Capacity for Forest Fire Forecasting in the Canadian Air Quality Model GEM-MACH

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Boulder, CO
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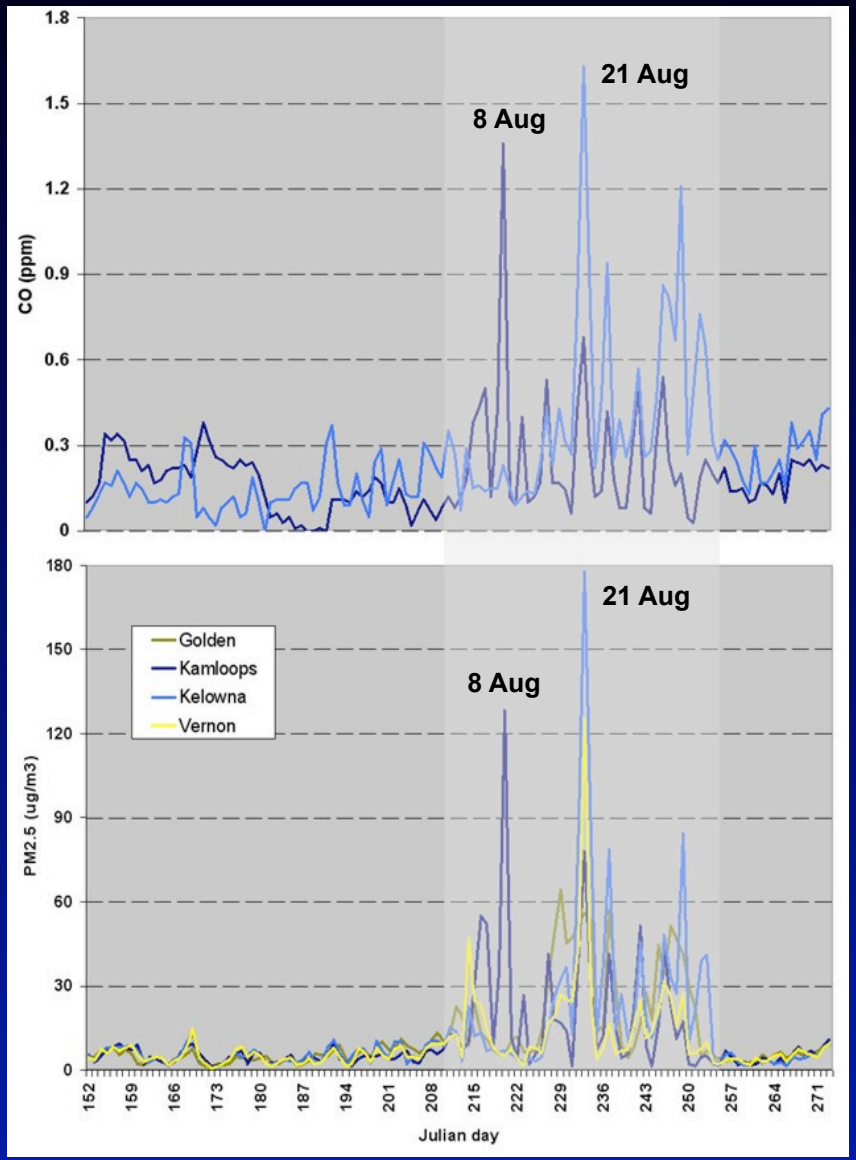
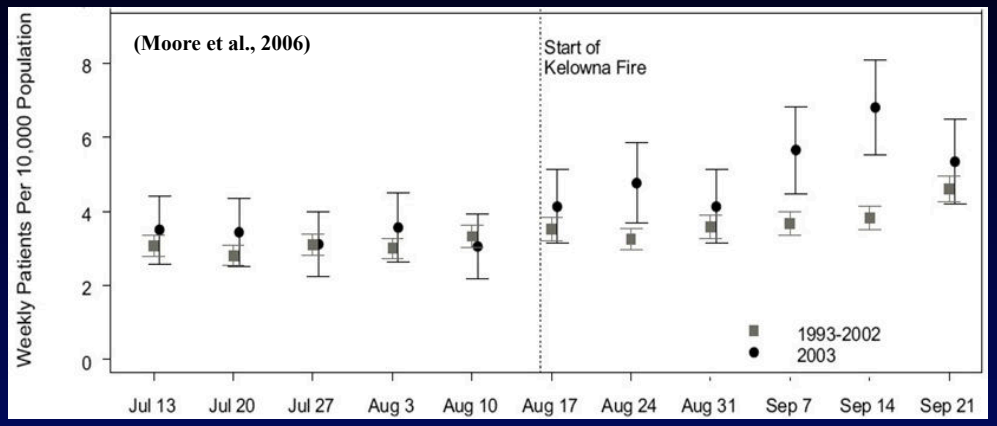
Air quality deterioration in British Columbia Interior, 2003

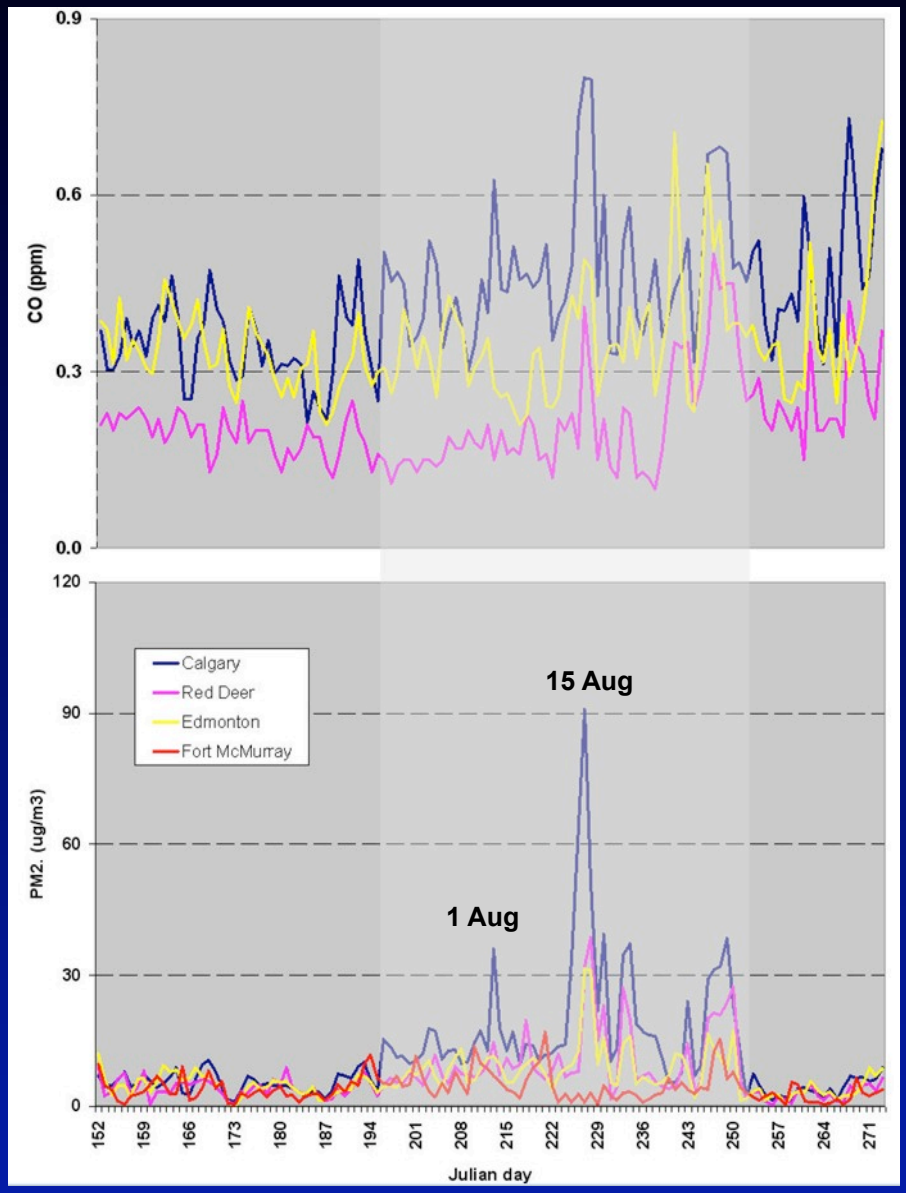
period with active fires



Visits to physicians in Kelowna



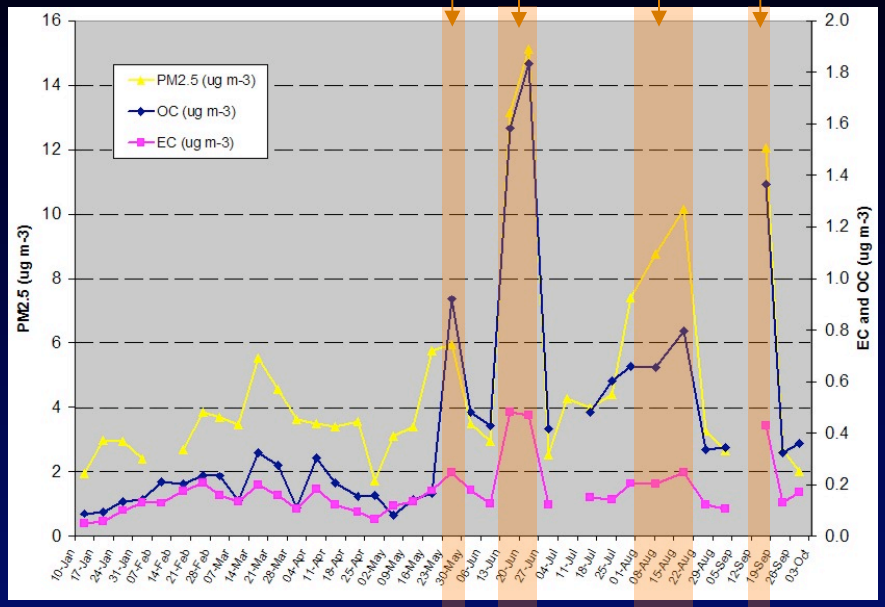
Air quality impact downwind in southern Alberta, 2003

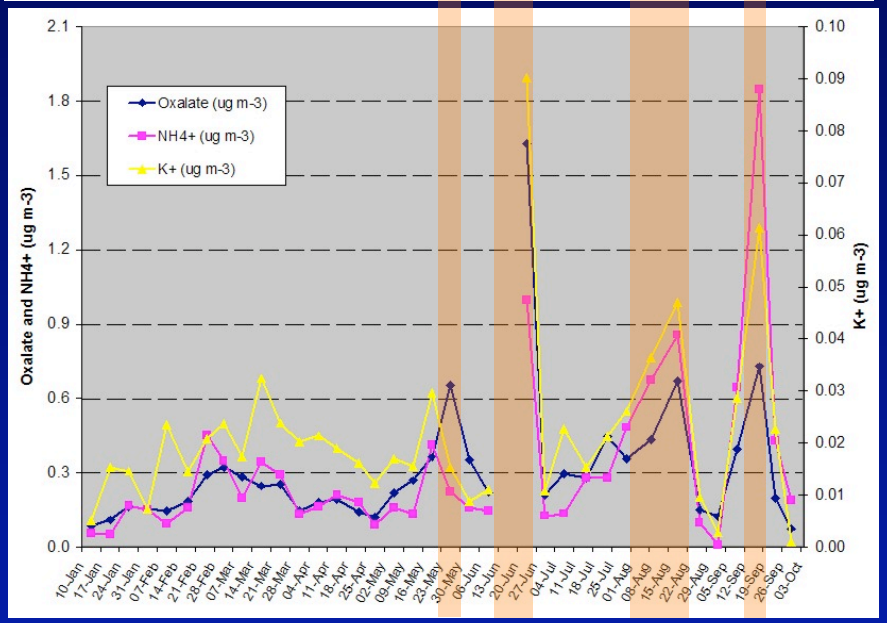


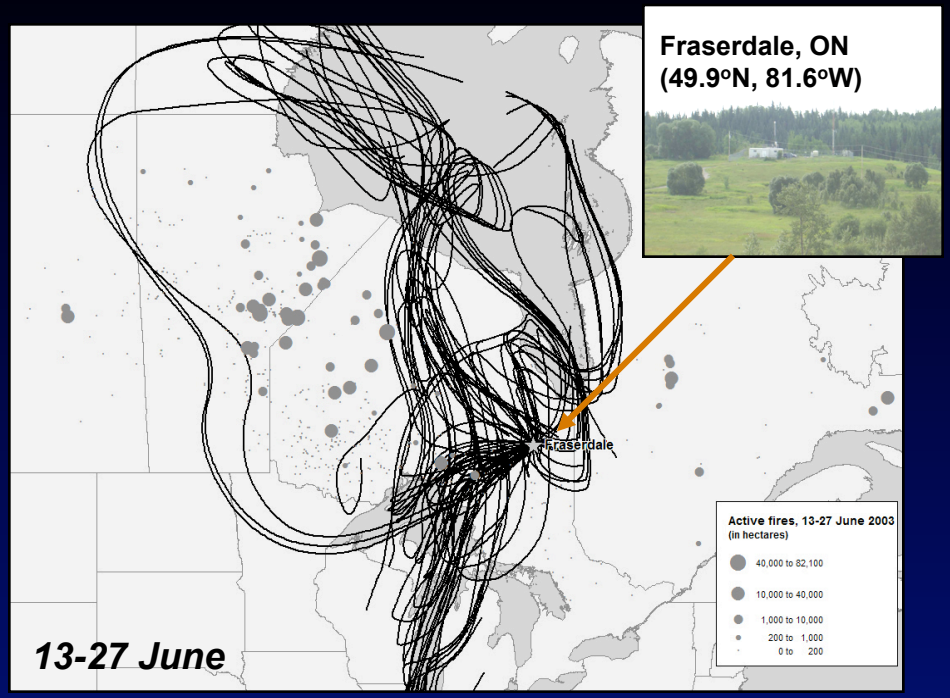
Pictures provided by Bob Myrick, Alberta Environment and presented at the Smoke Forecasting Workshop in Edmonton, Alberta in Feb 2007

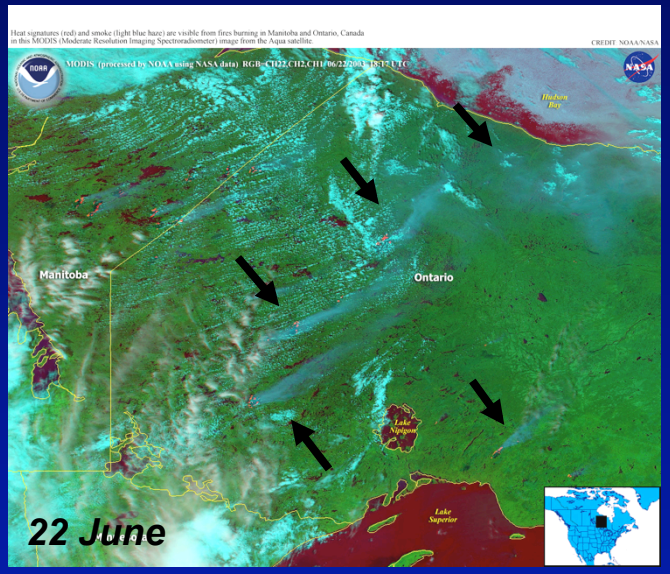
Northeastern Ontario, 2003

Samples with fire episodes

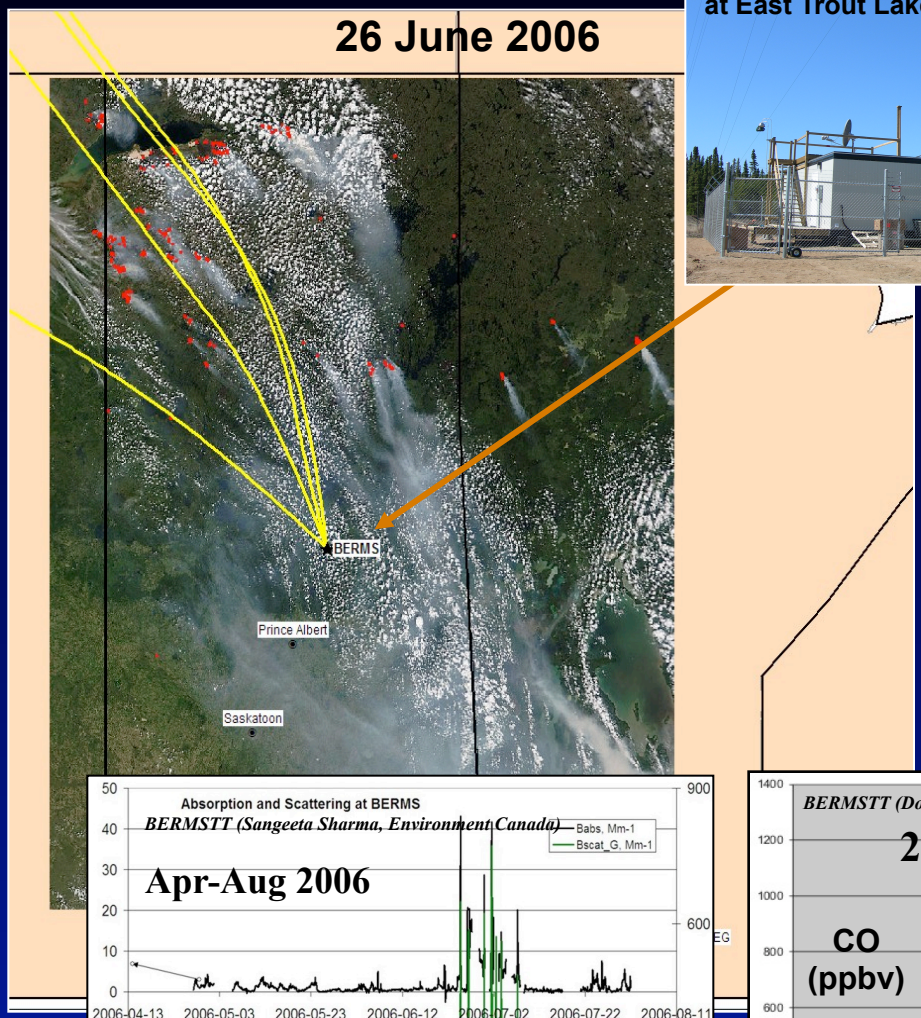


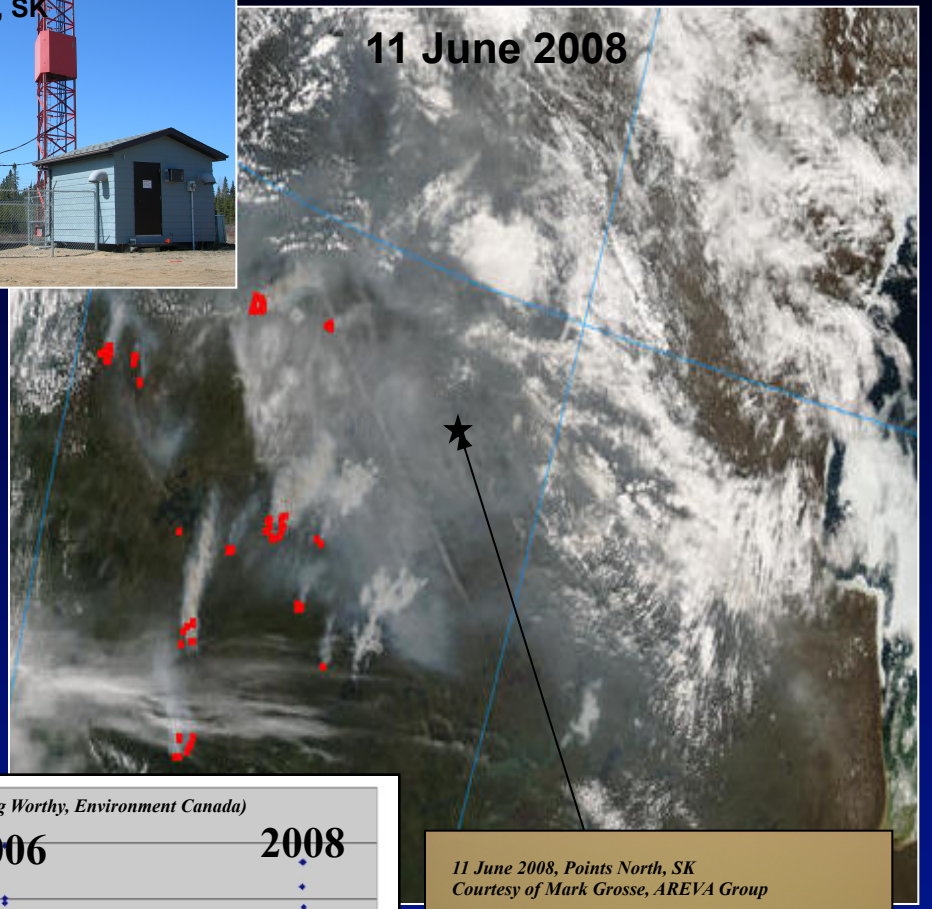


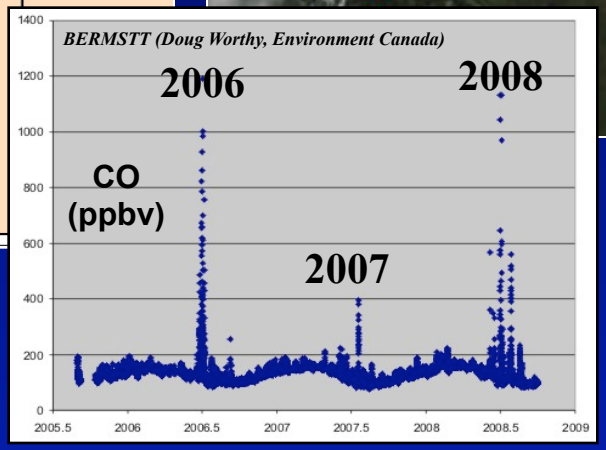




Northern Saskatchewan, 2006-2008







Modeling emissions from Canadian wildfires

- 20 chemical species: GHGs, CO, VOCs, NO_x, $PM_{2.5}$, Black Carbon, Particulate Organic Carbon

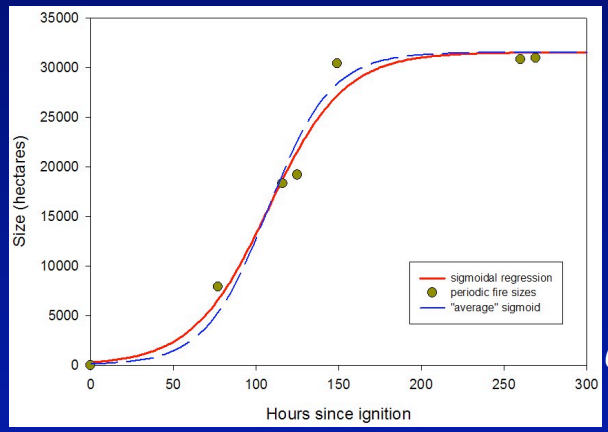
- Emission factors for flaming/crowning and smoldering combustion phases

- Hourly fuel consumption from Canadian Behaviour Prediction (FBP) System

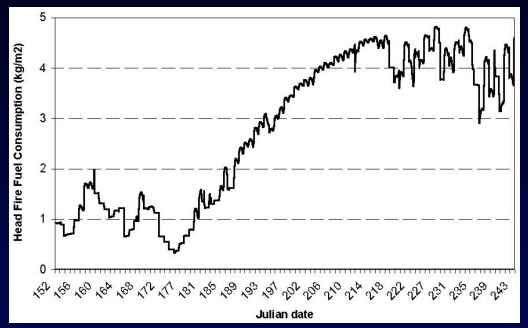
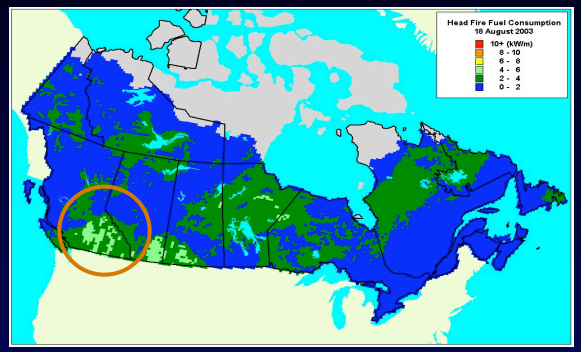
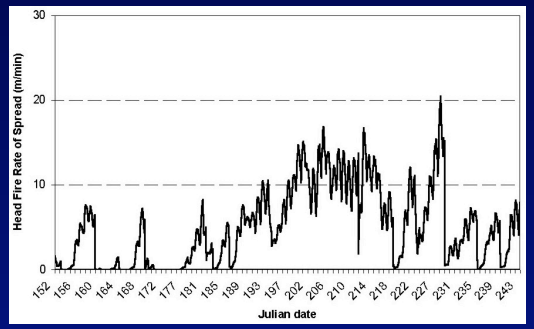
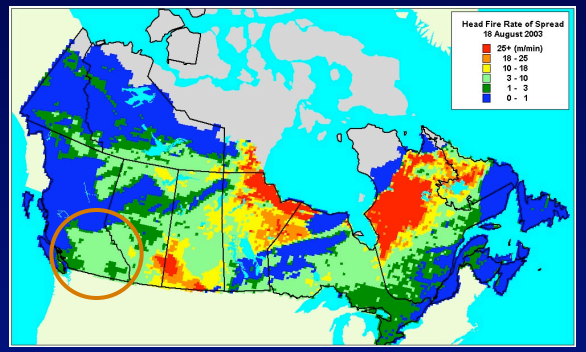
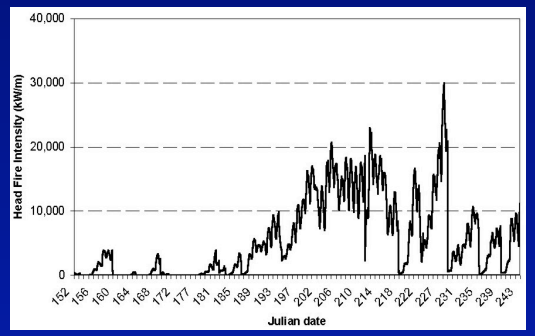
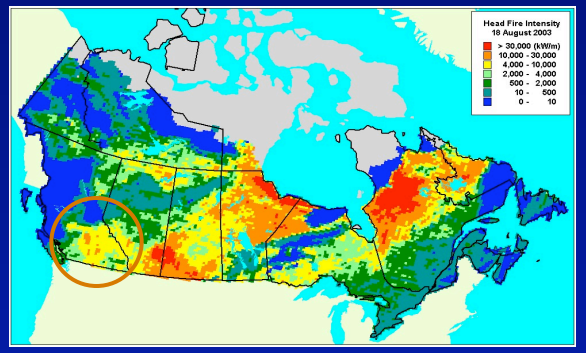
- Meteorological conditions from Canadian weather forecast model GEM

- Fire growth parameterization (S-shape curve) from field observations

- Fire datasets from provincial, and territorial, and federal fire management agencies: location (latitude, longitude), final size, start date, extinction date



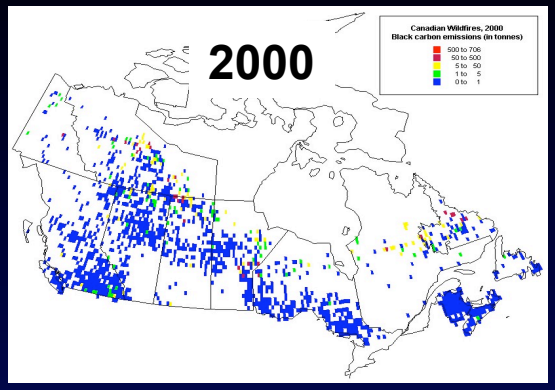
Fire behaviour in British Columbia Interior, 2003

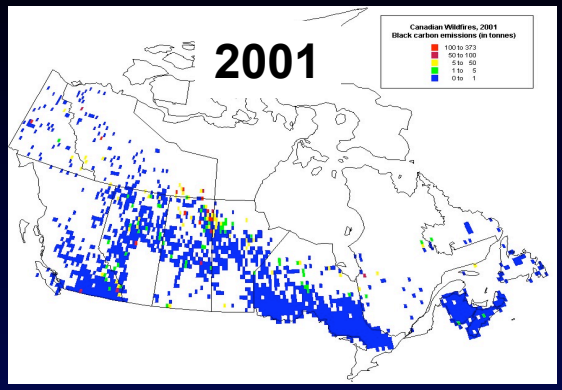
	June-August 2003	18 August 2003
Fuel consumption		
Rate of spread		
Fire intensity		

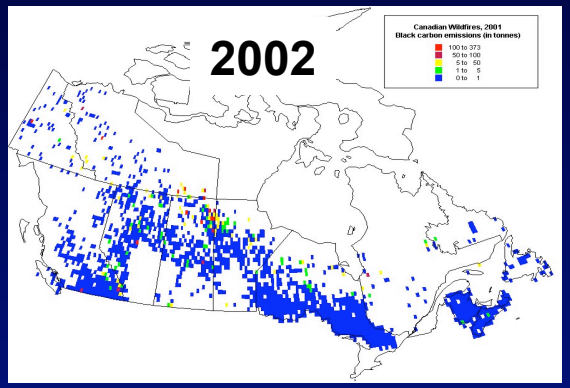
Black carbon emissions, 2000-2004

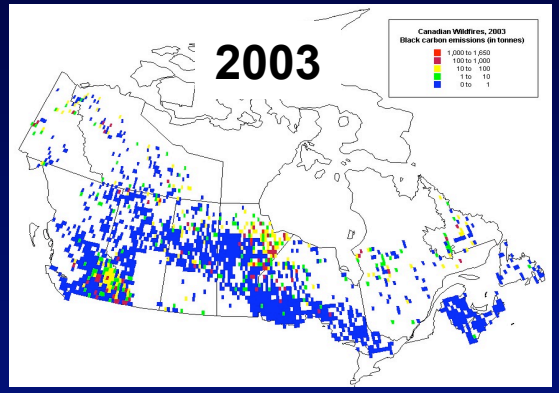
Wildfires

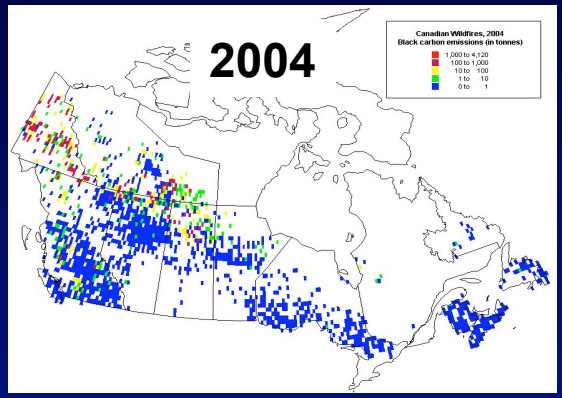
2000	6,000 t
2001	4,000 t
2002	42,000 t
2003	36,000 t
2004	60,000 t





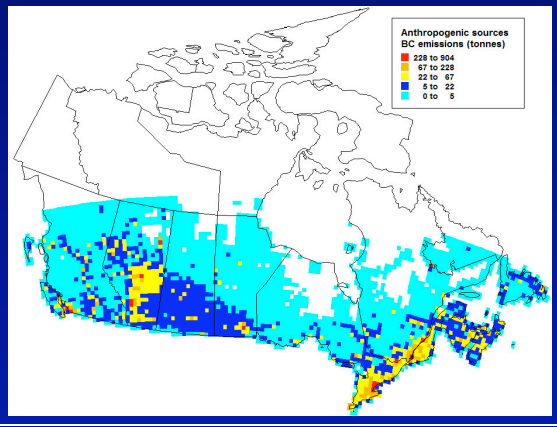


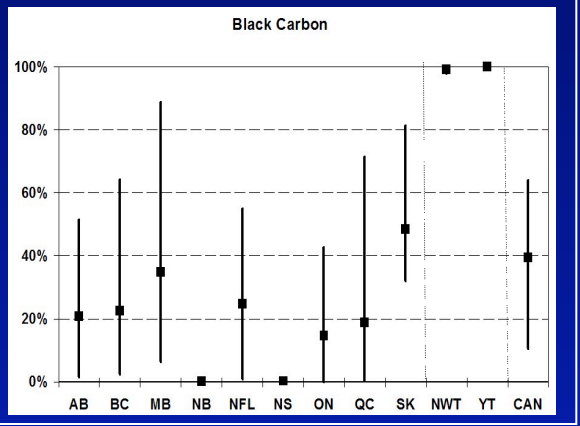




Comparison to 2001 anthropogenic sources

Mobile	10,000 t
Non mobile	20,000 t
Minor points	900 t
Major points	2,800 t

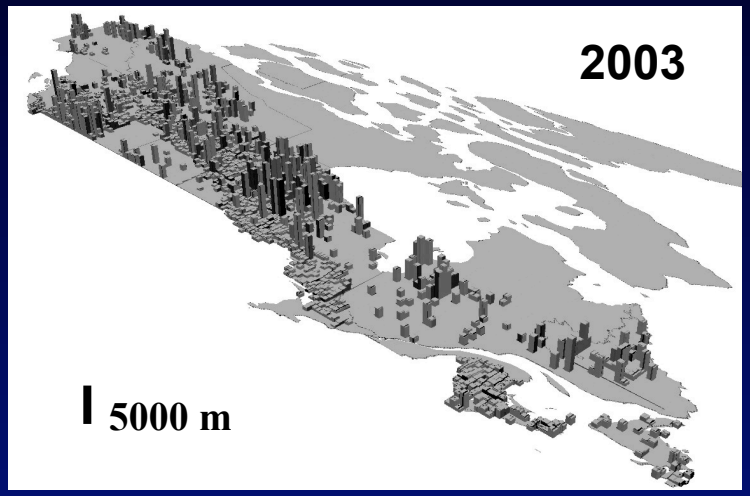




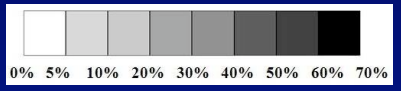
Injection heights

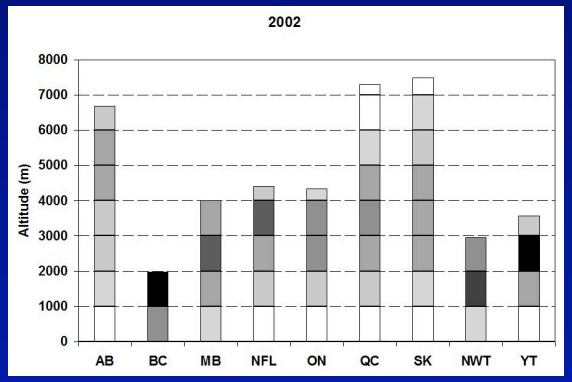
- Injection height is max altitude reached by plume column

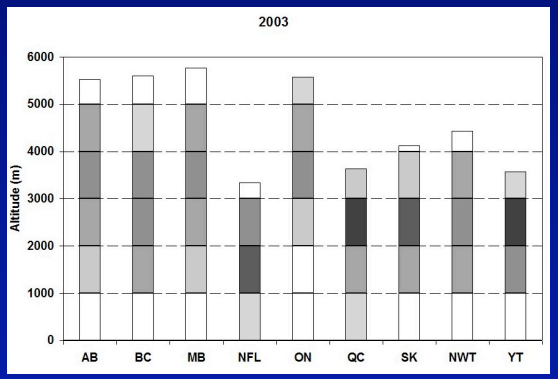
- Estimated hourly heights from fire energy calculated with Canadian FBP System

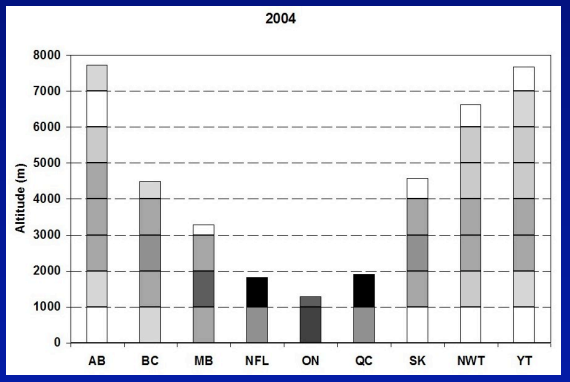


- Vertical distribution of injection heights in % by provinces and territories for 2002, 2003, and 2004



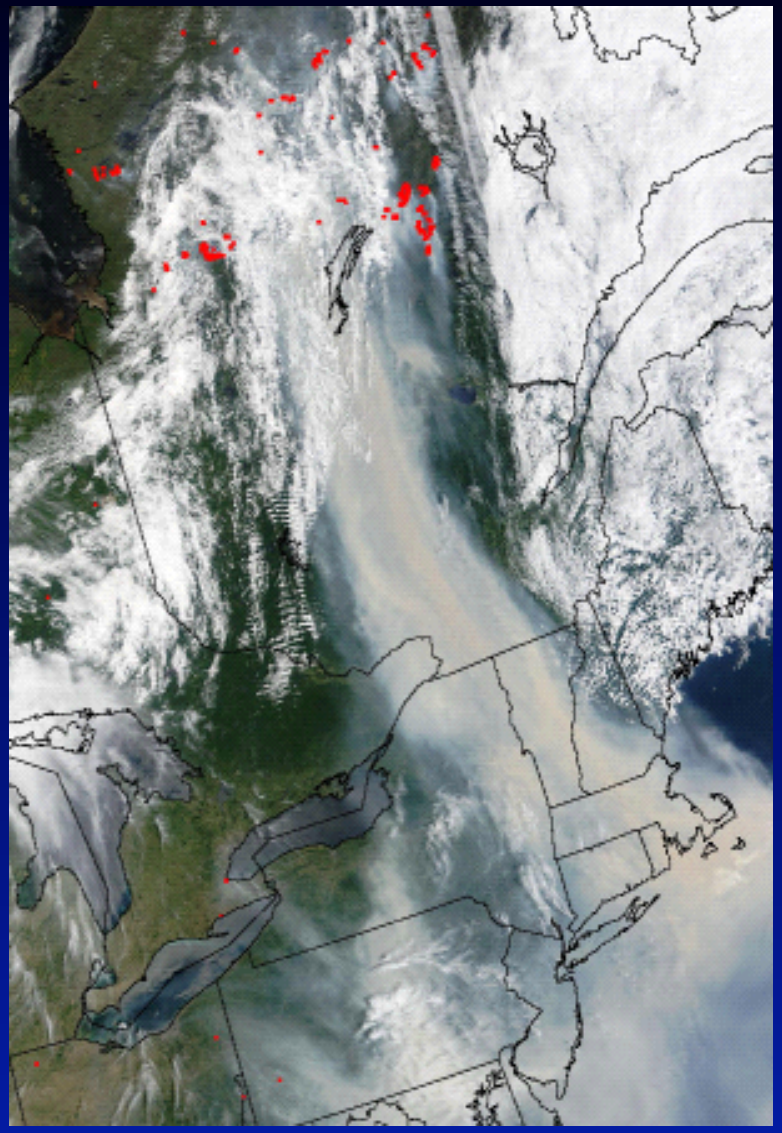






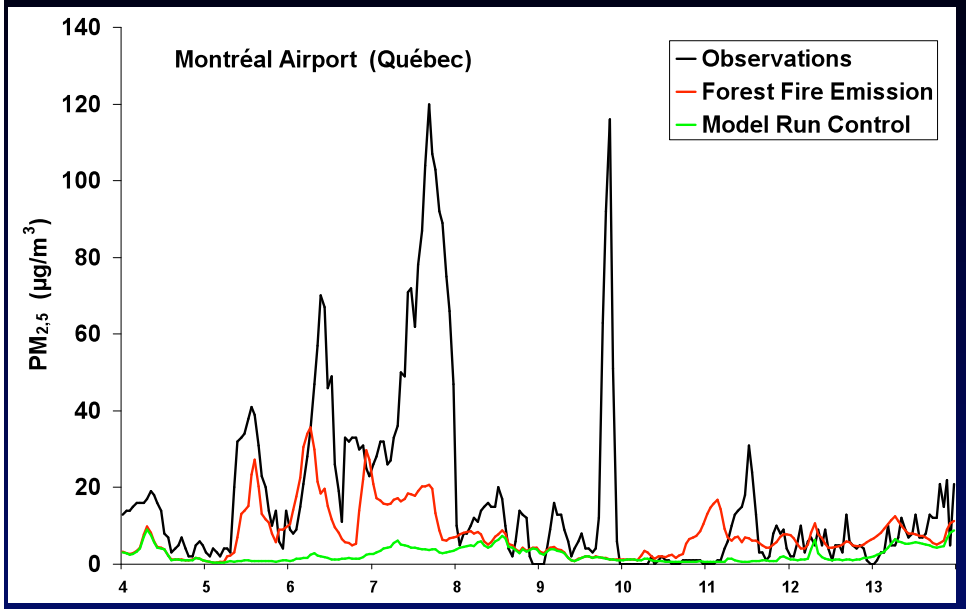
2002 Quebec smoke plumes

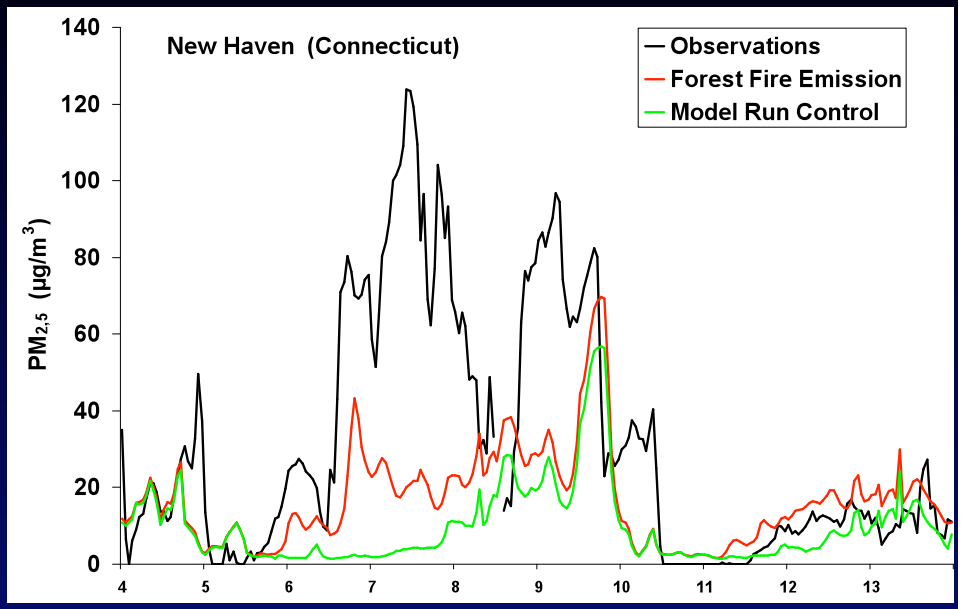
MODIS 7 July 2002 (1630 UTC)

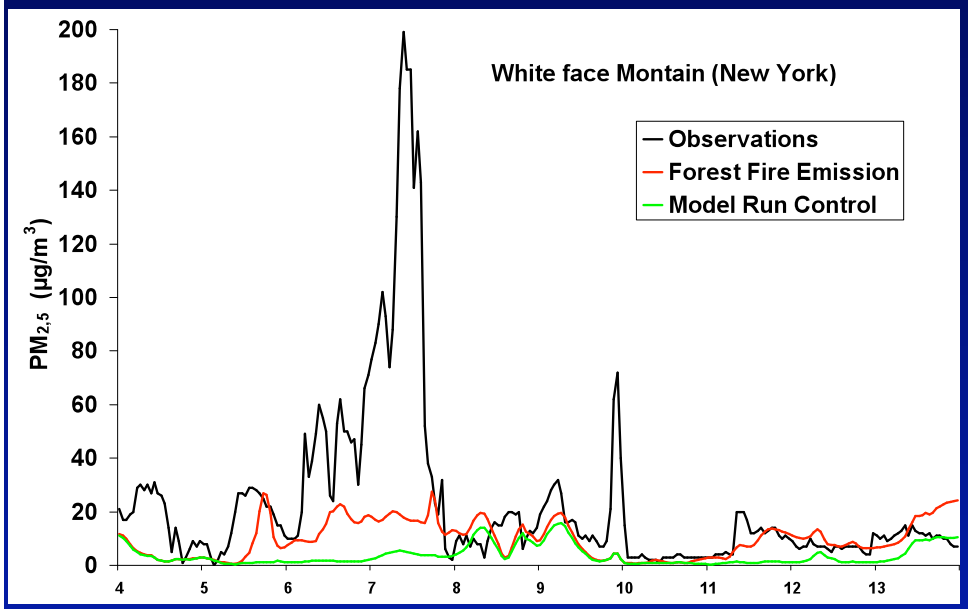


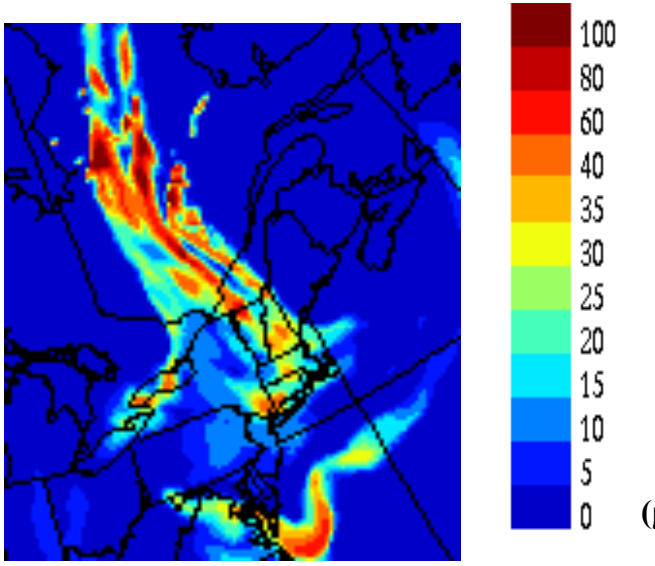
Air quality model CHRONOS

Air quality impact on the East Coast, 7 July 2002





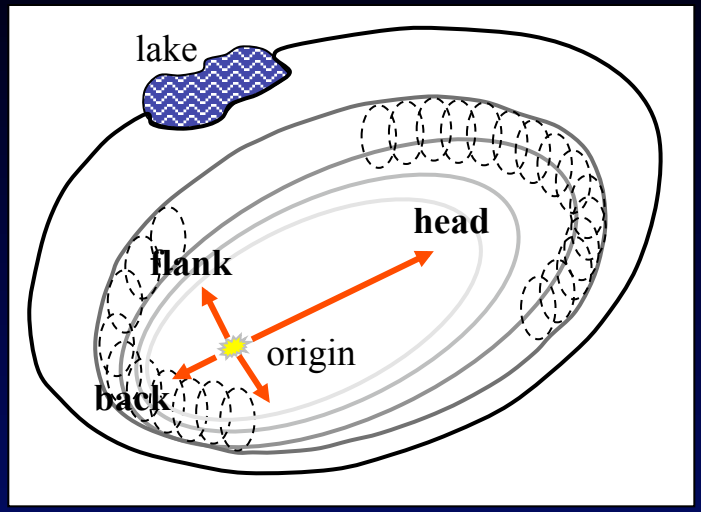




Development of a dynamic emission model

• Dynamic emission model:

- fire behaviour from Canadian FBP System
- surface weather from meteorological station/GEM
- **fire growth** based on elliptical wavelet propagation scheme *(Richards, 1990)*
- time step ~ 5-10 minutes
- developed in Fortran



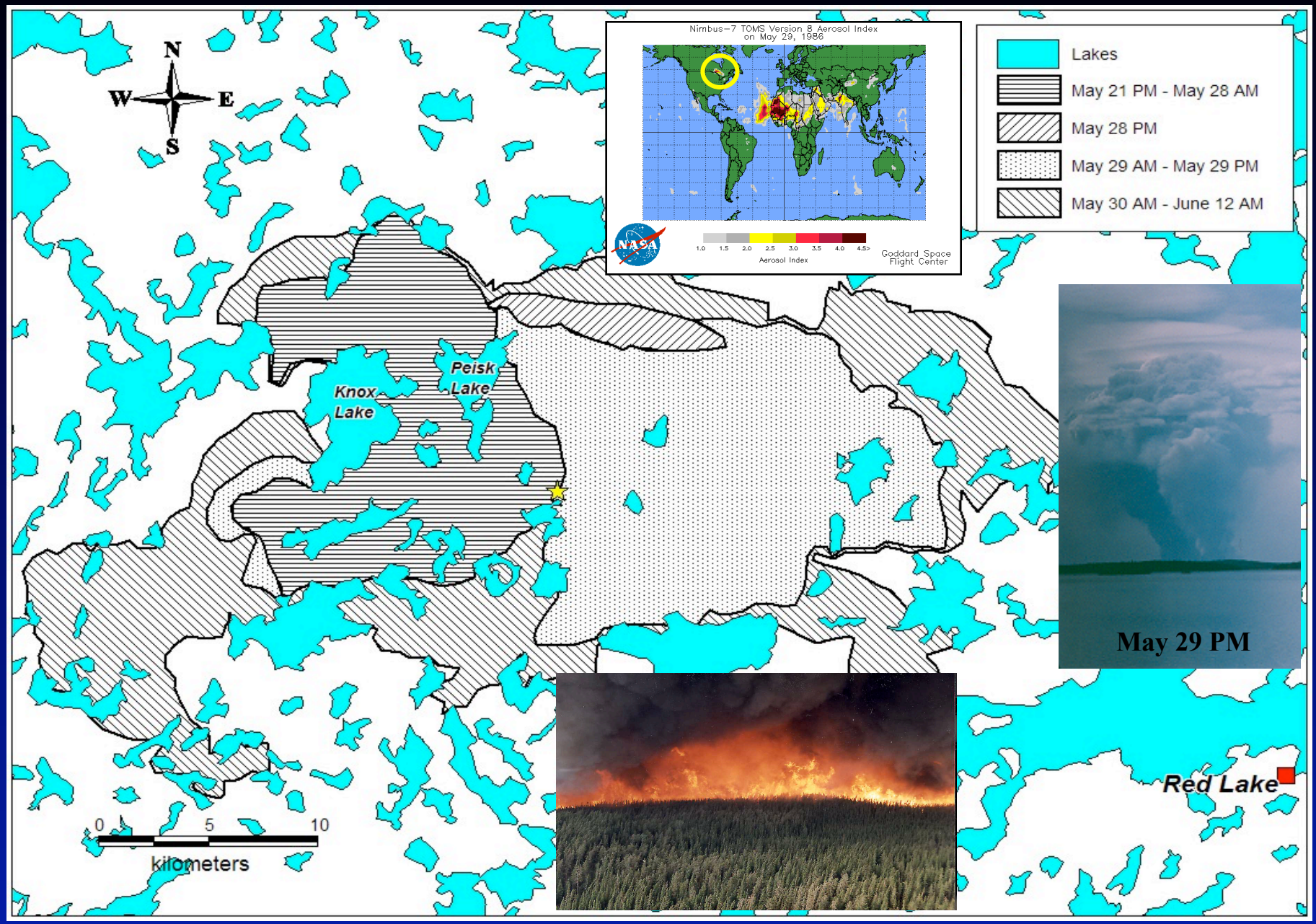
• Initial conditions:

- ignition point by lightning or from anthropogenic origin
- initial fire perimeters from surveying/satellite hotspots

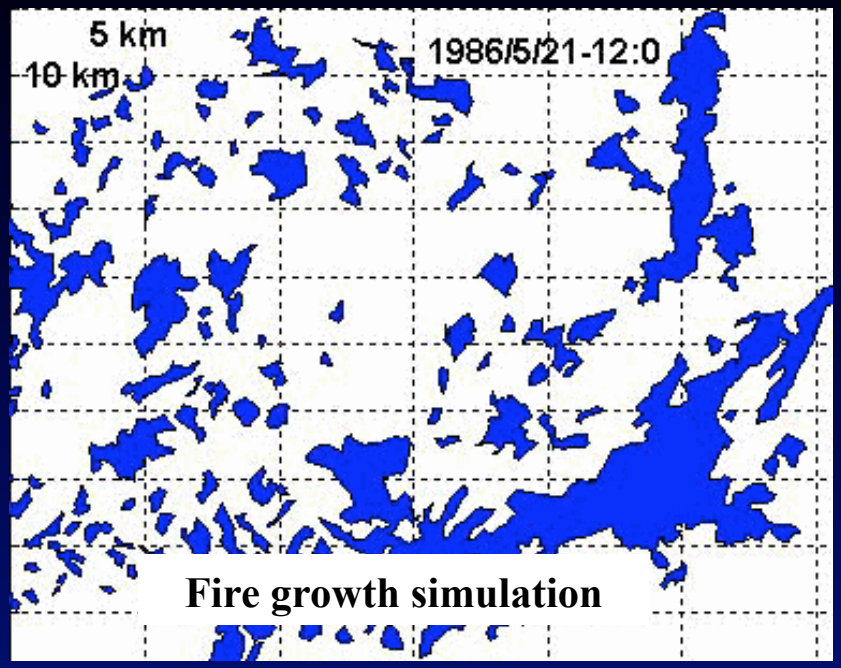
• Current injection height scheme based on energy released:

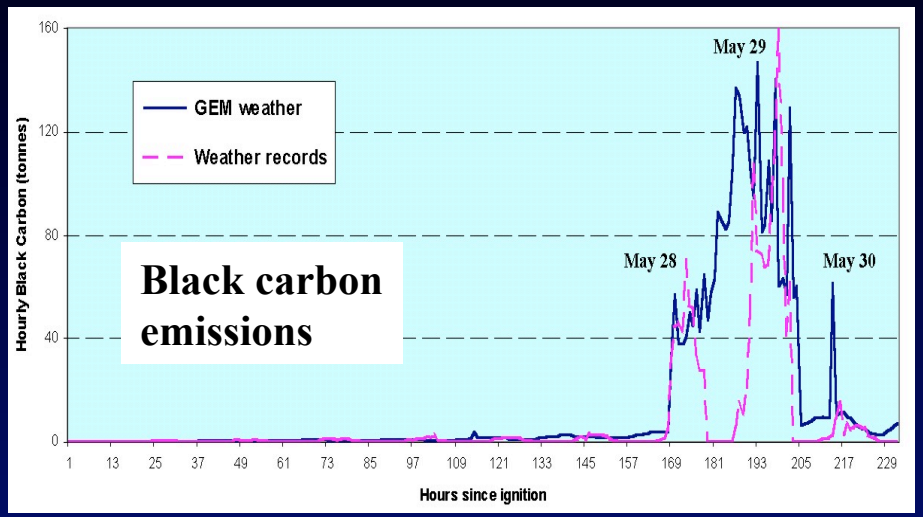
- altitude "in theory" *(Manins, 1985)*
- or based on field observations *(Harrison and Hardy, 2002)*

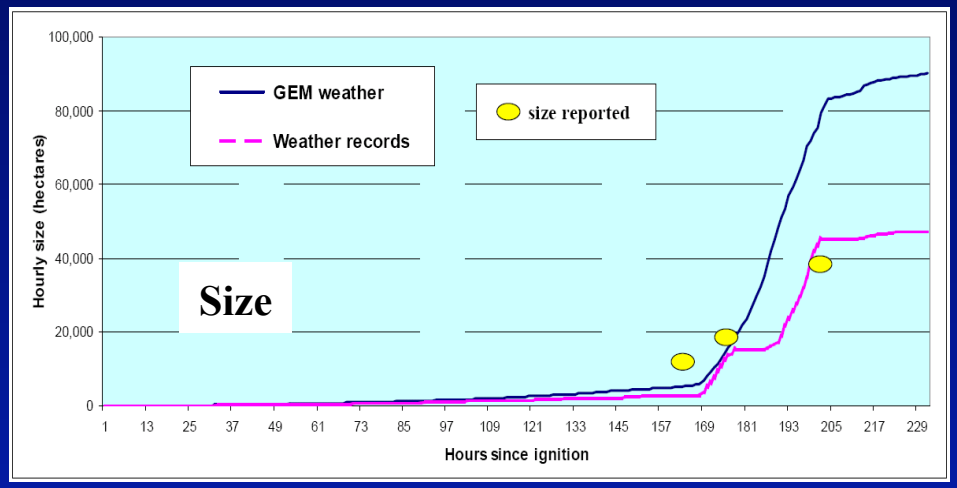
Fire Red Lake #7/86 in NW Ontario

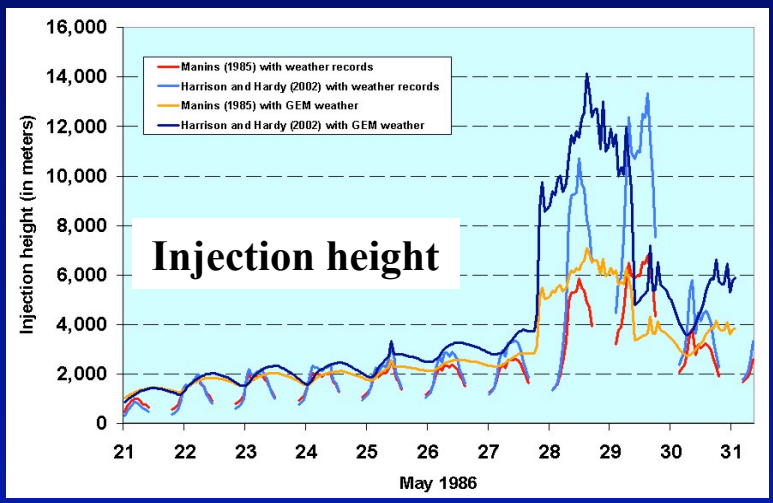


Emissions from Red Lake #7/86

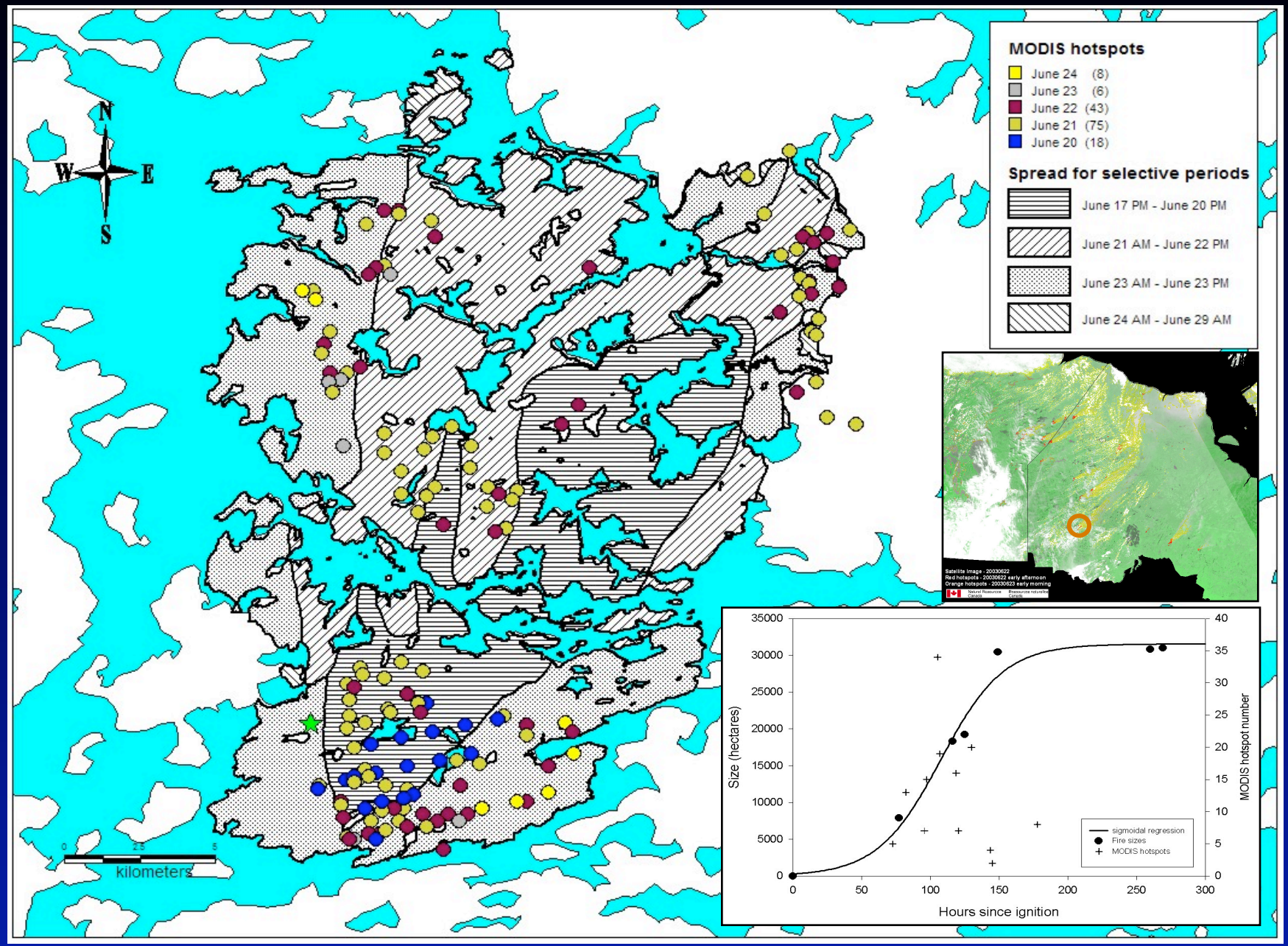






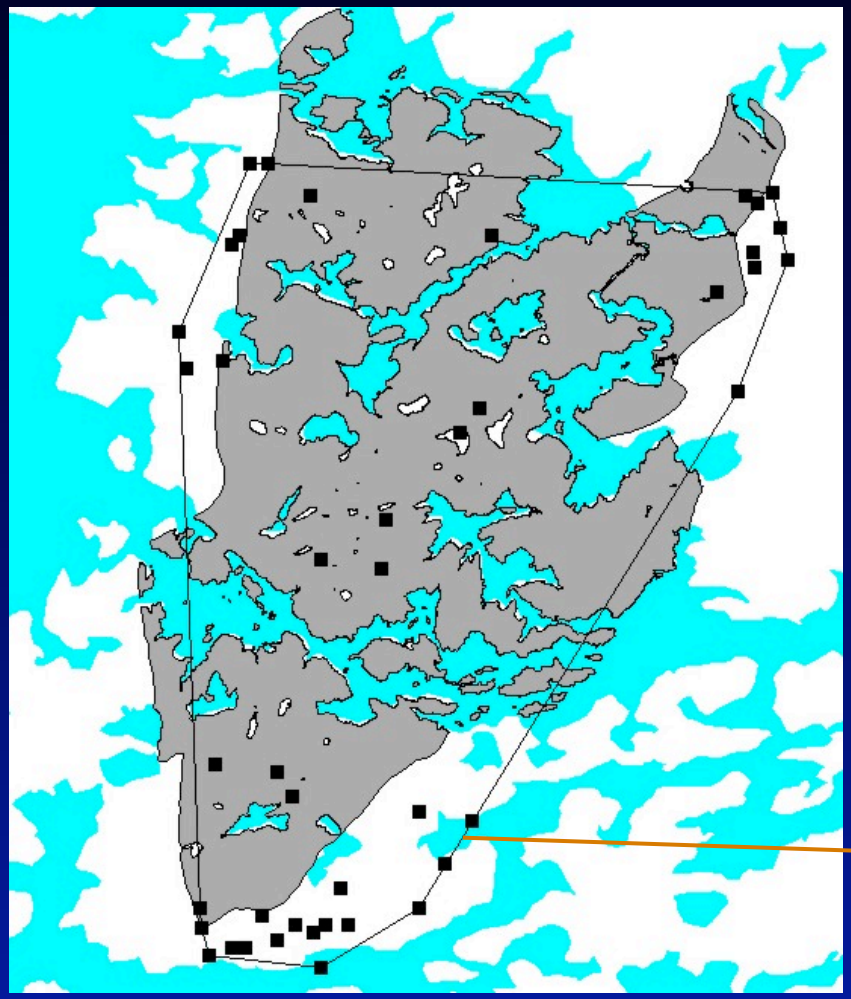


Fire Sioux Lookout #48/03 in NW Ontario



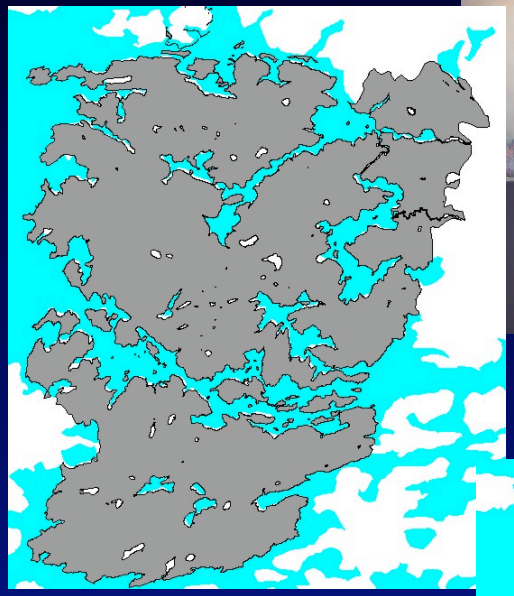
Growth forecasting from MODIS hotspots

June 22 PM

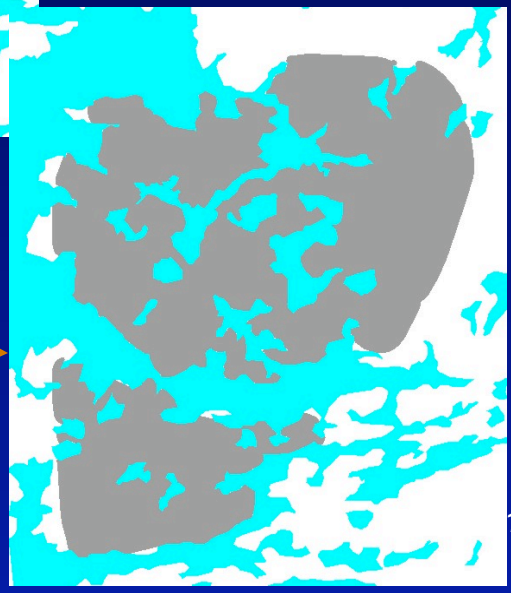


June 23 PM

Observed



Forecasted



Integration of Canadian forest fires in GEM-MACH