

Wildfire and Climate-Change in Canada – A New Reality?



Photo credit: Chris Schwarz, Government of Alberta

Mike Flannigan
University of Alberta and
the Canadian Partnership
for Wildland Fire Science



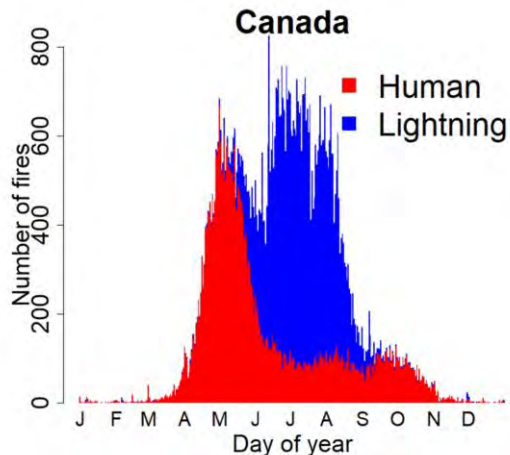
Canadian Partnership
for Wildland Fire Science

Outline

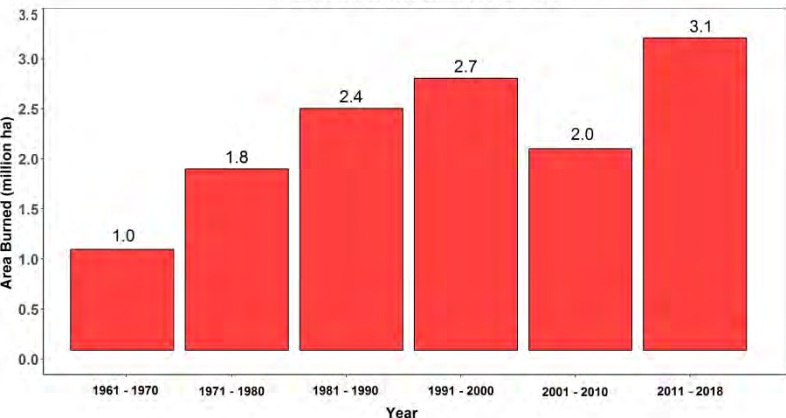


- **Fire in Canada**
- **Impacts of climate change on wildfire**
- **What can we do?**

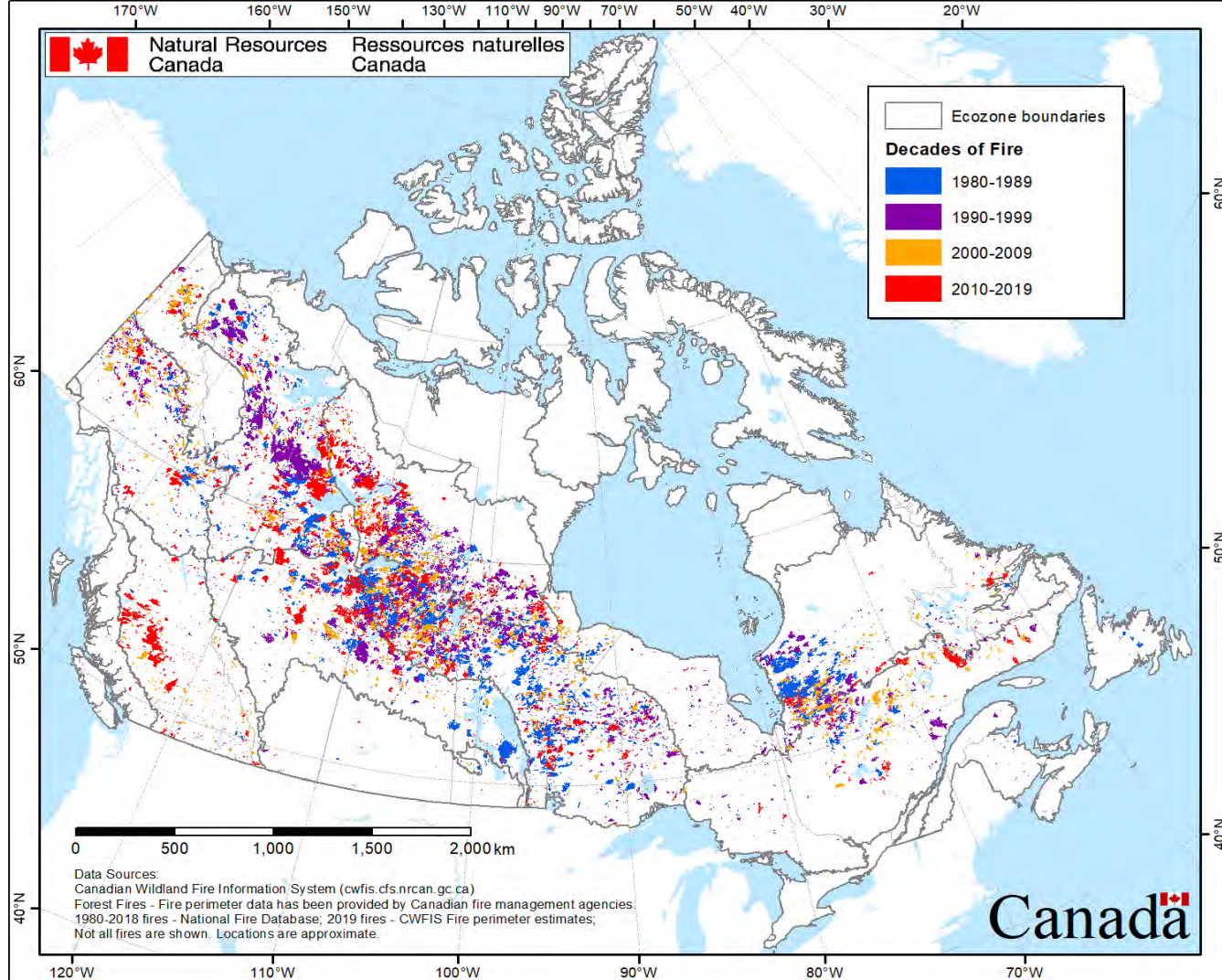
Canadian Fire Statistics



Average Annual Area Burned by decade in Canada (1961 - 2018)
Source: Canadian National Fire Database



- Incomplete prior to 1970.
- Currently - average of 7000 fires a year burn 2.8 Million ha – more than doubled since the early 1970s.
- Often high intensity/high severity crown fires.
- Area burned is highly episodic:
 - 0.4 to 7.6 million ha
- Lightning fires:
 - 40% to 50% of total fires
 - represent 80-90% of area burned
- Fire size - Extremes:
 - 3% of fires are >200 ha
 - represent 97% of area burned





Natural Resources
Canada

Ressources naturelles
Canada

Evacuations due to Wildland Fire 1980-2017

Number of evacuees (approx.)

- ◆ 1 - 100
- 101 - 1000
- 1001 - 10000
- > 10000

■ Forest Fires > 200 ha

■ Forested Area

Data Sources:

Evacuations - Natural Resources Canada, Evacuation Database

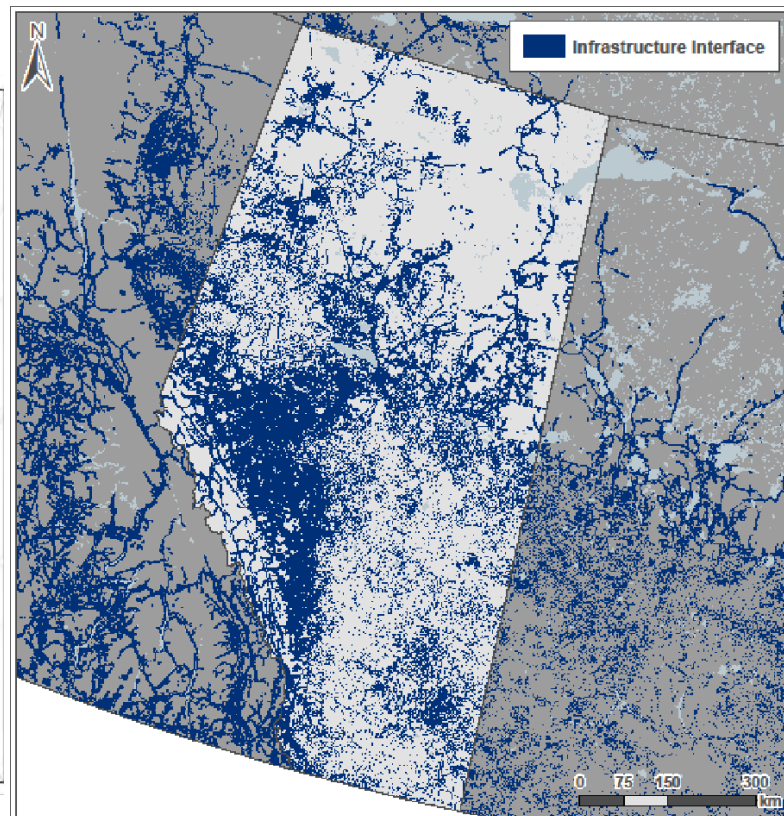
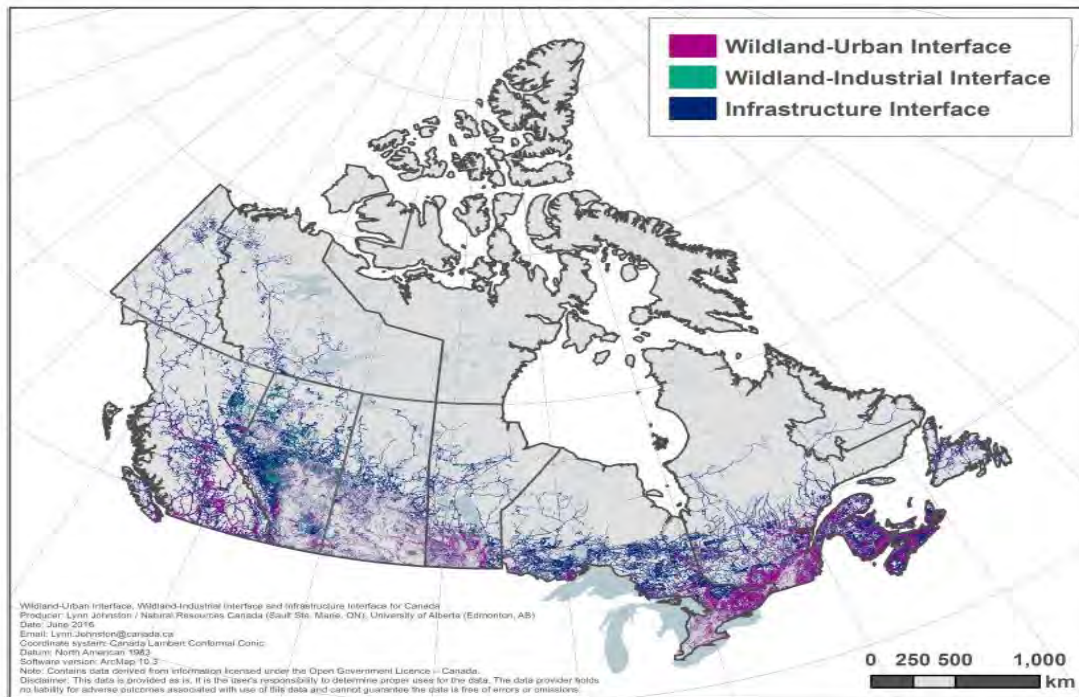
Fire data - Natural Resources Canada, National Fire Database

0 500 1,000 1,500 2,000 km



Canada

Maps of the “human-wildland interface”



Fire Management



- Canadian fire management agencies among best in the world.
- Canadian Forest Fire Danger Rating System.
- Fire Management is challenging and is becoming more challenging due to increased demands and climate change.

Fire Issues

- An average of \$800 million spent by fire management agencies in Canada a year on direct fire fighting costs. These costs are rising
- Health and safety of Canadians – evacuations – 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) may be reaching their limit of economic and physical effectiveness.

Fire Impacts



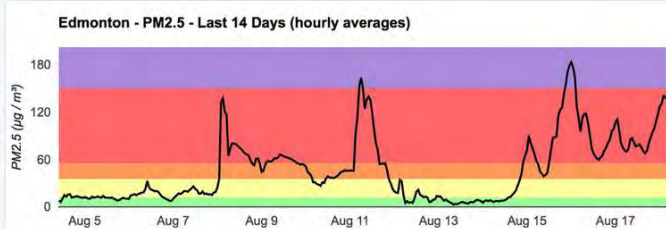
You Retweeted



Robert Rohde @rarohde · Aug 18

During the last 24 hours, Edmonton, #Canada (population 900,000) has had the worst air quality of any city for which we collect data, beating out places like India and China.

During the last 10 days, forest fires have repeatedly driven air quality to unhealthy levels.



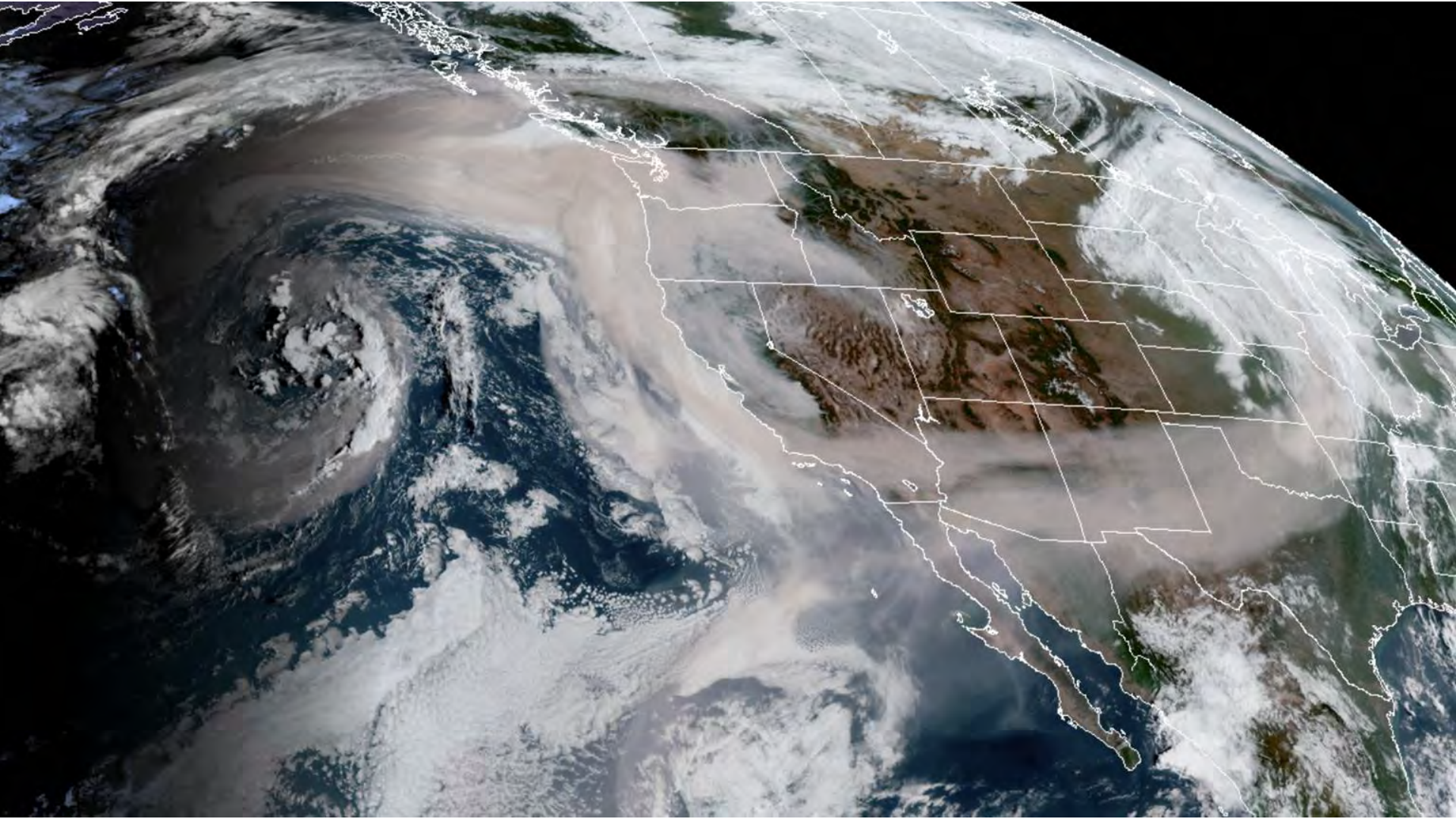
15

348

272

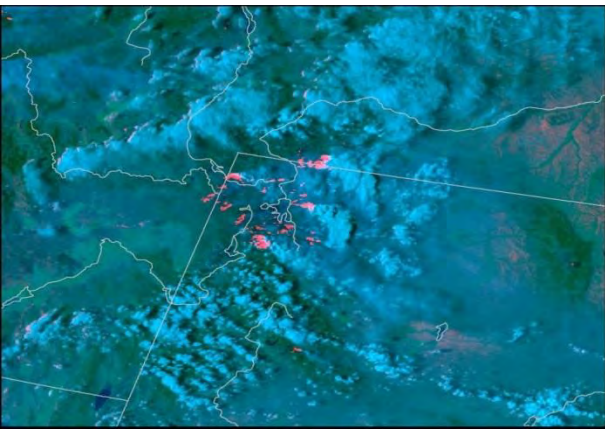


- Location, location location
- Slave Lake May 2011
- Fort McMurray 2016.
- 2017 Chile, Portugal, Spain, South Africa, Ireland, Greenland, USA (CA) and Canada (BC, AB, NT, SK and MB).
- 2018 Greece, California, England, Sweden, ON and BC
- 2019 Arctic, Amazon, Alberta, Australia etc.
- 2020 Australia, Siberia, Amazon and western USA especially California and Colorado etc.
- Globally, smoke related fatalities estimated at 330,000 per year

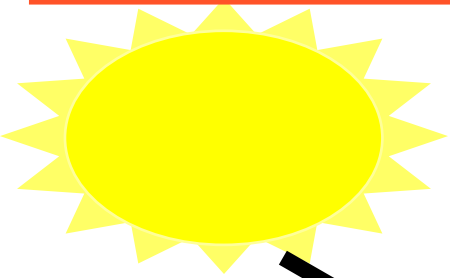


Forest Fires – 3 Ingredients

- Fuel – type, loading, moisture, structure.
- Ignition - human and lightning
- Weather – hot, dry windy. Extreme weather



Incoming solar energy heats the Earth, and outgoing heat radiation cools it off



Incoming Energy

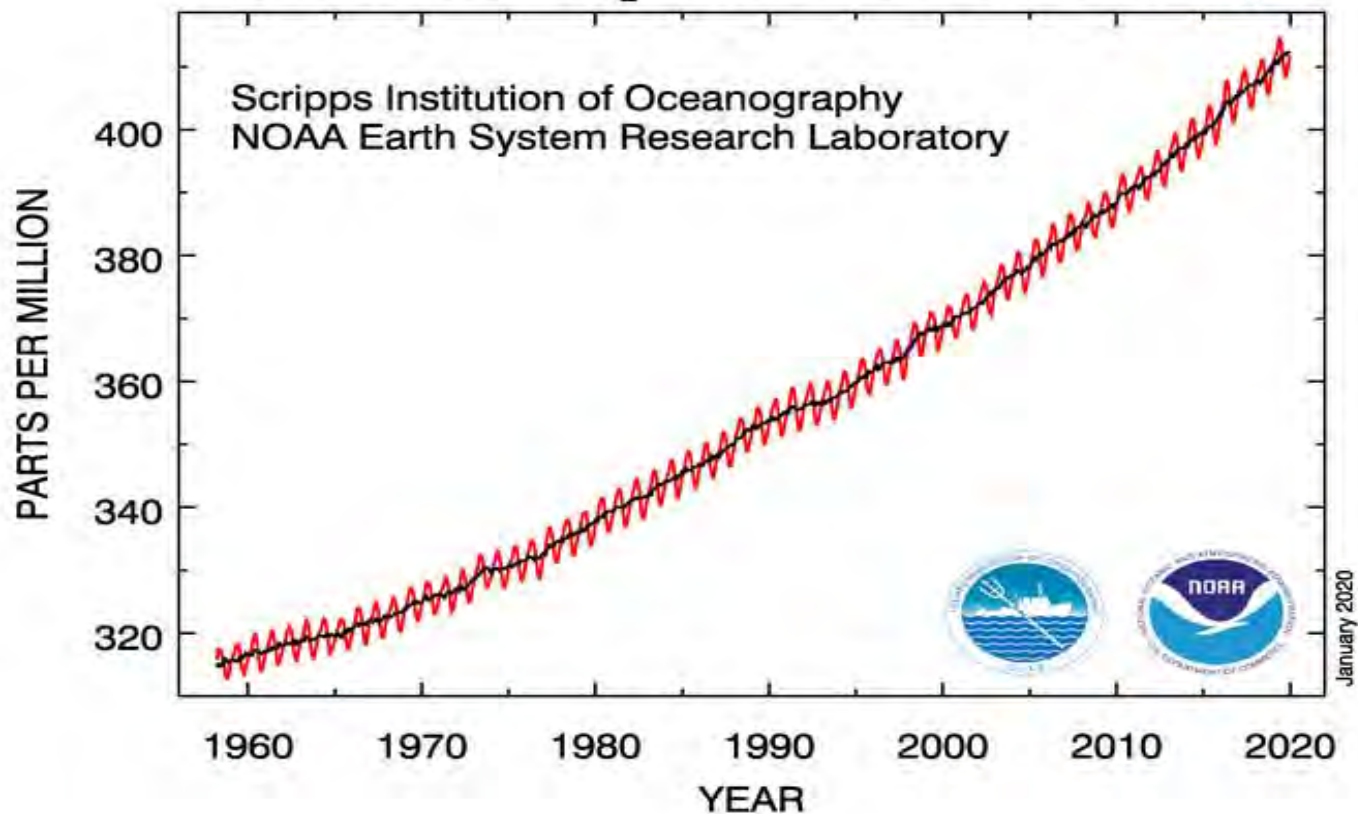
Reflected Energy



**Outgoing
Energy**

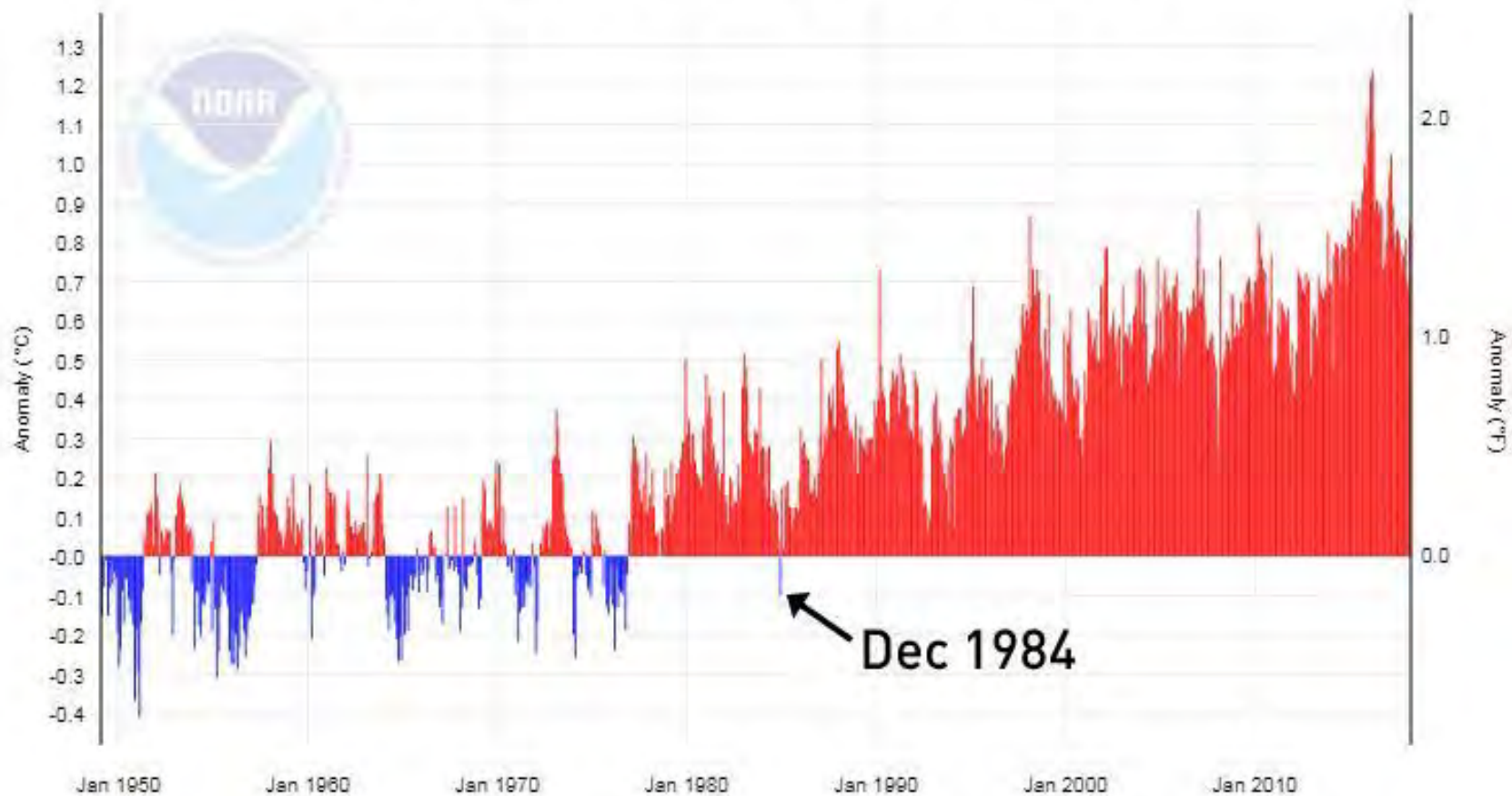
**Energy Trapped
By Greenhouse Gases**

Atmospheric CO₂ at Mauna Loa Observatory

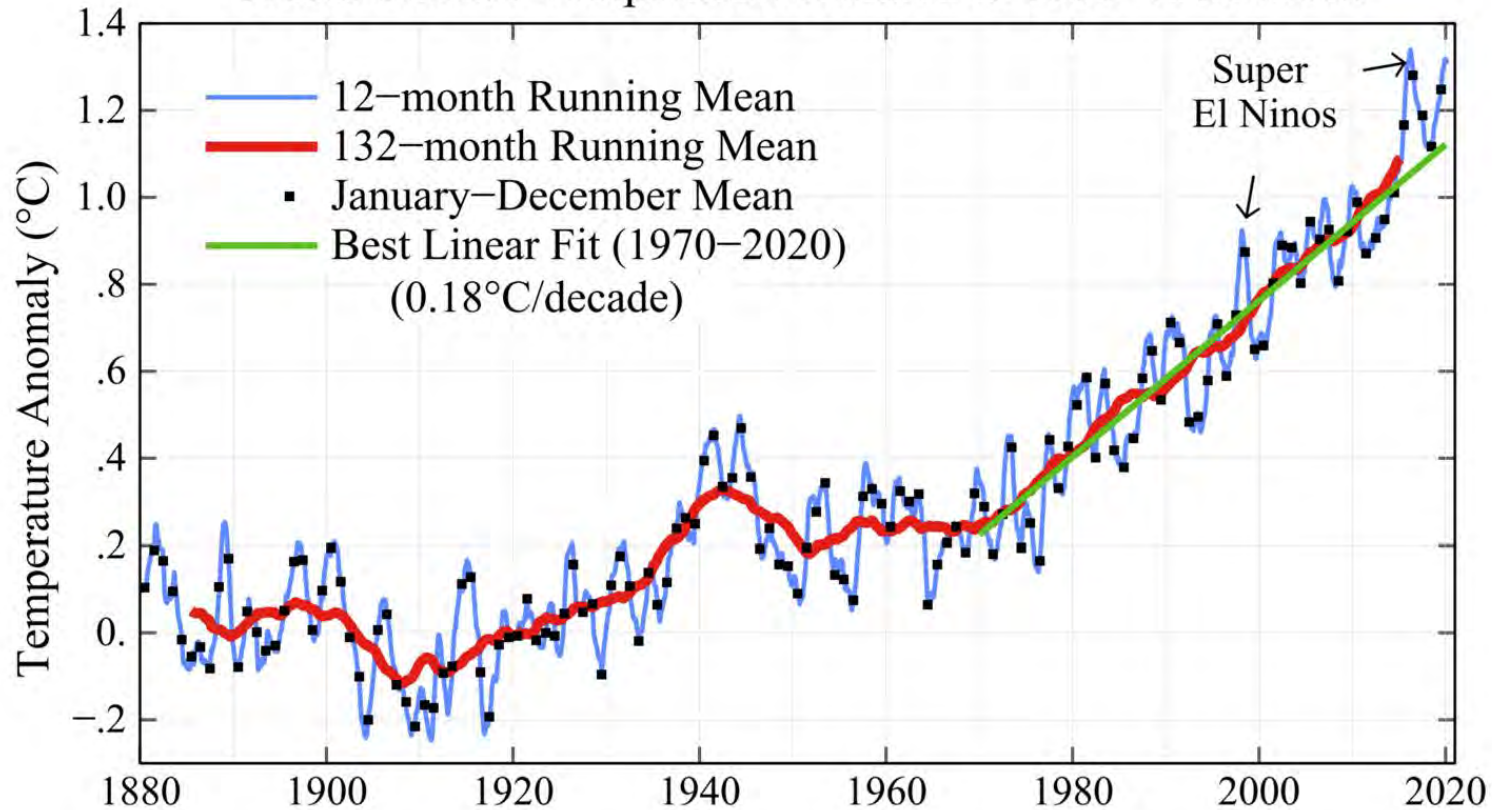


<http://www.esrl.noaa.gov/gmd/ccgg/trends/>

Global Land and Ocean Temperature Anomalies



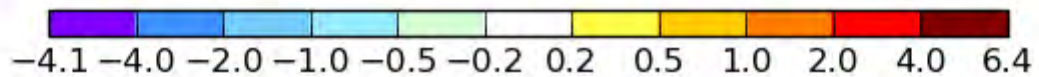
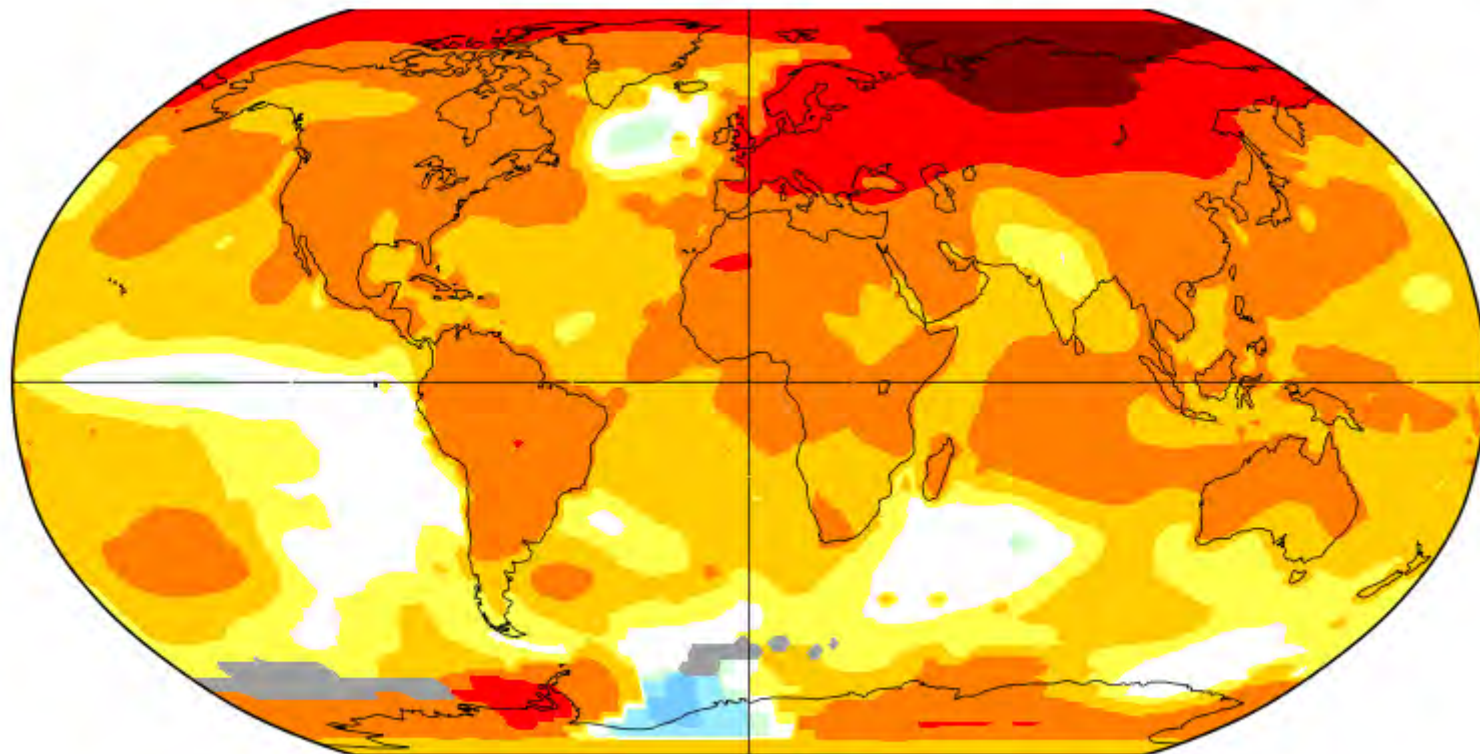
Global Surface Temperature Relative to 1880–1920 Mean



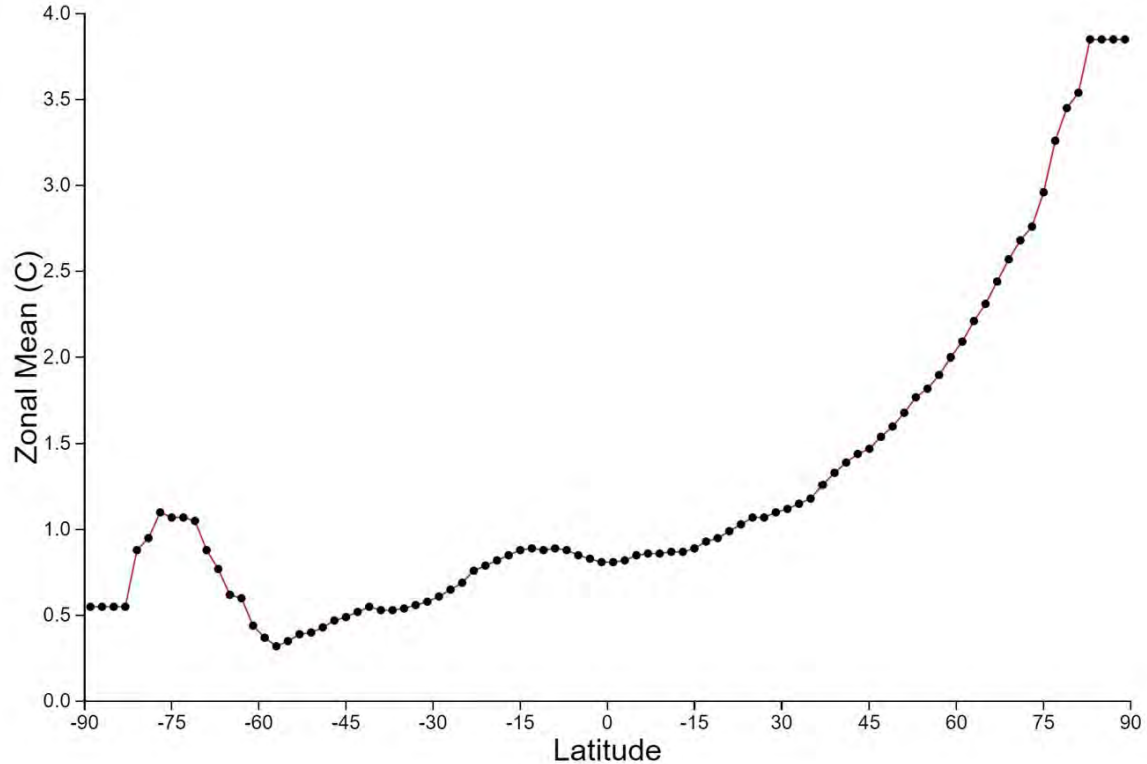
Annual J-D 2020

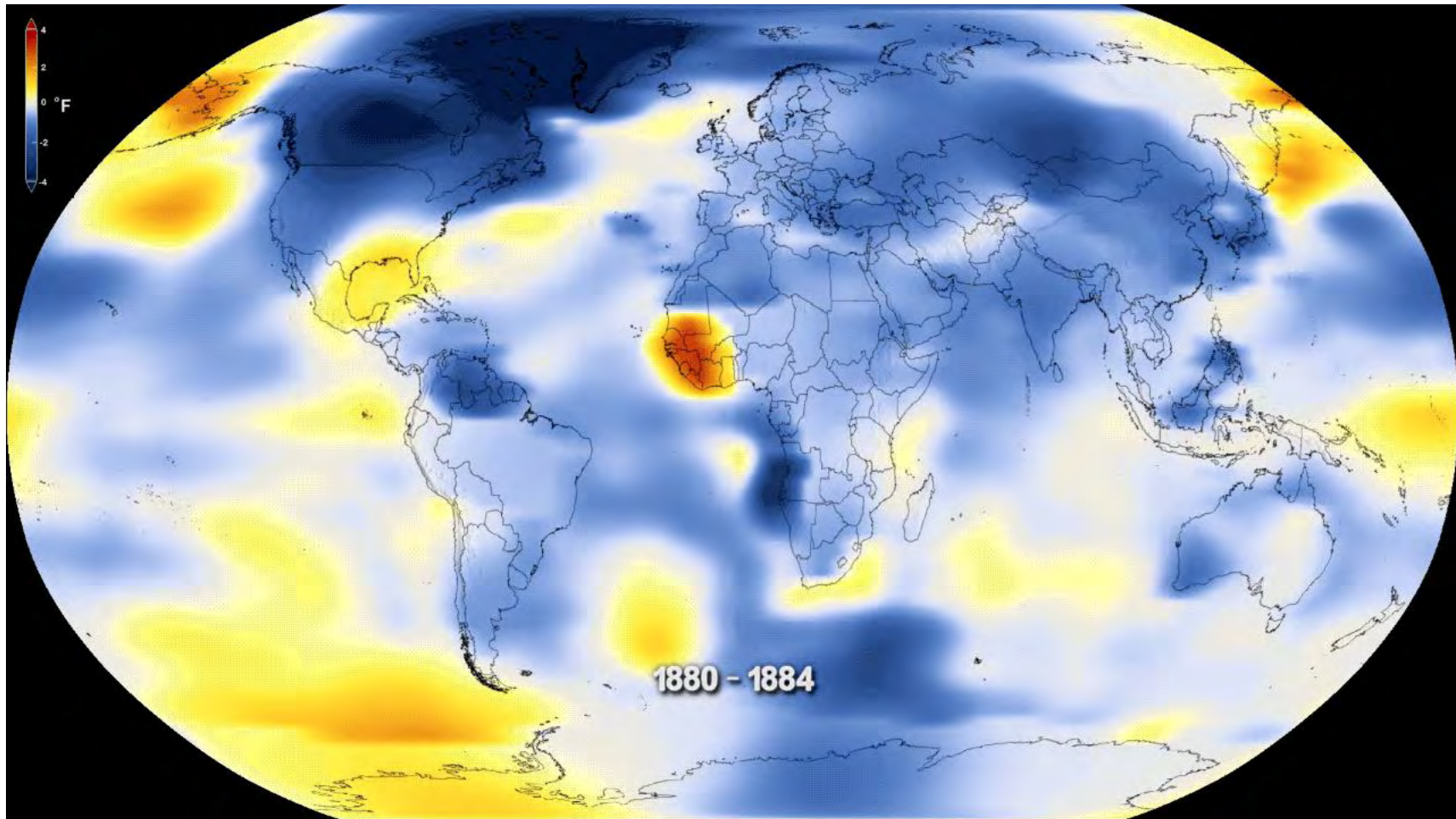
L-OTI(°C) Anomaly vs 1951-1980

1.02

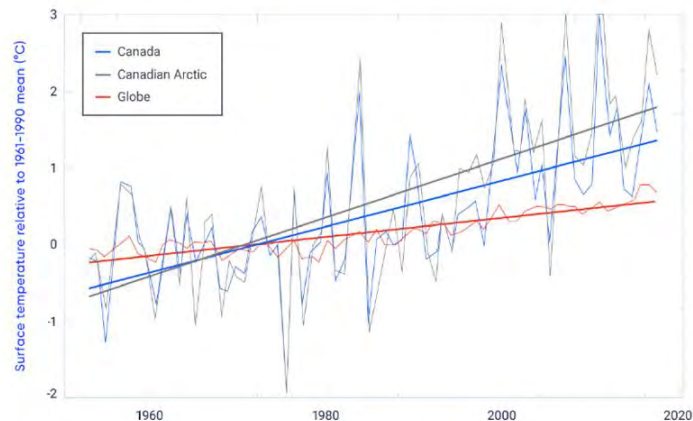
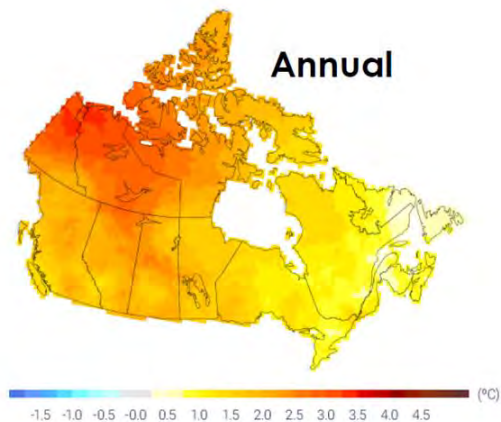


2020 Temperature Anomalies by Latitude





Canada has warmed, faster than the global average



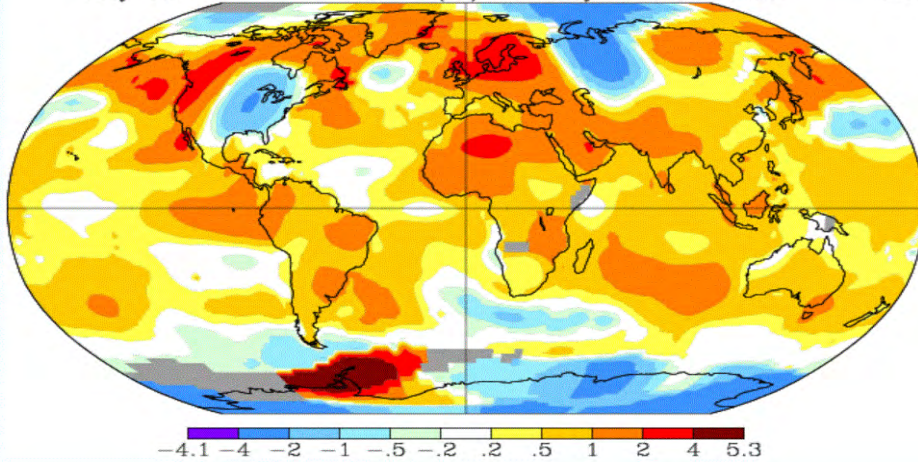
an

- Annual average temperature in Canada has increased by 1.7°C between 1948 and 2016.
- Canada has warmed about two times the global rate.
- Warming is not uniform across Canada. Northern Canada has warmed by 2.3°C, about three times global warming.
- Most of the observed increase in annual average temperature in Canada can be attributed to human influence.

July 2014

L-OTI(°C) Anomaly vs 1951-1980

0.52



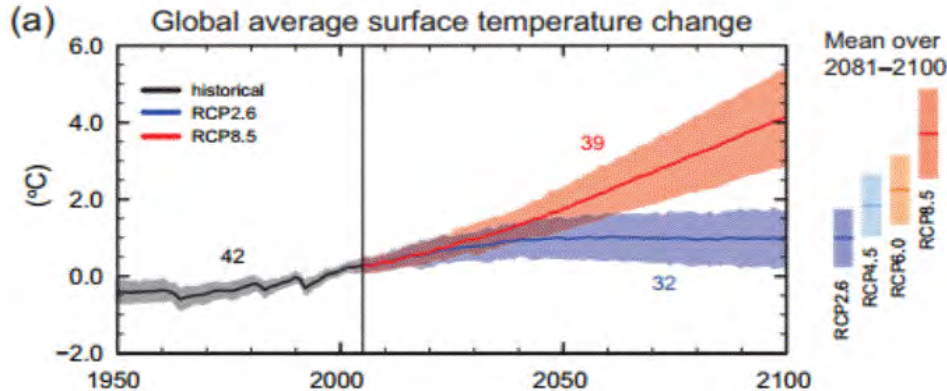
-4.1 -4 -2 -1 -0.5 -0.2 .2 .5 1 2 4 5.3

Note: Gray areas signify missing data.

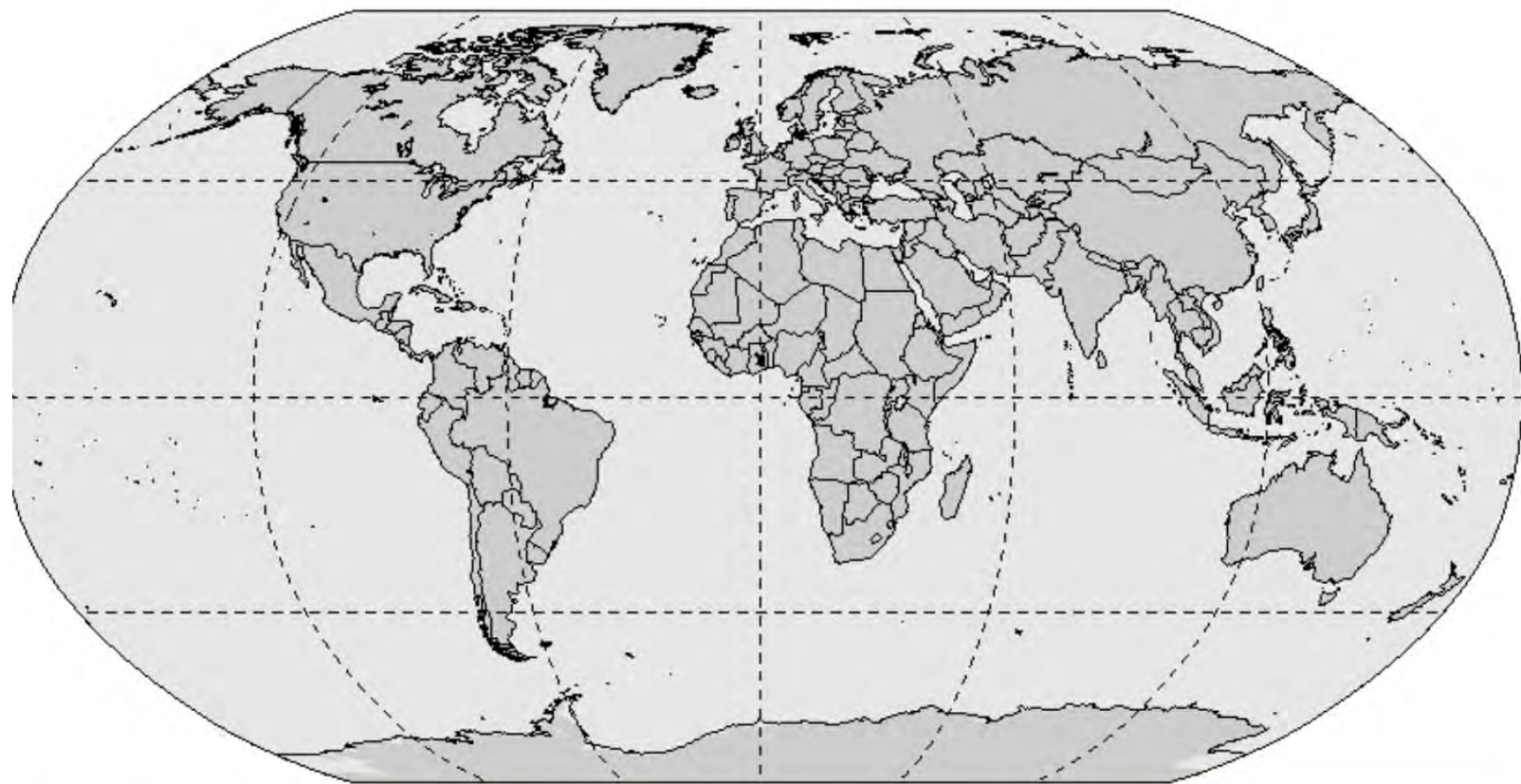
Note: Ocean data are not used over land nor within 100km of a reporting land station.

Climate Change Projections

- GCMs project up to a 6⁰ C increase in global mean temperature by 2100.
- Greatest increases will be at high latitudes, over land and in 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).
- Spatial and temporal variability in climate change.



CanESM2 RCP85 21-yr mean temperature(C) change yr=1996 vs 1986-2005

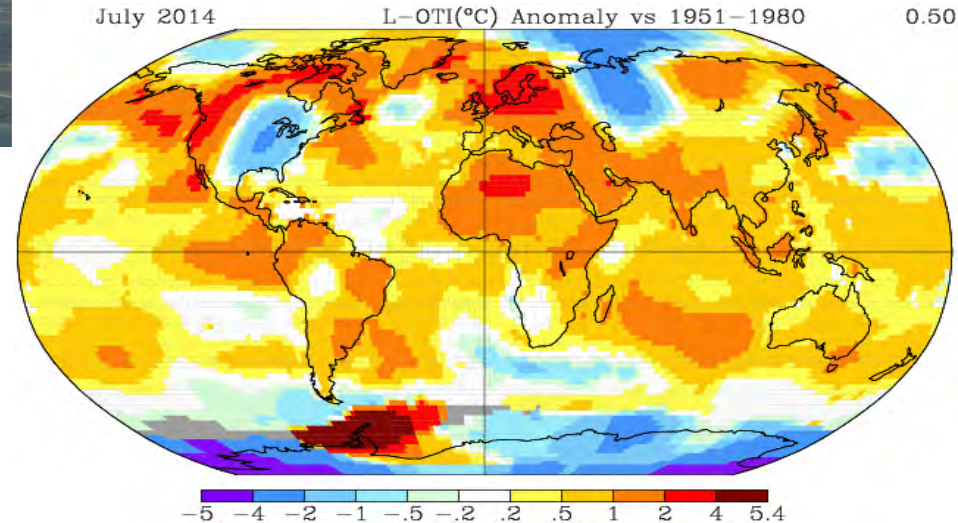


Fire & Temperature

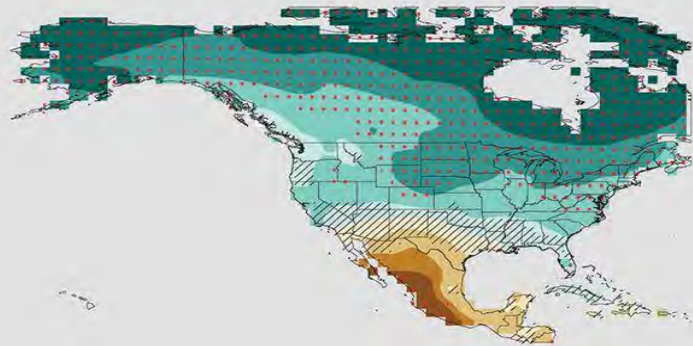


Photo credit: Government of the Northwest Territories

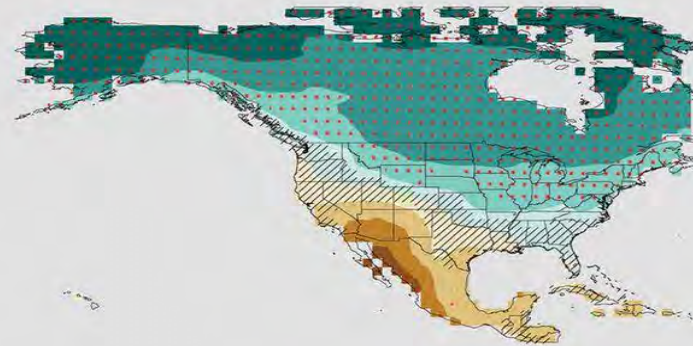
- **Drier fuels**
- **Lightning**
- **Fire season**



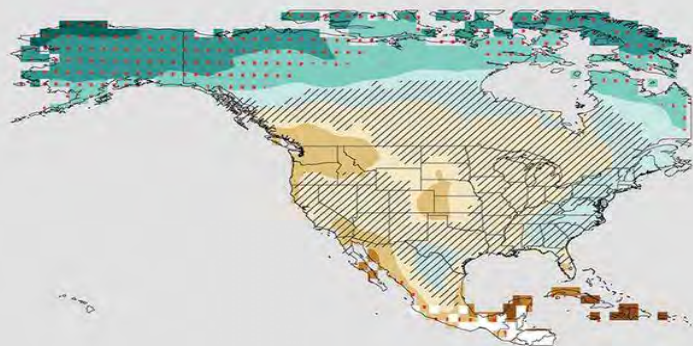
Winter



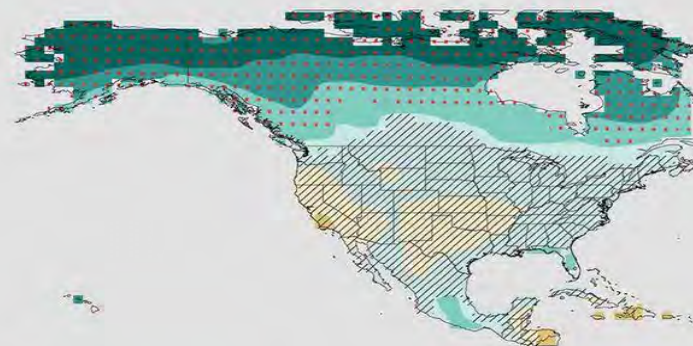
Spring



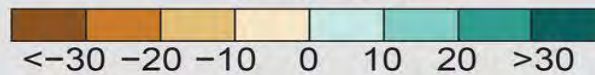
Summer



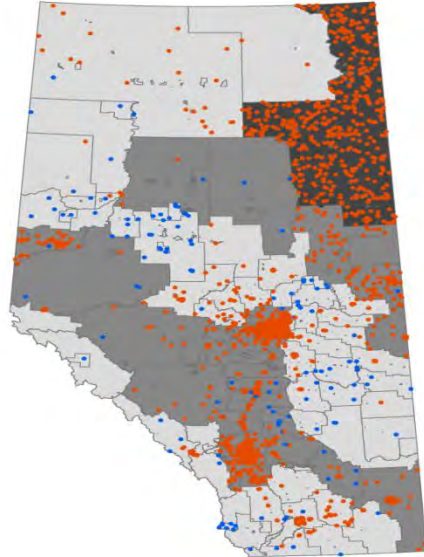
Fall



Change (%)



Development

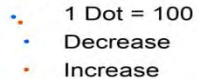


- Now more than ever Canadians live and work in the forest.
- Development increasing in parts of the country.
- More people = more fire and more exposure to fire.
- We can make communities more fire-resistant but not fire-proof

Assessment (\$ billion)



Population



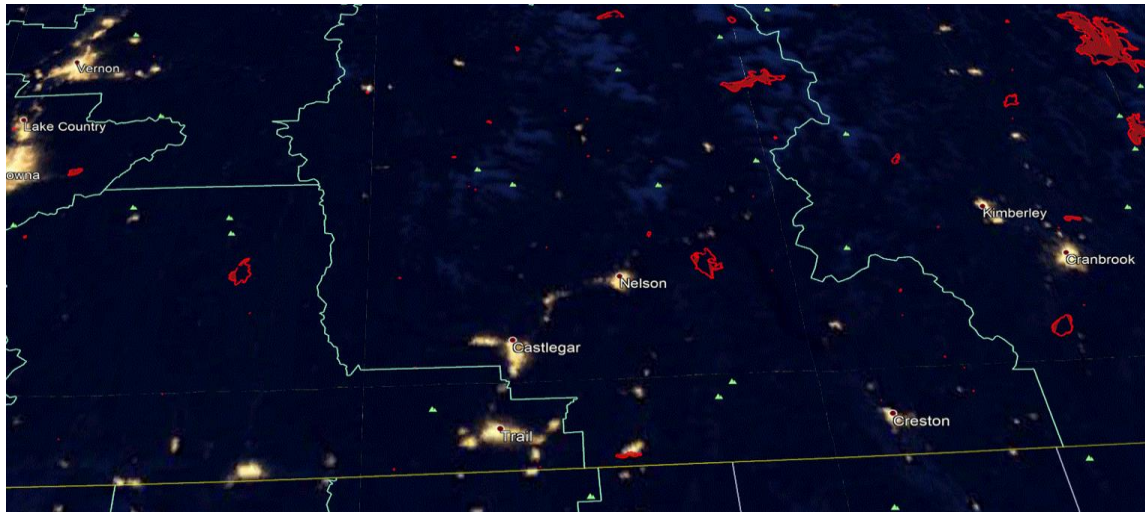
Opinion / Op-Ed

Op-Ed Why do we keep putting people in the way of wildfire? The wrong carrots and sticks.

In the last 10 years, 60% of new homes in the U.S. have been built on lands adjacent to fire-prone public lands.

Manage wildland fire in the future

- Update the Canadian Forest Fire Danger Rating System.
- Need for an Enhanced Early Warning System
 - -Use machine learning (AI) to identify severe fire weather episodes
- Use machine learning in building fire occurrence prediction systems.
- Enhance existing fire decision support systems
- More remote sensing
- Focus on community zones (sprinklers)
- Build shelters so evacuations are not necessary



Courtesy of Steve Taylor CFS

How can we manage wildland fire

- Explore fuel management, in concert with harvesting, grazing and carbon management.
- Emergency management phases include – prevention, mitigation, preparedness, response, recovery (review)
- More emphasis on prevention and mitigation as for every dollar spent on prevention and mitigation saves 4 to 11\$
- FireSmart Canada – fuel management, planning, education, cooperation, training and development



Summary

- **Fire and weather are strongly linked**
- **Changes in forest fires may be the greatest early impact of climate change on forests**
- **Longer fire seasons and this can be a problem for fire management as high intensity fires will occur outside the traditional/historical fire season.**
- **More fire occurrence, more crown fires (higher intensity), increased fuel consumption and more area burned.**



Photo credit: Xinli Cai

Summary - 2

- **More fire activity in the future and our fire management approaches have to adapt to this new reality.**
- **May be entering new territory with no historical analogues. The unknown unknowns. We can not rely on only our experience.**
- **Fire and society interactions will increase in the future. We have to learn to live with fire and smoke.**
- **Fire is a multi-faceted problem and will need multi-prong solutions.**





Photo credit: De



@CanadaWildfire

<https://www.canadawildfire.org/>



