

Condensation of Gasoline Exhaust Organic Vapour onto Sulfate Aerosol: Flow Tube Studies and Regional Air Quality Modelling

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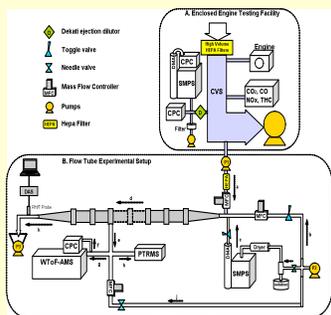
Air Quality Research Division, Environment Canada

Introduction

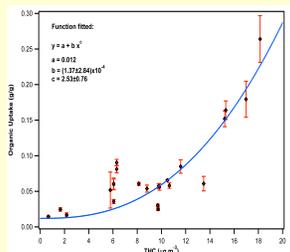
Parameterizations for organic aerosol formation are a key area of uncertainty in regional air quality model prediction of $PM_{2.5}$. Here, we present a new parameterization based on recent laboratory studies for the condensation of semi-volatile organic vapours from gasoline engine exhaust onto pre-existing inorganic particles.

Experimental Setup

The experiments were carried out at the Environmental Research Centre of Environment Canada using a setup that combines the engine testing facility with a flow tube for further dilution and condensation onto laboratory-generated inorganic sulfate particles.



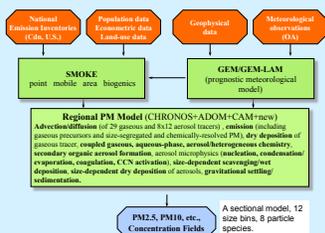
A parameterization was derived for the Henry's law equilibrium coefficient (uptake of organic vapour mass per mass of sulfate) as a function of the gas-phase total hydrocarbon (GTHC) vapour concentration.



AURAMS Description

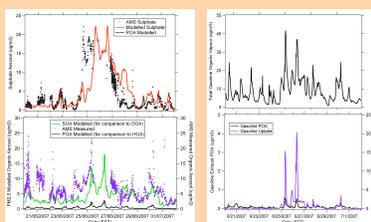
AURAMS is an off-line chemical transport model:

- driven by Canadian weather forecast model (GEM)
- 2005 Canadian and U.S. emissions inventory (SMOKE processed)
- 15-km grid spaced domain covering eastern North America



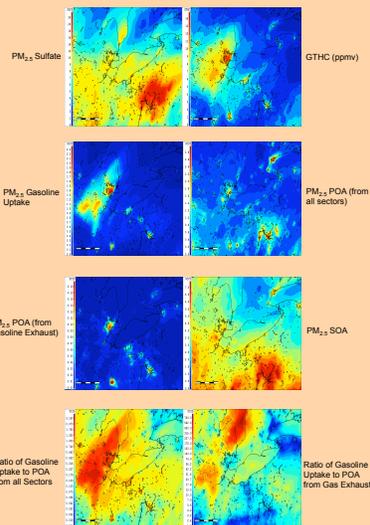
- Gasoline exhaust gas-phase total hydrocarbon (GTHC) vapour was treated as an additional gas-phase species
- GTHC was emitted, transported, lost by gas-phase chemistry and allowed to reach equilibrium with sulfate aerosol based on the measurement-derived uptake parameterization.
- Gas-phase loss by oxidation with OH, NO_3 and O_3 ($1.2E-11$, $1.2E-14$ and $6.7E-18$ $cm^3/molec/sec$, respectively (weighted averages from gasoline exhaust emission chemical profiles)

Windsor Time Series for BAQS-Met Period June 20 - July 1, 2007



3-Day Averaged Distributions (June 24 - June 27, 2007)

- period of southwesterly flow and high sulfate over Windsor/Detroit



- In urban areas, gasoline exhaust organic vapour uptake to sulfate was comparable to total POA and significant compared to urban SOA levels.

Conclusions

- Gasoline exhaust organic vapour uptake into sulfate particles is significant for urban cities frequently impacted by regional sulfate events.
- In the Detroit/Windsor airshed, modelled gasoline vapour uptake is larger than gasoline POA. At times of high sulfate, the gasoline organic vapour uptake is significant compared to total POA (from all mobile, point and area sources).

Acknowledgements

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