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Hamilton Airshed Modelling System

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Introduction

The Hamilton Airshed Modelling System (HAMS) is based on CMAQ [1] and was developed to better understand the processes and contributions to Hamilton's air quality, helping to inform future policy and human health impact decisions.

Model Description

HAMS handles the complex meteorology, multi-scaled emission sources, and the transportation and dispersion of emissions to achieve realistic simulations of local impacts on air quality. The model set-up shown in Figure 1 is applied to a series of nested tiers as shown in Figure 2 to best capture the multi-scaled influences on Hamilton's air quality. Table 1 outlines the spatial resolutions used for each of the modelling tiers. HAMS is used to model the 2012 air quality in the Hamilton Regional Municipality (Tier IV).

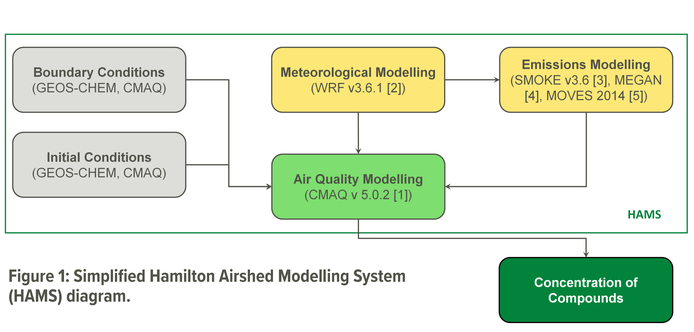

Figure 1: Simplified Hamilton Airshed Modelling System (HAMS) diagram.

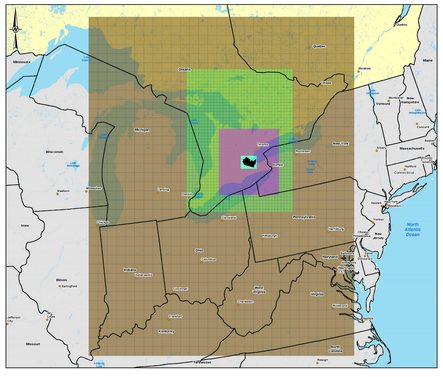

Figure 2: Visual representation of the nested tiers (grids) used to form HAMS. The tiers are selected and positioned to best capture the transboundary influences from USA and from Sudbury, Ontario (mining). Hamilton Regional Municipality is shown in black.

Table 1: Description of the spatial resolution of the four nested tiers.

Tier	Cell Resolution
Tier I	36 km x 36 km
Tier II	12 km x 12 km
Tier III	4 km x 4 km
Tier IV	1.33 km x 1.33 km

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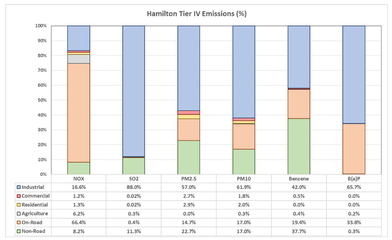
SMOKE ready national emissions inventory for Canada
Technical expertise on processing emissions in SMOKE

Stakeholder Advisory Committee (HIEA, Public Health, Community Stakeholders)
Providing direction and data

Emissions Modelling Results



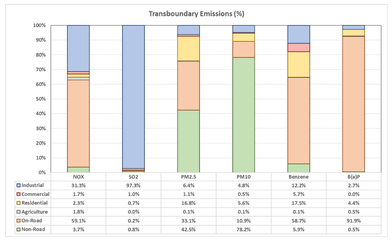


Figure 3: Tier IV emissions compared to transboundary emissions for selected compounds and emission source categories.

Industrial, commercial, residential, on-road, non-road (e.g., airport, marine, rail) and biogenic/agriculture emissions were prepared representative of 2012 (Figures 3 and 4). The emissions were sourced mainly from national emissions inventories, NPRI, traffic data, population data and energy use.

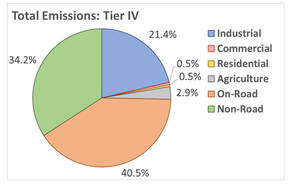


Figure 4: Total Tier IV emissions across the emission categories.

Model Performance Results

Model results are conservative and reliable. All compounds are predicted within a factor of two (not shown) with particulate matter meeting performance criteria. Seasonal and monthly variations are captured by HAMS with over predictions occurring in winter months. Transboundary NO_2 emissions are likely over stated leading to over prediction of ~10 ppb. Benzo(a)pyrene or B(a)P could be impacted by lack of observations and lack of detailed chemistry in HAMS (currently a tracer compound).

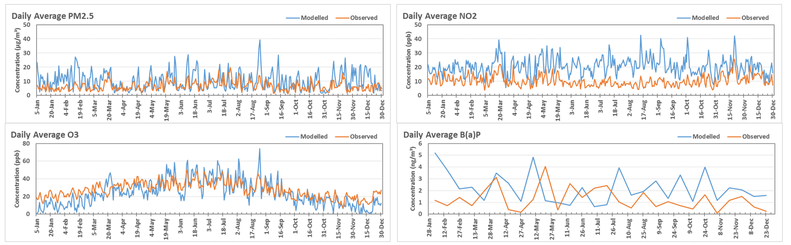


Figure 5: Time series comparison of modelled and observed concentrations for selected species.

Source Apportionment Results

Using a "zero-out" approach, emissions from selected source groups are removed from the inventory to assess their importance. Results indicate a strong transboundary influence, contributing upwards of 90% for particulate matter ($PM_{2.5}$ and PM_{10}). Local industrial emissions contribute less than 20% by compound to air quality in the Hamilton region, except for B(a)P. Local on-road sources are a major contributor to NO_2 levels, after transboundary sources. Transportation emissions are the major contributor to transboundary emissions for all compounds except SO_2 which is dominated by industrial sources.

Figure 6: Domain average source contribution by month for selected compounds

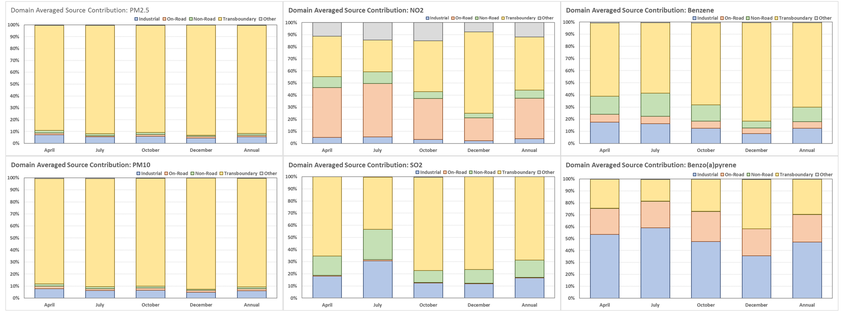
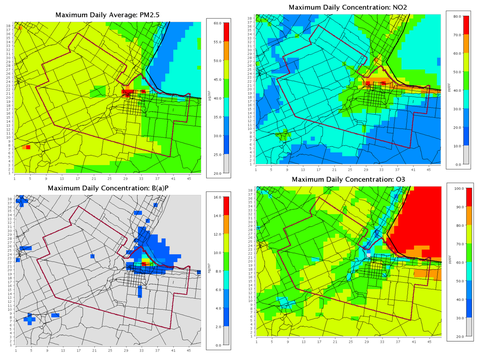


Figure 7: Maximum daily concentration of selected compounds. The region experiences high magnitude events but the annual average conditions are much lower, by at least an order of magnitude. Maximum concentrations occurred along Burlington Ave E and at the intersection of Highway 403 and Highway 8, depending on the compound of interest. O_3 and NO_2 show concentrations correlating with the major roadways.



Conclusions

HAMS is conservative and reliable in the simulation of Hamilton region air quality with compounds within a factor of two of the observations. There is a strong transboundary influence across the domain, heavily influenced by transportation (on-road and non-road) based on the transboundary emissions profile. Local industrial emissions have a comparatively small influence, apart from B(a)P. Further studies are needed to strengthen the source apportionment and provide more detailed information to support policy development to improve the air quality in the Hamilton region.

References

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