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Examining the Effects of Roadside Vegetation on Near-Road Air Pollution

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Presentation Overview

- Interest in Roadside Vegetation
- Research Results
- Summary/Recommendations

Why study roadside vegetation?

- Few “short-term” mitigation options for near-road air quality concerns
  - Emission reductions take long to implement (fleet turnover required)
  - Planning and zoning involved in rerouting/VMT reduction programs
  - Buffer/exclusion zones may not be feasible or effective
- Roadside vegetation may already be present
- Roadside vegetation has other positive benefits

Research Methodology

- EPA has initiated research to examine the role roadside vegetation may play in affecting near-road air pollution
  - Field studies
    - Research Triangle Park area (vegetation and noise barriers)
    - Detroit (vegetation)
    - San Francisco (vegetation)
  - Wind tunnel assessments
    - Vegetation removal processes
    - Site-specific configurations
  - Computational Fluid Dynamics (CFD) modeling
    - Generalized vegetative scenarios
    - Site-specific configurations

Noise Barrier & Vegetation Effects

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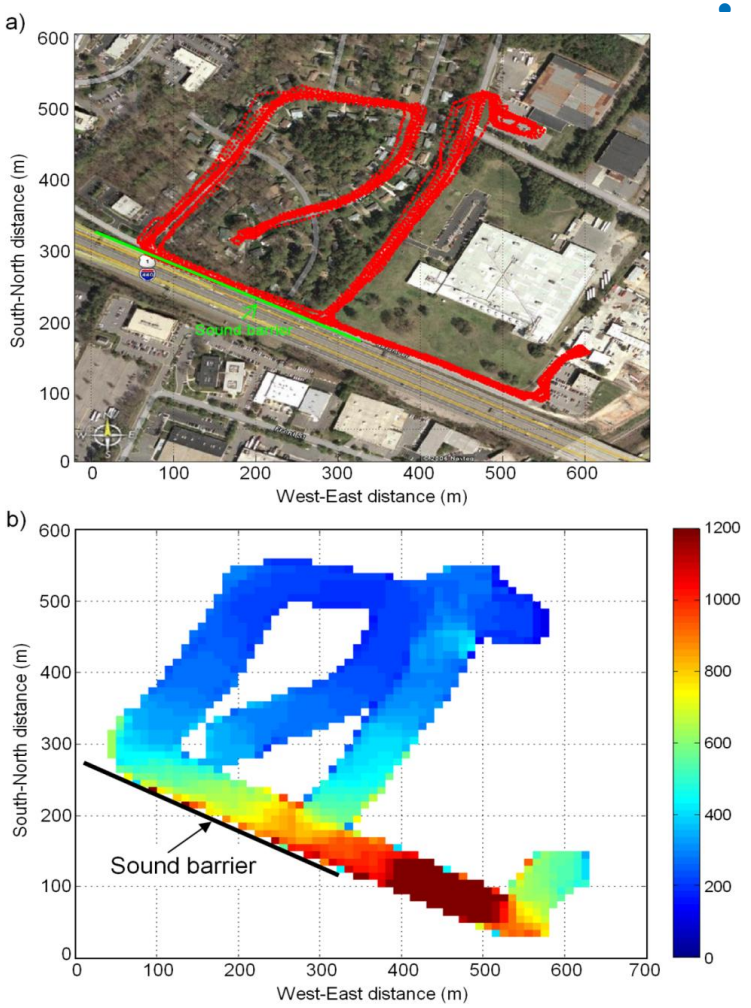
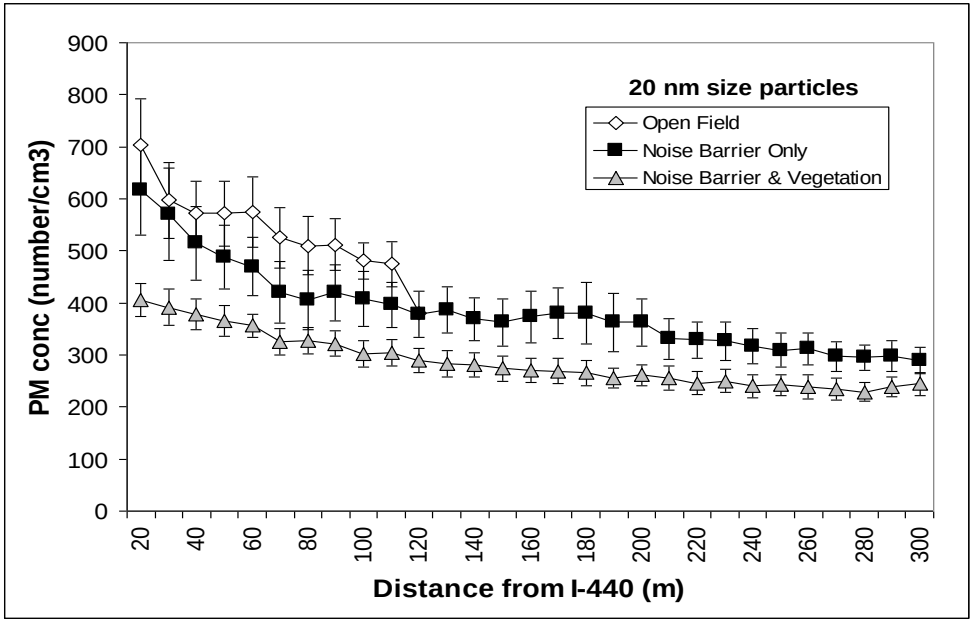


- Noise barriers reduced PM levels compared with a clearing

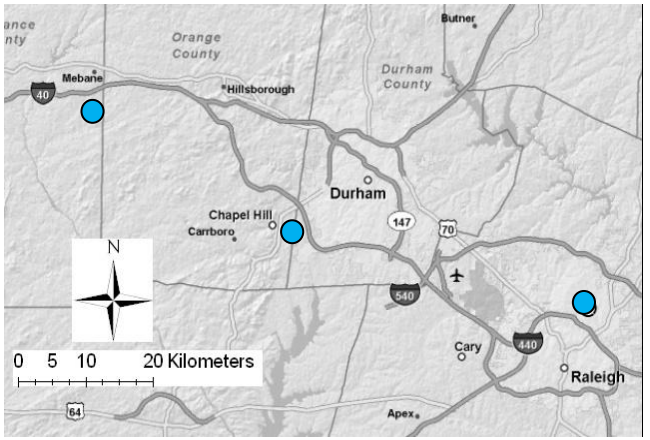
  Vegetation with noise barriers provided a further reduction of PM concentrations and gradients

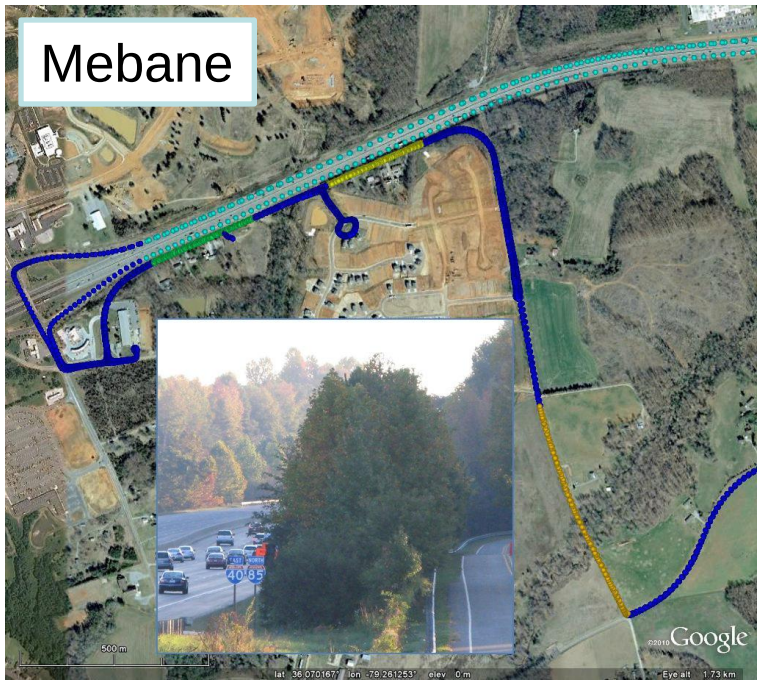


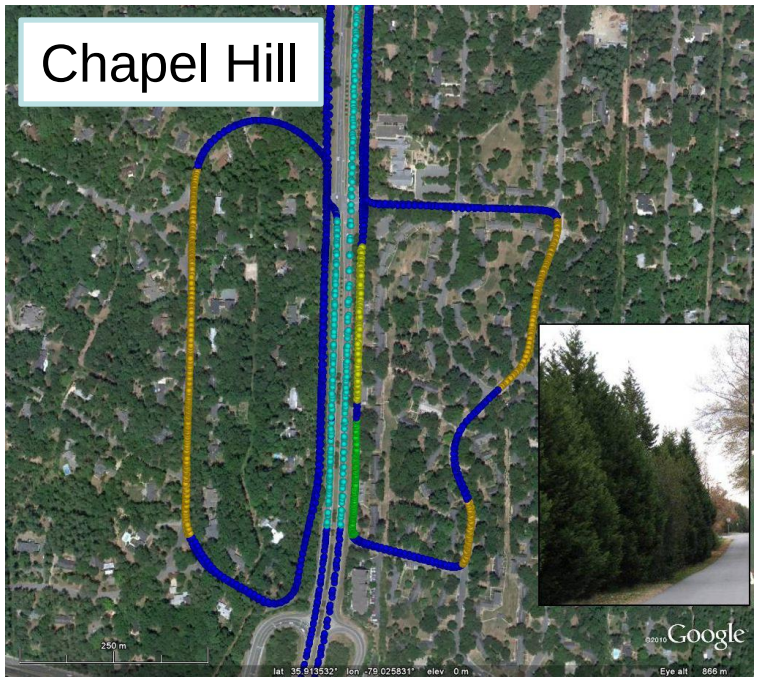
(Baldauf et al., 2008a; 2008b)

Vegetation Effects

- Field data: Mobile and fixed site sampling study at two sites in North Carolina
  - One with primarily pine trees (Chapel Hill)
  - One with primarily hardwoods (Mebane)







Vegetation Effects

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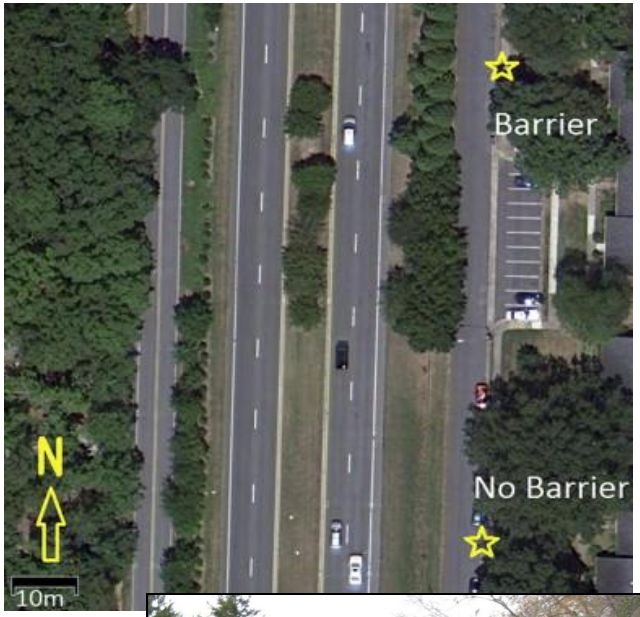
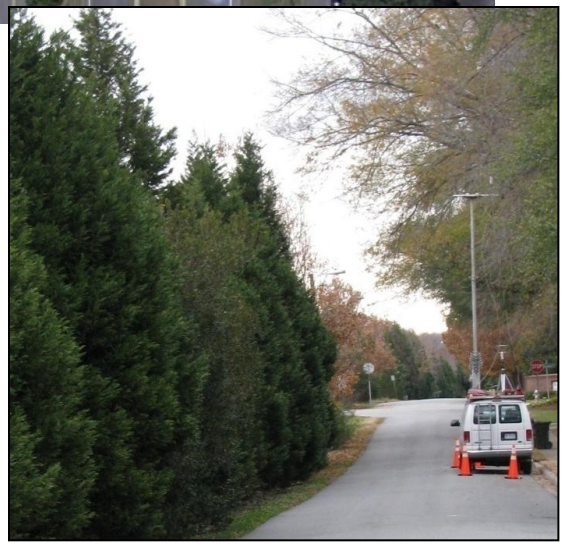
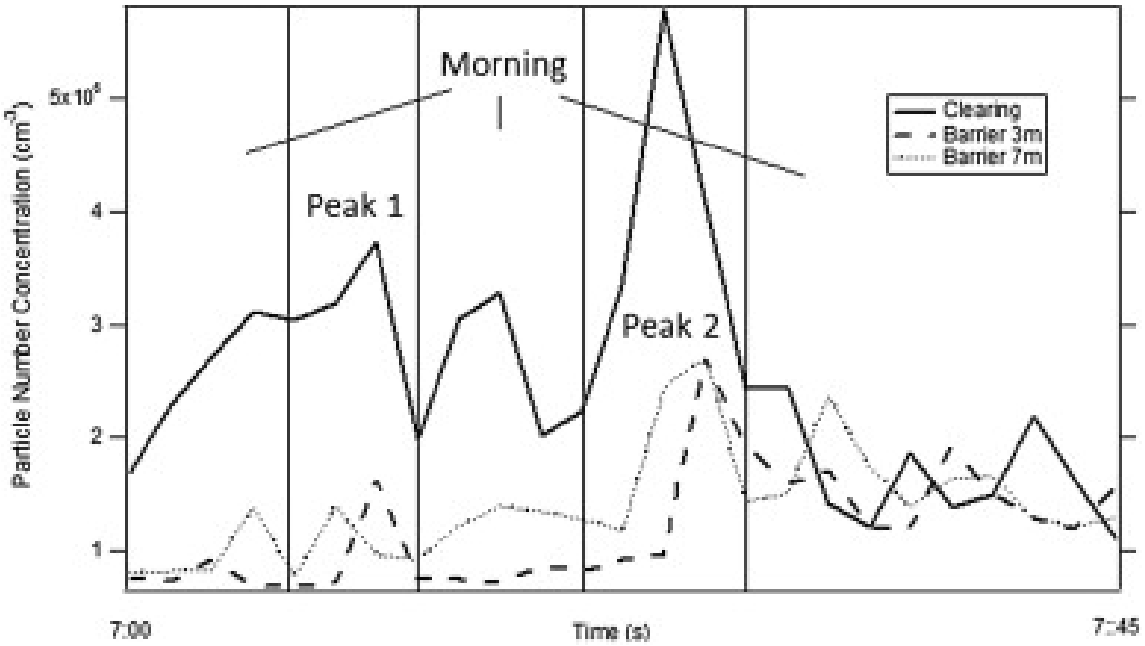




Steffans et al. (2011)



- Ultrafine PM number count generally reduced downwind of a vegetation stand
- Higher reductions most often occurred closer to ground-level
- Variable winds caused variable effects

Vegetation Effects

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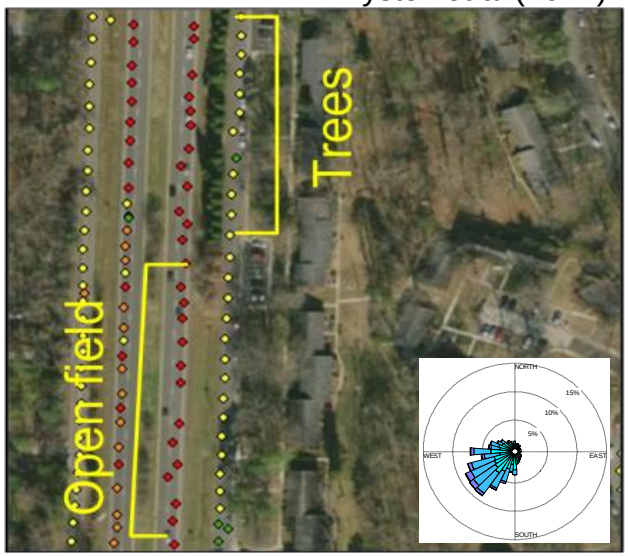
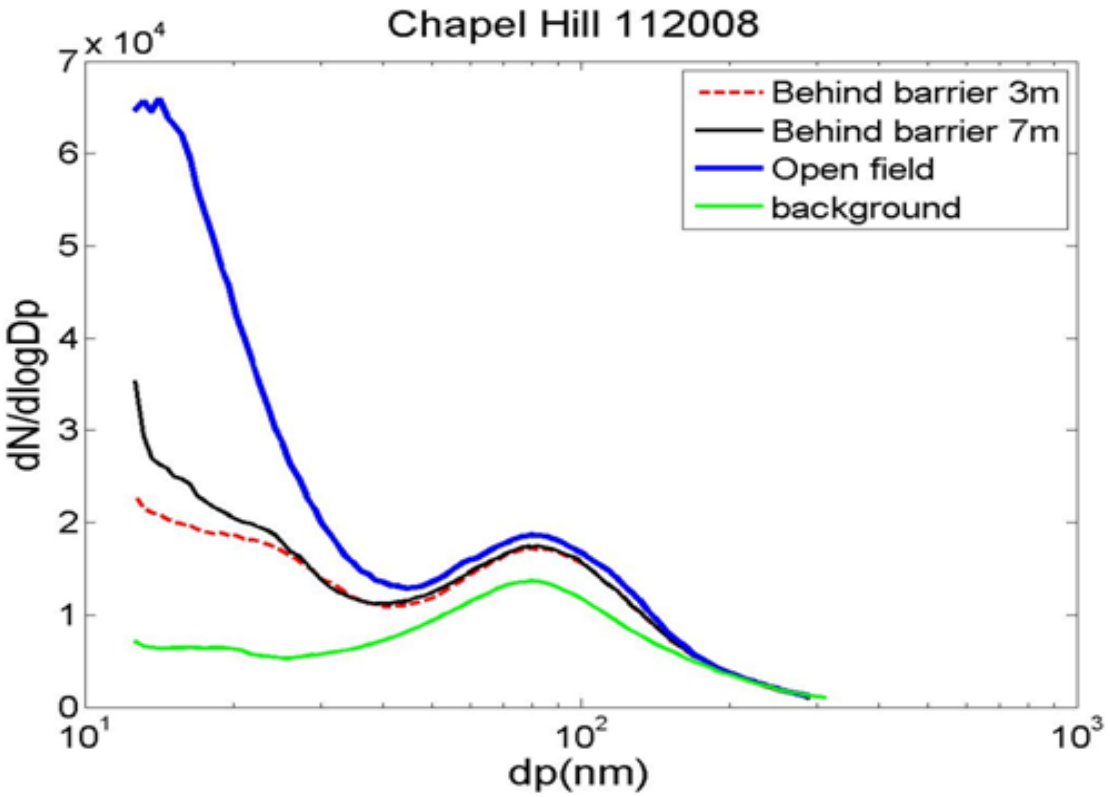
Khlystov et al (2012)

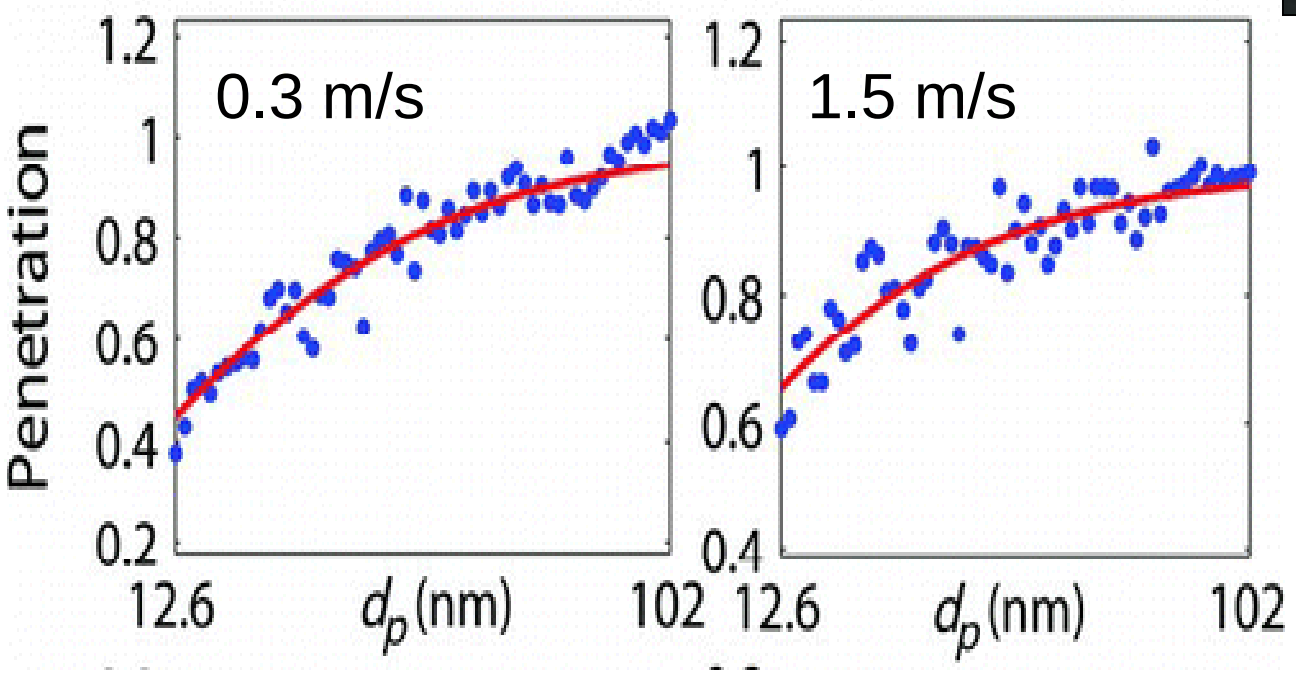


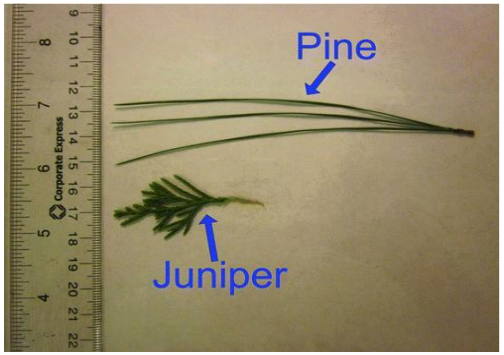


- Lower size fractions of PM most reduced downwind of the vegetation stand
- Effect most evident closer to ground-level

Vegetation Effects

- Smaller size PM have higher removal rate
- Removal increases at lower wind velocities
- Branch/leaf shape and size affects removal



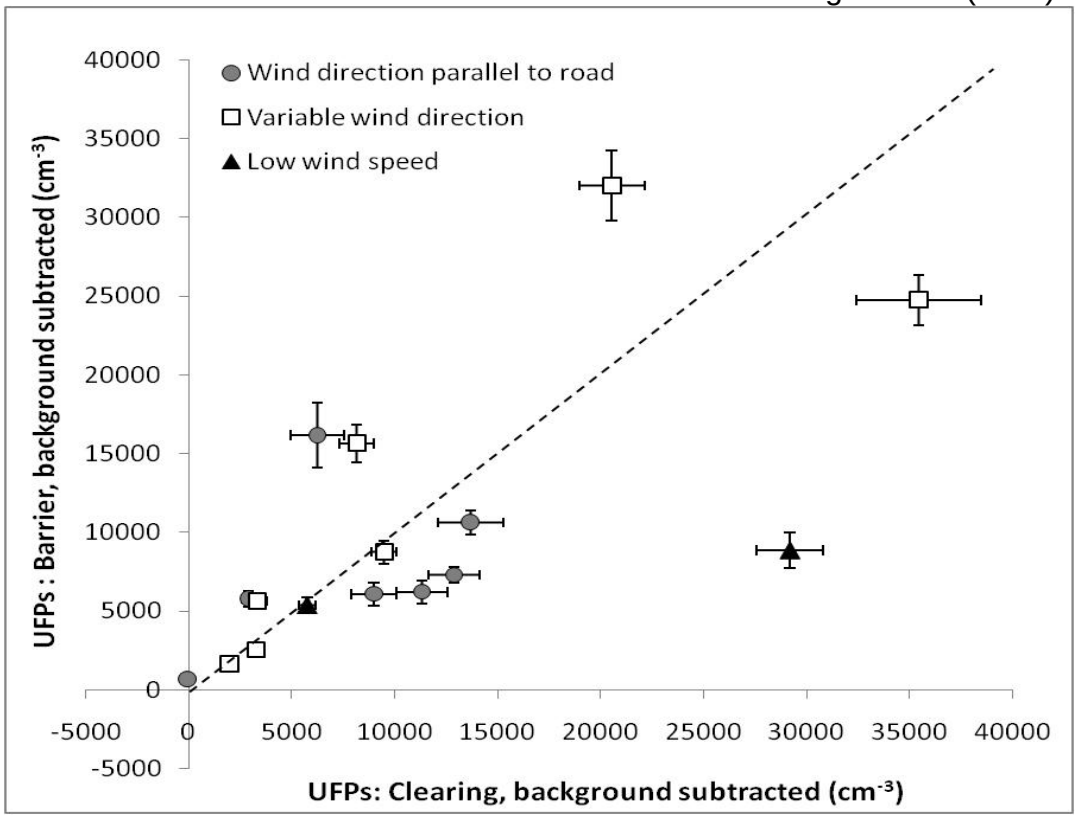


Cahill et al., (2010)

Vegetation Effects

- For thin tree stands, variable results seen under changing wind conditions (e.g. parallel to road, low winds) and larger spatial scales
- Future research looking into effects of lower porosity/wider tree stands

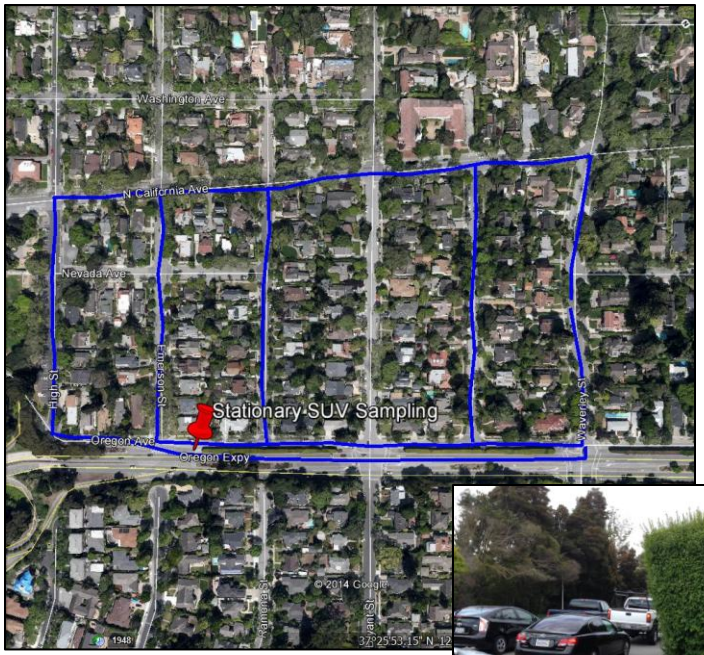
Hagler et al. (2011)

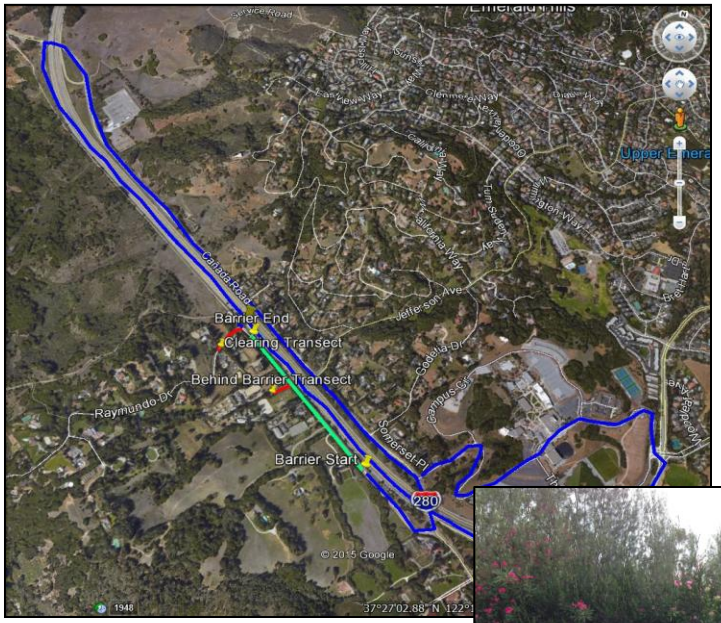


San Francisco Vegetation Study

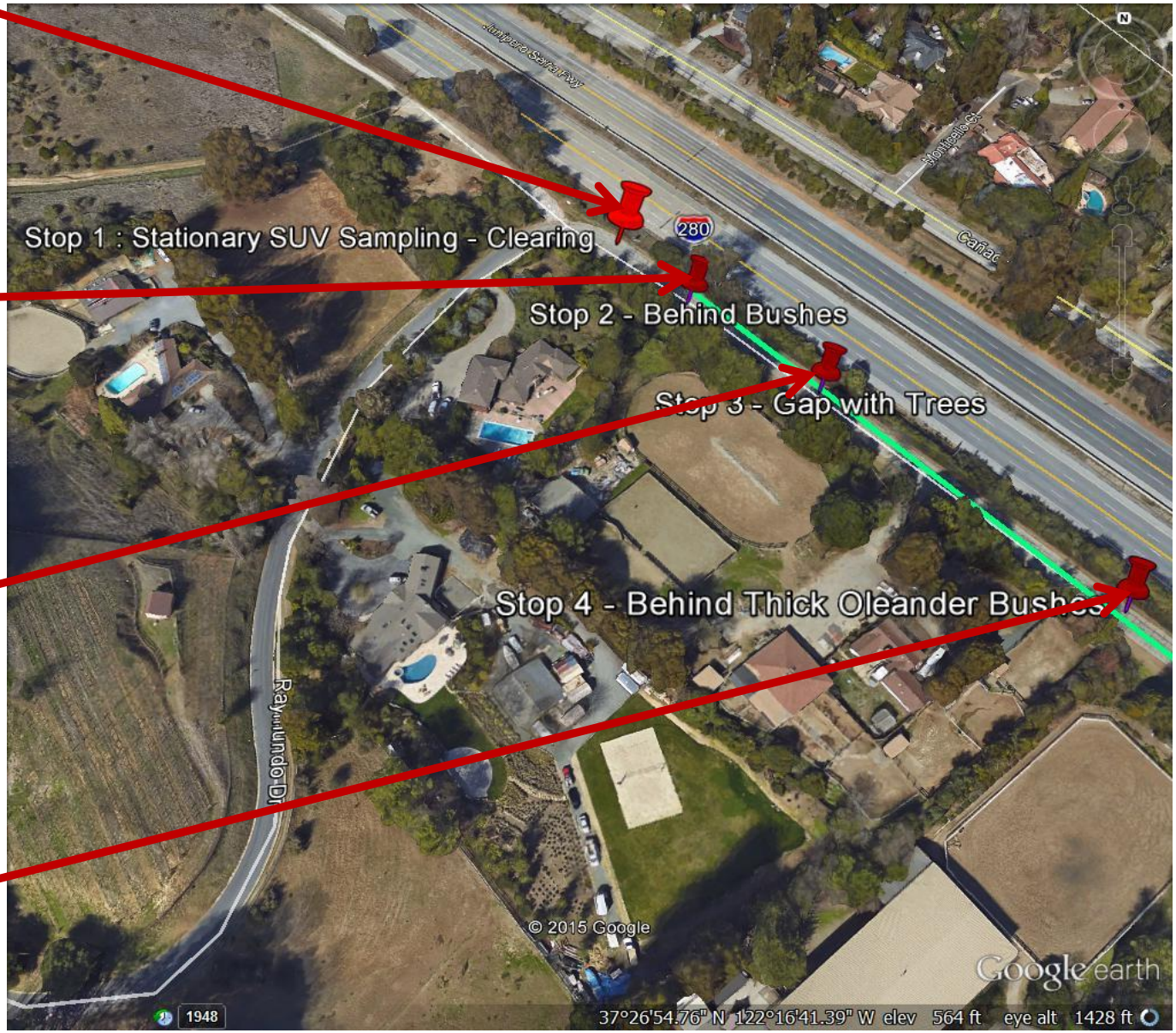
United States Environmental Protection Agency

- On-road and near-road mobile and fixed monitoring with varying vegetation types
  - Bush/tree combinations with varying porosity
  - Manicured hedges





San Francisco Vegetation Study



San Francisco Vegetation Study

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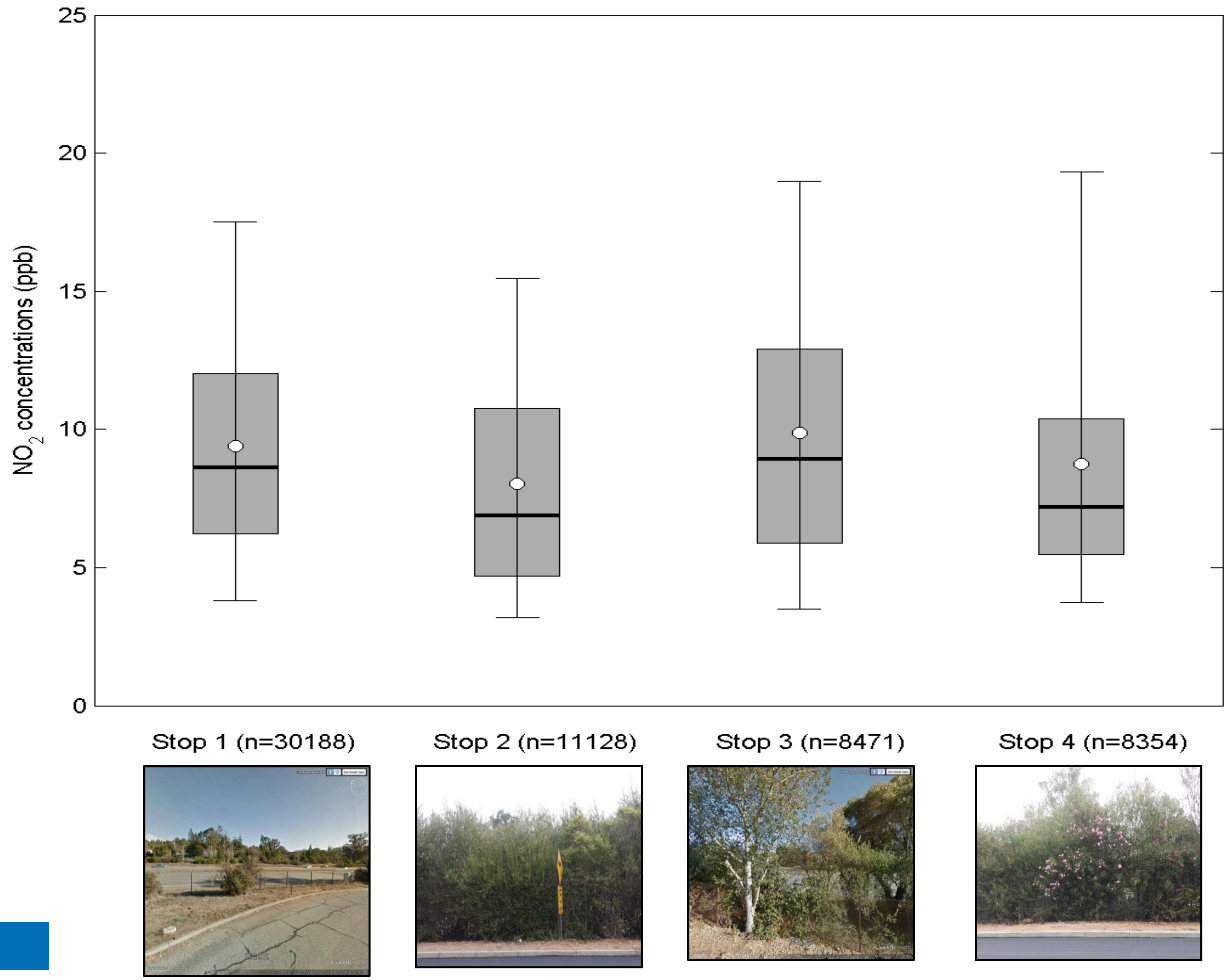
- Initial results suggest the importance of thickness, porosity and full coverage



- All wind directions
- ~10k data pts/stop
- ~10min/stop/day

Preliminary data: do not cite or quote

San Francisco Vegetation Study

United States Environmental Protection Agency

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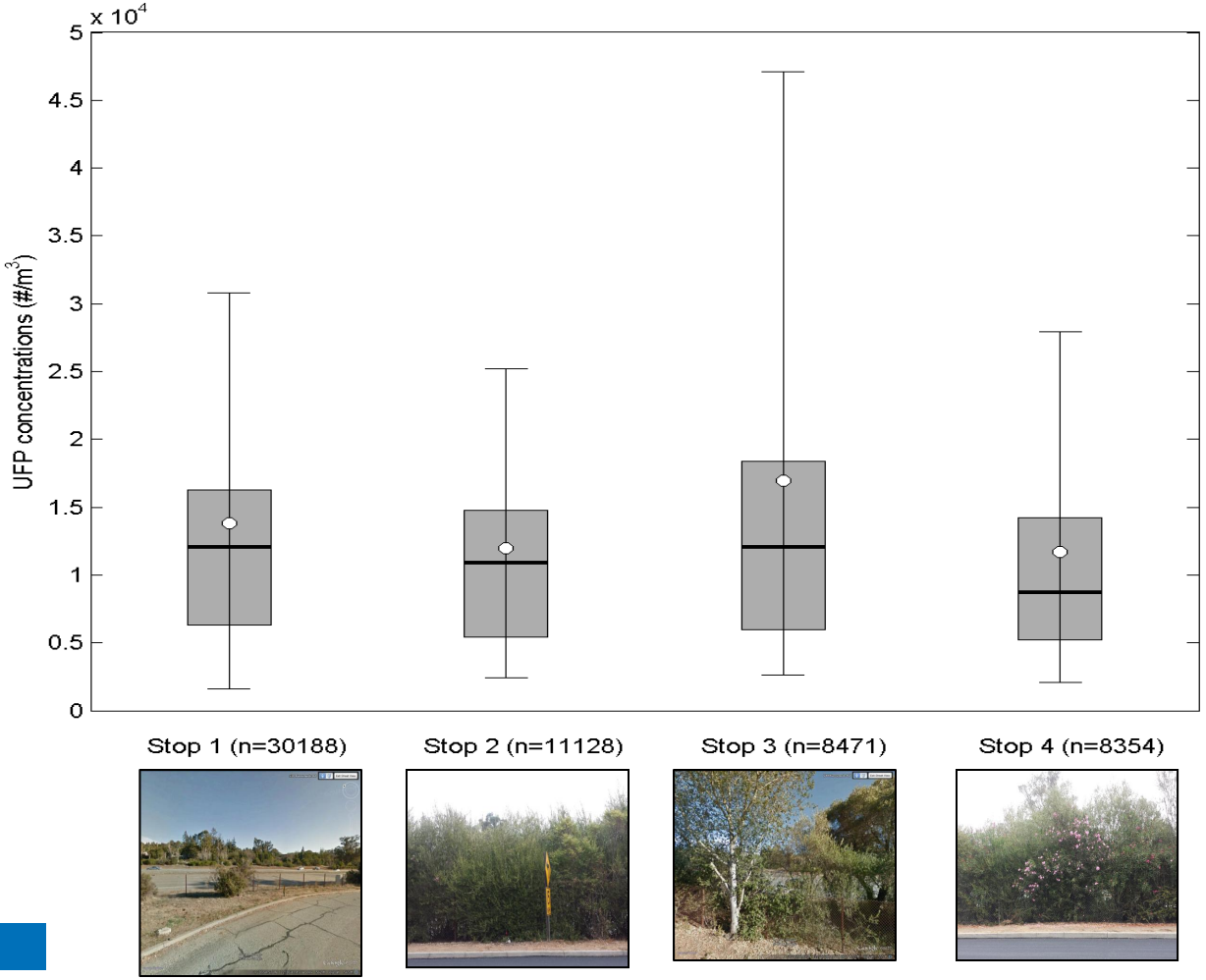

- All wind directions
- ~10k data pts/stop
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Summary - Vegetation

- Research shows the ability for roadside vegetation to reduce downwind pollutant concentrations near roads
- Design considerations are very important:
  - Generally, the higher and thicker the vegetation, the higher the pollution reduction
  - Pollutants can meander around edges or through gaps
    - Areas targeted for reductions should avoid edge effects
    - Existing vegetation with gaps may be increasing exposures
- Vegetation should be appropriate for the location of use
- Best practice guidance and case studies needed to fully evaluate potential effectiveness of roadside vegetation and avoid unintended consequences
- Models will be important in designing and evaluating vegetative barriers

Summary - Vegetation

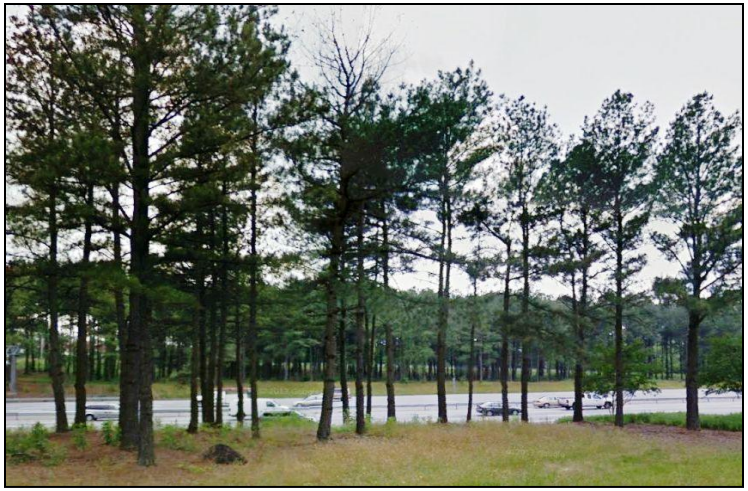
- Areas desired for reduced concentrations should avoid gaps and edge effects
  - Vegetation barrier should provide coverage from the ground to the top of canopy
  - Barrier thickness should be adequate for complete coverage so gaps are avoided
- Pine/coniferous trees and thick bushes may be a good choice
  - No seasonal effects
  - Complex, rough, waxy surfaces

Examples of full coverage barriers

Summary - Vegetation

- Pollutants can meander around edges or through gaps
- Barrier thickness should be adequate for complete coverage to avoid gaps
  - No spaces between or under trees
  - No gaps from dead or dying vegetation; maintenance important

Examples of inadequate barriers due to gaps



Summary - Barriers

- Combination of noise and vegetative barriers may provide most benefit
  - Increase potential for pollutant dispersion and removal
  - May be solid barrier with vegetation behind and/or in front
  - Use of climbing vegetation and hedges with solid barrier may also provide additional benefits
    - Field study results mixed
    - Vegetation on solid wall should extend enough to allow air to flow through

Examples of solid/vegetation barriers

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Kirk Clawson

For More Information

- Websites:
  - http://www.epa.gov/nrmrl/appcd/nearroadway/workshop.html
  - http://www.epa.gov/ord/ca/quick-finder/roadway.htm
- References

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