

Climate Change Effects on Wildland Fire Risk

in the Northeastern United States
and Great Lakes Region

Gaige Hunter Kerr
The Johns Hopkins University

28th Conference on Climate Variability and Change | January 11, 2016





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Wildfires threaten homes in Idaho, Washington, California and Oregon



By Ralph Ellis and [Laura Smith-Spark](#), CNN

🕒 Updated 10:06 PM ET, Sun August 16, 2015



CNN | August 16, 2015



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Wildfires threaten

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There aren't enough firefighters to fight all the Western wildfires

Los Angeles Times | August 18, 2015



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There aren't enough firefighters to fight all the Western wildfires

Chicago Tribune | August 23, 2015



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US | Tue Sep 1, 2015 10:20pm EDT

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The Washington Post | December 9, 2015

2015 now USA's costliest wildfire season on record

 Doyle Rice, USA TODAY 10:13 a.m. EST December 17, 2015

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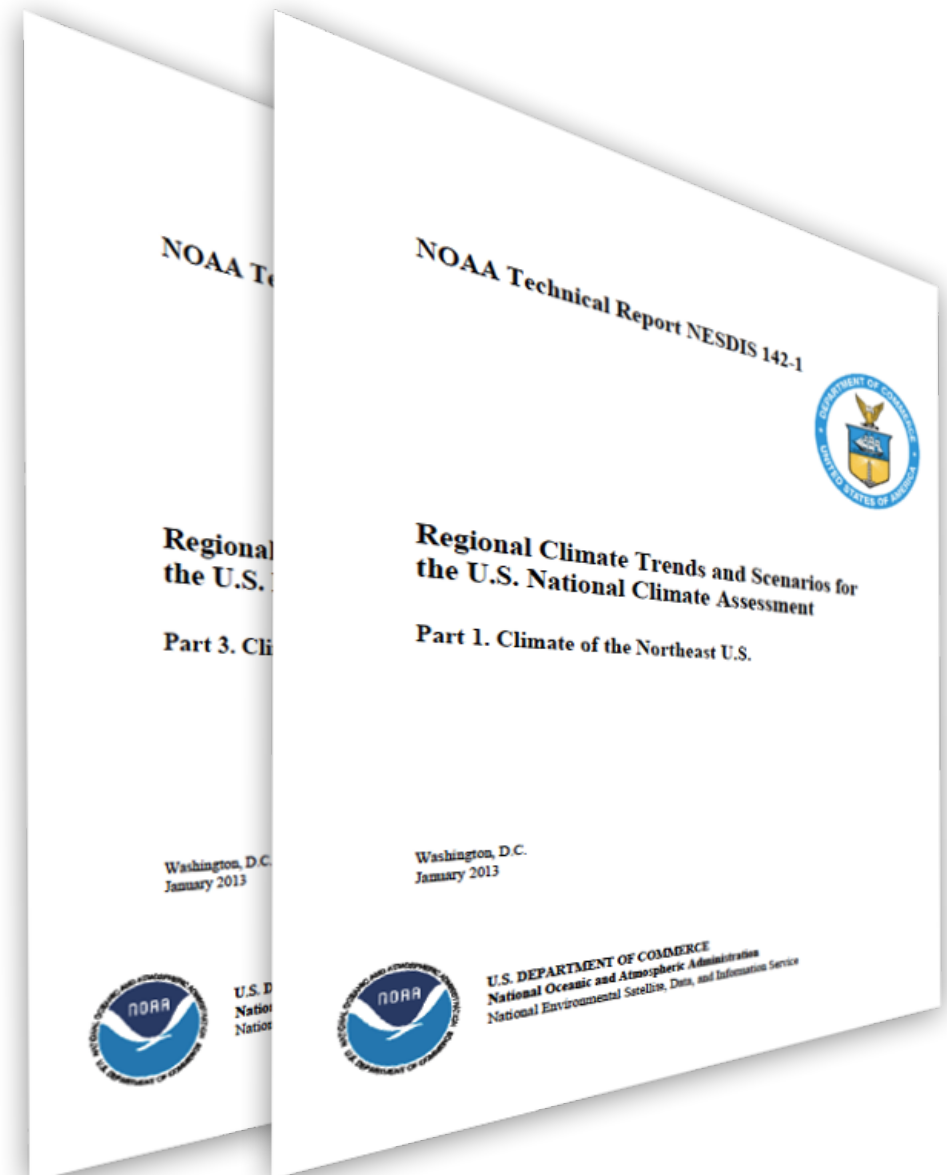
“ The agency is at a tipping point.

Climate change has led to fire seasons that are now on average 78 days longer than in 1970 [...] the acreage burned may double again by mid-century. ”

U.S. Forest Service | August 4, 2015

- Statistically significant increase in temperature
- Lengthening of the frost-free season
- Increase in average annual precipitation but a downward seasonal change during summer
- Simulated increase in the average annual number of consecutive warm days

NOAA Technical Reports, January 2013



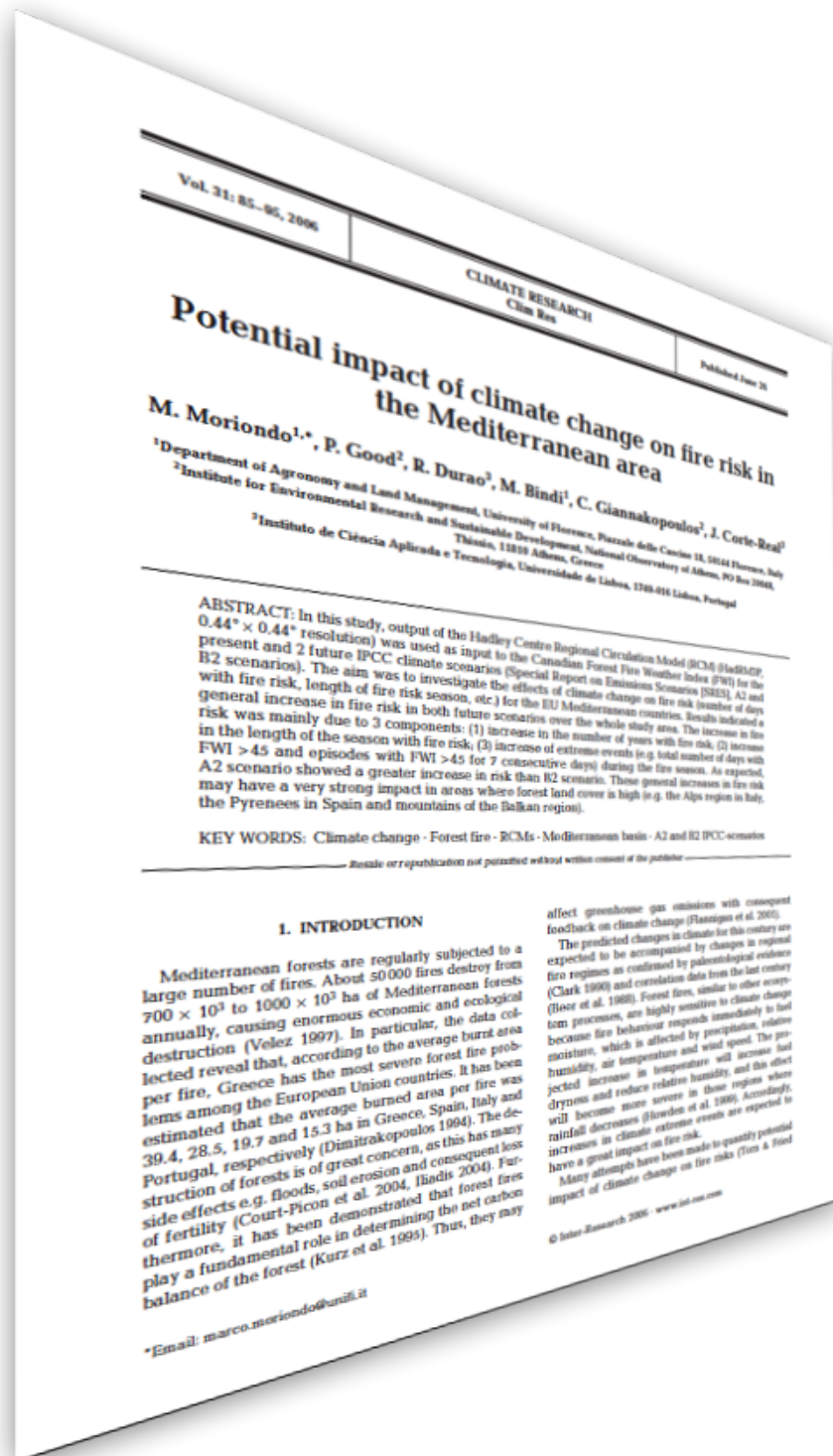


Fire Weather Simulations



“ Forest fires [...] are highly sensitive to climate change because fire behaviour responds immediately to fuel moisture, which is affected by precipitation, relative humidity, air temperature and wind speed. ”

Climate Research,
June 2006



Potential impact of climate change on fire risk in the Mediterranean area

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ABSTRACT: In this study, output of the Hadley Centre Regional Circulation Model (RCM) at 0.44° × 0.44° resolution was used as input to the Canadian Forest Fire Weather Index (FWI) for the present and 2 future IPCC climate scenarios (Special Report on Emissions Scenarios (SRES), A2 and B2 scenarios). The aim was to investigate the effects of climate change on fire risk (number of days with fire risk, length of fire risk season, etc.) for the EU Mediterranean countries. Results indicated a general increase in fire risk in both future scenarios over the whole study area. The increase in fire risk was mainly due to 3 components: (1) increase in the number of years with fire risk, (2) increase in the length of the season with fire risk, (3) increase of extreme events (e.g. total number of days with FWI > 45 and episodes with FWI > 45 for 7 consecutive days) during the fire season. As expected, A2 scenario showed a greater increase in risk than B2 scenario. These general increases in fire risk may have a very strong impact in areas where forest land cover is high (e.g. the Alps region in Italy, the Pyrenees in Spain and mountains of the Balkan region).

KEY WORDS: Climate change · Forest fire · RCMs · Mediterranean basin · A2 and B2 IPCC scenarios

1. INTRODUCTION

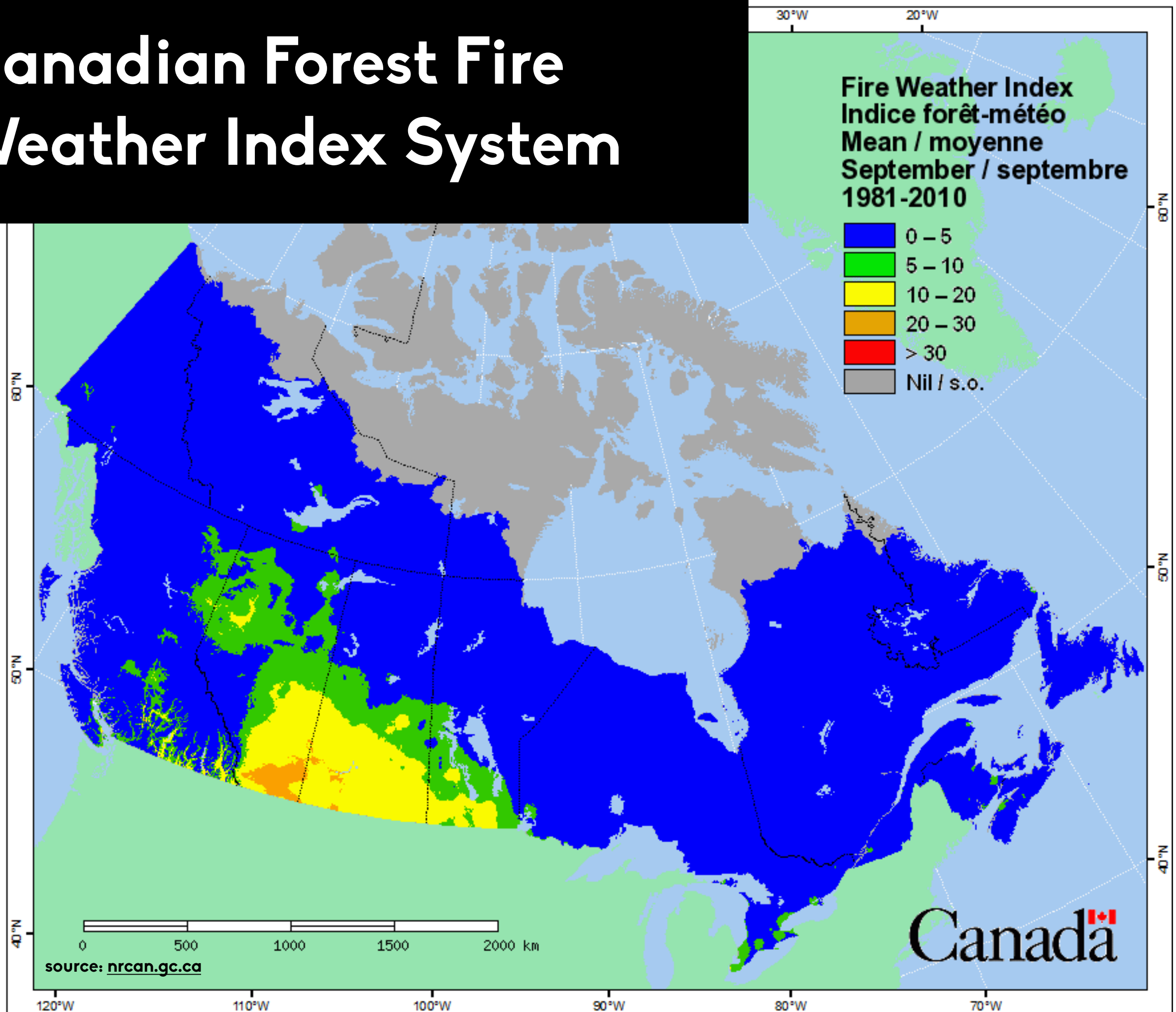
Mediterranean forests are regularly subjected to a large number of fires. About 50 000 fires destroy from 700 × 10³ to 1000 × 10³ ha of Mediterranean forests annually, causing enormous economic and ecological destruction (Velez 1997). In particular, the data collected reveal that, according to the average burnt area per fire, Greece has the most severe forest fire problems among the European Union countries. It has been estimated that the average burned area per fire was 39.4, 28.5, 19.7 and 15.3 ha in Greece, Spain, Italy and Portugal, respectively (Dimitrakopoulos 1994). The destruction of forests is of great concern, as this has many side effects e.g. floods, soil erosion and consequent loss of fertility (Court-Picon et al. 2004, Iliadis 2004). Furthermore, it has been demonstrated that forest fires play a fundamental role in determining the net carbon balance of the forest (Kurz et al. 1995). Thus, they may

affect greenhouse gas emissions with consequent feedback on climate change (Flannigan et al. 2005). The predicted changes in climate for this century are expected to be accompanied by changes in regional fire regimes as confirmed by paleontological evidence (Clark 1989) and correlation data from the last century (Floer et al. 1988). Forest fires, similar to other ecosystems, are highly sensitive to climate change because fire behaviour responds immediately to fuel moisture, which is affected by precipitation, relative humidity, air temperature and wind speed. The projected increase in temperature will increase fuel dryness and reduce relative humidity, and this effect will become more severe in those regions where rainfall decreases (Floer et al. 1988). Accordingly, increases in climate extreme events are expected to have a great impact on fire risk.

Many attempts have been made to quantify potential impact of climate change on fire risks (Ties & Ford

*Email: marco.moriondo@unifi.it

Canadian Forest Fire Weather Index System



Temperature,
Relative Humidity,
Wind, Precipitation

Wind

Temperature,
Relative Humidity,
Precipitation

Temperature,
Precipitation

Fine Fuel
Moisture Code

Duff Moisture
Code

Drought Code

Initial Spread
Index

Buildup Index

**Fire Weather
Index (FWI)**

Climate Simulations

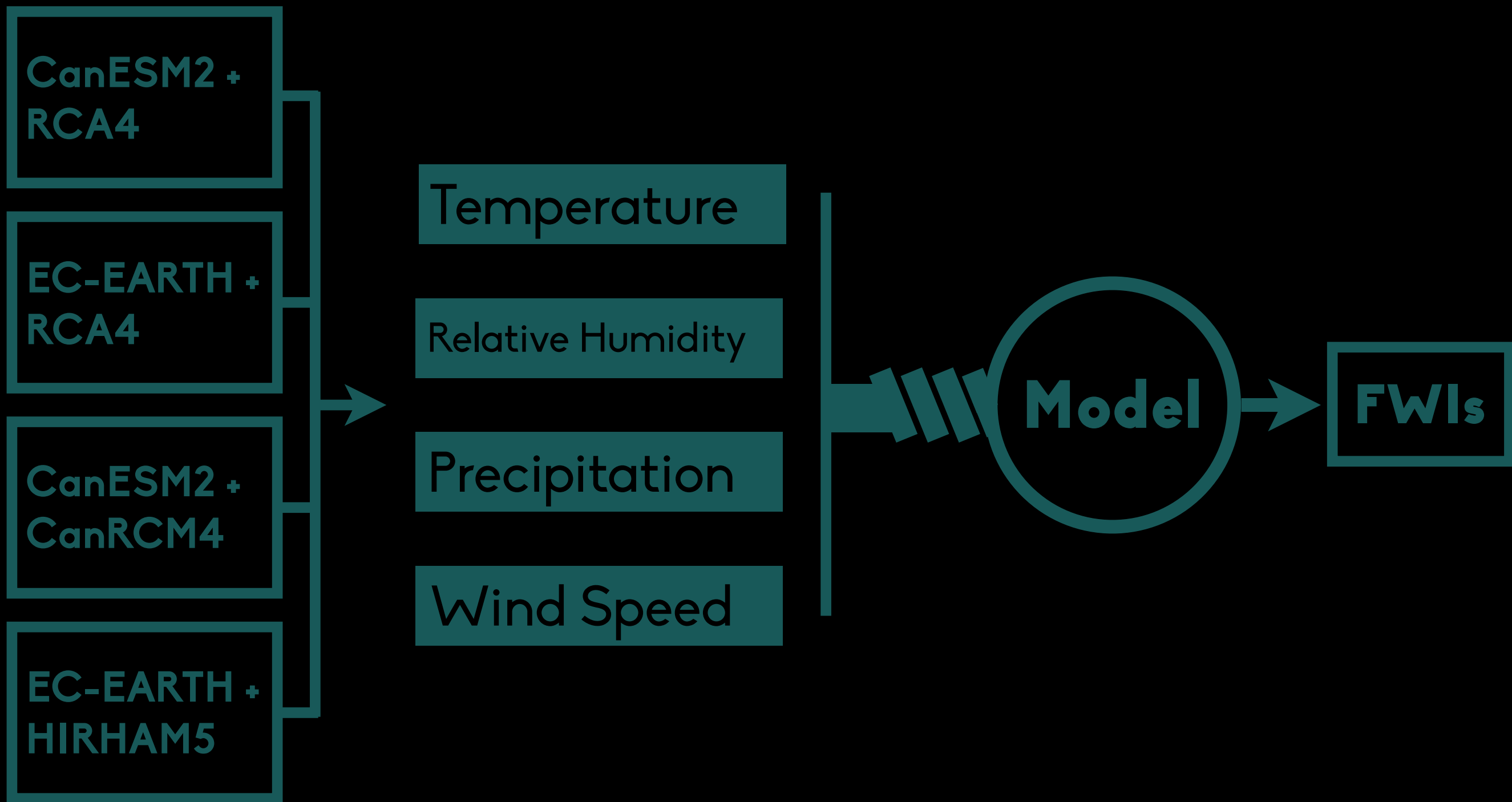


COordinated Regional climate Downscaling EXperiment



ICSU

International Council for Science



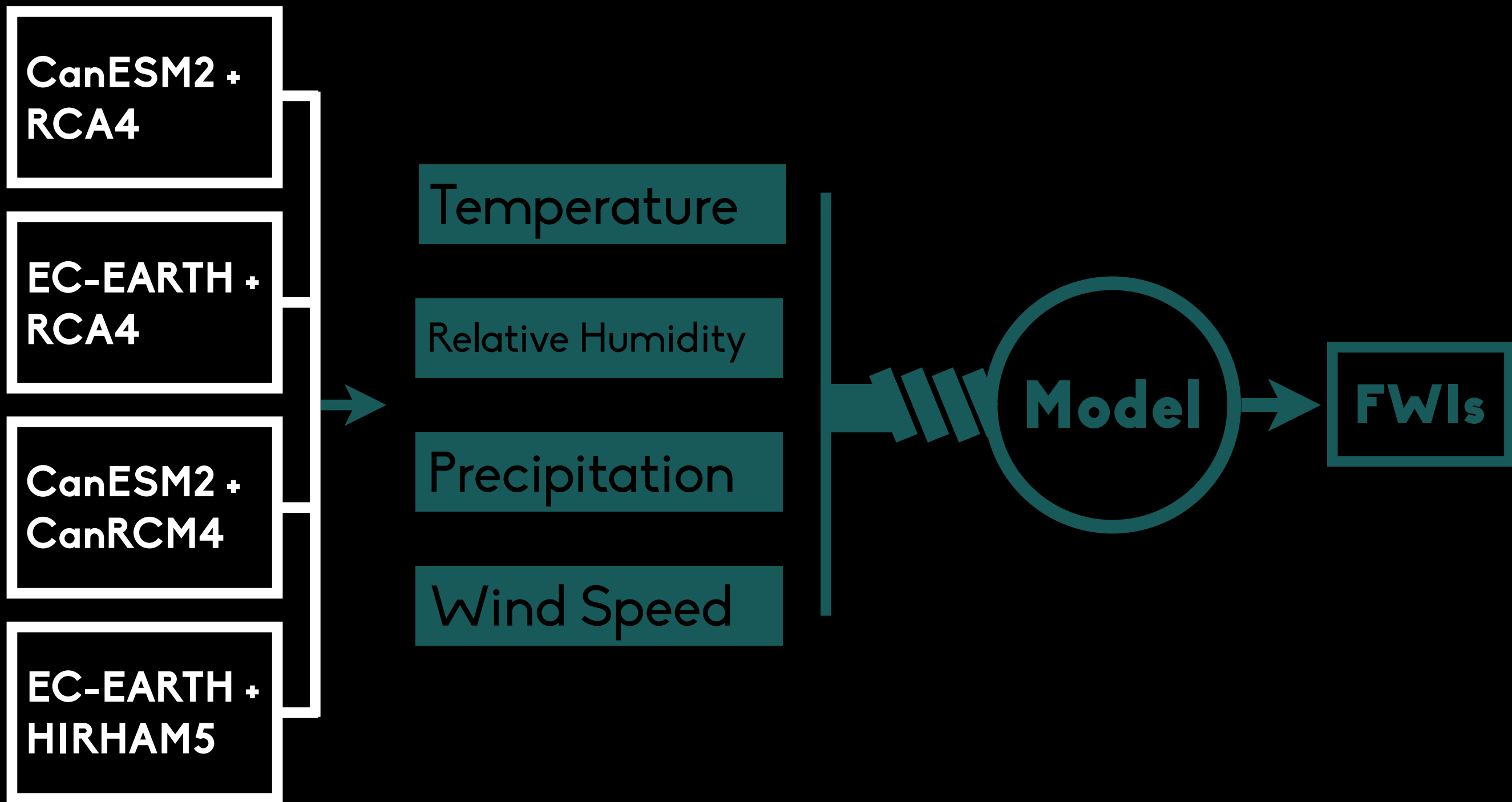
CORDEX
Models

Driving
Variables

Canadian Forest
Fire Weather
Index System

Output

RCP8.5, 0.44° horizontal grid resolution, daily frequency

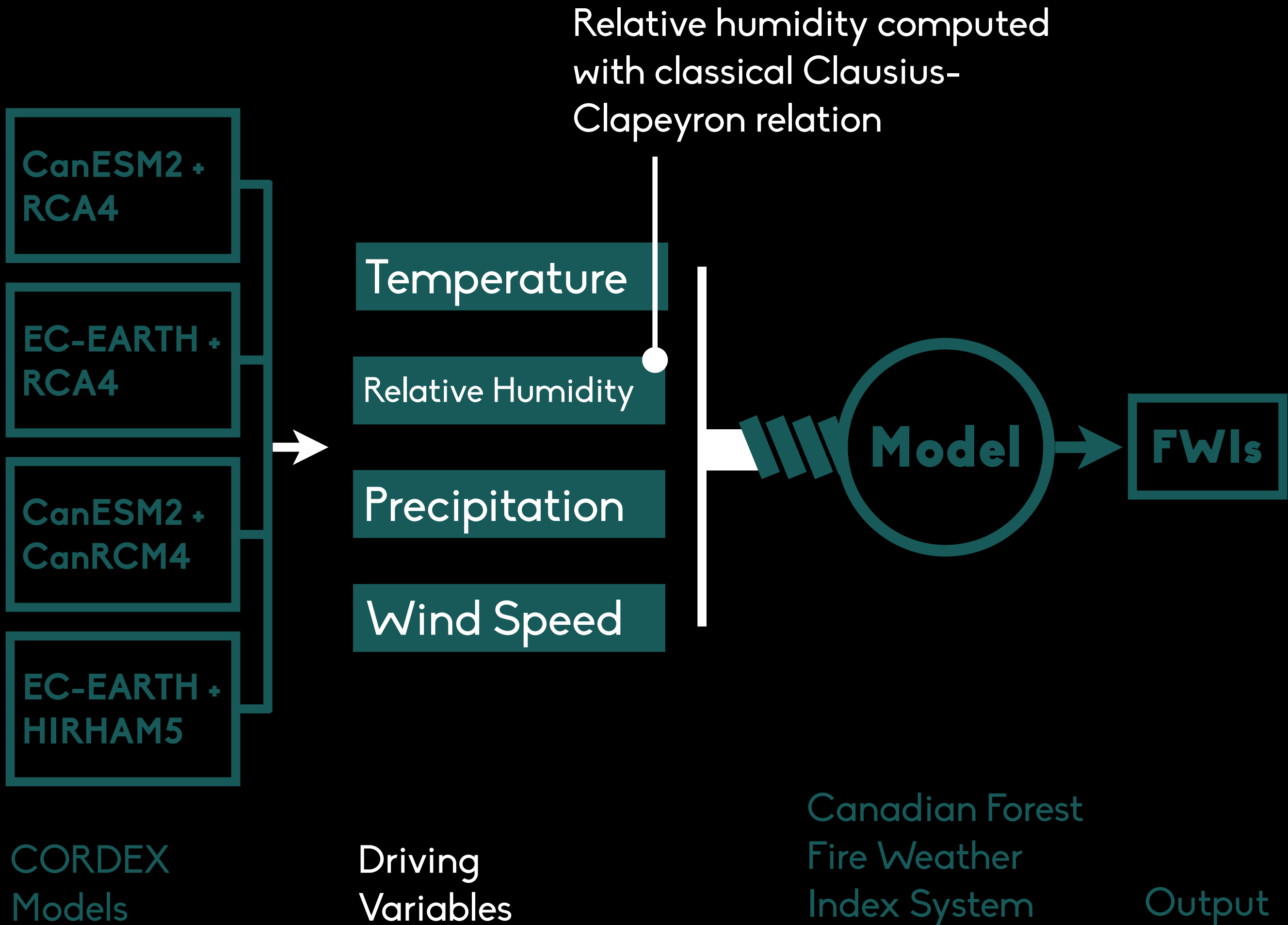


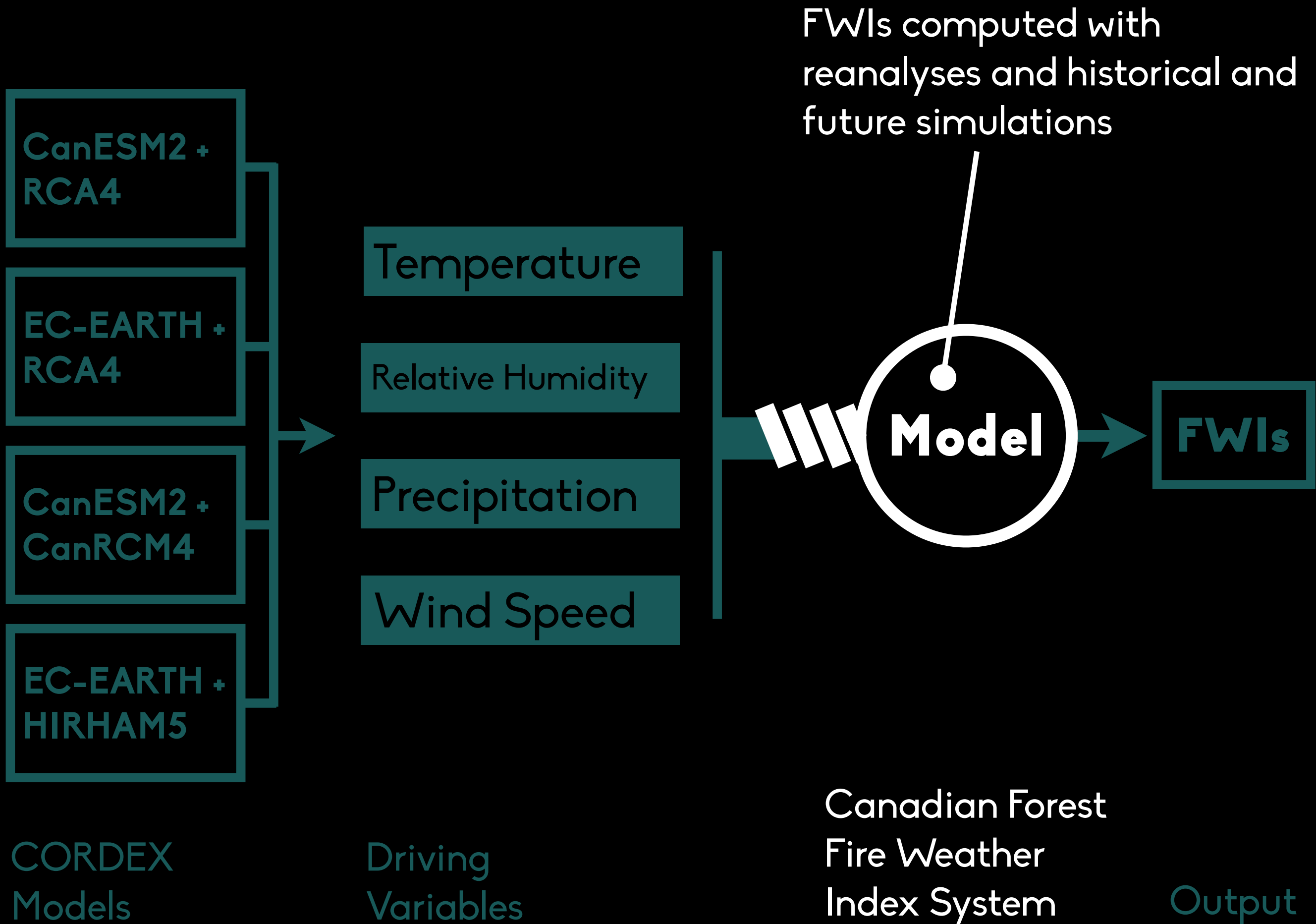
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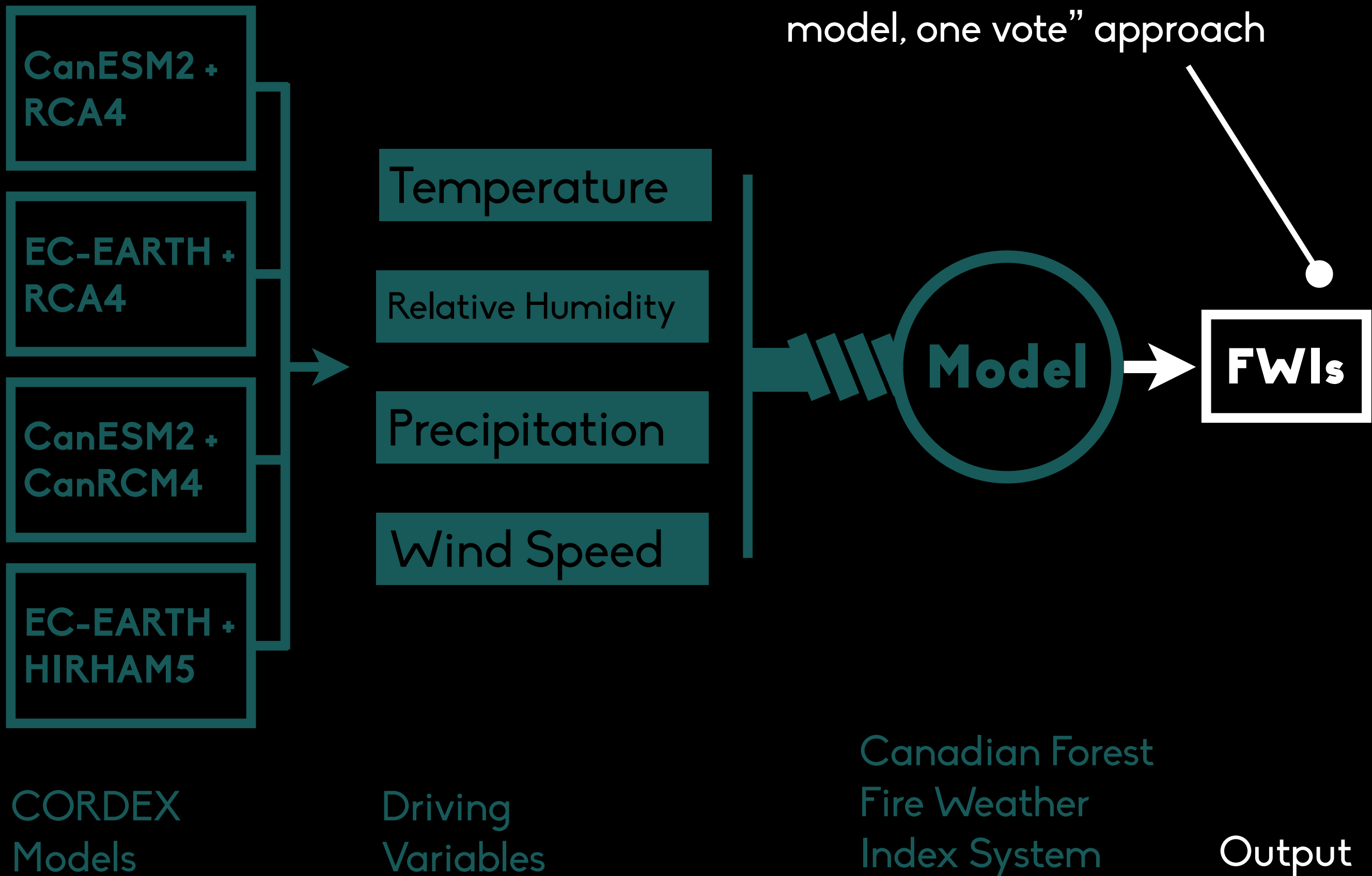
Driving
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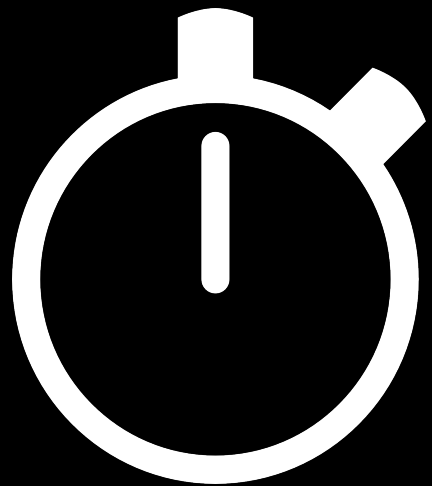








**Changing magnitude
of FWIs**



**Changing shape of the
fire season**

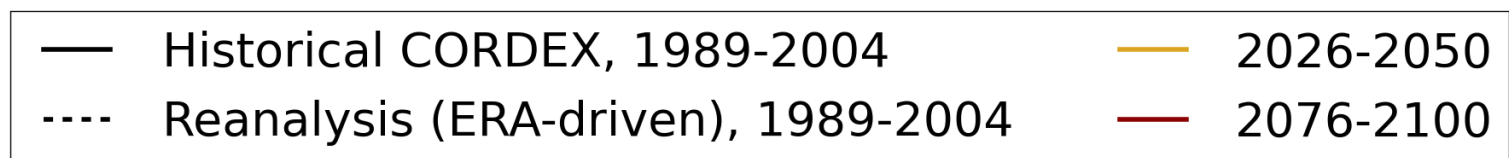
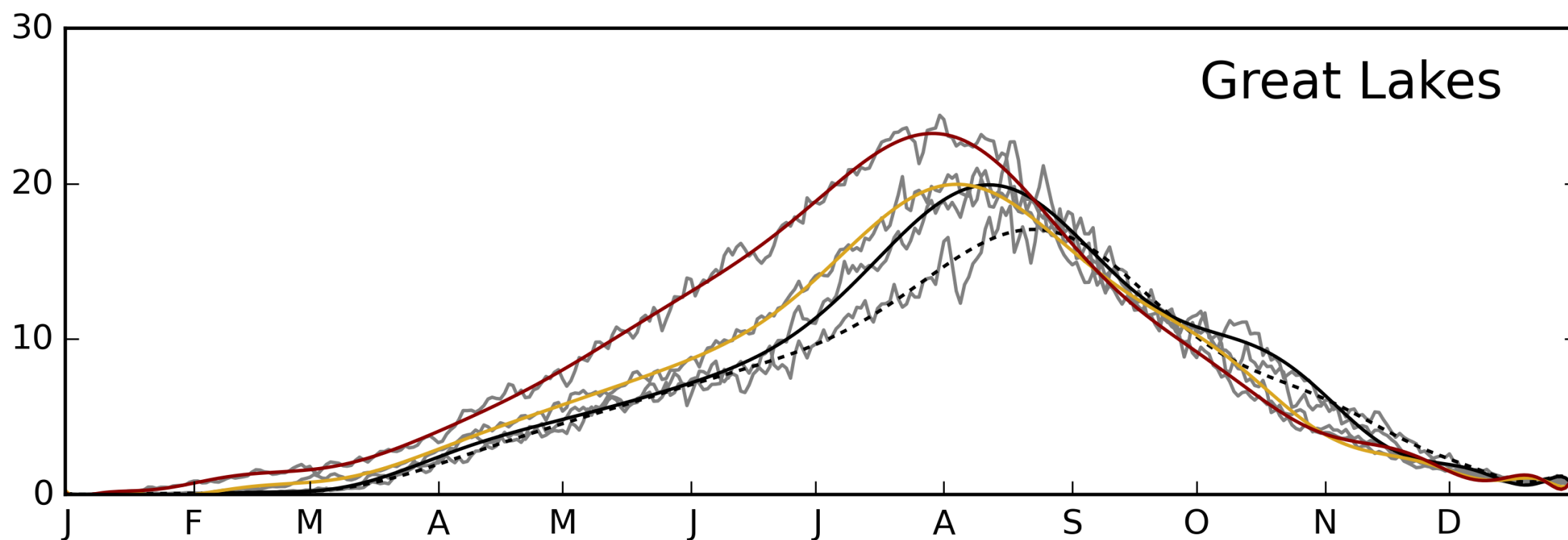
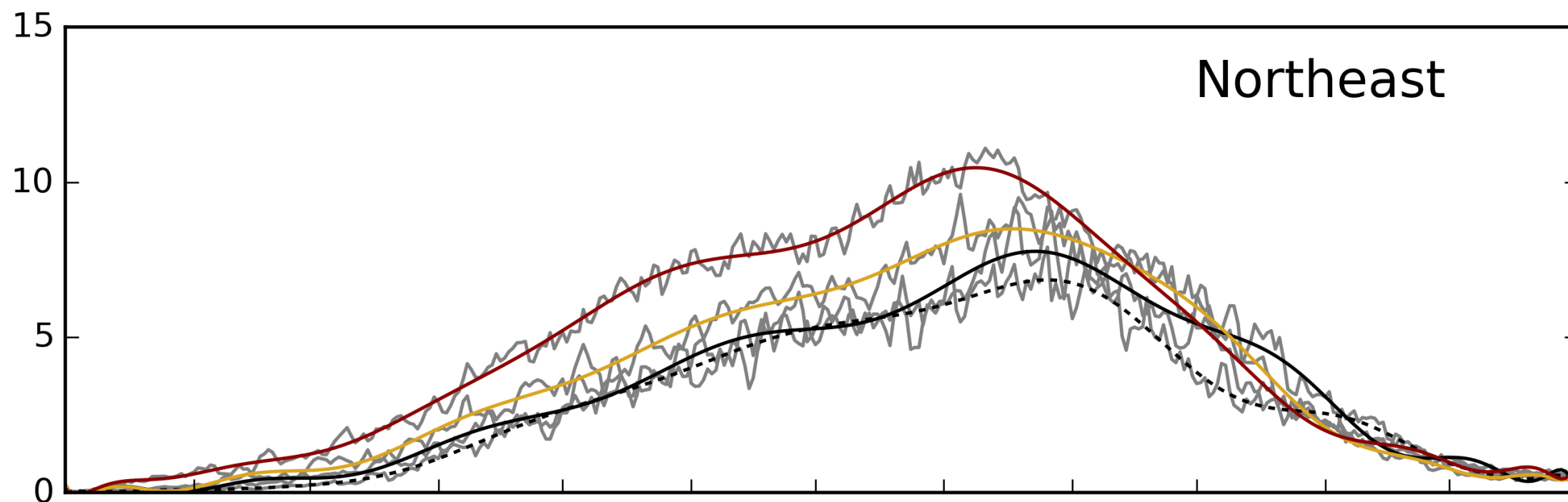


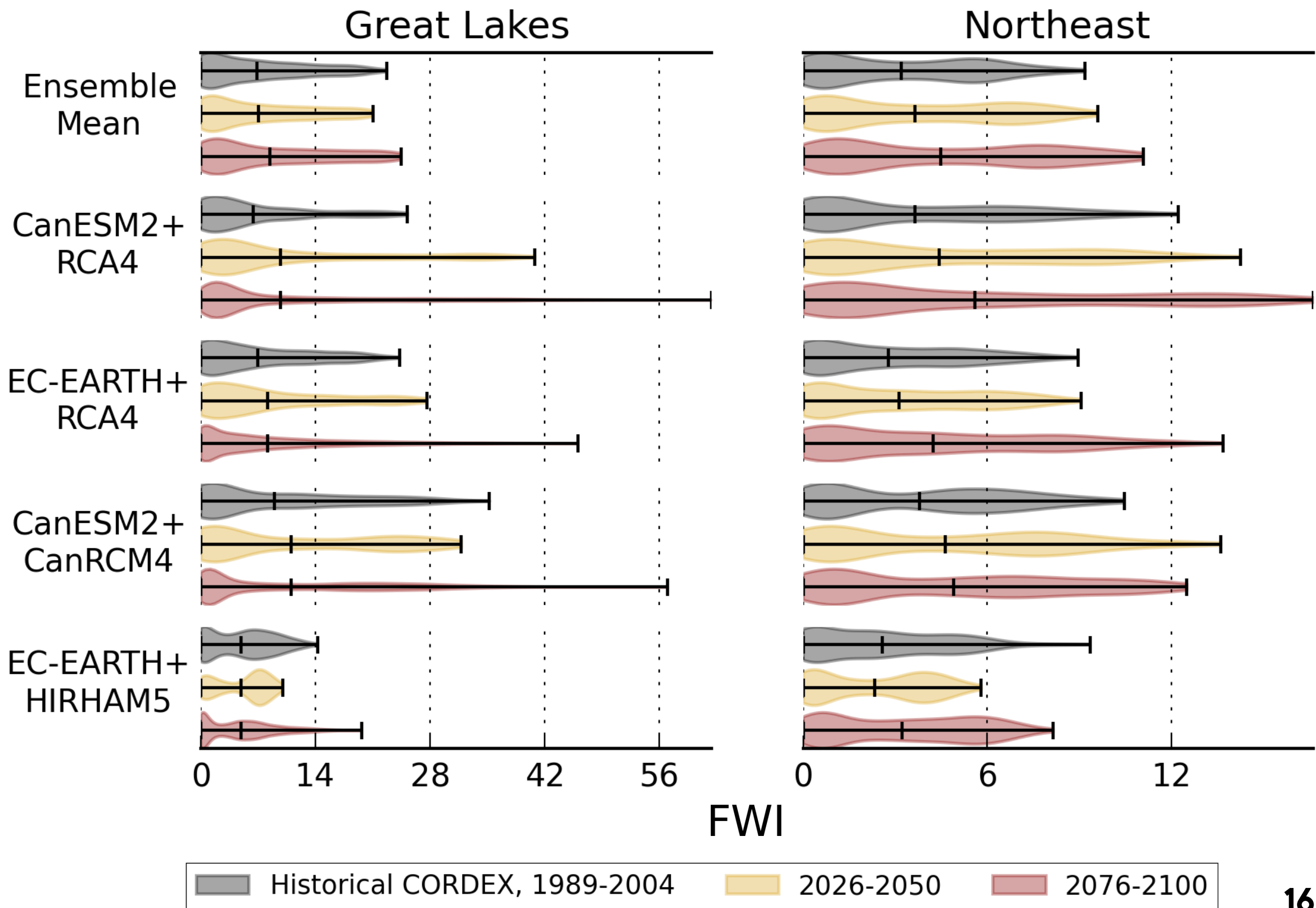
**Changing high risk
episodes**



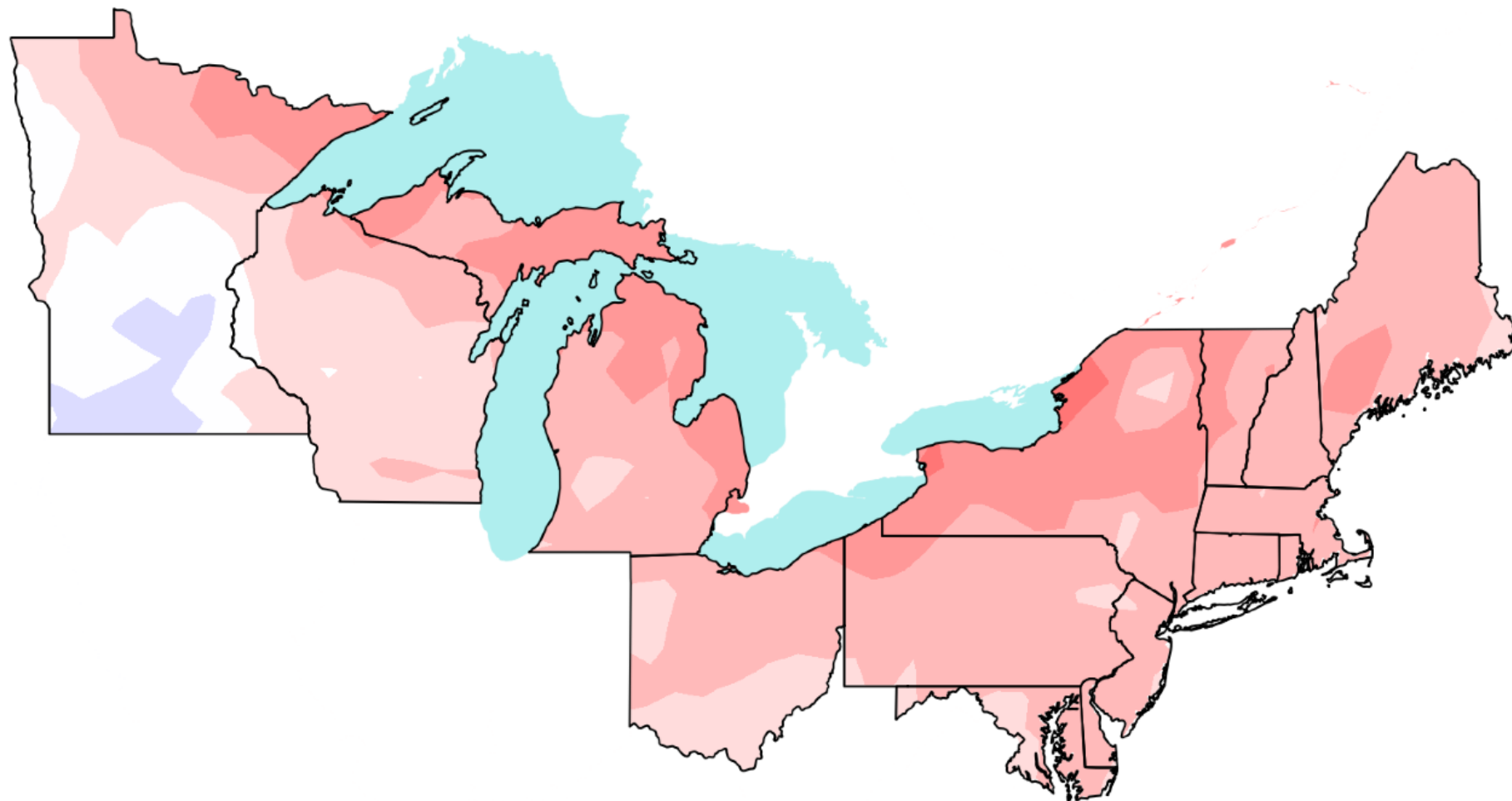
Changing
magnitude of
FWIs

FWI



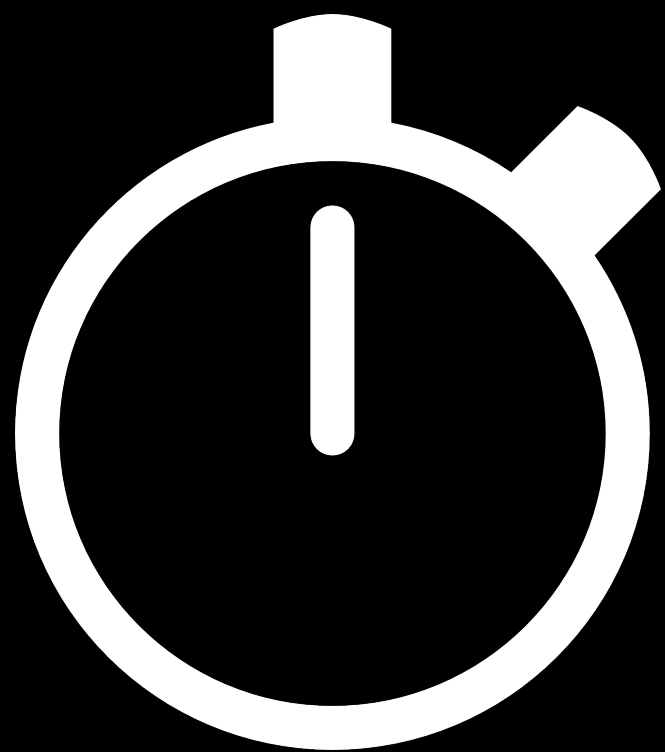


Trend Decade⁻¹ (1989-2100)

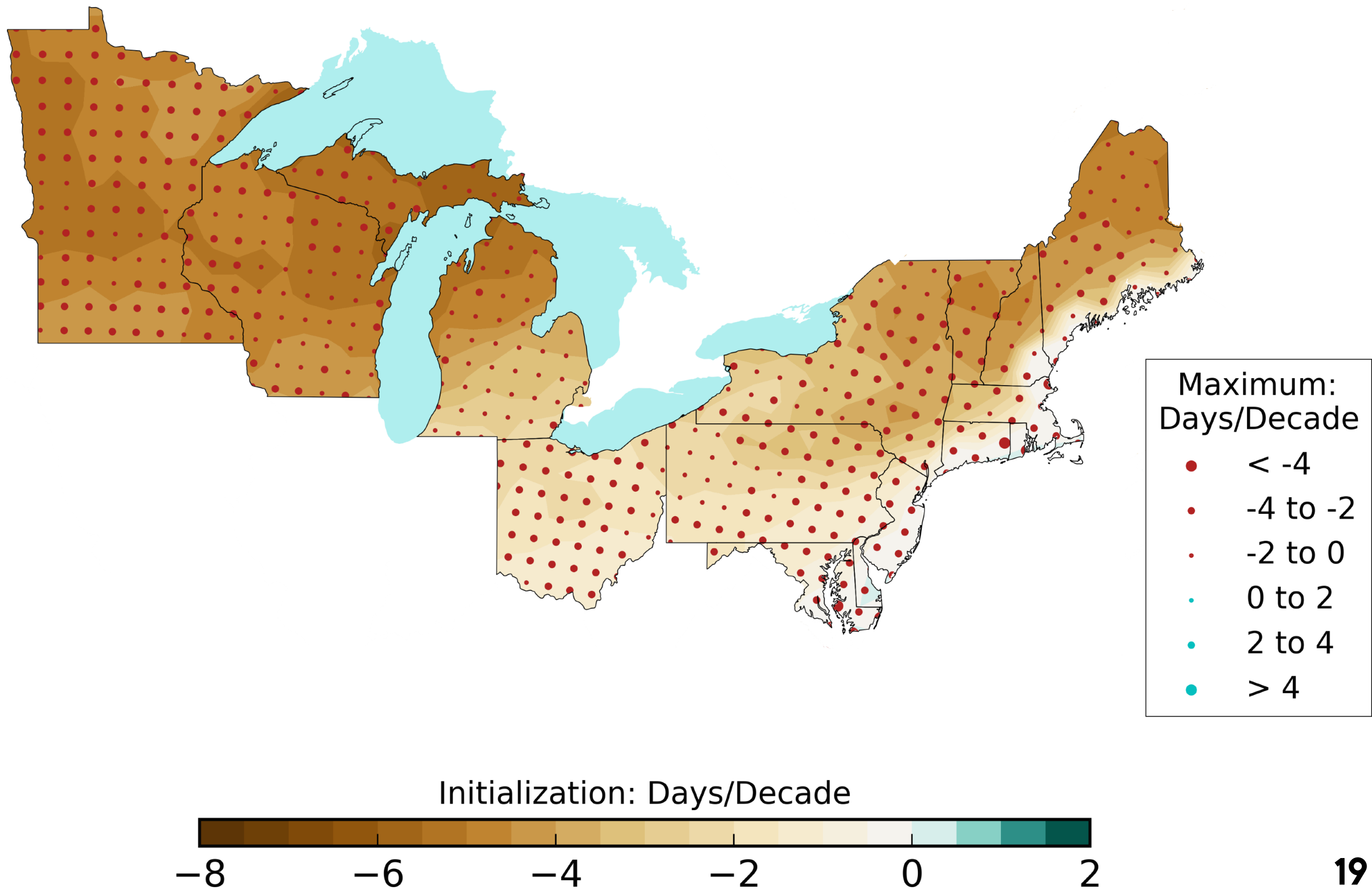


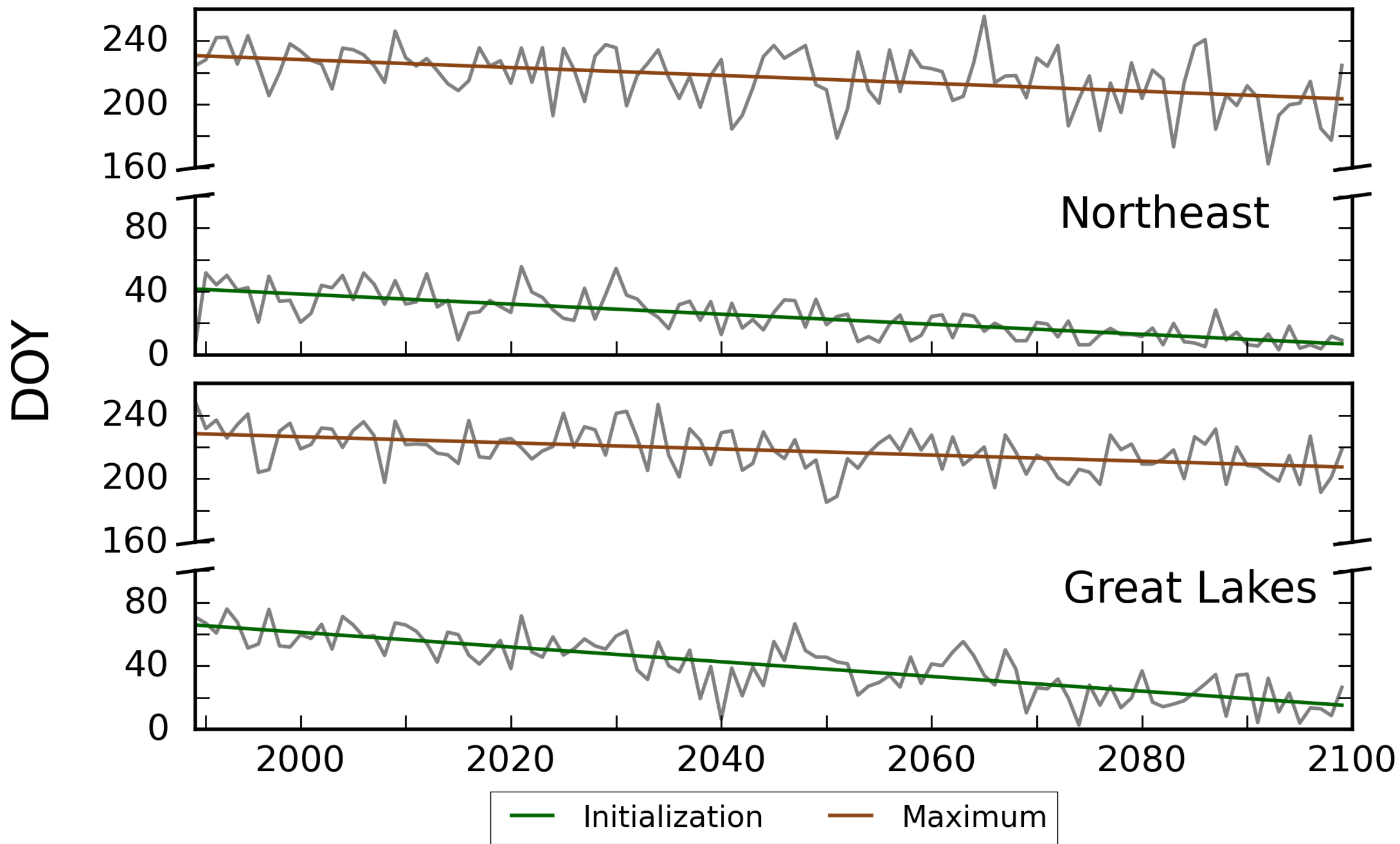
FWI





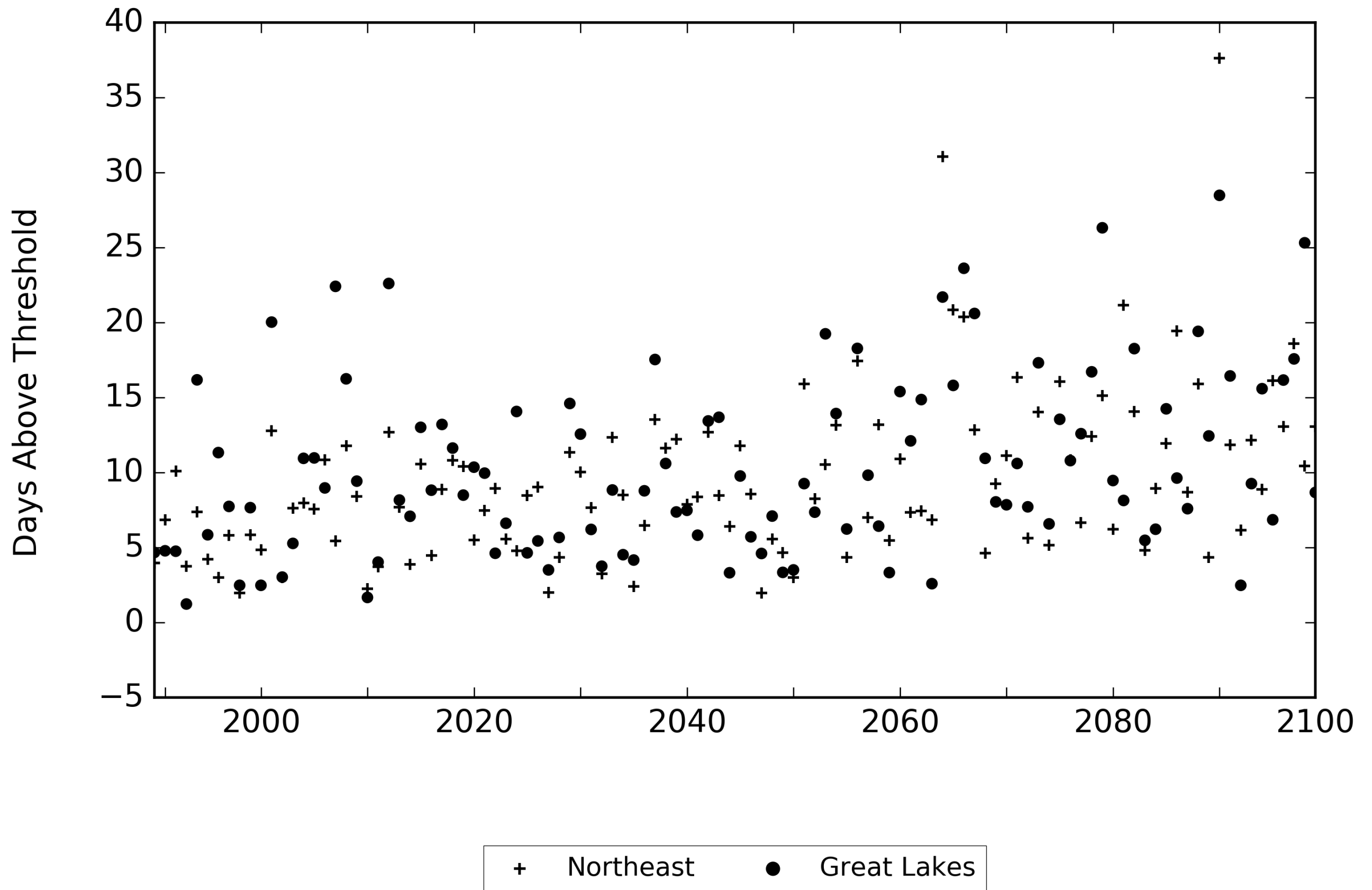
**Changing
shape of the
fire season**

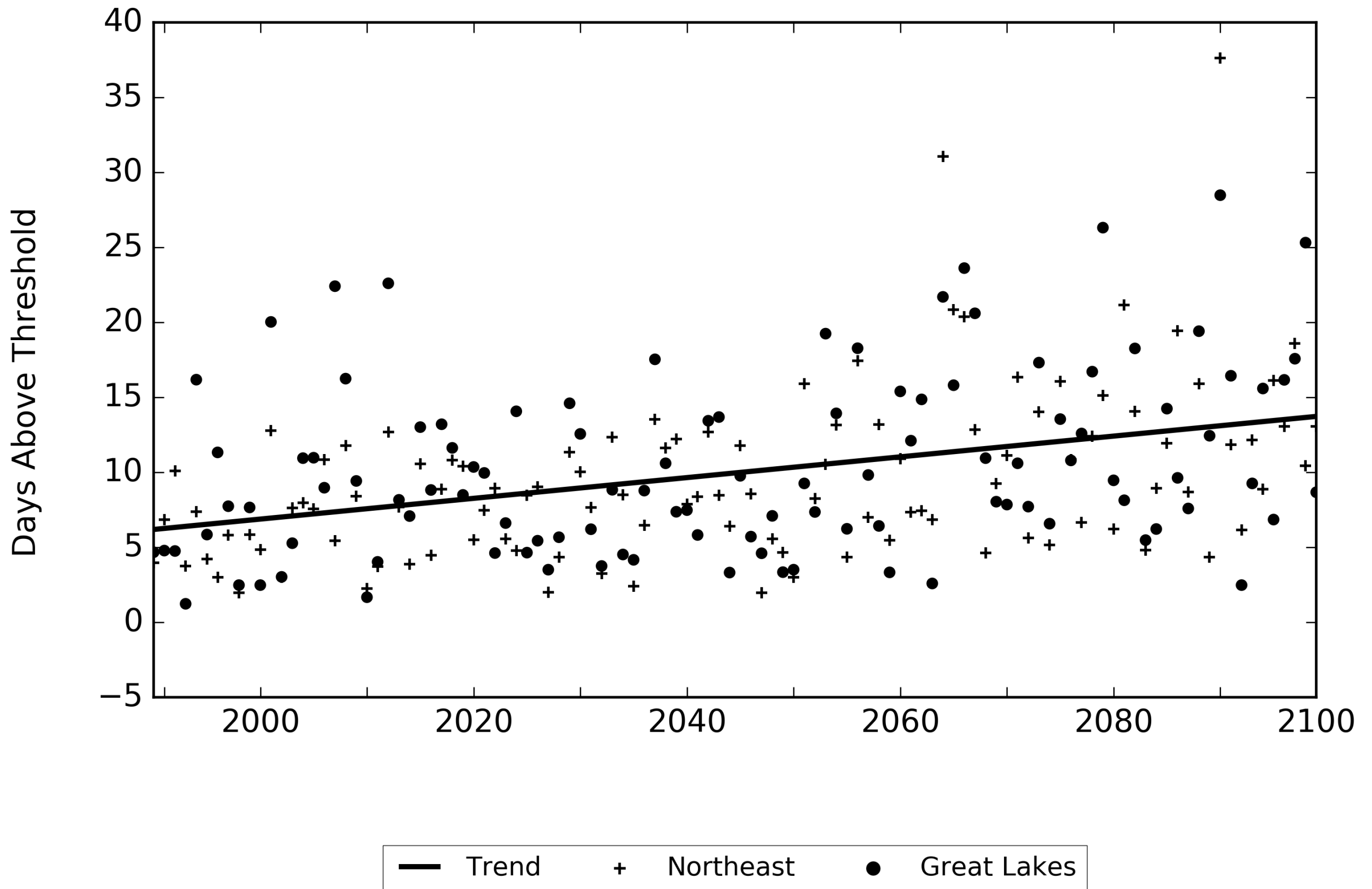




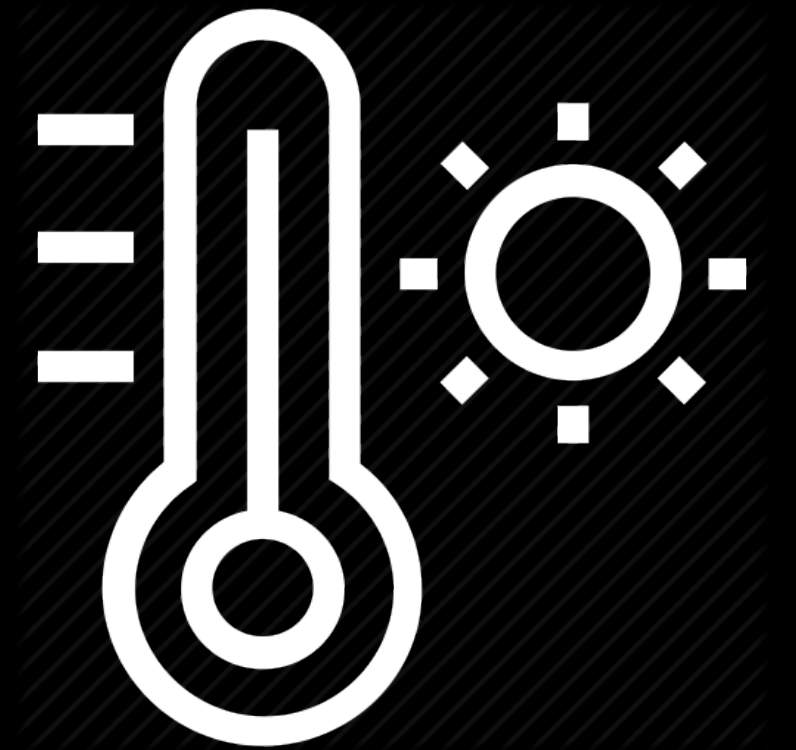


Changing high
risk episodes





Understanding Simulated Changes



Four driving variables — four cases

1. **historical** temperature
future relative humidity
future wind speed
future precipitation } FWI adjusted, temp

2. future temperature
historical relative humidity
future wind speed
future precipitation } FWI adjusted, RH

$$\text{FWI percentage change} = \frac{\text{FWI}_{\text{adjusted}} - \text{FWI}_{\text{future}}}{\text{FWI}_{\text{future}}} \cdot 100\%$$

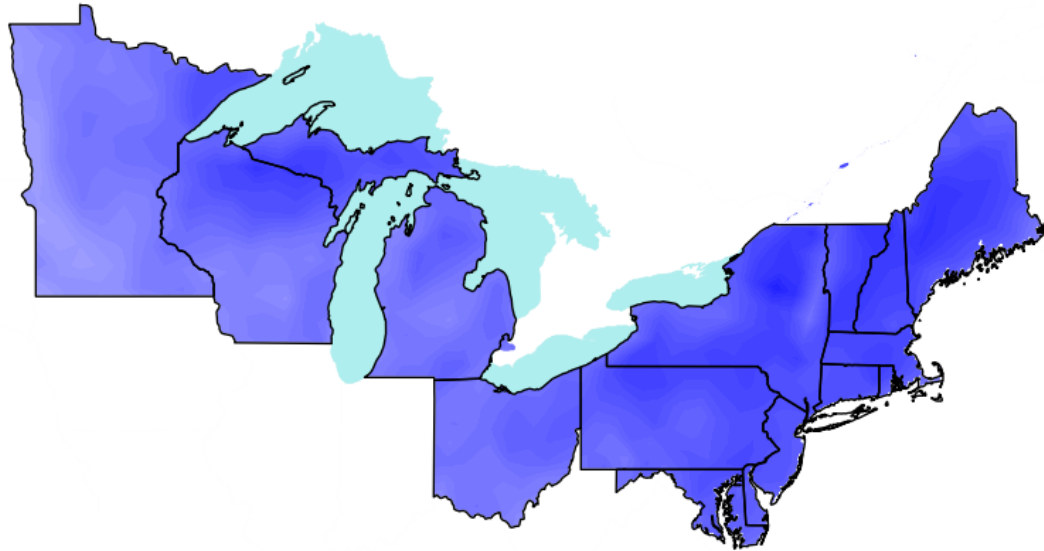
Four driving variables — four cases

3. future temperature
future relative humidity
historical wind speed
future precipitation } FWI adjusted, wind

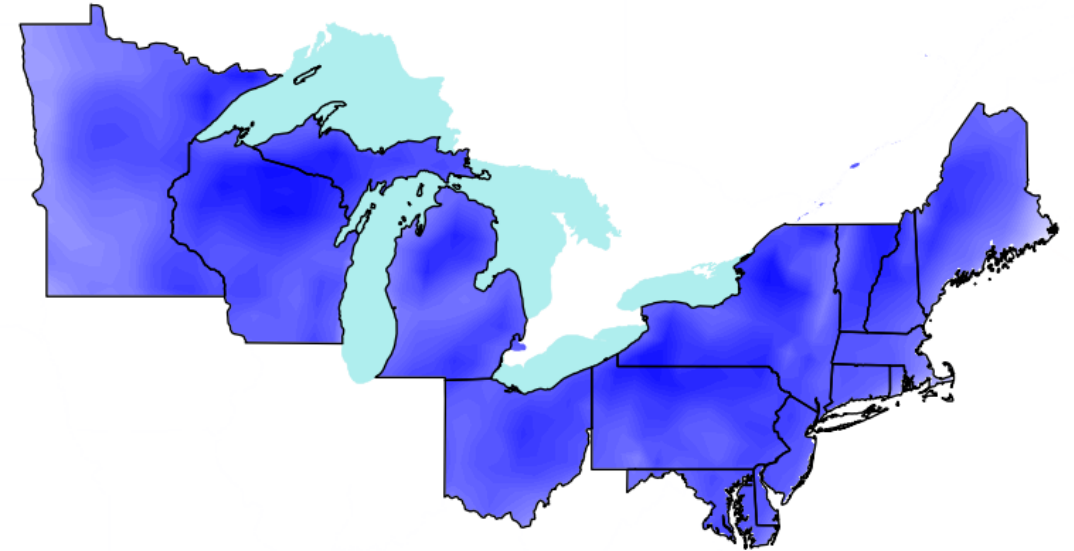
4. future temperature
future relative humidity
future wind speed
historical precipitation } FWI adjusted, precip

$$\text{FWI percentage change} = \frac{\text{FWI}_{\text{adjusted}} - \text{FWI}_{\text{future}}}{\text{FWI}_{\text{future}}} \cdot 100\%$$

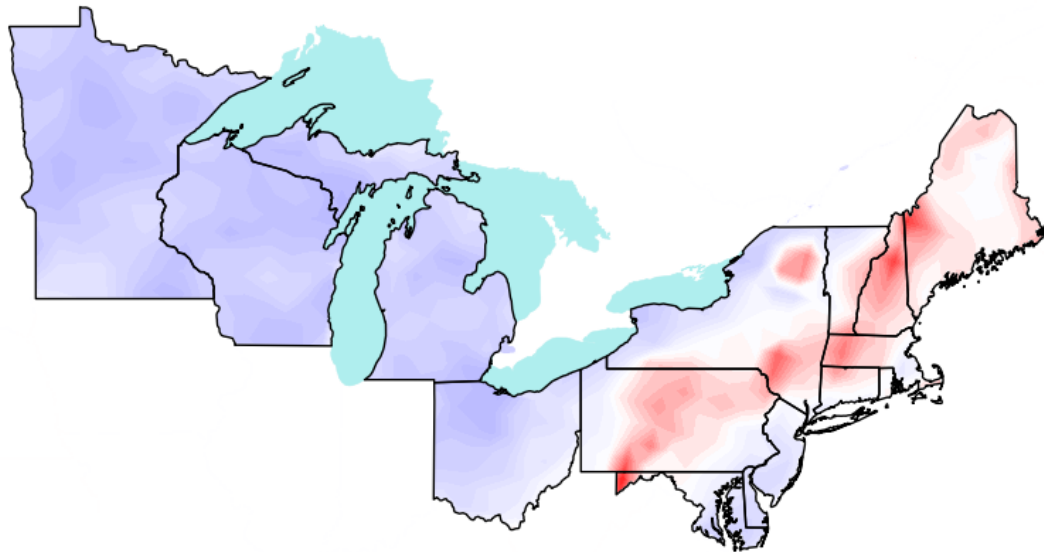
Temperature



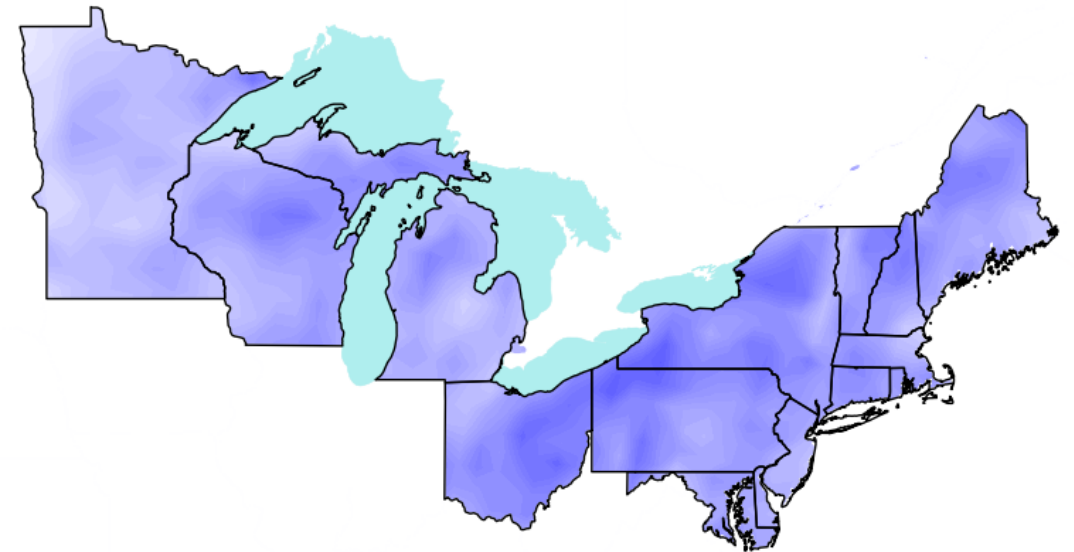
Relative Humidity



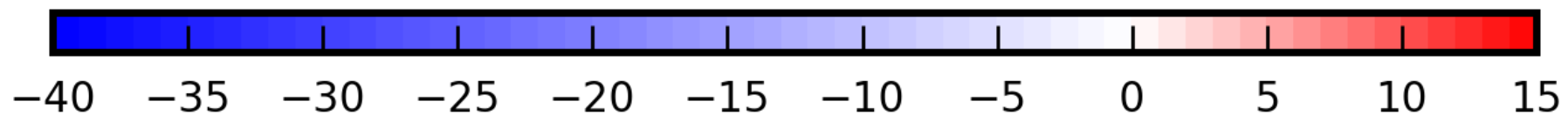
Wind Speed



Precipitation



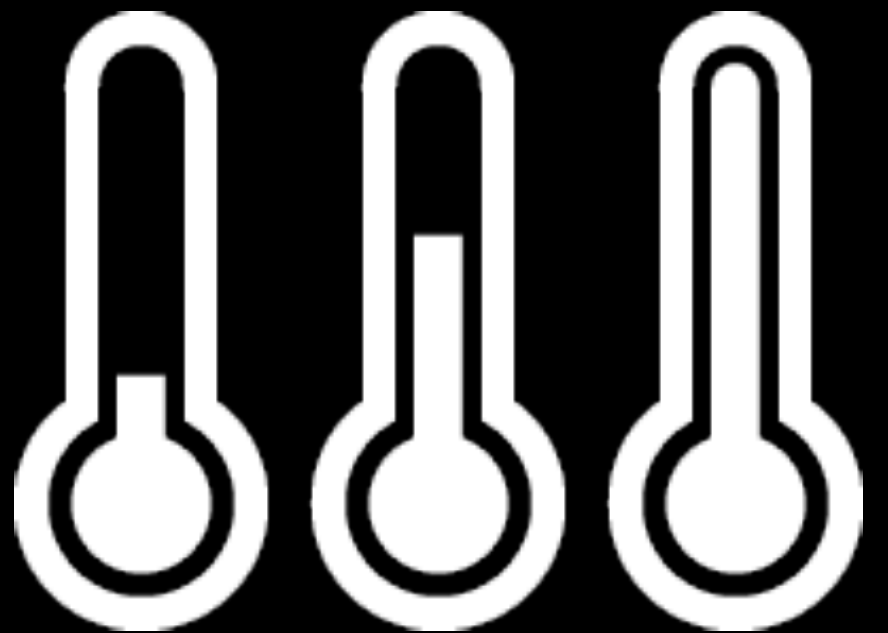
Percentage (%)



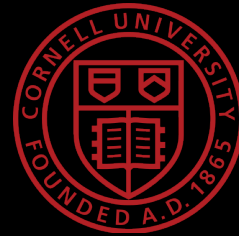
Summary

- Increased wildland fire risk during the 21st century with largest increases in northern portions of the focus region
- Significant changes in the date of the initialization of the Canadian Forest Fire Weather Index System and the peak of the wildland fire season
- Increasing duration of high risk episodes

Acknowledgments



Arthur DeGaetano



Cornell University

Mike Flannigan



UNIVERSITY OF
ALBERTA

Daniel Ward



Cathelijne Stoof



WAGENINGEN UR
For quality of life

North Atlantic Fire Science Exchange



Additional questions or comments? Contact gaige.kerr@jhu.edu