Regional Volatile Organic Carbon Signatures

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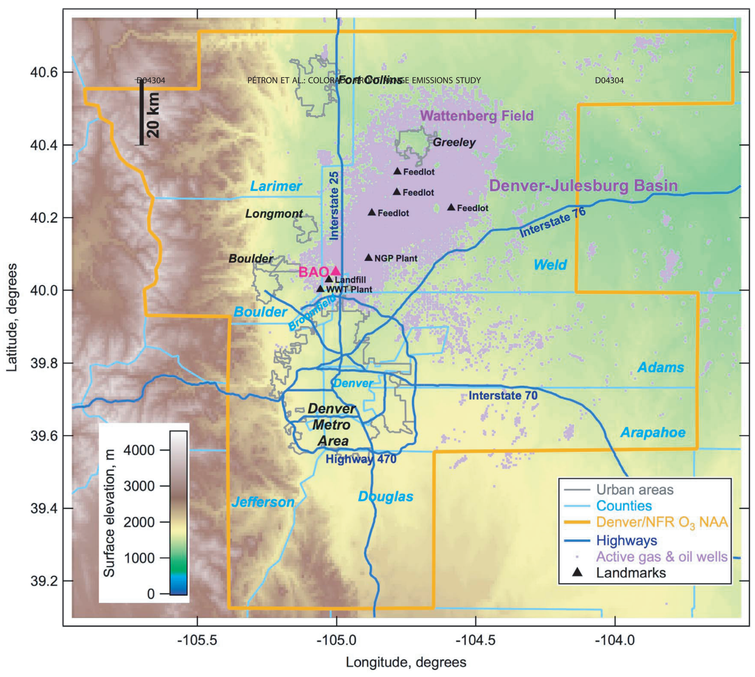
ABSTRACT

In the past five years, GMD has conducted field campaigns with discrete air sampling into glass-flasks and in-situ sampling in various hydrocarbon emission source regions. This is motivated by needs for:

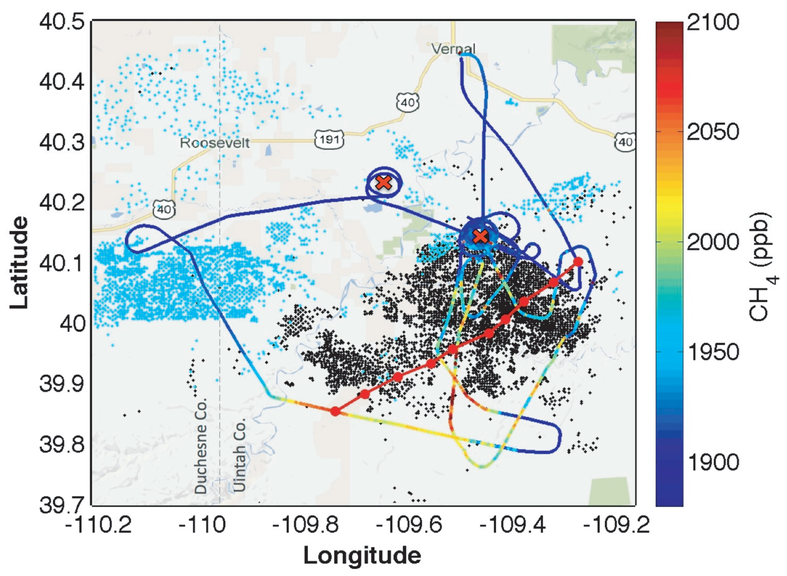
- modeling constraints in estimating the various components of the methane budget.
- quantifying sources of anthropogenic pollutants that contribute to tropospheric ozone formation, especially during "Winter-time ozone exceedances."
- understanding the natural sources of hydrocarbons.

OBSERVATIONS



Map of the study area centered on the Boulder Atmospheric Observatory (BAO), located 25 km east-northeast of Boulder. Overlaid on this map are the locations of active oil and gas wells (light purple dots) as of April 2008.

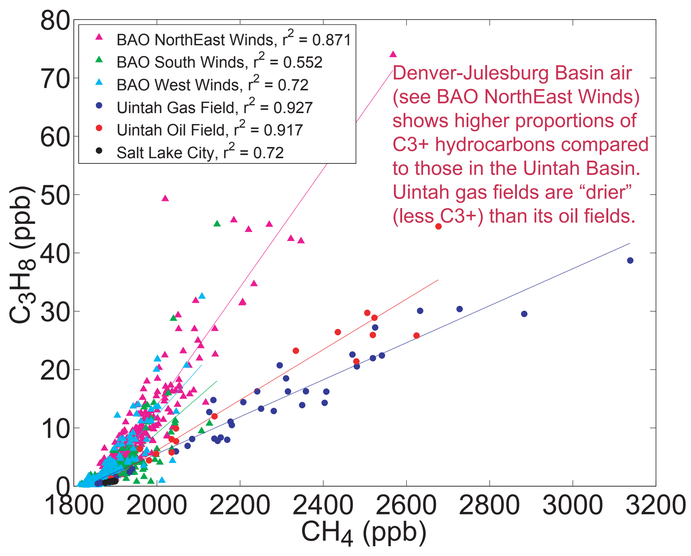
(From Pétron, G., et al., J. Geophys. Res., 117, D04304, doi:10.1029/2011JD016360, (2012).

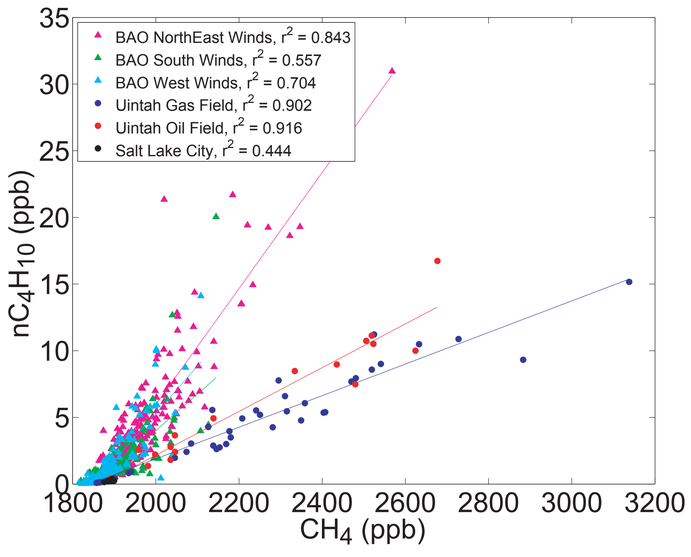


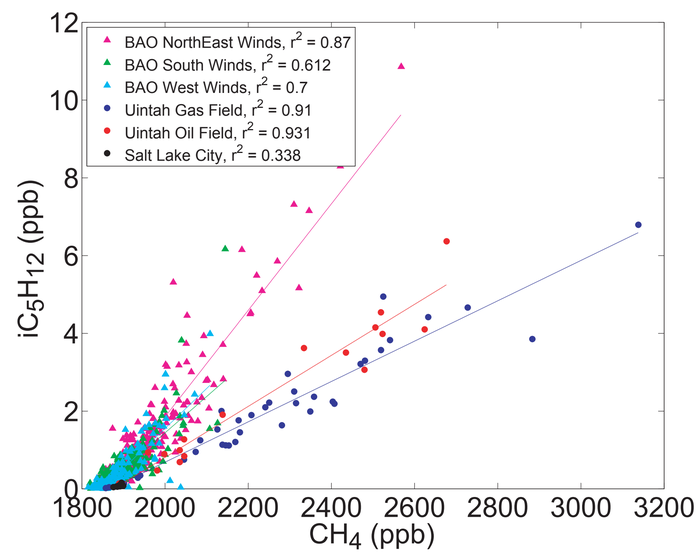
Aircraft flight track, February 3, 2012, overlain on gas (black dots) and oil (blue dots) well locations along with color-coded CH_4 mole fraction measured from the aircraft. Red circles and line show a three-hour back trajectory in 20-min increments of an air mass with enhanced CH_4 sampled downwind of the gas field, constructed using lidar wind measurements at Horse Pool. Red Xs indicate the locations of altitude profiles from near the surface to above the top of the boundary layer at 1700 magl.

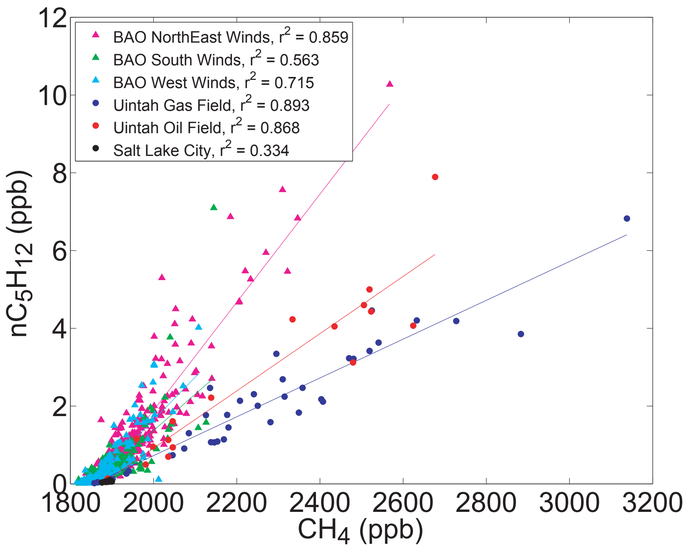
(From Karion et al., in prep., 2013).

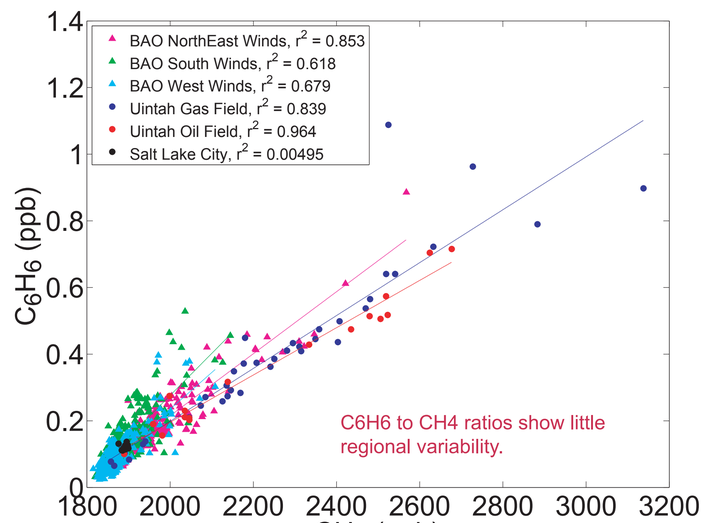
Unitah Basin (UT) aircraft surveys and BAO Tower (CO) Observations

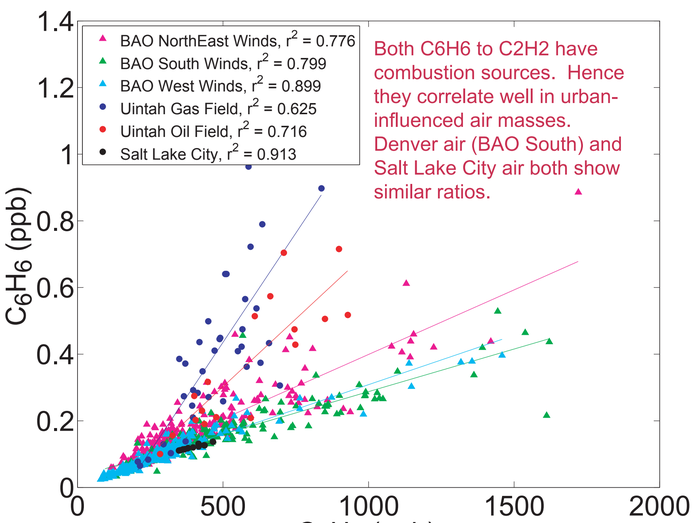












CONCLUSIONS AND NEXT STEPS...

1. Sources of methane and other GHGs may emit a mixture of multi-species tracers including hydrocarbons.
   - These multi-species are often emitted in distinctive emission ratios, resulting in characteristic signatures recognizable in atmospheric air samples from various geographic regions and/or affected common processes.
   - Source attribution for a given signature requires field work to capture downwind samples with enhanced mole fractions and upwind samples to characterize 'baseline' values. Subtraction of baseline values from polluted samples allows estimation of "enhancement levels" caused by local sources.
   - The relative contributions of various emission sources of one GHG to a regional air sample may be used to constrain models for another species, if they have at least one common source (e.g., ethane may help constrain oil & gas contributions to methane enhancements and distinguish them from wetland emissions).

2. New capability to analyze for additional multi-species is needed.
   - A **new gas chromatography / mass spectrometry system** ("***Perseus GC/MS***") is being developed in GMD to increase the volatility span of analytes and improve precision and accuracy in quantitation over a wider variety of samples and in the dynamic range of mole fractions.
     Combined with the existing suite of analytes, additional hydrocarbons such as ethane, toluene, xylenes and ethyl benzene may be used to better differentiate between gas, oil and coal exploration/extraction sources.