Changes in Fire Season Duration in the Eastern Boreal Forest of Canada, 1922-2020

Clara Risk, Patrick M. A. James (Institute of Forestry and Conservation, University of Toronto)

Background

Climate change is severely affecting the boreal forest and altering fire regimes fires [1], including fire season duration [2]. Fire season lengthening will increase area burned [3], carbon release [4], and risks to human safety. Although the effects are expected to vary spatially [5], [6], we know relatively little about where these changes will be most pronounced. Understanding local variation in fire season length is important to determine potential impacts on timber supply, communities, and carbon. In this study, we evaluate changes in fire season duration in the eastern boreal forest of Canada using a random forests (RF) model.

Research Questions

1. How has fire season duration changed between 1922-2020 in the eastern boreal forest and how do these changes vary spatially?

2. Are changes due to earlier starts or later ends to the fire season?

Results

Fire season length is increasing in all ecozones (Fig. 4). Changes in fire season length are mostly due to earlier start dates (Fig. 5) as opposed to later end dates (Fig. 6).

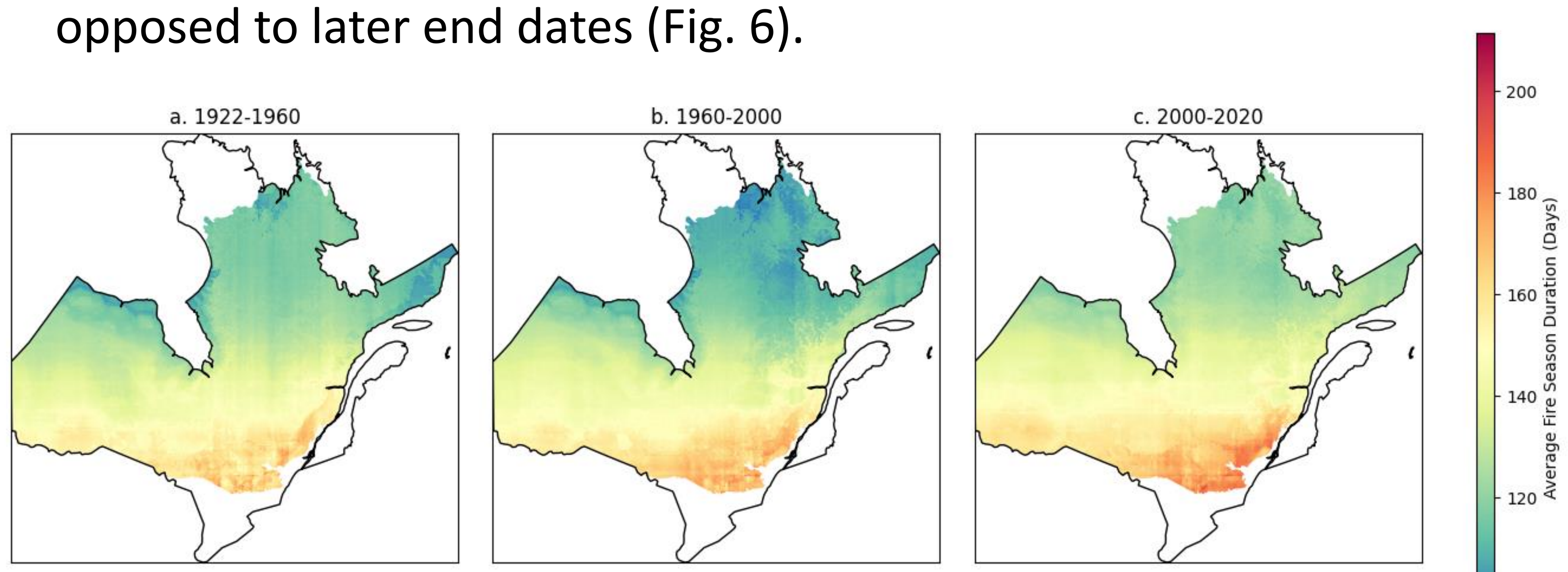

Fig. 2. Average fire season duration for the time periods (a) 1922-1960, (b) 1960-2000, (c) 2000-2020.

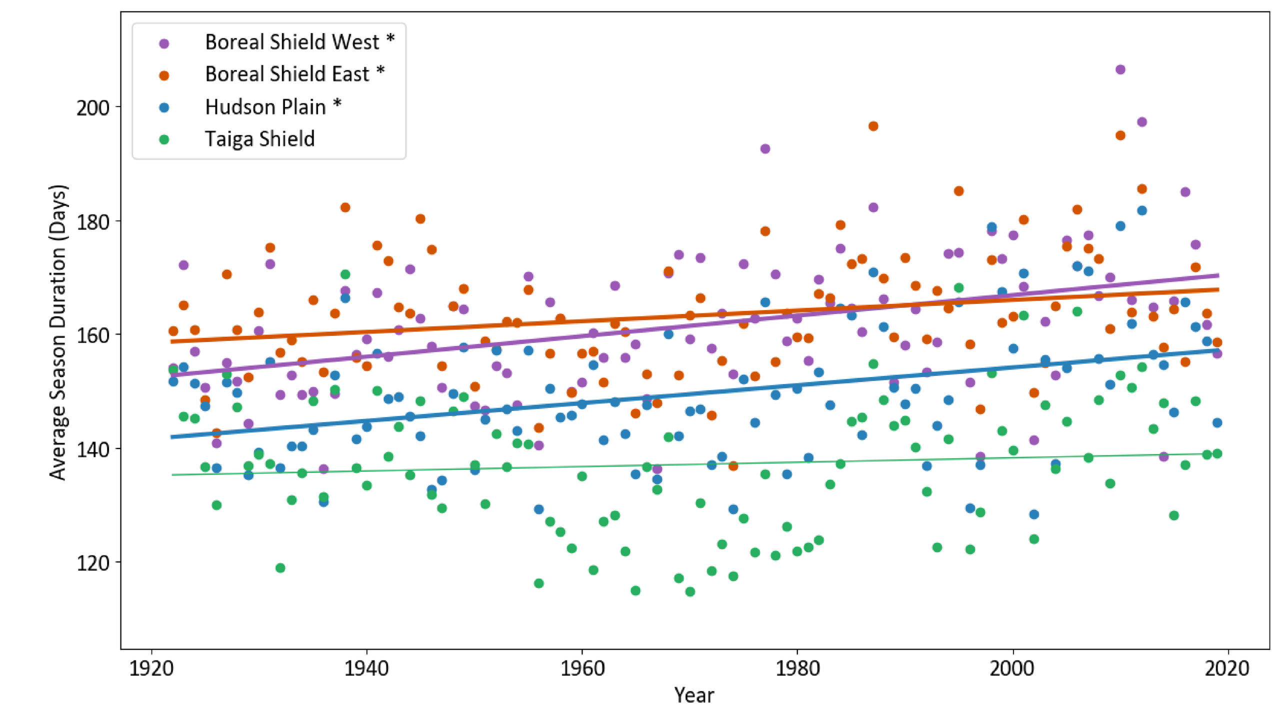

Fig. 4. Changes in fire season length in four ecozones from 1922 – 2020. Lines fitted using linear regression (shown with asterisk in legend if significant at α=0.05).

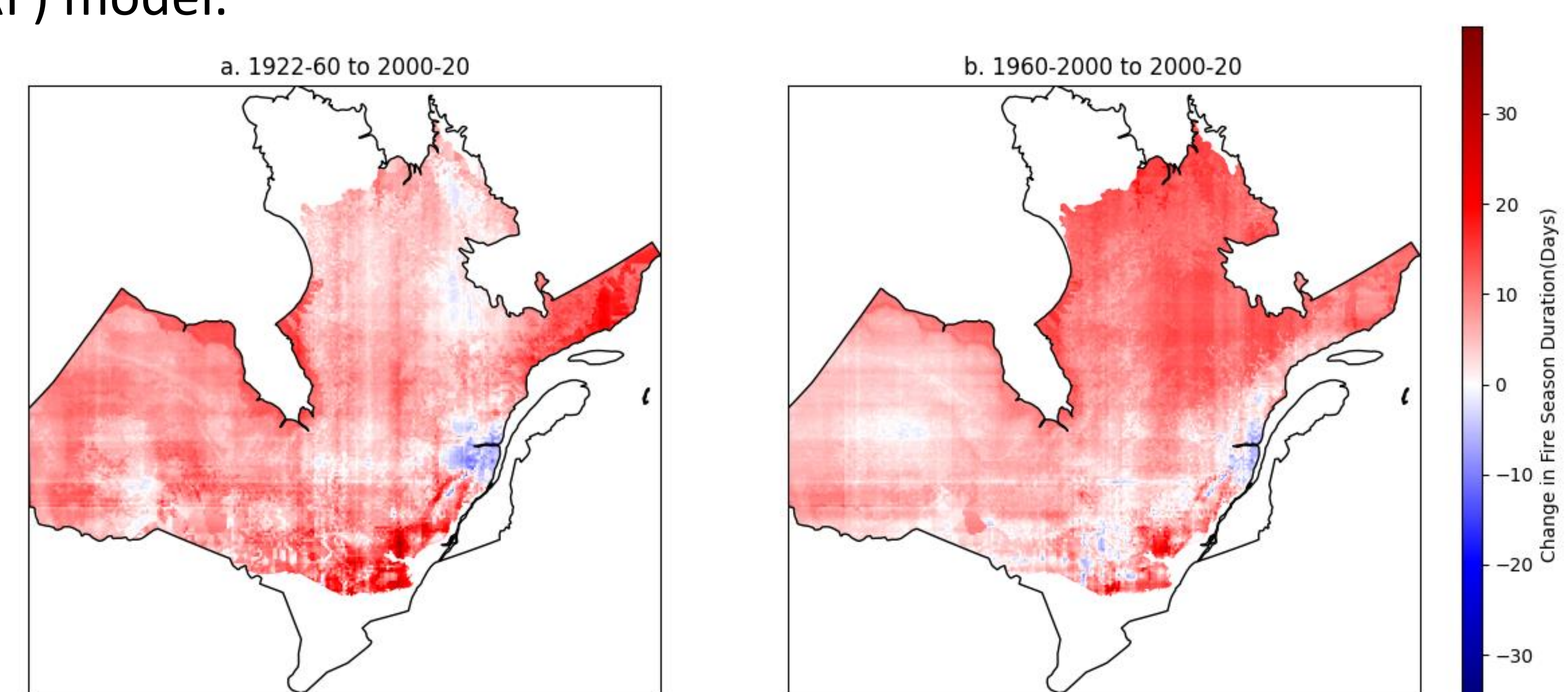

Fig. 3. Average fire season duration change for (a) 1922-60 compared to 2000-20 and (b) 1960-2000 compared to 2000-20.

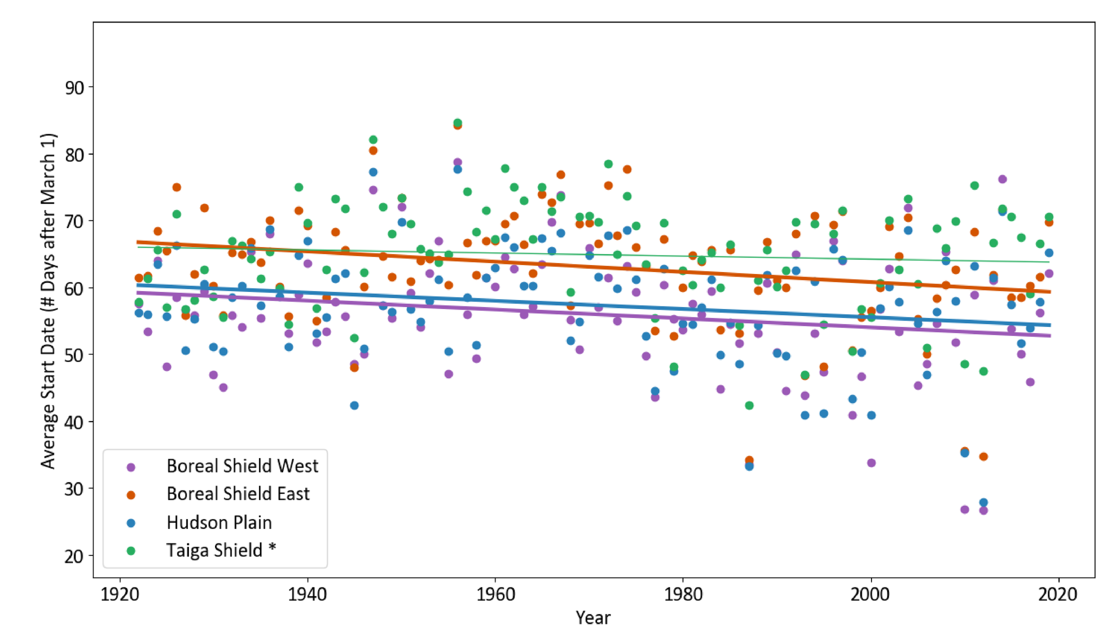

Fig. 5. Changes in fire season start date in four ecozones from 1922 – 2020.

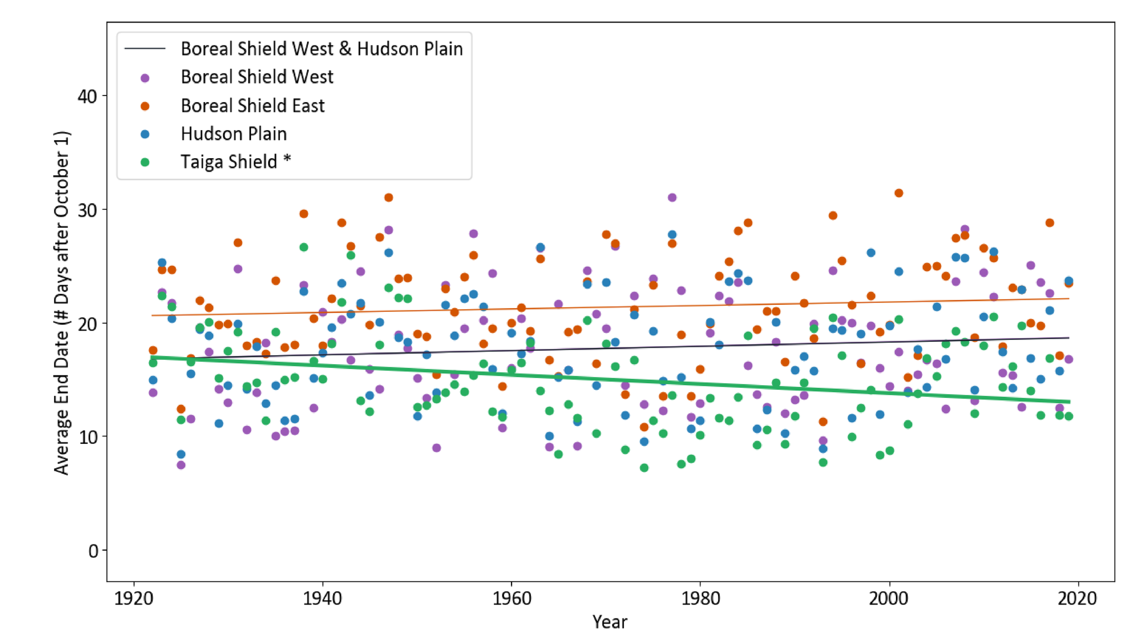

Fig. 6. Changes in fire season end date in four ecozones from 1922 – 2020.

Methods

We used an RF model to generate continuous estimates of the start and end dates of the fire season on a 10 × 10 km grid across the study area using weather station data from Environment & Climate Change Canada [8]. We selected RF as opposed to other potential methods due to its strong relationship to fire ignition dates in the Canadian National Fire Database (CNFDB) for the fire season start date and low mean absolute error (MAE) calculated from cross-validation.

Fire season start and end date definitions were consistent with the Canadian Forest Fire Weather Index System (three days of maximum daily temperatures over 12⁰C and under 5⁰C) [2]. We calculated the fire season duration as the number of days between the modelled start and end dates across the study area, in each cell of the regular grid. We then overlayed the continuous surfaces for each year in a defined time period (Fig. 2) and computed the average in each pixel. For each year, we also computed the average fire season start date, end date, and duration in the ecozones (Fig. 1).

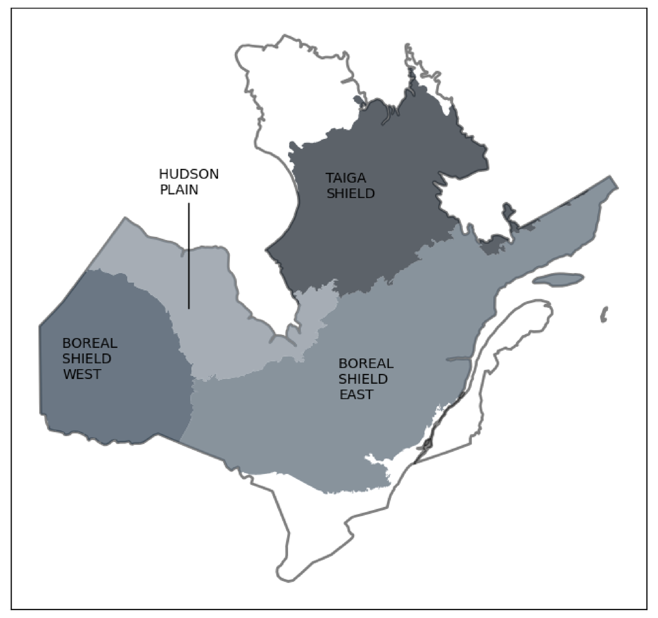

Fig. 1. Ecozones in study area based on the National Ecological Framework for Canada [3], [7].

Discussion

Fire season length is increasing across the boreal forest (Fig. 4), mainly due to earlier start dates (Fig. 5). Changes are pronounced in the Boreal Shield West and Hudson Plain ecozones in northwestern Ontario and in the Boreal Shield East ecozone covering much of Québec and Ontario. Longer seasons will increase pressure on fire management systems in these provinces and increase risk to remote communities. Long fire seasons will also result in greater release of carbon, particularly because parts of northern Québec and Ontario are dominated by peat [9], which could release more carbon to atmosphere during a forest fire [4]. Climate change is set to further exacerbate these changes [2], [3], which is concerning in terms of complex interactions [10] between an altered fire regime and other natural disturbances, such as insect outbreaks [1]. Future research includes an impact assessment to evaluate how these changes could impact communities and carbon release to the atmosphere, as well as monitoring of the trend in the coming decades.

References

[1] Seidl, R. et al. 2017. *Nat. Clim. Chang.* **7**: 395–402. [2] Wotton, B.M. et al. 1993. *For. Chron*. **69**: 187–192. [3] Flannigan, M. et al. 2005. *Clim. Change*. **72**: 1–16. [4] X. J. Walker et al.2019. *Nature.* **572**: 520–523. [5] Flannigan, M. et al. 2013. *For. Ecol. Manag*. **294**: 54–61.[6] Jolly, W. et al. 2015. *Nat. Commun*. **6**. [7] Agriculture and Agri-Food Canada. 2013. http://www.agr.gc.ca/atlas/supportdocument_documentdesupport/aafcEcostratification/en/ISO_19131_National_Ecological_Framework_for_Canada_Data_Product_Specification.pdf. [8] Environment and Climate Change Canada (Government of Canada). 2020. https://climate.weather.gc.ca/historical_data/search_historic_data_e.html. [9] Xu, J. et al. 2018. *Catena*. **160**. [10] Peters, D.P.C. et al. 2004. *Proc. Natl. Acad. Sci. U. S. A*. **101**: 15130–15135.