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REDUCED-FORM AIR QUALITY MODELING FOR COMMUNITY-SCALE APPLICATIONS

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Abstract: 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. 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. 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. 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 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. This presentation describes the Community modeling tools C-LINE and C-PORT that are intended to be used by local government, city planners and community groups.

Key words: *Air pollution, Dispersion Modeling, Emissions, Exposure*

INTRODUCTION

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. 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. Health effects have been associated with near-road exposures and proximity to large emission sources, so characterizing emission sources is important for understanding potential health effects. Community groups are becoming increasingly active in local initiatives that seek to mitigate potentially harmful environmental conditions. However, there is a lack of tools that can be applied to study near-source pollution in an easy manner, and explore the benefits of improvements to air quality and exposures – either due to voluntary or mandatory programs. To address this need, US EPA is developing tools to help community groups to assess air quality impacts from roadway traffic and other sources potentially affecting the community. The modeling tools are designed for a quick assessment and they require limited technical expertise. Such web-based, easy-to-use models can provide valuable insights for the community and can also assist with the decision-making process.

REDUCED-FORM MODELS FOR COMMUNITY-SCALE APPLICATIONS

Reduced-form models provide an opportunity to examine how changes in input parameters can affect results. The power of such tools is to be able to make these assessments in a fairly quick time, and to assess what-if scenarios. These scenarios are created by changing input parameters related to activity, emissions or even meteorological parameters and understanding changes in associated air quality at community scales (that typically range from 10 to 100 square kilometers). The targeted user-community is expected to be non-technical and less sophisticated with modeling expertise, and hence the web-based approach to keep things more intuitive and easy to use.

We are developing a series of community tools (e.g. C-LINE and C-PORT) to study local air quality due to various sources. Each community tool is a modeling and visualization system that accesses inputs, performs calculations, visualizes results, provides options to manipulate input variables, and performs basic data analysis all through an easy-to-use web-based interface. These reduced-form models are intended to support local communities and planners to get an initial assessment of near-source air quality impacts of transportation-related sources (roads, ships, terminal activities, etc.) using national-scale input databases, and reduced-form modeling approaches. These reduced-form models use standard dispersion algorithms and have been evaluated against other regulatory dispersion models, access publicly available emissions, traffic and meteorological datasets, and are optimized to use in community-sized areas (100-1,000 km^2). The user is not required to provide input data, but can provide their own if desired.

Community-LINE Source Model (C-LINE)

The **C**ommunity **LINE** Source Model (C-LINE) is intended to inform the community user of local air quality impacts due to mobile sources in their region of interest (Barzyk et al., 2015). C-LINE is a web-based model that estimates emissions and dispersion of toxic air pollutants for roadways in the U.S. This reduced-form air quality model can examine what-if scenarios for changes in emissions, such as traffic volume, fleet mix and vehicle speed. C-LINE accesses 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 (Fig 1). C-LINE can identify potentially at-risk populations located near roadways and effects that changes in traffic activity may have on those populations. Currently, C-LINE is capable of modeling any region of the U.S. and can be applied to a number of community-scale applications such as assessing air quality by schools located near busy highways. C-LINE is intended to support local communities and planners to get an initial assessment of near-source air quality impacts of transportation-related sources using national-scale input databases, and reduced-form modeling approaches. C-LINE computes air quality concentrations of primary mobile source pollutants using an analytical version of the R-LINE dispersion model. Specific emissions for each road link are calculated by combining national database information on traffic volume and fleet mix with emissions factors from EPA's MOtor Vehicle Emission Simulator (MOVES) modeling system. Users can modify emissions for each road link by changing traffic composition, speed and/or volume. C-LINE is currently capable of modeling any region of the United States. C-LINE 2.0 can be downloaded from the Community Modeling and Analysis System (CMAS). The CMAS is currently operated under contract by the University of North Carolina at Chapel Hill's Institute for the Environment (https://www.cmascenter.org/c-tools/)

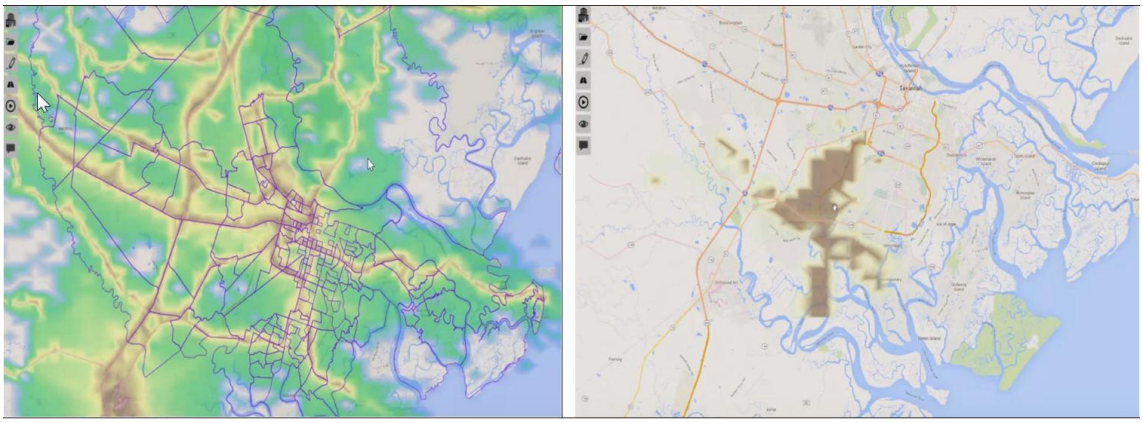

Figure 1. Example screen shot from C-LINE showing modelled near-road pollutant gradients (left) as well as the change in $PM_{2.5}$ concentrations resulting from emissions changes (right).

Community modeling system for near-port air quality analysis (C-PORT)

The **C**ommunity modeling system for near-**PORT** (C-PORT) Tool is intended to inform the community user of localized air quality due to port-related activities in their region of interest using a simplified modeling approach. C-PORT provides a platform for air quality modeling and visualization that can

inform community users about ways that emissions from commercial ports can impact local air quality. The model allows users to visualize and evaluate different planning scenarios under consideration, helping them identify the impacts of varying development alternatives to help make better long-term decisions that protect community health and promote sustainability. Using C-PORT, for example, communities can model the impact of proposed or potential development scenarios, such as increased transport, alternative trucking routes, or alternative energy sources (Fig. 2). In addition, C-PORT can help community leaders identify local hotspots and estimate relative contributions from different source sectors, focus on specific nearby populations and locations, and incorporate input from citizen science and data collection activities, as available, thereby identifying where additional mitigation (e.g. tree buffers) might further reduce potential impacts. The web-based, and easy-to-use interface currently includes data from 20 coastal ports (Seattle, WA; Baltimore, MD; New York/New Jersey; Hampton Roads, VA; Morehead City, NC; Wilmington, NC; Charleston, SC; Savannah, GA; Brunswick, GA; Jacksonville, FL; Port Canaveral; Palm Beach, FL; Everglades, FL; Miami, FL; Tampa, FL; Panama City, FL; Pensacola, FL; Mobile, AL; Gulfport, MS; Pascagoula, MS), and has a map-based interface similar to the widely used Google Earth. The tool has been developed for visualizing changes in air quality due to changing development scenarios, and is not intended to support or replace any regulatory models or programs.

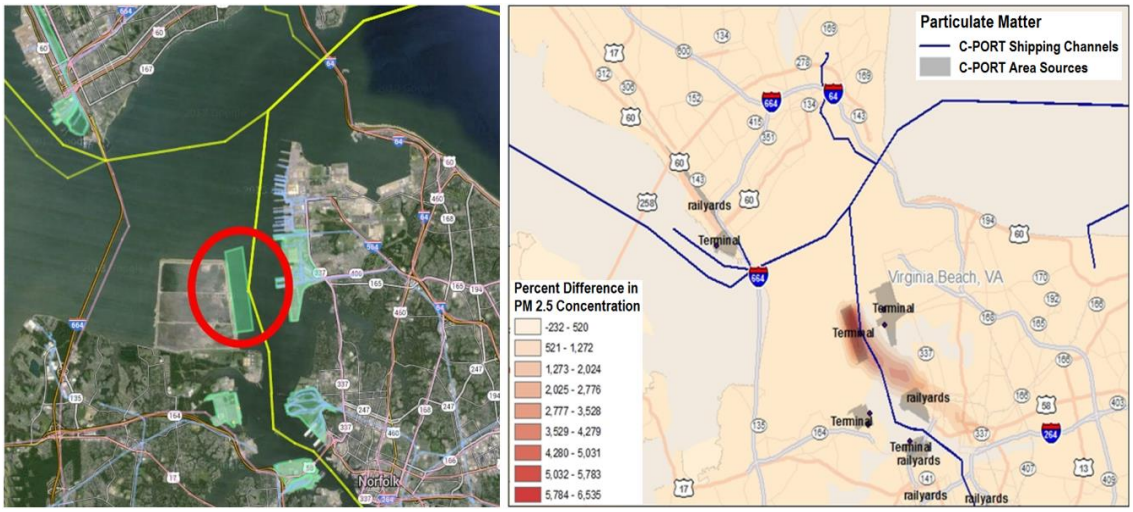

Figure 2. Example screen shot from C-PORT showing planned construction of Craney Island to increase container volumes at Panama Canal (left) as well as the change in PM2.5 concentrations (%) resulting from the proposed expansion (right)

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