Sustainable Urban Atmospheres Research

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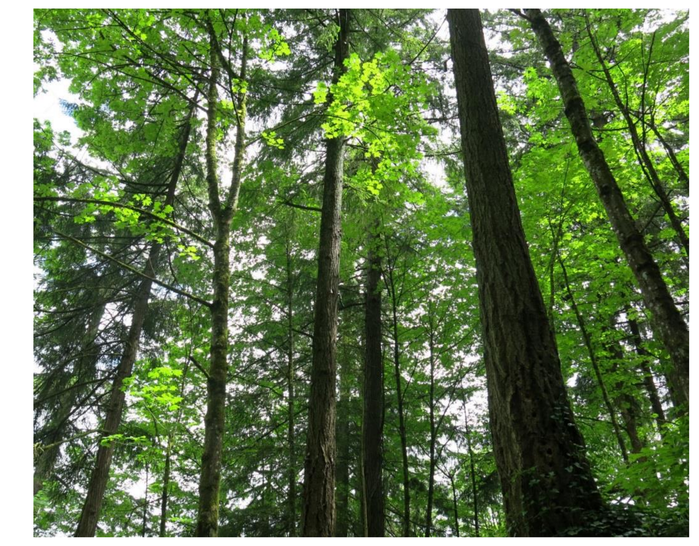
Sustaining the Quality of Urban Air



With the knowledge that the world's population is increasingly living in urban settings, our research agenda is to understand how urban systems and activities impact air quality in the urban environment as well its impact on the rural and pristine landscapes that surround cities. <u>Our goal is to use scientific knowledge to inform high and low tech mitigation measures to improve urban air quality</u>.

Urban tree canopy and nitrogen oxides

Meenakshi Rao and Rodrigo Gonzales-Abraham

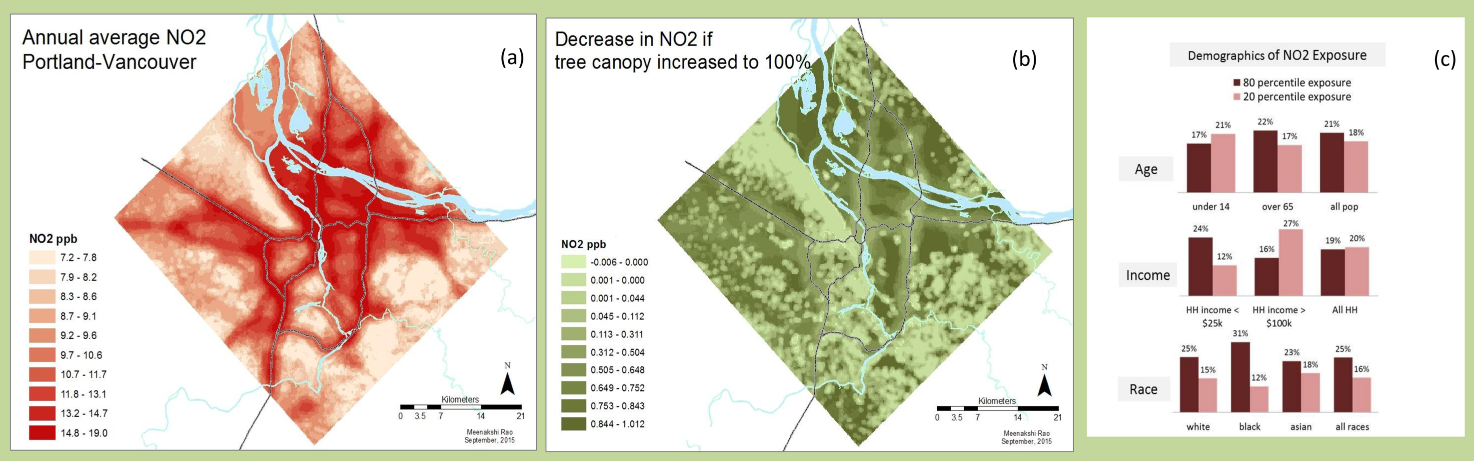
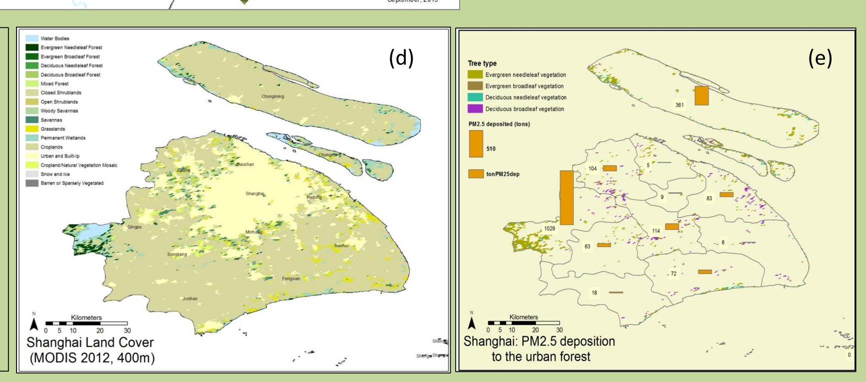
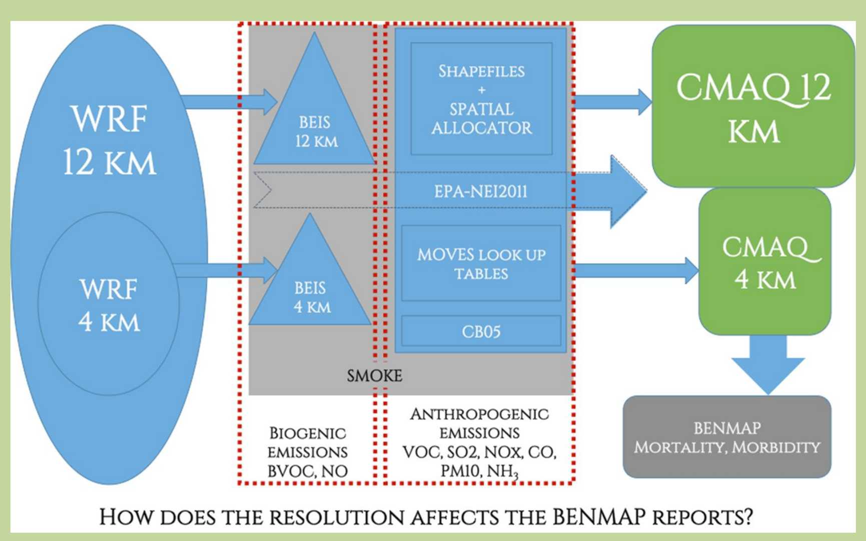


Figure 1: Average annual NO_2 in the Portland-Vancouver area, modeled using "random forest" based on summer and winter observations (174 summer, 82 winter).
Figure 2: Estimated decrease in ambient NO2 concentrations across the Portland-Vancouver area if tree canopy were maximized.
Figure 3: Demographics of exposure to NO_2 in the Portland area.
Figures 4: MODIS land cover for Shanghai China.
Figure 5: Estimated PM2.5 removed by the urban canopy, by district, in Shanghai. Calculations following Nowak et al (2013).





Can trees mitigate urban NO_2?

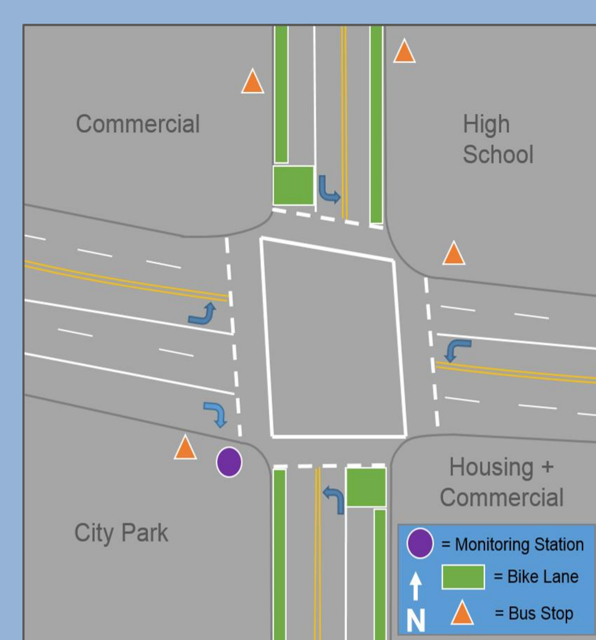
UFORE, the big-leaf deposition model from the USFS, indicates that < 1% of urban air pollutants are removed by the urban forests in US cities. Landscape level studies have found mixed results, ranging from no effect of trees on air pollutant s to removal of 1-21% of near-roadway NO_2 in Shanghai. It is clear that the role of the urban forest in removing air pollutants needs better characterization.

Combining modeling using the atmospheric chemistry and transport model CMAQ and observations of urban NO_2, we are undertaking a sensitivity analysis to better characterize therole of the urban forest in air pollution removal.

Funded by: USFS, NSF, PSU

Intelligent Traffic Management and Air Quality

Christine Kendrick and Sauda Ahmed



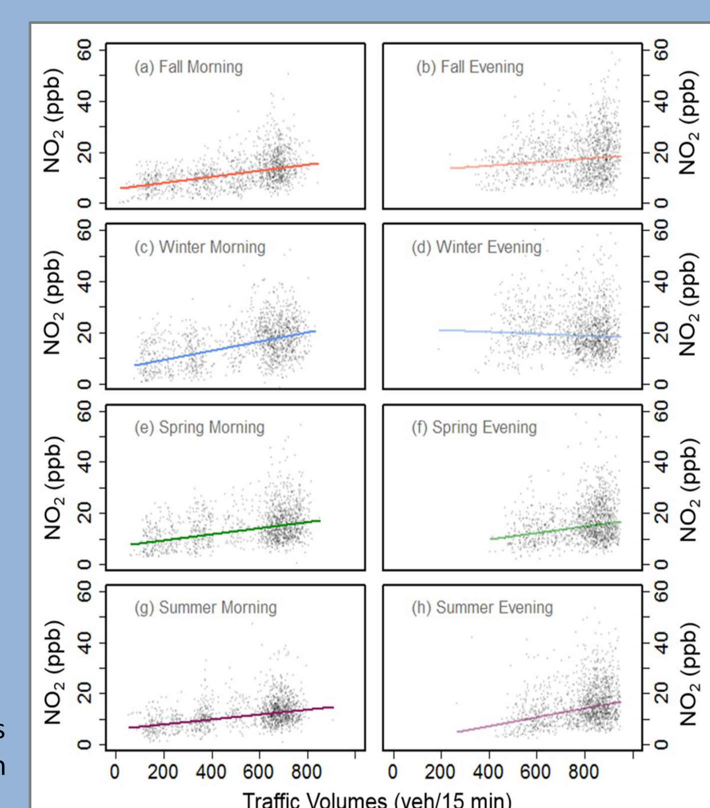


Figure above. Schematic of intersection where continuous roadside air quality monitoring station is housed in traffic signal cabinet. **Figure right**. Median roadside NO_2 as a function of traffic volumes.

Research Objectives

- Establish unique roadside air quality monitoring station for an urban arterial roadway. Air quality data is integrated with continuous traffic volumes, measures of congestion, and traffic signal operation variables.
- Determine when and how traffic volumes can be used as a proxy for exposure assessment.
- Use covariate and propensity score matching to assess the effects of changing traffic signal cycle lengths on roadside NOx as traffic signal timing is a potential mitigation strategy.
- Compare dispersion modeling predictions with measurements to improve modeling methods.

Publications

Kendrick, C.M., Koonce, P., George, L., 2015. Diurnal and seasonal variations of NO, NO2, and PM2.5 mass as a Function of traffic volumes alongside an urban arterial. *Atmospheric Environment, 122*, 133-141.

Kendrick, C.M., Moore, A., Haire, A., Bigazzi, A., Figliozzi, M., Monsere, C., George, L., 2011. The Impact of Bicycle Lane Characteristics on Bicyclists Exposure to Traffic-Related Particulate Matter. *Transportation Research Record: Journal of the Transportation Research Board, No. 2247*, 24-32.

George et al. 2011. Evaluation of Transportation Microenvironments Through Assessment of Cyclists' Exposure to Traffic-Related Particulate Matter Oregon Transportation Research and Education Consortium Final Report.

Funded by: EPA, NSF, NITC, USDOT

Impact of Reactive Nitrogen on the Columbia River Gorge

Jacinda Mainord and Philip Orlando

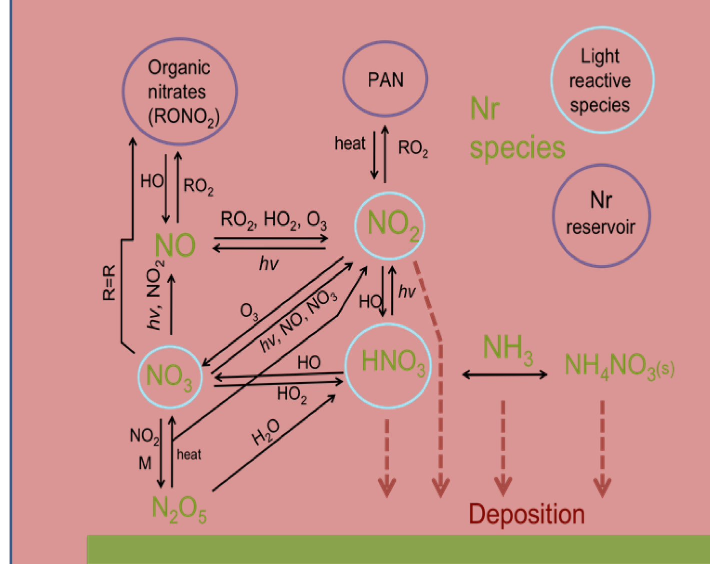


Figure 1. Possible reaction pathways, reservoirs and sinks for reactive nitrogen species.

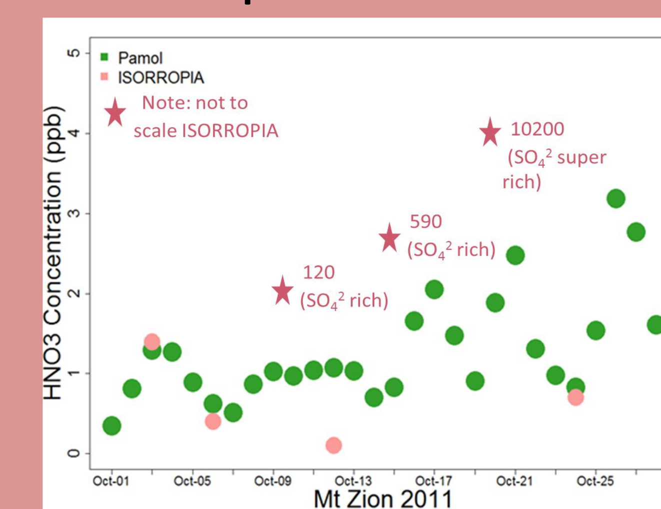


Figure 2. Gas (Pamol) and aerosol (ISORROPIA) box model HNO_3 predictions at Mt Zion IMPROVEi n October 2011.

The Columbia River Gorge, located between the states of Oregon and Washington, can be used as a natural flow tube with seasonal and bimodal winds with unique sources of reactive nitrogen constrained at the eastern and western ends. On the west, Portland-Vancouver metropolitan area influences summertime reactive N with predominately westerly winds. In the east lie Boardman coal-fired power plant and 25000 cattle head confined animal feeding operation and influence the gorge with winter easterlies.

With these unique sources and wind patterns, our **research objective is to characterize the influence of source on reactive nitrogen partitioning and secondary inorganic aerosol (SIA) formation and to compare observations of reactive nitrogen with model predictions**. How are reactive N species different in urban, industrial and agricultural plumes? Can gas phase and aerosol phase box models agree on predictions of nitric acid (HNO_3)?

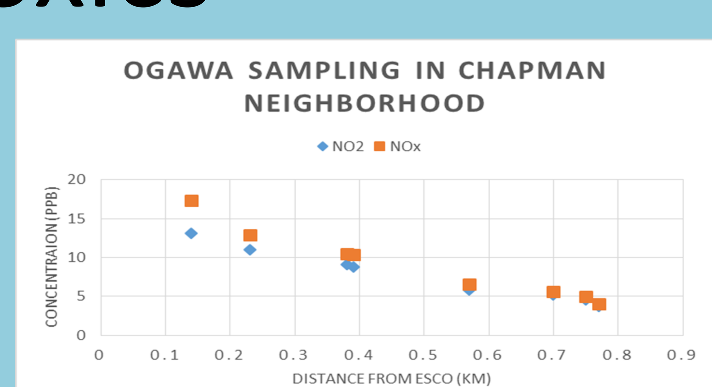
We used gas phase kinetic box modeling (Pamol) using ambient precursors to predict HNO_3 formation and compared with aerosol thermodynamic box model (ISORROPIA) equilibrium gas phase concentrations. We found that sometimes the models agree, but in conditions with sulfate rich and sulfate super rich aerosols, ISORROPIA HNO_3 equilibrium concentrations were magnitudes greater than Pamol predictions. Additional measurements of HNO3 and NH3 will be made in order to investigate more key players and reactions in the formation of SIA and their precursor gas phase concentrations.

Funded by: NSF

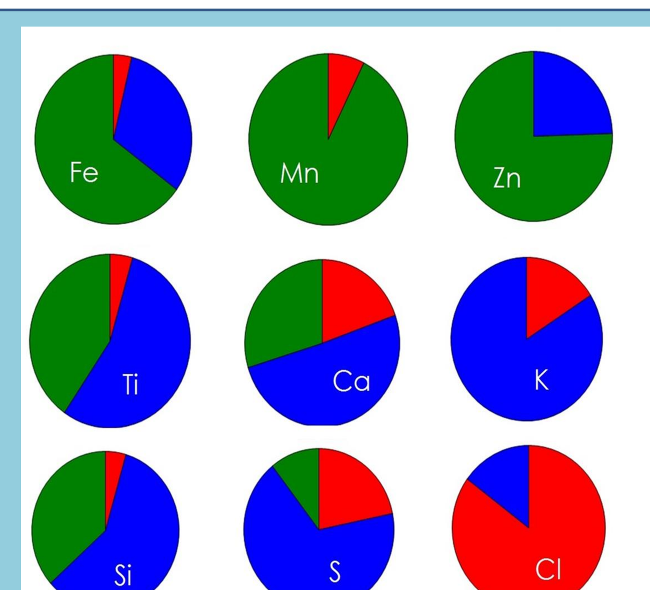
Intra-urban air toxics

Derek Espinoza (NSF- REU Student)

Exposure to air toxics, such as heavy metals, are a significant concern in urban settings where manufacturing co-exists with residential areas. We have been exploring methods to rapidly deploy instruments to assess air toxics exposure in urban areas. In this study we deployed a field particulate matter sampler at a neighborhood school near an industrial facility. The filters were analyzed for heavy metals. The metal data was further analyzed by Positive Matrix
Factorization to statistically determine the source categories impacting the school. Field sampling can be easily deployed but is an expensive method to assess air quality for every neighborhood. Some works in progress: We working are working on a mobile app for geo-coding human perception to air quality that would be integrated into a dispersion model. In addition we are working with Intel Corp. to develop high quality low-cost/low power air quality sensors that can be easily deployed.



Nitrogen dioxide was measured as a tracer from the industrial site to the school receptor site. The decay indicates that emissions from the source is likely diluted by around a factor of three by the time it reaches the school.



Industry, Residential, Area

Positive Matrix Factorization analysis of Chapman data indicates the likely source categories for the metals measured at Chapman

Standing: Philip Orlando, Meenakshi Rao, Linda George, Christine Kendrick, Jacinda Mainord; Kneeling: Derek Espinoza, Sauda Ahmed, Rodrigo Gonzales-Abraham