

NARSTO Supersite Transboundary Intensive Field Study, Canada, 2001-2002

Description

The goal of this project is measurement of PM_{2.5} composition and related pollutants to improve estimates of the local vs. long-range transport contribution to particles. The regions of interest are from SW Ontario to SW Québec, and the Saturna/Vancouver area. This work is proposed for Summer-Winter-Summer, 2001-02. In addition to the long-range transport emphasis the time resolution in the datasets will be improved to provide more detail for a variety of purposes, especially process studies and model development.

It is known that U.S. sources contribute significantly to the regional particle levels during certain time periods and likely have a significant impact on the annual average. However, sources within Ontario also play a role, and better information on the relative importance of these sources vs. U.S. sources is critical to policy development. Improved information on this issue can be obtained through more detailed ambient measurements in urban and rural areas and through the use of models. The proposed work will provide the measurements needed to infer more about the sources of particles in areas impacted by regional transport and to improve regional models (e.g., AURAMS and Models-3/CMAQ) for future application.

More information can be found at URL:

http://www.chem-eng.utoronto.ca/~aerosols/july/july_about.htm

Background

During July 2001 and winter 2001-02 the eastern U.S. Supersites, which are part of the USEPA PM research program, are going to carry-out an intensive field study involving simultaneous measurements in St. Louis, Pittsburgh, Baltimore, New York City and Boston. Outlying areas around each site will also be involved through State agency assistance. These data will represent the most comprehensive temporally and spatially resolved particle-related air quality data ever collected in eastern North America. Given the high potential for these data to be important for future model evaluation studies of Models 3, additional rural and aircraft components are being considered by the USEPA.



The Toronto-Egbert region is recognized by the USEPA to be an additional eastern Supersite and has thus been encouraged to participate. There are four main reasons for being involved:

1. Access to the meta-dataset for future model evaluation of regional models.
2. Expansion of the dataset to include sufficiently comprehensive Canadian data (southern Ontario and southwestern Quebec) for more relevant model evaluation of the Canadian regional models.
3. Compilation of an improved dataset for source apportionment and assessment of long-range transport and transboundary influences.
4. Provision of a "spark" for coordinating the activities of several Toronto-area projects, including the start-up of new CAPMoN and NAPS PM monitoring, which will lead to more complementary data than is currently being compiled by these projects.

There are four research projects focusing on Toronto air pollutants with an emphasis on particles. Together these projects, which include daily ambient measurements (J. Brook, MSC), real-time single particle size and chemistry (G. Evans, U of Toronto), urban POPs (M. Diamond, U of Toronto), elemental analysis of PM (S. Mabury, U of T) and PM_{2.5} personal exposure (A. Sass-Kortsak, U of Toronto), provide a solid foundation from which to carry-out the necessary work.

Proposed Measurements

The Toronto-area TSRI projects have already lead to the establishment of a permanent monitoring site on the roof of the Gage Research building at U of Toronto and at the Wallberg Engineering building (Chem. Eng.). A complete suite of measurements are being collected daily from the Gage roof (see website), including particle organics and gas-particle partitioning of organics (IOGAPS), both in collaboration with the Geography and Chemistry Departments. There are frequent measurements at Wallberg, as well. **In particular, the Chem. Eng. group has developed and is now operating an instrument for size determination (0.3-3.0 μ m) and chemical analysis (time-of-flight mass spectrometry), referred to as LAMS (Laser Ablation Mass Spec).** These TSRI activities need to be supplemented in order to meet the project objectives stated above. This includes additional measurements and increased temporal resolution at U of Toronto and the operation of regional sites to characterize the background/transboundary contribution.

The measurement activities during the study will build upon ongoing work, which includes the MOE/NAPS monitoring network, to the extent possible. Thus, the main location of measurement will be U of T (Gage/Wallberg), MOE-Etobicoke south, and three regional background sites (Egbert, Simcoe and St. Anicet).



The new samplers will include:

- R&P 5400 and 8400N and SMPS at Wallberg (high time resolution OC, BC and particle nitrate)
- SO₂ at Wallberg
- Sulphate from TECO at Wallberg (high time resolution particle sulphate)
- MOUDI at Gage (size-distribution of organic and element carbon)
- IOGAPs and Chemvol at Gage (organic speciation)
- Dichot Partisol at Egbert (mass and water soluble organics and inorganics)
- OC/BC auto-filterpack system at Egbert
- Semi-hiVol at Egbert (organic speciation)
- SMPS at Egbert (10 nm - 300 nm size distribution)
- Dichot Partisol at Simcoe (mass and trace metals)
- Anderson PM Speciation sampler at Simcoe (OC/BC, inorganic and organic water soluble compounds)
- HiVol at Simcoe (organic speciation)
- OC/BC auto-filterpack system at St. Anicet
- Dichot Partisol at St. Anicet (mass and inorganic ions)
- AQI Bus (MOE) to Georgian Bay (to be operated fully by MOE)

In addition to these samplers, which are necessary to carry-out the desired study, there will be a Dichot Partisol operating at Montréal, Ontario Street.

In addition to the proposed new samplers, an increase in sampling frequency for some of the filter-based samplers is proposed. Two per day filters will be collected at Simcoe, U of Toronto, St. Anicet and Egbert, as well as the continuous/semi-continuous samplers noted above and already in operation as part of the TSRI projects.

- **At Evans and St Anicet** the samplers are automated and thus site visits are likely only required every-other-day, at most.
- **At Egbert**, a daily visit is required. This is not a problem due to the onsite staff, however, weekend coverage will be needed (Hanson-Smith).
- **At Simcoe**, one visit per day will be needed during the periods the high volume samplers are running. Project partners from OPG and potentially McMaster will hopefully help conduct these visits, possibly using the services of P. Dasco.
- **At UofT (Gage)** the VAPS, Partisol, IOGAPs and HiVols will need to be visited twice a day.

This represents an increase from 1 to 2 changes a day for the VAPS and Partisol and from 1-in-6 to 1-in-3 for the PAH HiVol. A second HiVol will be run collecting samples twice a day for twelve days for analysis at McMaster. The IOGAPs and second Chemvol are new samplers and are currently visited as needed, but will be changed daily during the study (approx. 12 days of operation).



Chemical Speciation of Organics and Semi-Volatile Organics

Organic carbon is a large, unresolved fraction of PM_{2.5}. Chemical speciation of this fraction is useful for source identification (primary emissions or secondary formation). During STIFS, the goal of the organic speciation will be to measure compounds that are indicative of atmospheric oxidation and/or secondary organic aerosol formation as well as "age" of the organic species. The daily and day/night variations in these compounds will be compared with how OC/BC changes.

Samples for organic analysis will be collected at Gage, Simcoe and Egbert during twelve days near the beginning of the study. In addition, during these days total semi-volatile organics will be measured at Gage (UofT). This will be accomplished using the IOGAPS with TOT analysis of quartz filters and SIFs.

Simcoe: 1 sample per day coinciding with the VAPS.

Gage: 2 samples per day coinciding with the VAPS.

Egbert: 2 samples per day coinciding with the dichot Partisol

Compounds:

EPS (Gage-only) PAHs

UofT (Gage-only) oxy-PAHs,

McMaster PAH & nitro-arenes (e.g., 2-nitro-fluoranthene), ketones and quinones

Proposed Suite of Measurements for July 2001 and Feb. 2002

Combining the additional samplers with the existing equipment should lead to the measurements shown below for each site. These tables are for July 2001. The scope of the winter Supersite campaign is still uncertain. It depends upon USEPA planning and on the amount of resources we will have left. If possible the winter measurements will be similar to the July measurements. Year 2 measurements will be determined later. The tables below will lead to day and night samples from Toronto, Egbert and Simcoe in order to look at secondary organic aerosol formation from OC/BC and organic tracers. This will also help identify the local contributions from the long-range transport contributions since certain OC compounds become enriched as the particles age (i.e., travel longer distances).



UofT Site

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|--|---|
| Continuous/semi-continuous measurements | |
| SO ₂ , O ₃ , PM _{2.5} -TEOM, CO, NO _x , COH | TSRI site with SO ₂ added at Wallberg |
| Meteorology (T, RH, WS, WD, insolation) | |
| p-NO ₃ | 10 min fine particle nitrate-8400N |
| OC/BC | 1 hour carbon-5400 |
| 10 min particle size distribution: 6-200 nm | ChemEng-SMPS |
| real-time particle size [0.3-5 mm] and chemical composition | ChemEng-LAMS |
| 10 min particle size distribution: 0.2-5 mm | ChemEng APS |
| Integrated samples (in EDT) | |
| 2 per day (10AM-18PM, 19PM-9AM) | |
| water soluble organic and inorganic species | see Appendix A for species measured |
| OC/BC | |
| 1 per day (10AM-9AM) | |
| trace metals | Appendix A |
| Mass size distribution 0-18mm | OC/BC, SO ₄ MOUDI |
| Sampling Frequency to depend upon conditions (2 per day ~12 days only) | |
| Organic speciation (Chemvol) | Quinones and other polar compounds |
| Organics (HiVol) | McMaster |
| Non-volatile TOC and semi-volatile TOC | IOGAPS (some organic speciation to be done) |
| PAHs (NAPS, Diamond hivol) | standard NAPS suite (Appendix B) |
| PM _{2.5} , (mass, SO ₄ , NO ₃ , NH ₄ , OC, BC) | 24 hour, 2-4 days per week personal samples. Continuous CO. |
| CO | |



Etobicoke South

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|---|------------------------------|
| Continuous/semi-continuous measurements | |
| SO ₂ , O ₃ , PM _{2.5} -TEOM, PM ₁₀ -TEOM, CO, NO _x , COH | AQI site |
| Meteorology (T, WS, WD) | |
| OC/BC | 1 hour carbon-5400 |
| Integrated samples (in EDT) | |
| 1 per day (10AM-10AM): | |
| Fine particle (PM _{2.5}) inorganic ions and mass | IC at ETC |
| 1 per day if feasible (time TBD): | |
| VOC | standard NAPS canister C2-C9 |

Egbert

| | |
|---|------------------------------------|
| Continuous/semi-continuous measurements | |
| PM _{2.5} -TEOM, O ₃ | |
| Others gases (e.g., NO _y) | CORE site instrumentation ????? |
| 10 min particle size distribution: 6-150 nm | MSC-SMPS (1st half of study) |
| Meteorology (T, RH, WS, WD, insolation) | |
| Integrated samples (in EDT) | |
| 2 per day (10AM-18PM, 19PM-9AM) | |
| PM _{2.5} water soluble organic and inorganic species | Dichot Partisol |
| PM _c water soluble organic and inorganic speices | Dichot Partisol (selected samples) |
| PM organics (12 days only) | Semi-hivol |
| OC/BC | filterpack on NEW valve system |
| 1 per day (TBD) | |
| VOC | (standard NAPS canister C2-C9) |



Simcoe

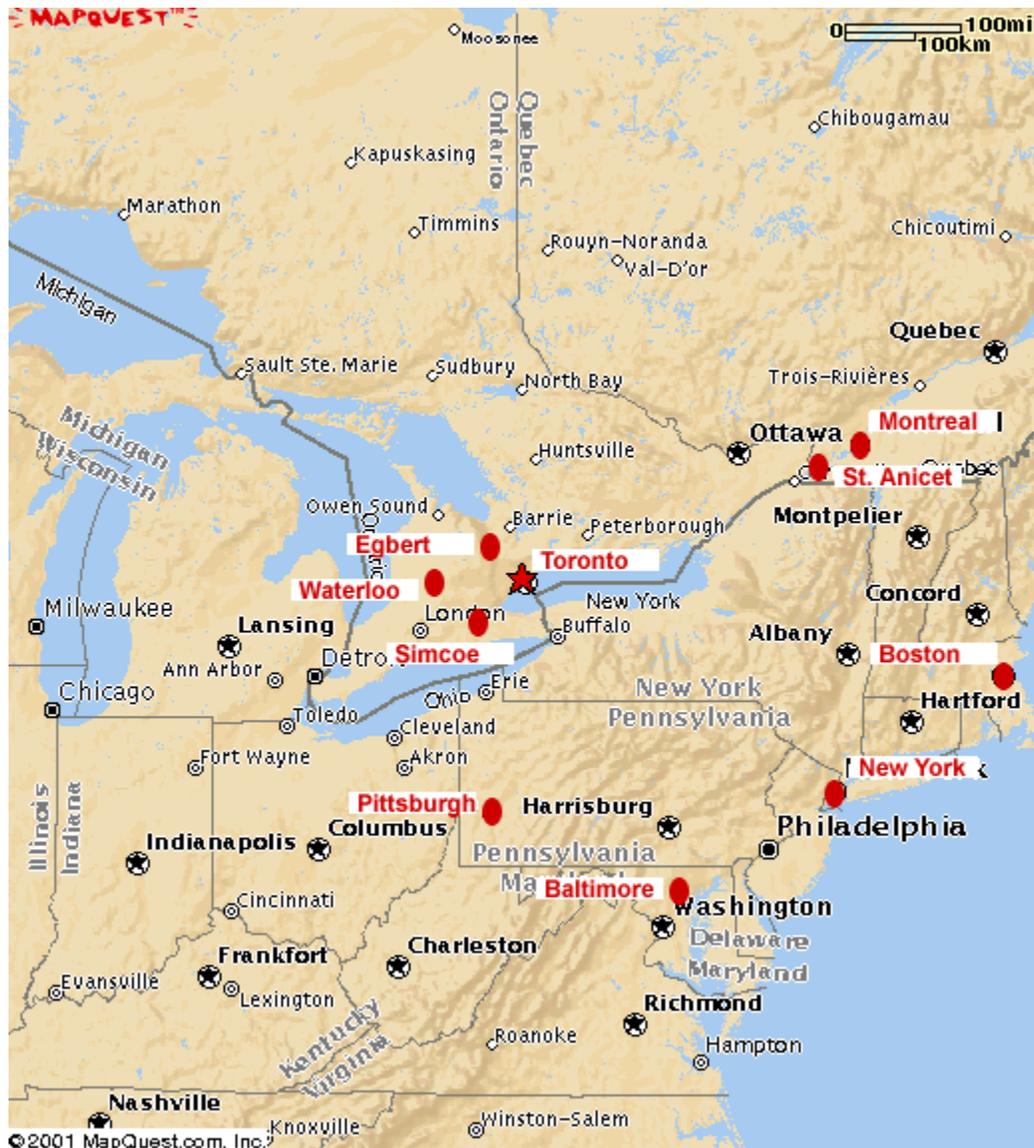
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| Continuous/semi-continuous measurements | |
| SO ₂ , O ₃ , PM _{2.5} -TEOM, NO _x | MOE site |
| | |
| Integrated samples (in EDT) | |
| 2 per day (10AM-18PM, 19PM-9AM) | |
| PM _{2.5} and water soluble organic and inorganic species | Anderson speciation sampler (Appendix A) |
| OC/BC | Anderson speciation sampler |
| Sample duration to depend upon conditions (1 per day ~12 days only) | |
| Organics (12 days only) | McMaster |
| One per day (10AM-10AM) | |
| trace metals (by OPG) | Appendix A – analytical method T.B.D. |

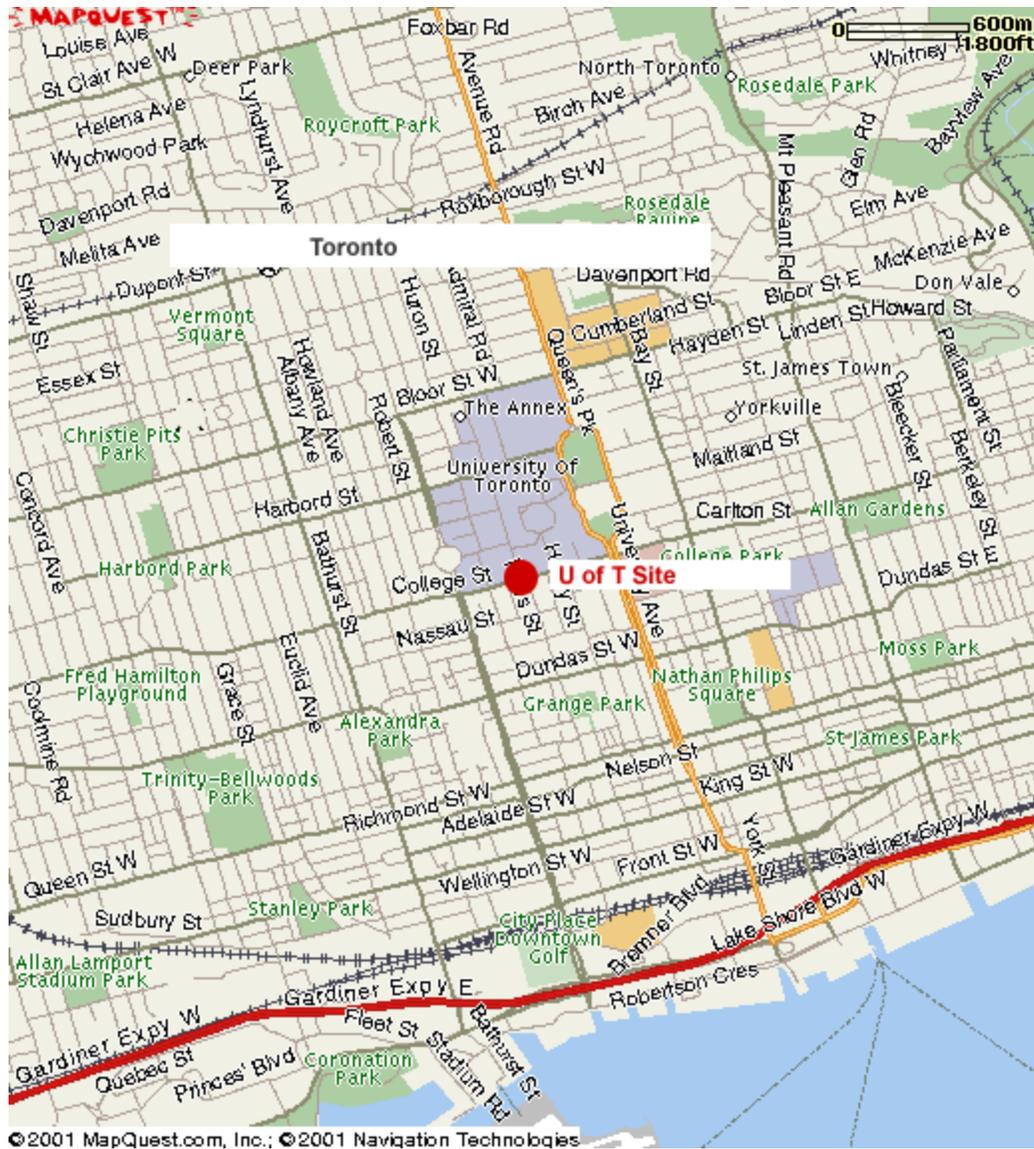
St. Anicet

| | |
|---|-------------------------------------|
| Continuous/semi-continuous measurements | |
| O ₃ , PM _{2.5} -TEOM | |
| Integrated samples (in EDT) | |
| 2 per day (10AM-18PM, 19PM-9AM) | |
| PM _{2.5} and water soluble inorganic species | Dichot Partisol (IC) |
| OC/BC | Campbell valve system w/filterpacks |
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The following maps illustrate the key locations of the study.

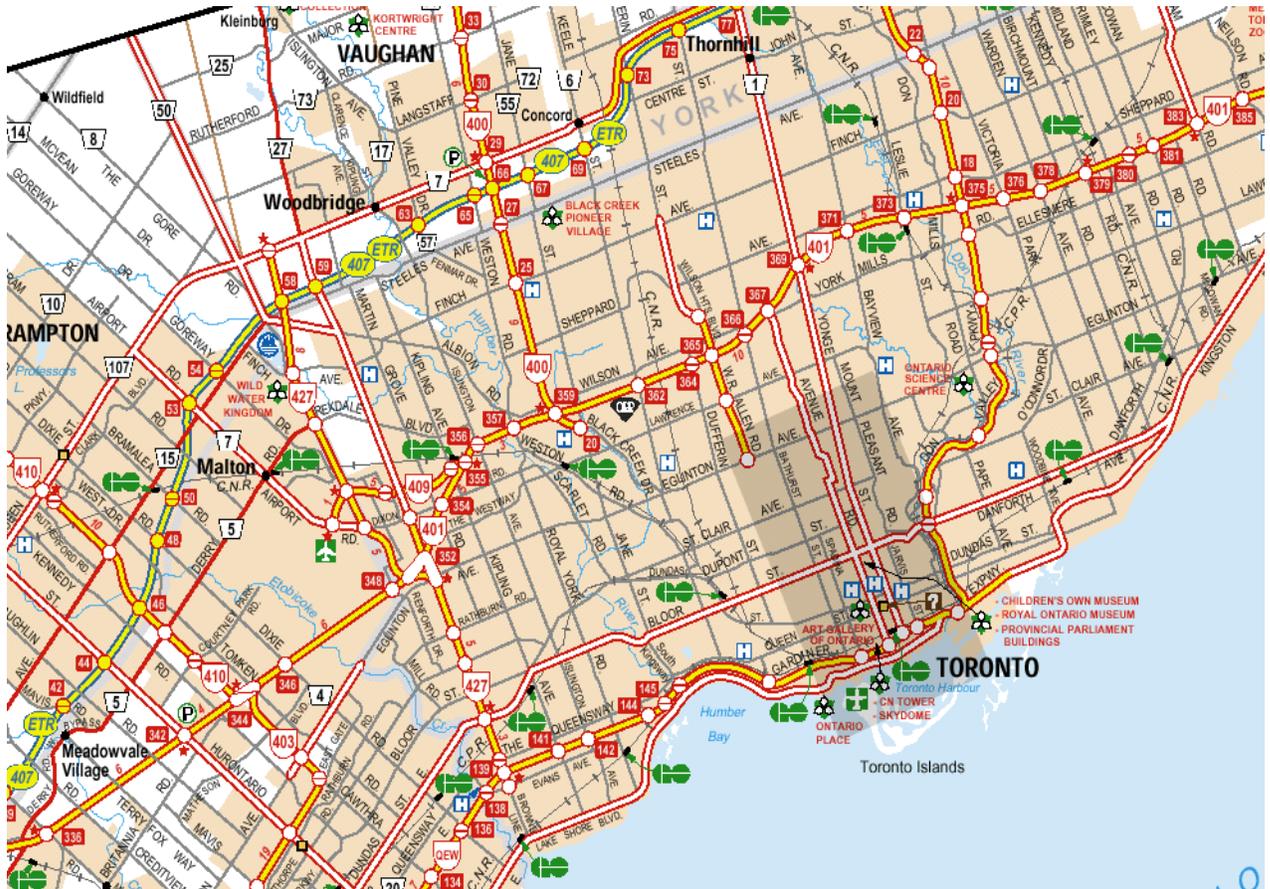




Daily Walking Circuit

During the July Campaign Project, summer student Andrei Sonoc will perform a daily walking circuit around downtown Toronto, using a portable nephelometer to analyze PM_{2.5} at different locations.

The area of interest is highlighted in the following map:



The nephelometer is illustrated next:

