Wildland Fire and Climate Change

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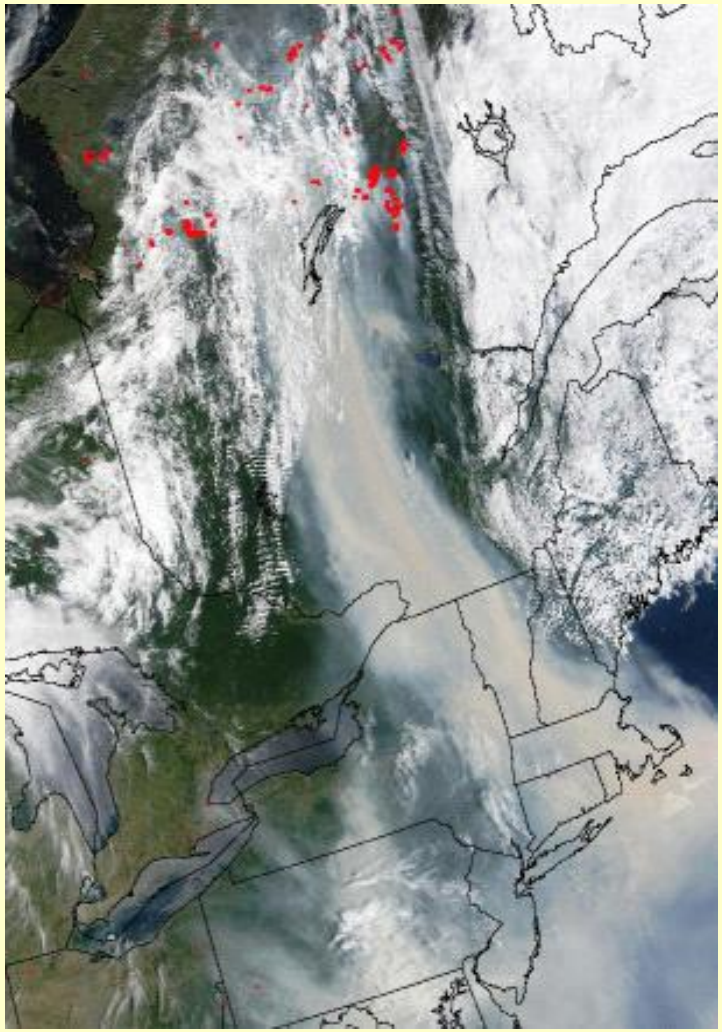
WESTERN PARTNERSHIP FOR
WILDLAND FIRE SCIENCE

Outline

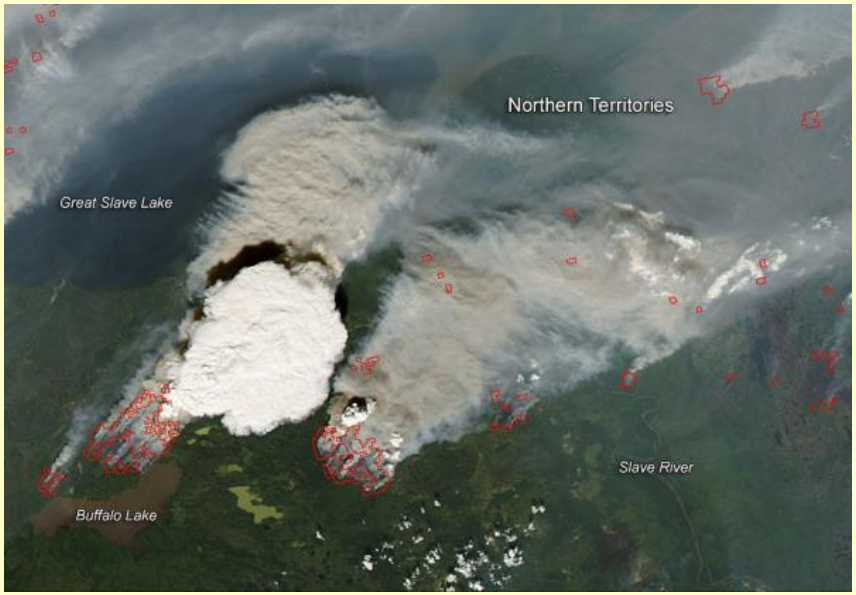


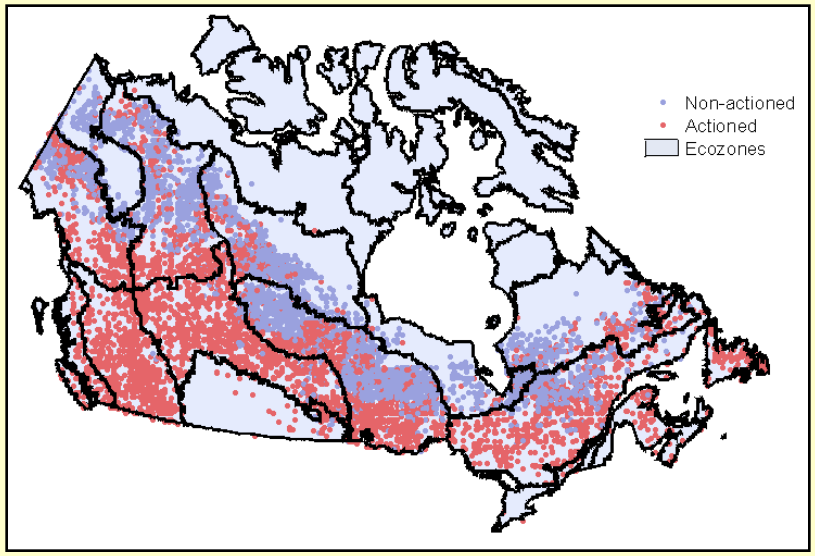
- **Fire background**
- **Climate change**
- **Implications of climate change on wildland fire**

Global Wildland Fire

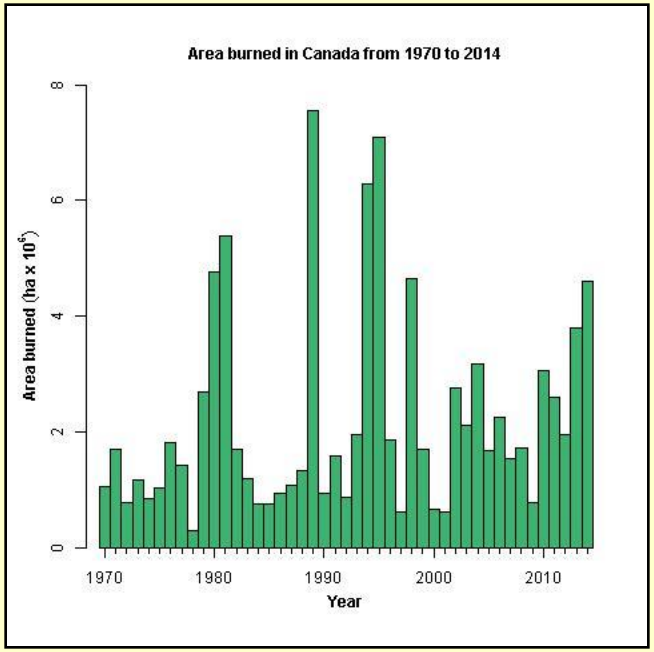
- On average about 350-450 M Ha burn every year. Larger than the size of India
- No idea as to how many fire starts though people are probably responsible for about 90% of the starts
- Largest area burned is in grasslands and savannas
- Fire is a necessary component in some ecosystems

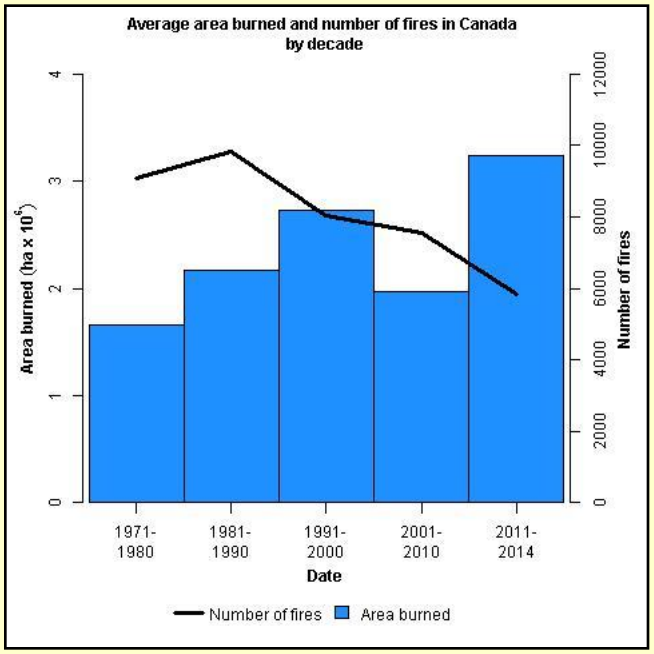
Fire Issues





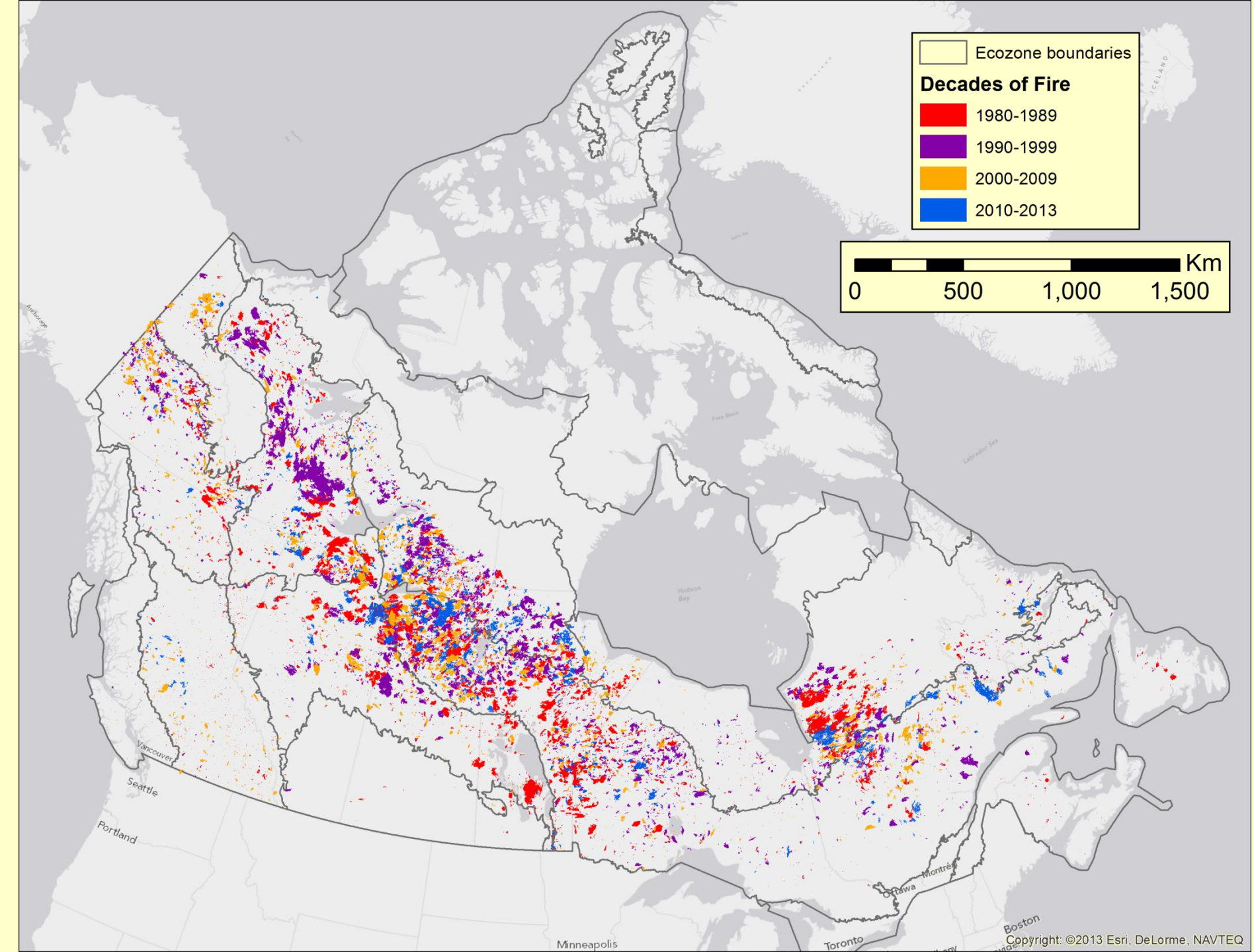
- An average of $800 million spent by fire management agencies in Canada a year on direct fire fighting costs
- Health and safety – evacuations, impacts on economic activity – smoke
- Property and timber losses due to fire
- Balancing the positive and negative aspects of fire
- Traditional approaches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





Canadian Fire Statistics

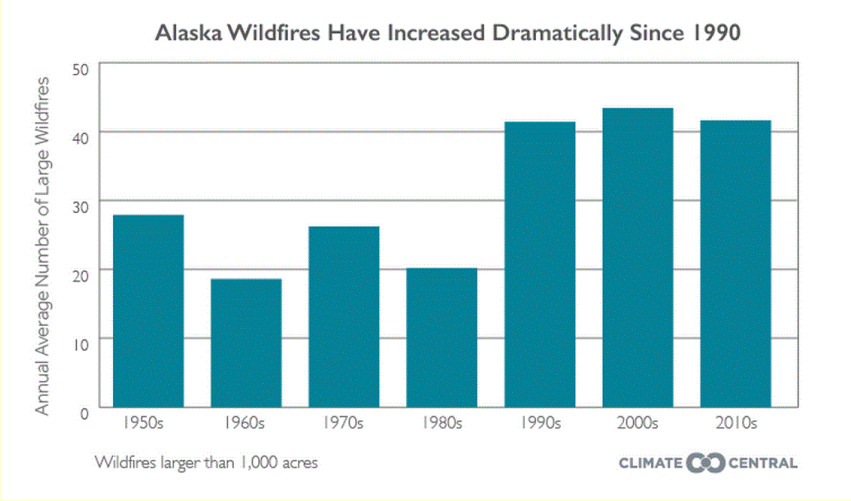
- Incomplete prior to 1970
- Currently - average of 8000 fires a year burn 2 million ha – 1 million ha in the early 70s
- Primarily crown fires
- Area burned is highly episodic
  - 0.4 to 7.6 million ha
- Lightning fires
  - 35% of total fires
  - represent 85% of area burned
- Fire size
  - 3% of fires are >200 ha
  - represent 97% of area burned


Ecozone boundaries
Decades of Fire
1980-1989
1990-1999
2000-2009
2010-2013
Km
0
500
1,000
1,500
Vancouver
Seattle
Portland
Minneapolis
Toronto
Ottawa
Montréal
Boston
Copyright: ©2013 Esri, DeLorme, NAVTEQ

Fire Impacts

- Location, location location
- Australia 2009, 2013 Russia 2010, USA 2011-2013, Quebec 2013, Sweden and BC,NT 2014, AK &SK 2015
- Slave Lake May 2011
- Smoke related fatalities estimated at 330,000 per year

Fire in Alaska

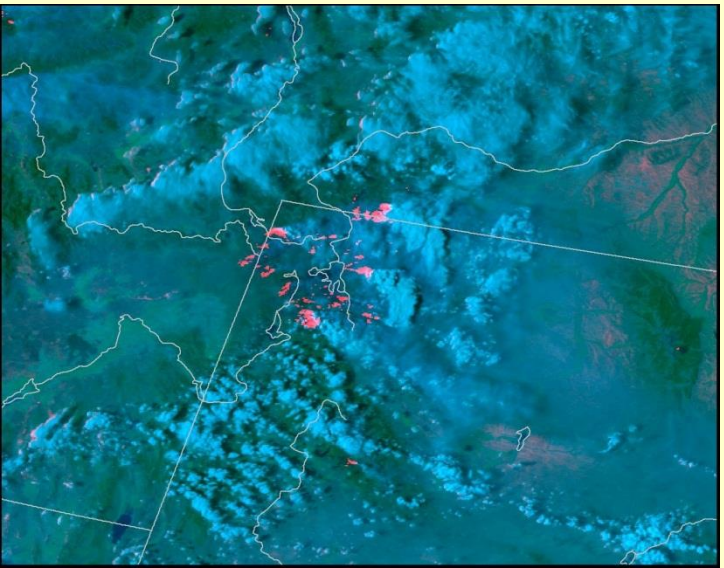


- 2015 over 700 fires have 4.75 Million acres

http://www.climatecentral.org/news/alaska-entering-new-era-for-wildfires-19146

Fire Ecology

- Boreal forests survive and even thrive in semi-regular high intensity fires (stand renewal)
- Removes competition
- Allows sunlight to reach the forest floor
- Prepares seedbed
- Survival strategies - Cone serotiny, vegetative reproduction and bark thickness
- Standard climax succession models not applicable to much of the boreal - WYSIWYG applies
- Disturbances like fire help shape the composition and biodiversity of our forests

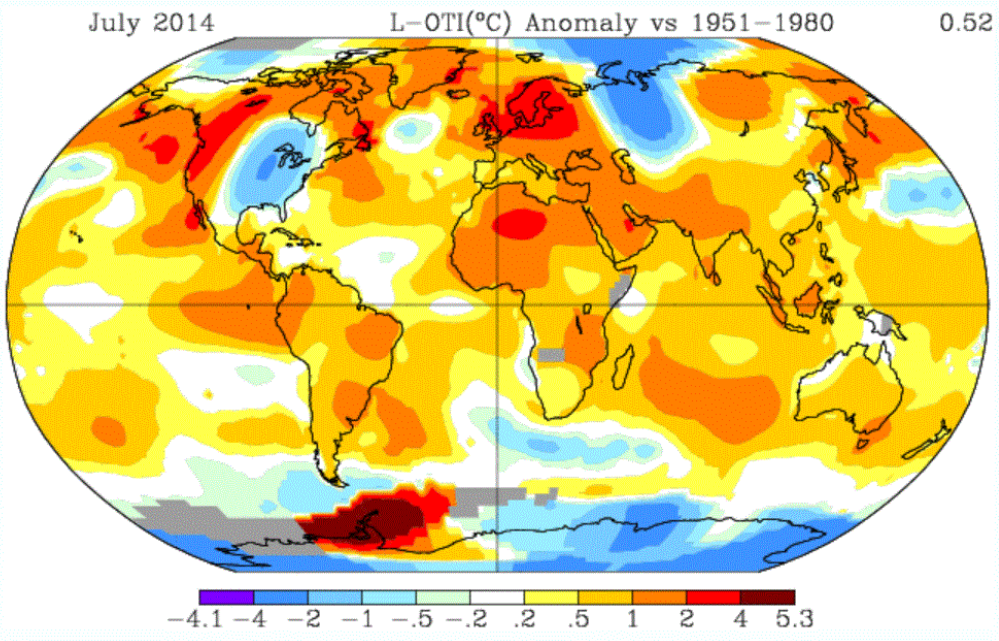


Forest Fires – 4 Key Factors

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

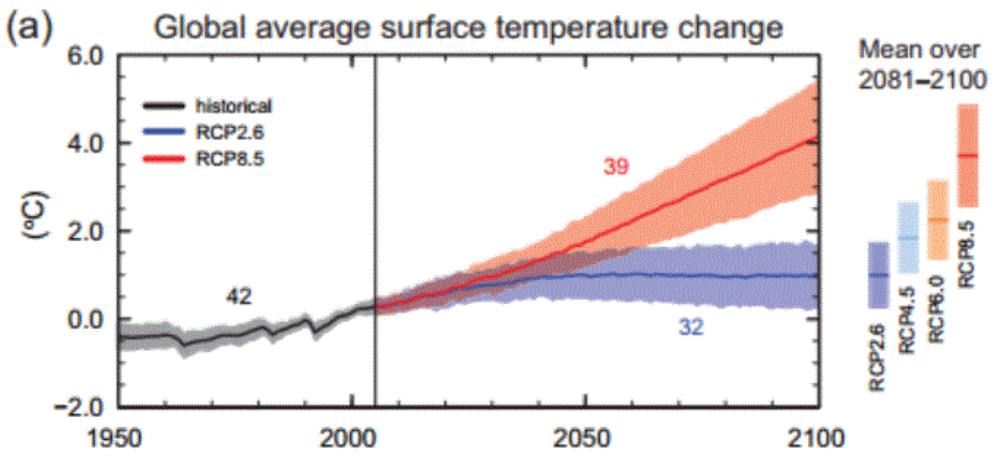
Fires -Key Factors Part 2

- 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, enforcement
- 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)

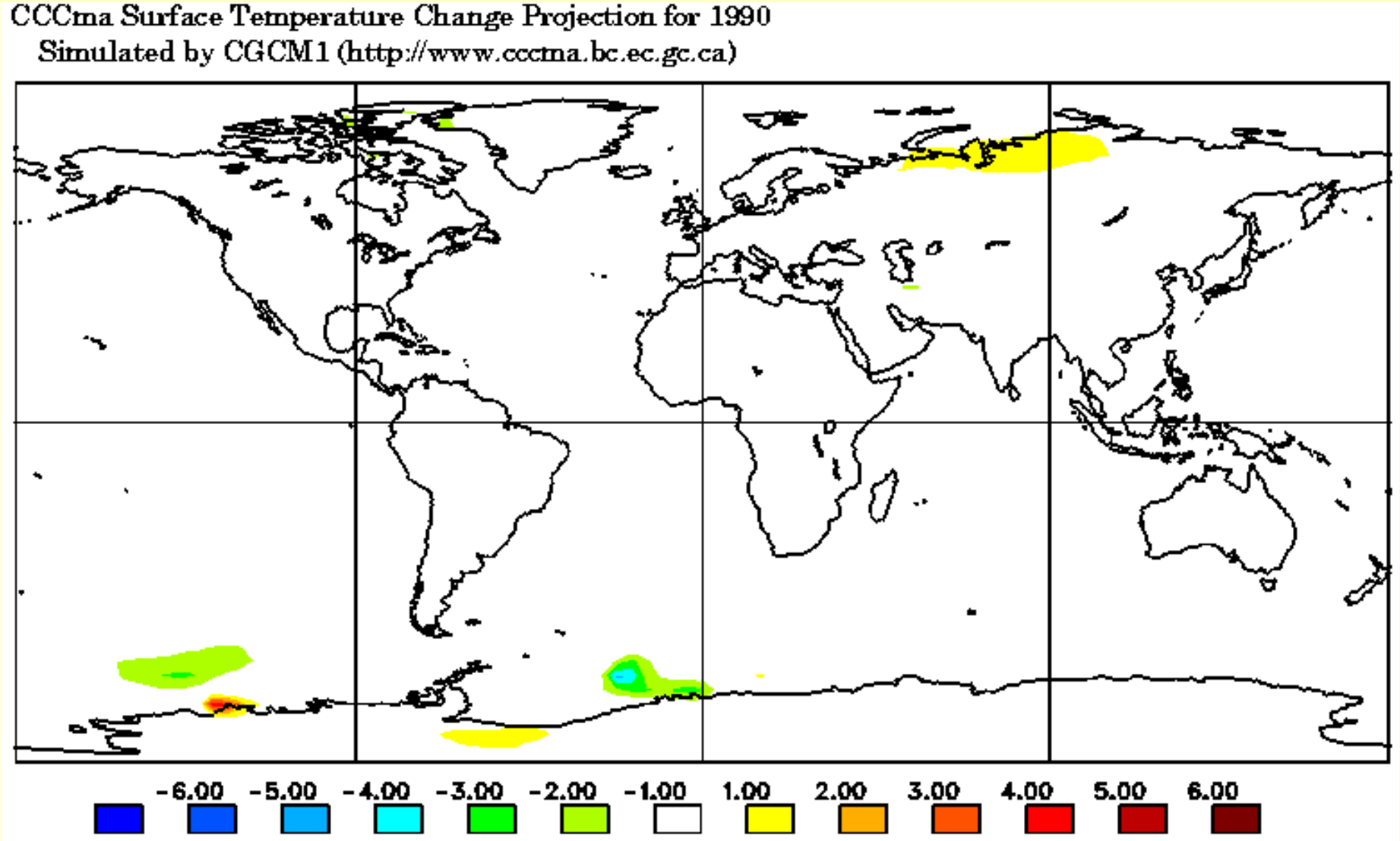


Climate Change Projections

- GCMs project up to a 6^0 C increase in global mean temperature by 2100
- Greatest increases will be at high latitudes, over land and winter/spring except the Arctic Ocean when seasonally ice-free
- Projected increases in extreme weather(e.g., heat waves, drought, floods, wind storms and ice storms)

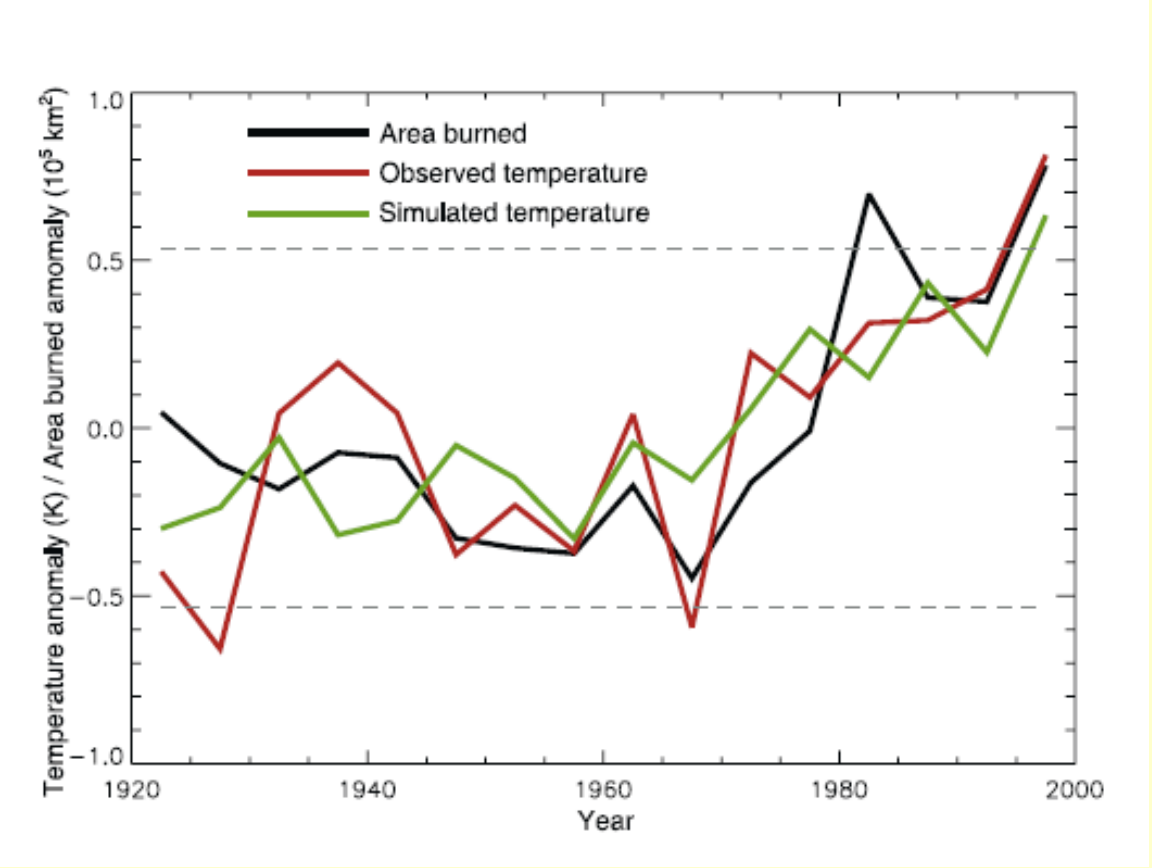


Projected temperature changes vary considerably from year to year



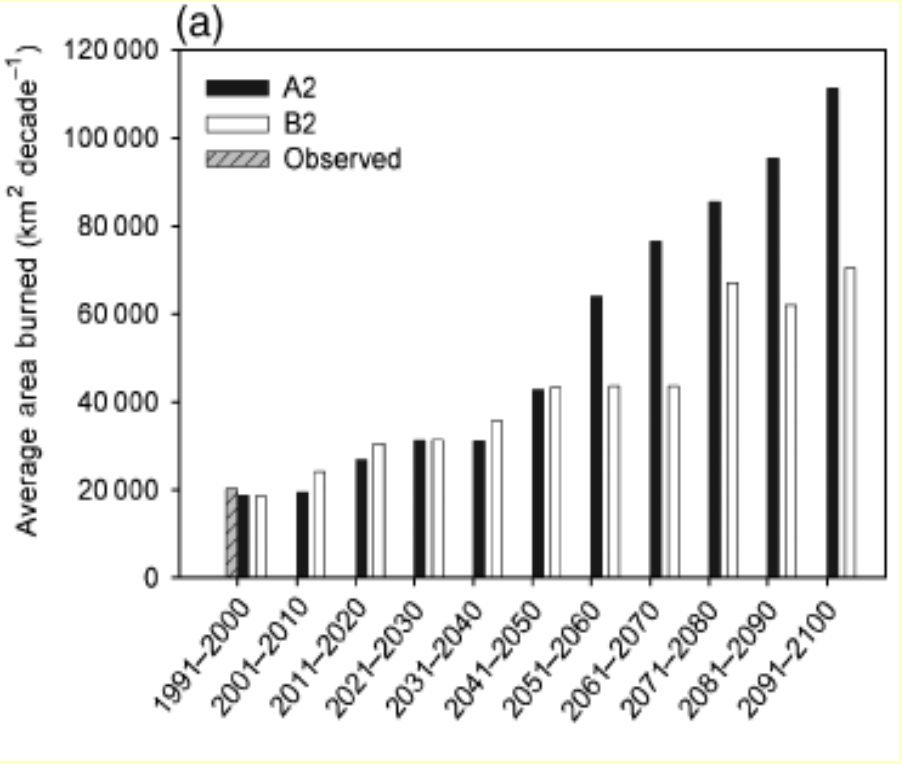
Trend Observations

- Is area burned correlated with increasing temperature?
- Is this caused by anthropogenic effects?



Gillett, N.P.et al. 2004. Detecting the effect of climate change on Canadian forest fires. Geophysical Research Letters. 31(18), L18211, doi:10.1029/2004GL020876.

Area Burned – Alaska W. Canada

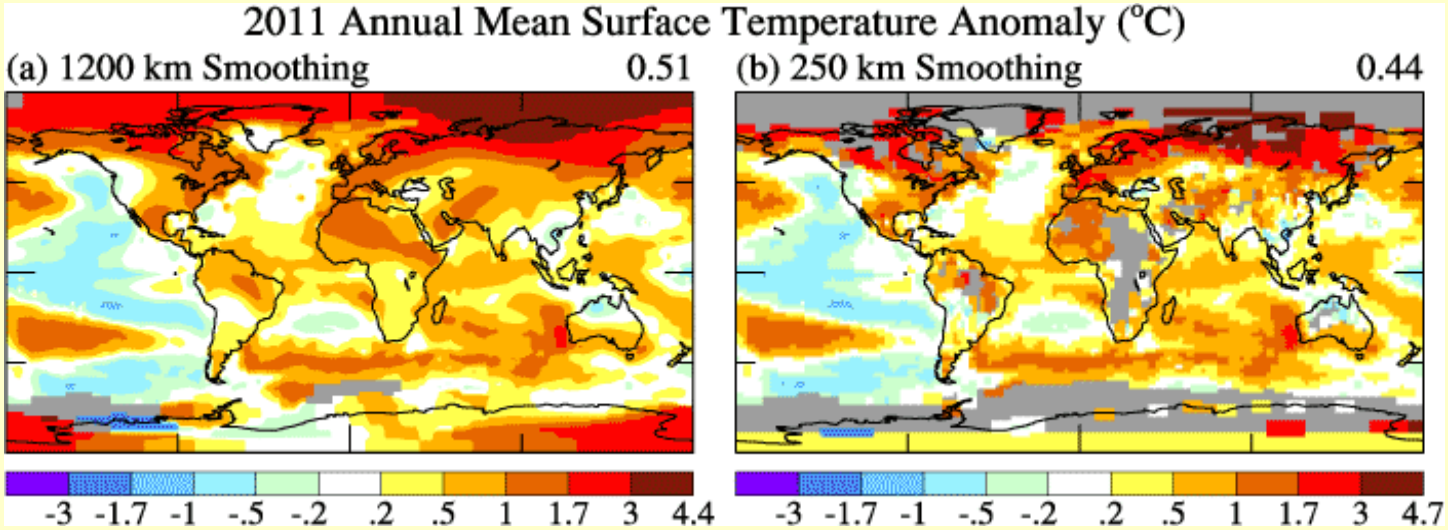


- Predicted mean annual area burned (km^2/yr) per decade for Alaska and western Canada driven by the NCEP model development datasets(1990–2005) and the CGCM2 A2 and B2 climate scenarios (2006–2100).

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.

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 Approx. 15% increase.in prec. for every degree of warming
- 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.



Parisien, M-A., Parks, S.A., Krawchuk, M.A., Flannigan, M.D., Bowman, L.M., and Moritz, M.A. (2011). Scale-dependent controls on the area burned in the boreal forest of Canada, 1980-2005. *Ecological Applications* 21: 789-805.

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

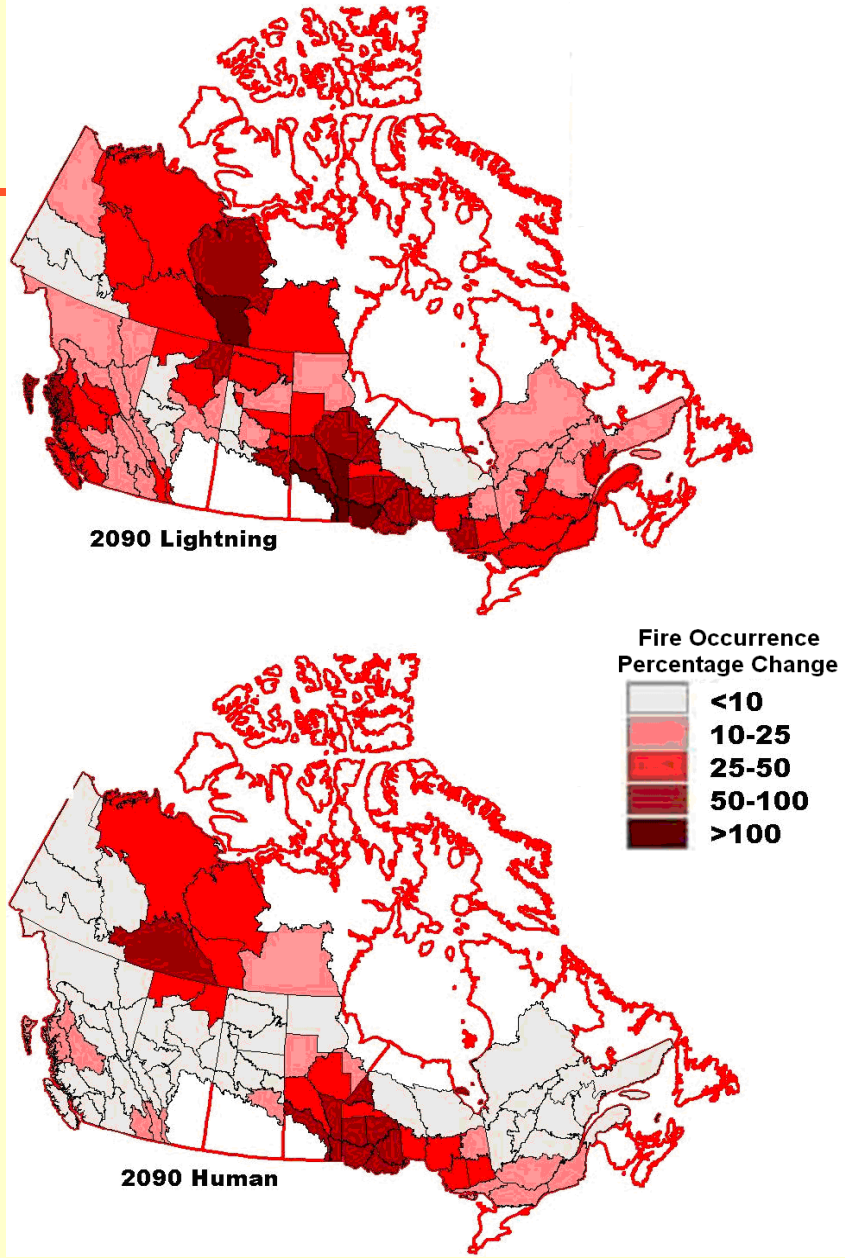
  Area burned

  Fire occurrence

  Fire season

  Fire intensity

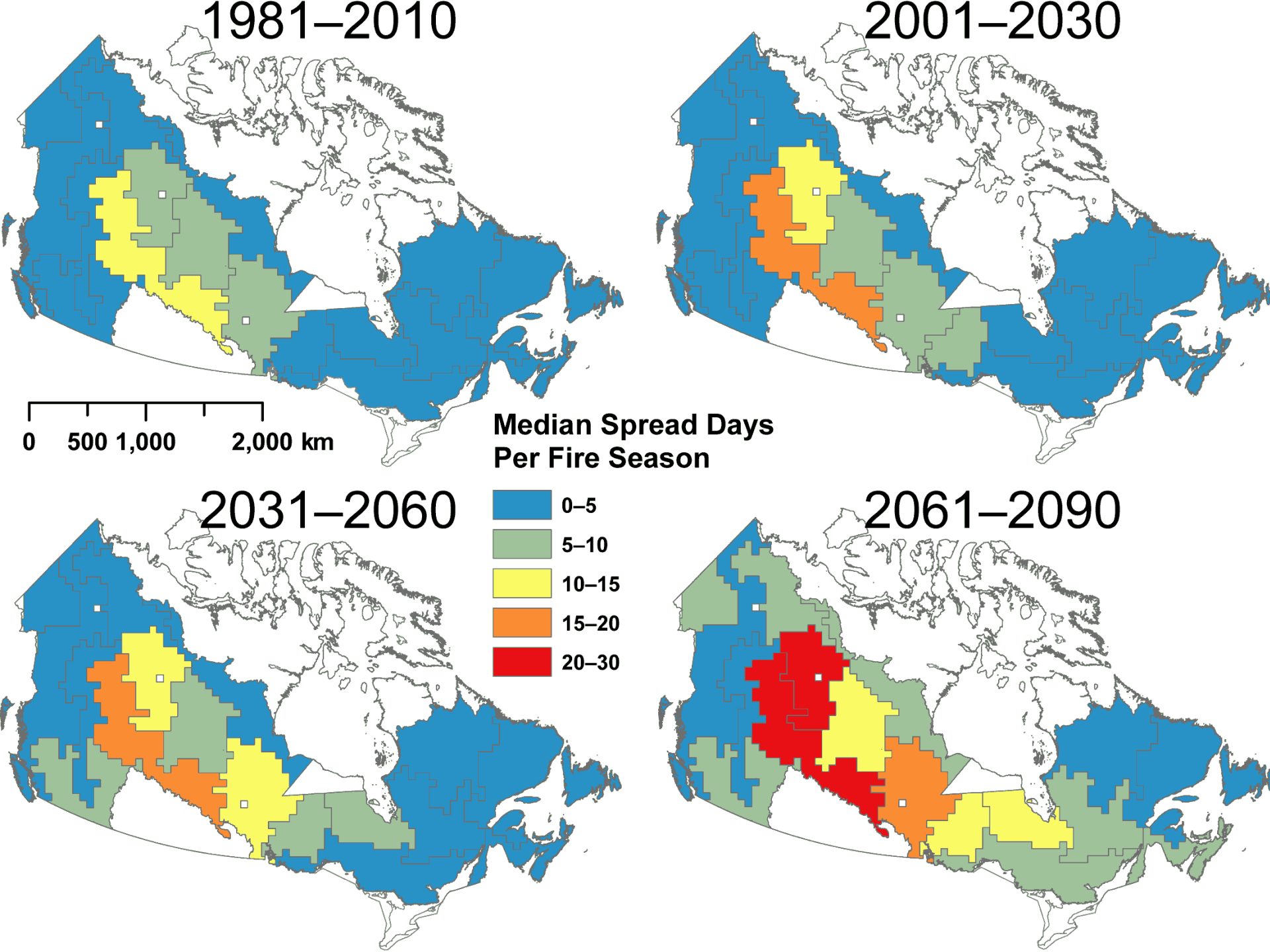
  Fire severity



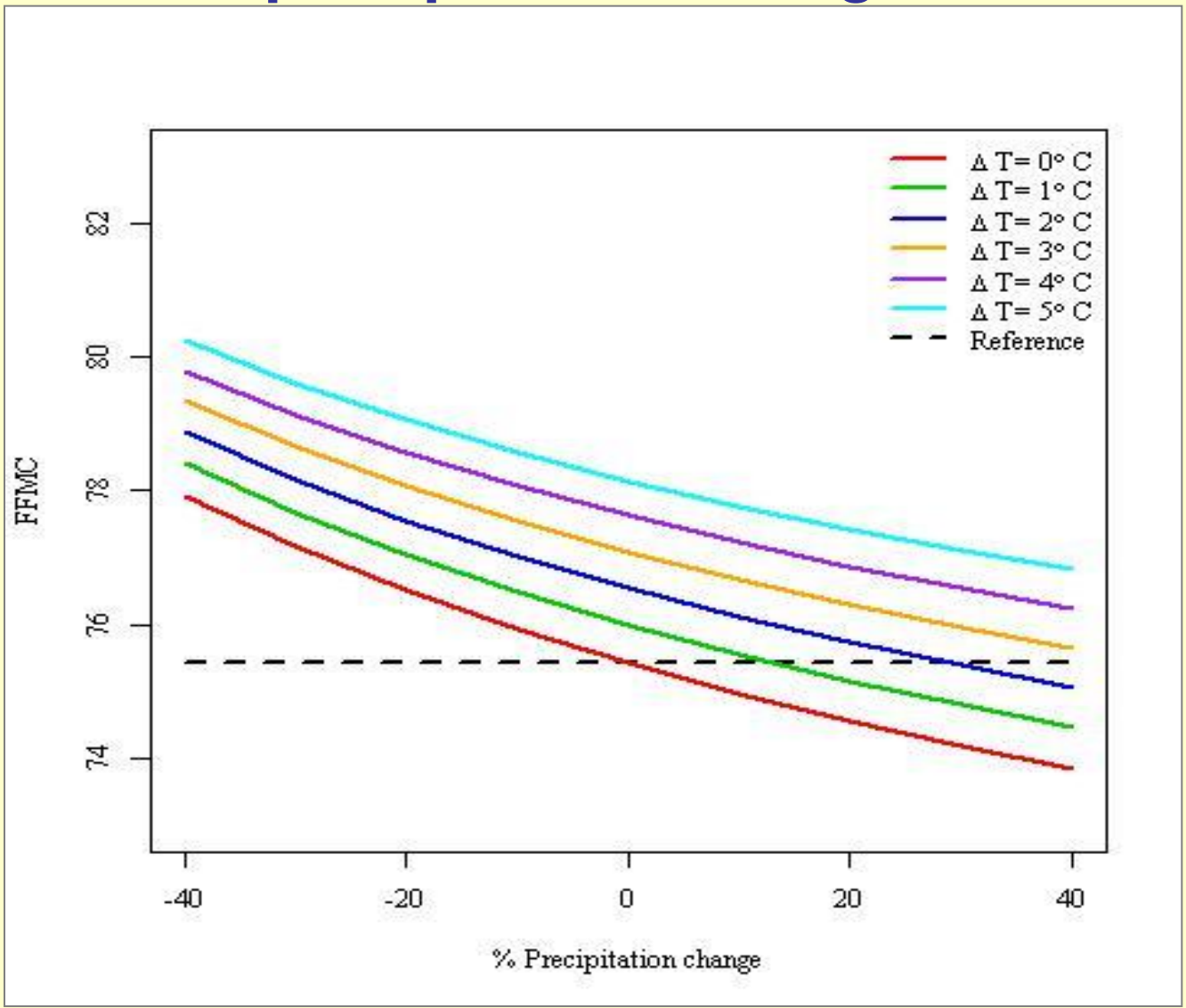
Relative change (percentage increase) in fire occurrence between future and baseline scenarios for the Canadian Climate Centre GCM. Relative change is given as the percentage increase in number of fires predicted by the GCM (future scenario minus baseline scenario) divided by the total number of fires 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.


1981–2010
2001–2030
2031–2060
2061–2090
0 500 1,000 2,000 km
Median Spread Days
Per Fire Season
0–5
5–10
10–15
15–20
20–30

Mean Seasonal FFMC for 12 stations across Canada as a function of temperature and precipitation change



Peat

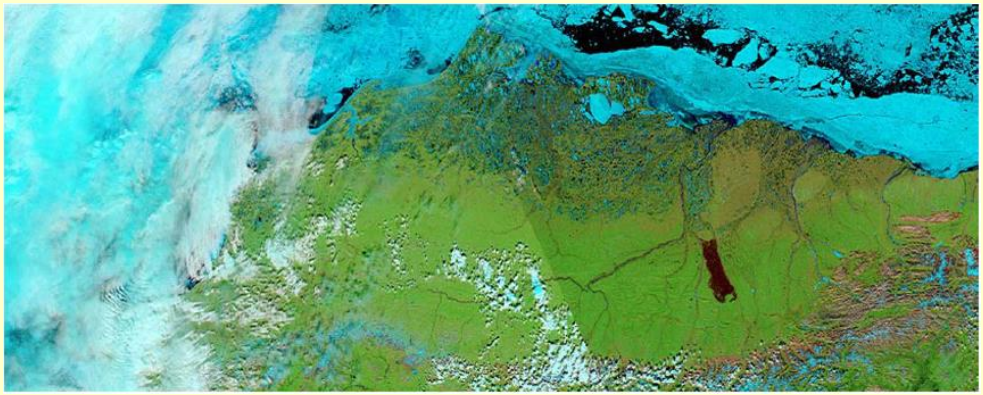
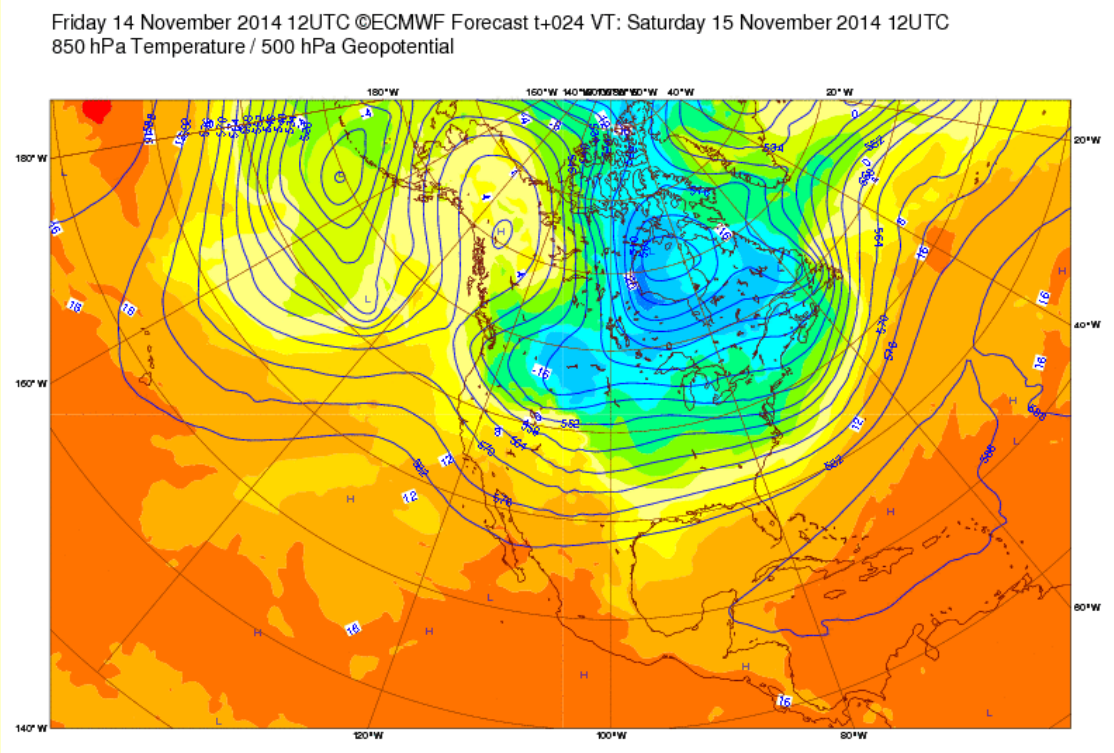


Photo credits Alaska Forest Service

- 700 Pg carbon stored in the boreal forest ~30-35 % of the global terrestrial biosphere
- Indications that this legacy carbon could be vulnerable in a warmer world
- More peatland burns during the severe fire years

A wild card – the Jet Stream



- Band of fast moving air – energy derived from the temperature difference between equatorial regions and polar regions
- Jet streams determine the strength and movement of the synoptic weather systems (day-to-day weather)
- Climate change may be causing a weakening of the jet stream as the temperature difference between the equator and poles decreases
- Atmospheric patterns – stagnate, meandering – more extremes – droughts, floods, heat and cold

Summary

- **Fire and weather 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**

- **Traditional approaches to fire management may no longer be viable**

Photo credit: Ontario MNR

Photo credit: Dennis Quintilio

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http://www.ualberta.ca/~flanniga/

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