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# Evaluate Wildfire Emissions in the Canadian GEM-MACH Air Quality Forecast System

2012 EPA Emissions Inventory Conference & Workshops  
Tampa FL.

**Environment Canada**

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**Canadian Forest Service/Natural Resources Canada**

Kerry Anderson

# Objective

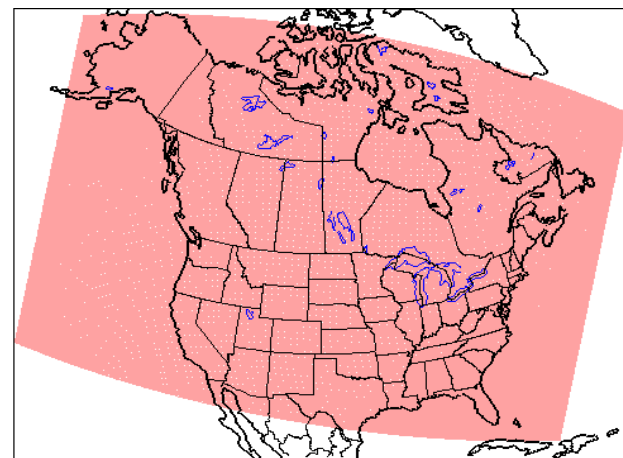
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- Air quality forecast with impact of wildfire emissions
  - smoke dispersion information
  - visibility information
  - input for the Air Quality Health Index (AQHI)
    - calculated based on relative risks of  $O_3$ ,  $PM_{2.5}$  and  $NO_2$ .

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# GEM-MACH System

- Meteorological & chemical models
  - GEM-MACH
    - Multi-scale weather forecast model with in-line chemistry module
    - Gas, aqueous-phase chemistry and 2-bin representation of PM size and 9 PM components.
    - Twice daily (00z, 12z), resolution 15-km and 58 vertical levels (up to 0.1 hpa)
  - GEM-MACH emissions:
    - Area sources
    - Mobile sources
    - Point sources
    - Biogenics calculated online (BEIS3)
- Canadian wildfires ~1.9 million hectares/yr (2001-2011)



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Edmonton without smoke

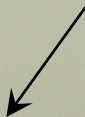


Grant MacEwan  
University

Edmonton, August 19, 2010, 11:35 AM

(Hourly PM2.5 ~80  $\mu\text{g}/\text{m}^3$ )

Grant MacEwan  
University



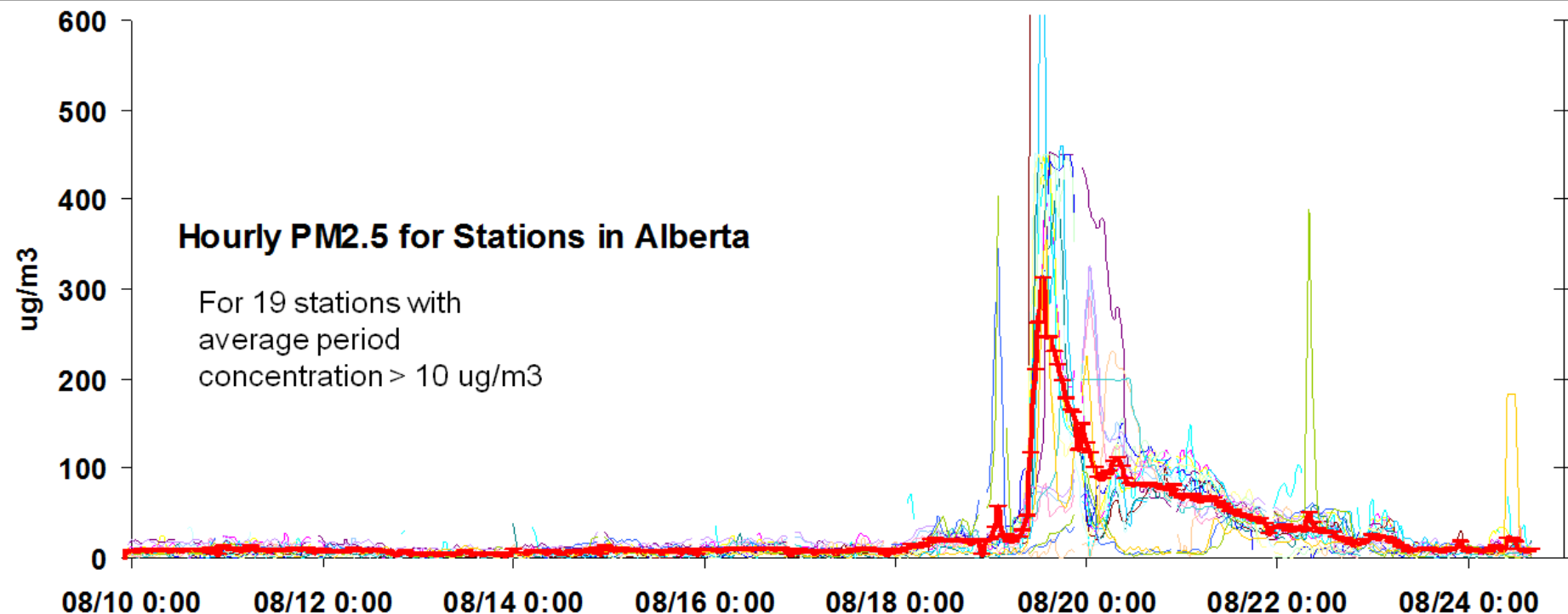
Edmonton, August 19, 2010, 2:00 PM

(Hourly PM2.5 ~250  $\mu\text{g}/\text{m}^3$ )

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# PM2.5 Surface Measurements



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# Real-time Fire Information

## BlueSky Framework -- US Forest Service

- SMARTFIRE (US fire information, STI)



- CWFIS (Canadian Wildland Fire Information System)

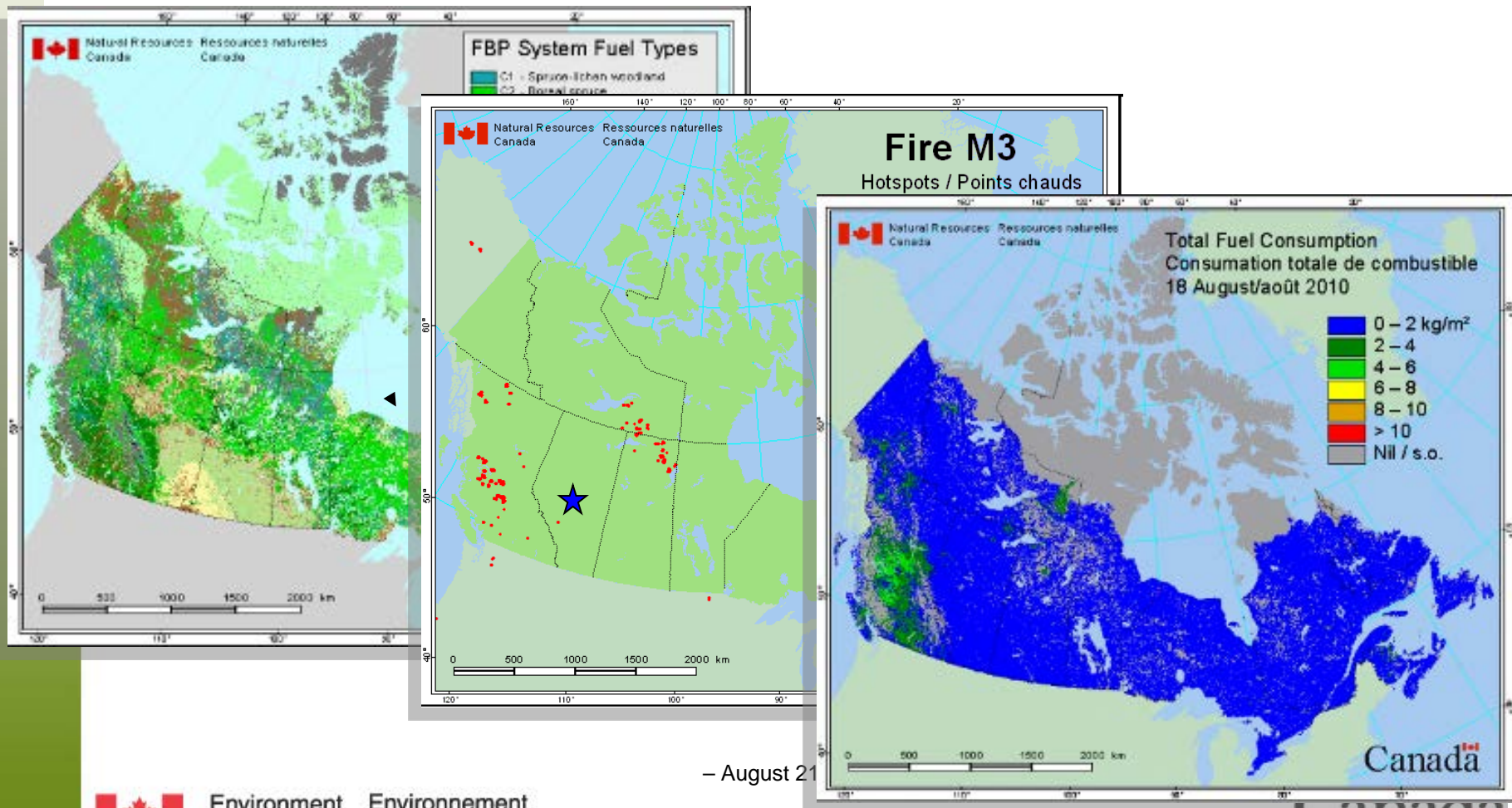
- runs daily during fire season;
- Includes:
  - landuse databases;
  - Hotspot detection;
  - FBP (Fire Behavior Prediction);
  - Fuel consumption / fire type





# Canadian Wildland Fire Information System

- <http://cwfis.cfs.nrcan.gc.ca>



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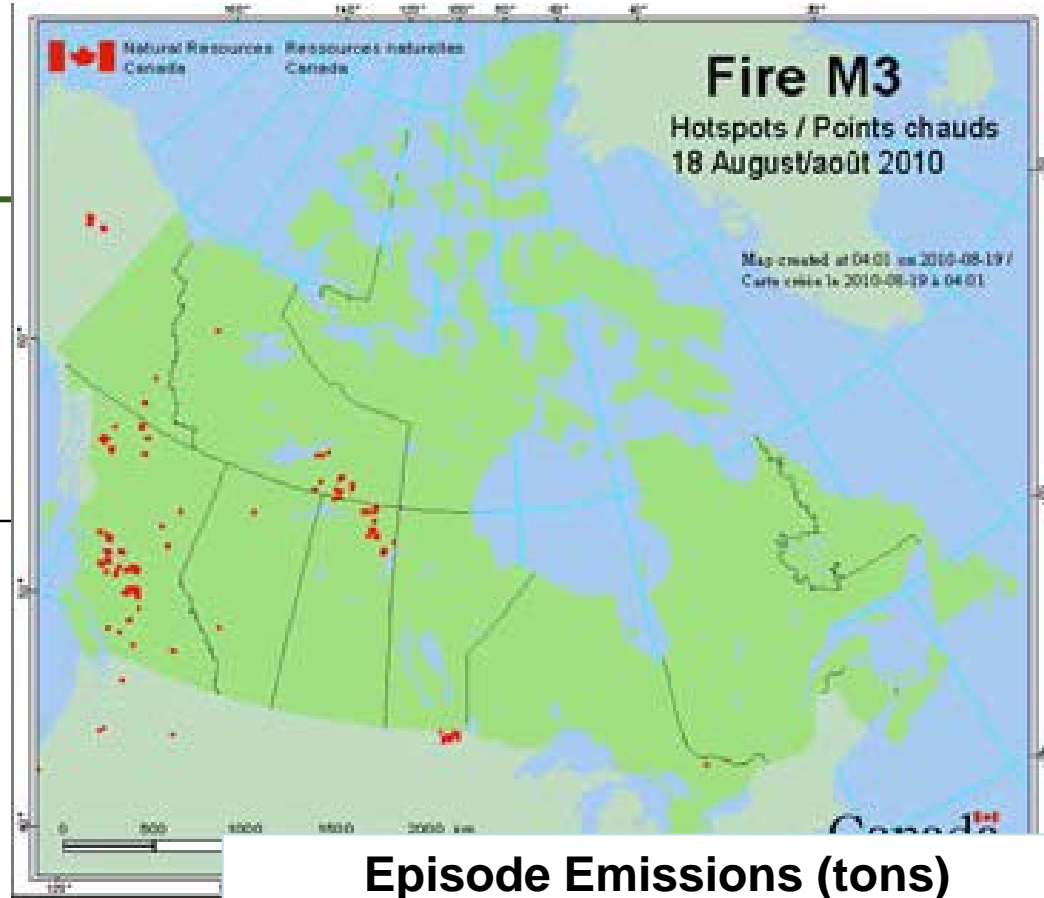
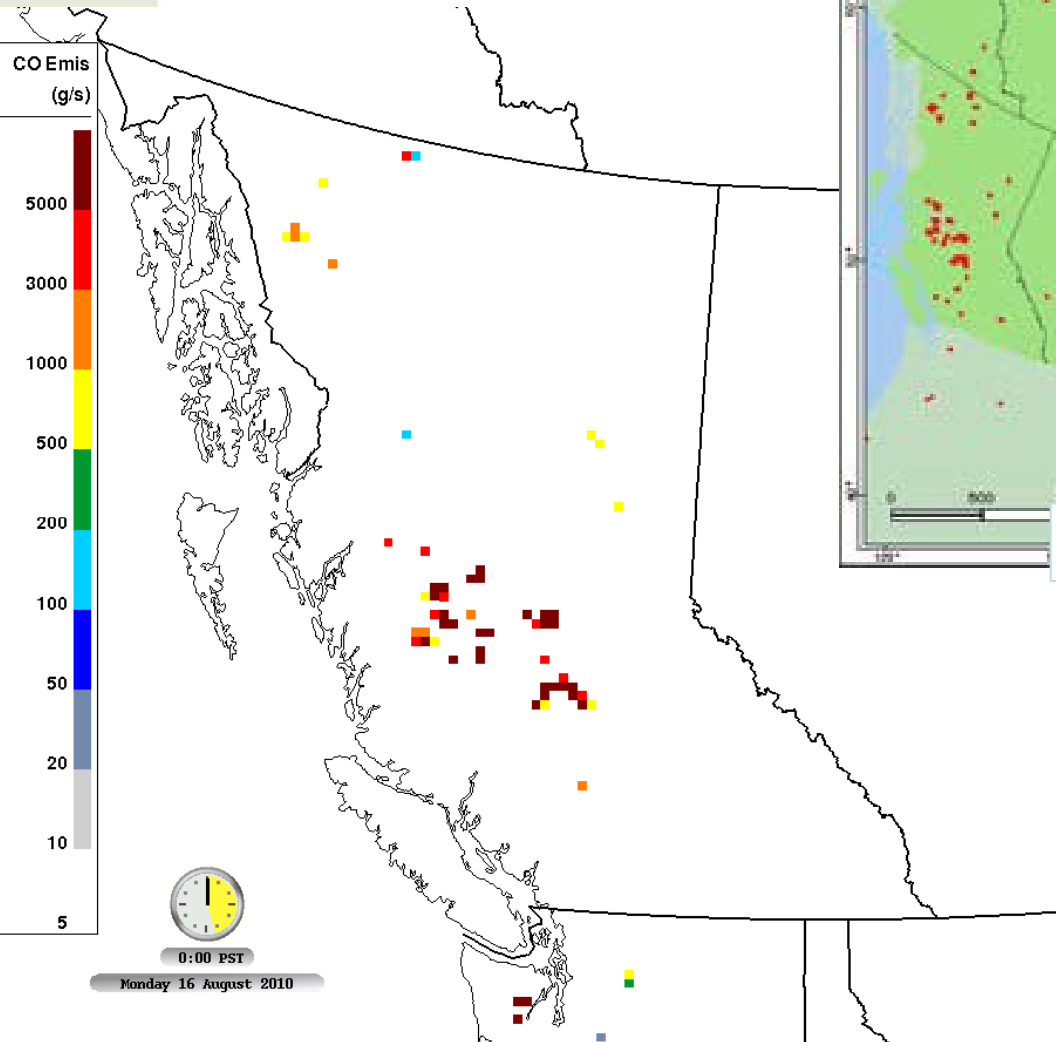
# Case Study

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- Wildfire event in Central British Columbia (Cariboo Region)
- Two week simulation: August 10 – 24 2010
- Fire emissions modelled as major point sources
  - (1) Briggs plume rise algorithm within GEM-MACH
  - (2) Normalized profile under PBL
- PM<sub>2.5</sub> results compared with operational forecast predictions

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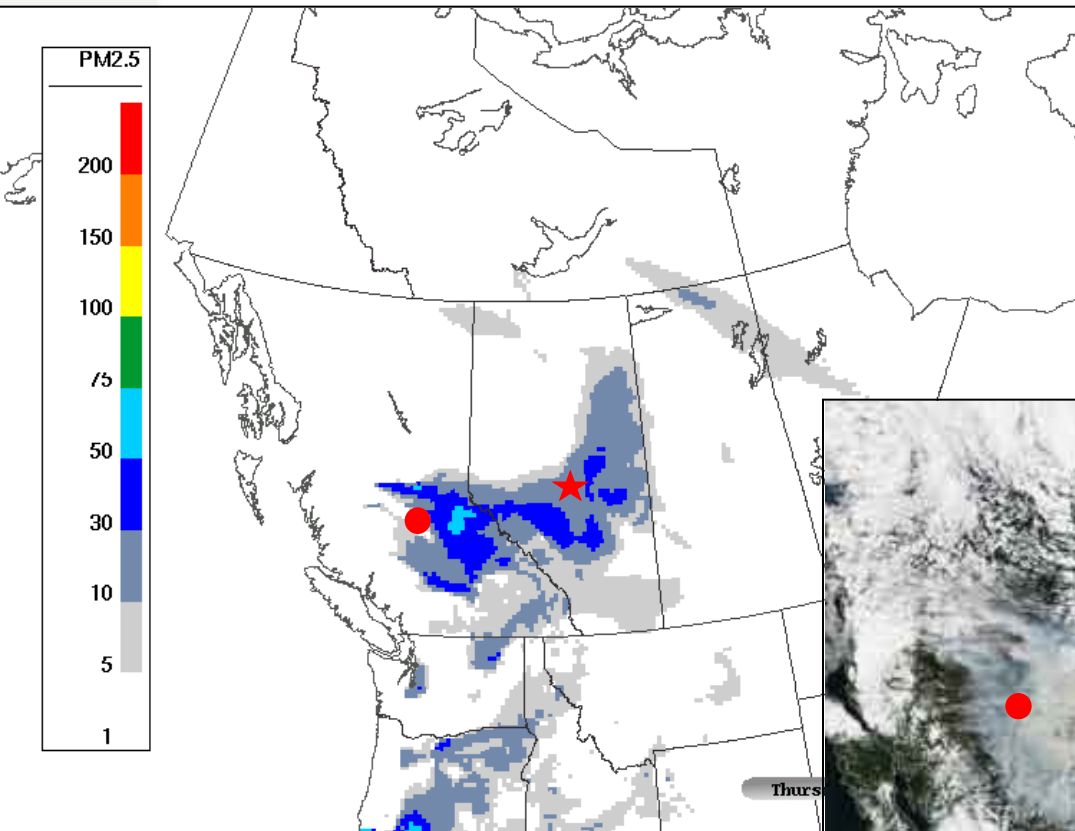
# Fire Emissions



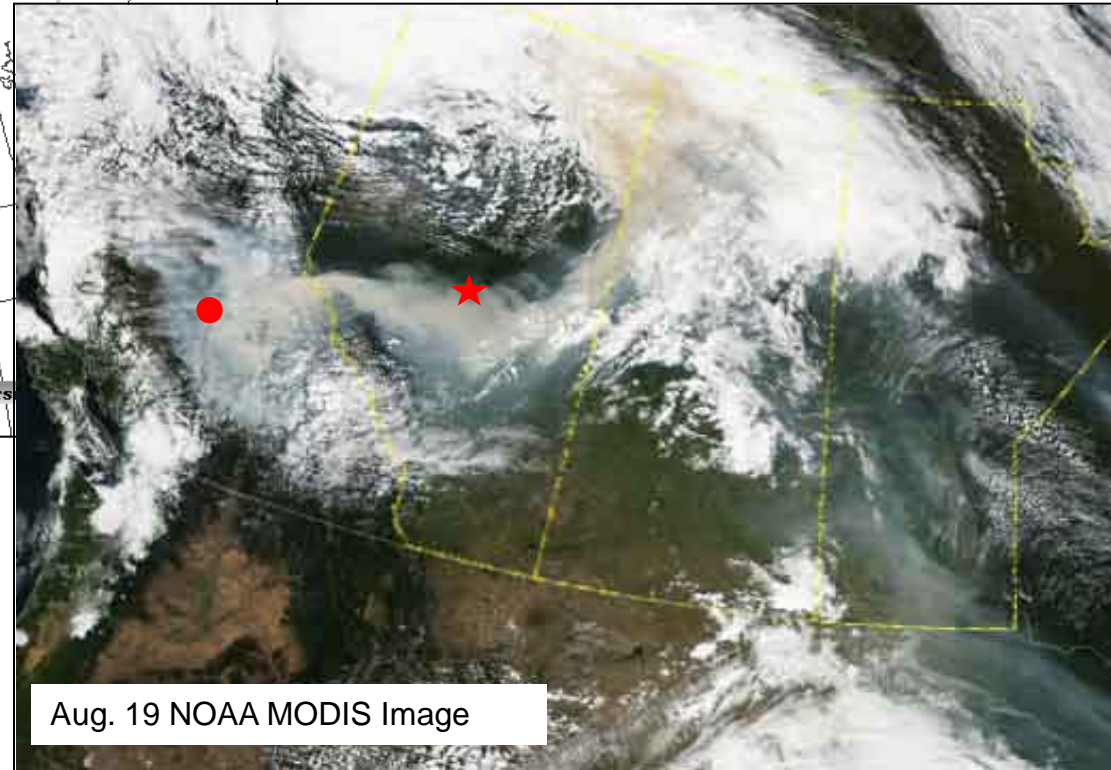
## Episode Emissions (tons)

	BC+AB Fire	BC+AB Anthropogenic
<b>CO</b>	654,122	126,541
<b>PM2.5</b>	59,608	9,032
<b>PM10</b>	70,337	41,552

# Aug. 19 surface $PM_{2.5}$ difference (fire minus no-fire) vs. MODIS



- Williams Lake, BC
- ★ Edmonton, AB



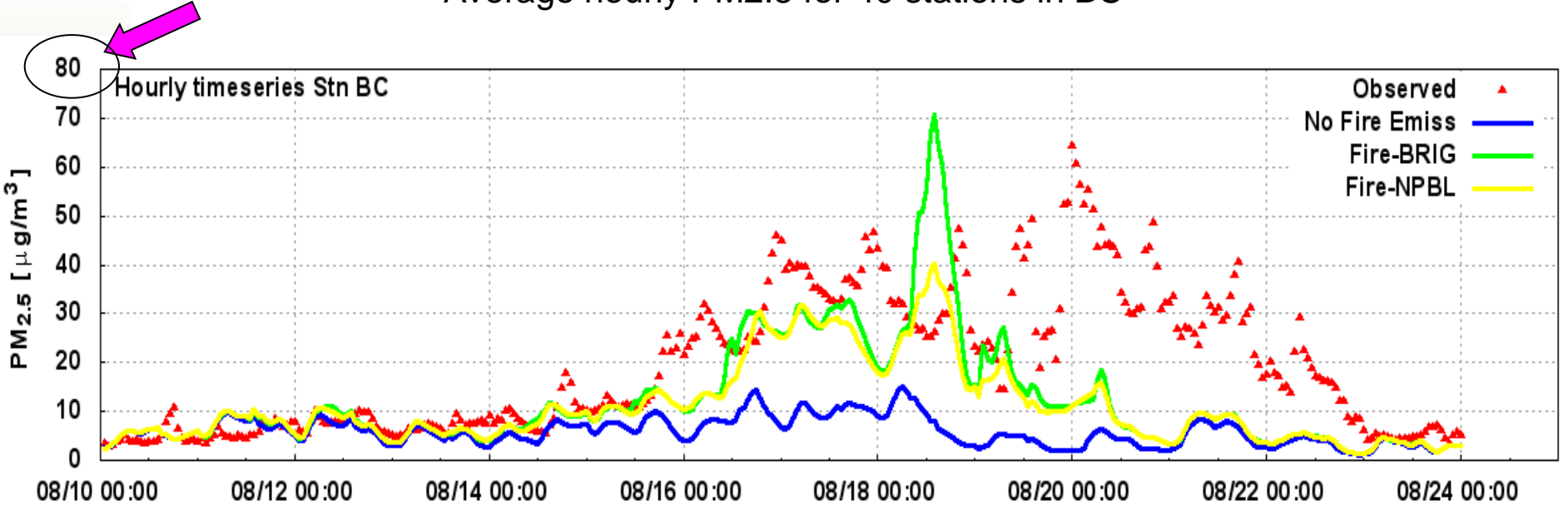
Aug. 19 NOAA MODIS Image



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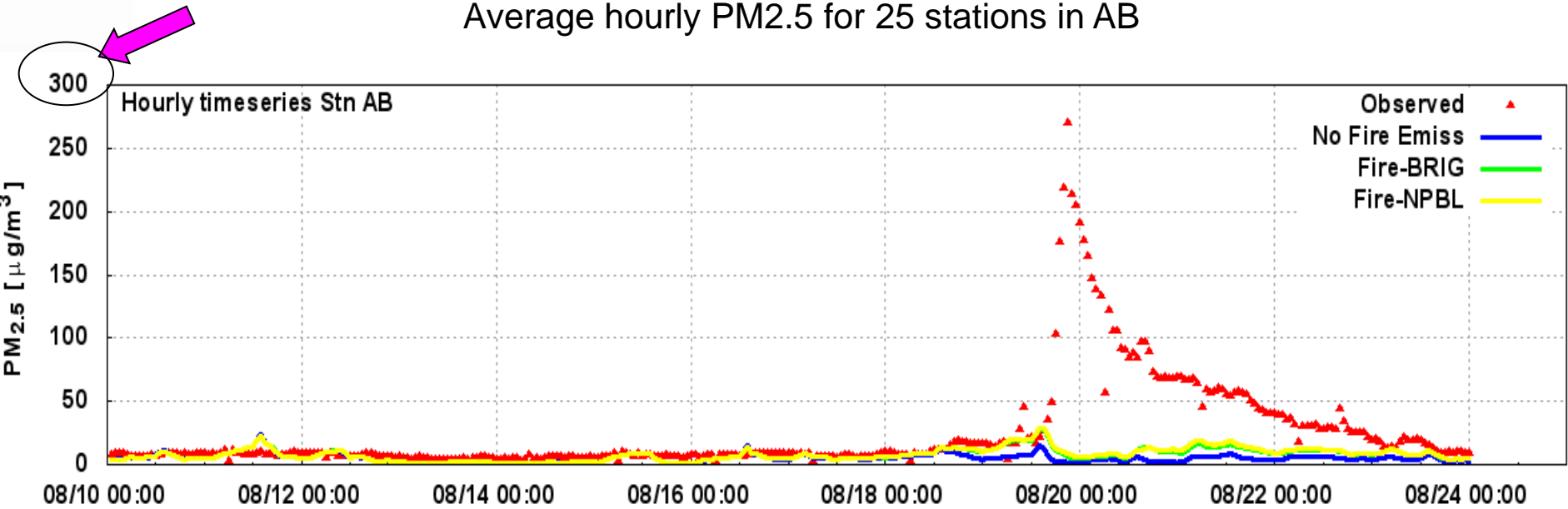
### Average hourly PM2.5 for 40 stations in BC



Obs. Avg.	NoFire	+ Fire Briggs'	+ Fire NPBL
19 $\mu\text{g}/\text{m}^3$	6 $\mu\text{g}/\text{m}^3$	12 $\mu\text{g}/\text{m}^3$	11 $\mu\text{g}/\text{m}^3$

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### Average hourly PM2.5 for 25 stations in AB



Obs. Avg.	NoFire	+ Fire Brig's	+ Fire NPBL
27 $\mu\text{g}/\text{m}^3$	5 $\mu\text{g}/\text{m}^3$	8 $\mu\text{g}/\text{m}^3$	8 $\mu\text{g}/\text{m}^3$

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# Operational Test Case

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A test system was setup to run alongside the current operational forecast for summer 2012.

Same configuration as operational forecast

Preliminary analysis:

- Good spatial distribution of  $PM_{2.5}$

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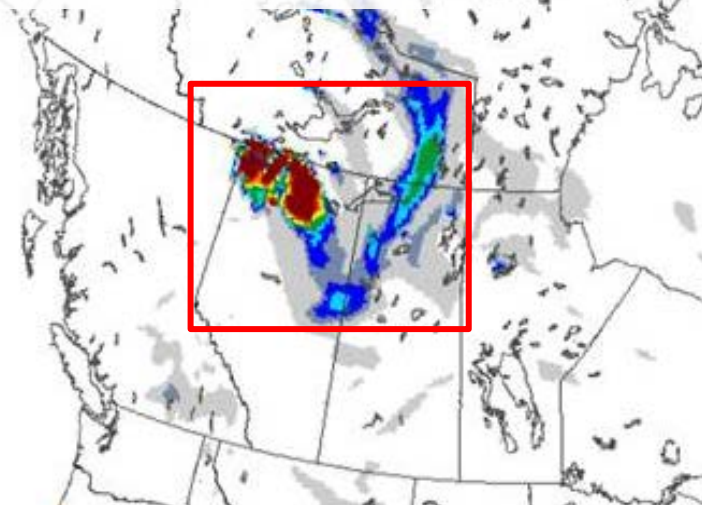
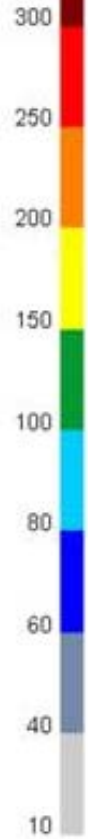
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(ug/m3)

# GEMMACH-15

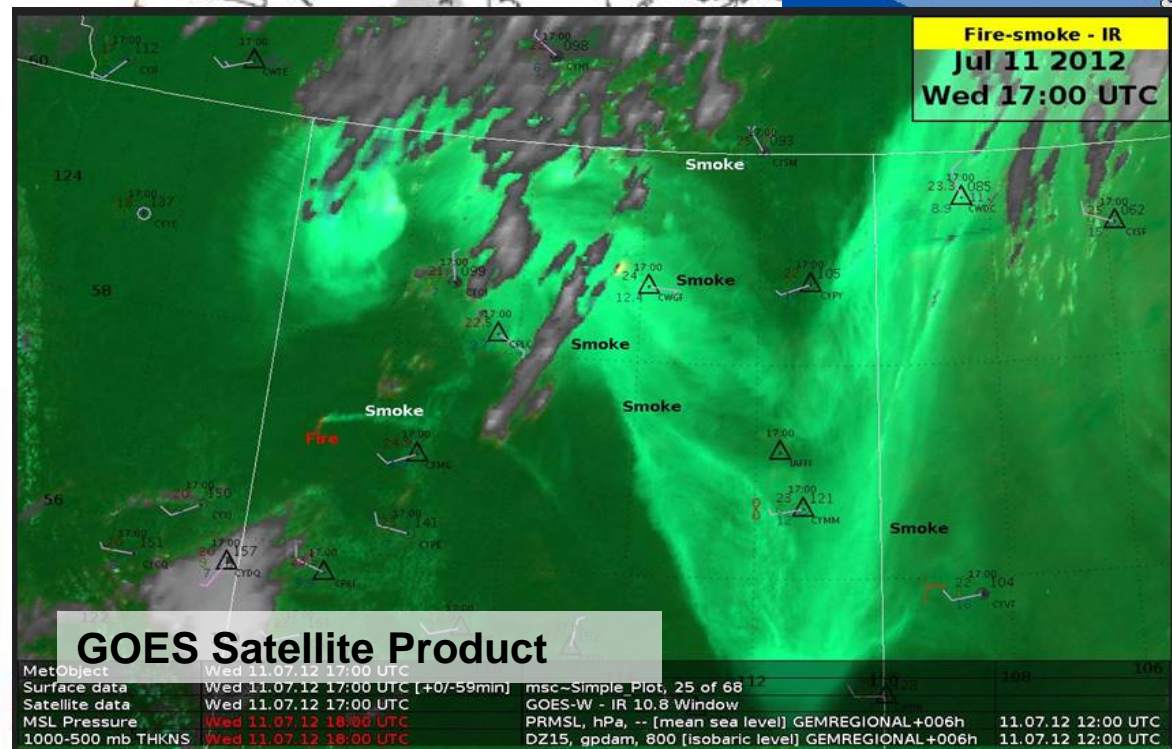
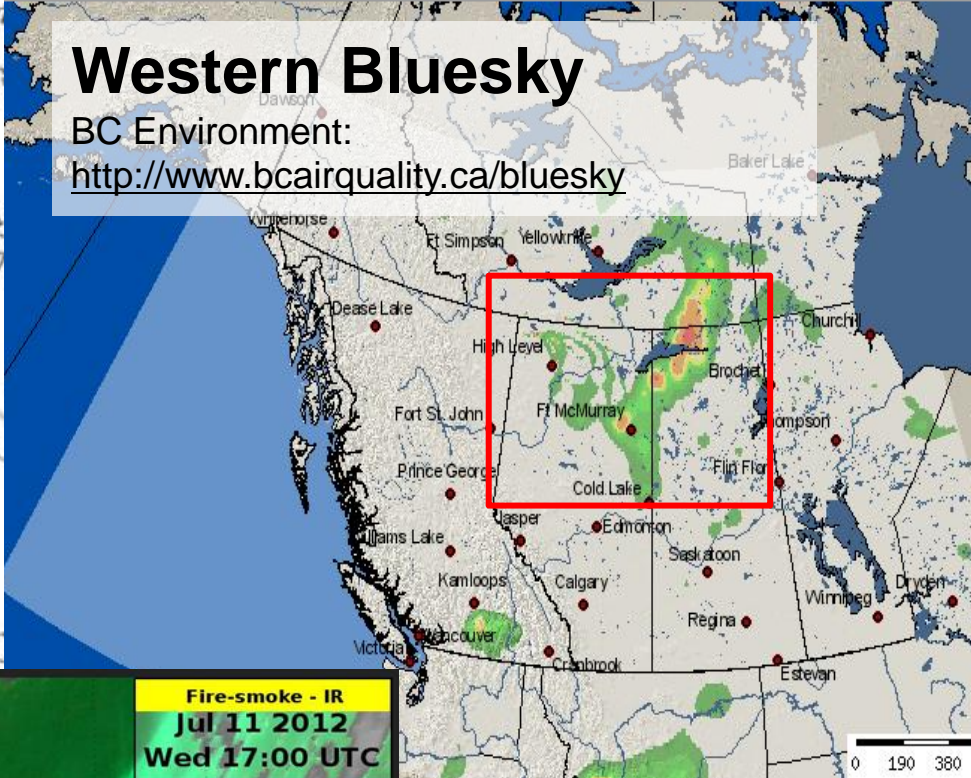
PM2.5 difference



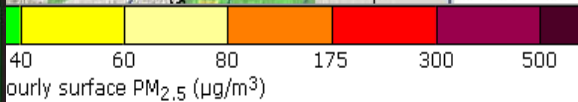
# Western Bluesky

BC Environment:

<http://www.bcairquality.ca/bluesky>



**Fire-smoke - IR**  
**Jul 11 2012**  
**Wed 17:00 UTC**





# Conclusions

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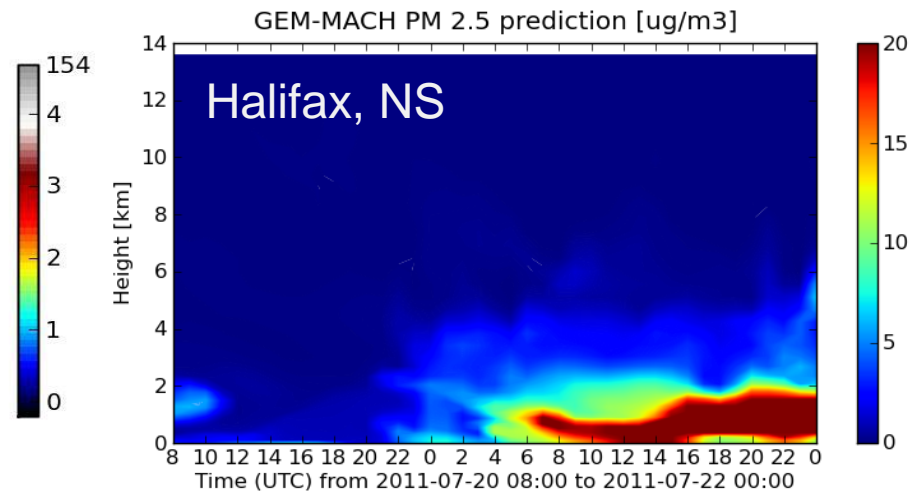
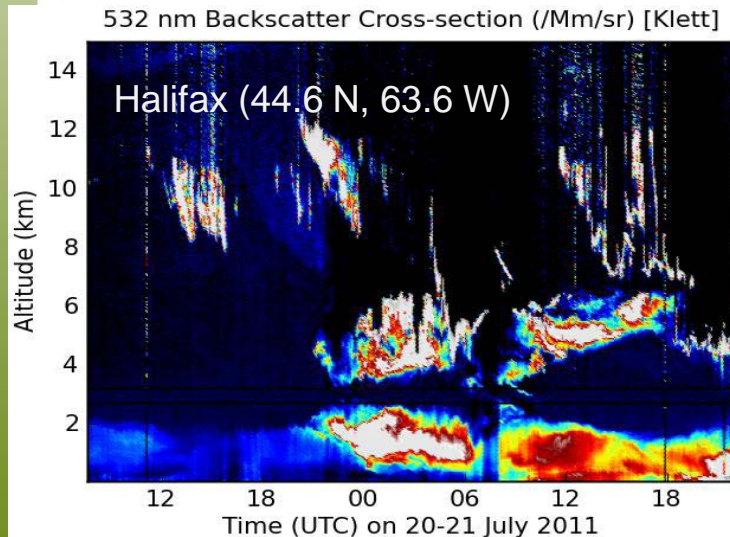
- the goal of this project is to enhance the capacity of Environment Canada's GEM-MACH operational air quality forecasting system to include wildfire emissions
- preliminary results show that fires produce large amount of emissions can impact PM<sub>2.5</sub> forecast results
- GEM-MACH captured general PM<sub>2.5</sub> trends but underestimated magnitudes, especially for receptors further downwind
- Simple plume-rise parameterization influenced PM<sub>2.5</sub> near the source but ineffective for receptors downwind

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# Ongoing Work

- Update GEM-MACH science parameterizations
- Continue evaluation of model system

New case study with BORTAS measurements for Sioux Lookout fire in Ontario (Jul. 15-30 2011)



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# Acknowledgement

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- Sonoma Technology, Inc. – Kenneth Craig
- Washington State University – Joe Vaughan
- Environment Canada – AQMAS and GEM-MACH development team

\*Now at Scion Research Institute, New Zealand

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# Thank You

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