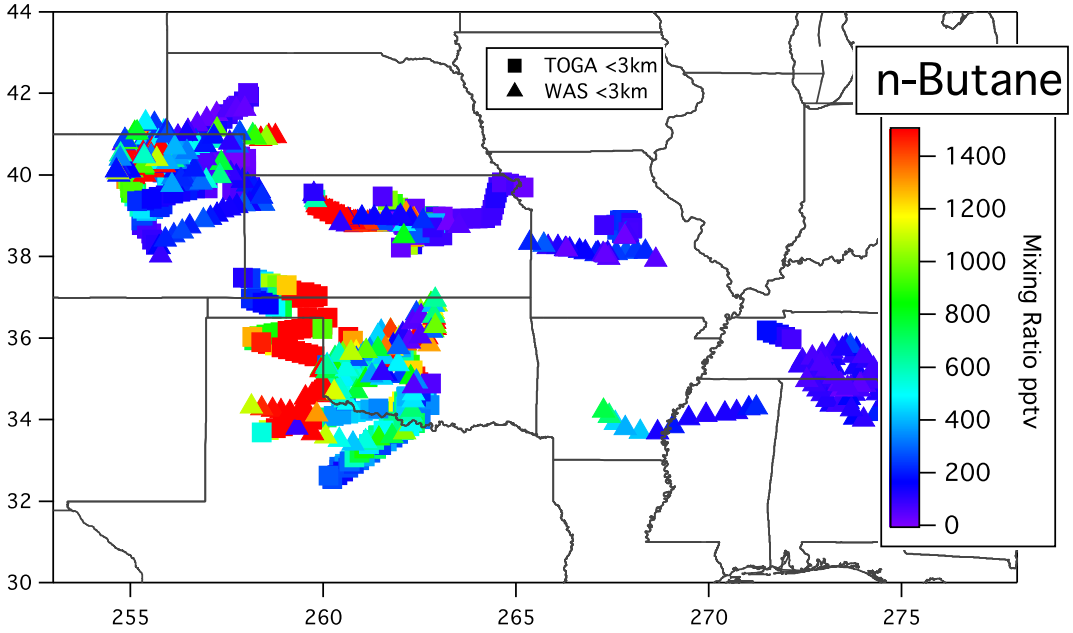
Sources to be characterized:
Oil and gas
Biogenic
Fires
Urban
Photochemical

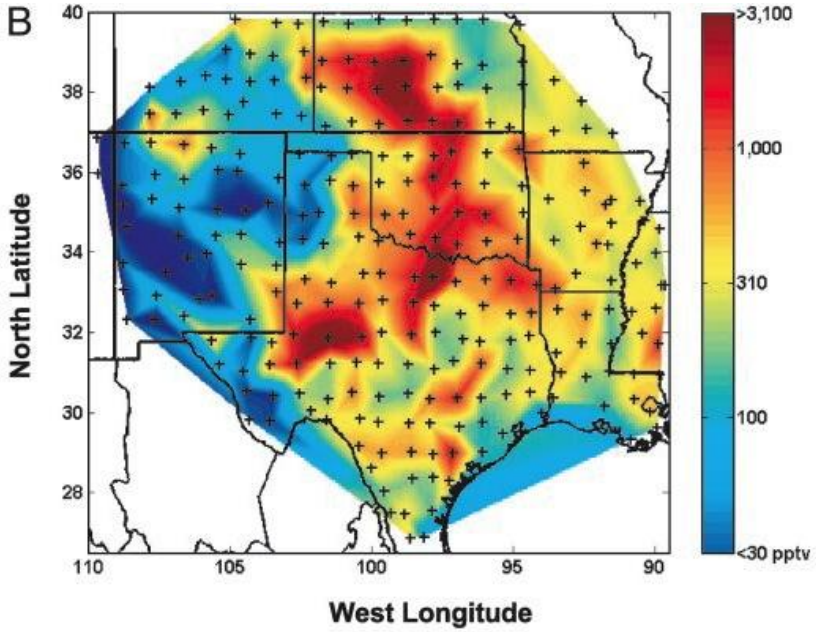


VOCs -DC3 2012

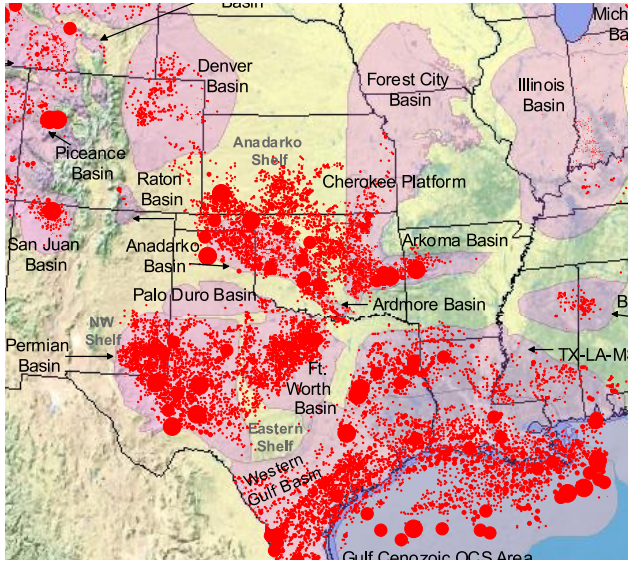
TOGA (GV) and WAS (DC-8) data at Palt <3km

The hydrocarbon – and particularly alkane levels were very high for many low altitude “inflow” regions - consistent with oil and gas production areas.

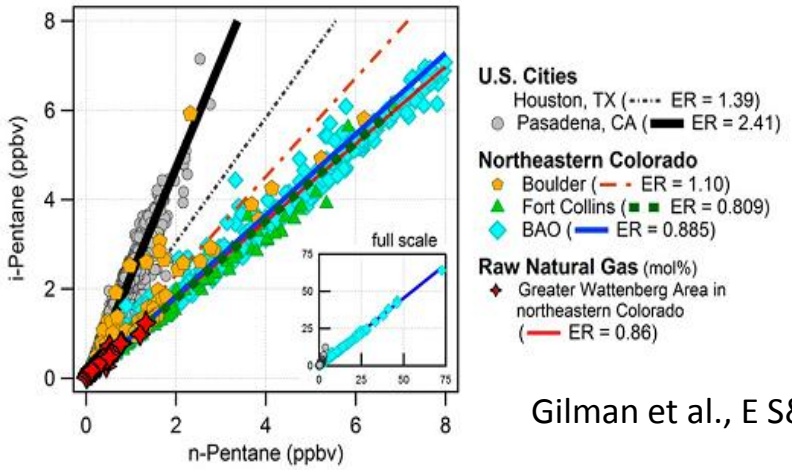




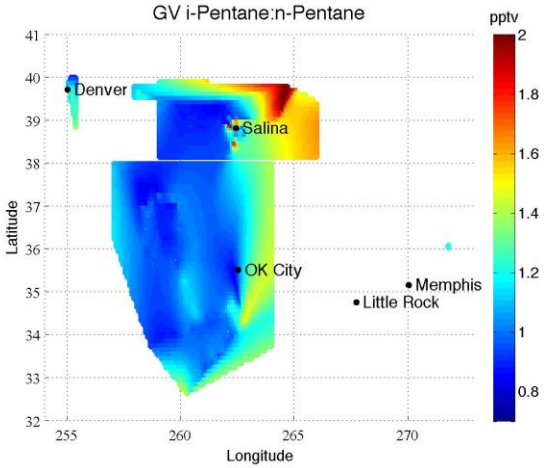
n-Butane (Katzenstein et al., 2003)

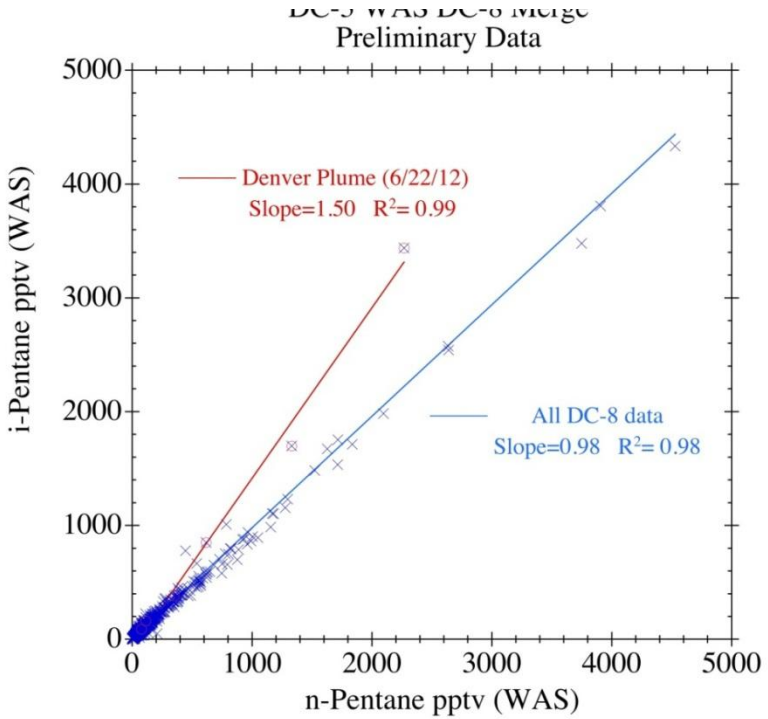


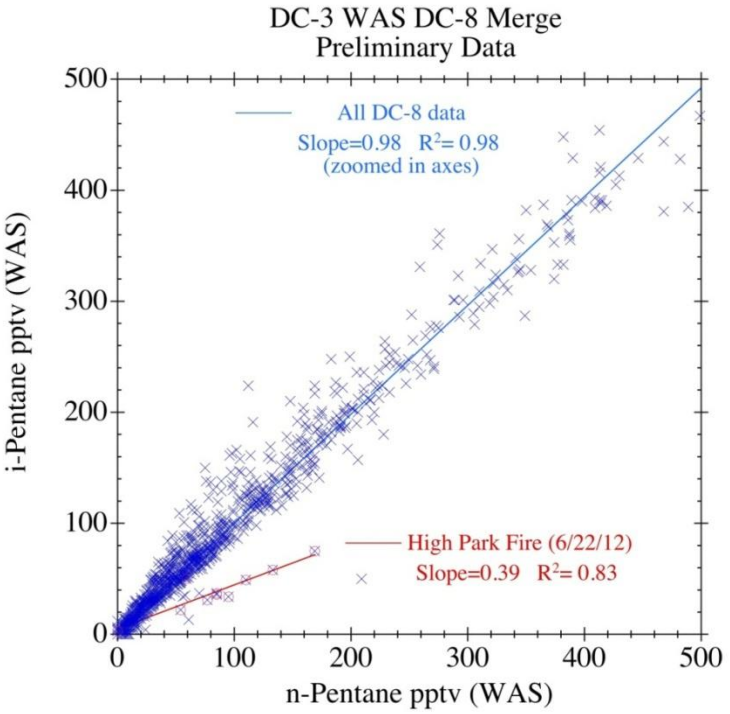
Gas Production in Conventional Fields (EIA)



Gilman et al., E S&T, NOAA







Widespread signature from oil/natural gas????

VOCs -Biogenics

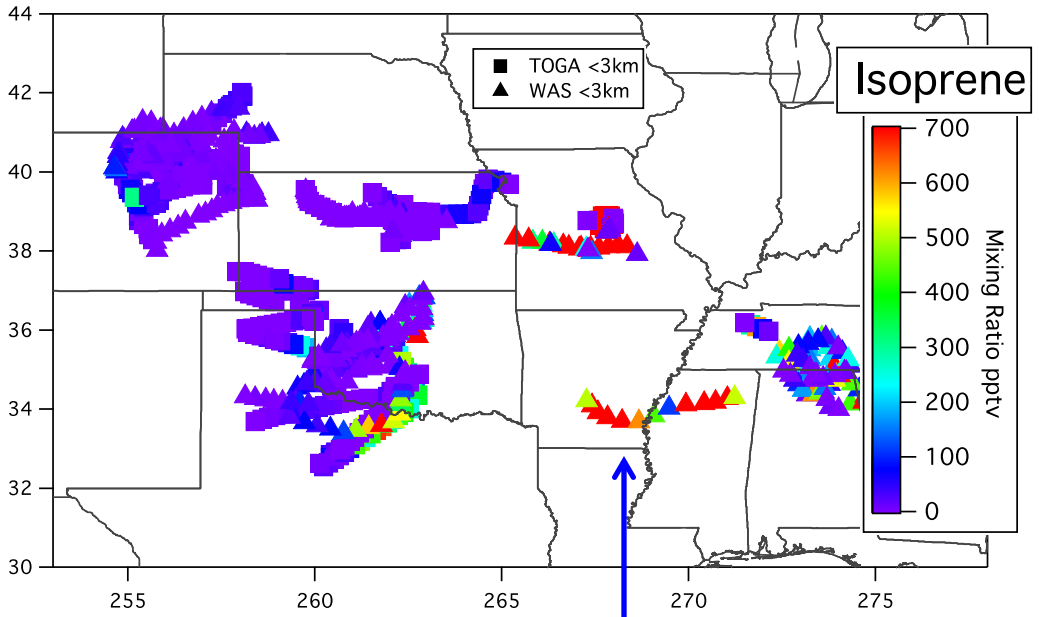
TOGA (GV) and WAS (DC-8) data at Palt <3km

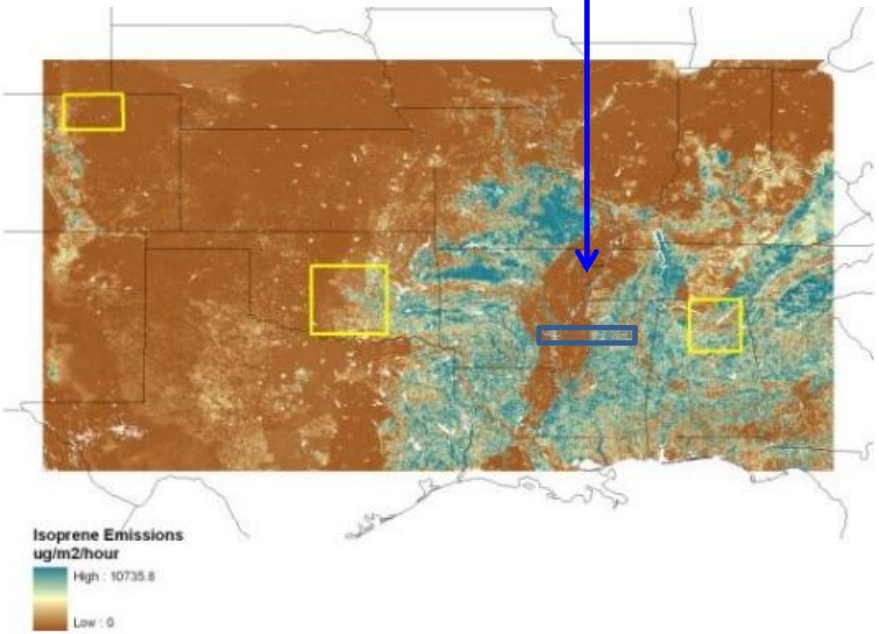
Biogenics relatively low in west although along front range some significant values were encountered

Highest in Mississippi basin

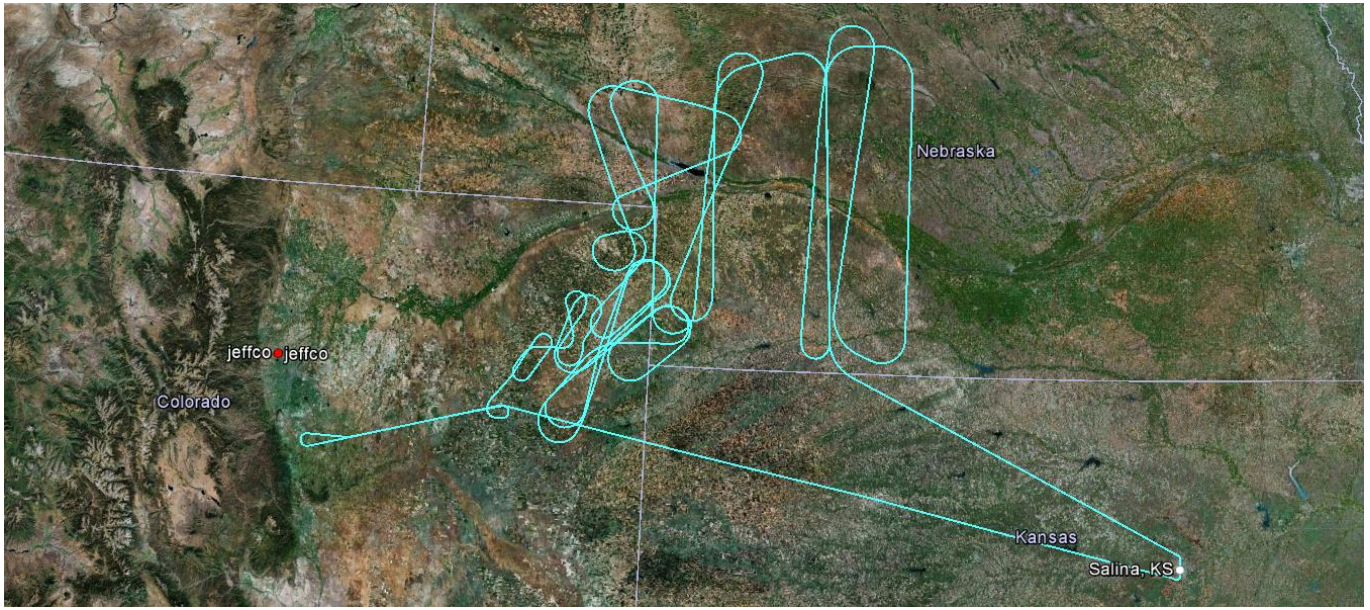
Isoprene emissions calculated by the MEGAN model (Guenther et al., 2006) for the southern central U.S. on a typical June day. Courtesy of Christine Wiedinmyer. (from Science Plan)

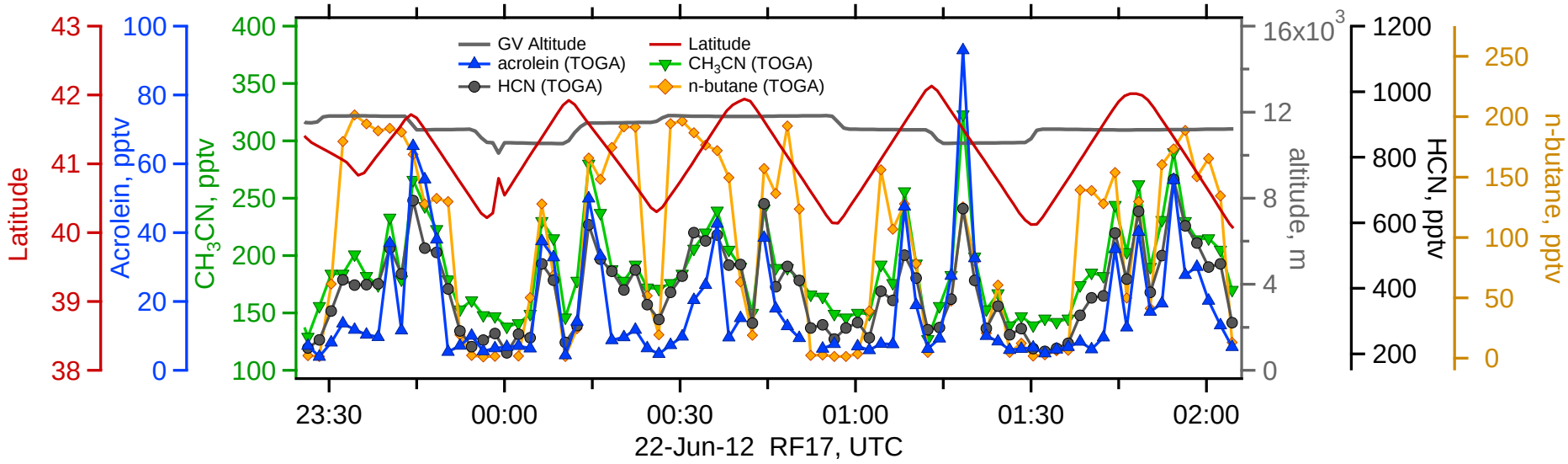
Biogenics/Isoprene



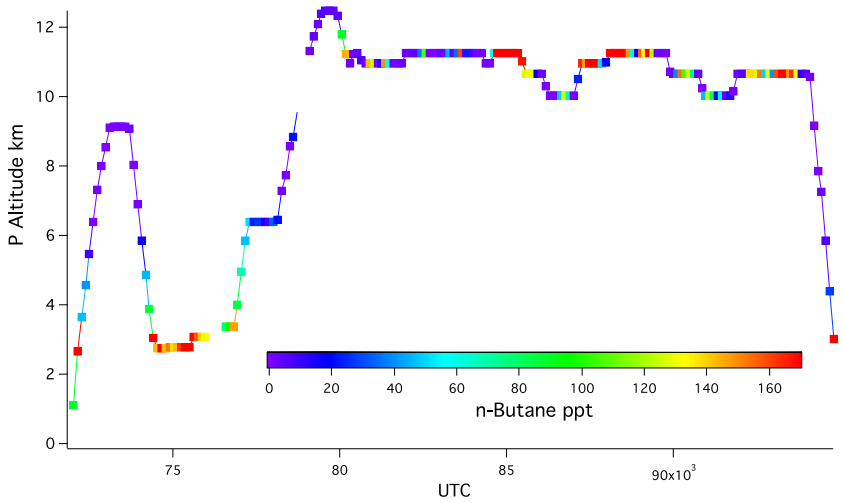


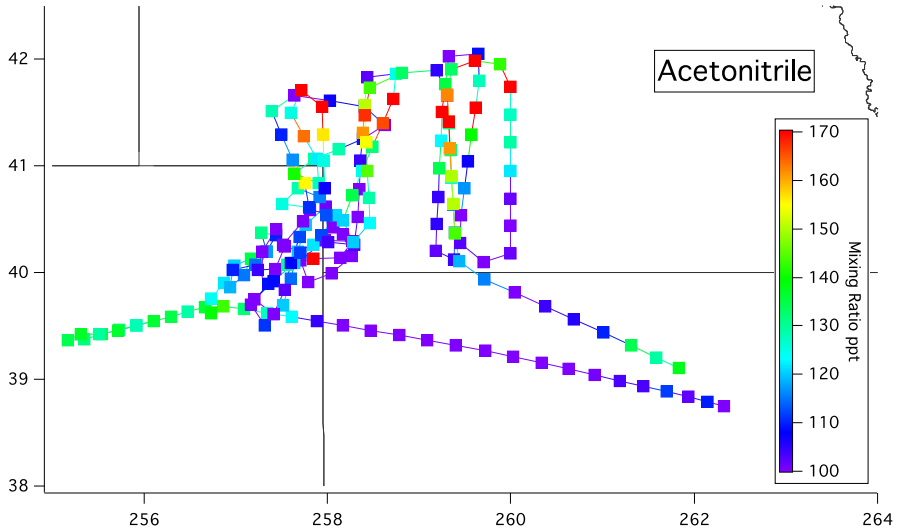
Fires – June 22

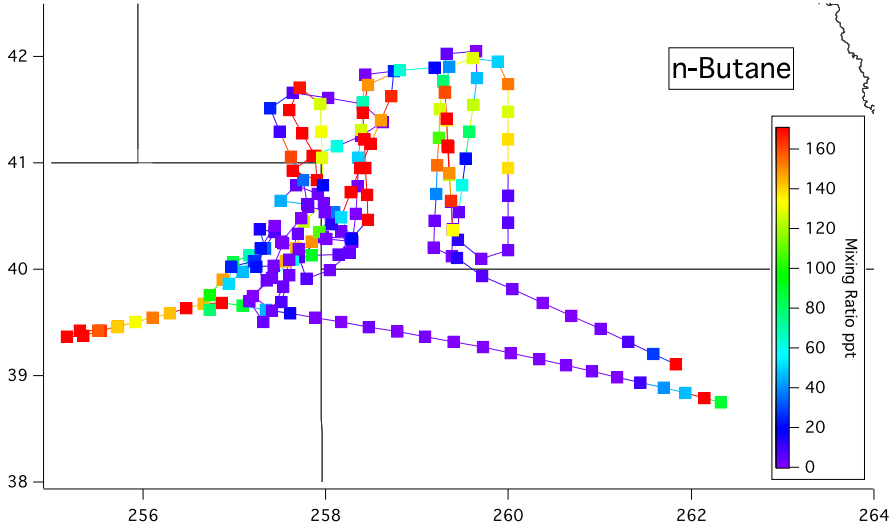


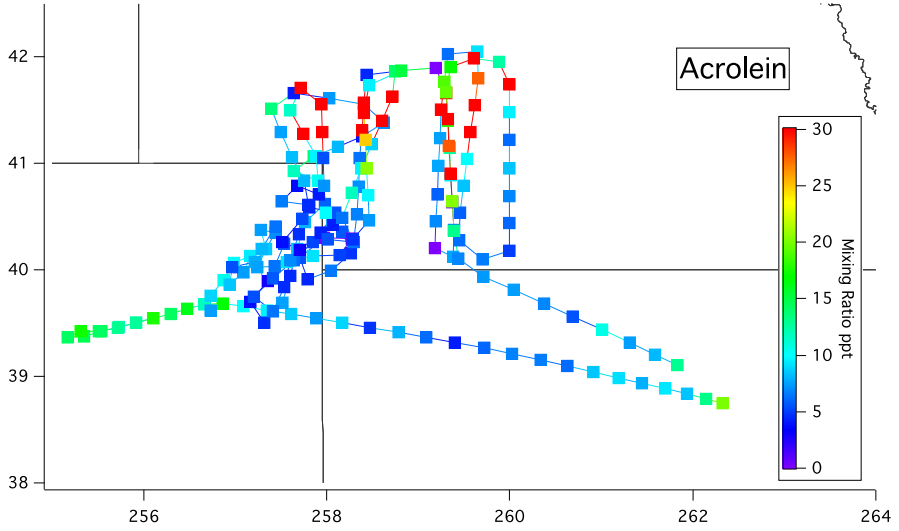


June 22 TOGA GV plume tracer measurements – vertical and horizontal extent



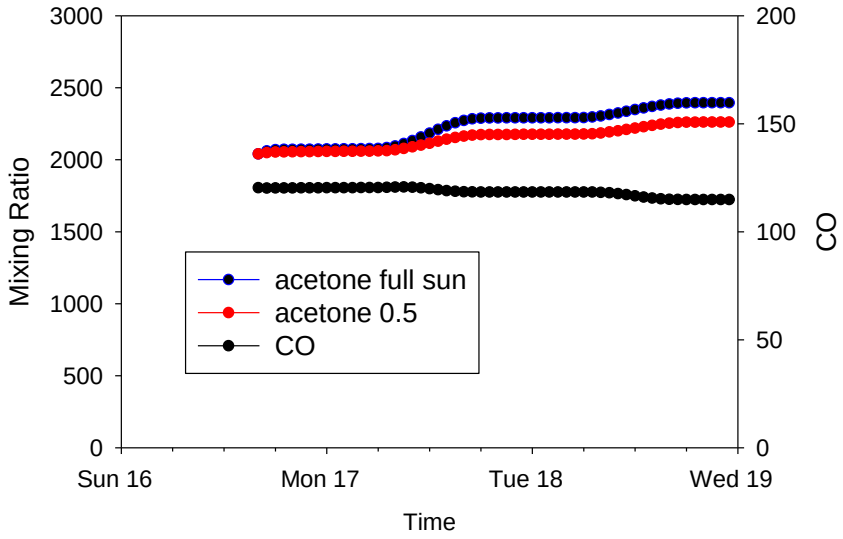




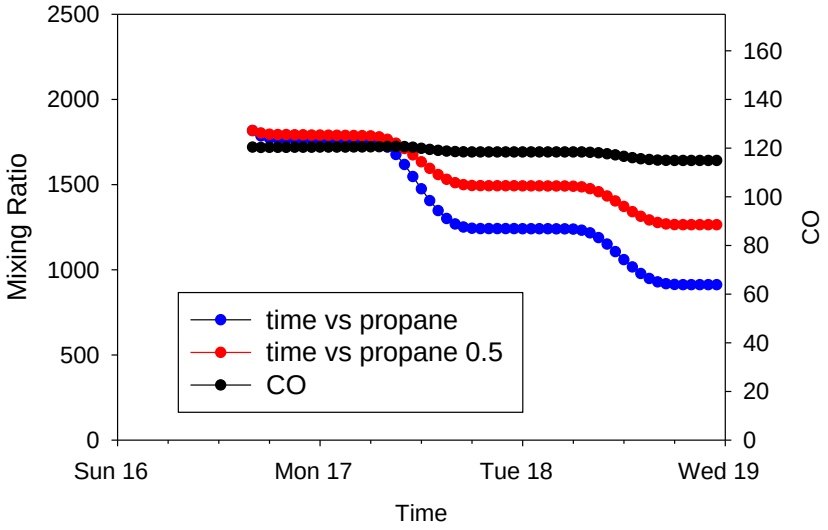


Photochemical source

Some species have chemical sources – (sometimes in addition to primary sources) e.g., HCHO, acetone, NO3, N2O5, etc.

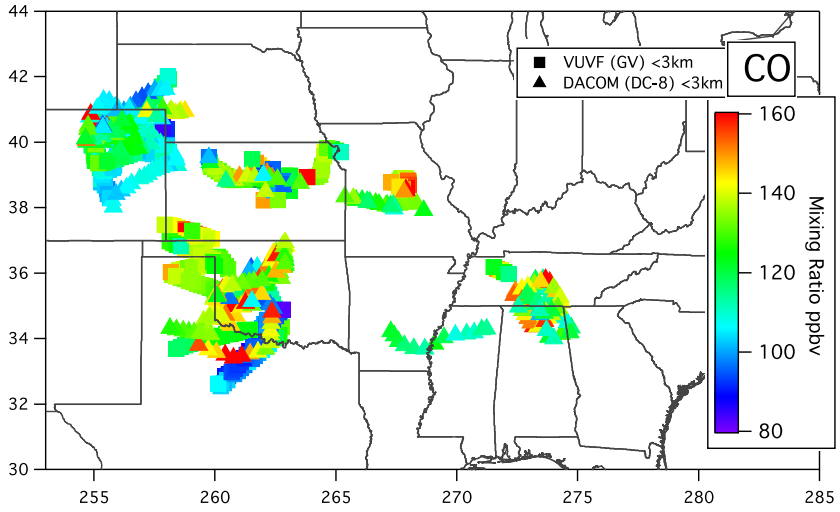


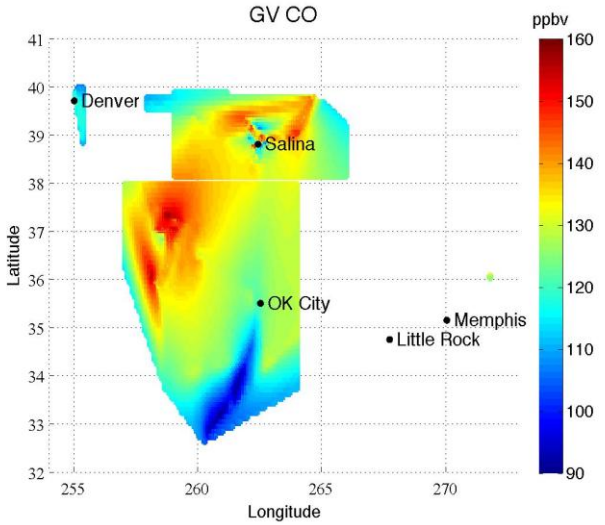
NCAR MM run – June 16 initial conditions



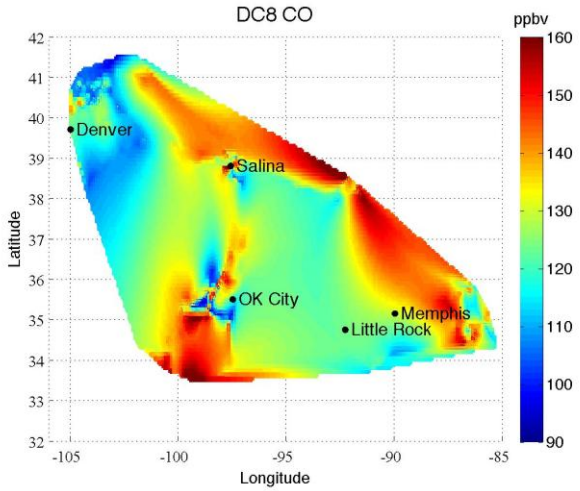
Others don't but if you want to classify in terms of ERs have to do it at t=0 or adjust to t=0

Sources /surface emissions – CO

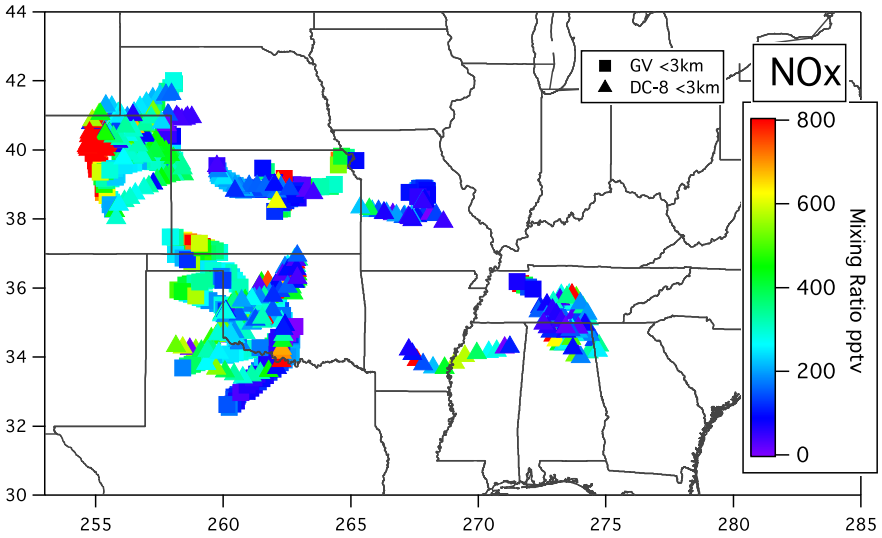


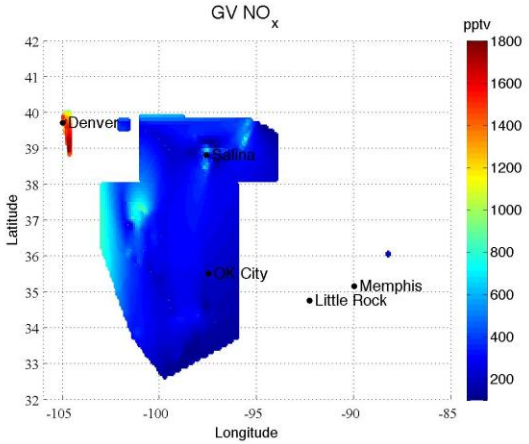


2-D contour plot – Campos/Farris

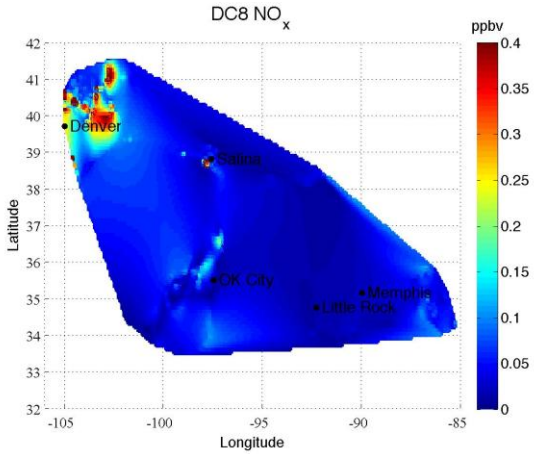


Sources /surface emissions –NOx

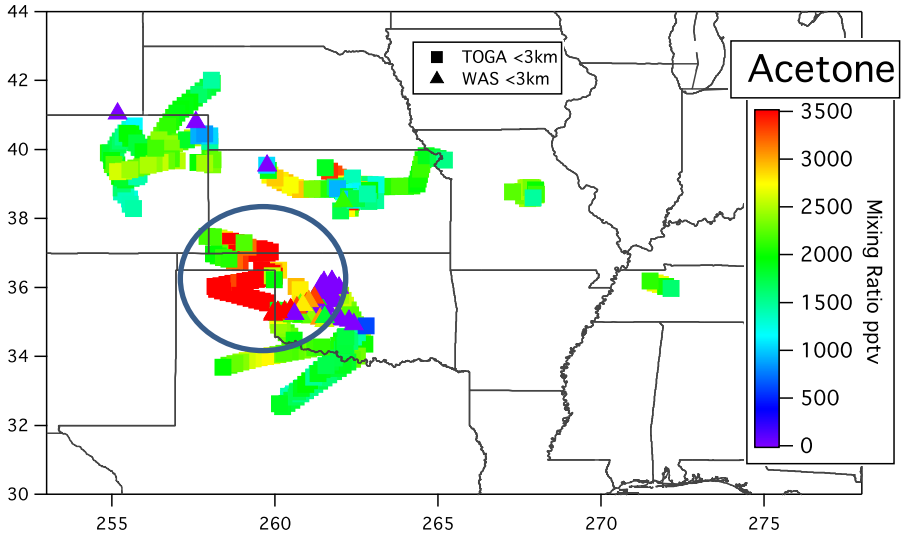


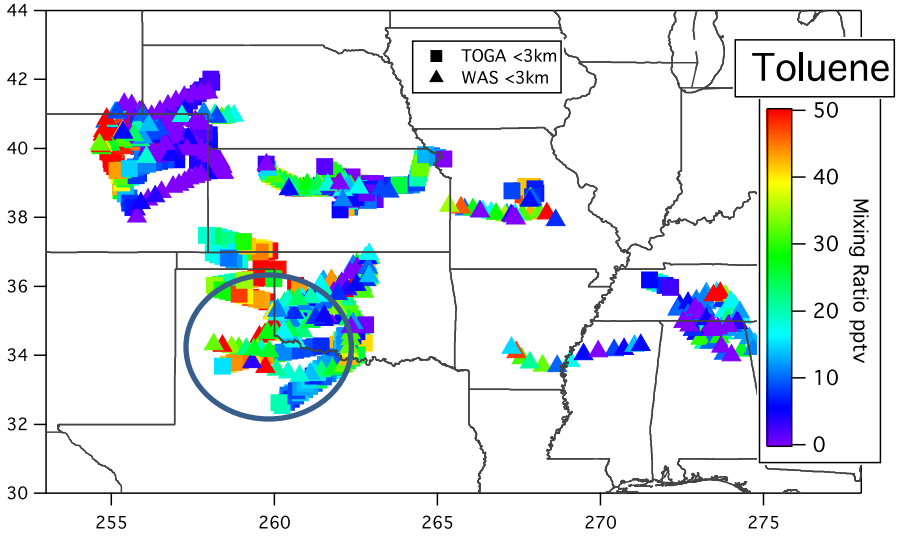


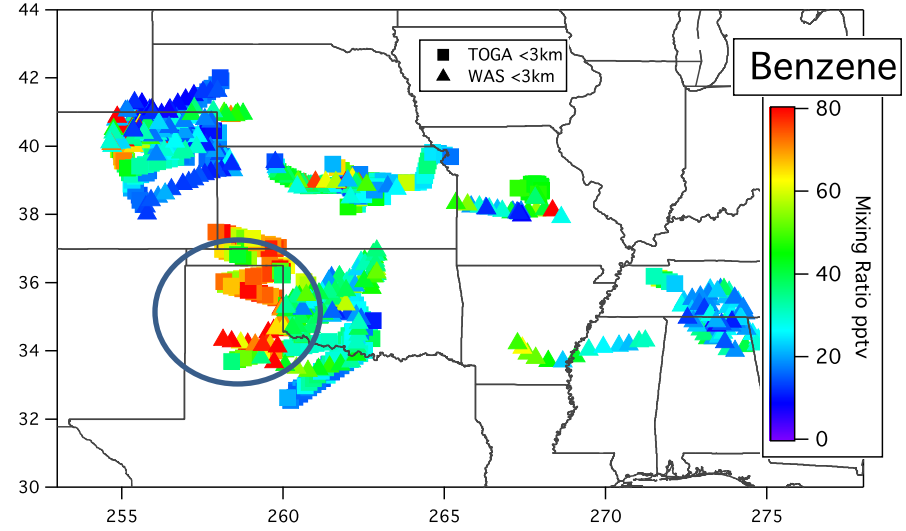
2-D contour plot – Campos/Farris

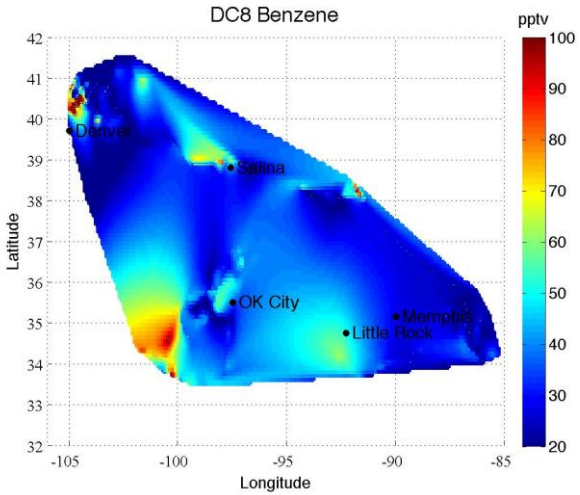


More VOCs



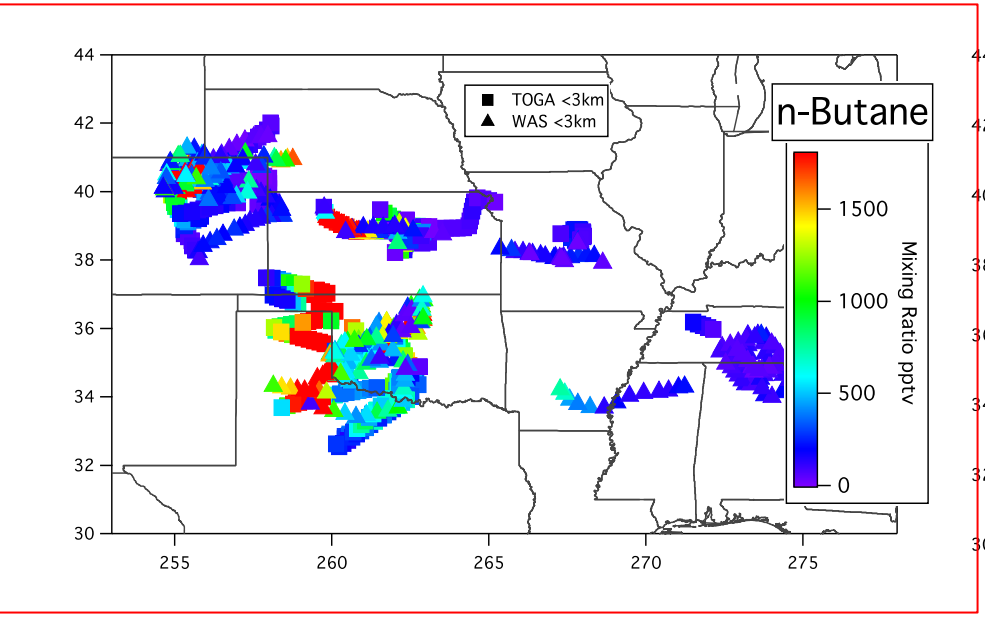


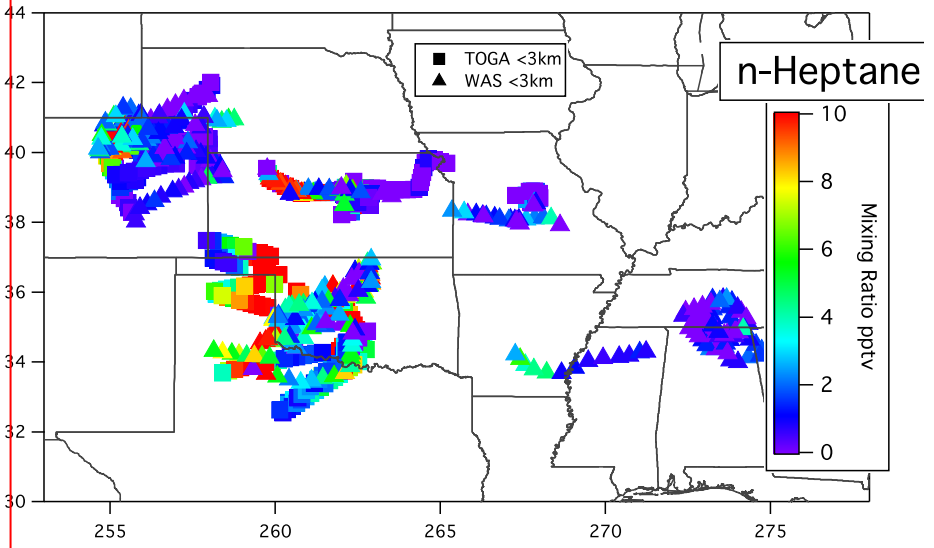




Benzene used in fracking mixtures!!!

More VOCs


TOGA <3km
WAS <3km
n-Butane
Mixing Ratio pptv
1500
1000
500
0
44
42
40
38
36
34
32
30
255
260
265
270
275


TOGA <3km
WAS <3km
n-Heptane
Mixing Ratio pptv
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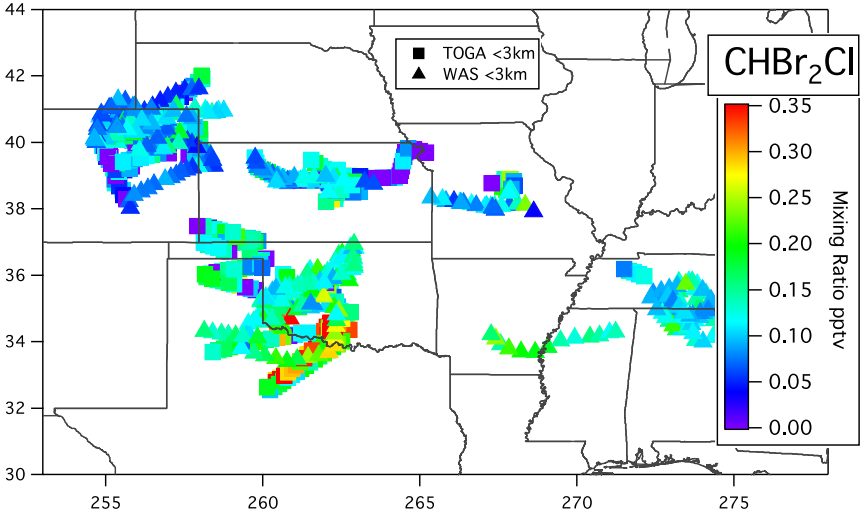
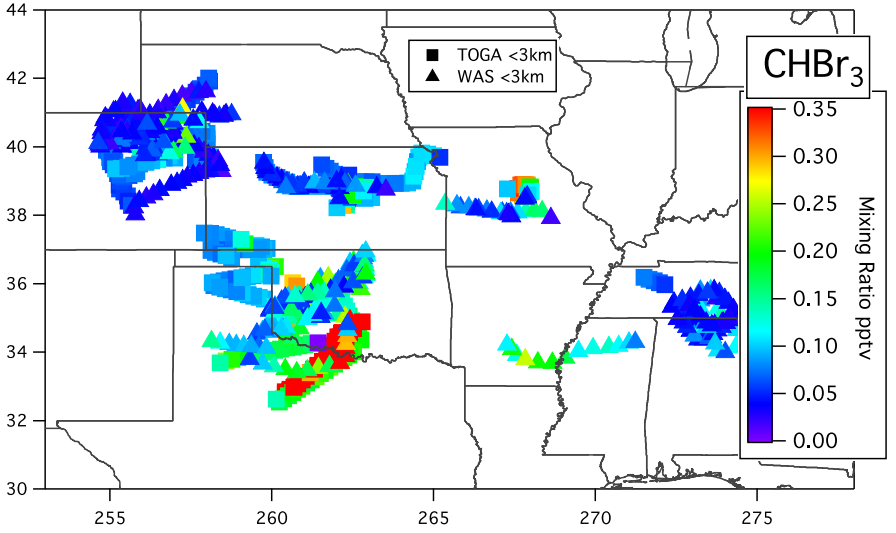
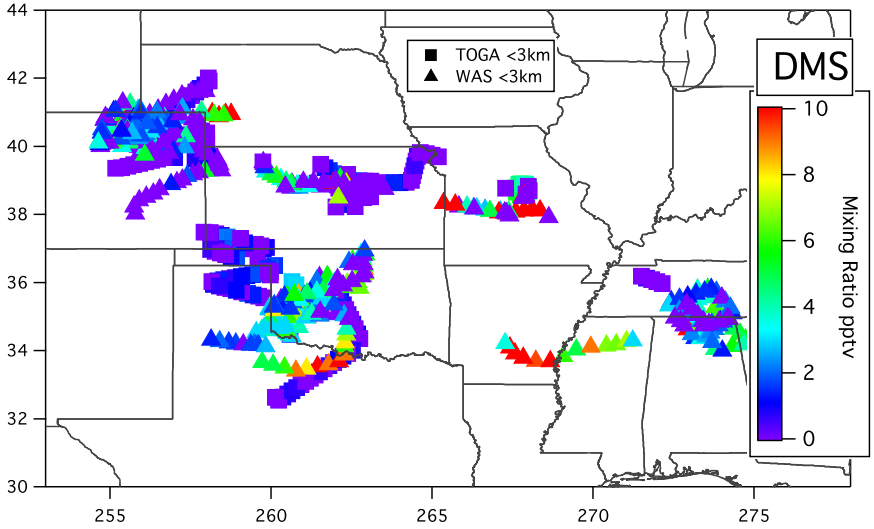
8
6
4
2
0
44
42
40
38
36
34
32
30
255
260
265
270
275

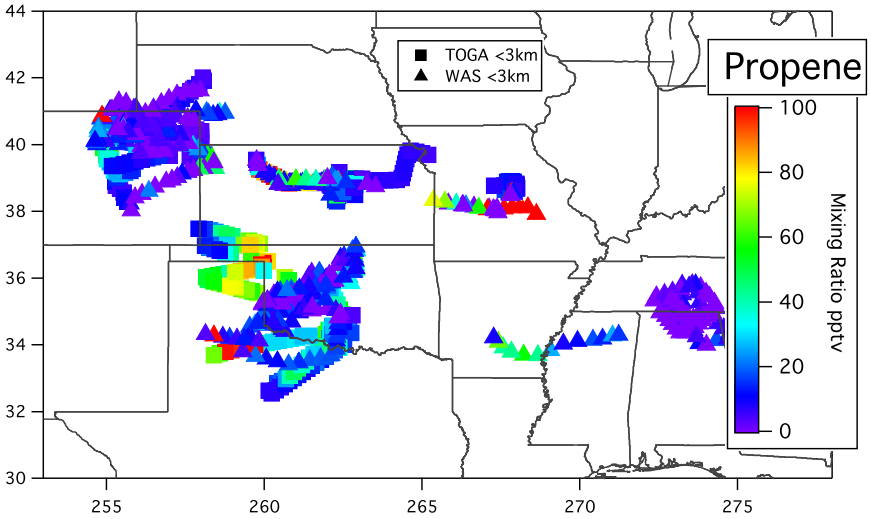

TOGA <3km
WAS <3km
CHBr2Cl
Mixing Ratio pptv
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
44
42
40
38
36
34
32
30
255
260
265
270
275


TOGA <3km
WAS <3km
CHBr3
Mixing Ratio pptv
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
44
42
40
38
36
34
32
30
255
260
265
270
275

More VOCs….

DMS Highest in Mississippi basin – potentially interesting find



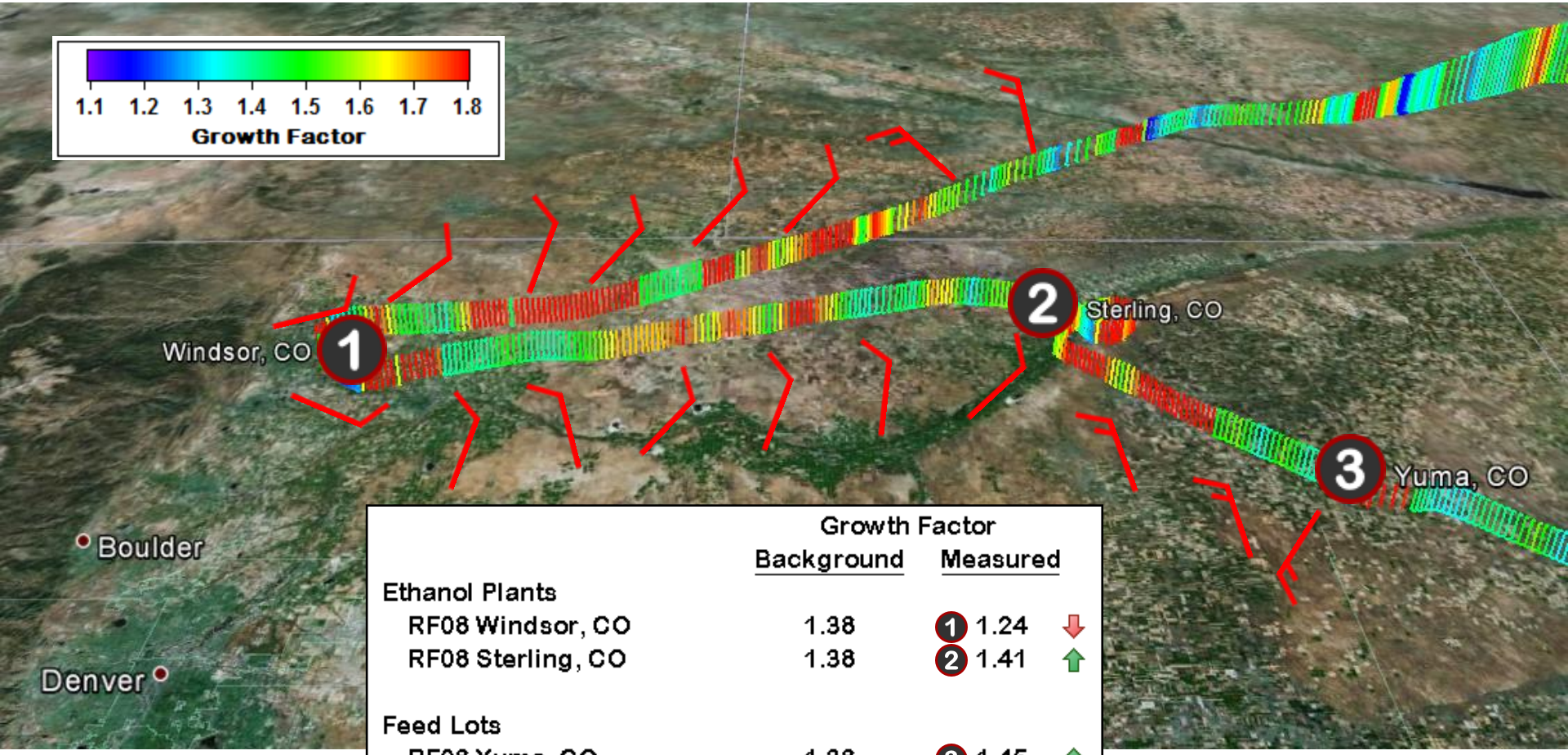


Sub-saturated Aerosol Hygroscopicity: RF08 (DC-8) / Source Characterization

DC-8 / Taylor Shingler and Armin Sorooshian / University of Arizona

Instrument: Differential Aerosol Sizing and Hygroscopicity Spectrometer Probe (DASH-SP) → Growth Factor = $D_{p,wet}$ / $D_{p,dry}$

1. $D_{p,dry}$ = 200 nm, RH ~ 84%
2. $D_{p,dry}$ = 200 nm, RH ~ 89%
3. $D_{p,dry}$ = 200 nm, RH ~ 89%

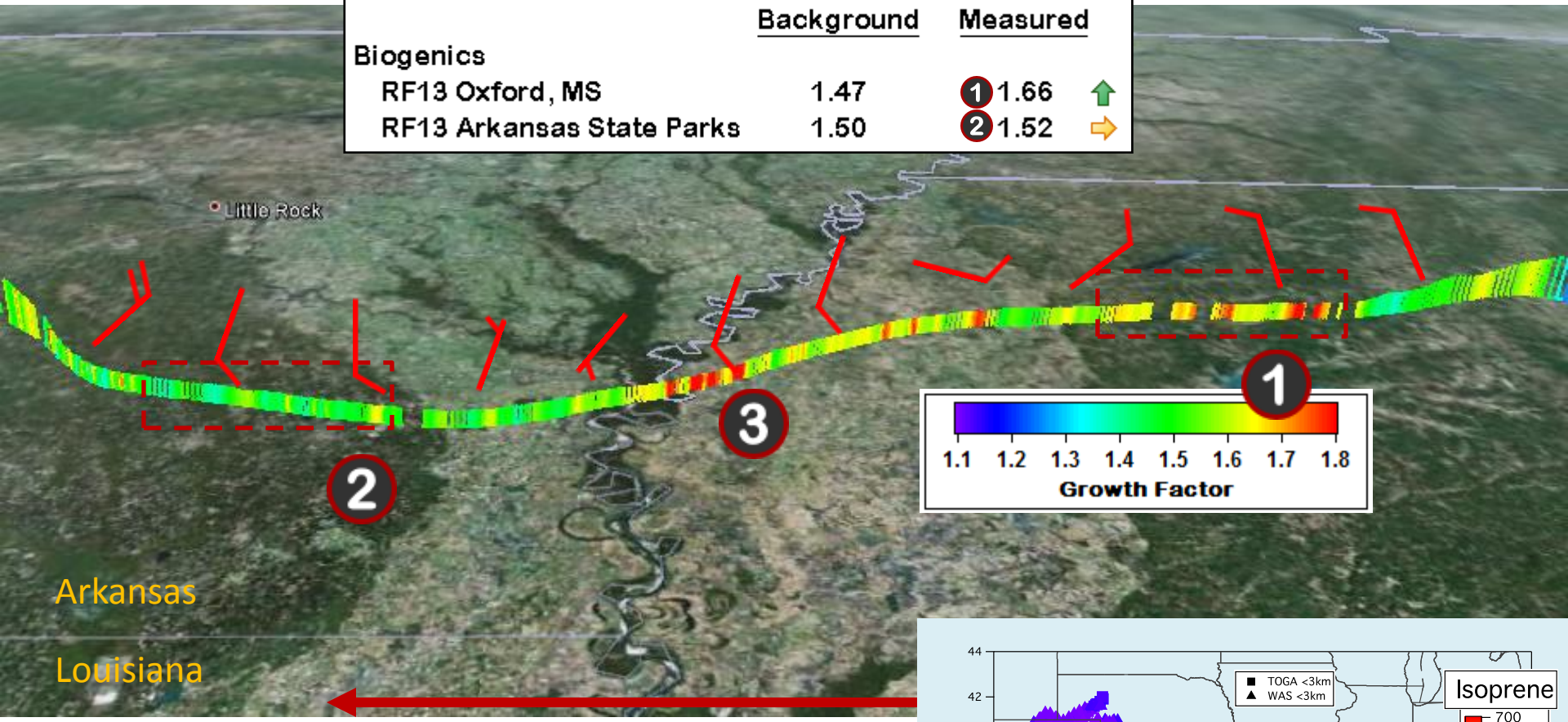


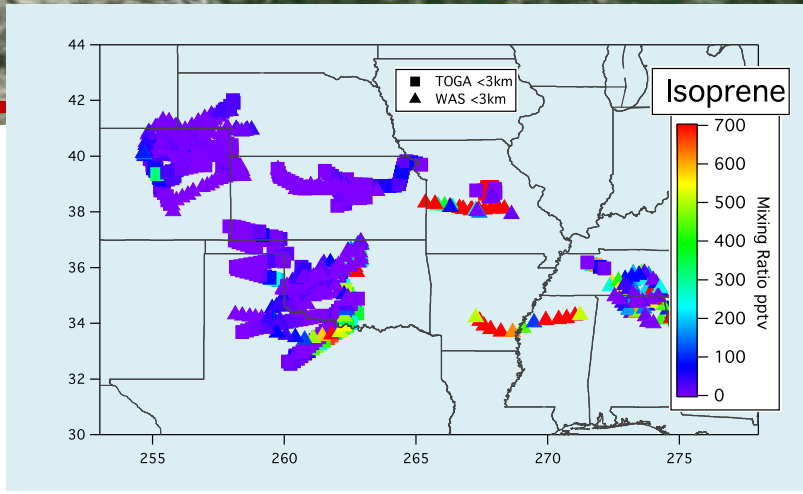
	Growth Factor Background	Growth Factor Measured
Ethanol Plants		
RF08 Windsor, CO	1.38	1 1.24 ↓
RF08 Sterling, CO	1.38	2 1.41 ↑
Feed Lots		
RF08 Yuma, CO	1.38	3 1.45 ↑

Sub-saturated Aerosol Hygroscopicity: RF13 (DC-8) / Source Characterization

DC-8 / Taylor Shingler and Armin Sorooshian / University of Arizona

	Growth Factor	
	Background	Measured
Biogenics		
RF13 Oxford, MS	1.47	❶ 1.66
RF13 Arkansas State Parks	1.50	❷ 1.52





❶ $D_{p,dry}$ ~ 175-350 nm, RH ~ 84%

❷ $D_{p,dry}$ ~ 175-350 nm, RH ~ 87%

❸ $D_{p,dry}$ ~ 175-350 nm, RH ~ 92%

Discussion Topics

Oil and gas

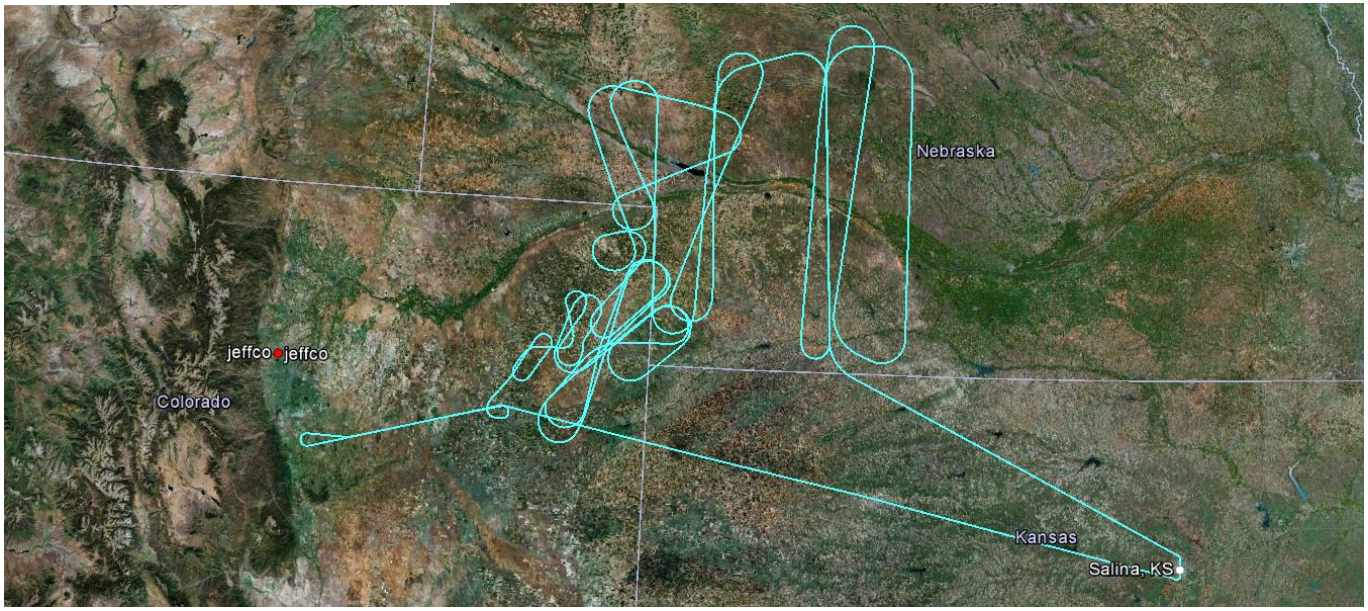
Fires

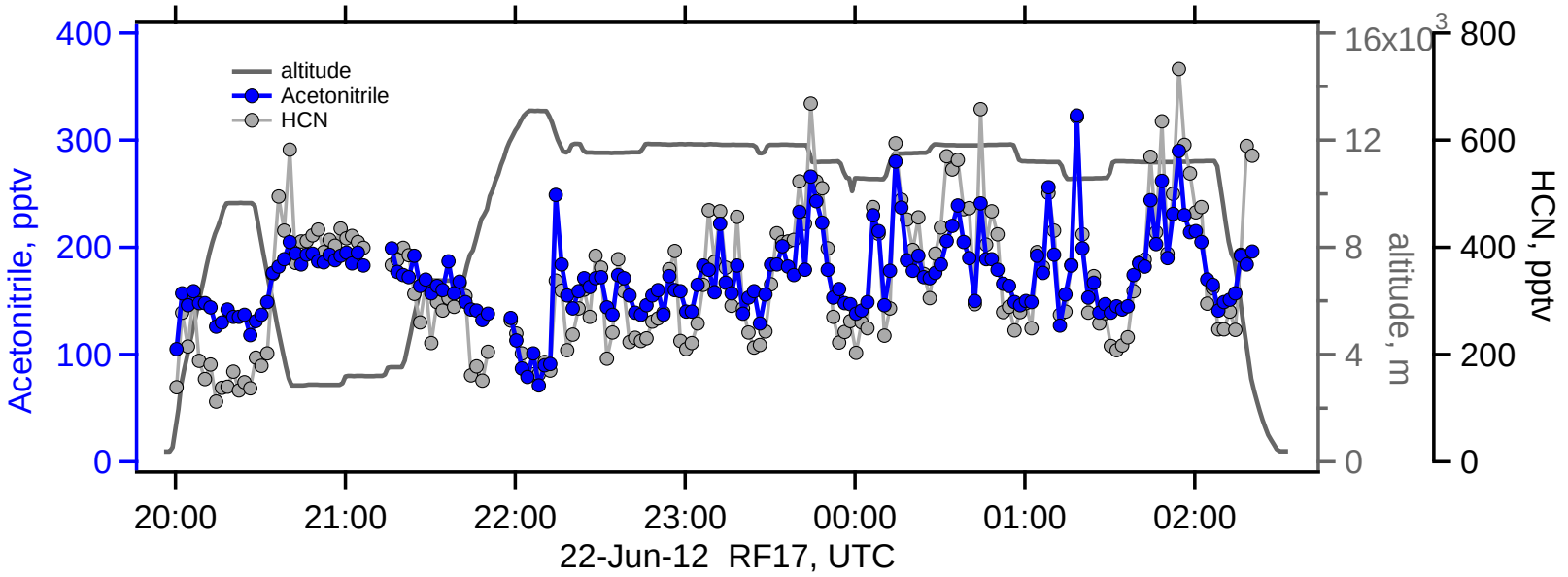
Anthropogenic

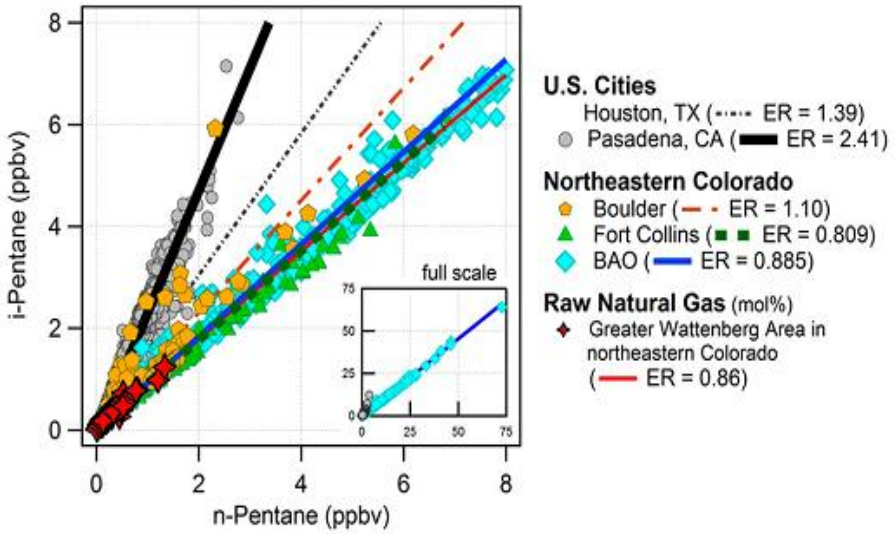
Biogenic

Chemical

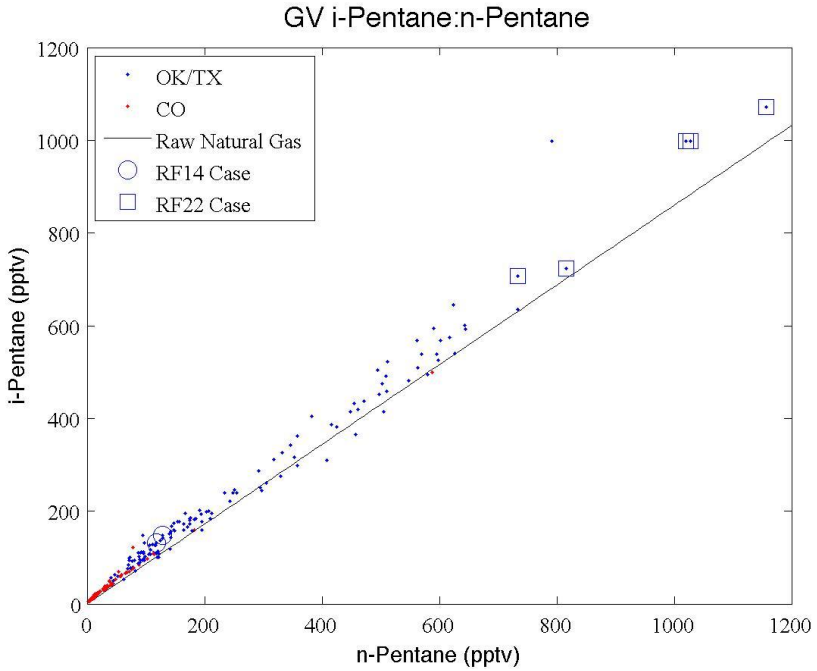
Fires – June 22

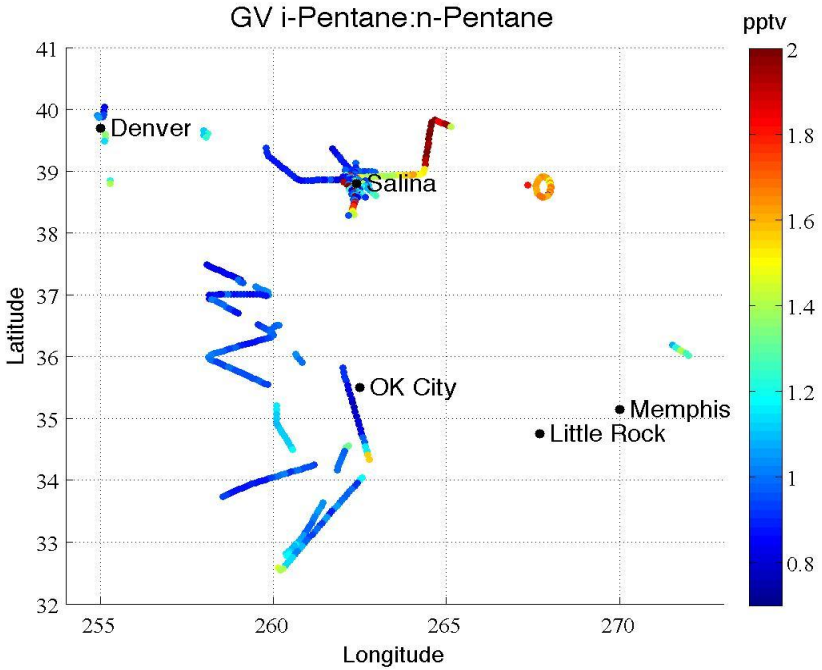


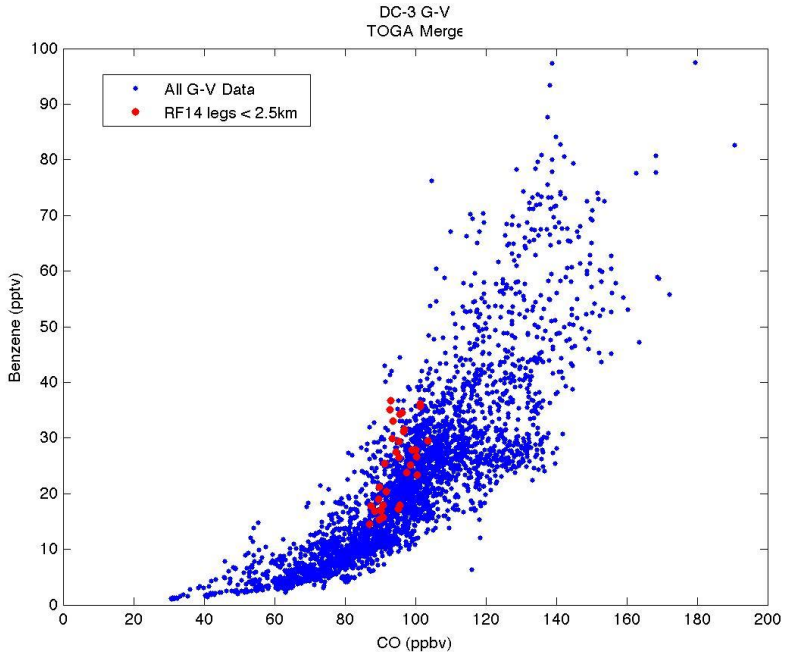




from Gilman, J.B., et al., *Environ. Sci. Technol.* 2013, 47, 1297−1305, dx.doi.org/10.1021/es304119a







Select Tracer Data G-V Lower Tropospheric Data (<2.5km Alt), All Flights