REDUCED-FORM AIR QUALITY MODELING FOR COMMUNITY-SCALE APPLICATIONS

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Motivation

Transportation plays an important role in modern society, but its impact on air quality has been shown to have significant adverse effects on public health. Busy roadways and large emission sources can impact local air quality within several hundred meters of the source. At present, EPA estimates >50 million people in the U.S. living within 100 meters of major roads and transportation facilities. About 2 million school children attend classes at a school within 200 meters of a highway. On average, people spend >1 hour per day driving on roads. These statistics highlight the public health significance of near-road exposures. There is also a strong scientific consensus on elevated health risks for near-road populations. Numerous reviews (HEI, CDC, WHO) summarizing findings of hundreds of studies conducted mainly in the last decade, conclude that exposures to traffic emissions near roads are a “public health concern.” There is a need to inform community members of local air quality impacts from transportation-sources in their neighborhoods.

C-LINE model

The Community LINE Source Model (C-LINE) is a web-based model designed to inform the community user of local air quality impacts due to roadway vehicles in their region of interest using a simplified modeling approach. As has been established in near-road and near-source monitoring studies, busy roadways and large emission sources, respectively, may impact local air quality near the source. Reduced-form air quality modeling is a useful tool for examining what-if scenarios of changes in emissions, such as those due to changes in traffic volume, fleet mix, or vehicle speed. Examining various scenarios of air quality impacts in this way can identify potentially at-risk populations located near roadways, and the effects that a change in traffic activity may have on them. C-LINE computes dispersion of primary mobile source pollutants using meteorological conditions for the region of interest and computes air-quality concentrations corresponding to these selected conditions. C-LINE is currently available as a "beta-version" and will be made publicly available in October 2016. To access C-LINE online via CMAS, the user must create a CMAS account and log in before using the model (https://www.cmascenter.org/c-tools/c-line.cfm).

C-PORT model

C-LINE functionality has been expanded to model emissions from port-related activities (e.g. ships, trucks, cranes, etc.) in a reduced-form modeling system for local-scale near-port air quality analysis. Ports are a critical feature of the US & world economy; 95% of all foreign goods by weight enter U.S. through ports. U.S. has 360 commercial ports, including 150 deep-draft seaports. Ports may be considered multi-modal transportation facilities as they typically have truck and rail yard facilities for the shipment of goods to and from the port. Multiple air pollutants can be emitted from these multi-modal facilities, affecting communities near the port as well as along freight movement corridors. To address these issues we developed the Community modeling system for near-PORT (C-PORT) assessments. It is capable of identifying potential locations of elevated air pollution concentrations. C-PORT includes pollution from ships, truck traffic, rail, port activities. The model is based on dispersion algorithms, local emissions, and GIS methodology. C-PORT will be available for beta testing online via CMAS in summer 2016 (https://www.cmascenter.org/c-tools/)

Intended End Users

C-LINE/C-PORT is a modeling and visualization system that access inputs, performs atmospheric dispersion calculations, visualizes results, provides options to manipulate input variables, and performs basic data analysis to present model results in an interpretable manner. It is intended to inform the community user of local air quality due to mobile-source emissions using a simplified modeling approach. The model is intended to be used by local government, city planners and community groups. C-LINE accesses publicly available traffic and meteorological datasets, and is optimized for use on community-sized areas (100-1,000 km^2). The user is not required to provide input data, but can provide their own if desired. C-LINE/C-PORT models are not intended for regulatory use.

Summary and Ongoing Research

This research has highlighted the need for easy to use models that can accurately assess impacts of traffic and other transportation facilities on nearby air quality. The model has also provided a framework for integrating new modeling algorithms developed through research and development of the R-LINE model on pollutant transport and dispersion from roadways. In future efforts, we plan to expand the functionality of newly developed community models C-LINE and C-PORT to provide more accurate exposure characterization near emission sources: near ports, near airports (C-AIRPORT) and near distributed generation sources (C-ENERGY).

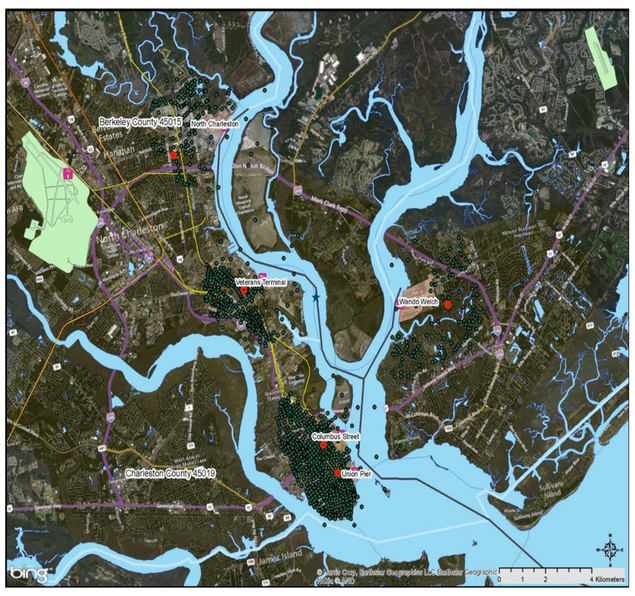
Example of C-PORT application in Charleston, SC

As freight volume increases in some ports, communities near the port and along goods movement corridors may experience increased local-scale air pollution due to increased traffic. The C-LINE/C-PORT tool would allow to identify potentially at-risk populations located near emission sources, and the effects that change in traffic and other port-related activities may have on them.

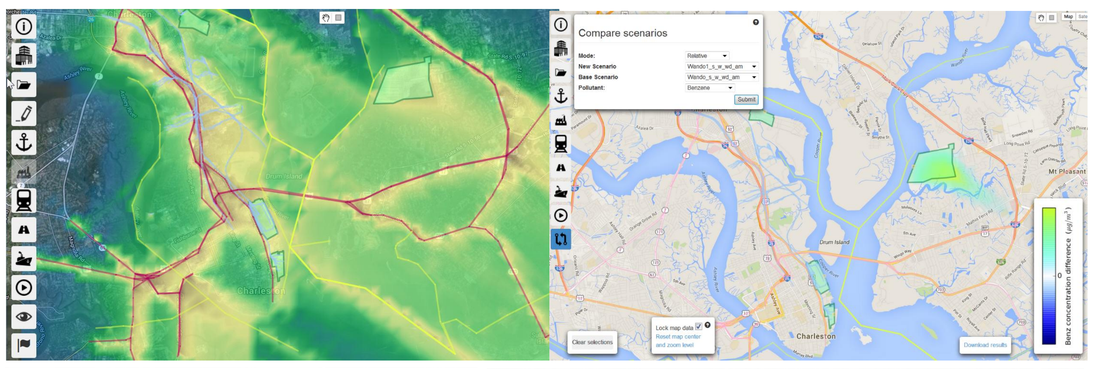
Containers: Wando Welch Terminal

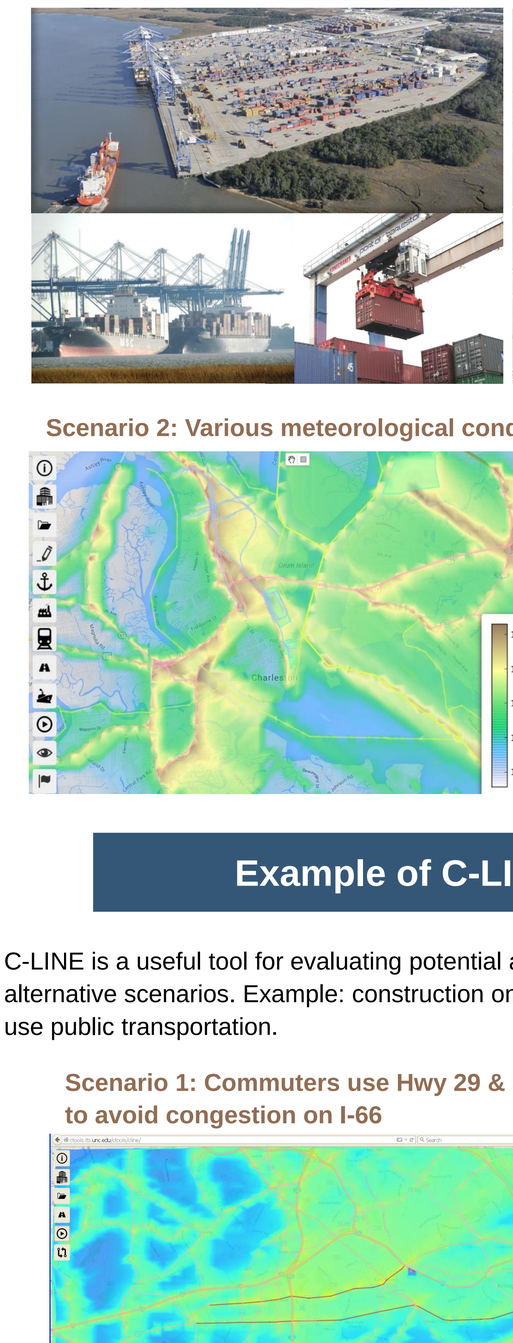
Rolling freight: Columbus Terminal

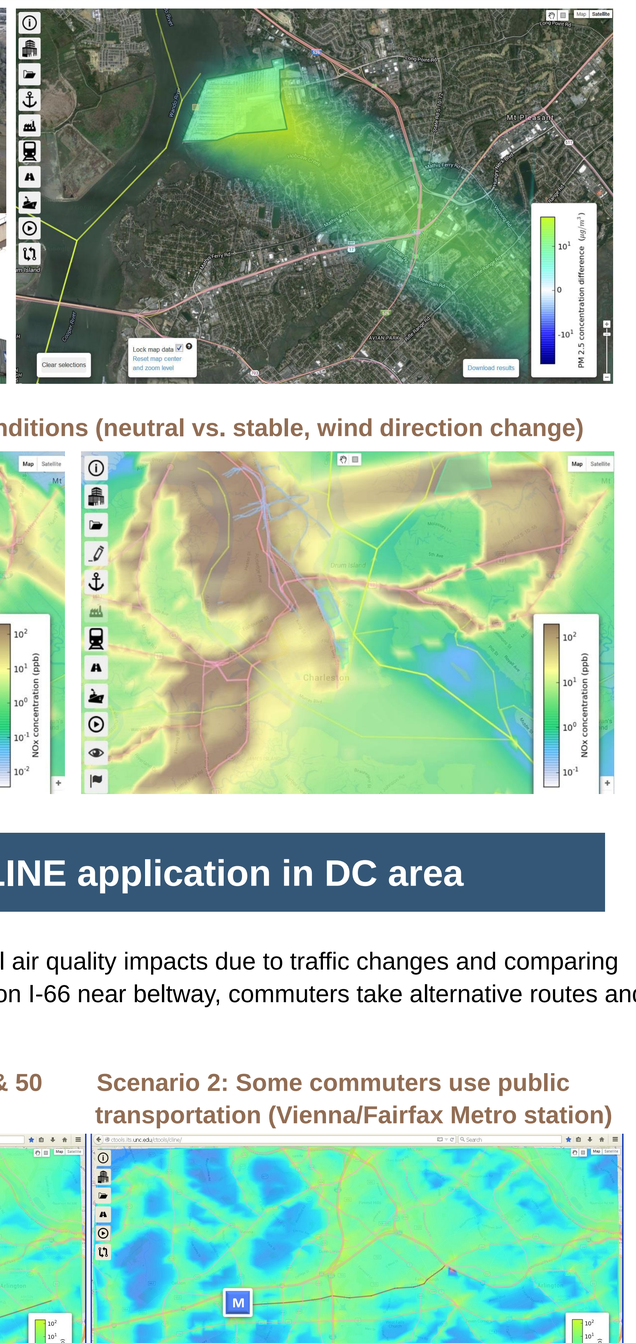
Bulk material: Veterans Terminal



Scenario 1: Emission controls at Wando container terminal







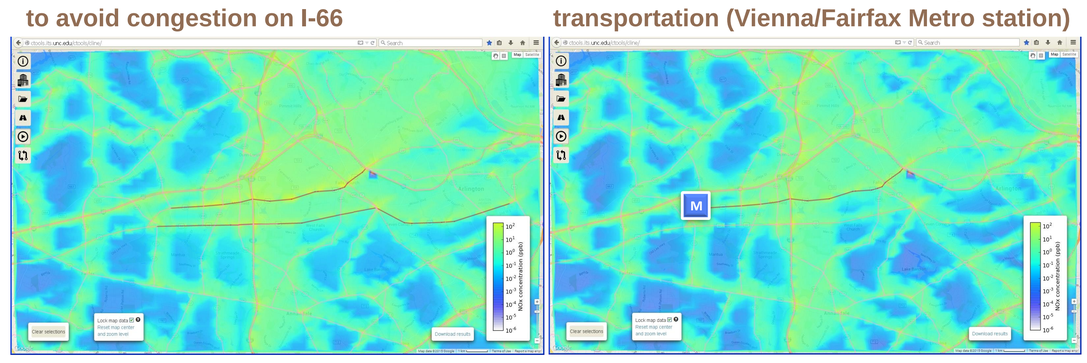
Scenario 2: Various meteorological conditions (neutral vs. stable, wind direction change)

Example of C-LINE application in DC area

C-LINE is a useful tool for evaluating potential air quality impacts due to traffic changes and comparing alternative scenarios. Example: construction on I-66 near beltway, commuters take alternative routes and use public transportation.

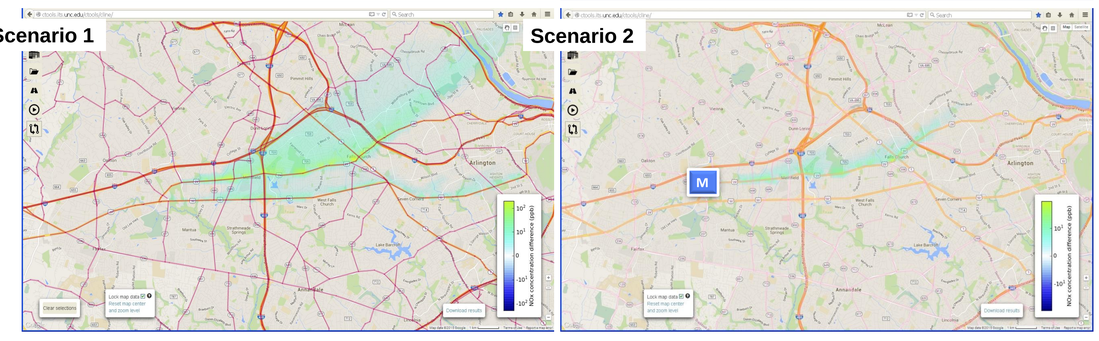
Scenario 1: Commuters use Hwy 29 & 50 to avoid congestion on I-66

Scenario 2: Some commuters use public transportation (Vienna/Fairfax Metro station)



Scenario 1

Scenario 2



Concentration difference due to increased traffic on Hwy 29 and Hwy 50