AQHI Implementation Status

Canadian Update for
NOAA Forecasters Focus Group
September 13, 2012

Commitments

- In partnership with Health Canada
- AQHI part of $600M Clean Air Regulatory Agenda package
- Commitments over the next 5 years
  - *to reach 90% of the Canadian population with the AQHI with expansion to rural areas and the North,*
  - to promote the index widely with target populations in order to gain acceptance and understanding, and
  - to ensure that the science underpinning the index remains up-to-date.
  - to provide a nationally consistent program, a branding exercise will be undertaken to develop a common look and feel for outreach products and campaigns

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Grande Prairie
Prince George
Fort Chipewyan
Spruce Grove
Fort McKay
Fort McMurray
Quesnel
Cold Lake
Kamloops
Williams Lake
Fort Saskatchewan
Comox/Courtenay
Whistler
Drayton Valley
Edmonton
Prince Albert
Nanaimo/Parksville
Red Deer
WestShore
Calgary
Saskatoon
Duncan
Castlegar
Victoria /Saanich
Okanagan Valley
Regina
Brandon
Vancouver and Lower Fraser Valley
Squamish
Swift Current
Winnipeg
Medicine Hat
Lethbridge

Grand Falls-Windsor
Corner Brook
St. John's
St. Peters Bay
Charlottetown
Summerside (Wellington)
Sydney
Bathurst
Port Hawkesbury
Moncton
Pictou
Québec
Kentville
Halifax
Montréal
Greenwood
Sault Ste. Marie
Gatineau
Ottawa
Saint John
Peterborough
Kingston
Fredericton
Greater Toronto Area
Hamilton
London
Windsor

In Canada, 74 communities receive the AQHI as of July 2012 (RI 10)

Status

- AQHI available for 61% of Canadians
- 74 forecast locations ... AQHI forecasts available in all provinces
  - AQHI adopted in 7 provinces
    - Retirement of their provincial AQI's
  - Remaining provinces pilot testing
    - Quebec, Ontario and New Brunswick
  - Increased traffic for Weather Office AQHI pages
    - 55% site visits
    - 200% for page views

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Air Quality Forecast Guidance for the Canadian AQHI Program

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Operational AQ Forecast Model

GEM-MACH: (**G**lobal **E**nvironment **M**ulti-scale – **M**odelling **A**ir quality and **CH**emistry)
→ EC's operational weather forecast model with an on-line chemistry module

Model Configuration (as of October 2012)	
Grid Configuration	Limited area model (LAM) over North America
Horizontal Grid Spacing	10 km
Vertical Coordinate	80 hybrid levels
Model Top	0.1 hPa (~60 km)
Time Step	300 s for meteorology 900 s for chemistry
Emissions	Canada 2006 US 2012 (projected) Mexico 1999 BEIS v3.09 / BELD3
Model Output	Meteorology & Chemistry (gases and particles)

Model Domain

EC weather model
GEM-MACH

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Model Sequencing

METEOROLOGICAL INITIAL AND BOUNDARY CONDITIONS

EMISSIONS

Regional Deterministic Weather Model (GEM)

SMOKE Emissions Processer

Launched twice per day:
- 00, 12 UTC
- output by 05, 17 UTC
- 48-hr forecasts

Prepare piloting fields

Chemical initial conditions (from prev. forecast)

Emissions database

GEM-MACH

Model Output:
O_3, NO_2, NO, SO_2, $PM_{2.5}$, PM_{10}
+
Meteorological fields

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UMOS (Updateable Model Output Statistics)

- Post-processing applied to GEM-MACH raw model output
- Corrects model bias (at point locations) through multi-variate linear regression approach
  - Applied to meteorological variables since 2000
  - Adapted for air quality variables (O_3, NO_2, $PM_{2.5}$) in 2010
  - Predictors:
    - Meteorological and chemical variables from GEM-MACH
    - Persistence (observations at 00Z or 12Z, depending on model run)
- <u>Strengths</u>:
  - Consistently removes model bias for improved day-to-day predictability
  - Provides point forecast
- <u>Weakness</u>:
  - Method is dependent upon having a large statistical database of past events, so performance during rarely occurring, bad air quality episodes can be poor
  - Non-linear approaches are currently under investigation

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GEM-MACH/UMOS Performance
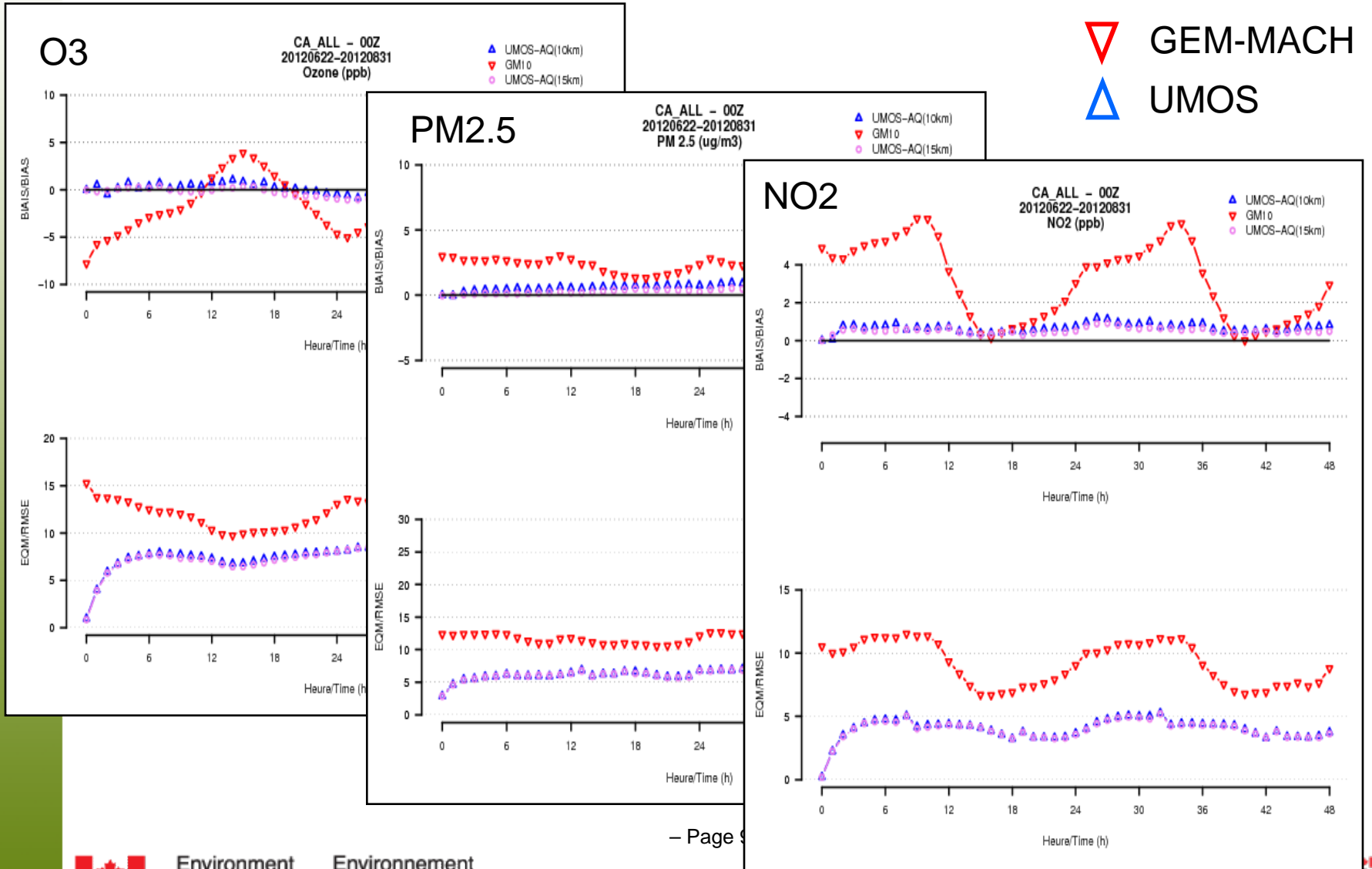
GEM-MACH/UMOS Performance

Ozone
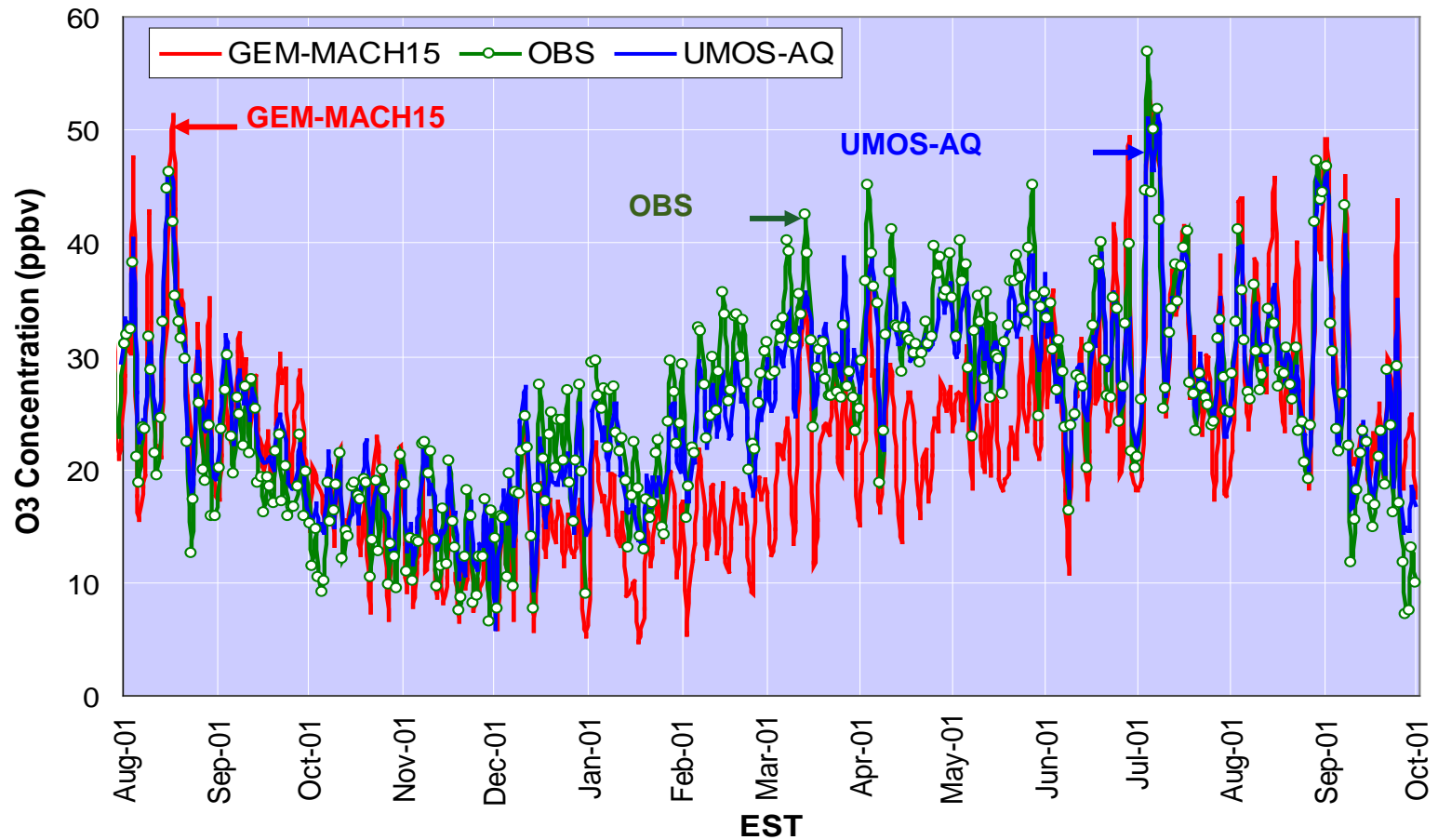
Canadian Air Quality Forecast Suite: Objective Analysis at Surface

- OA for **O_3 and $PM_{2.5}$**
  - Operational implementation planned for Fall 2012
  - NO_2 product in development for 2013
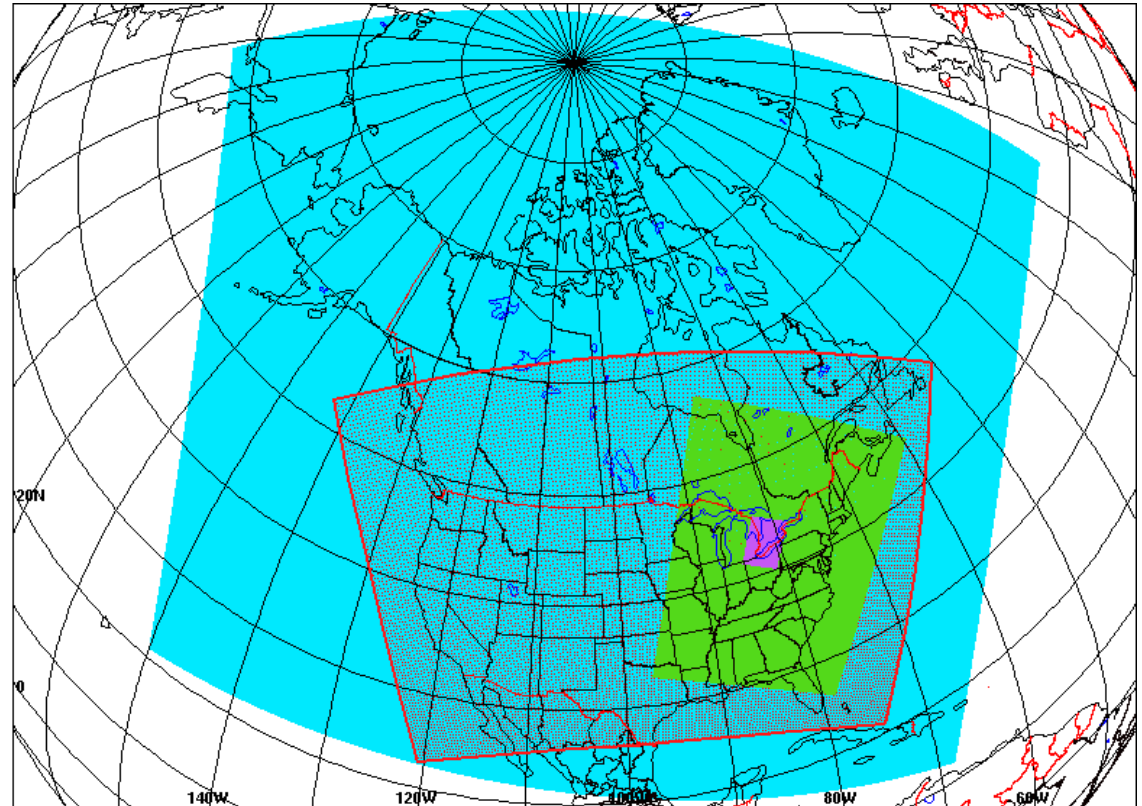
O_3 objective analysis

$PM_{2.5}$ objective analysis
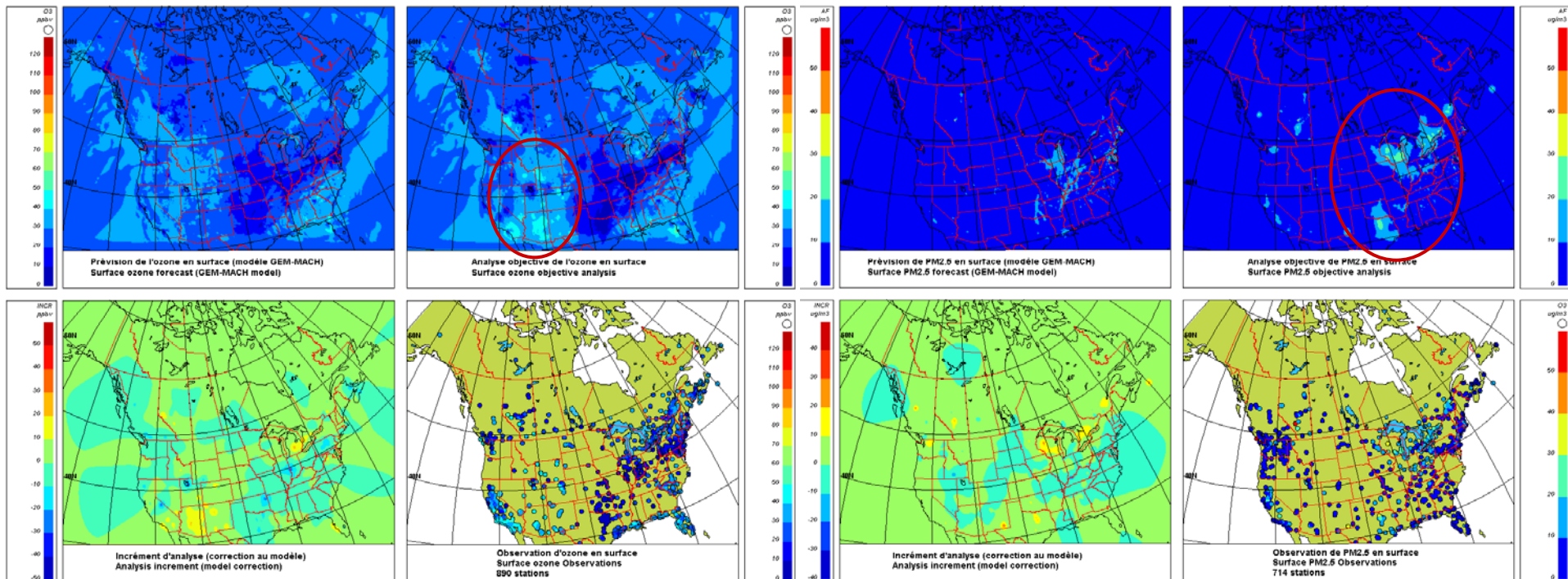
Showcasing research products for AQHI forecasting: High-resolution window

Capacity tested with predecessor to GEM-MACH

- 42-km → 15-km → 2.5-km nests
- 42- and 15-km AURAMS driven by 15-km GEM
- 2.5-km AURAMS driven by 2.5-km GEM.

GEM-MACH2.5 cascade currently in development

15-km GEM-LAM, 42-km, 15-km, and 2.5-km AURAMS domains (from BAQSMet study, Makar et al.)

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Showcasing research products for AQHI forecasting: High-resolution window
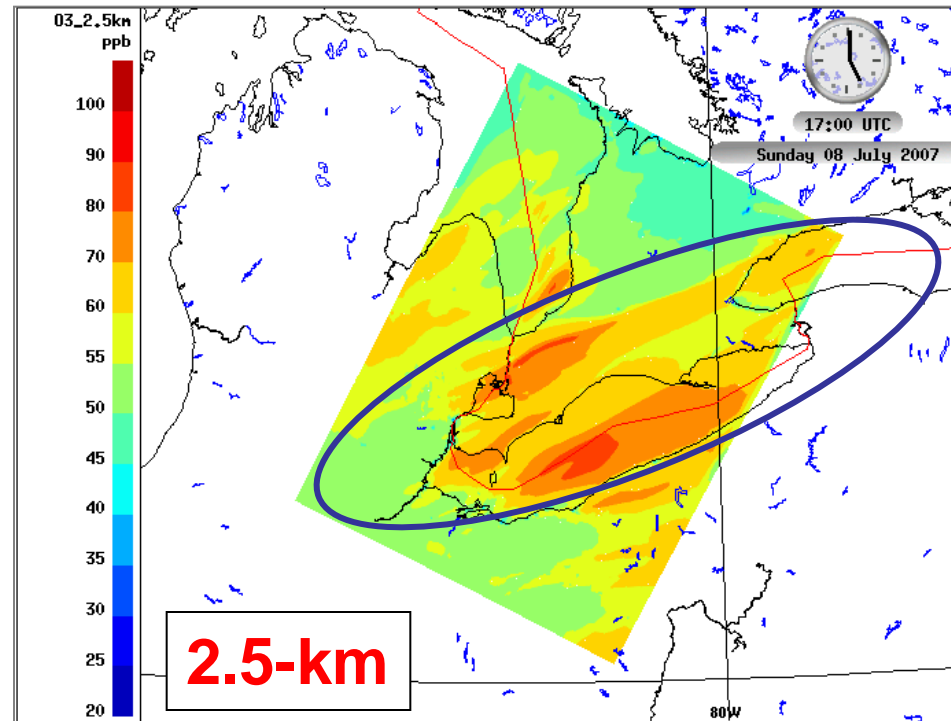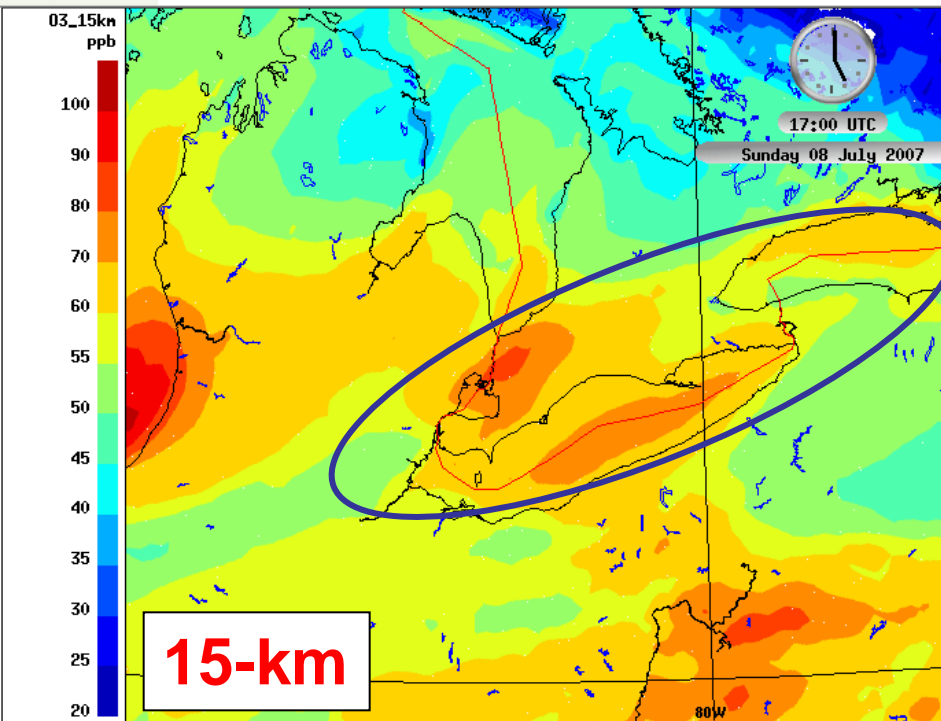
15-km

2.5-km

15- vs 2.5-km model prediction: O$_3$ (17 Z, July 8, 2007)- (from BAQSMet study, Makar et al.)

➡ The model captures the transport of ozone along the lake breeze frontal convergence zone better at 2.5-km resolution than at 15-km resolution

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Showcasing research products for AQHI forecasting: High-resolution window
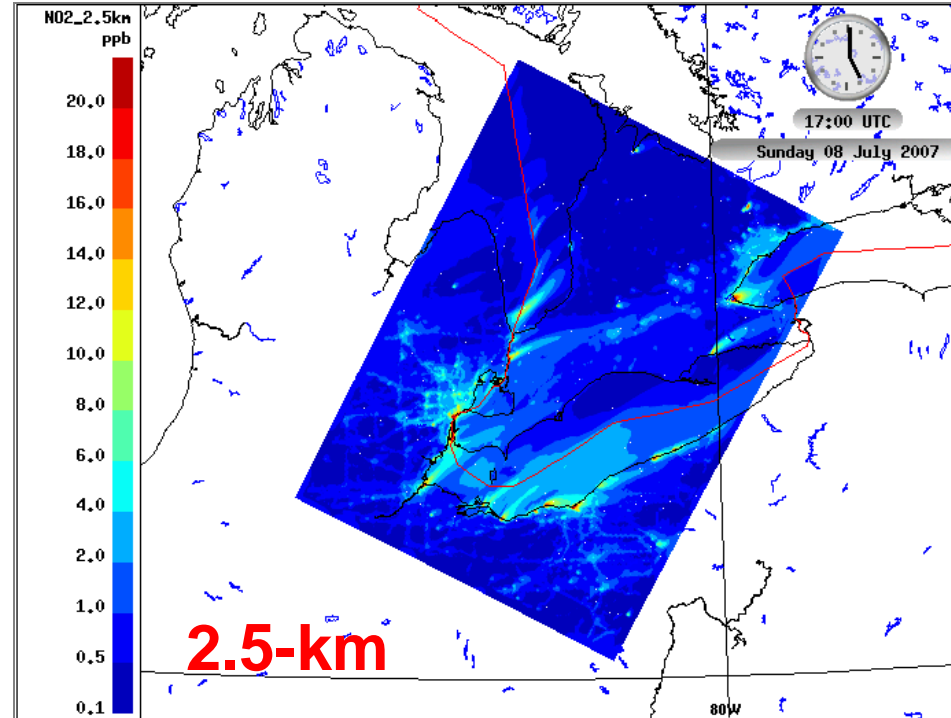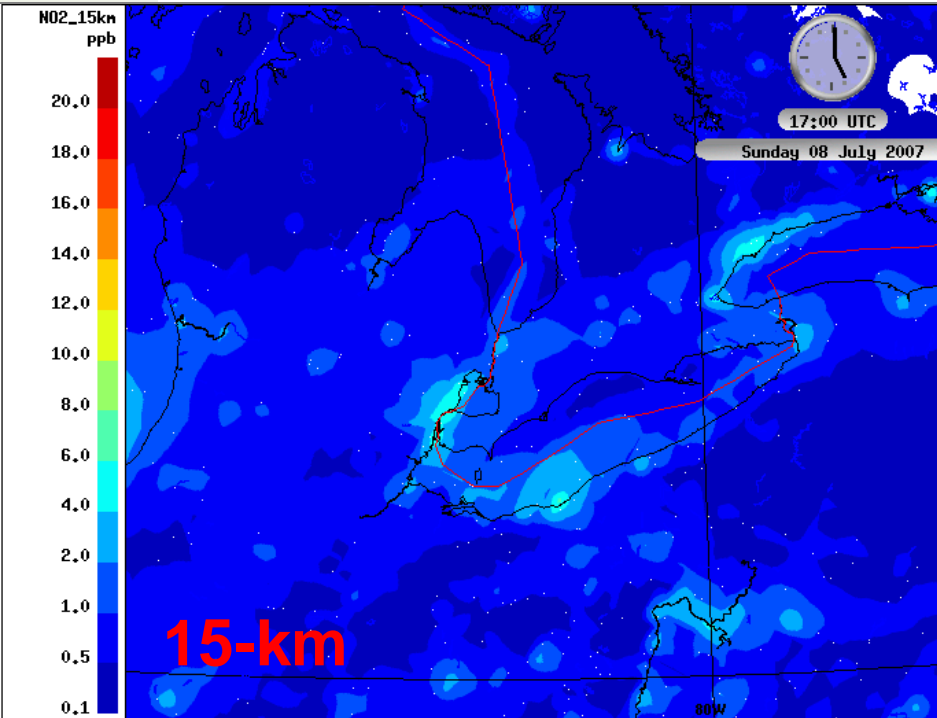
15- vs 2.5-km model prediction: NO$_2$ (17 Z, July 8, 2007) – BAQSMet Study (Makar et al.)

➡ The local emissions are also better captured by the model at higher (2.5-km) than at lower (15-km) resolution
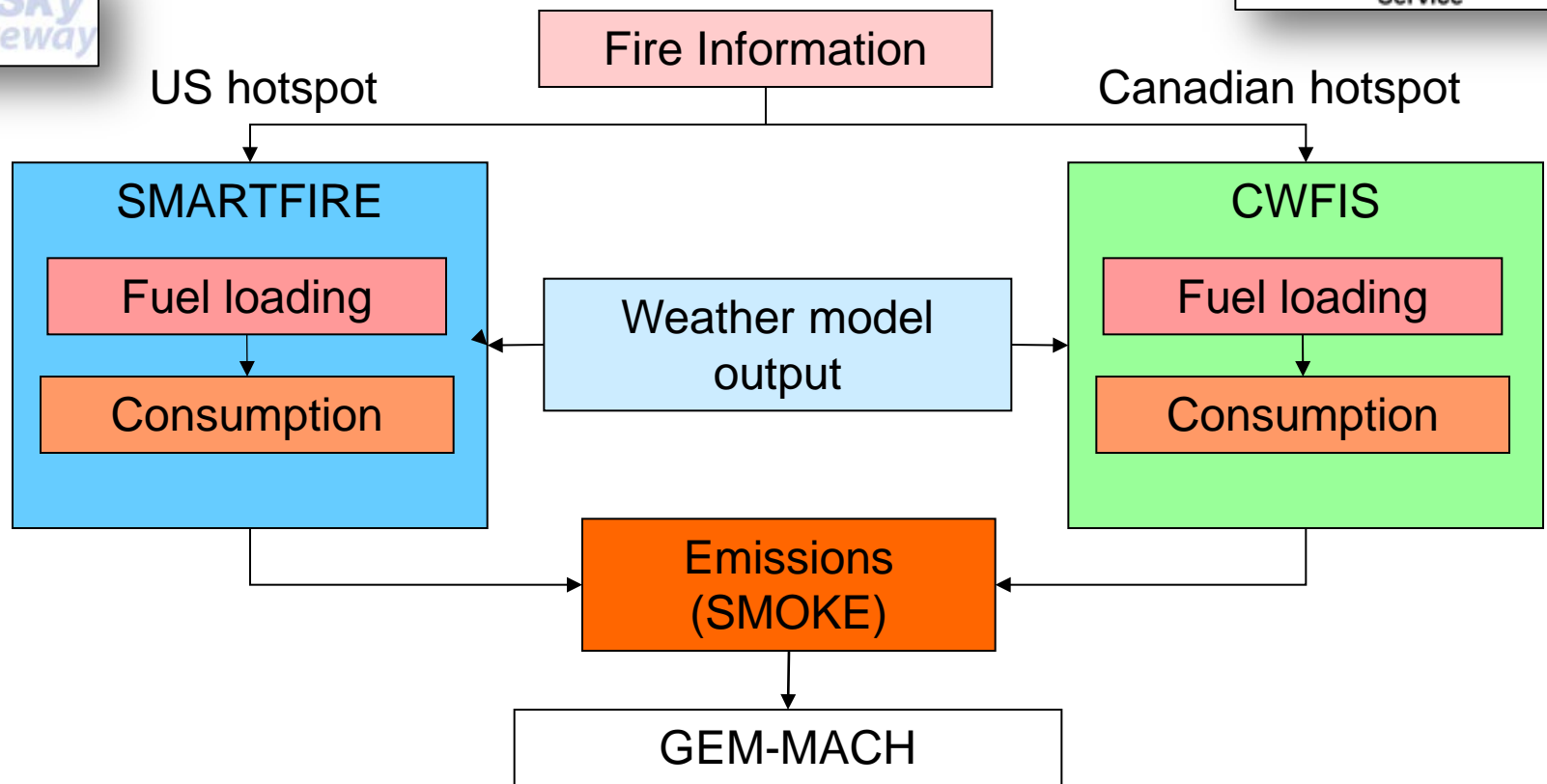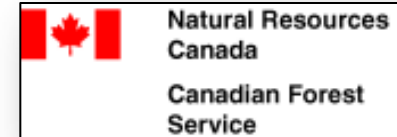
Note: spatial distribution of emissions from mobile sources will be improved by a recent update of surrogate data to better reflect the Canadian road network.

Forest Fire Smoke Forecast System: "FireWork"

A collaboration between Canadian Forest Service and Meteorological Service of Canada to

- Develop a comprehensive air quality forecasting system which includes the impact of wildfire emissions and provides
  - Input for the Air Quality Health Index (AQHI);
  - Smoke dispersion information;
  - Visibility information
- Replicate modularity of BlueSky while integrating Canadian components

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Approach

Fire Information

US hotspot

Canadian hotspot

SMARTFIRE
- Fuel loading
- Consumption

Weather model output

CWFIS
- Fuel loading
- Consumption

Emissions (SMOKE)

GEM-MACH

Natural Resources Canada

Canadian Forest Service

Environment Canada

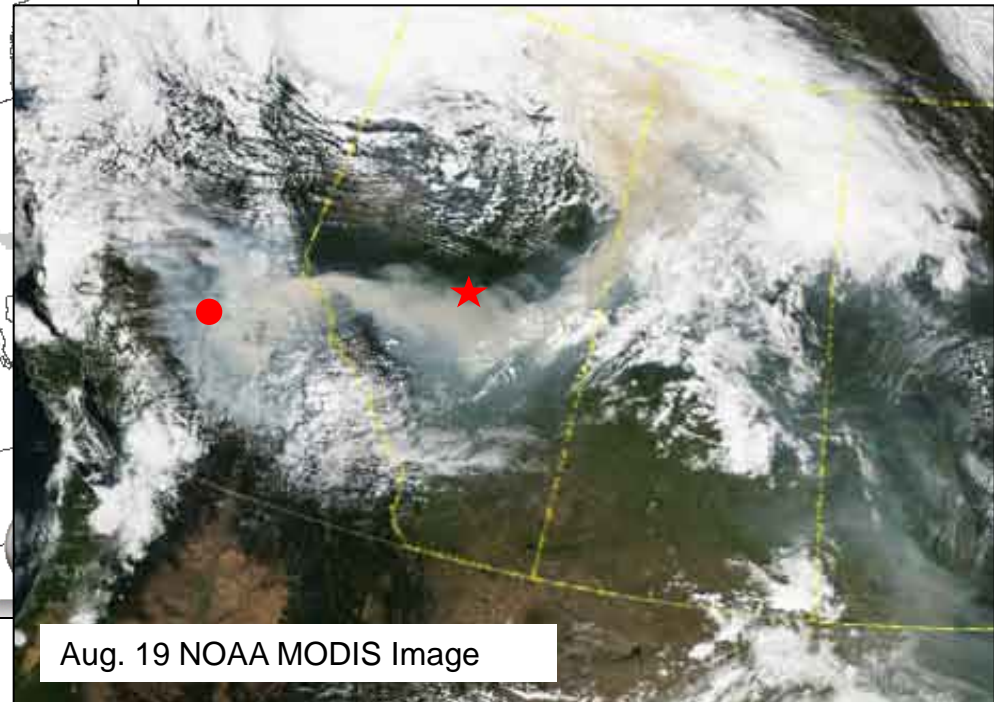Environnement Canada

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2010 Cariboo BC fire Case Study

Aug. 19 surface PM$_{2.5}$ difference taking model forecast with fire emissions minus operational forecast without fire emissions and comparing to MODIS imagery
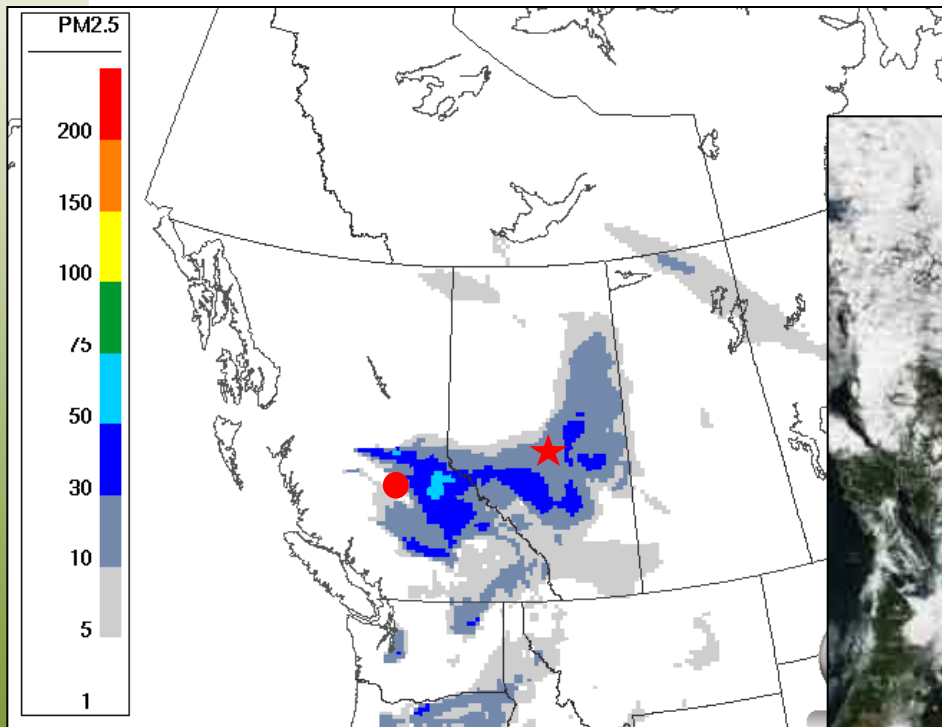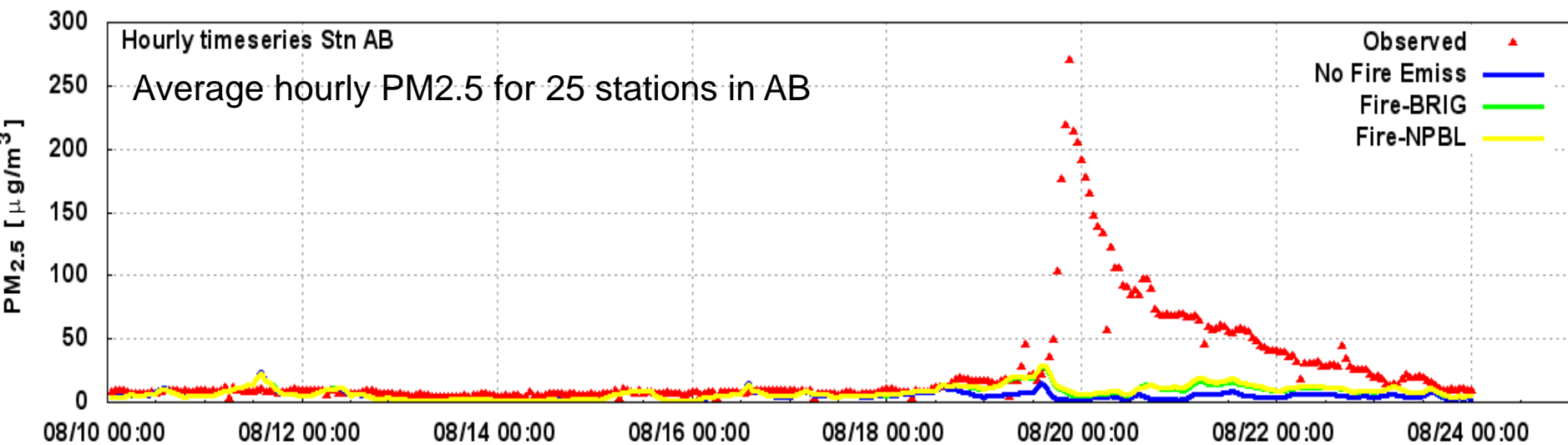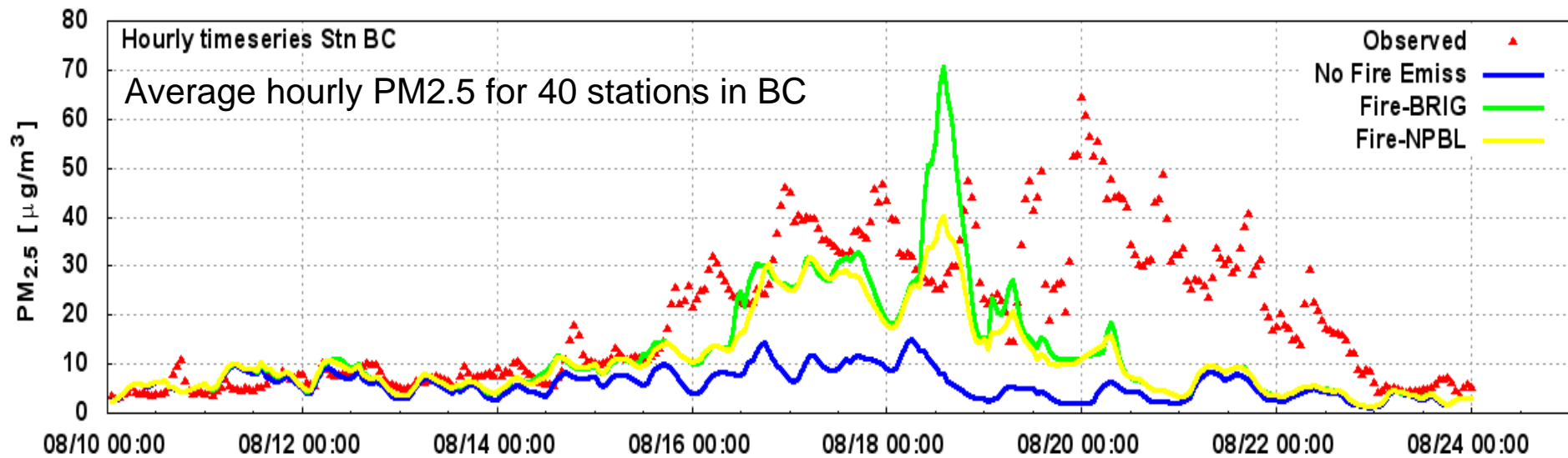
● Williams Lake, BC
★ Edmonton, AB

Aug. 19 NOAA MODIS Image

Preliminary analysis shows good spatial and temporal agreements, but details are missed in the quantitative forecasts

2010 Cariboo BC fire Case Study

Average hourly PM2.5 for 40 stations in BC

Average hourly PM2.5 for 25 stations in AB

Future

- Implementation of Firework (forest fire smoke forecasting component of GEM-MACH)
  - Better PM2.5 forecasts
  - Mapped service for emergency responders
- Identifying environmental benefits of AQHI awareness
- Integration of the AQHI into new MSC dissemination
  - DMS, EC Alert Me, etc ....
- Revamp of airhealth.ca
- Pan Am Games Summer 2015
  - Monitoring and urban-scale modelling demonstration

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Challenges

- Implementation
  - Health concerns expressed by the partners delay implementation
  - Formulation questions
- Monitoring
  - Partner austerity, e.g. impacts on monitoring networks and outreach commitment
  - Transition to FEM PM2.5 monitoring
- Forecasting
  - AQHI forecast only for low population areas/regions
    - Possible synthetic observation for 'self calibration'
- Urban scale
- Outreach
  - Sustainability of outreach commitment

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