Climate Change and Wildland Fire in Canada

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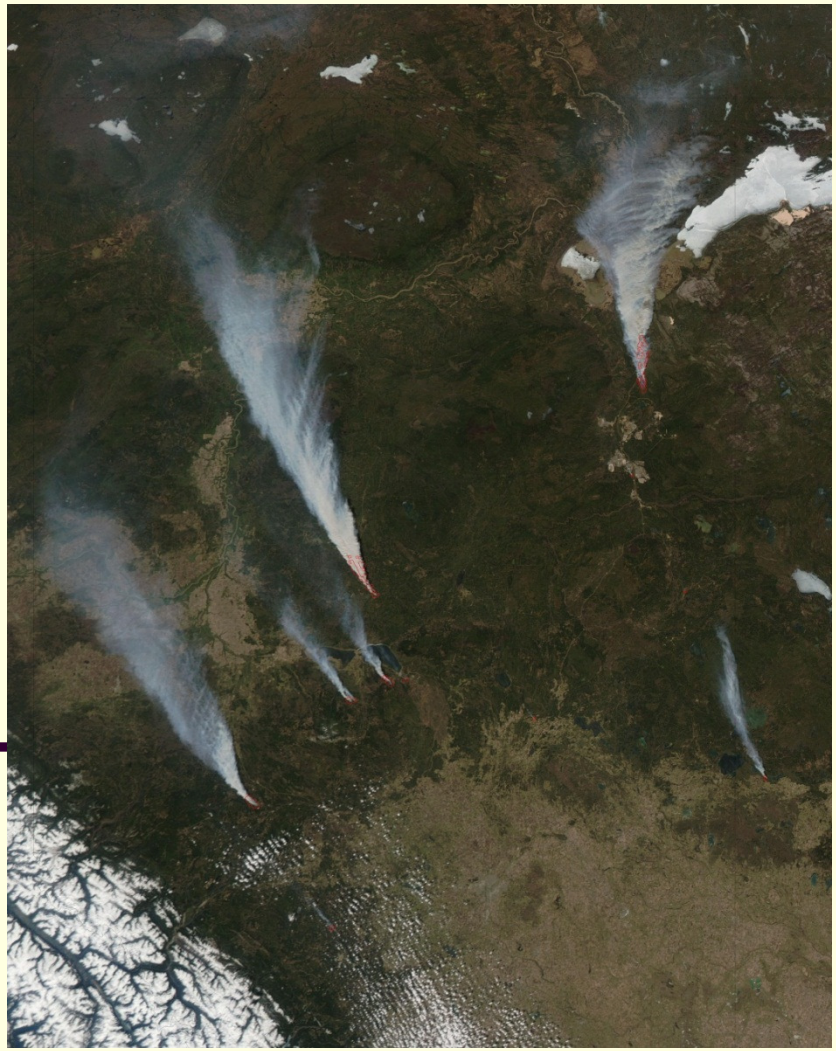
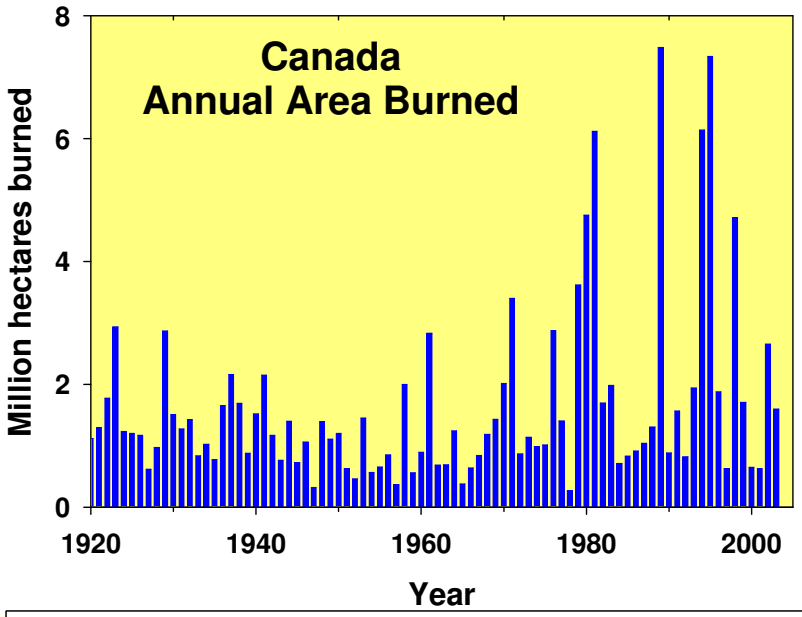
WESTERN PARTNERSHIP FOR WILDLAND FIRE SCIENCE

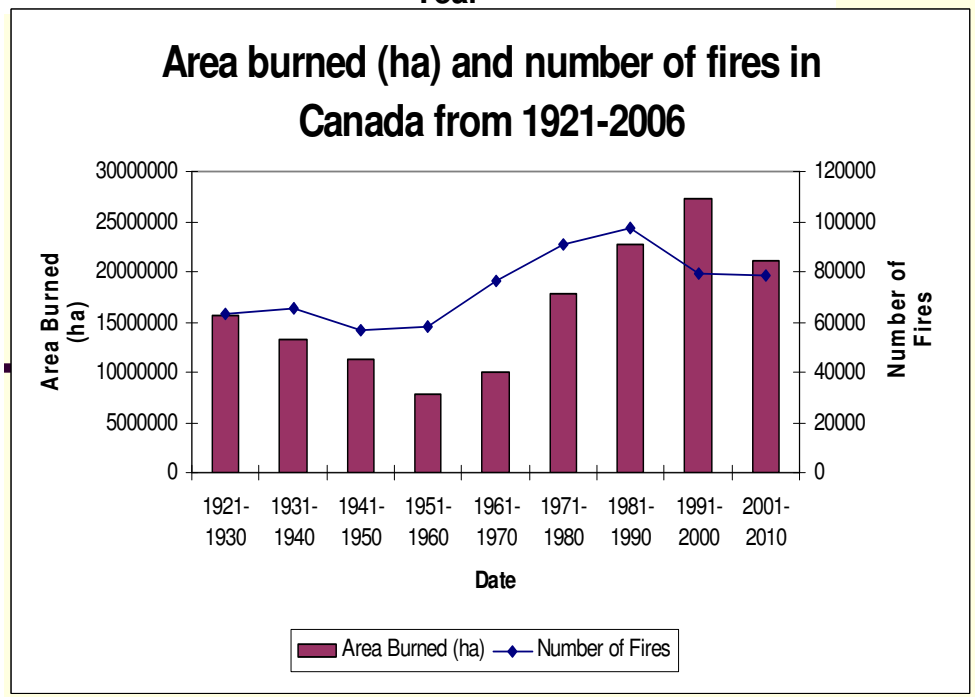
Outline



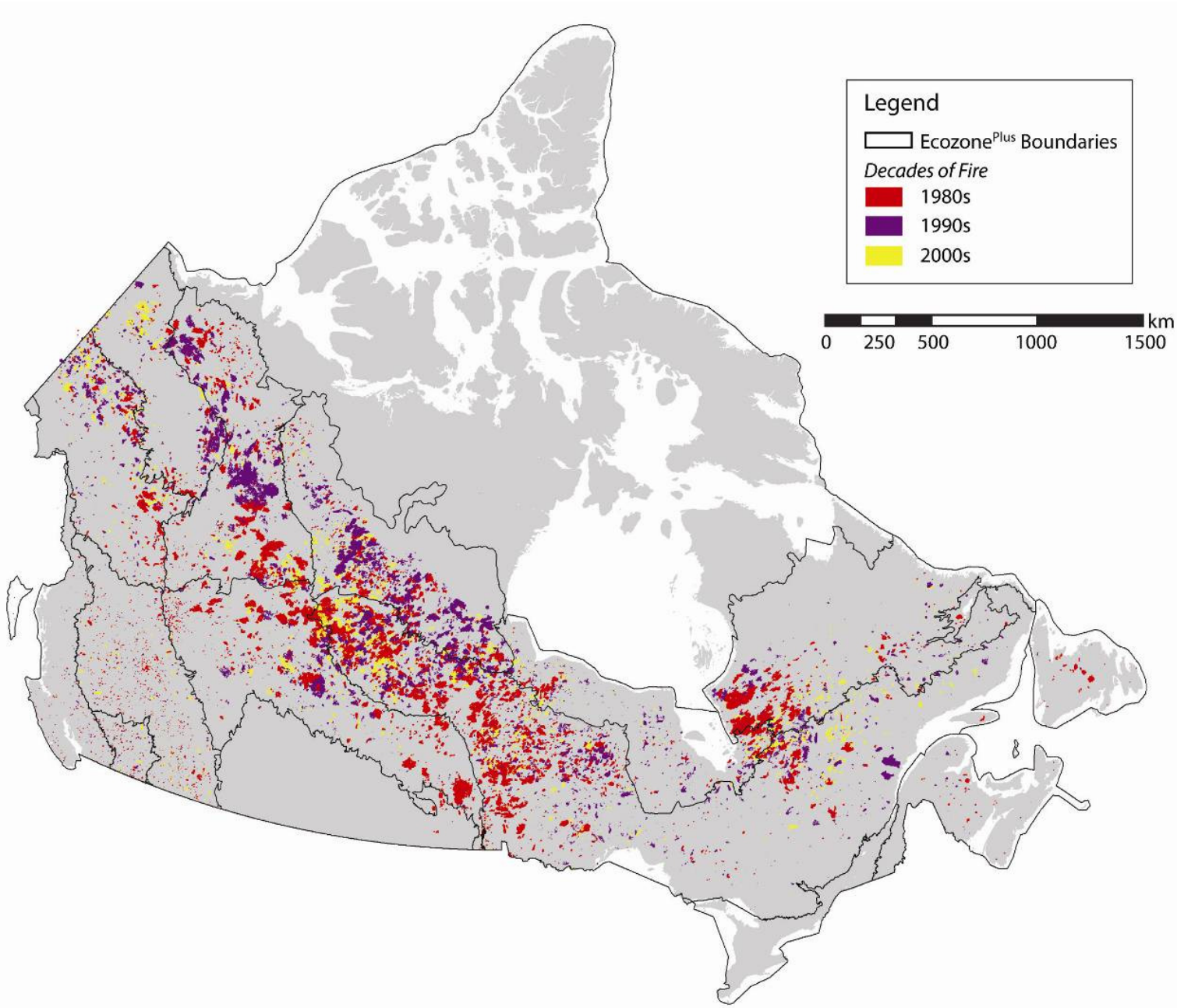
- Fire background
- Climate change
- Impacts of climate change on fire activity
- Options

Canadian Fire Statistics



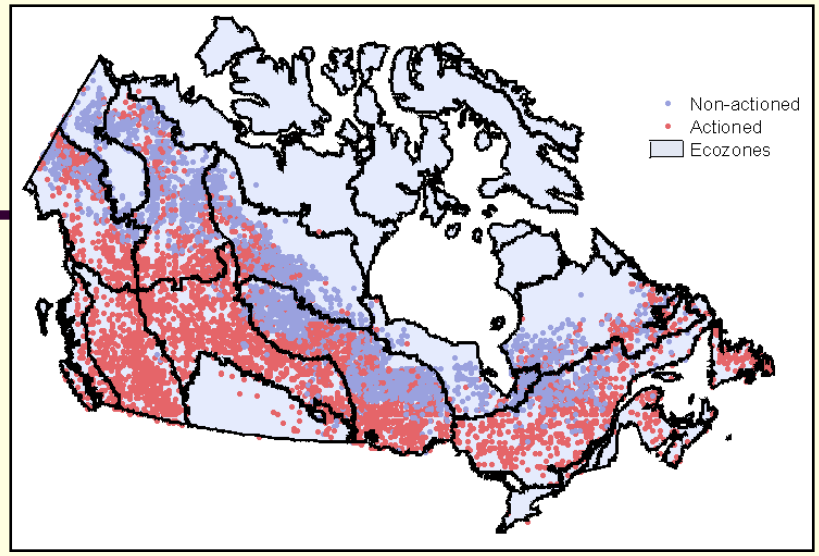


- Incomplete prior to 1970
- Currently - average of 9000 fires a year burn 2 million ha – 1 million ha in the early 70s (Alberta – nearly 1400 fires 130k ha)
- Primarily crown fires
- Area burned is highly episodic
  - 0.4 to 7.6 million ha
- Lightning fires
  - 35% of total fires
  - represent 85% of area burned
- Fire size
  - 3% of fires are >200 ha
  - represent 97% of area burned



The distribution of large fires across Canada, 1980s to 2000s.
Each colour represents the fires in the corresponding decade (1980s to 2000s).
The 2000 decade includes only data from 2000-2007

Fire Issues



- An average of $800 million spent by fire management agencies in Canada a year on direct fire fighting costs
- Health and safety of Canadians – evacuations – smoke (mercury)
- Property and timber losses due to fire
- Balancing the positive and negative aspects of fire
- Traditional approaches to fire suppression (e.g., crews, air tankers) are reaching their limit of economic and physical effectiveness
- International Agreements carbon and biodiversity

Wildland Urban Interface

- On average a total of 5500 people are evacuated from 10 communities per year
- On average 20 communities with about 70000 people are threatened by large fires each year
- Reasons for evacuations
  - Threat life/property 62%
  - Smoke and health 14%
  - Transportation 3%
  - Unknown 21%

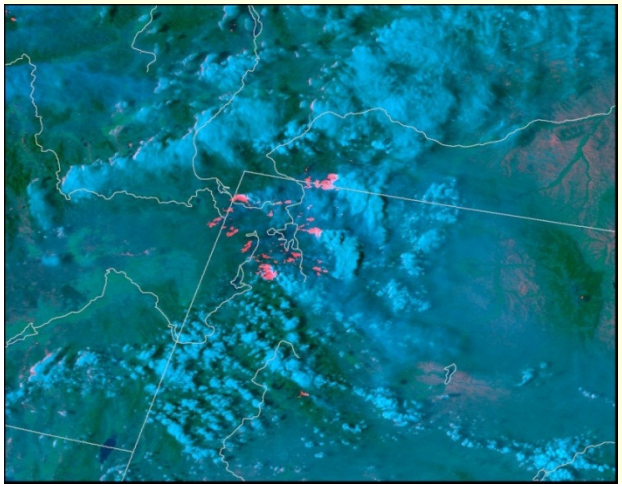
Forest Fires – 4 Key Factors

- Fuel - loading, moisture, structure etc.
- Ignition - human and lightning
- Weather - temperature, precipitation atmospheric moisture and wind; upper atmospheric conditions (blocking ridges)
- Humans - land use, fragmentation, fire management etc.

Fires -Key Factors Part 2

- Weather is a component in all 3 natural factors – fuel, ignitions (Lightning) -.
- Options -Weather – we can't control; only options are fuel and human-caused fire ignitions
- Prevention – education, restricted fire zones, reduce or eliminate industrial activity during periods of high fire danger
- Fuel – modifications – fuel break,reduce fuel load or change fuel type either at the landscape level (strategically) or areas of high value (e.g., communities)
- Response – sprinklers should be part of the process

Fire – Climate Interactions

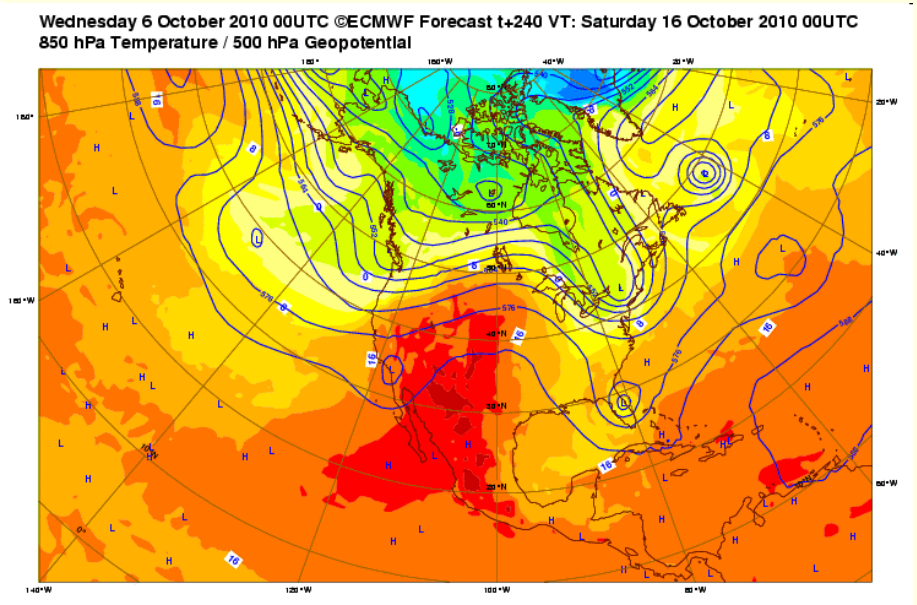


- There are definite linkages between sea surface temperatures and patterns and fire activity at scales of 2-50 years
- Understanding these relationships will help for seasonal forecasts as well as multi-year forecasts
- Climate oscillations/patterns such as ENSO, PDO, AO and AMO influence climate and weather and thereby fire activity
- Just starting to understand the relationships – interactions between these processes

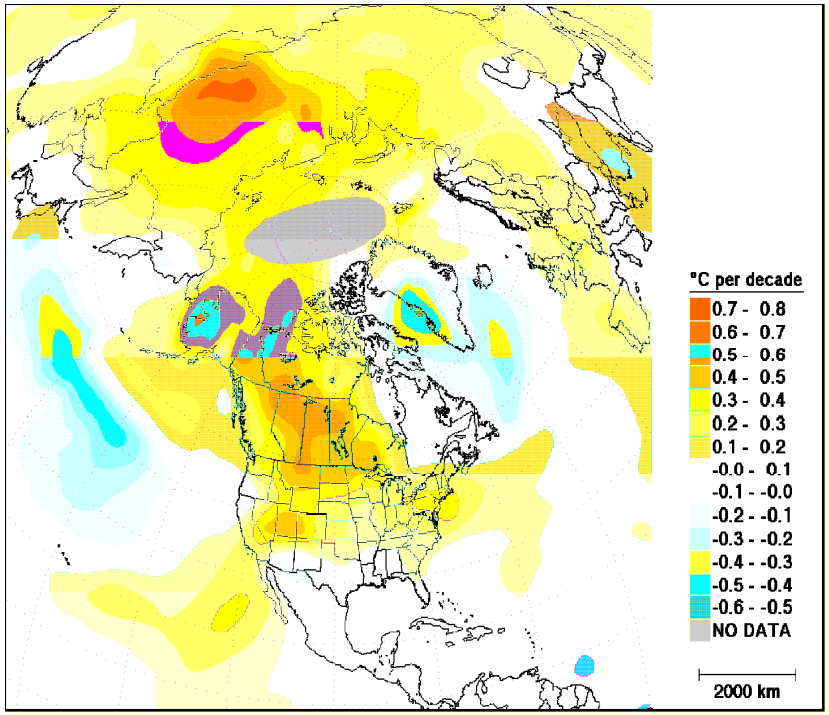
Beverly, J.L. Flannigan, M.D. Stocks, B.J. and Bothwell, P. 2011. The association between Northern Hemisphere climate patterns and interannual variability in Canadian wildfire activity. Canadian Journal of Forest Research. Accepted.

Shabbar, A., Skinner, W. and Flannigan, M. 2011. Prediction of Seasonal Forest Fire Severity in Canada from Large-Scale Climate Patterns. Journal of Applied Meteorology and Climatology. 50:785-799.

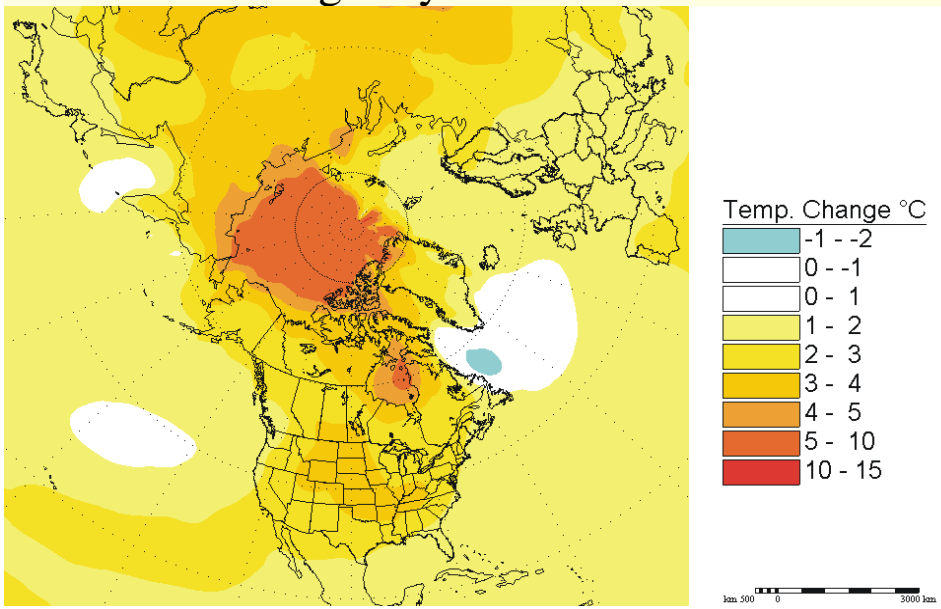
Blocking (Stationary) Ridges



- Important to fire activity because descending air associated with upper ridges -warm/hot, sunny and dry conditions
- Last 7- 10 days or more and allows the forest fuels to dry out (FFMC and DMC to increase significantly)
- When the upper ridge breaks down there can be thunderstorms with strong gusty winds and often have a change in wind direction
- Models suggest that in the future there will be stronger blocking ridges that may last longer than present day



Observations above – temperature changes by 2050 below



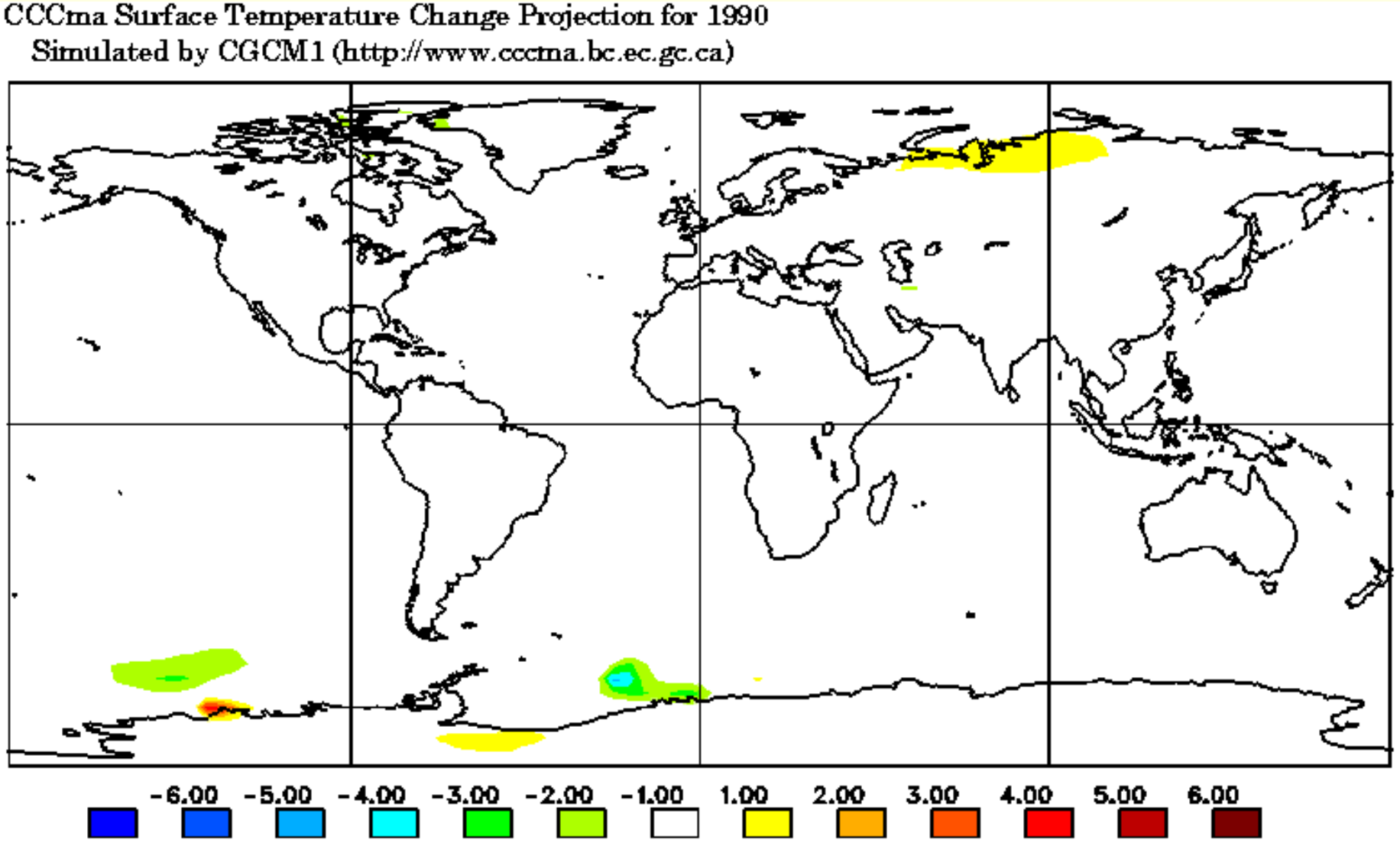
Climate Change Projections

- GCMs project 1.4 – 5.8^0 C increase in global mean temperature by 2100
- Greatest increases will be at high latitudes, over land and winter/spring
- Projected increases in extreme weather(e.g., heat waves, drought, floods, wind storms and ice storms)
- Observed increases across west-central Canada and Siberia over past 40 years

Variability

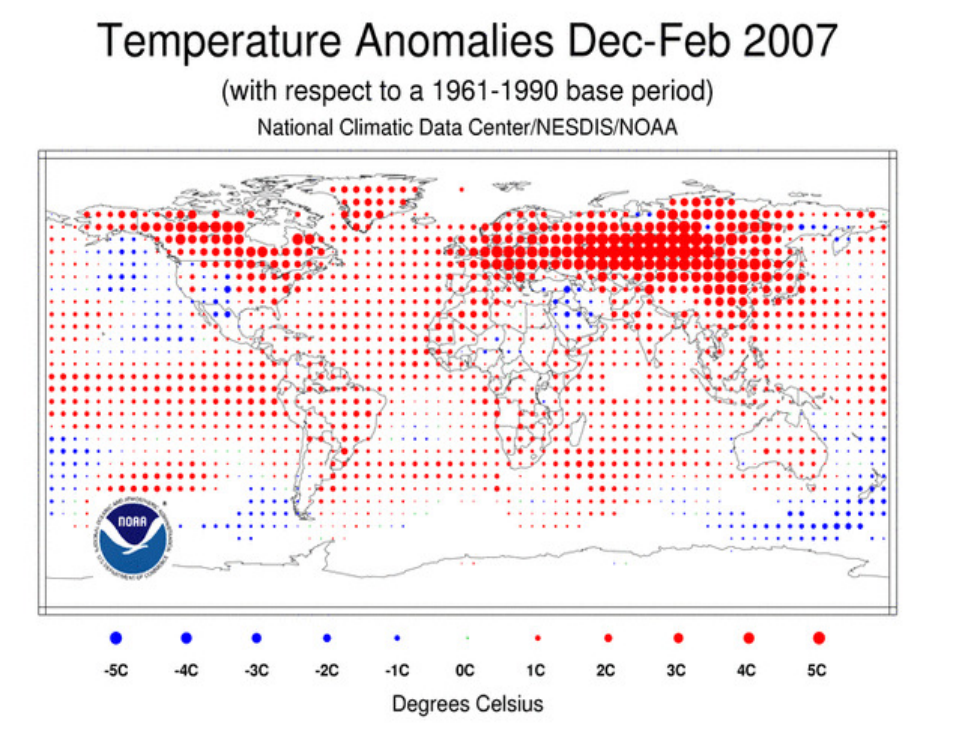
- Variability – a real problem for fire with respect to extremes – a few critical days are responsible for most of the area burned
- Fire then flood
- Flood then fire
- Wind – average unchanged but more variable

Projected temperature changes vary considerably from year to year

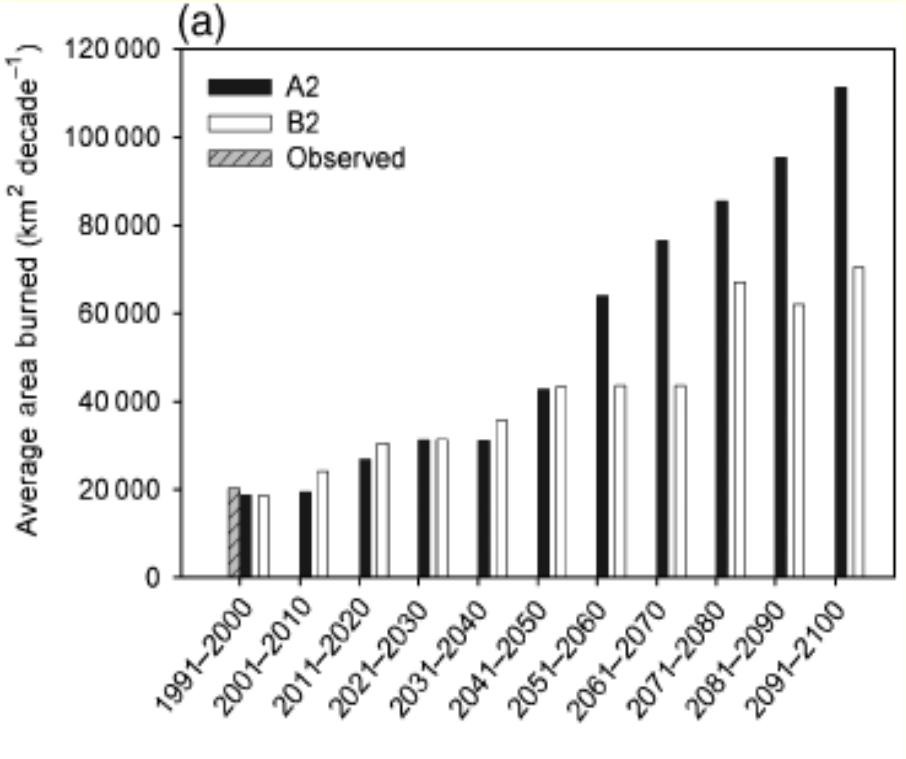


Fire & Temperature

- Key variable in fire activity for 3 reasons
- First, the amount of moisture the atmosphere can hold is highly sensitive to temperature. This drives fuel moisture; if temperature increases then significant increases in precipitation are needed to compensate.
- Second, temperature has a strong positive correlation with lightning…the warmer it is the more lightning we have.
- Third, the warmer it is the longer the fire season; particularly important at high northern latitudes.



Area Burned – Alaska W. Canada



- Predicted mean annual area burned (km^2/yr) per decade for Alaska and western Canada driven (by the NCEP model development datasets(1990–2005) and the CGCM2 A2 and B2 climate scenarios (2006–2100).

Balshi, M et al. 2008. Modeling historical and future area burned of western boreal North America using a Multivariate Adaptive Regression Splines (MARS) approach. Global Change Biology. DOI: 10.1111/j.1365-2486.2008.01679.x.

Future Fire

- Changes in climate (including warmer temperatures, changes in precipitation, atmospheric moisture, wind, and cloudiness) affect wildfires
- Direct, indirect, and interactive effects of weather/climate, fuels, and people will determine future fire activity

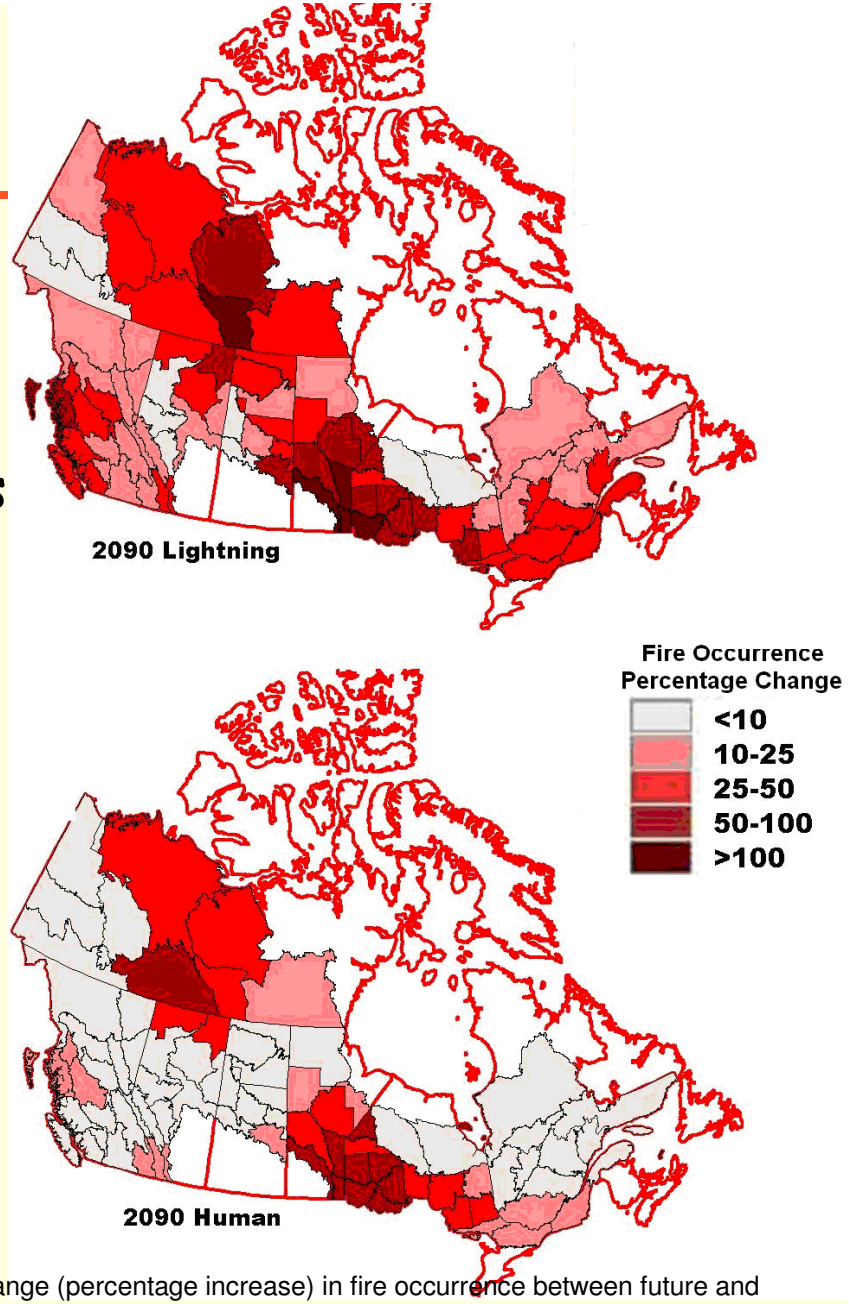
Area burned

Fire occurrence

Fire season

Fire intensity

Fire severity



Relative change (percentage increase) in fire occurrence between future and baseline scenarios for the Canadian Climate Centre GCM. Relative change is given as the percentage increase in number of fires predicted by the GCM (future scenario minus baseline scenario) divided by the total number of fires in the baseline scenario (i.e., (N2020-2040 – N1975-1995)/ N1975-1995); "no data" is shown in white.

Flannigan, M.D., Krawchuk, M.A., de Groot, W.J., Wotton, B.M. and Gowman, L.M. (2009). Implications of changing climate for global wildland fire. *International Journal of Wildland Fire*,18, 483-507.

Wotton, B.M., Nock, C.A. and Flannigan, M.D. (2010). Forest fire occurrence and climate change in Canada. *International Journal of Wildland Fire*,19,253-271.

Fire and Carbon

Fire plays a major role in carbon dynamics: it can determine the magnitude of net biome productivity

1) combustion: *direct loss*

2) decomposition of fire-killed vegetation

3) Change in vegetation type : *different sink potential when there is a change in vegetation type. Example forest stand renewal – young successional stands have potential to be greater sinks than mature stagnant forests*

The role of Peat

- 700 Pg carbon stored in the boreal forest ~30-35 % of the global terrestrial biosphere.. peat is a major component.

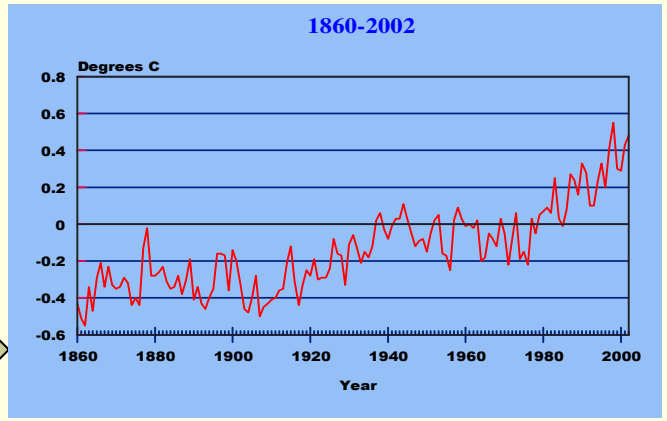
- Climate change will mean the melting of permafrost, more droughts which suggest peat fires will be more common.

-Peat fires can release significant amounts of GHGs for example peat fires in Indonesia during 1997 released the equivalent of 20-50% of global fossil fuel emissions. Peat in the boreal dwarfs the amount of peat in tropical regions

-Difficult to extinguish; can burn through winter under the right conditions

Fire and Weather Feedbacks: *potentially positive*

Fossil Fuel emissions: increase greenhouse gases



Cause warmer conditions

Weather becomes more conducive to fire: more fire

Carbon released from more fire enhances greenhouse gases further

Options and Adaptations

- Health and safety of Canadians through improved fire weather and fire behaviour systems. The Canadian Forest Fire Danger Rating System is used across Canada and in many parts of the world.
- Adaptation options for fire management agencies with respect to climate change altered fire regimes including community protection
- Inputs for decisions on International Agreements – forest fire is a critical element in determining if our forests are carbon sinks or sources?

Options and Adaptations - 2

- Protecting buildings and communities
- FireSmart programs aimed at reducing risk to your property and communities
- Building materials – landscaping; defensible space helps but spotting appears to be the problem
- Treating fuels near communities – removing fuel, changing fuel type from conifer to deciduous, sprinklers
- More people living and working in the forest – risk will increase
- http://partnersinprotection.ab.ca/

Summary

- Fire and weather/climate are strongly linked

- A warmer world will have more fire - Changes in forest fires may be the greatest early impact of climate change on forests

- Increased risk in the future due to increased exposure and increased fire activity

- There will be more incidents like Slave Lake and Kelowna in the future

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