Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

Overview of the 2015 Pan Am Games Legacy Data Set

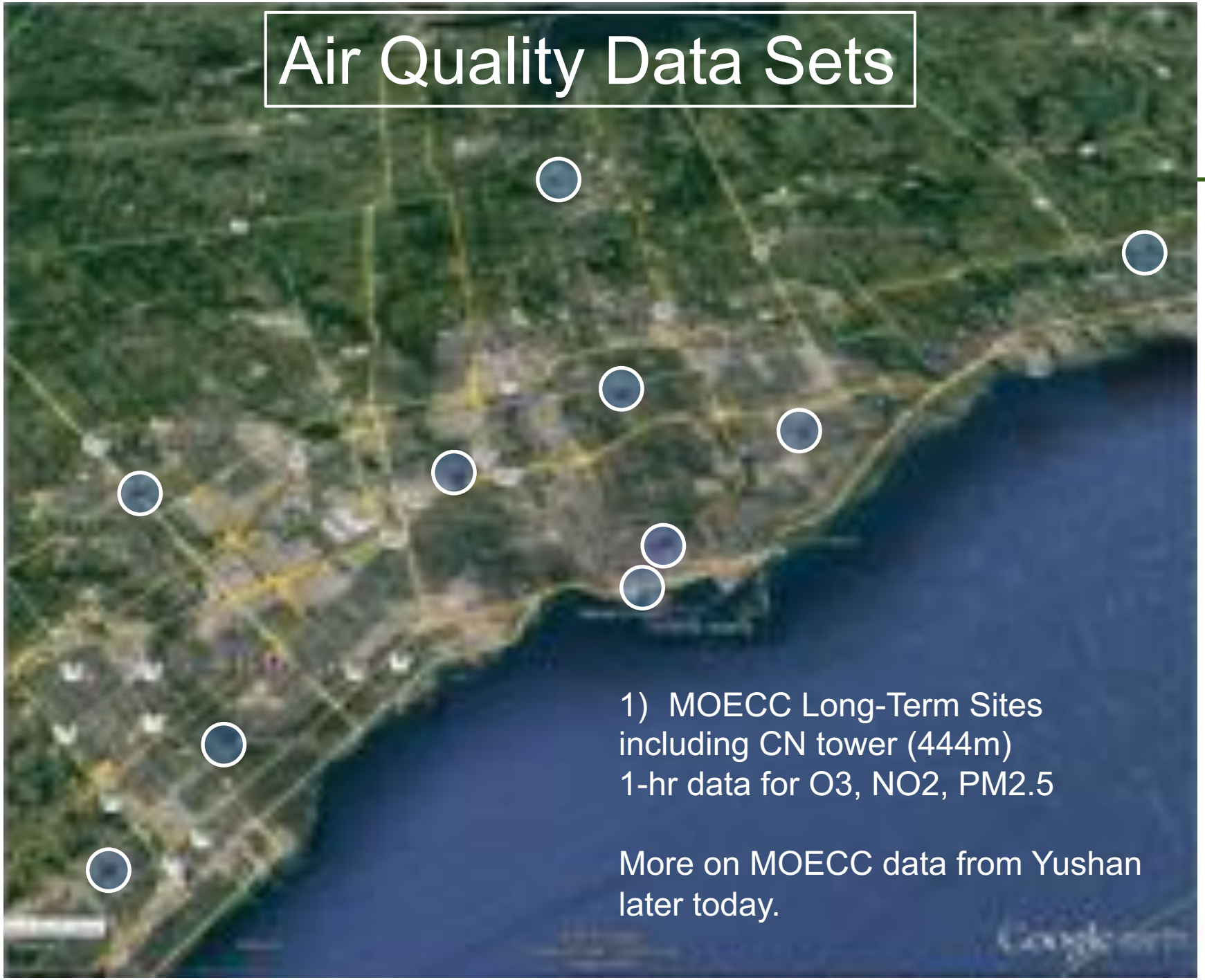
Craig Stroud, David Sills, Paul Joe
Science and Technology Branch,
Environment and Climate Change Canada

IWAQFR 2017

Part 1: Air Quality

Pan Am TORONTO 2015

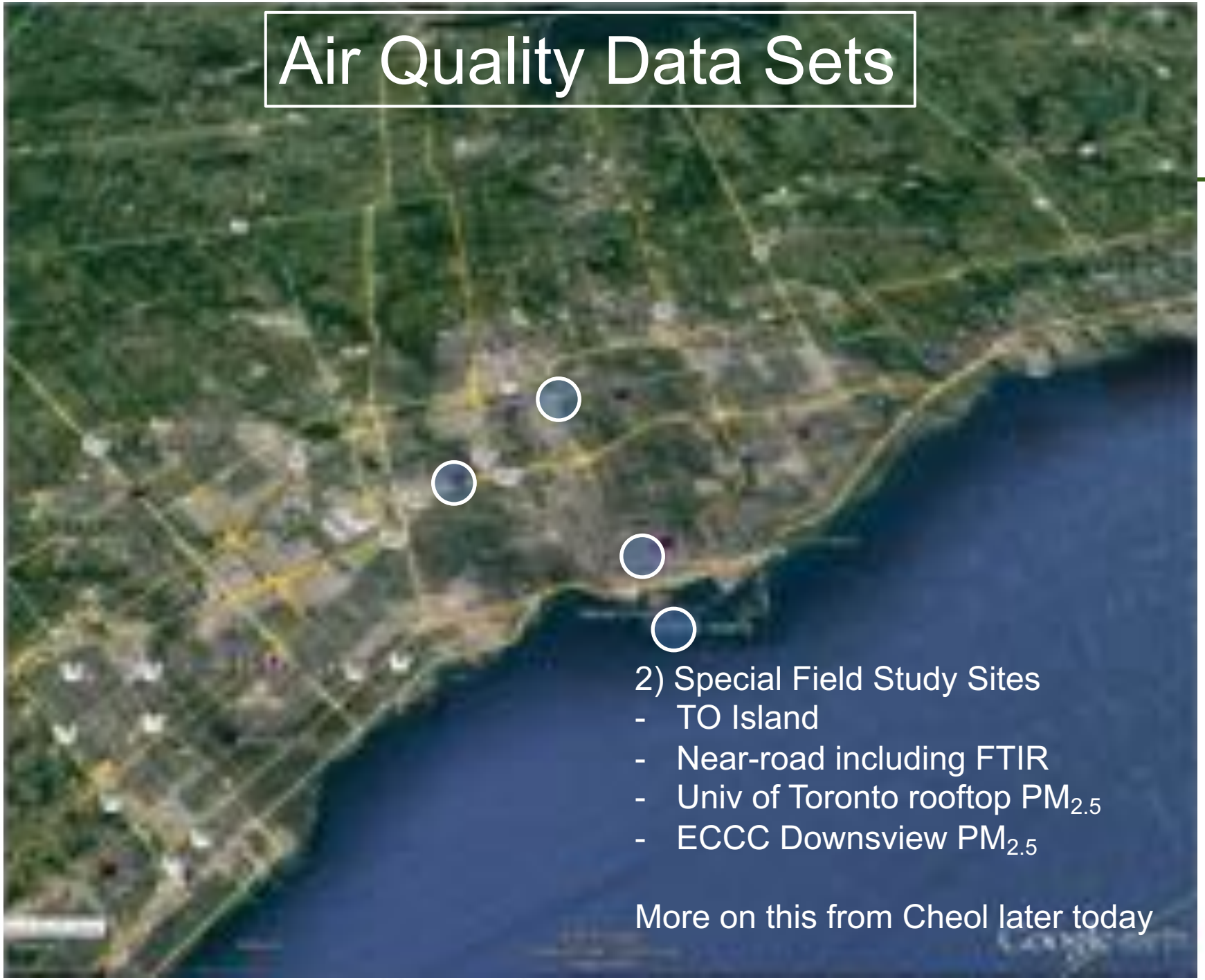
Air Quality Data Sets



1) MOECC Long-Term Sites including CN tower (444m)
1-hr data for O3, NO2, PM2.5

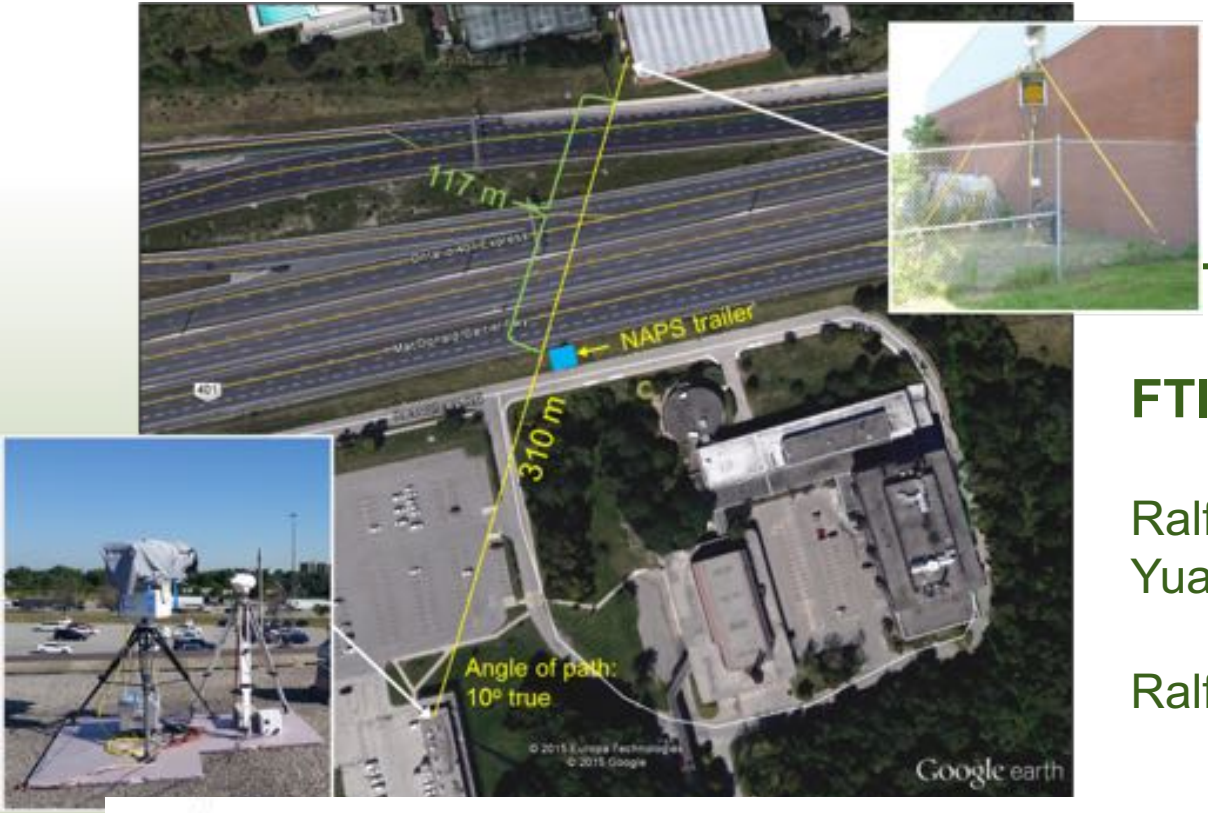
More on MOECC data from Yushan later today.

Air Quality Data Sets



2) Special Field Study Sites
- TO Island
- Near-road including FTIR
- Univ of Toronto rooftop $PM_{2.5}$
- ECCC Downsview $PM_{2.5}$

More on this from Cheol later today

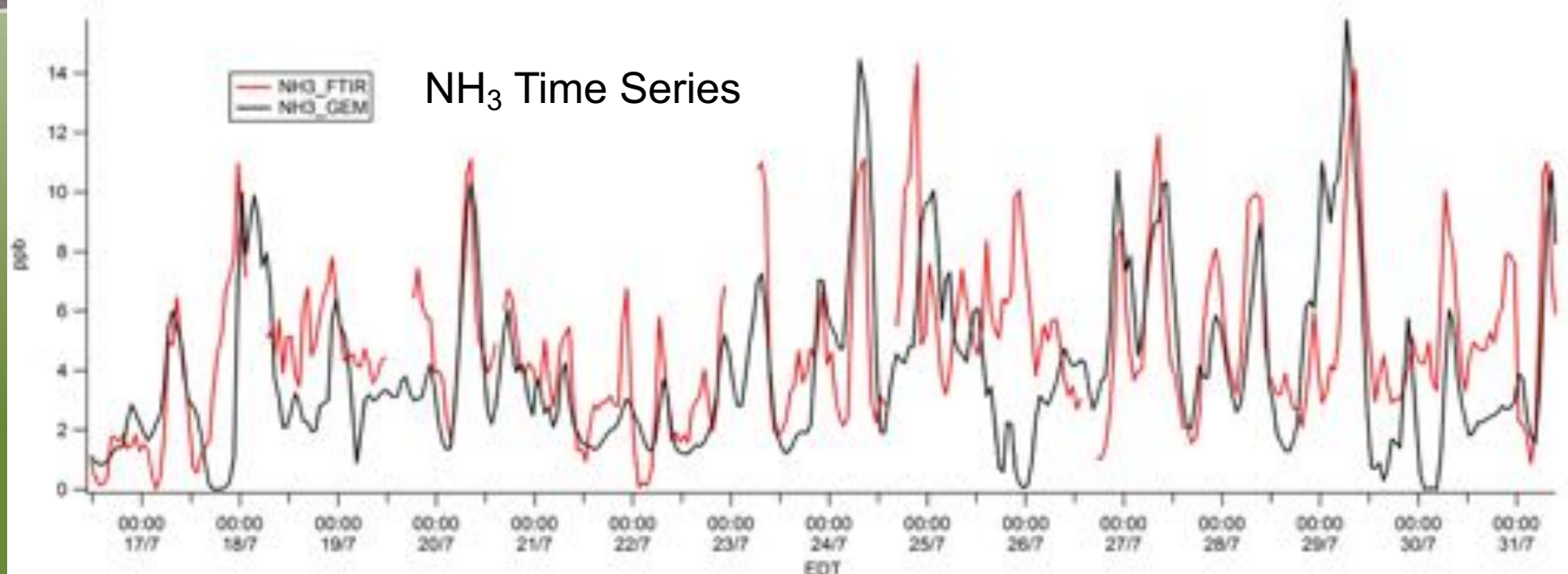


FTIR Long Path Spectrometer

Ralf Staebler, ECCC
Yuan You, PDF

Ralf.Staebler@canada.ca

NH_3 Time Series



University of Toronto Chemical Eng. Roof Top

Prof. Arthur Chan, Jeff Brook, Craig Stroud

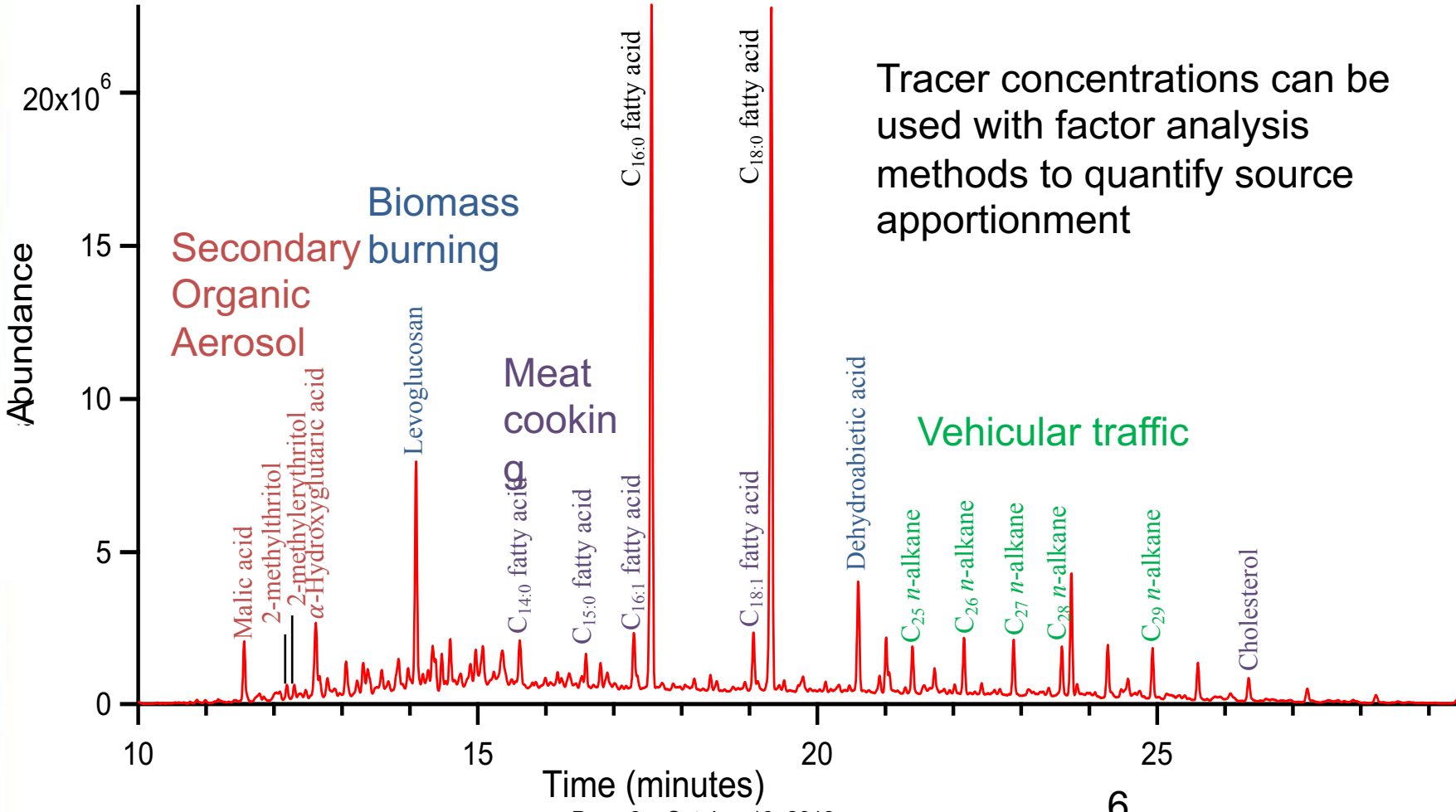
Methods:

- Morning, afternoon, night samples on particle filters and gas denuders
- Chemical characterization of gas- and particle-phase organics using TD-GC/MS

Objectives

- Source apportionment of organic components in $PM_{2.5}$
- Validate emission inventories in regional air quality models

Molecular tracers measured by GC/MS

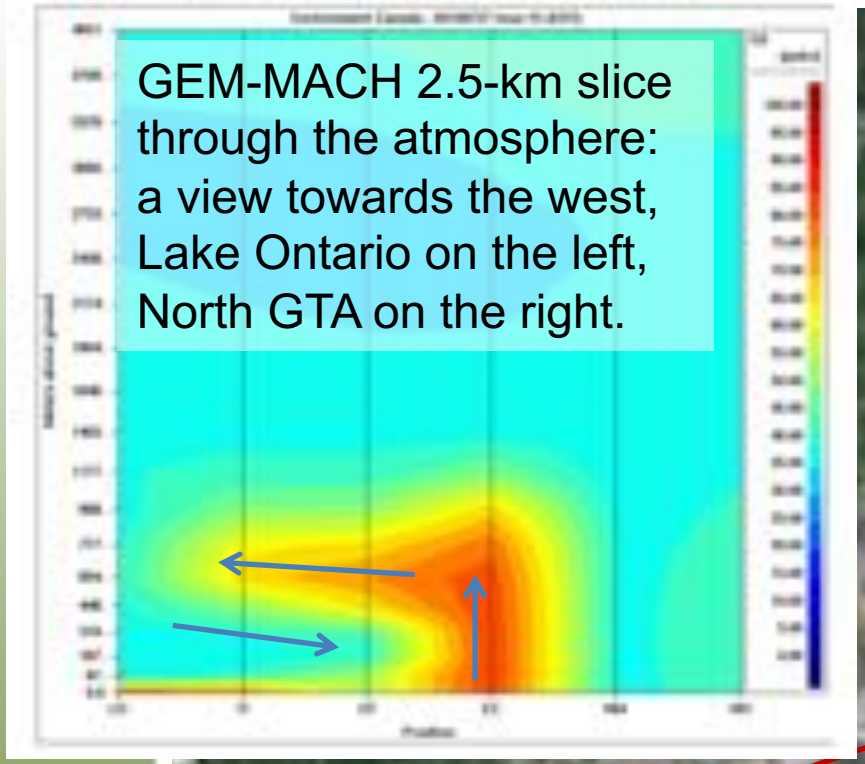


Tracer concentrations can be used with factor analysis methods to quantify source apportionment

CRUISER Mobile

More on CRUISER from Jeff Brook later today.

Ozone Vertical Cross Section, July 27, 2 pm ELT
Classic Lake Breeze Circulation Predicted



NO
NM
OS
EC
TE
UT
PA
TI
MI
OA
LO

Note the GEM-MACH grid spacing

Location Names

OA Oakville
MI Mississauga
PA Pearson Airport
TE Toronto East
OS Oshawa University
LO Lake Ontario
TI Toronto Island
UT University of Toronto
EC Environment Canada
NM Newmarket
NO North GTA

Meta Data for GEM-MACH Output

The **xsection_date** folder contains air quality and meteorological predictions from the GEM-MACHv2 model run at 2.5km grid spacing. Files were created for two cross sections (one south to north (S_N) and the other west to east (W_E)). The file names have this format:

species_XSECTION_S_N_panam_YYYYMMDDHR_forecasthr.png
species_XSECTION_W_E_panam_YYYYMMDDHR_forecasthr.png

Species = AF (fine particulate matter, ug/m3), AQHI index (0 to 10), HR (relative humidity), MPQC (cloud water, kg/kg), MPQR (rain water, kg/kg), N2 (nitrogen dioxide, ppbv), O3 (ozone, ppbv), TAM1 (ammonium aerosol, ug/kg), TCO (carbon monoxide, ug/kg), TEC1 (elemental carbon, ug/kg), THCH (formaldehyde, ug/kg), TISO (isoprene, ug/kg), TNH3 (ammonia, ug/kg), TNI1 (nitrate aerosol, ug/kg), TNO (nitric oxide, ug/kg), TOC1 (secondary organic aerosol, ug/kg), TPC1 (primary organic aerosol, ug/kg), TSO2 (sulfur dioxide, ug/kg), TSU1 (sulfate aerosol, ug/kg), TT (temp, C), TTOL (toluene, ug/kg), ZZ (vertical velocity, m/s)

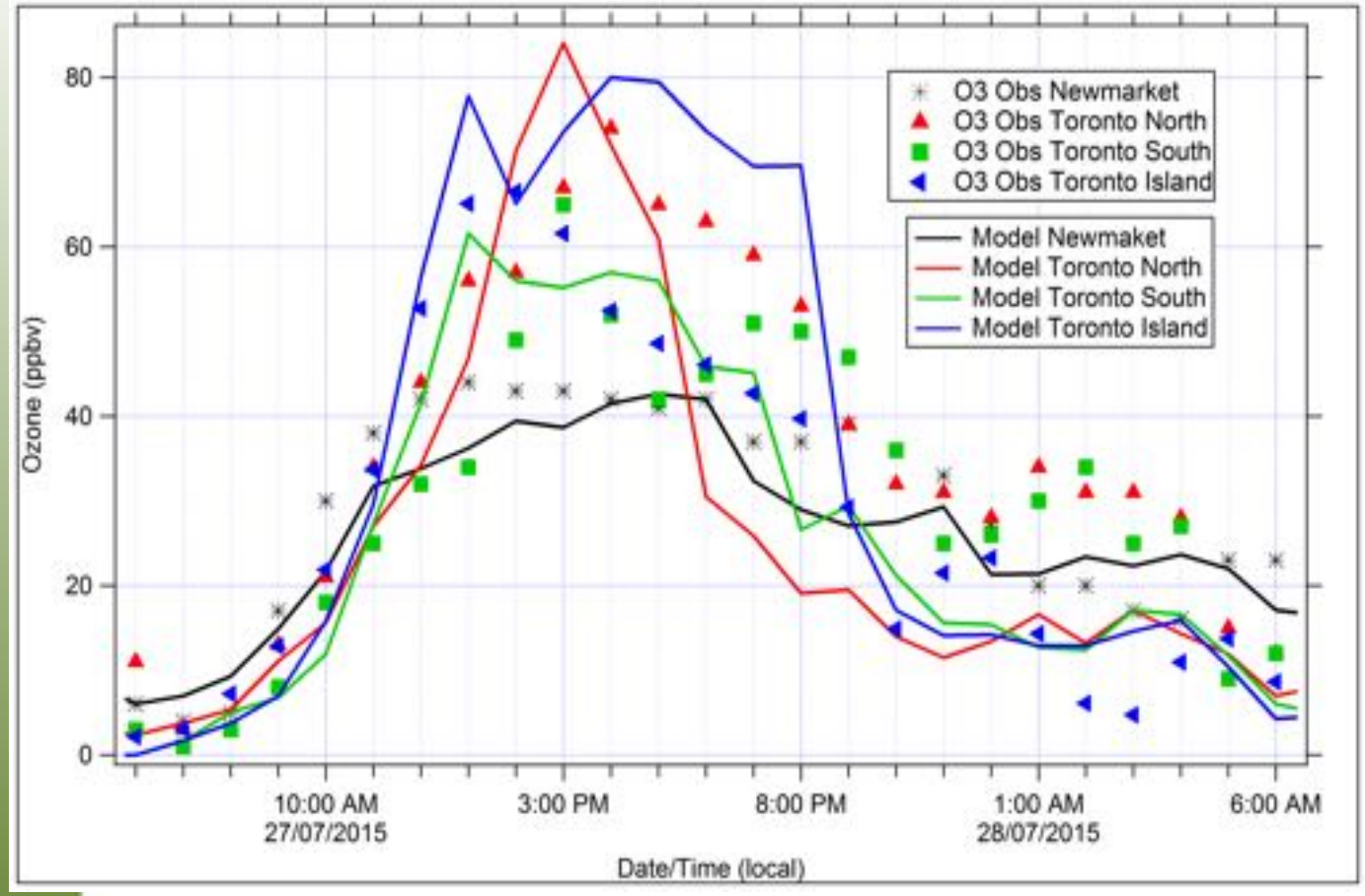
Vertical cross section goes from surface to 4051m above ground level.

The S_N transect passes through Lake Ontario, Toronto Island, Univ of Toronto, EC Downsview, Newmarket, and North Ontario

The W_E transect passes through Oakville, Mississauga, Pearson Airport, Toronto East, and Oshawa.

Forecasthr = this is the model forecast hour added to 06Z.

Ozone Diurnal Time Series for July 27



Yonge/Finch

Bay/Wellesley

Ozone increase is predicted quite well by GEM-MACH for all four locations.

Meta Data for GEM-MACH Output

The **stn_data_date** folder contains air quality predictions from the GEM-MACHv2 model outputted as text files for point locations. The files are named as follows:

chem_YYYYMMDDHR_Location_Level_Interval.txt

The files are column formatted, separated by spaces, YYYYMMDDHR where HR is local time.

Location name = MOECC building, PanAm supersite name.

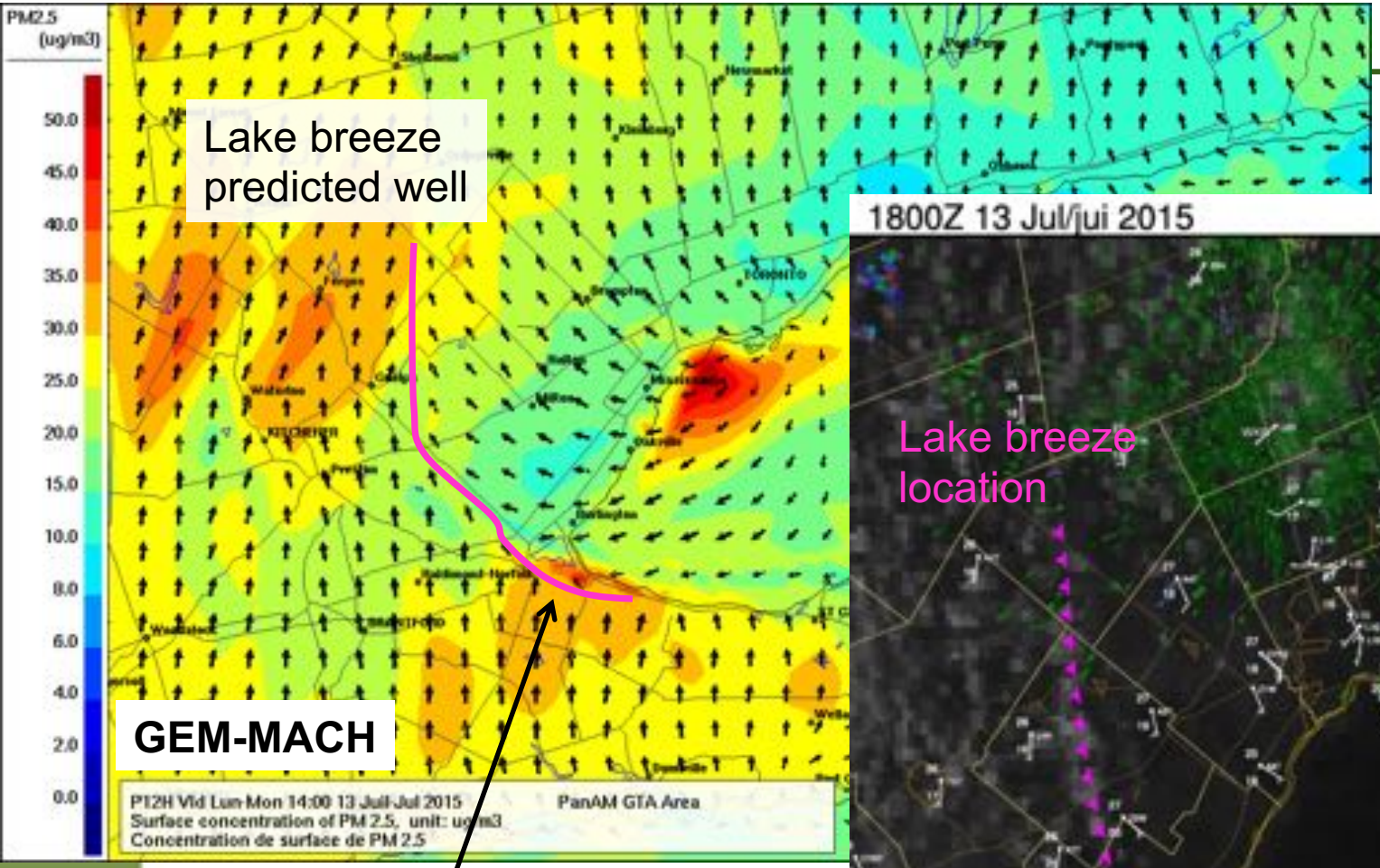
Level = 1p000hyb, 40 levels from surface (1.0) to hybrid level 0.1868 (top of troposphere)

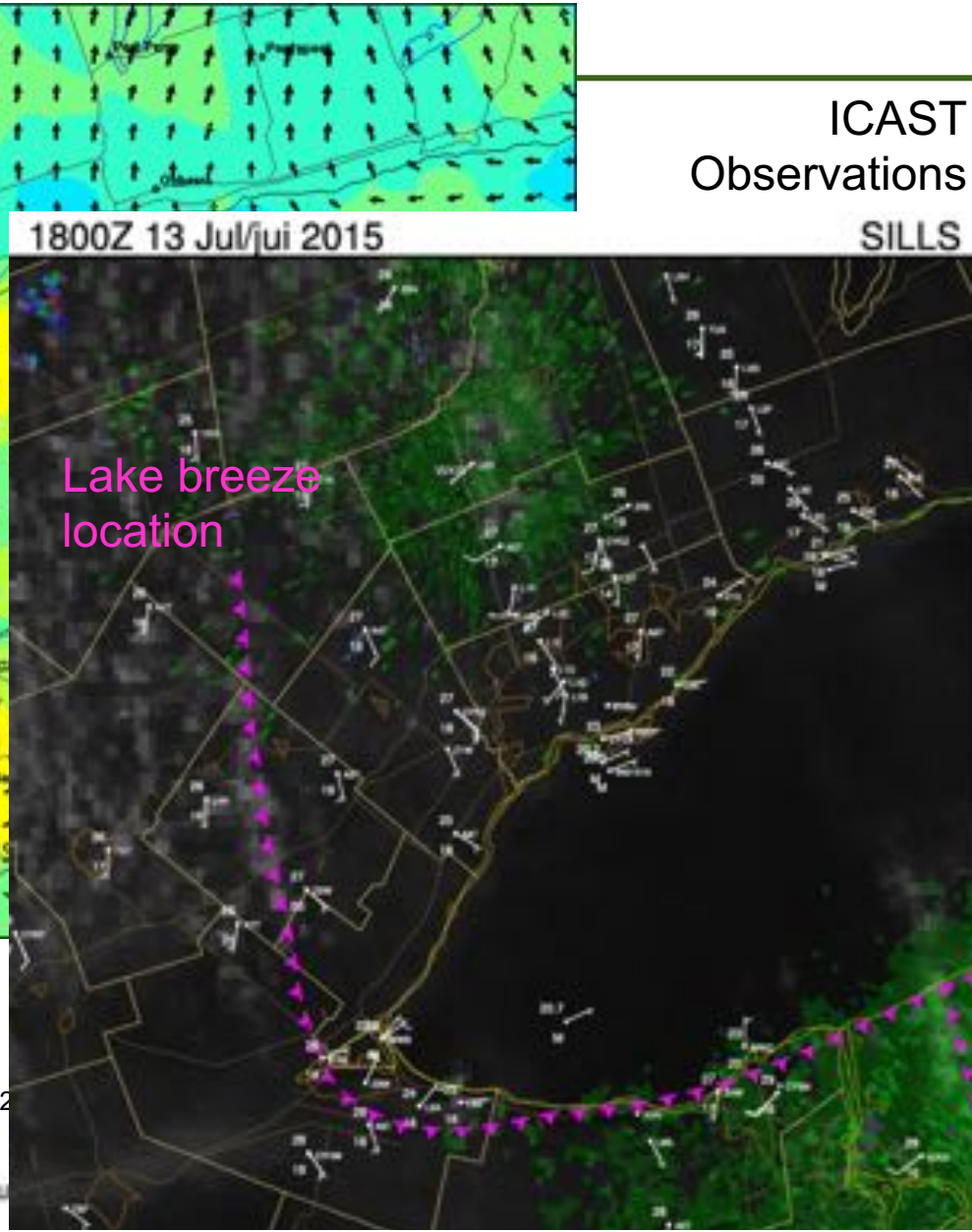
Interval = 1hr output interval

Species = same list as above (AF, O3, N2, TCO, TSU1, …)

met_YYYYMMDDHR_Location_Surface.txt where HR is local time. These are met variables for a surface location.

Fine $PM_{2.5}$ Episode at Hamilton July 13





Measured 30 ug/m^3 of $PM_{2.5}$ contributed to an observed AQHI of 6. Model predicted similar concentration.

Meta Data for GEM-MACH Output

The **surface_conc_date** folder contains air quality predictions from the GEM-MACHv2 model outputted as image surface maps. The files have the following naming structure:

surface_species_YYYY_MM_DD_HR_Forecasthr.kmz where species include AF (fine particulate matter, ug/m3), AQHI (Air Quality Health Index), N2 (nitrogen dioxide, ppbv) and O3 (ozone, ppbv). Kmz files can be opened with Google Earth and have zooming capability.

surface_species_domain_YYYYMMDDHR_Forecasthr.png These static image files are surface maps of model predicted concentrations. The domain can be for the GTA or for highres (southern Ontario). The species names are as stated above for xsection files.

Meta Data for GEM v4 2.5km Output

The **met_date** folder contains meteorological predictions from the GEMv4 model run at 2.5-km grid spacing. Here is a description of the file names and variables:

variable_level_yr_month_day_starttime_forecasthr.kmz where

variable = HR (relative humidity, %), MPQC (cloud mass, kg/kg), MPQR (rain mass, kg/kg), TCC (cloud cover fraction), TT (temp, C), ZZ (vertical velocity, m/s)

level = surface or 0p6hyb or 0p925hyb . These are hybrid model levels. 0p6hyb=4km agl, 0p925hyb=750 m agl.

Starttime = 06Z (2am local time)

Forecasthr = this is the model forecast hour added to 06Z.

kmz files can be opened with Google Earth and the user can change the viewpoint.

met_variable_domain_pressurelevel_YYYYMMDDHR_forecasthr.png where

variable = PR (precipitation, m), also see list above.

domain = gta (Greater Toronto Area window), highres (High resolution domain)

wind_domain_pressurelevel_YYYYMMDDHR_forecasthr.png where

wind barbs are plotted with wind speed in knots.

png files are static image files.

Meta Data for Objective Analysis

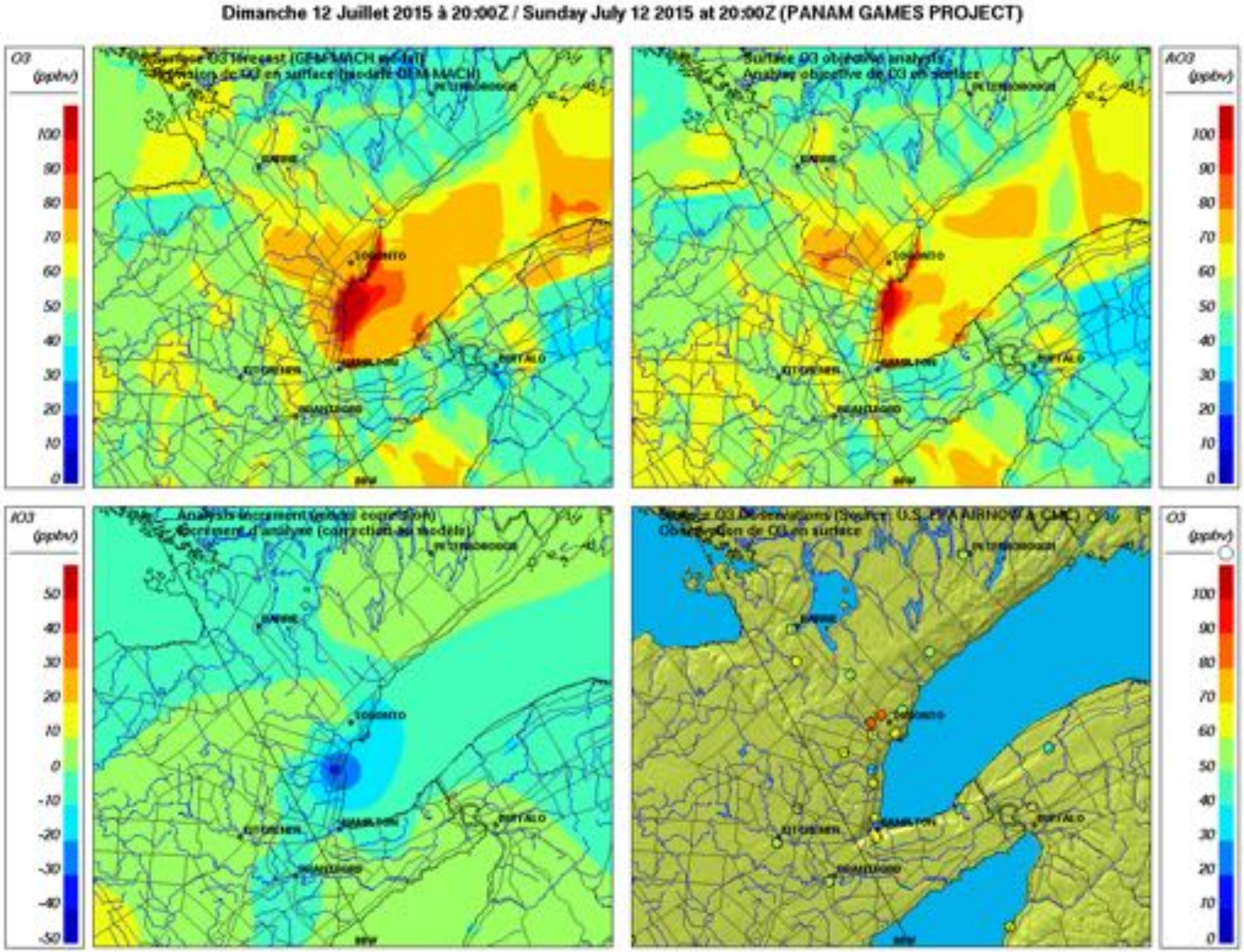
OA4pan_O3_PANAM_201507DDHRZ.png This image is for ozone. DD is day and HR is hour in Zulu. It contains 4 panels. The top/left panel is raw model output in ppbv. The bottom/right is the surface measurements. The top/right is the merged model and observations (most accurate result, termed objective analysis). The bottom/left panel is the difference between the model and revised model output.

OA4pan_PM25_PANAM_201507DDHRZ.png This is the image for PM2.5 ug/m3. HR is hour in Zulu.

OA4pan_NO2_PANAM_201507DDHRZ.png This is the image for NO2 in ppbv. HR is hour in Zulu.

OA4pan_AQHI_PANAM_201507DDHRZ.png This is the image for AQHI index. HR is hour in Zulu.

Objective Analysis



Government of Canada Open Data Portal

- Data sets are being uploaded to the following address:

http://open.canada.ca/data/en/dataset/f7ff59c9-80d2-4e63-932d-fa75793ed192

Questions and Comments are Welcome !!

Craig.Stroud@canada.ca
David.Sills@canada.ca
Diane.Johnston@canada.ca

Environment and Climate Change Canada
Environnement Changement cl

Overview of the 2015 Pan Am Games Legacy Data Set

Craig Stroud, David Sills, Paul Joe
Science and Technology Branch,
Environment and Climate Change Canada

IWAQFR 2017

Part 2: Meteorology

Pan Am TORONTO 2015

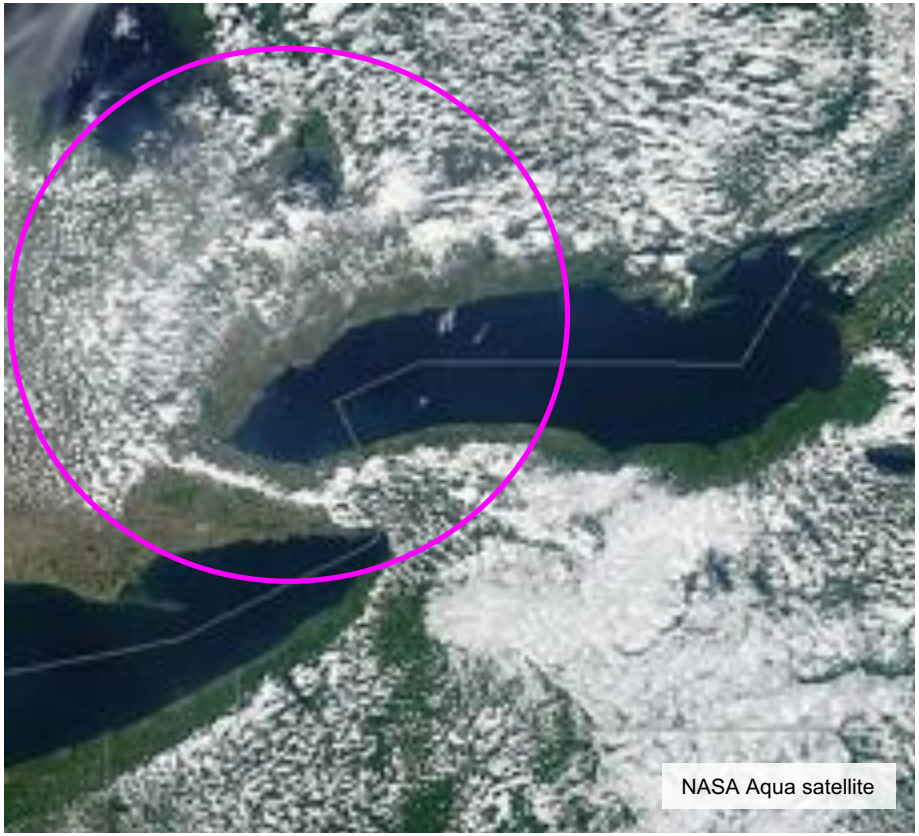
Science Showcase Contributors

Norbert Driedger (S&T-King)
Emma Hung (S&T-King)
Dominique Brunet (S&T-VF)
Brian Greaves (S&T-King)
Bill Chang (S&T-HQ)
Bill Burrows (S&T-Edm)
Neil Taylor (Edm Lab)
Helen Yang (Tor Lab)
Anna-Belle Filion (Mtl Lab)
Victor Chung (Tor Lab)
Sylvie Leroyer (S&T-CMC)
Diane Johnston (MSC PA-HQ)
Tsoi Yip (MSC PA-HQ)
Laura Huang (S&T-HQ
Kathy Hayden (S&T-HQ)
Ismail Gultepe (S&T-HQ)
Zen Mariani (S&T-HQ)

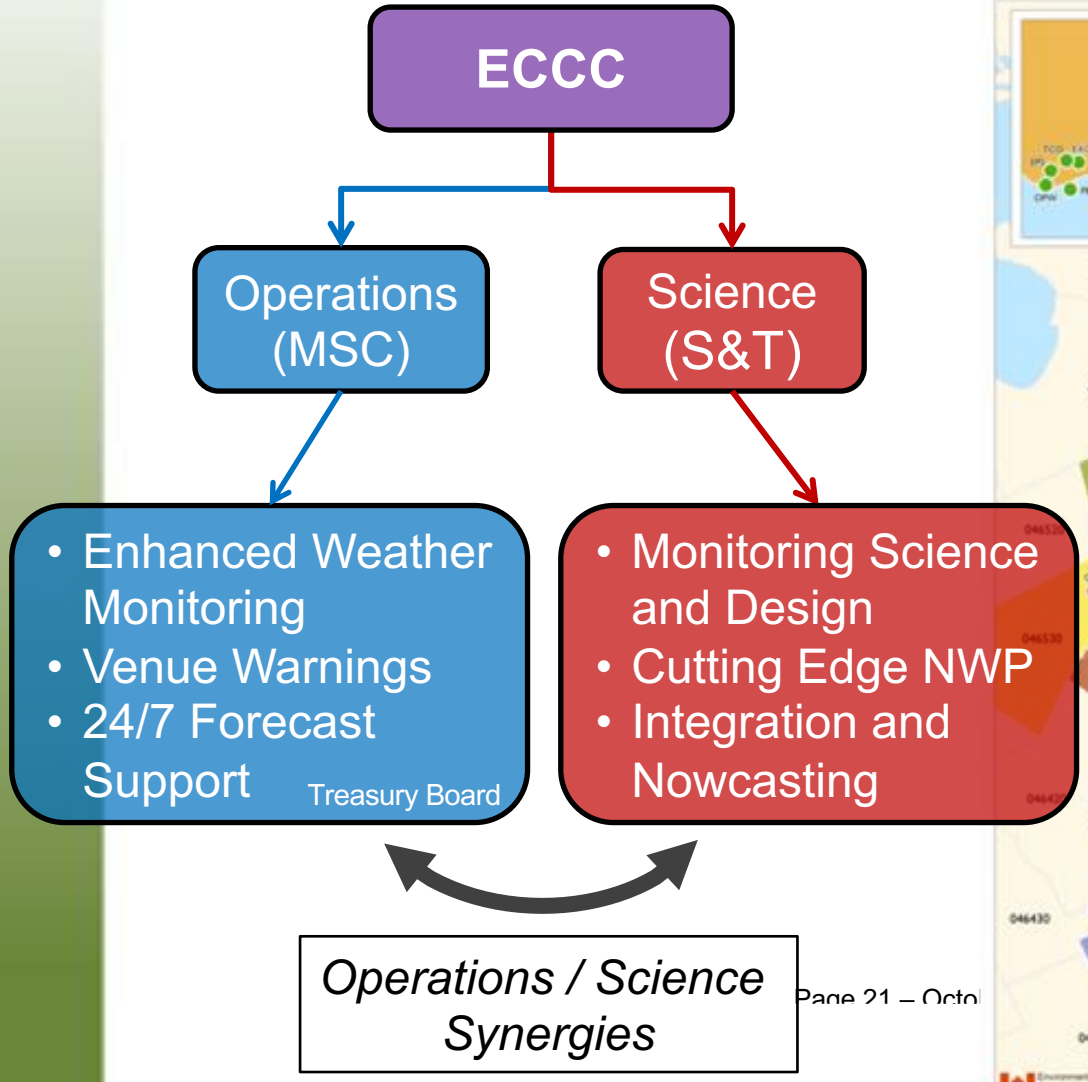
Michael Harwood (S&T-HQ)
Karen Haynes (S&T-HQ)
Rob Reed (S&T-King)
Reno Sit (S&T-HQ)
Jason Iwachow (S&T-HQ)
John MacPhee (MSC PA-HQ)
Joan Klaassen (MSC PA-HQ)
Ron Frenette (Mtl Lab)
Jason Milbrandt (S&T-CMC)
Anna Glazer (S&T-CMC)
Eva Mekis (S&T-HQ)
Sudesh Boodoo (S&T-HQ)
Janti Reid (S&T-HQ)
Bob Crawford (S&T-King)
Nathan Batten (S&T-Student)
Meghan Green (S&T-Student)
Daniel Liota (S&T-Student)

Science Objectives

- Lake breeze focus – *significant influence on thunderstorms and air pollution*
- Legacy data sets for process studies and NWP validation



ECCC Role / Mandate

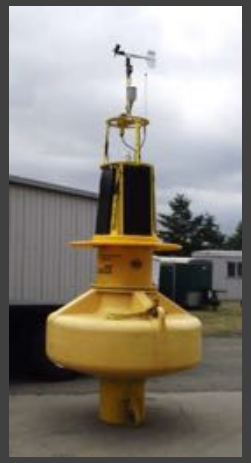


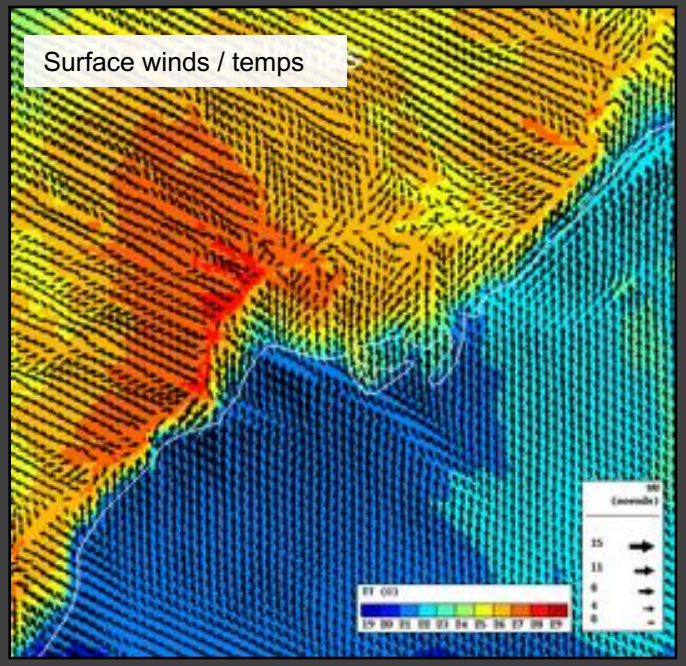
Experimental Design

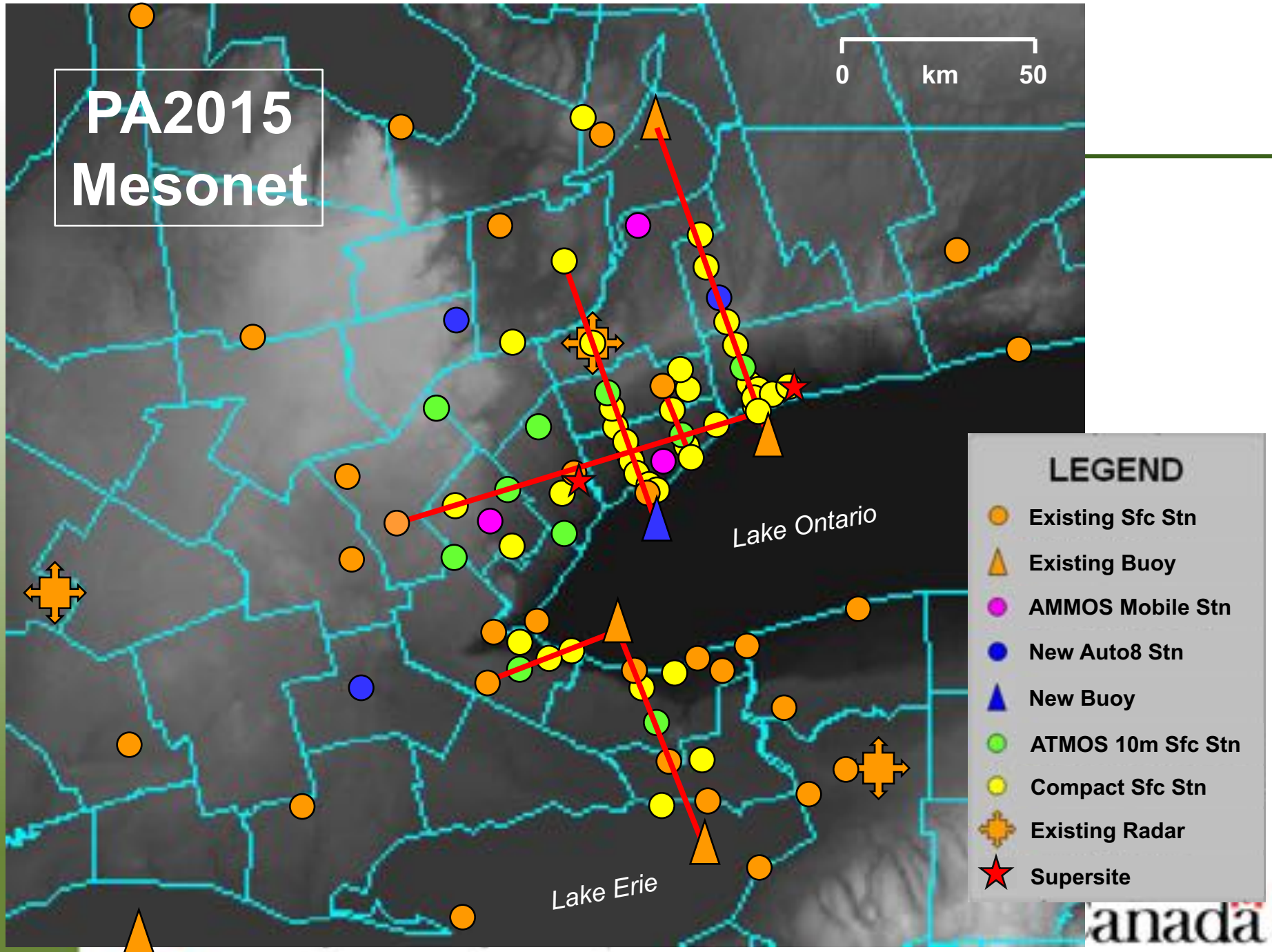
- 55 new surface stations
  - 1-min data
  - Including 10 S&T 10 m ATMOS stations
- 2 ‘supersites’
  - Oshawa (PUMS)
  - Pearson Airport
- 14-stn total lightning system
  - SOLMA
- 3 mobile met/AQ vehicles
  - AMMOS
- 2 Doppler LiDARs
  - 1 mobile, 1 fixed

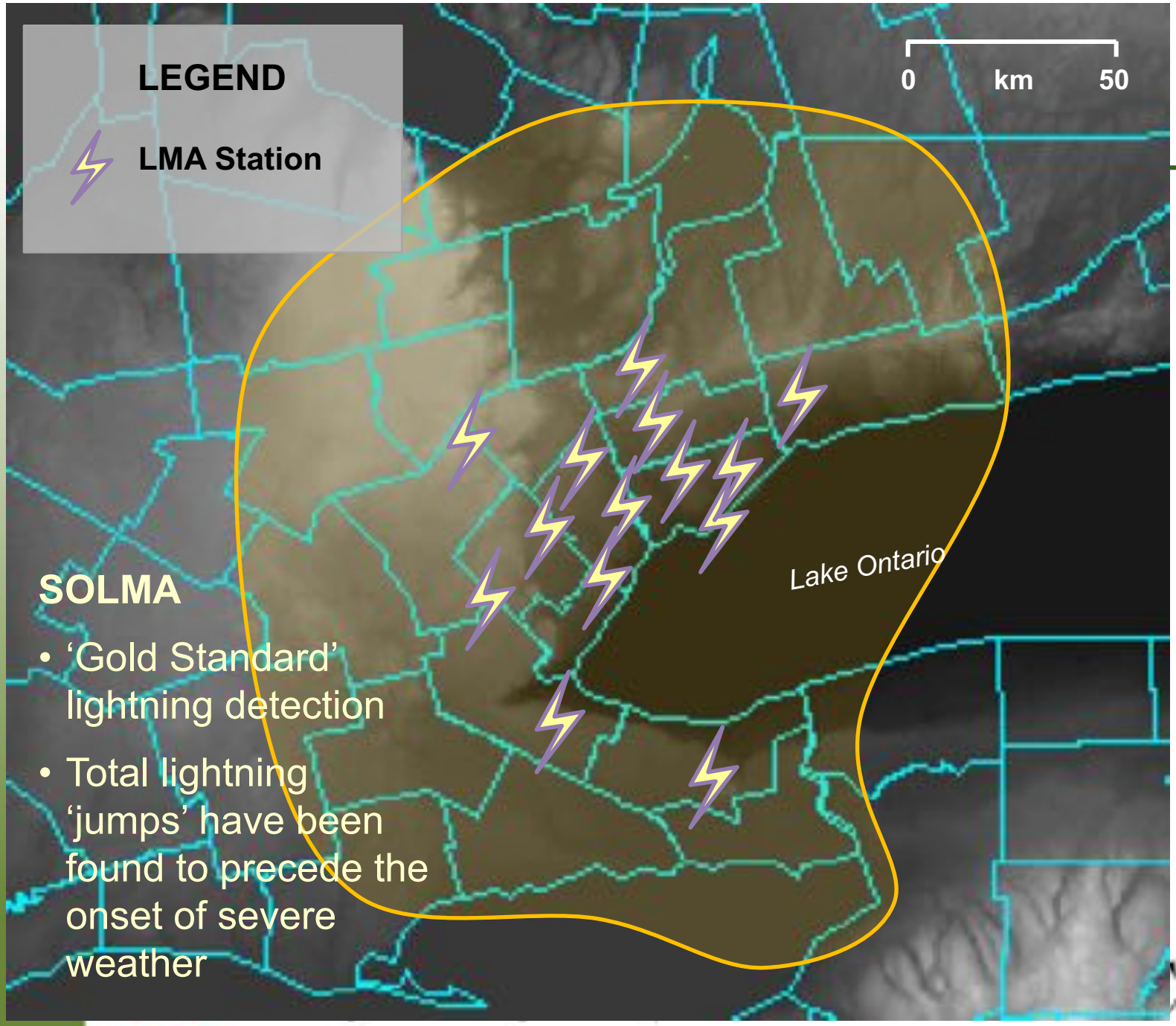
Experimental Design

- 1 Waverider buoy and 2 instrumented boats
  - Sailing venue
- Lake and wave modelling
- Rawinsonde launches
  - 4 per day from King Radar
- 4 UV sensors
- 250 m urban HRDPS model
  - Cascade from 2.5 / 1 km
- Website for real-time data access / blogging





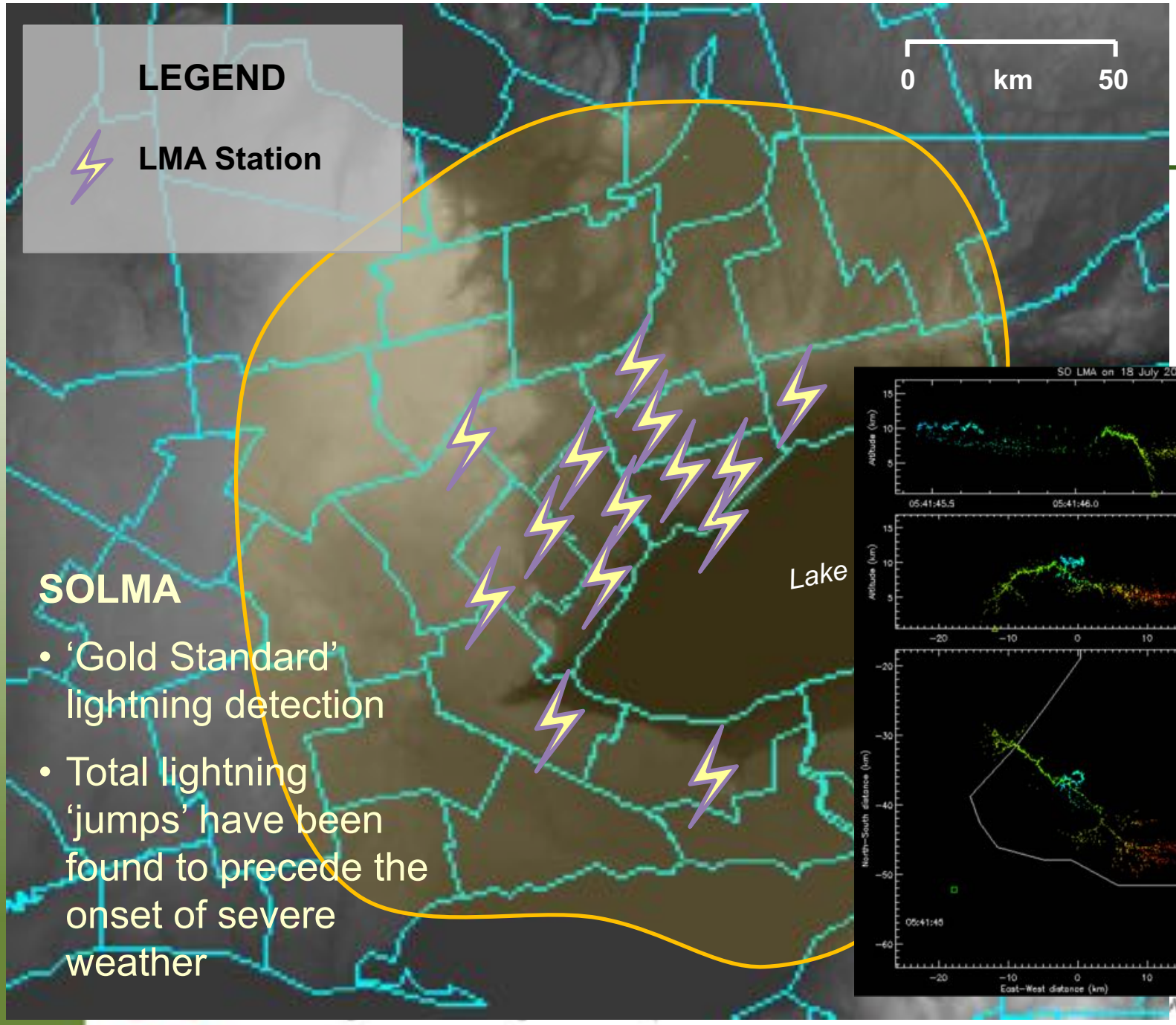

PA2015
Mesonet
0
km
50
Lake Ontario
Lake Erie
LEGEND
Existing Sfc Stn
Existing Buoy
AMMOS Mobile Stn
New Auto8 Stn
New Buoy
ATMOS 10m Sfc Stn
Compact Sfc Stn
Existing Radar
Supersite



SOLMA

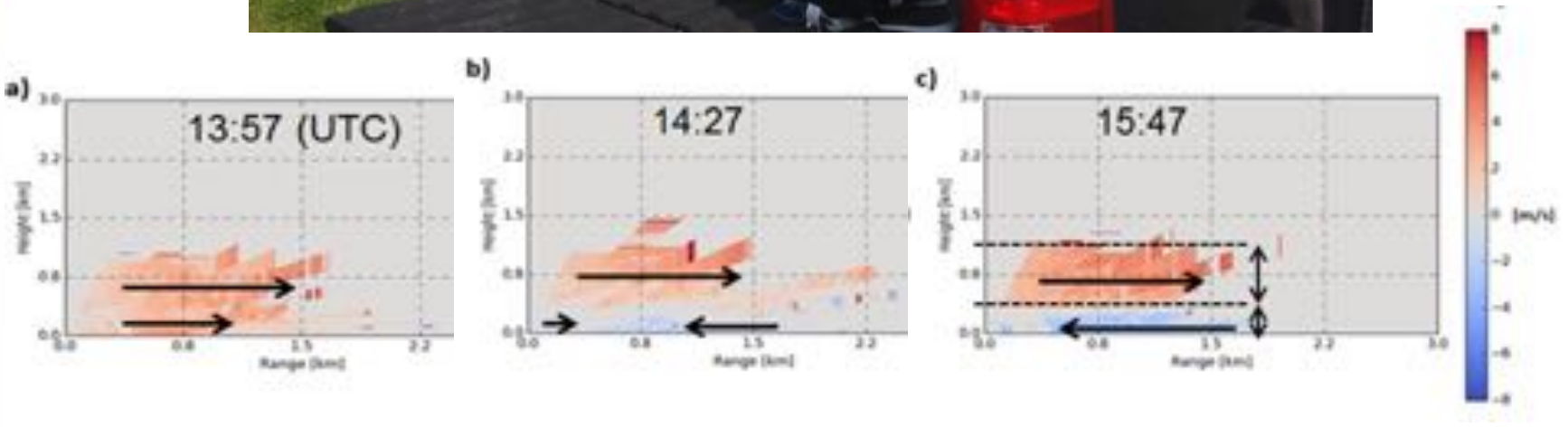
- 'Gold Standard' lightning detection
- Total lightning 'jumps' have been found to precede the onset of severe weather

anada


LEGEND
LMA Station
0
km
50
Lake
SOLMA
• ‘Gold Standard’ lightning detection
• Total lightning ‘jumps’ have been found to precede the onset of severe weather
SO LMA on 18 July 2015
Altitude (km)
05:41:45.5
05:41:46.0
05:41:46.5
1500 pts
alt-histogram
North-South distance (km)
East-West distance (km)
05:41:45

LiDAR – Fixed + Mobile

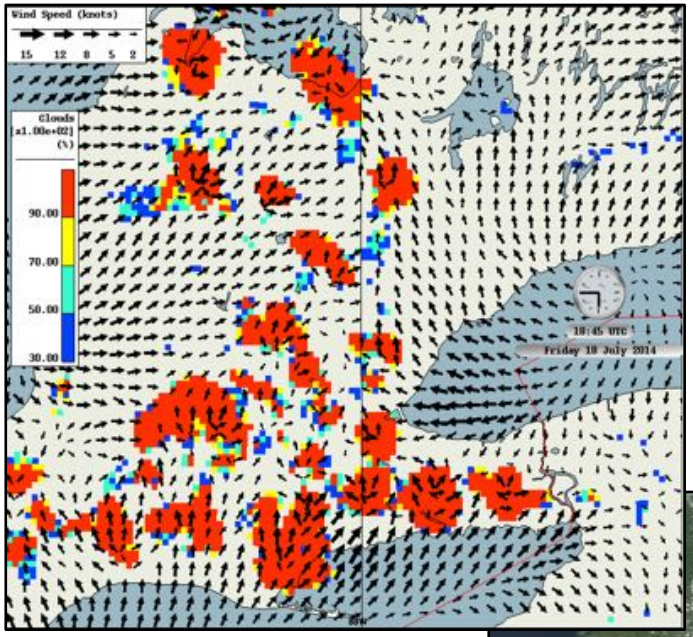
Hanlan's Point Lidar



Supersites – PUMS + YYZ

PUMS Instruments

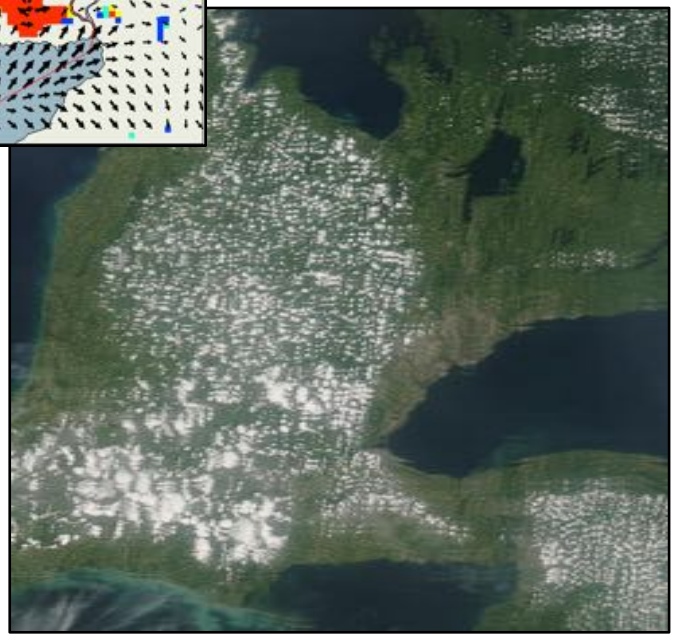
2.5-km HRDPS Model



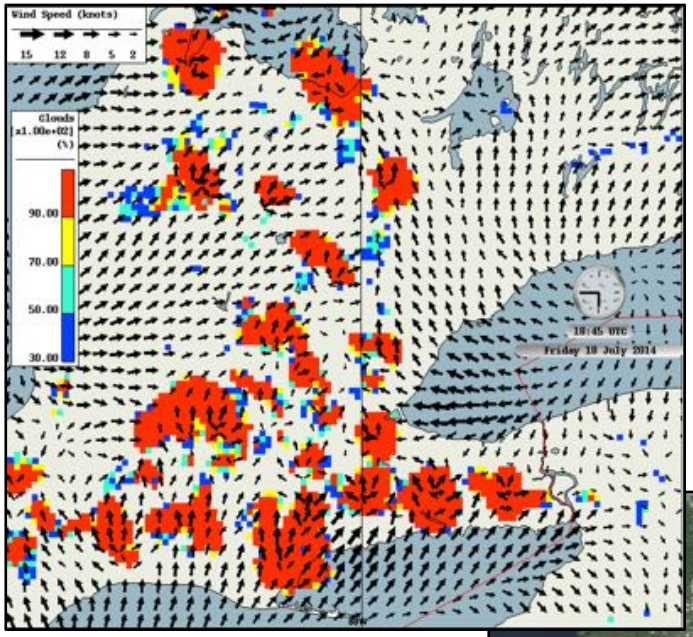
2.5 km

- Cascade from 2.5 km to 1 km to 250 m
- 24-hour integration run once per day
- 1048 x 1048 grid cells in 250 m domain
- More levels near sfc

MODIS

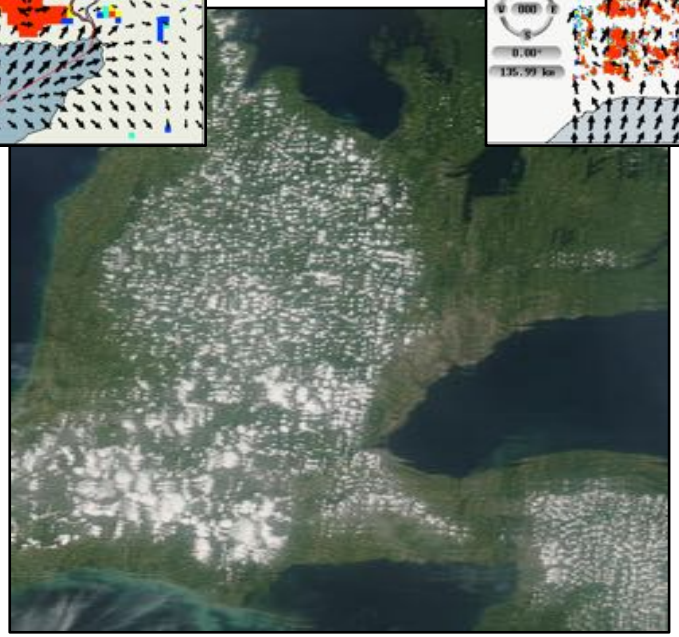


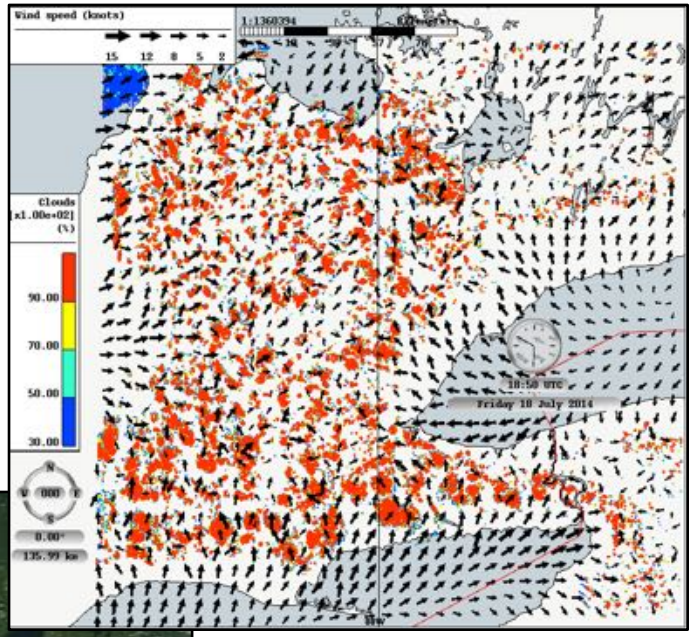
250-m Urban HRDPS Model



2.5 km

- Cascade from 2.5 km to 1 km to 250 m
- 24-hour integration run once per day
- 1048 x 1048 grid cells in 250 m domain
- More levels near sfc

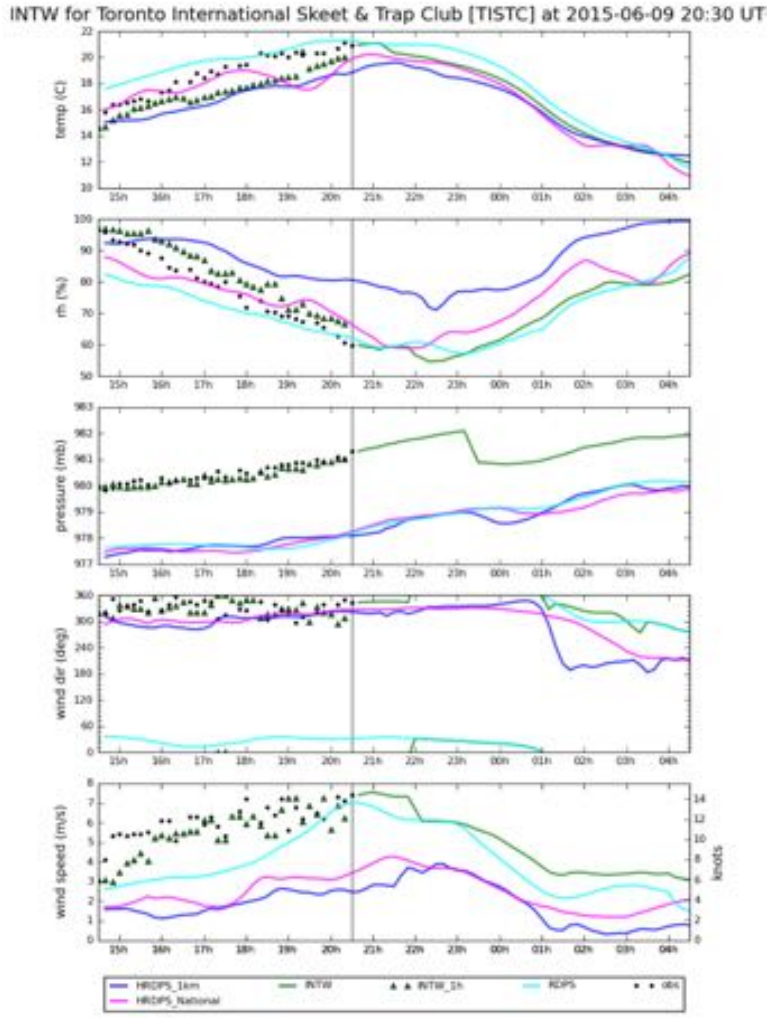




250 m

- Urban scheme
- Detailed microphysics
- Hi-res sfc analyses (land and water)
- Running time 1h 30m with 1824 CPUs

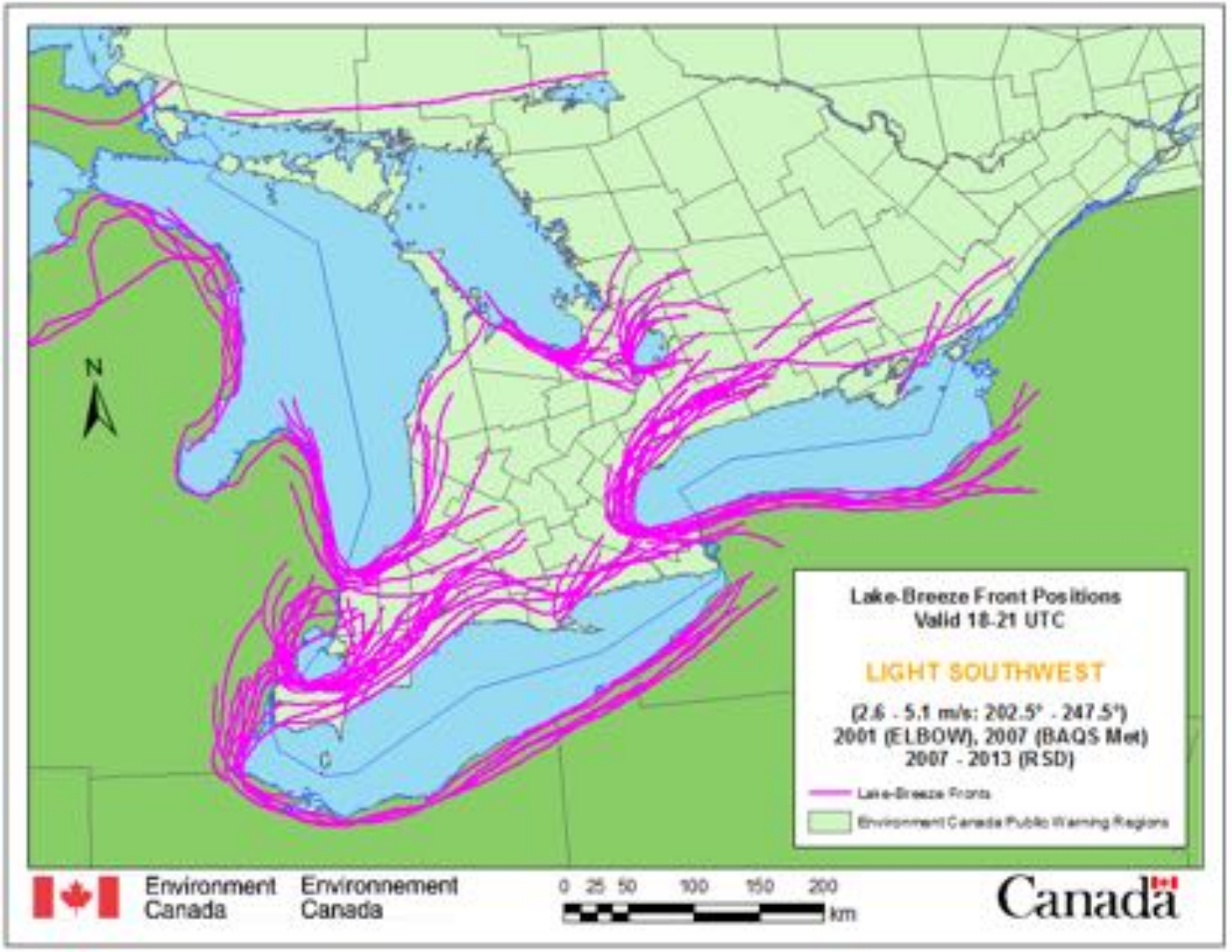
INTW Venue Nowcasts



6 hour forecast (with previous 6 hours)

- Weighted 4 RDPS and HRDPS models runs based on recent performance + bias correction
- Blended with obs
- 6-hr nowcasts of temperature, RH, wind speed and direction, pressure every 10 min at all 20 venue locations

Regional Climatologies



‘Next Gen’ Demonstration

The Games a unique opportunity to demonstrate and evaluate a MetObject-based prototype system for forecasting, nowcasting and alerting:

- *Integrate and employ enhanced monitoring, NWP and climatology data focused on lake-breeze front influence on severe weather / AQ*
- *Generate experimental products to help support Pan Am and OSPC forecasters and field operations during the Games*

Games Weather Conditions

- Lots of lake breeze activity during Games periods!
  - 22 / 26 days in southern Ontario
  - 19 / 26 days in Pan Am domain
- Several heat and poor air quality episodes, some with clear lake breeze influences
- Little lightning / severe weather in Pan Am domain during Games periods
  - Just 10 days with storms, 9 of those with severe weather (but nothing significant)

Summary

David.Sills@canada.ca

- The Toronto 2015 Pan / ParaPan Am Games provided a focal point for collaborative science activities and accelerated a number of projects
- Scope kept growing right up until the Games!
- Unique, world-class data set for process studies and hi-res model validation – numerous reports and presentations, publications under way
- All data to be available via the open data portal

Thank you / Merci!