National Smoke Forum 2014
October 10, 2014
Halifax, NS

Wildland/Vegetation Fire Smoke: A Growing Global Concern

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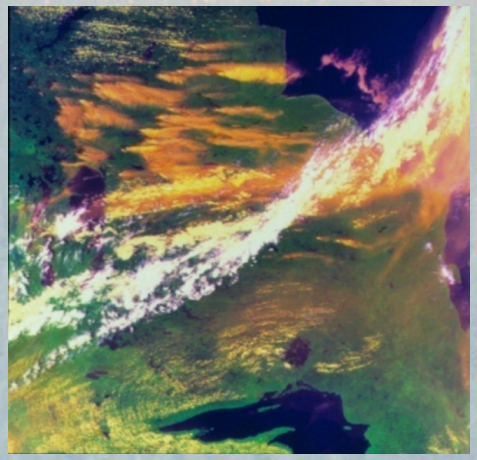
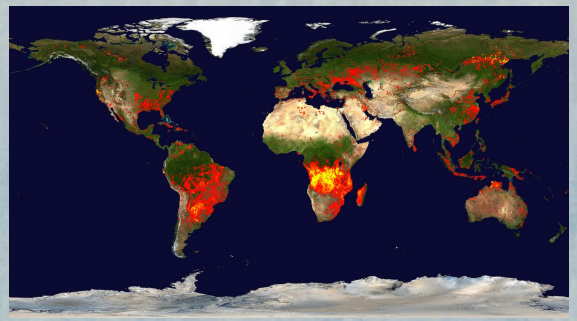
Sault Ste. Marie, ON



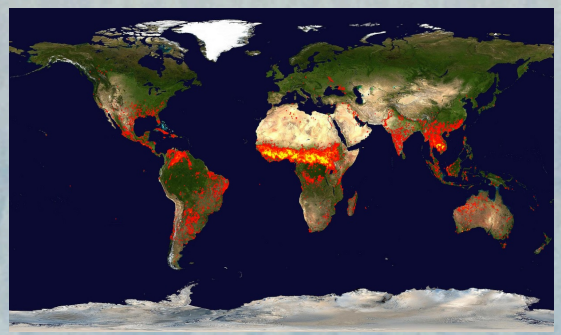
Adapted from article in The Canadian Smoke Newsletter 2014:
"Towards Establishing a National Forum on Smoke Forecasting in Canada"

Global Context

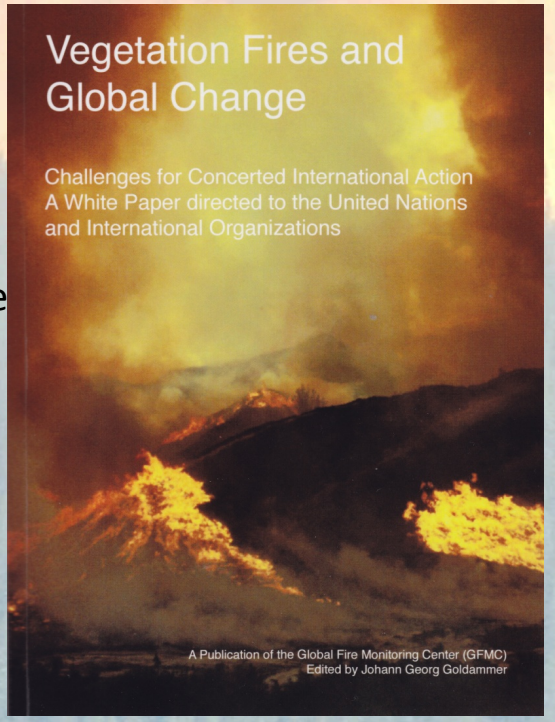
- Global burned area estimate: 3-6 million km^2 (~50% in Africa)
- Largest increases in tropics (deforestation/land-use change in SE Asia/South America) and Mediterranean Europe/Eurasia (changing socio-economics, rural abandonment)
- Impacts and vulnerability increasing:
  - climate change, expanding WUI (urban exodus), land abandonment/rural exodus, changing lifestyles, economic development
  - growing populations, industrialization, infrastructure and disturbance-sensitive technologies - society becoming more vulnerable to vegetation fires, particularly fire smoke pollution



July



January

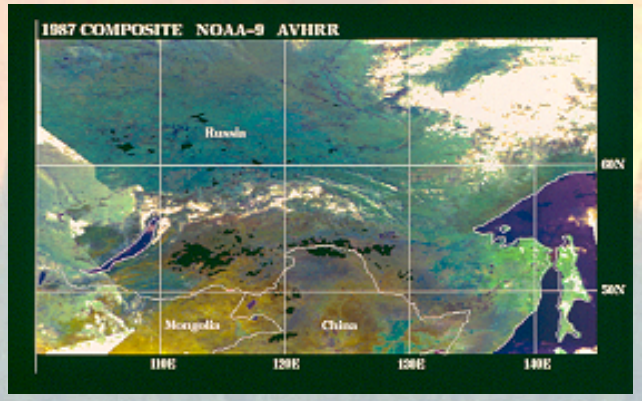


Global Vegetation Fire Smoke (VHS) Trends

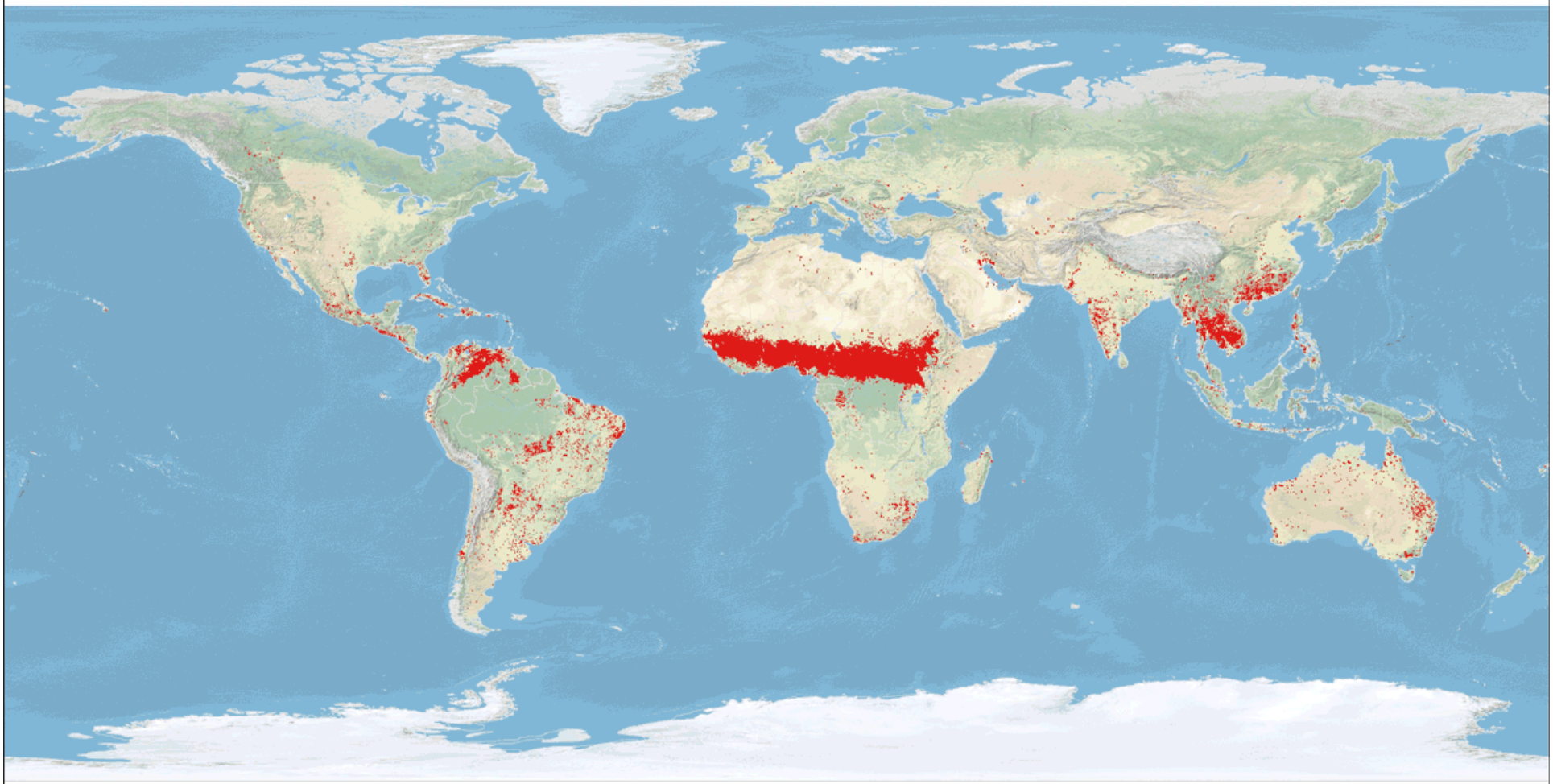
- Evidence that VFS has influenced society since Middle Ages
- Increasing application of fire in land-use change over past 3-4 decades
- More frequent and extended smoke episodes
- In metropolitan or urban areas impacts of VHS coupled with fossil fuel emission burden resulting in increased human vulnerability
- Require better measurement and scientific understanding of impacts in order to prevent/ mitigate VFS impacts
- Transboundary effects require development of international policies to address root causes and impacts

VHS Trends (cont'd)

- Tropical land-use change (e.g. South America, Southeast Asia) - shifting cultivation, rain forest conversion to pastures/plantations
- Southern Europe abandonment of rural areas – fuel accumulation, more fires
- Eurasia countries in transition, lack of infrastructure
- Increasing fire activity and severity in NA – WUI, CC, forest health
- More fires, more smoke and more human exposure globally



MODIS Rapid Response Active Fire Detections for 2007

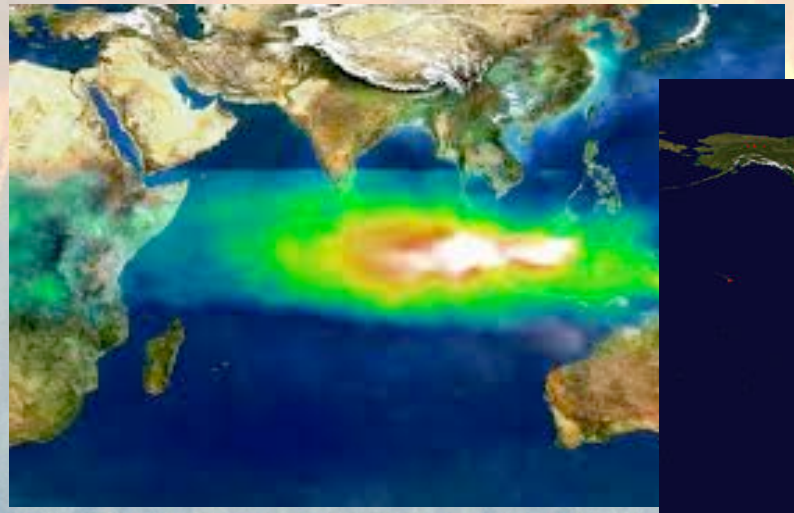


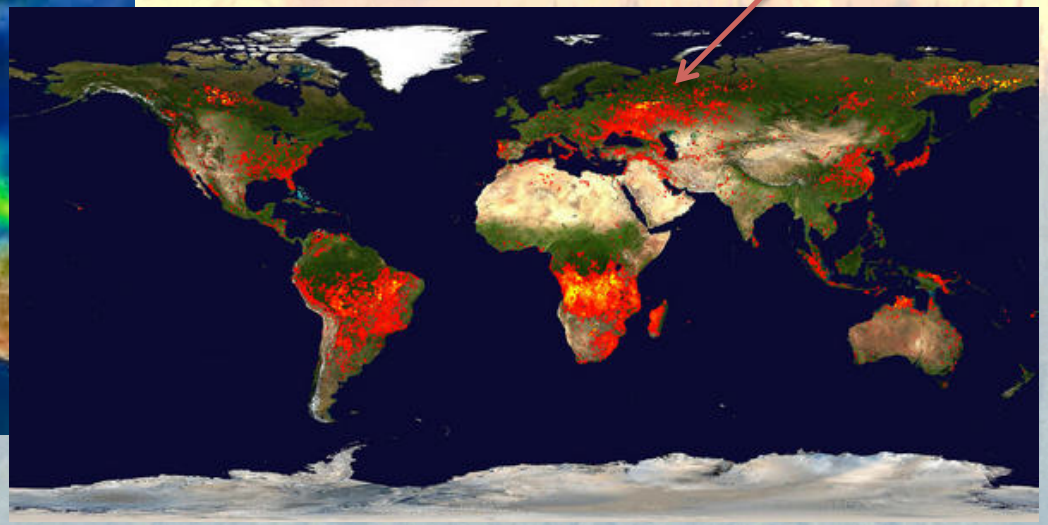
January February March April May June July August September October November December

Active fires, shown in red, are detected using MODIS data from the Terra Satellite.
Source: MODIS Rapid Response http://rapidfire.sci.gsfc.nasa.gov/
Fire Information for Resource Management System (FIRMS)
http://maps.geog.umd.edu

Awareness of Smoke Impacts

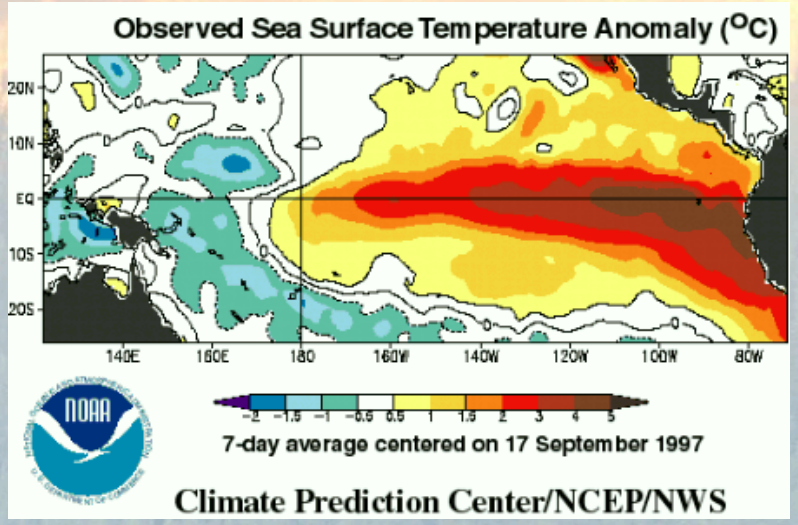
- Initial focus on tropics (Brazil, Africa, SE Asia)
- Two significant fire/smoke/health events focused attention:
- SE Asia in 1997-1998 and Western (European) Russia in 2010





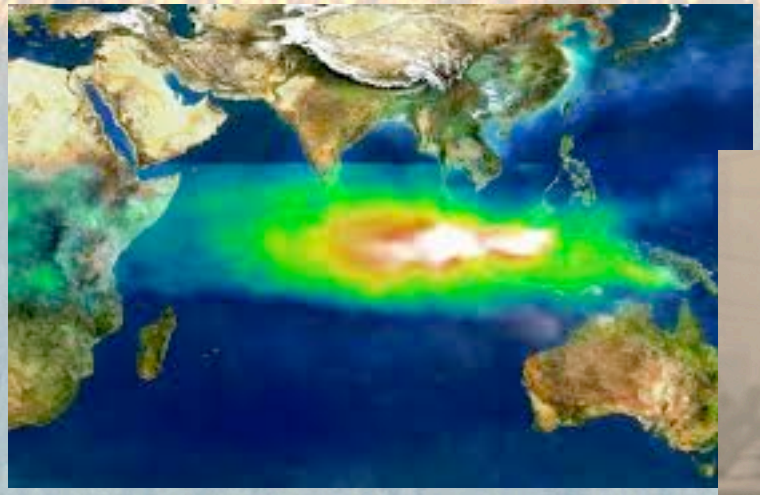
SE Asia El Nino Event 1997/1998

- El Niño event: displaced warm water to eastern Pacific Ocean, producing cool waters near Indonesia
- Suppresses monsoon rains that dampen use of fire to clear land for agriculture
- RESULT: extended drought and deep burning in peat/swamp biomes
- WHO air quality standards exceeded by 300% for over 200 days



SE Asia El Nino Event 1997/1998

- Estimated 9.5 million hectares burned in 1997/1998 (15-25 thousand hectares in non El Niño years)
- Low-level smoke trapped in region, mixing with urban smog, becoming more toxic
- Huge impact on human health (immediate & long-term)
- Estimates that carbon particulates would have the greatest effect, causing 6,800–14,300 deaths, while Ozone would be responsible for 2,300–5,900 deaths.



Natural Hazards **21:** 131–144, 2000.

The 1997 El Niño, Indonesian Forest Fires and the Malaysian Smoke Problem: A Deadly Combination of Natural and Man-Made Hazard*

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Baird & Associates, Ottawa, Ontario, Canada

(Received: 6 October 1998; in final form: 26 March 1999

Abstract. The El Niño of 1997–1998 produced the most intense impact on the conterminous U.S.A., generating a series of powerful rain and wind storms off the coast of California in early February 1998. The 1997–1998 El Niño also produced severe flooding and extensive mud slides along the west coast of South America and prolonged drought conditions in northeast Brazil. On the other (west) side of the equatorial Pacific, the El Niño produced the worst drought in 50 years over Indonesia and helped spread the ongoing forest fires on the island of Borneo to well over one million acres. In this paper, the smoke and pollution problem over Malaysia will be analyzed in the context of ongoing Indonesian forest fires and the severity of the 1997 El Niño – a deadly combination which led to the most hazardous smoke problem over Malaysia during August–September 1997. The severity of the smoke pollution is documented using media reports and available API (air pollution index) values over selected cities in Malaysia. The role of the El Niño and its evolution in enhancing the smoke pollution over Malaysia is further discussed and suitably documented. Some of the mitigation measures presently being adopted in Malaysia to combat the smoke pollution are briefly discussed.

Key words: El Niño, Indonesian forest fires, South Asian drought, extreme smoke pollution, health hazards.

1. Introduction

The oncoming of the 1997–1998 El Niño was recognized as early as March 1997 with the appearance of a positive sea-surface temperature (SST) anomaly off the coast of equatorial South America, a sure sign of an El Niño arrival (Rasmusson and Carpenter, 1982). By the end of May 1997, the SST anomaly off the equatorial South America had reached a value of +2.9 °C – highest since August 1983. This prompted meteorologists and oceanographers to speculate that the approaching El Niño would be at least as strong as the 1982–1983 El Niño which had caused worldwide havoc in terms of torrential rains on the west coast of South America, severe drought in Indian and south Asian monsoon rainfall, and major swings in

* Paper presented at the Seventh International Symposium on Natural and Man-Made Hazards, Chania, Greece, 17–22 May 1998.

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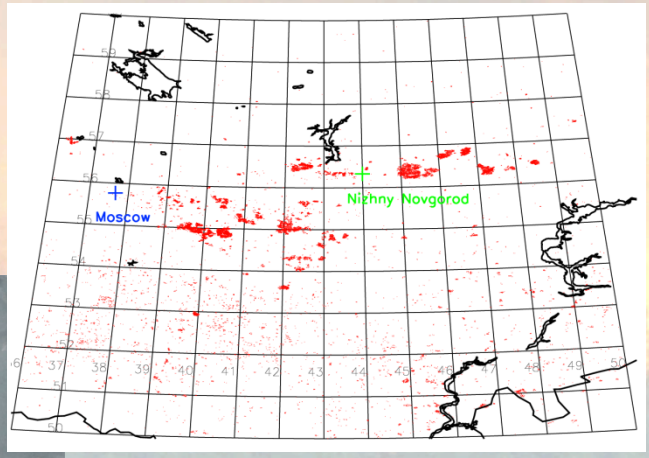
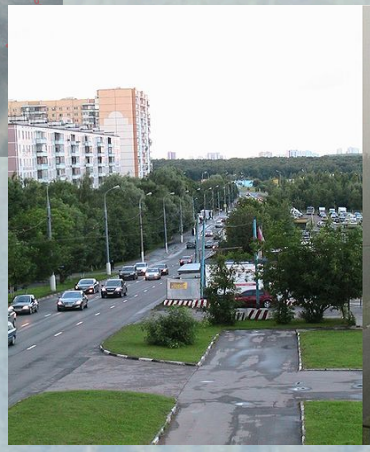
Awareness of Smoke Impacts

- 2010 Moscow
  - extreme heat and drought conditions
  - fires in agricultural and abandoned peat lands east of Moscow - rural abandonment
  - extreme heat and smoke pollution in Moscow late July through August
  - 55,800 additional deaths (above long-term average) in Russia in July/August period

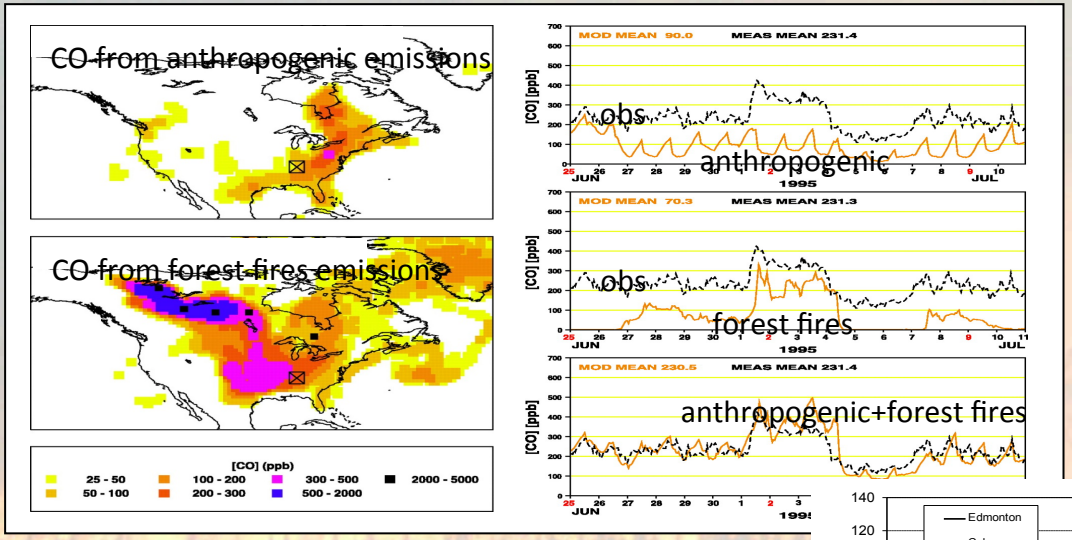




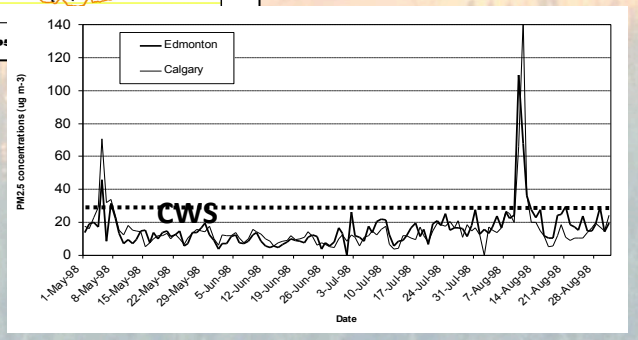
Western Russia 2010

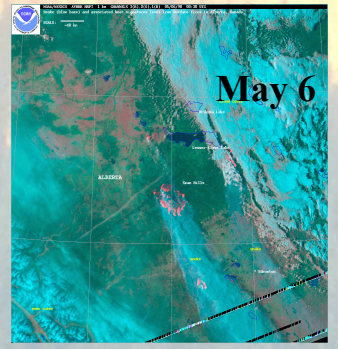
- Unprecedented heat wave began in June
- Numerous fires in western Russia (Moscow to Urals)
  - Heavily populated, cultivated region - large fires uncommon
  - Peatlands drained for energy production – not flooded after 2002 fires
  - Birch and pine forest, heavy agricultural production
  - Increasing rural abandonment in 21st century
- Over 1000 fires, ~200,000 hectares burned
  - Smoke pollution levels extreme over Moscow and region for extended period
  - Daily mortality in Moscow doubled from 350 to 700 (heat stress/smoke impacts)
  - Longer-term health impacts unknown but significant
  - More than 50 people killed, 5000 homeless, 15 billion USD in losses

Canadian Fire Smoke Transport/Urban Impacts

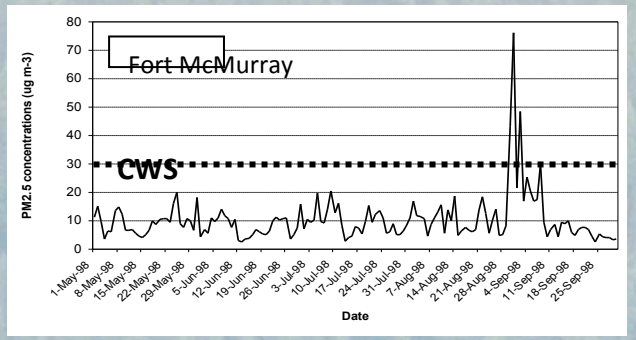


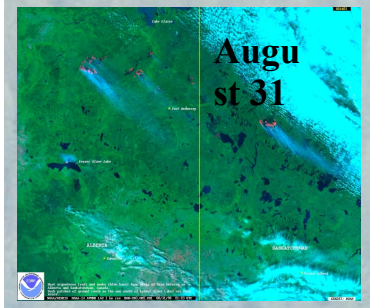
1995



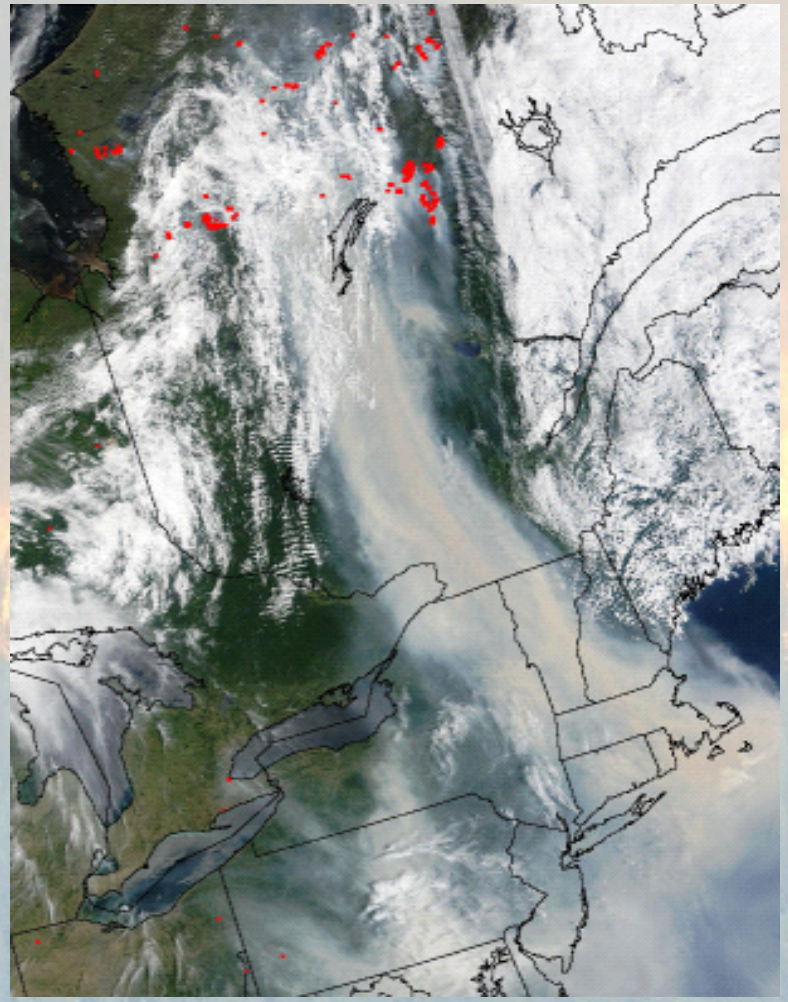


1998

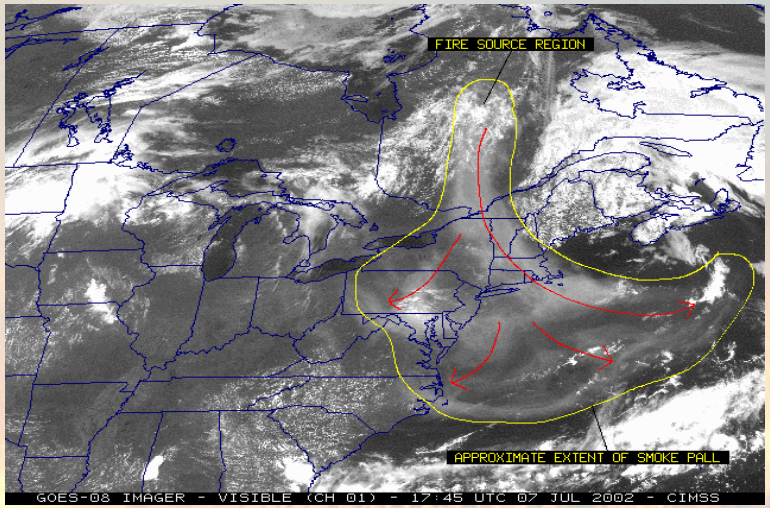


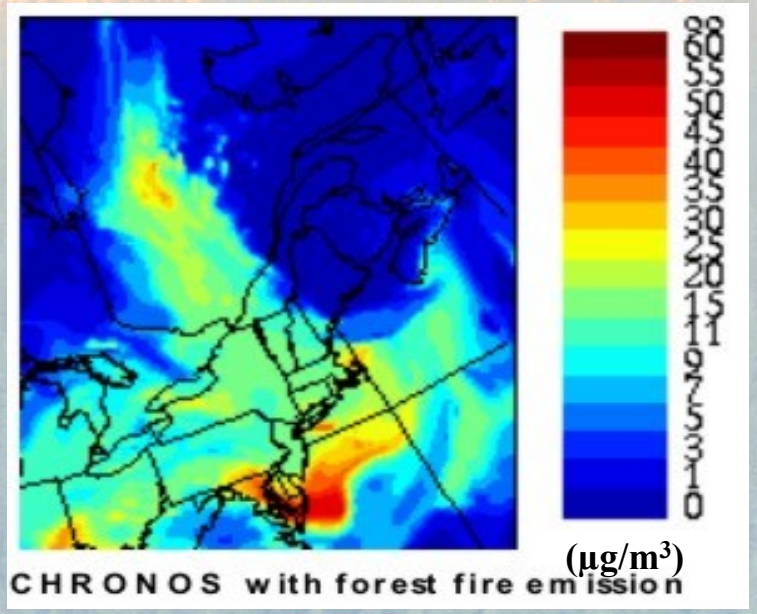


Quebec 2002 Wildfires

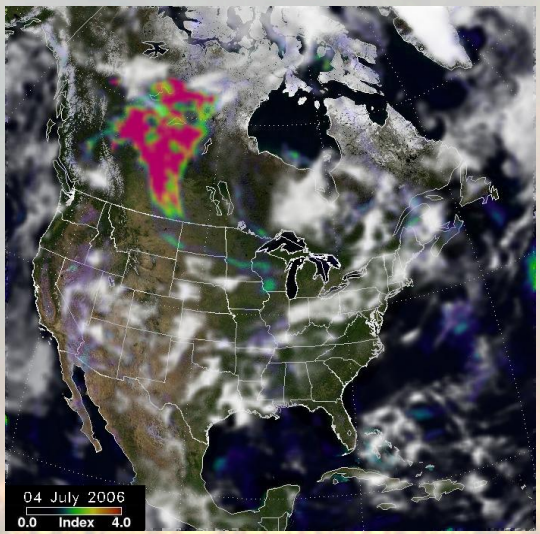


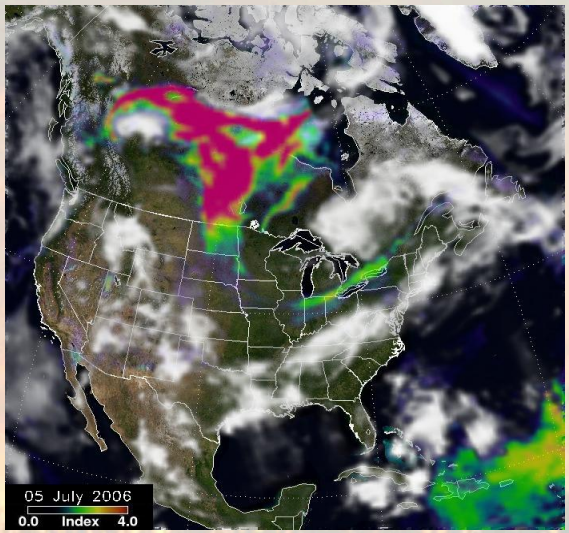
Terra MODIS 1629-1641 UTC (NA)

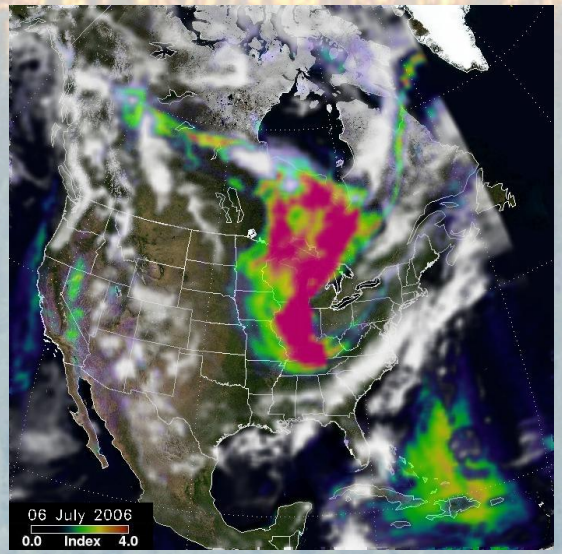


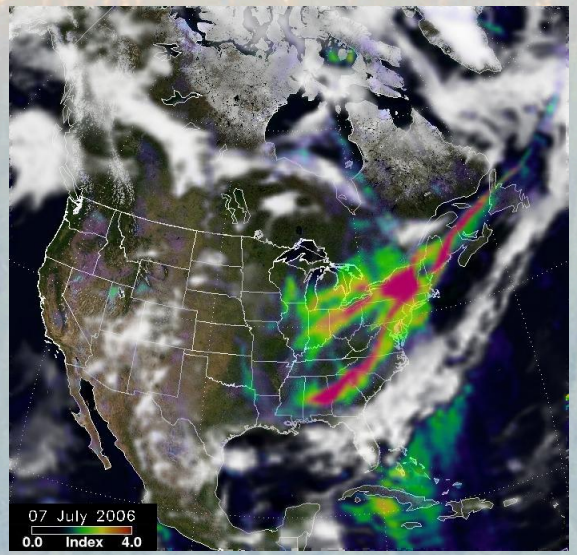


West-Central Canada Fires 2006









Smoke moves to southeast, affecting air quality in populated regions of eastern Canada and USA

Omar Torres, NASA-GSFC/UMBC-JCET

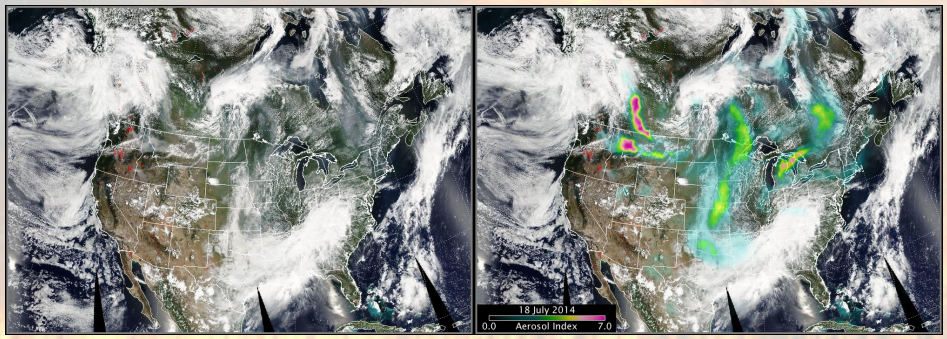
Hwy 88

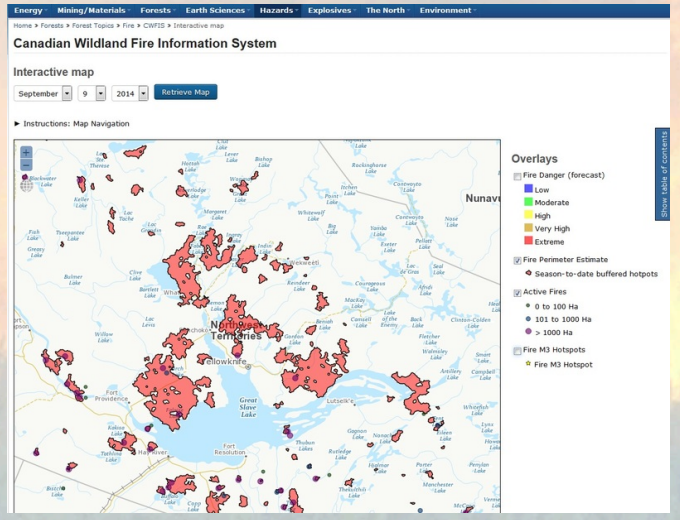
May 15, 2011 1738h MDT

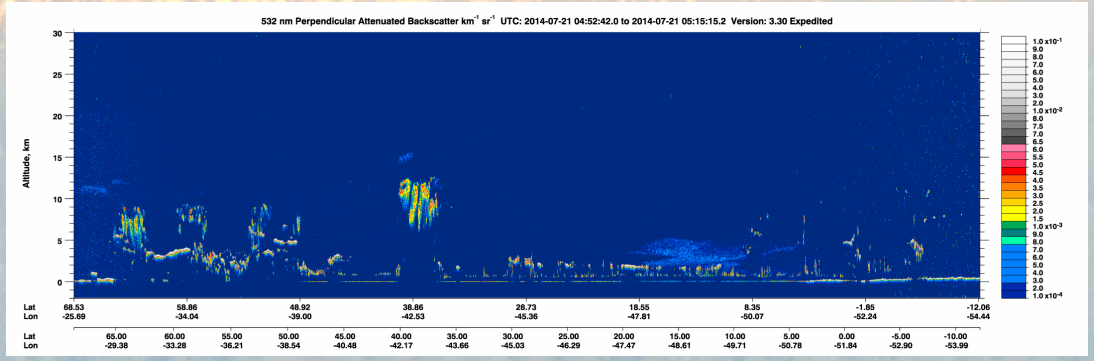
* note flat column, black smoke

Northwest Territories 2014

- Protracted burning period, modified suppression zone, extensive smoke transport (~4 million hectares)

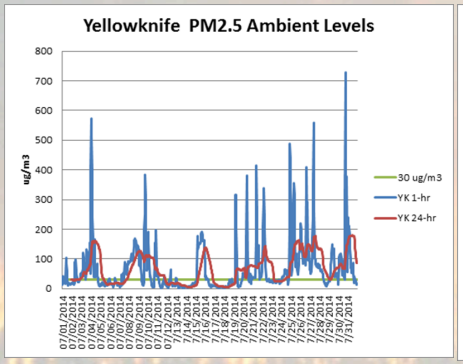


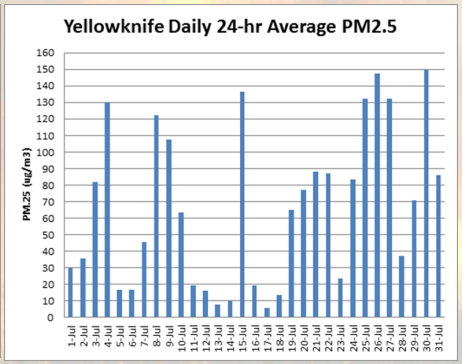


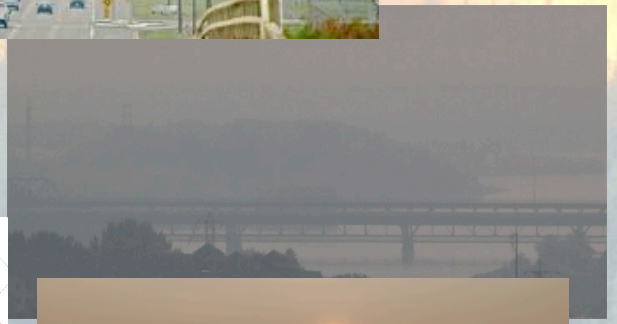


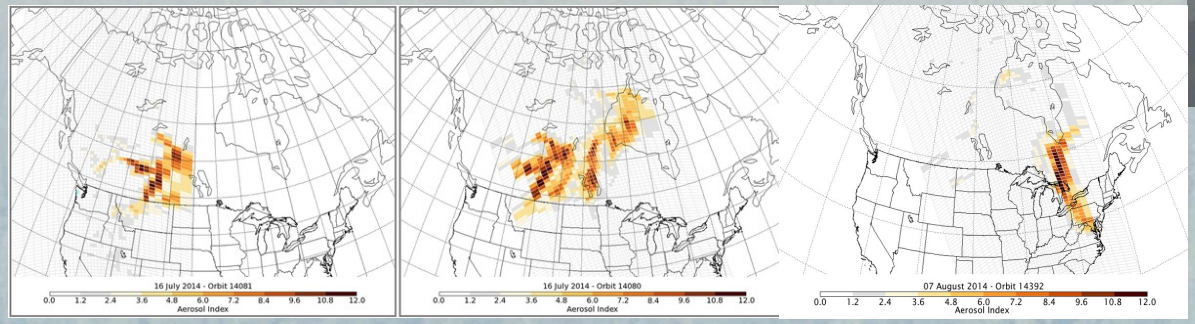
NWT 2014 Smoke Transport

- Monitored downstream - improving ground-based/satellite technology
- Large air quality impacts (Yellowknife and downstream)



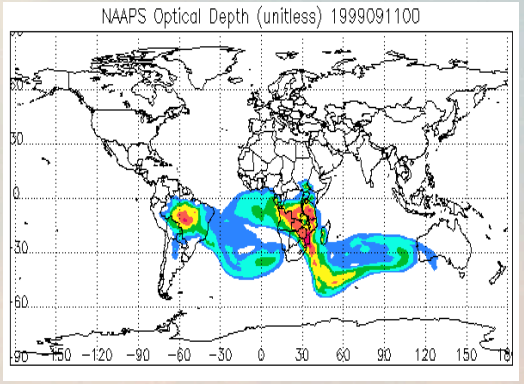


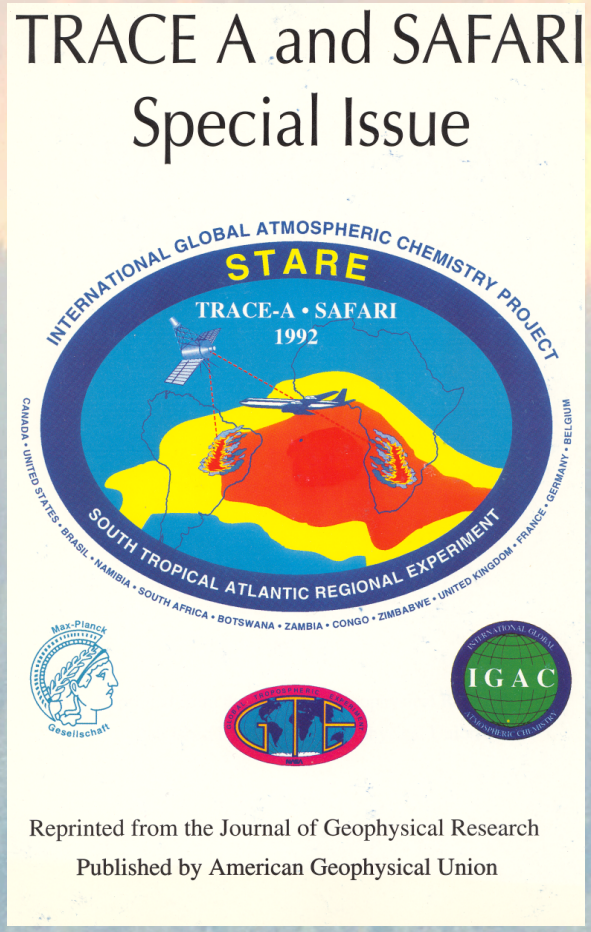




SAFARI-92

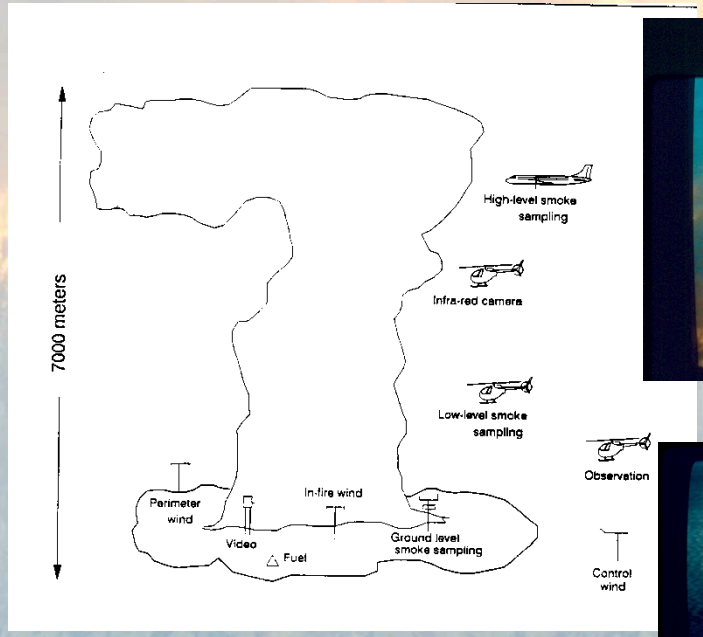
- Emphasis on tropical biomass burning/smoke chemistry and transport
- IGBP IGAC local-regional-international scale experiment (tropospheric aerosols)
- International/ interdisciplinary co-operation

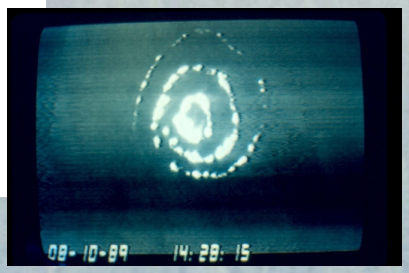


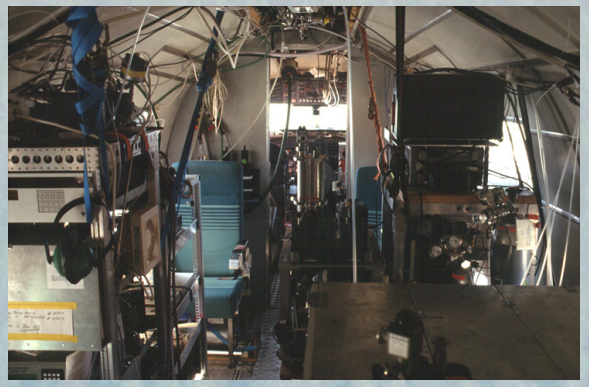


CDN Smoke Chemistry/Transport Studies

- Mass fire experiments (ON) in late 1980s
  - Tower, aircraft/helicopter sampling – chemistry, plume dynamics
- ICFME late 1990s - helicopter smoke sampling

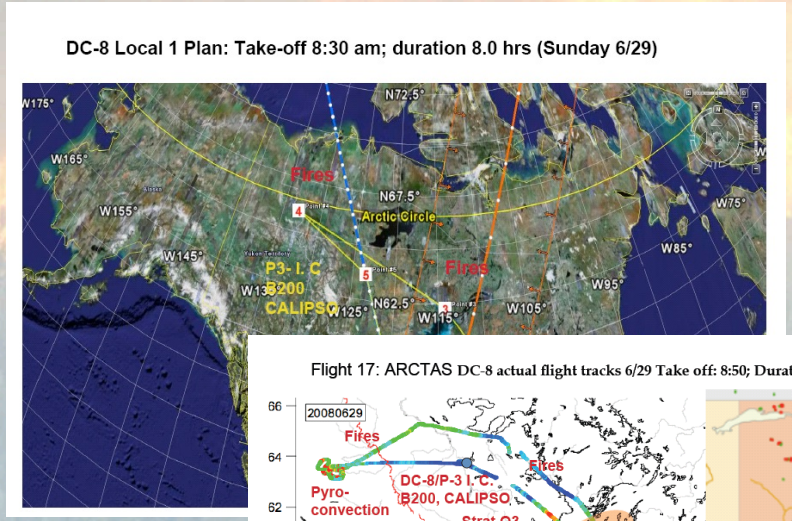


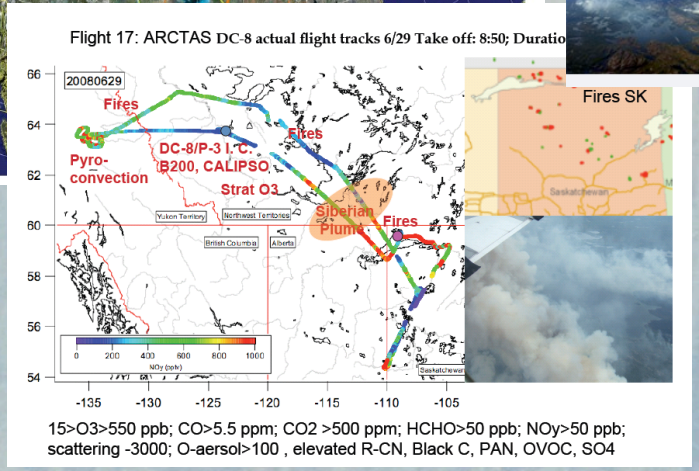


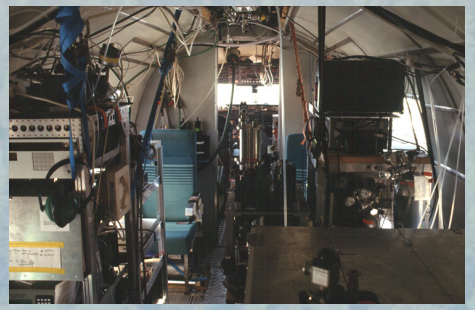


CDN Smoke Chemistry/Transport Studies

- ARCTAS 2008
  - Large NASA effort - smoke chemistry, plume dynamics, long-range transport
- BORTAS 2010 – UK aircraft, outflow over Atlantic

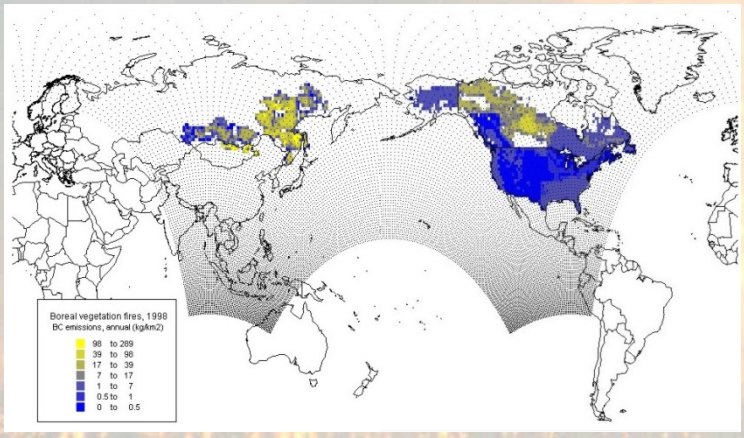


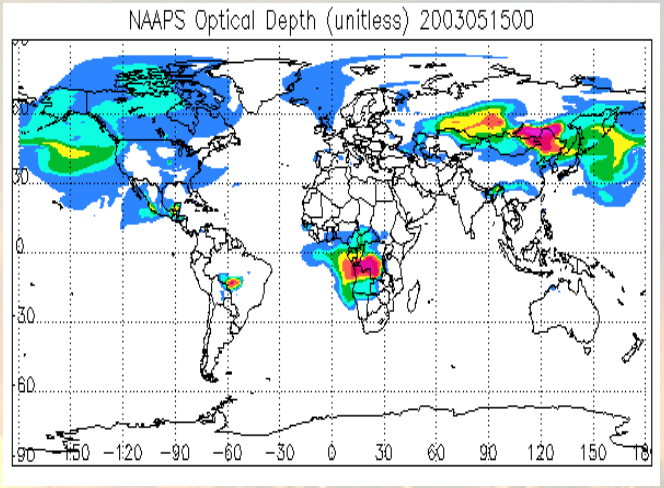




Smoke Transport From Russian 2003 Wildfires

Focus of numerous smoke transport Presentations at AGU in 2003

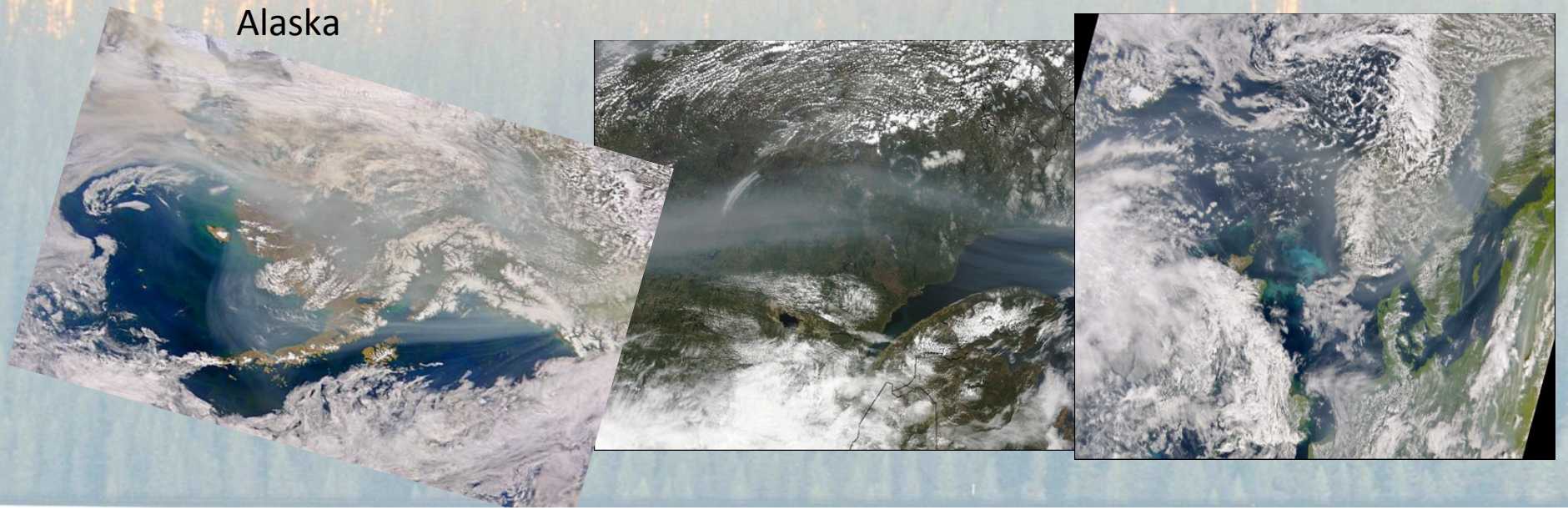




Finland

Eastern Canada

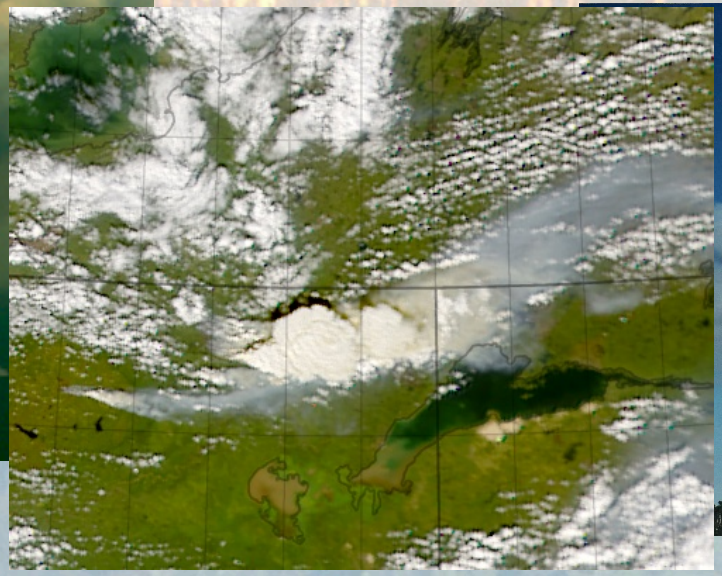
Alaska



Smoking Pyrocumulonimbus: Analysis of Two Major Canadian Boreal Fire Blowups from Satellite and Ground Measurements

Brian Stocks[1], Mike Fromm[2], René Servranckx[3], Steve Miller[4], Joe Turk[4], and David Diner[5]

[1] Canadian Forest Service, Sault Ste. Marie, ON
[2] Naval Research Laboratory, Washington, DC
[3] Canadian Meteorological Centre, Dorval, QC
[4] Naval Research Laboratory, Monterey, CA
[5] Jet Propulsion Laboratory, Pasadena, CA



AGU 2005 Fall Meeting – San Francisco, CA

Summary

- Smoke issue first gained widespread notice in Tropics with massive land-use change
- Initial international focus on smoke chemistry, transport and tropospheric ozone
- Now a growing issue in boreal and temperate zone countries
- Numerous international/interdisciplinary smoke experiments conducted in many regions globally - continuing.