



Environment
Canada

Environnement
Canada

Canada

Science Showcase for Pan Am and ParaPan 2015

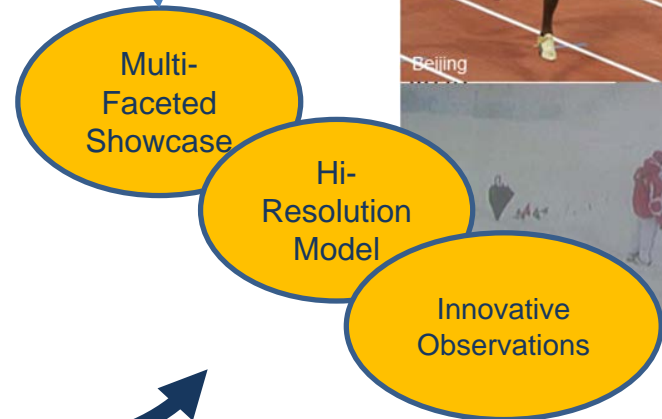
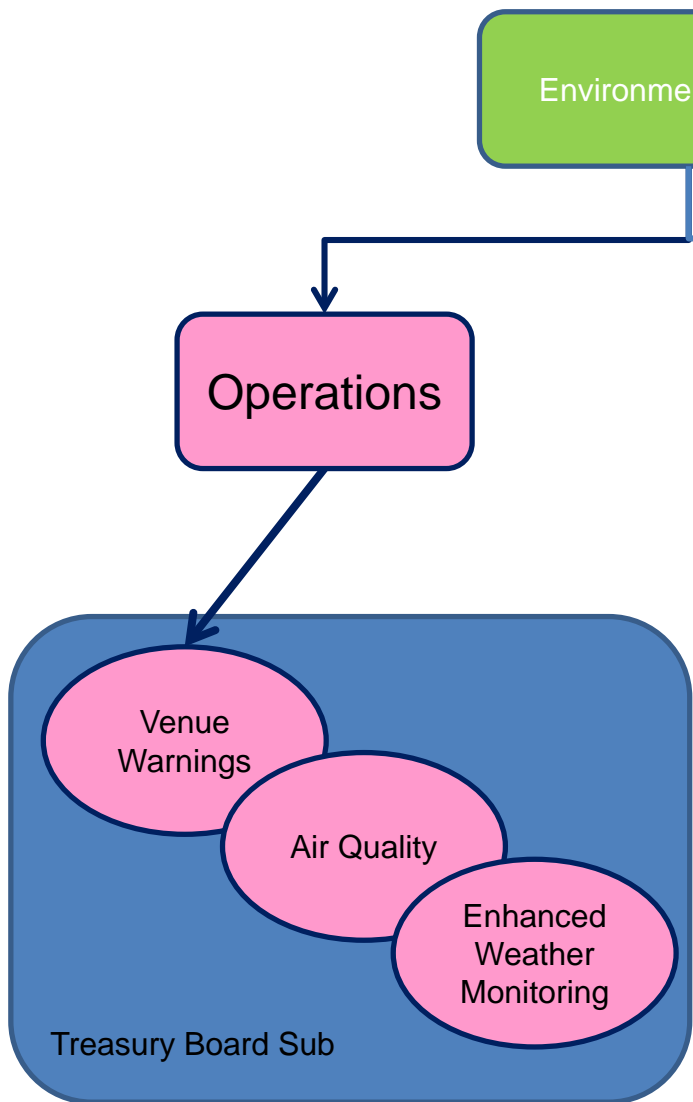
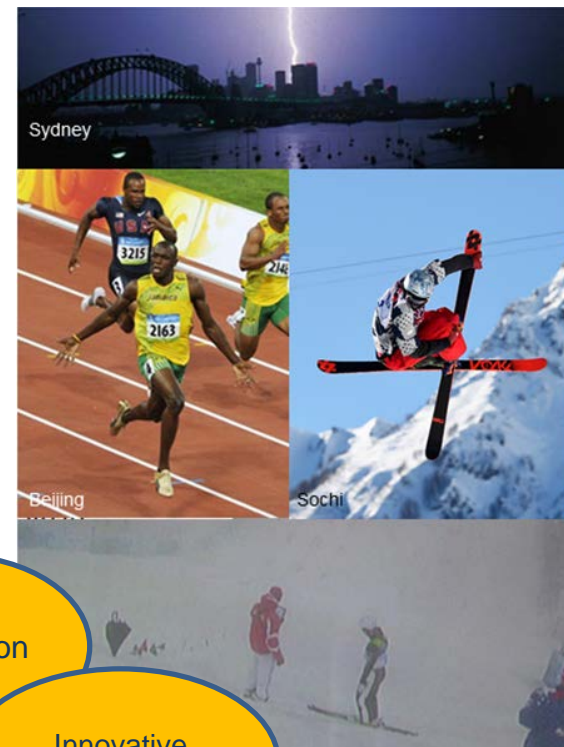
A Meteorology + Air Quality + Health + Urban Project

Stephane Belair/Paul Joe

Cloud Physics and Severe Weather
Research Section



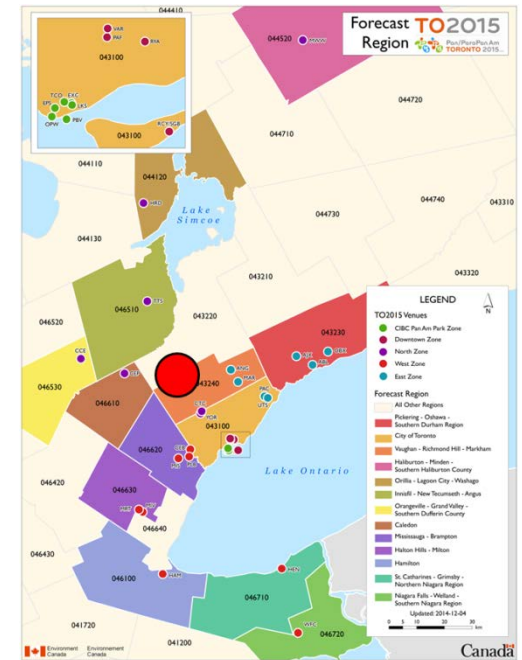
Previous Experience



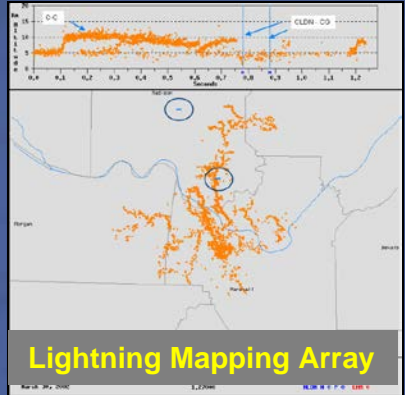
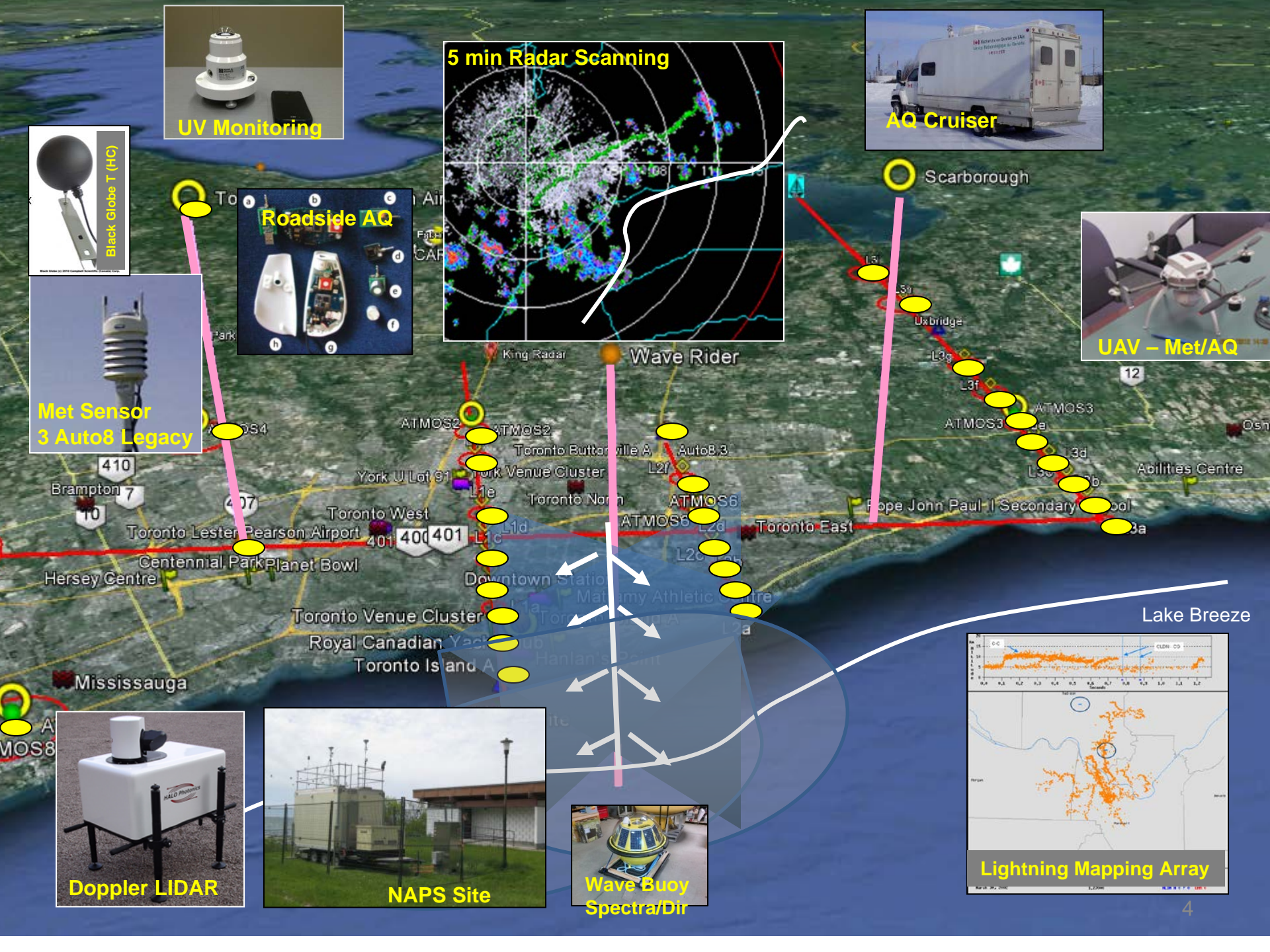
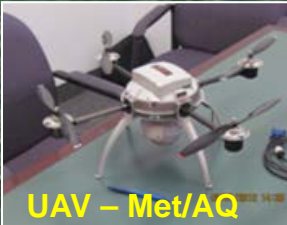
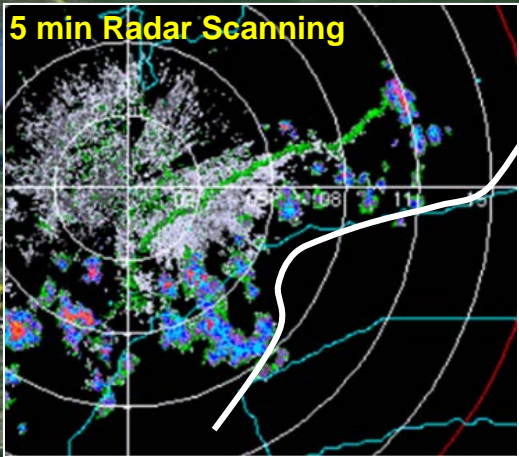
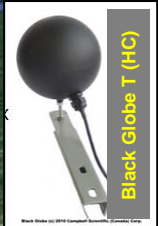
Operations + Science Synergies

There have been several recent incidences with large crowds and severe winds.

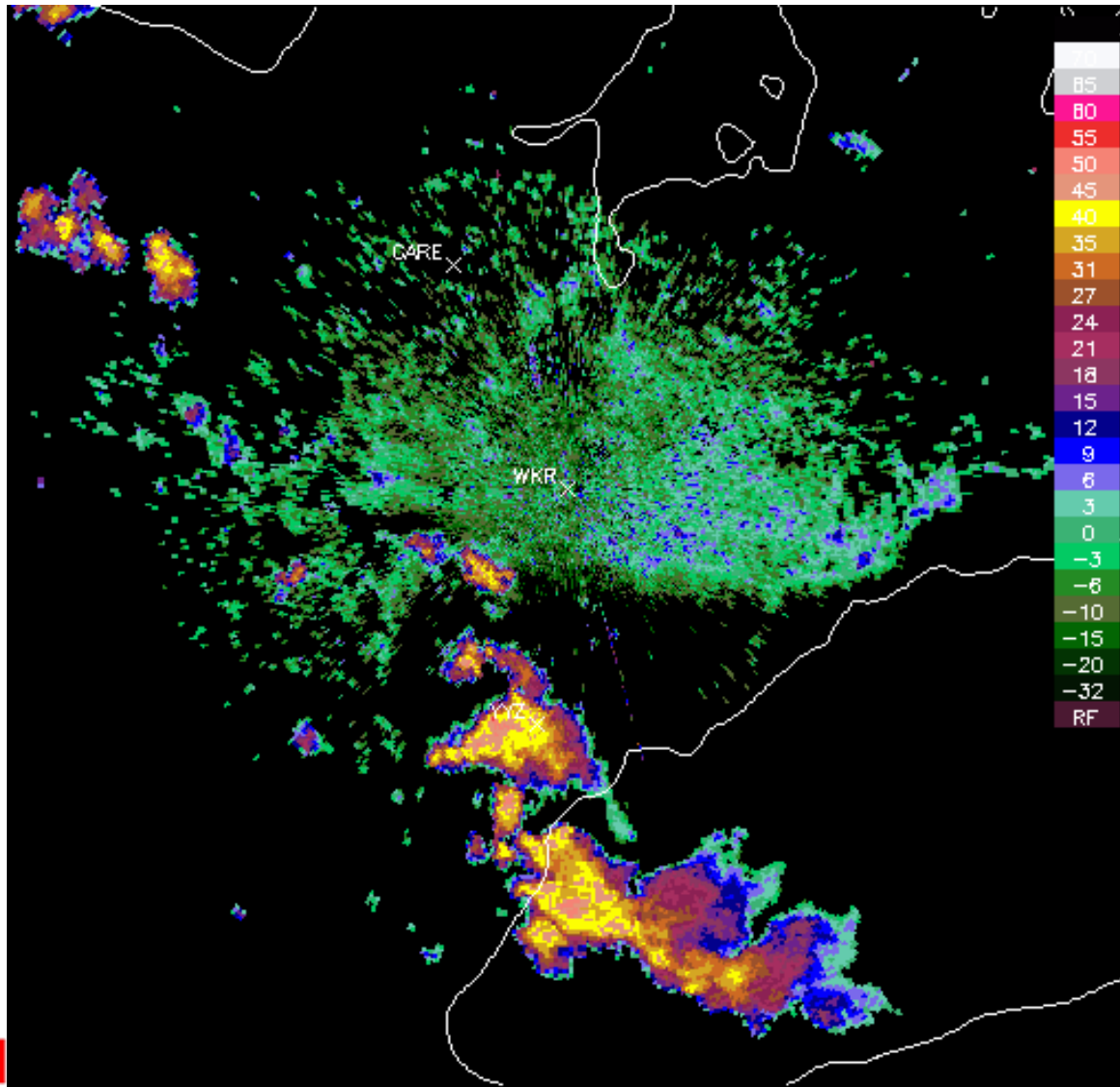
Camrose Big Valley Jamboree 2009



Ottawa Bluesfest 2011



Radar, Insects and Thunderstorms



- Reds and yellow indicate heavy rain.
- Greens and blue indicate insects.
- Insects are caught up in the lake breezes to reveal their presences and location.
- Lake breezes are zones of vertical motion that can create new or intensify existing thunderstorms.

The Urban Challenge

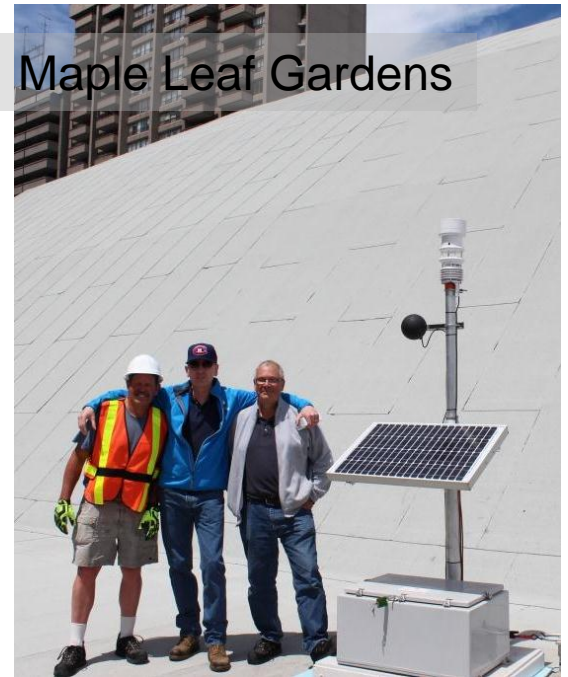
Typical “urban” stations



Quality control of urban measurements must take into account the highly variable surface.

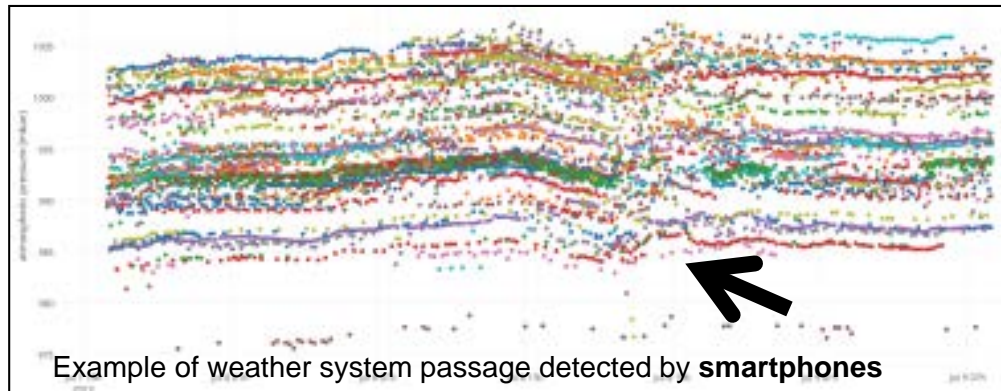
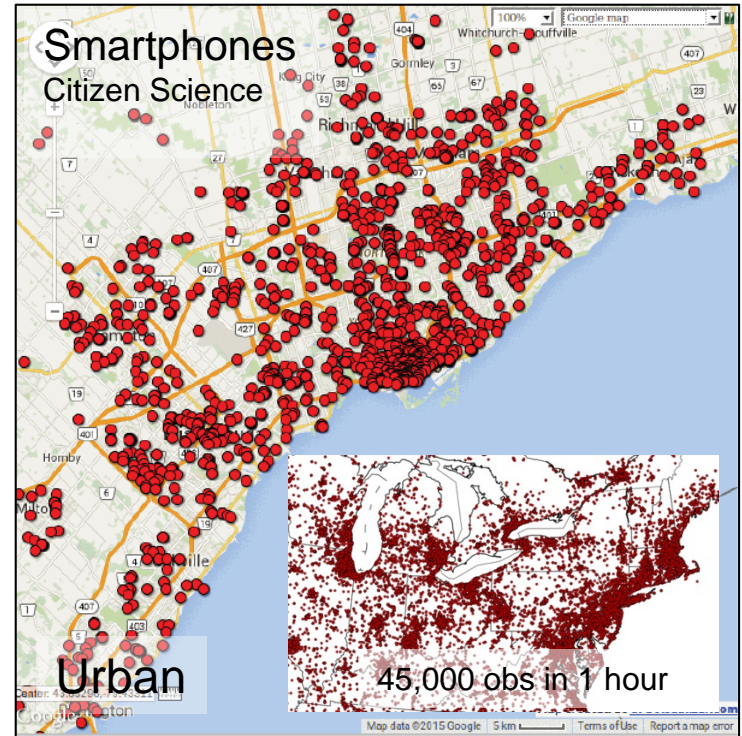
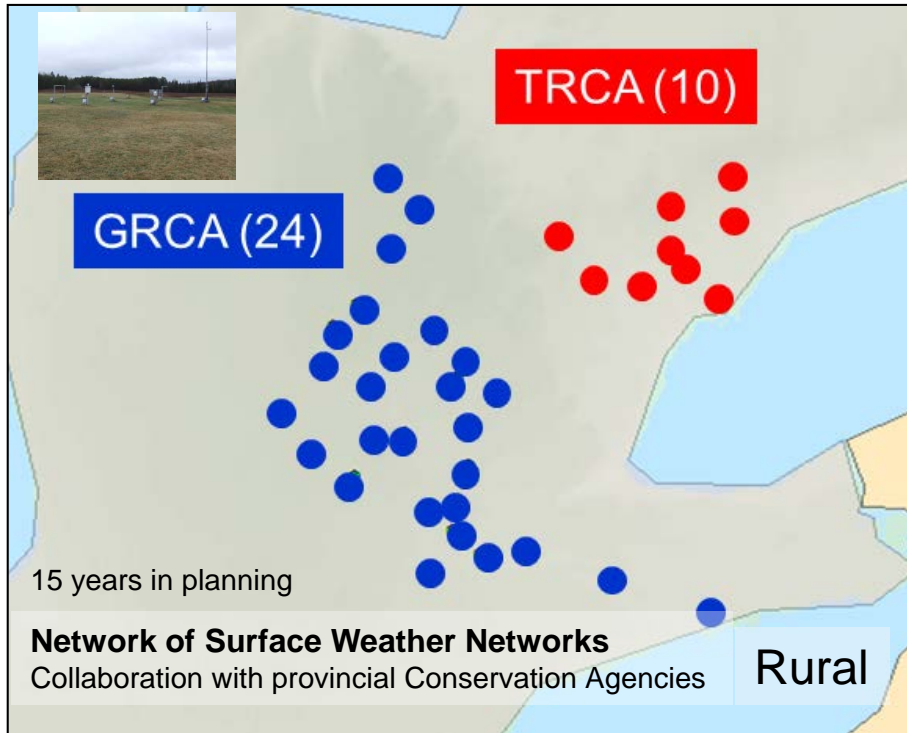


The “standard” weather station




Maple Leaf Gardens

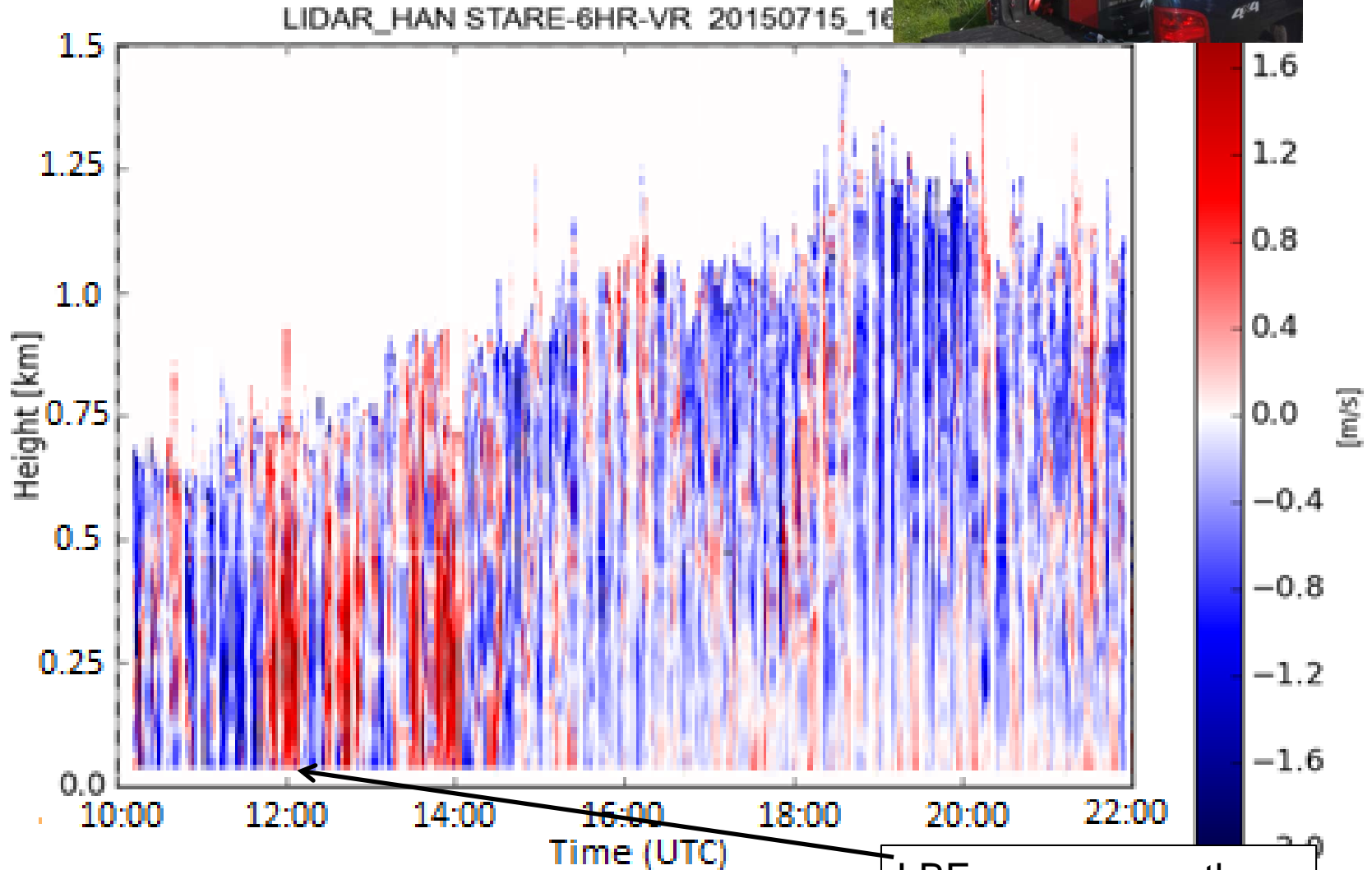
Network of Network via PA15 Branding



SMARTPHONE/Weather

- Pressure
 - Temperature
 - Relative Humidity
 - UV
 - Signal strength (related to precipitation rate)
- 
- A photograph of a smartphone is shown in the background of the list, tilted slightly to the right.

Lidar Observation of Enhanced Vertical Velocity at Lake Breeze



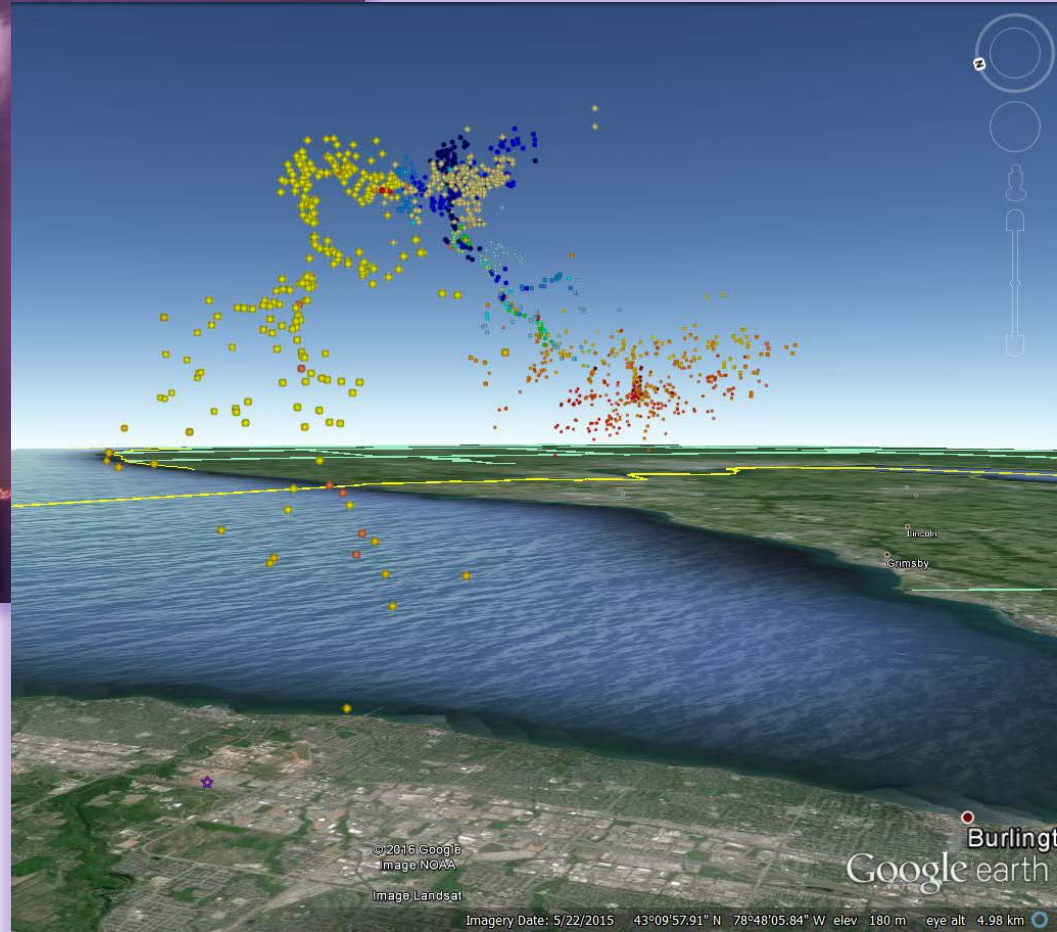
LBF passes over the
HAN Lidar on Jul 15

Lightning Mapping Array: Bolt from the Blue, 18 July 2015

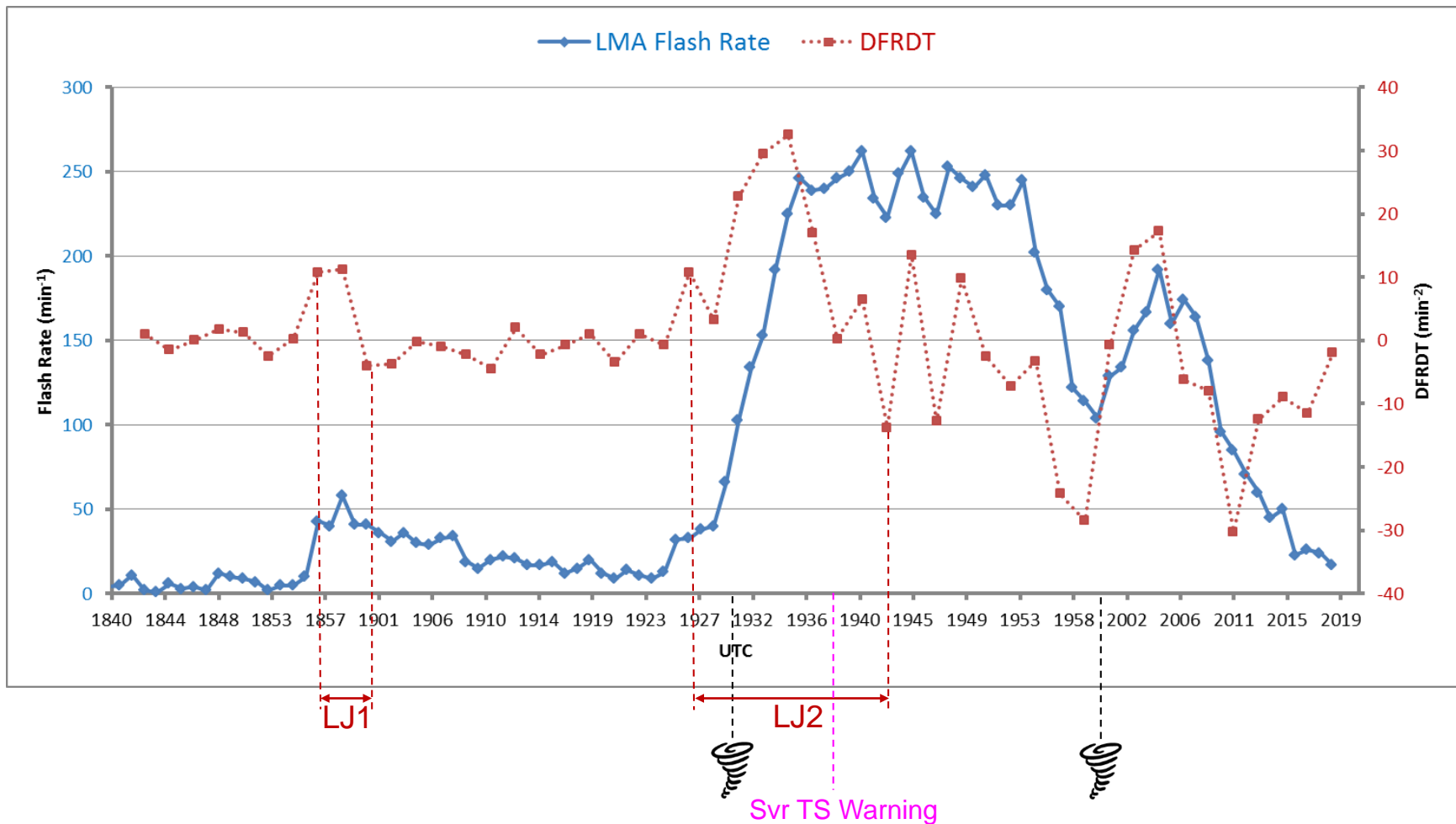


Kerns Rd facing ESE

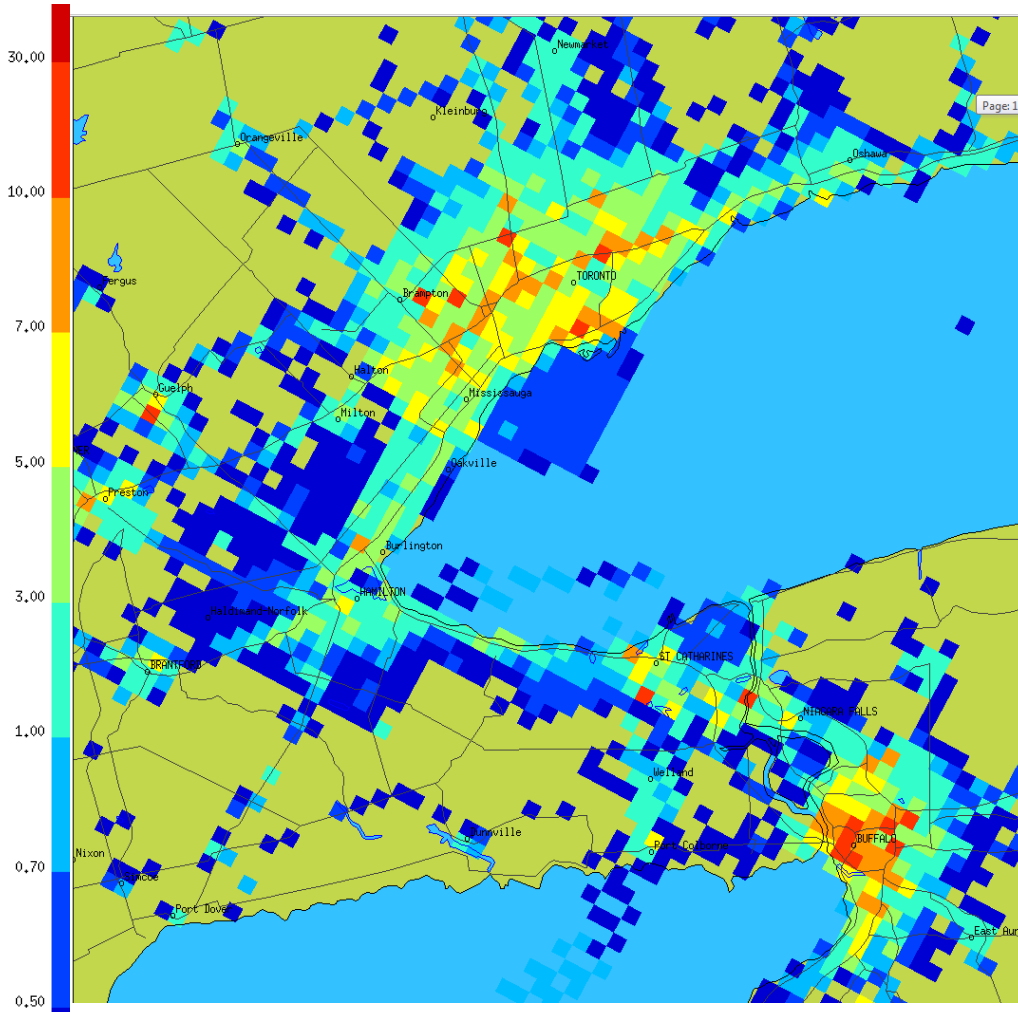
05:41:45.45 to 05:41:46.90 UTC



Case Study of Lightning Jump and Two EF1 Tornadoes, 24 June 2014



Nitric Oxide Area Emissions Map (The Urban AQ problem)

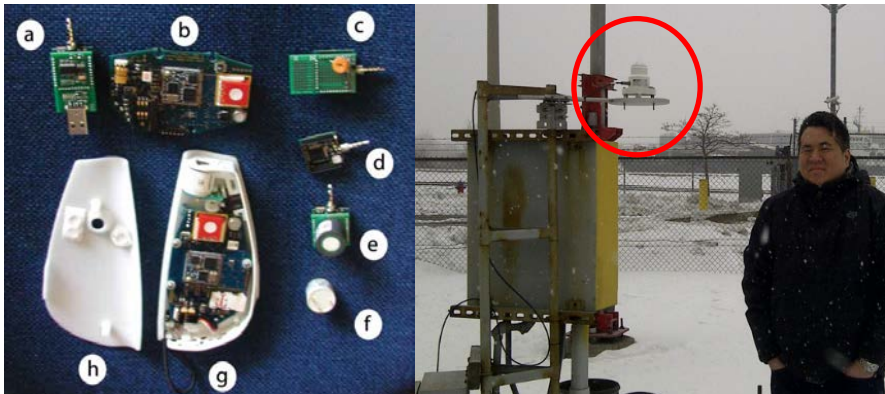
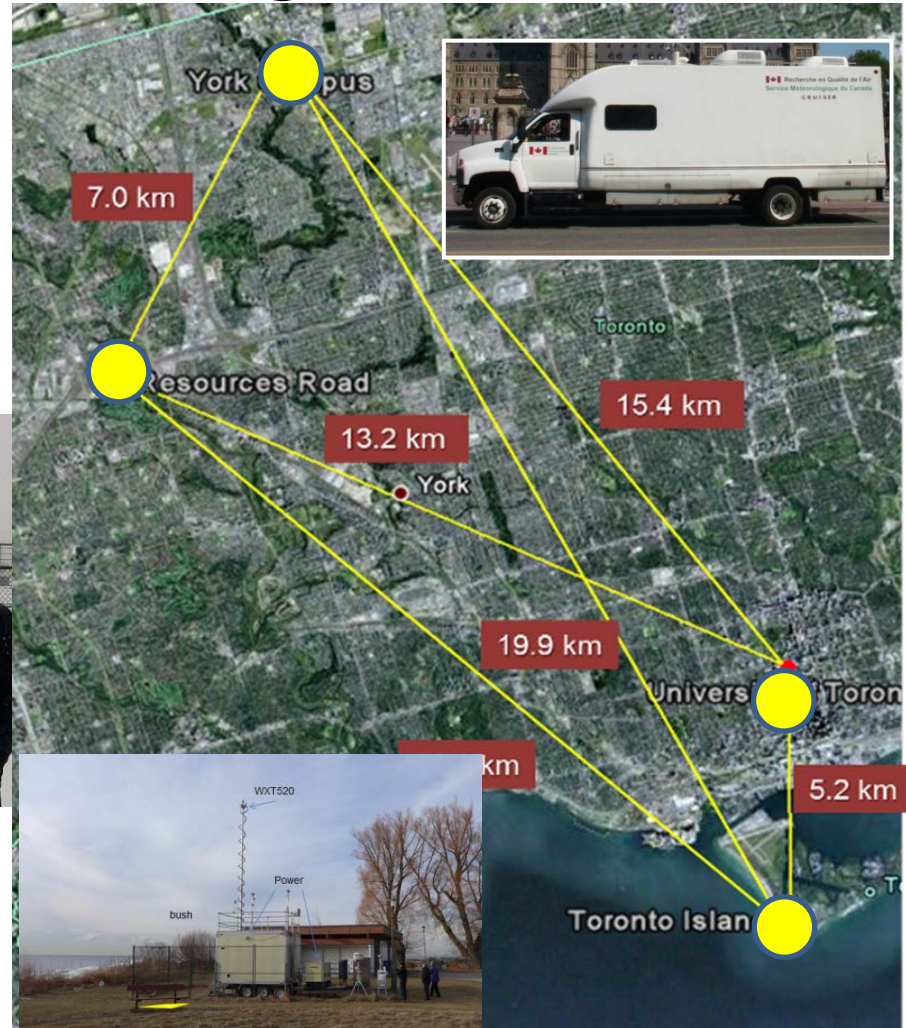


Emission totals by source type are from the Canadian National Pollutant Release Inventory (NPRI),

Note the scale.

AQ Urban Monitoring

- **Elements observed (hourly):**
 - PM2.5; PM10; Ozone; NO2; some UV
 - 2 additional AQ monitoring stations (at U of T Downtown & at York U)
- **Two additional AQ monitoring stations**
 - (U of T Downtown & York U)

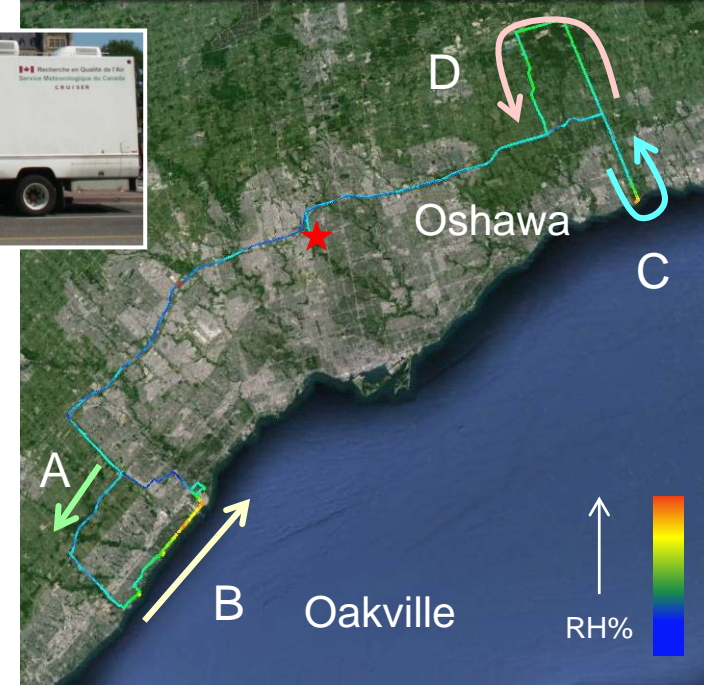


Left: Road side air quality sensors will measure and validate models that predict the impact of the road traffic on air quality.

Right: AQRD will be testing a new and improved system for forecasting the UV index. After the Games, the performance of the pilot system will be compared to the existing system and become operational if the results are significantly better.

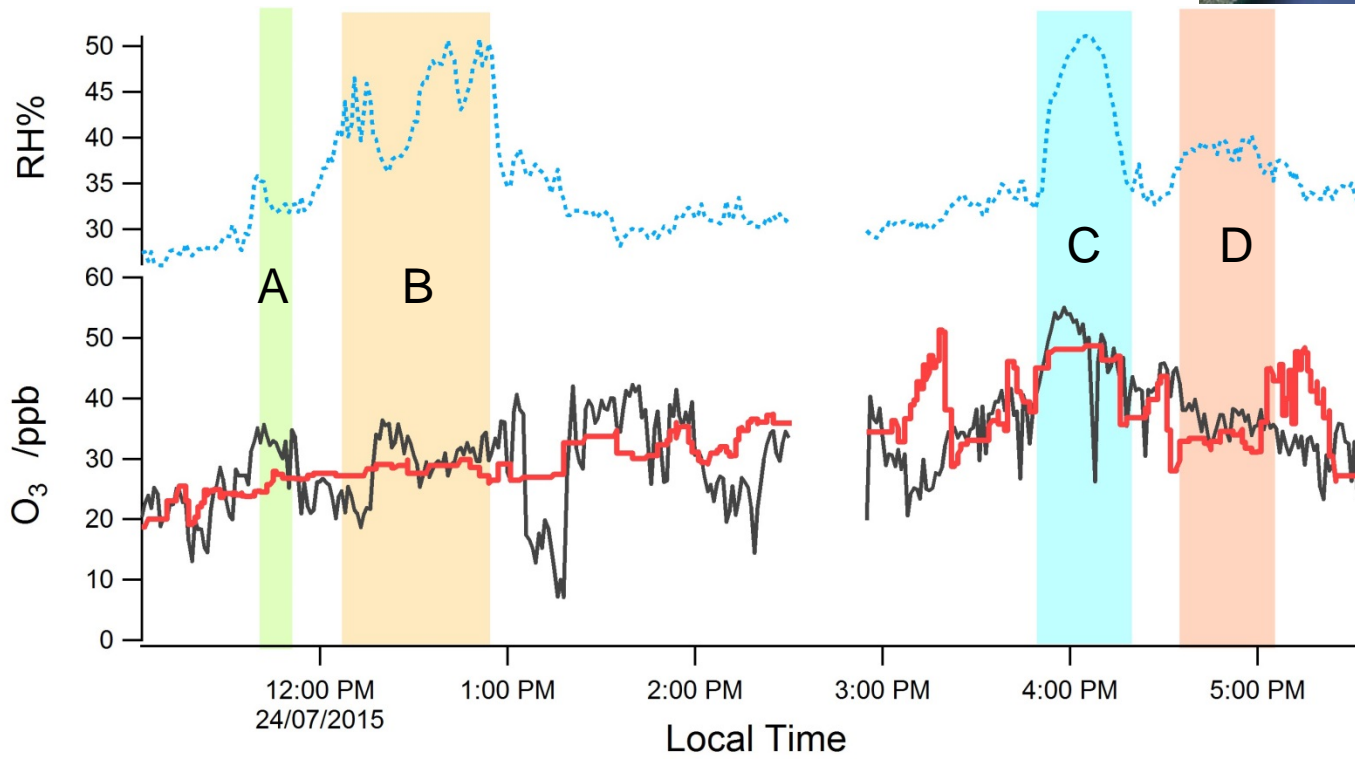
EC is collaborating with Ministry of Environment and U of Toronto to double the number of AQ sites in Toronto

Lake Breeze Case: July 24



Segment	CRUISER avg (ppb)	MODEL avg (ppb)
A	31.4	26.7
B	28.8	28.2
C	46.9	45.1
D	37.3	33.9

Good agreement for modelled vs. measured ozone!



— GEM-MACH
— CRUISER
... RH%

Higher ozone in "lake air" near Oshawa

"urban-rural" difference

Wave Buoys



Specialized buoys deployed to supplement meteorological measurements over water. Include wave height and direction to validate lake circulation and wave predictions in Lake Ontario and, in the future, the Arctic.

Black Globe Thermometer measures “body heat stress”



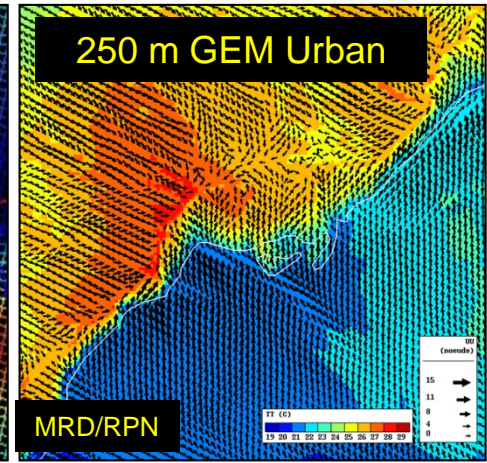
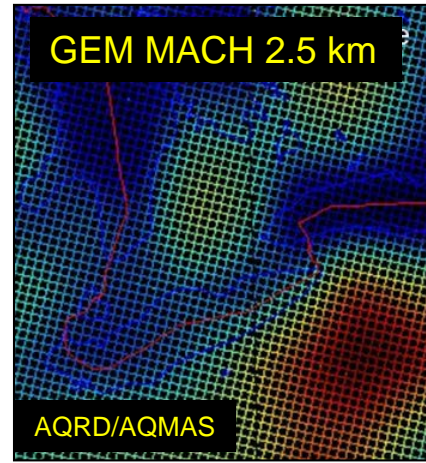
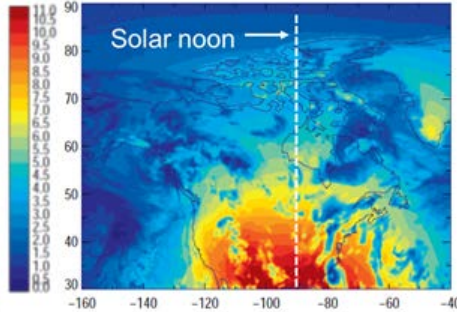
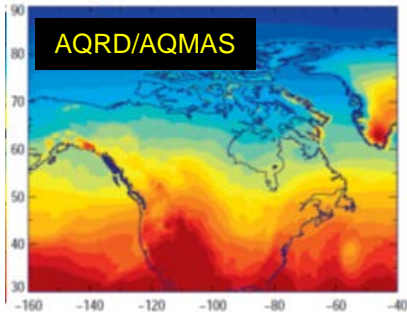
Black Globe (c) 2010 Campbell Scientific (Canada) Corp.

EC is installing Black Globe Thermometers. This will provide data to health researchers to enable predictive studies. Used by Public Health and hospitals for staffing.

Environmental Prediction Applications

1 day forecast based on model column ozone following ozone assimilation

Data assimilation and impact of clouds

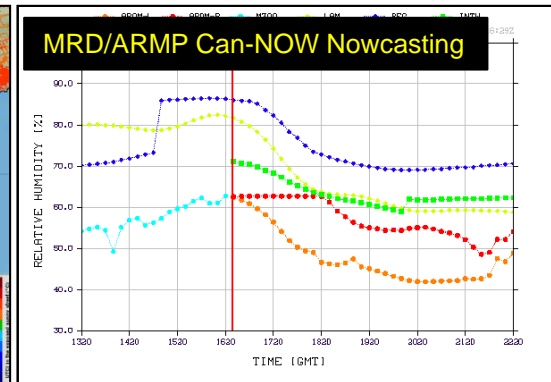
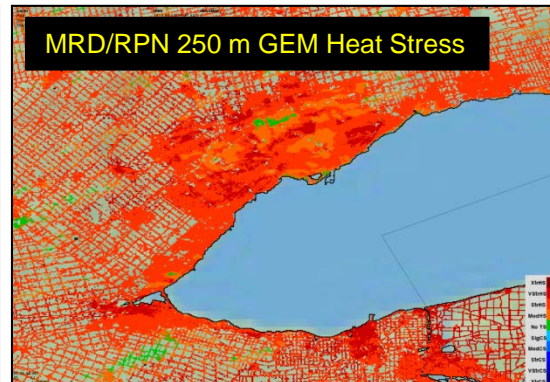
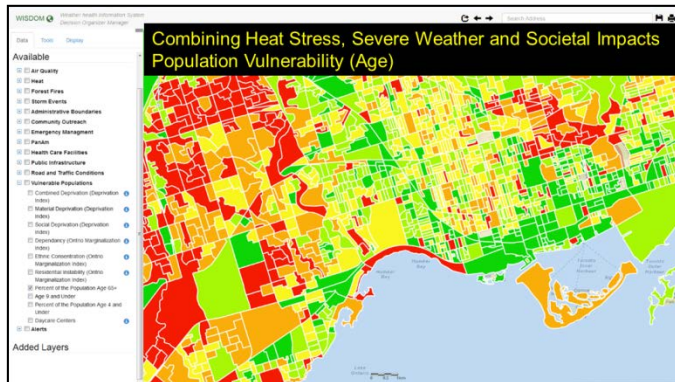
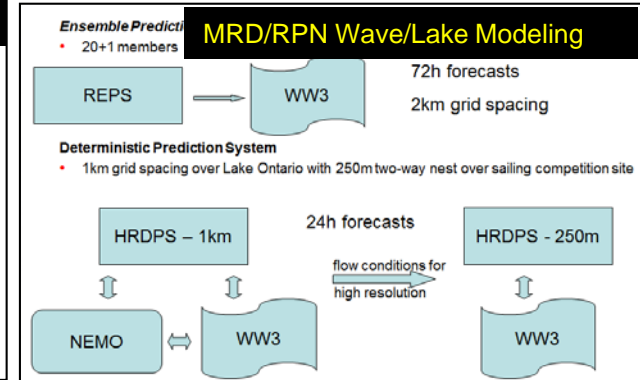
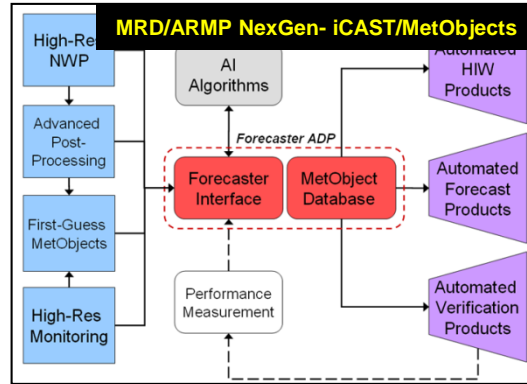


Validate:

- 2.5 km Air Quality Model
- UV Index Model
- 250 m Urban Model
- Wave/Lake Model

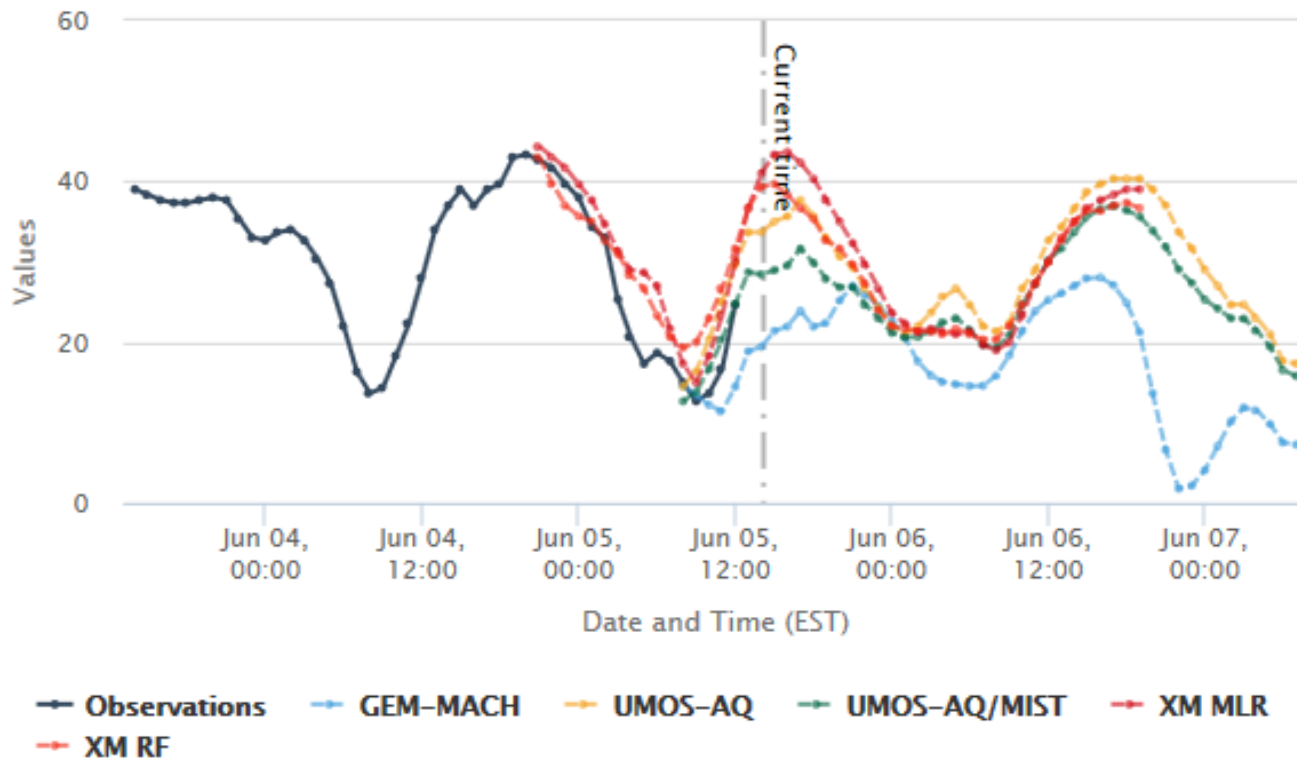
Other

- Weather and Health Services
- Aviation Nowcasting
- Arctic Monitoring



Example of AQ Post-Processing at fine scale

3-Hour Rolling Mean O₃ Observations and Forecasts



Real-Time Forecast Product

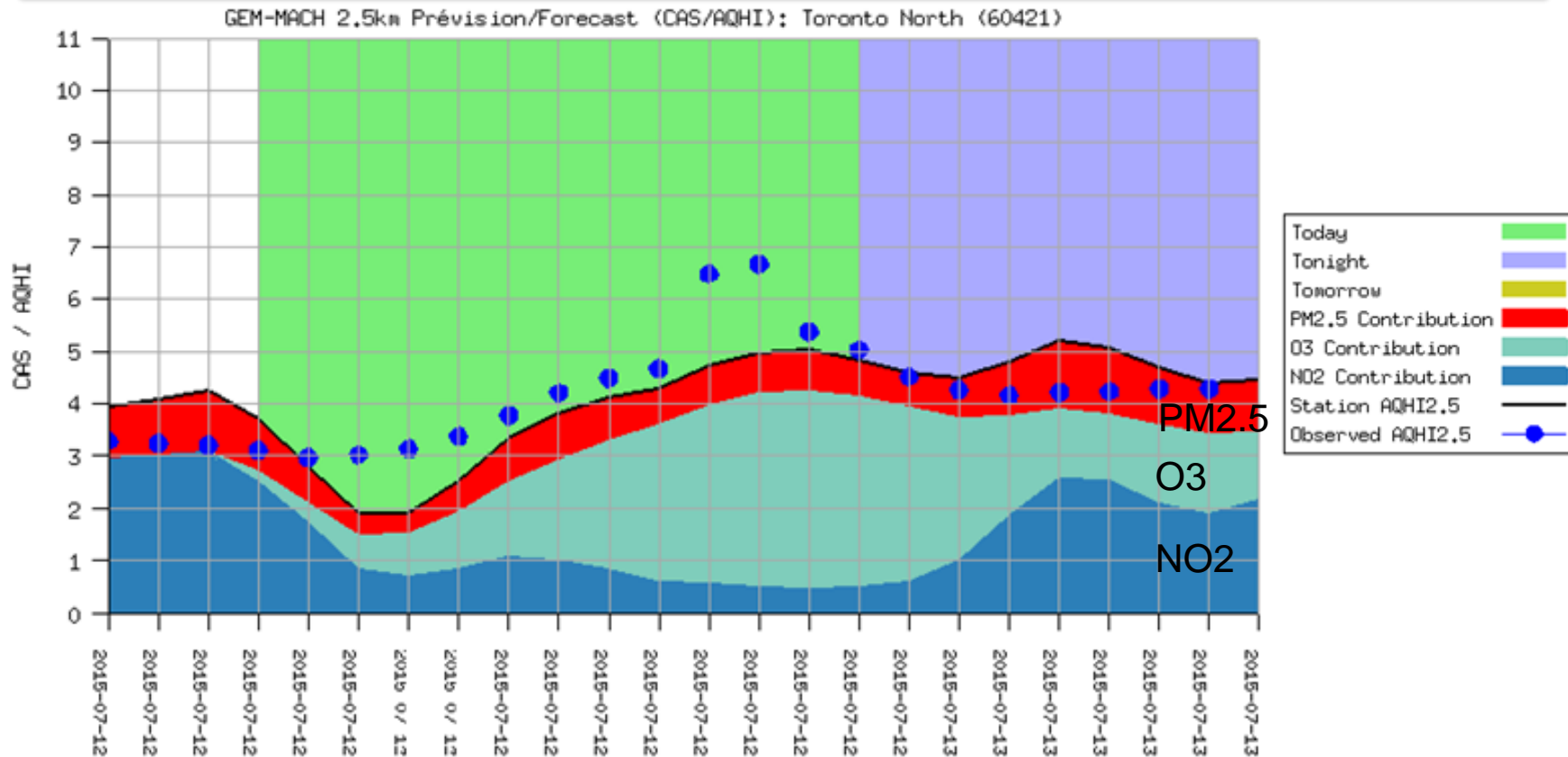
Comparison of Forecast Curves:

UMOS-AQ is the tool used to “correct” the model forecast, based on linear statistical methods.

XM MLR and XM RF are non-linear correction techniques being tested in a real-time setting.

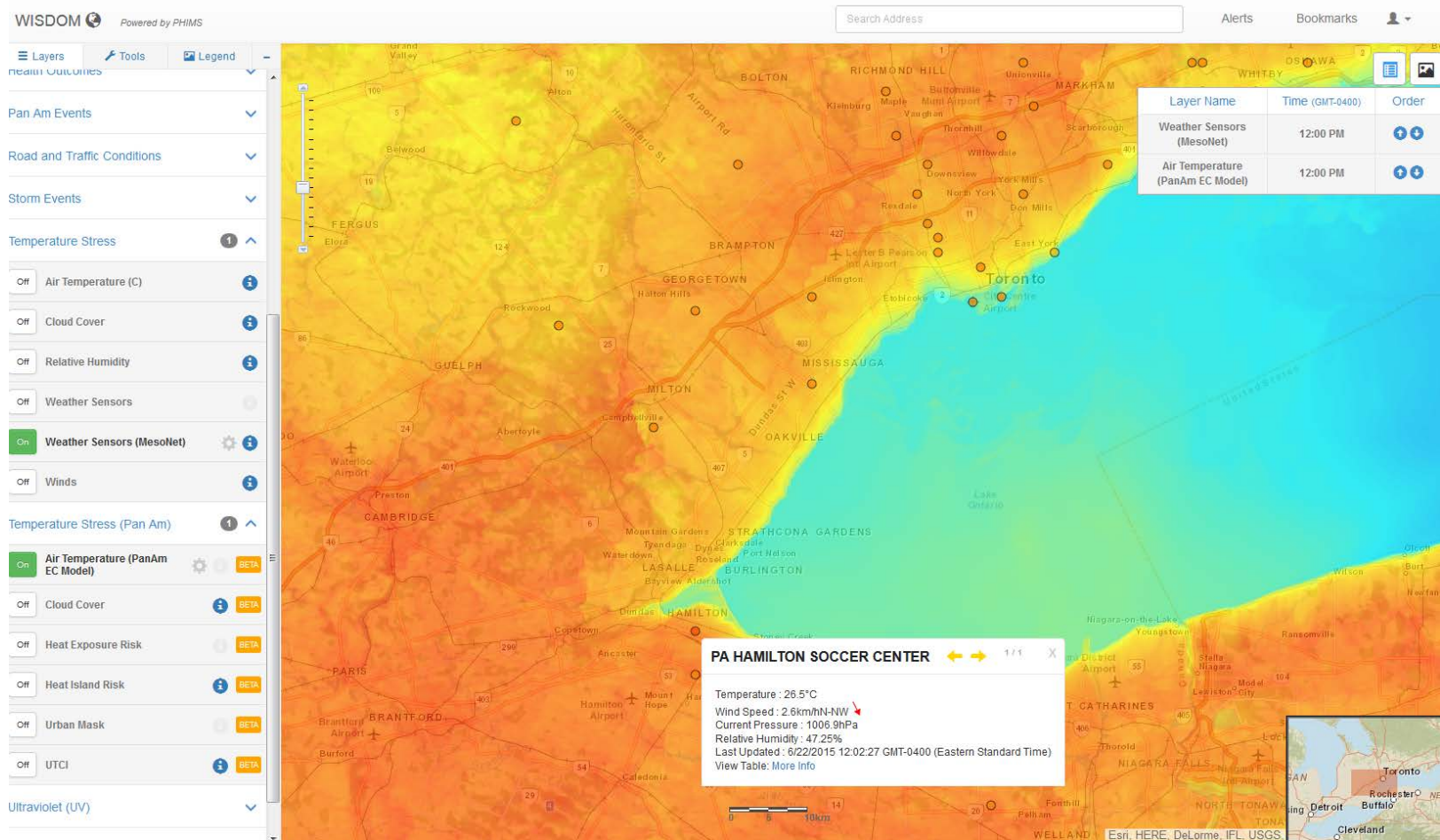
Example of GEM-MACH AQHI Forecast

An example of the GEM-MACH v2 time series predictions displayed on the MSC AQHI demonstration website for July 12, 2015. Collaboration with Paul-Andre at AQMAS.

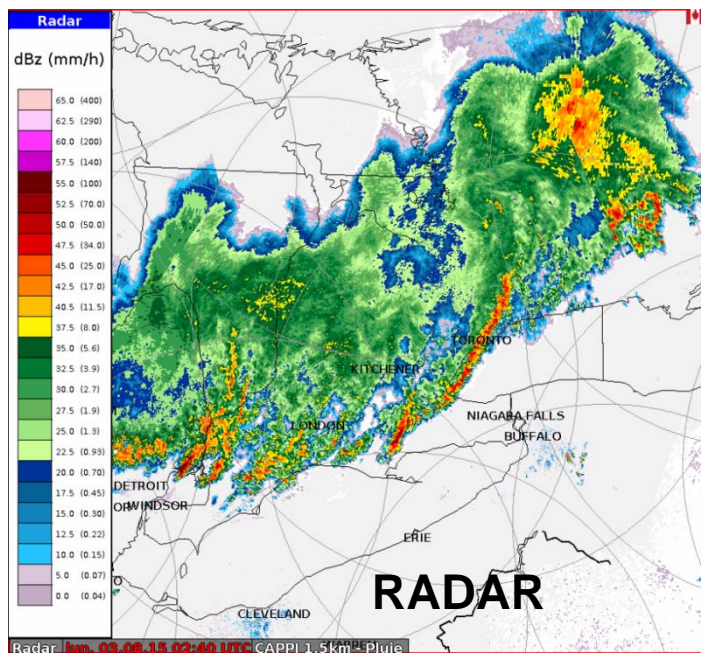


The forecast products were placed on several data portals for dissemination (CMC AQHI Development website, EC-Pass website, Aairsensors.ca website and the WISDOM health data website).

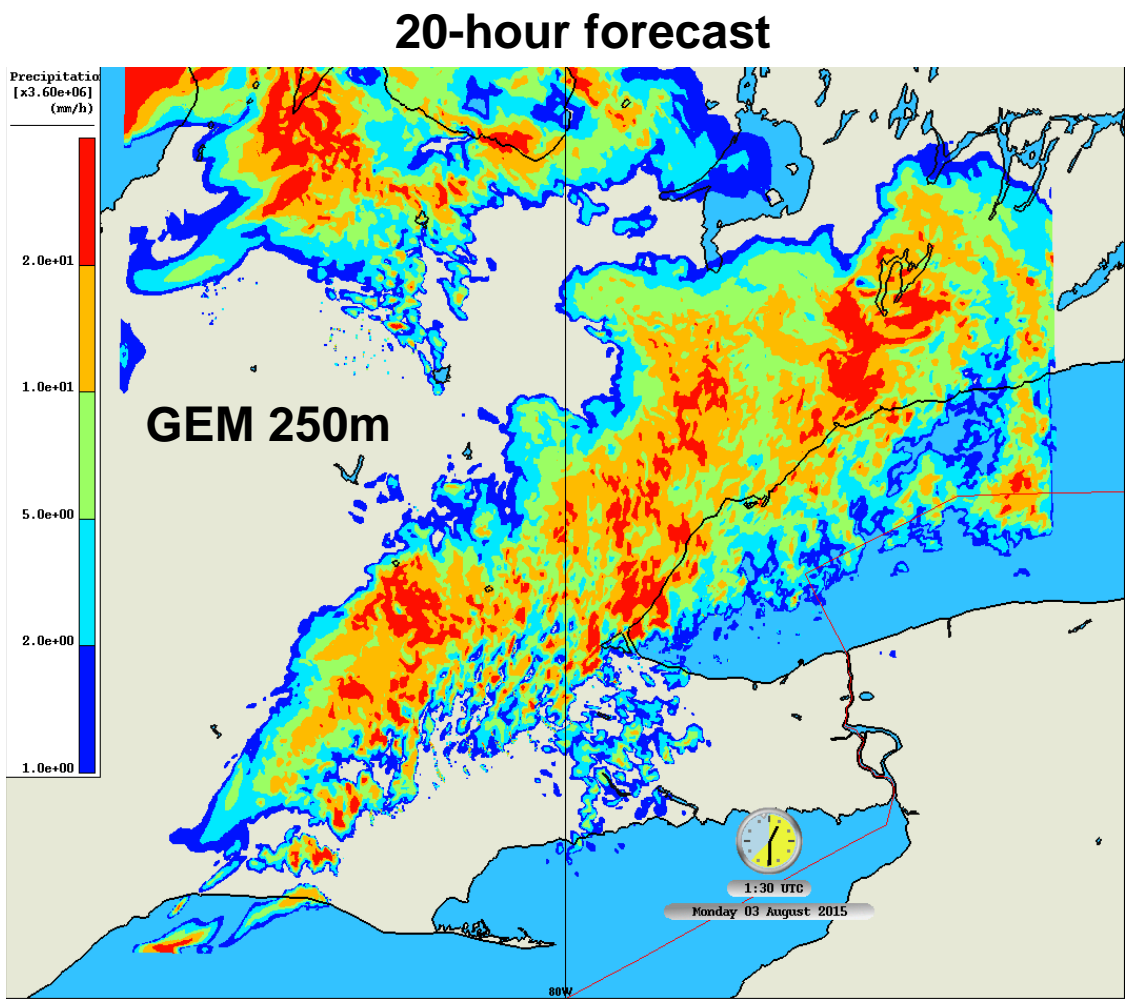
Urban GEM Temperature model (250m) and Mesonet Temps



Severe weather: Multiple convective events on August 2nd, 2015

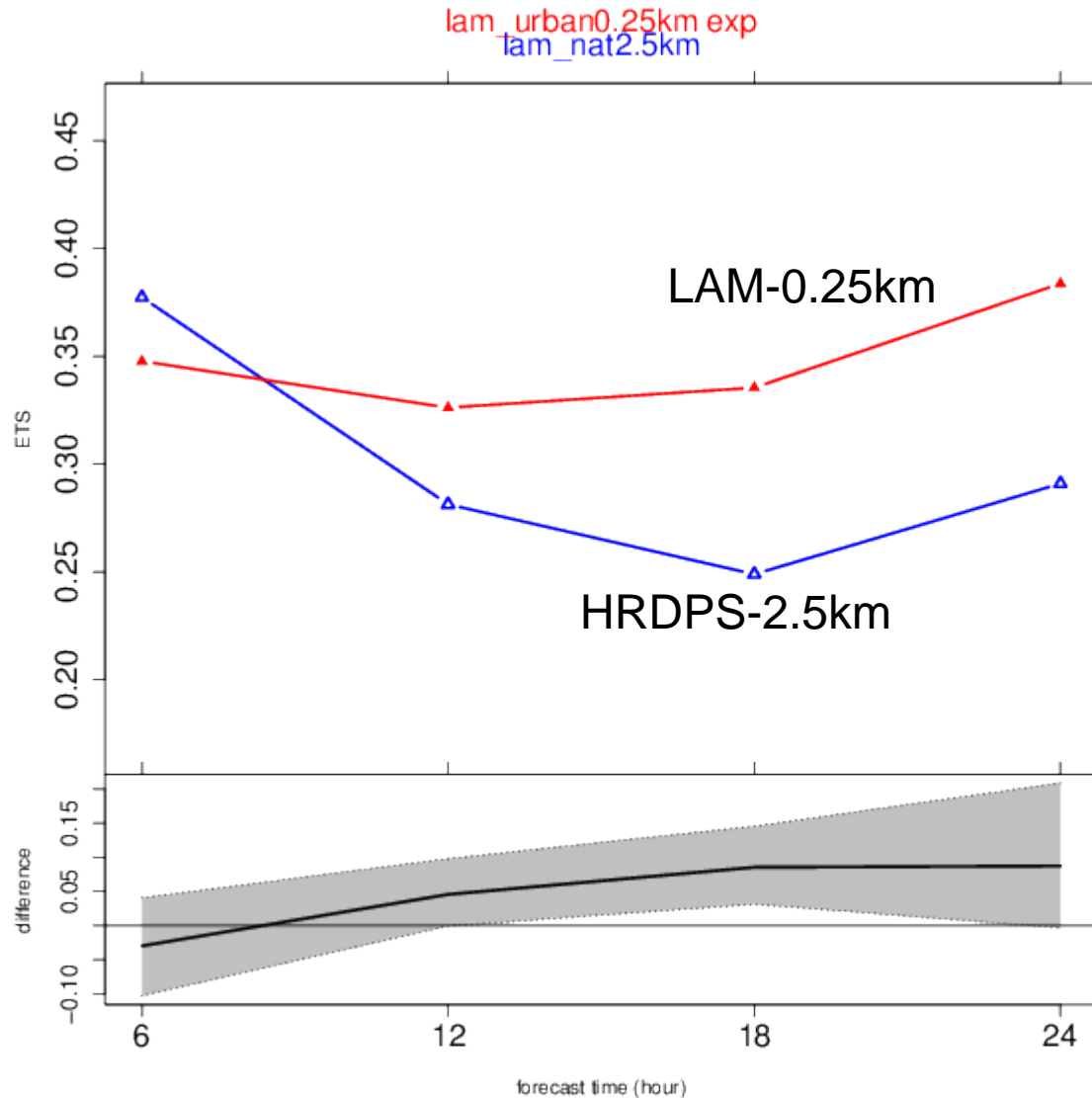


Valid at 11:08 pm on August 2nd, 2015



Valid at 9:30 pm on August 2nd, 2015

Objective evaluation over Pan Am 2015

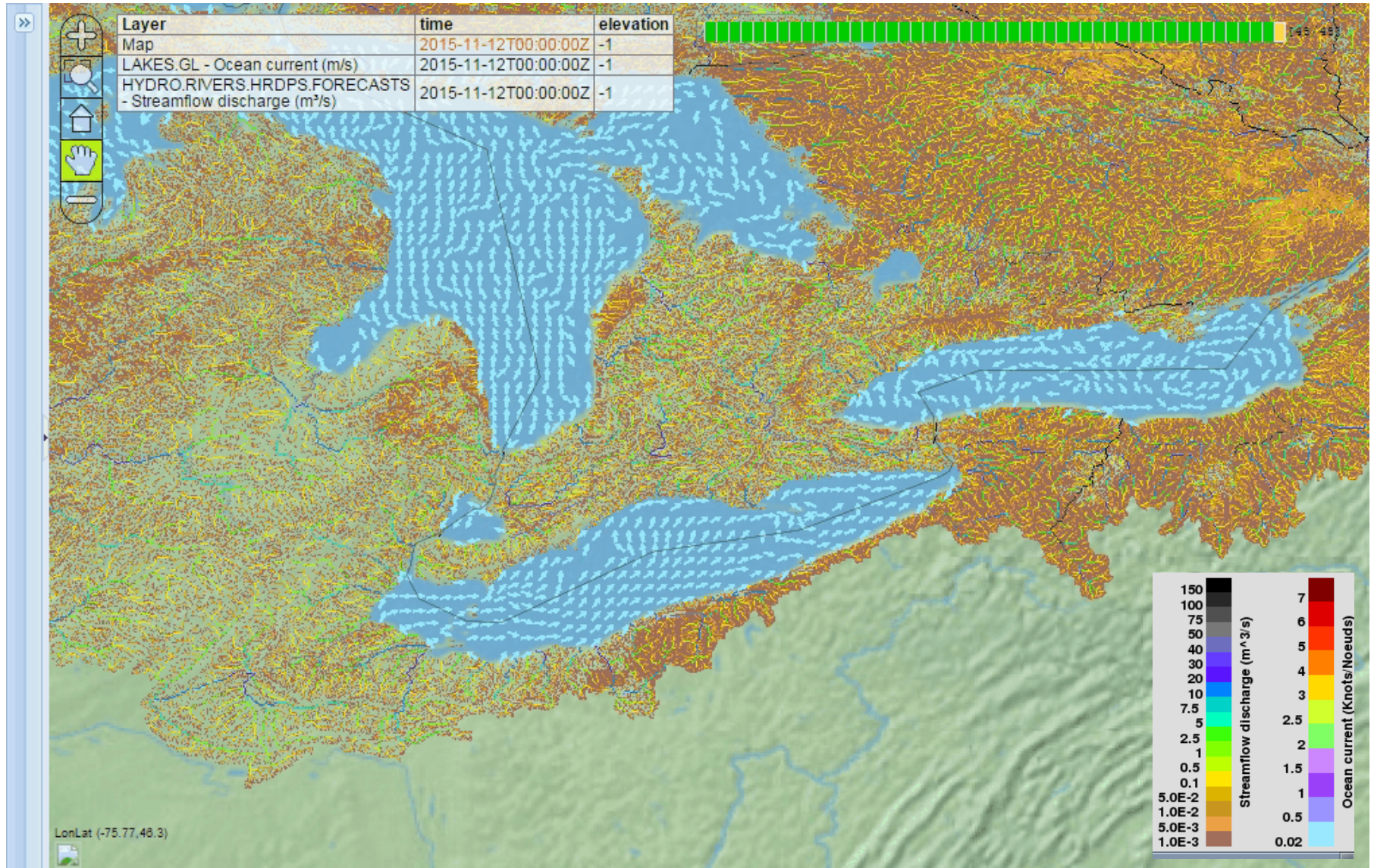


*6-hourly
precipitation
accumulations
greater than 2 mm*

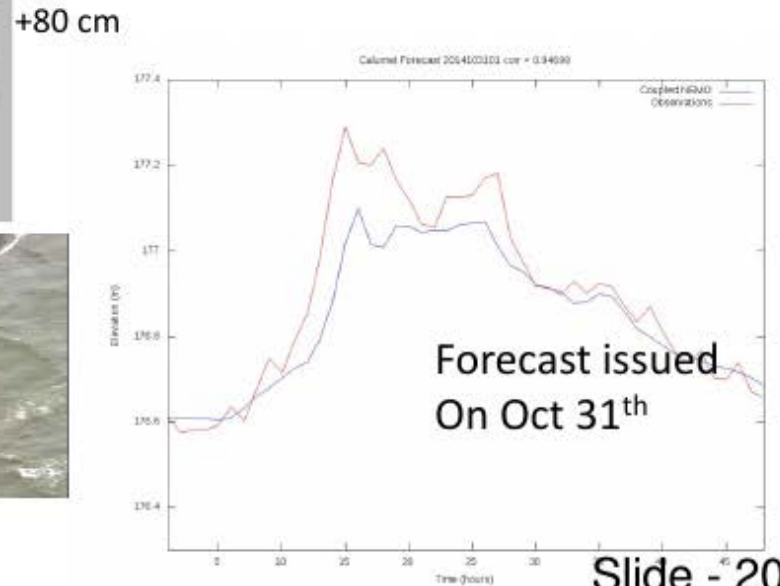
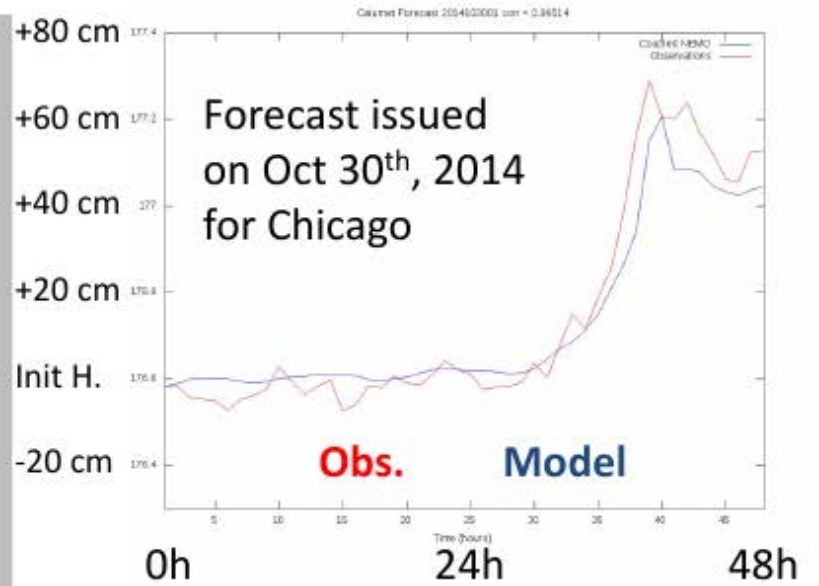
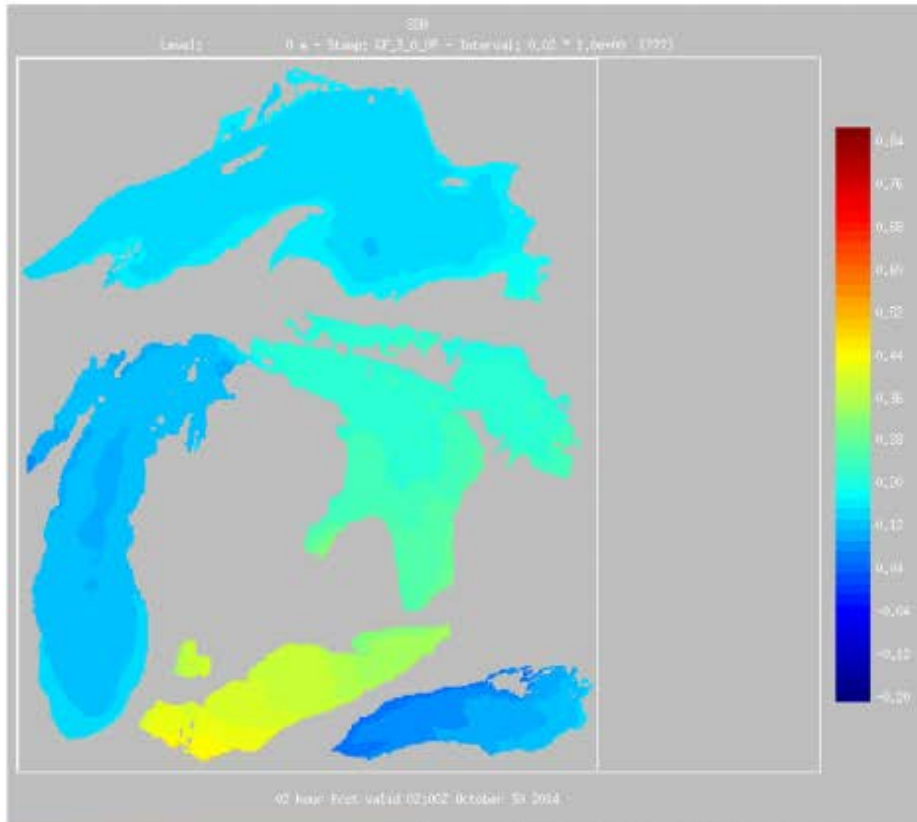
*Equitable Threat
Score*

*May to August
2015*

WATROUTE and NEMO forecast

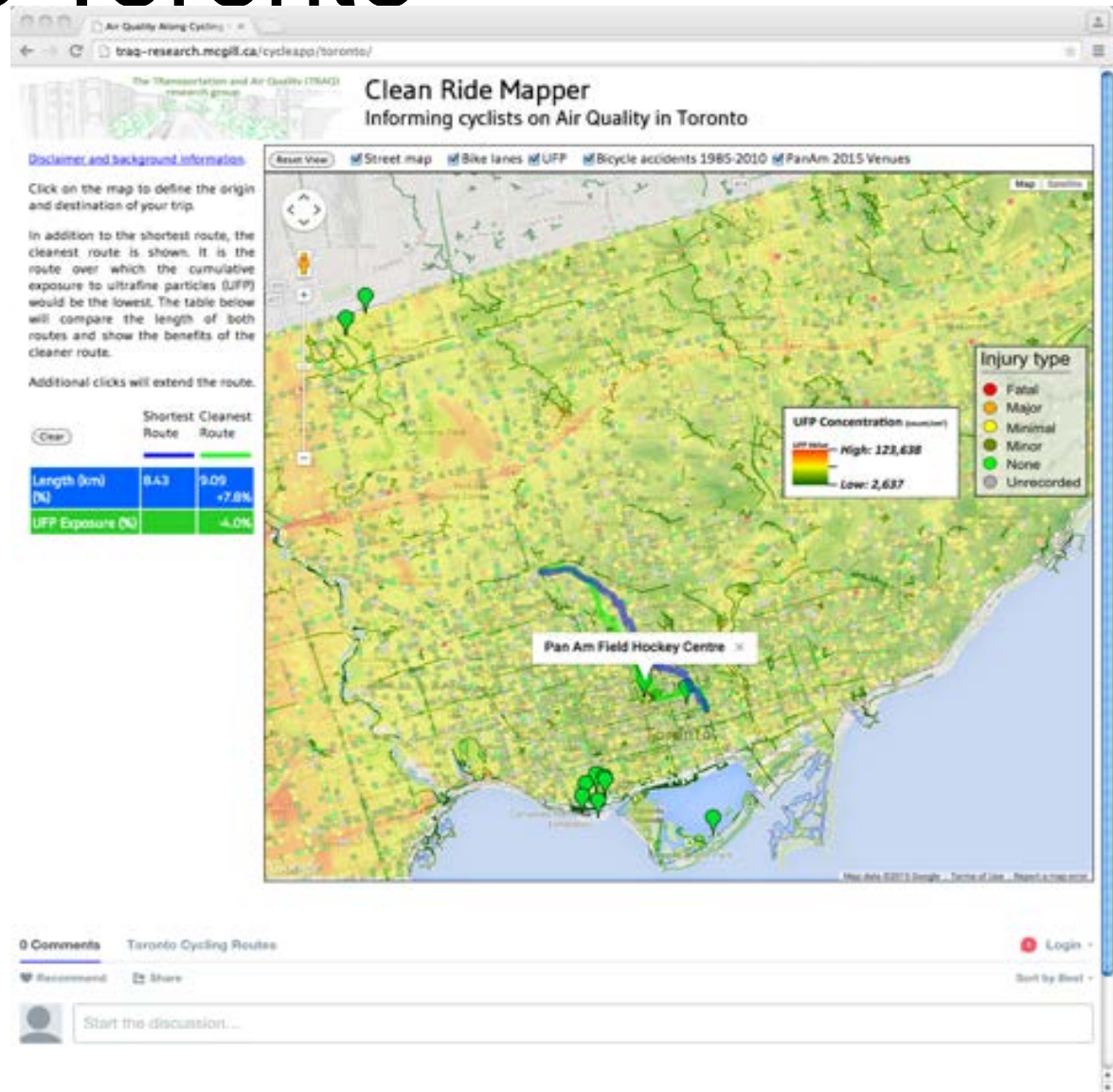


Water level forecasts with NEMO



Clean Ride Toronto

- The cycling app for Toronto was developed by McGill University and Health Canada
 - <http://traq-research.mcgill.ca/cycleapp/toronto/>
- New features
 - Improved navigation
 - More data (e.g. Pan Am Venues)
 - Ultrafine Particle Surface



Global Perspective

World Meteorological Organization

- Legacy data set for international science community (under WMO)
 - Global Atmospheric Watch Urban Meteorology (GURME) – Atmospheric Composition
 - Nowcasting and Mesoscale Research Meteorology (NMR) - Weather
- International Workshop on Air Quality Forecast Research Jan 10-12, 2017, Toronto
 - Legacy Data Set release target
 - Theme 1: Operational Forecasting and Communicating Impacts
 - Theme 2: Emissions Forecasting
 - Theme 3: Data Assimilation and Evaluation/Post-Processing
 - Theme 4: Interactions between Meteorology and Air Quality Prediction
 - Theme 5: Urban and High-Resolution Air Quality Modelling



The WMO is a United Nations Agency responsible for weather, climate, ice and water

Thank You!

