An Investigation of Summertime Emissions Along the Wasatch Front According to the Post-SMOKE 2017 Emissions Inventory

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Abstract

Emissions inventories play a critical role in efforts to understand and mitigate harmful air pollution. Typical inventories contain estimations of a pollutant's emission rate on an annual basis per emission source (tons per year). Air quality modelers use this annualized estimation to further describe the pollutants' spatial distribution, temporal distribution, and chemical speciation using the Sparse Matrix Operating Kernel Emissions model (SMOKE). Post-SMOKE inventories help us understand emissions during peak pollution seasons along the urban corridor.

The Northern Wasatch Front (Salt Lake, Davis, and parts of Tooele and Weber counties) is a designated ozone nonattainment area. The reports included in this presentation highlight post-SMOKE anthropogenic* emissions inventories for a representative ozone exceedance day in July, 2017. The reports are interactive and allow users to deeply explore emissions sources that contribute to ozone formation in the nonattainment area.

Researchers at the Utah Division of Air Quality (UDAQ) are excited to share these model results in an easily accessible format that can help inform the public about ozone precursor emissions.

Background

The summertime emissions inventory shown here is part of UDAQ's ozone State Implementation Plan (SIP) for the Northern Wasatch Front. The important precursor pollutants that allow ozone to form in the atmosphere are the oxides of nitrogen (NOx) and volatile organic compounds (VOC). Both NOx and VOC are emitted from anthropogenic sources along the Wasatch Front, such as vehicles, paint, or lawnmowers. The interactive inventory will help you explore the sources of NOx and VOC from many different emission source types (**anthropogenic* sources only**). Emissions inventories are collected and processed through the Sparse Matrix Operating Kernel Emissions Model (SMOKE). SMOKE modeling spatially allocates, temporalizes, and chemically speciates annual emissions estimations from the emissions inventories. Emissions inventories contain annual estimations of the amount of pollutant emitted from a given emission source, typically represented in tons of that pollutant per year. SMOKE takes that annual emission rate and some other inputs to determine 1) where the emissions are coming from geographically, 2) when those emissions are emitted throughout the year, month, and week, and 3) what chemical species are included in the emission of pollutant. From SMOKE, air quality scientists get emissions data in tons of pollutant per day for a given emissions source. Emissions sources are identified by a Source Classification Code (SCC). Each SCC represents a unique source category-specific process or function that emits air pollutants. SCC's and their emissions are classified into broader source sectors. Sectors relevant to the Northern Wasatch Front Ozone State Implementation Plan include: nonpoint, point, electric generating units (EGU's), onroad mobile, nonroad mobile, airports, rail, solvents, and livestock.

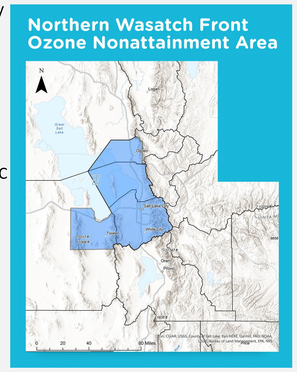

Figure 1: The Northern Wasatch Front Ozone Nonattainment area boundary.

Figure 2: Emissions sectors used in SMOKE modeling. Broader sectors (area, nonroad mobile, point, and onroad mobile) were used in previous SMOKE modeling exercises. Recent improvements to SMOKE inputs and emissions inventories allow for the newer, more highly resolved emissions sectors listed inside the green & blue rectangles.

Click below to explore the interactive emissions inventory!

https://deq.utah.gov/air-quality/finding-emission-reductions-for-ozone

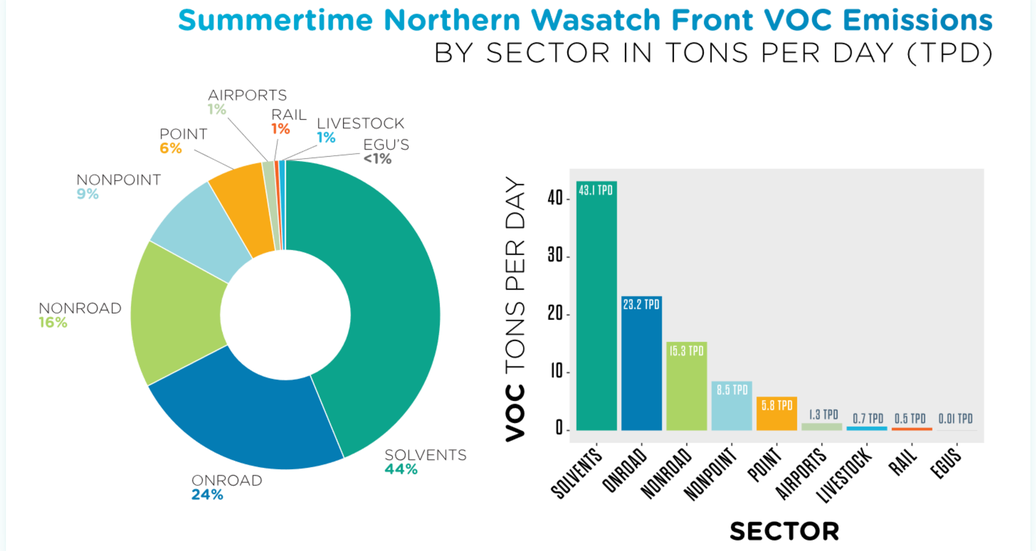

Figure 3: VOC emissions from all emissions sectors in the Northern Wasatch Front Summertime emissions inventory (Salt Lake, Davis, and parts of Weber and Tooele counties). All emissions shown in tons of VOC per day. Emissions modeled for representative ozone day, July 5th, 2017.

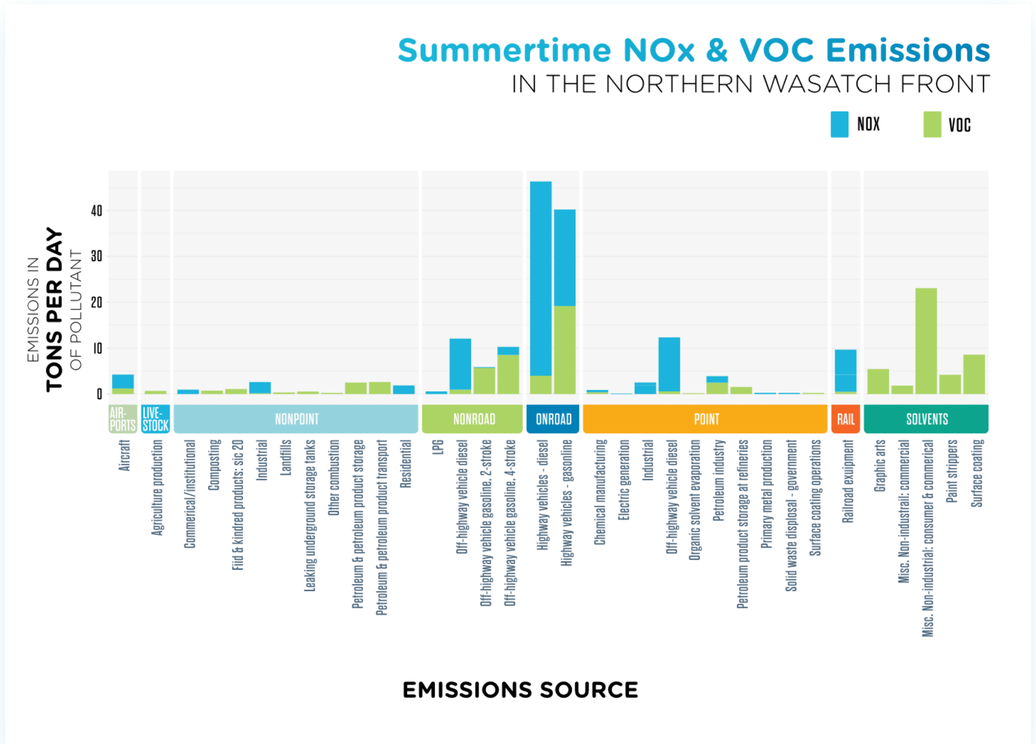

Figure 4: VOC and NOx emissions from various sectors and select Source Classification Codes (SCCs) in the Northern Wasatch Front Summertime emissions inventory (Salt Lake, Davis, and parts of Weber and Tooele counties). Only SCCs contributing greater than 0.12 tons per day of emissions are shown. Emissions modeled for representative ozone day, July 5th, 2017.

Methods

UDAQ's SMOKE configuration for this ozone attainment demonstration was based on EPA's 2016v2[1] air emissions platform, using SMOKE 4.8.1. Emissions for non-Utah states within the modeling domain are sourced directly from the 2016v2 platform. Emissions within Utah are sourced from UDAQ's statewide emissions inventories, with one exception: the solvents sector uses EPA's new VCPy framework[2] (projected from 2016 to 2017). The VCPy framework significantly improves upon previous solvents emissions estimates due to recent studies on volatilization rates and chemical speciation of VCPs. Onroad and Nonroad mobile emissions were modeled using MOVES3. Point sources are spatially allocated by each unit's latitude-longitude coordinates. All other non-point sources are allocated according to gridded spatial surrogates such as population or road networks. Emissions are temporalized by temporal profiles derived from various research studies or defaults provided by EPA, with some Utah-specific adjustments. Emissions are chemically speciated by speciation profiles provided by EPA.

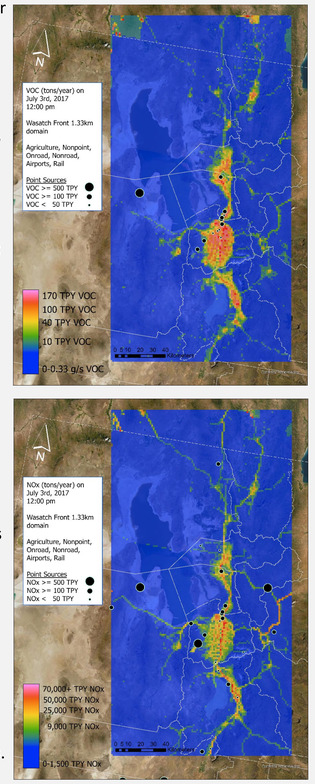

Figure 5: (top) Gridded VOC emission distribution at noon on July 3rd, 2017, and (bottom) gridded NOx emission distribution at noon on July 3rd, 2017. Point sources are shown atop the grid as black dots proportionally sized to their VOC and NOx emissions respectively.

* **Non-anthropogenic or non-VOC sectors modeled in SMOKE but *not shown* in the interactive inventory include wildfires and prescribed fires, agricultural burning, biogenic emissions (modeled with BEIS 3.6.1 and BELD 4), area fugitive dust, & fertilizer.**

Next Steps

Spatiotemporal allocation and chemical speciation in SMOKE are sometimes quite uncertain. Research efforts to develop Utah-specific temporal and speciation profiles for ozone precursor emissions are needed to improve our understanding of emissions along the Northern Wasatch Front. Additional measurements of emissions rates and pollutant concentrations will help improve emission factors and emissions inventories themselves.
We are currently modeling the projected 2023 emissions inventory. This future-year simulation will help UDAQ scientists determine the necessary regulation to control ozone concentrations along the Wasatch Front.

References & Acknowledgements

[1] EPA 2016v2 Air Emissions Modeling Platform. Released February 2022. https://www.epa.gov/air-emissions-modeling/2016v2-platform

[2] Seltzer, K. M., Pennington, E., Rao, V., Murphy, B. N., Strum, M., Isaacs, K. K., and Pye, H. O. T.: Reactive organic carbon emissions from volatile chemical products, Atmos. Chem. Phys., 21, 5079–5100, https://doi.org/10.5194/acp-21-5079-2021, 2021.

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