Comparison of Current and Future Boreal Fire Regimes in Canada and Russia

WJ de Groot  E Kukavskaya
MD Flannigan  G Ivanova
BJ Stocks  AS Cantin
DR Cahoon  N Jurko
AJ Soja  SG Conard
Outline

- General fuel, weather and fire statistics
- Comparison of North American and Eurasian boreal forest fire regimes
- Future trends in boreal fire regimes under climate change
## General Fire Regime Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Canada</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area burned (M ha/yr)</td>
<td>0.3-7.5</td>
<td>12-20</td>
</tr>
<tr>
<td>Crown Fire</td>
<td>97%</td>
<td>20%</td>
</tr>
<tr>
<td>Fire intensity</td>
<td>High</td>
<td>Lo-Mod</td>
</tr>
</tbody>
</table>
Forest Composition

Tree Proportions in Canada by Area

- Spruce: 52%
- Fir: 11%
- Pine: 9%
- Aspen: 4%
- Populus sp.: 11%
- Unclassified: 6%
- Abies sp.: 6%
- Betula sp.: 6%
- Acer sp.: 2%
- Tugia sp.: 1%
- Thuja & other conifers: 4%
- Other hardwoods: 2%
- Pseudotsuga menziessii: 1%
- Pseudotsuga menziessii: 1%
- Other trees: 1%

Tree Proportions in Russia by Volume

- Larch: 31%
- Spruce: 31%
- Pine: 19%
- Fir: 9%
- Larch: 4%
- Aspen: 4%
- Birch: 2%
- Other trees: 1%
- Quercus sp.: 1%
- Pseudotsuga menziessii: 1%
- Tsuga sp.: 2%
- Pinus sylvestris: 1%
- Other hardwoods: 2%
- Picea sp.: 1%
- Populus tremula: 1%
Historical Fire Weather
Canadian Fuels Data

C1 Spruce-lichen woodland
C2 Boreal spruce
C3 Immature jack/lodgepole pine
C4 Mature jack/lodgepole pine
C5 Red and white pine
C6 Pine plantation
C7 Ponderosa pine-Douglas fir
D1 Deciduous (leafless)
M1/M2 Boreal mixedwood
O1 Grass
Russian Fuels Data

Fuel Types:
- Larix
- Pinus sylvestris
- Pinus sibirica
- Betula
- Picea
- Abies
- Populus tremula
Modelled Fire Behaviour and Effects

Using the Canadian Fire Effects Model (CanFIRE), simulated every large fire:

- satellite determined fire perimeters
- simulated each fire as a one-day fire event
- interpolated fire weather using the date with most MODIS hotspots
- using standard fuel types/loads (e.g., mature stand, average biomass data)

Calculated:
- Head fire intensity
- Type of fire (surface, crown)
- Fuel consumption and carbon emissions
Large (>200 ha) Fire Occurrence
Mean Fire Return Interval

Fire Frequency by Ecoregion
2001 - 2010

Fire Frequency by Ecoregion
2001 - 2007
Mean Fire Return Interval

Fire Frequency by Ecoregion
2001 - 2010

Fire Frequency by Ecoregion
1979 - 2009

Mean Fire Return Interval (YRS)
- 1 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 351 - 500
- 501+
- No Fire / No Data

0 500 1,000 KM

Canada
## Average National Fire Statistics
(Canada 2001-2010; Russia 2001-2007)

<table>
<thead>
<tr>
<th>Metric</th>
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<th>Russia</th>
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<tbody>
<tr>
<td>Number of large fires per year</td>
<td>295</td>
<td>10,923</td>
</tr>
<tr>
<td>Large Fire Frequency (#/yr/100M ha forest)</td>
<td>64</td>
<td>1732</td>
</tr>
<tr>
<td>Total area burned (M ha)</td>
<td>1.6</td>
<td>12.4</td>
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<tr>
<td>Area Burned (M ha/yr/100M ha forest)</td>
<td>0.34</td>
<td>1.96</td>
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<td>Large Fire Size (ha)</td>
<td>5342</td>
<td>1132</td>
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<td>Fire Freq. (MFRI, yrs)</td>
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<tr>
<td>Crowning Fires (%)</td>
<td>54.7</td>
<td>1.2</td>
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<tr>
<td>Fire Intensity (kW/m)</td>
<td>7042</td>
<td>1996</td>
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<tr>
<td>Carbon emission rate (t/ha)</td>
<td>27.1</td>
<td>11.1</td>
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<td>Total carbon emissions (Mt/yr)</td>
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Edmonton AB Canada, 7-10 Oct. 2013
Boreal Fire Regimes

- Russia is characterised by very many large surface fires of low-moderate intensity
- Canada is characterised by a small number of very large crown fires having very high intensity

Why?
- Forest composition (genus)
- Tree morphology and fire ecology (species)
- Human-caused fire?
Boreal Fire Regimes

Forest Composition

- Crown-fire promoting:
  - *Picea*
  - *Abies*
  - *Pinus*

- Non-crowning:
  - *Larix*
  - *Betula*
  - *Populus*
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Boreal Fire Regimes

Tree morphology and fire ecology

Pinus sylvestris

Pinus banksiana

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Future Change in Fire Weather Severity

Cumulative Severity Rating (CSR) for 2091-2100 using HadCM3 and A2
Future Change in Fire Danger Severity

Results and implications:

- Fire weather severity increased in both countries for all GCM and CC scenarios.
- Head fire intensity and daily severity rating (indicators of fire control difficulty) substantially increased in both countries.
- Peak extreme HFI and DSR values in mid-summer in both countries, but Russia also had a secondary peak in late spring/early summer.
- Generally, Canada will experience greater increases than Russia, resulting in more crown fire and increased C emissions.
- Increases in HFI and DSR are so great (up to 3X current) that it could push current suppression capacity beyond a tipping point, resulting in many more larger fires.

Note: Effects of increased numbers of fires, area burned, and changing fuel type were not studied.
References

Session 138:
Forests, fire and climate change dynamics

Presentations in this session will focus on the latest scientific understanding of climate change and future global fire regimes, feedback to the global carbon balance, expected human and environmental impacts, and potential management strategies to mitigate negative impacts.