Some Plume Dispersion Highlights From Joint Urban 2003 and Urban 2000

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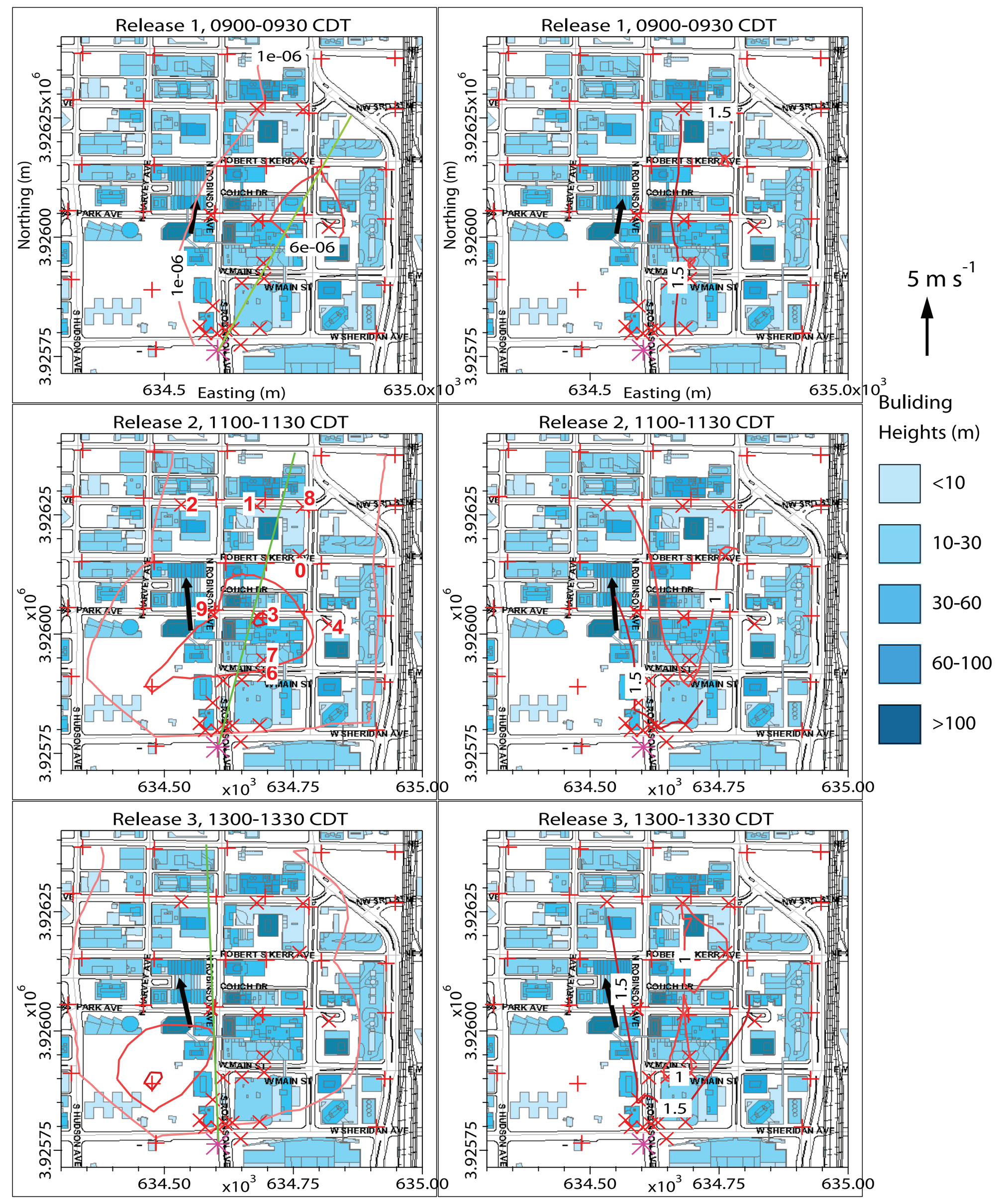
Joint Urban 2003

Daytime

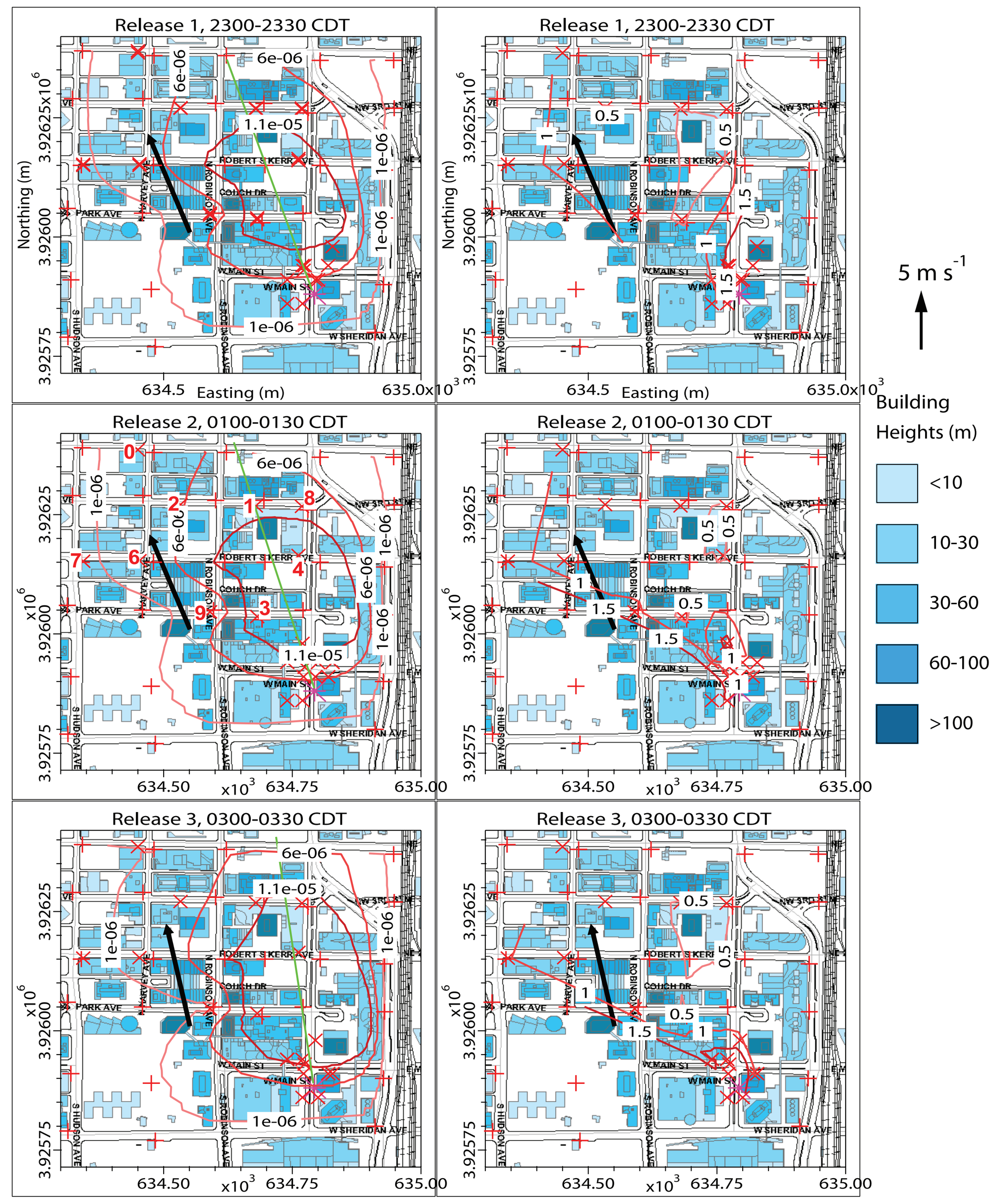
Normalized Concentrations Concentration Fluctuation Intensity



Daytime with higher concentration fluctuation intensity ($i=\sigma/\mu$) and lower normalized mean concentrations.

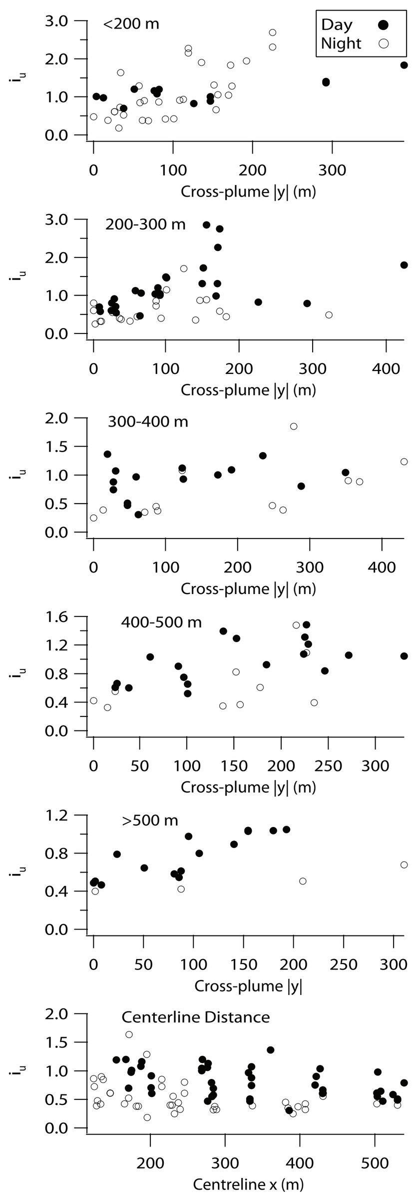
Nighttime

Normalized Concentrations Concentration Fluctuation Intensity



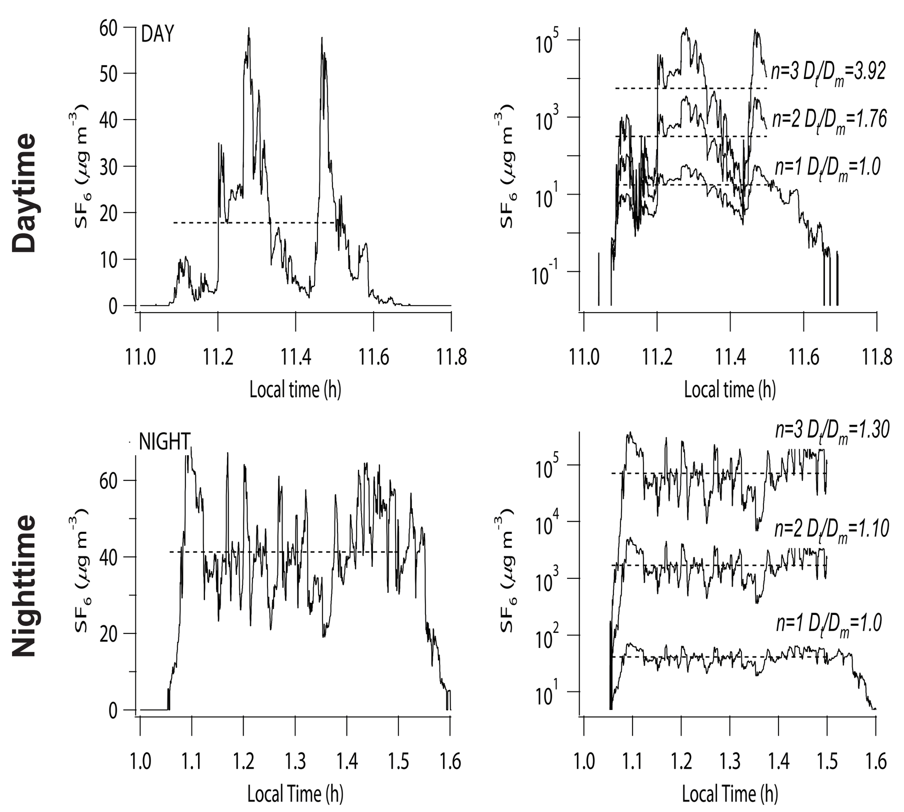
Nighttime has lower concentration fluctuation intensity ($i=\sigma/\mu$) and higher normalized mean concentrations.

Fluctuation Intensity: Cross sections and centerline profile



Intensities generally higher in day than night and increases away from plume centerline.

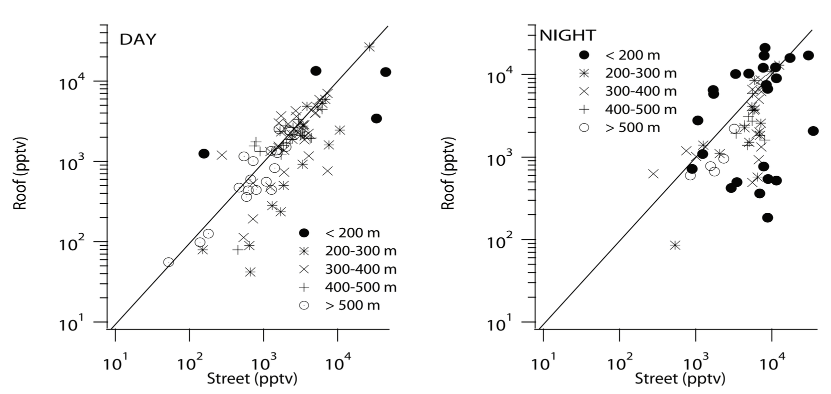
Effect of Fluctuation Intensity on Toxic Dosement



Daytime typically much more variability and larger fluctuations than nighttime. Toxic dosement ($D=\int c(t)^n\,dt$) significantly affected by larger concentration fluxtuations.

Vertical Mixing

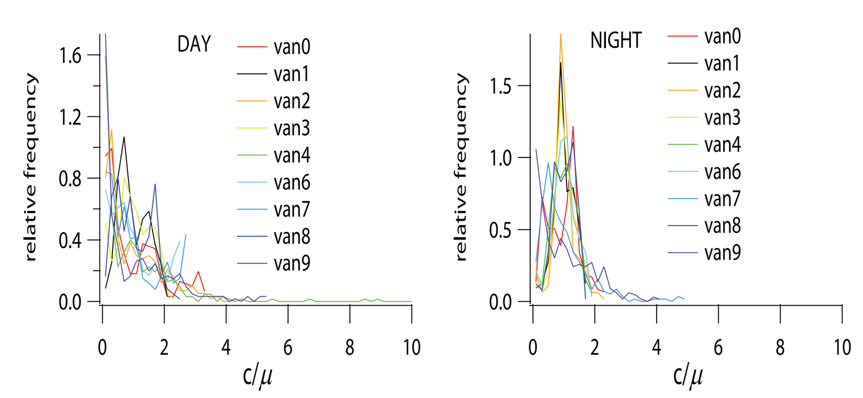
Daytime Nighttime



Comparison roof and street sampler concentrations.
Day: Generally good vertical mixing.
Night: Generally poorer vertical mixing at all distances.

Concentration Probability Distributions

Daytime Nighttime



Day: Lognormal distribution best in-plume characterization.
Night: Normal distribution best in-plume characterization.

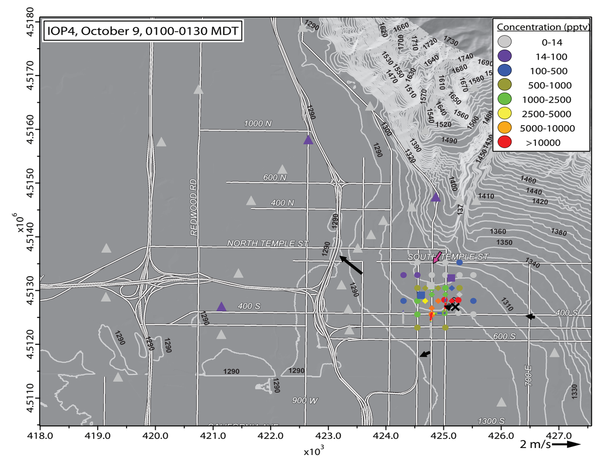
Summary

Daytime - Nightime Differences	Daytime	Nightime
1. Concentration Fluctuation Intensity	Larger	Smaller
2. Normalized Surface Concentrations	Smaller	Larger
3. Vertical Mixing	More Uniform	Suppressed
4. Susceptibility to Increased Toxic Dosement for Given Species Toxicity and Mean Concentration	Greater	Lesser
5. Characteristic Data Distribution	Lognormal	Normal

Urban 2000

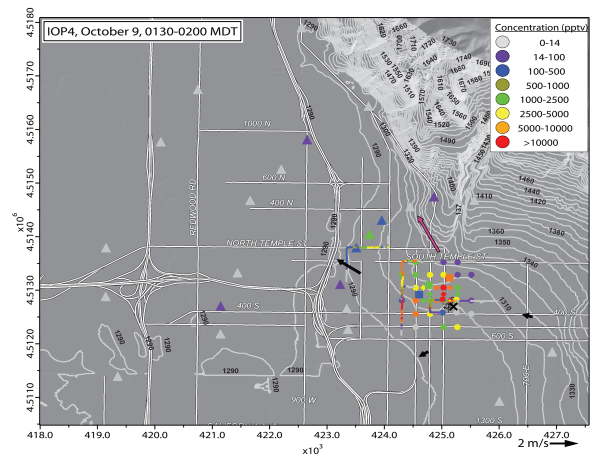
Typical Nocturnal Dispersion Pattern

a



Plume transport follows light down canyon and down valley drainage wind flow towards the west.

b



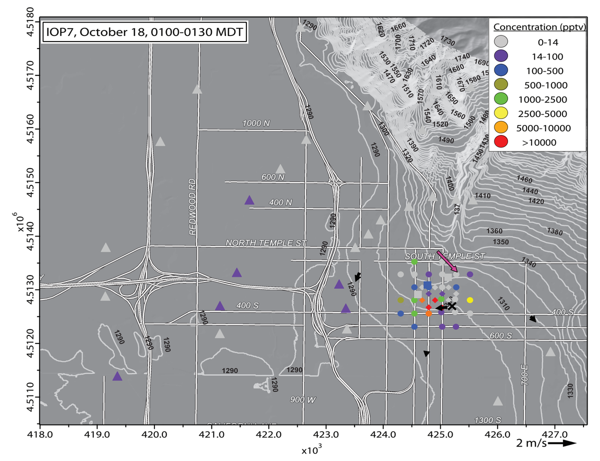
Plume continues to move down valley to the west and northwest.

c

No significant concentrations were measured during the next half-hour after the release had ended. The plume had essentially dispersed.

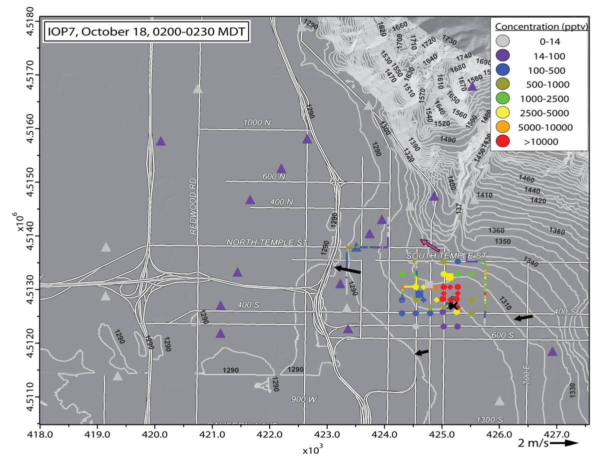
Unexpected Anomalous Upwind Dispersion Pattern

a



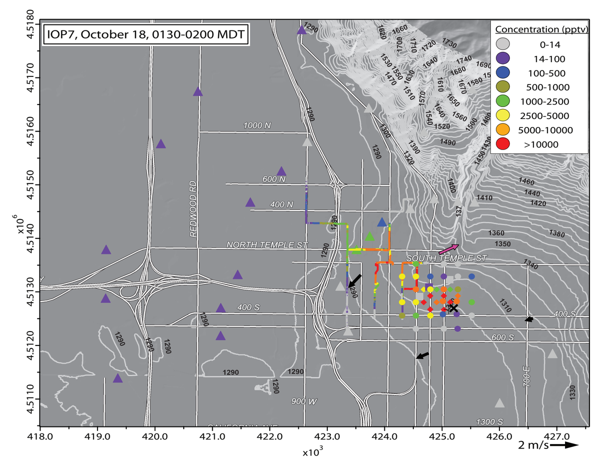
Plume initially showed a typical drainage flow pattern despite winds blowing in different directions.

c



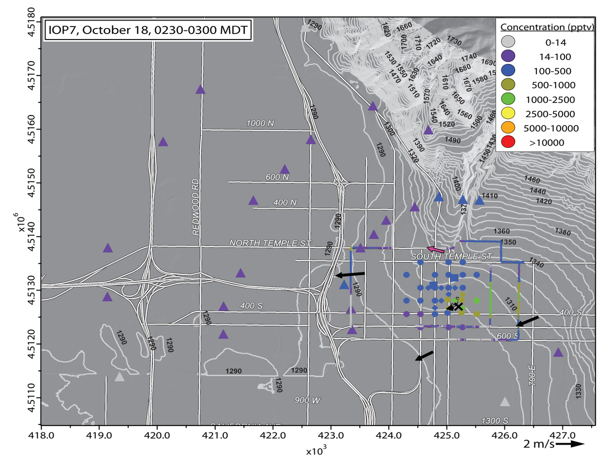
With the release over and well developed easterly wind flow, large concentrations are now measured upwind of the release site.

b



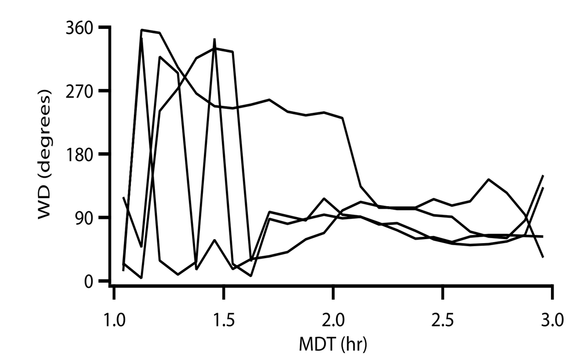
Plume continues toward the northwest contrary to the observed wind field.

d

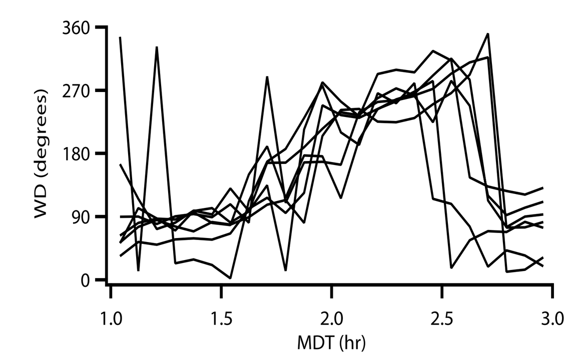


Large concentrations continue upwind of the release site.

Wind Directions during Anomalous Release Pattern



PNNL stations surrounding downtown.



All stations within 150m of release.

Summary

1. Poor correlation between observed winds and plume dispersion in anomalous case (except in close proximity to release).
2. Suggests dispersion driven by local, small scale flows in a shallow layer influenced by urban canopy and local topography.
3. Localized winds can sometime override effects of topography even in stable conditions.
4. Likely trapping and re-release of tracer from buildings or poorly ventilated areas in urban canopy.

Why is this important?

1. Emergency responders need to understand that toxic chemicals may not travel the direction they think the wind is blowing especially if the wind measurements are made some distance from the release.
2. The only way to document and prepare for unexpected plume behavior is through the use of dense meteorological networks and/or atmospheric tracer experiments.
3. Atmospheric dispersion models need to be able to predict this type of behavior to be useful in an urban environment.