Large-scale climatic controls of fire activity in red pine forests point to the role of winter/spring conditions since 1675 AD and generally less fire prone weather since the mid-20th century

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Main goal and Hypothesis

Aim: examine the effect of large-scale modes of climate variability on the regional history of red pine forests

Hypotheses:

1. There are states of atmospheric circulation, captured by climate oscillation indices, that are consistently associated with increased fire activity over the distribution range of mixed pine forests in eastern North America.

2. These states mark periods of increased climatological fire hazard over the study area.

Main findings

- Years with increased fire activity in the reconstructed record fire records were associated with:
  - El Niño
  - Positive NAO
  - The combination La Niña/PDO neutral
- Only La Niña/PDO neutral in the modern record
- Warmer winters/springs might lead to higher fire activity
  - Formation of thinner snowpack that melts quicker => drier fuels
- Frequency of fire-prone climate states decreased in the mid 20th cent.

Methods

|	FIRE DATA	CLIMATE INDICES
HISTORICAL RECORD (1675-1900)	Synthesis of dendro-resolved fire reconstructions from red pine forests	ENSO PDO NAO
MODERN RECORD (1959-2020)	Area burned from observation data from the Canadian government	
MODERN RECORD (1950-2020)	Fire relevant monthly weather data (mid-troposphere SLP and temperature)	

- Identify associations between climate indices and fire activity in the reconstructed record

- Use a modern-day analog to develop mechanistic explanations of the associations we observed
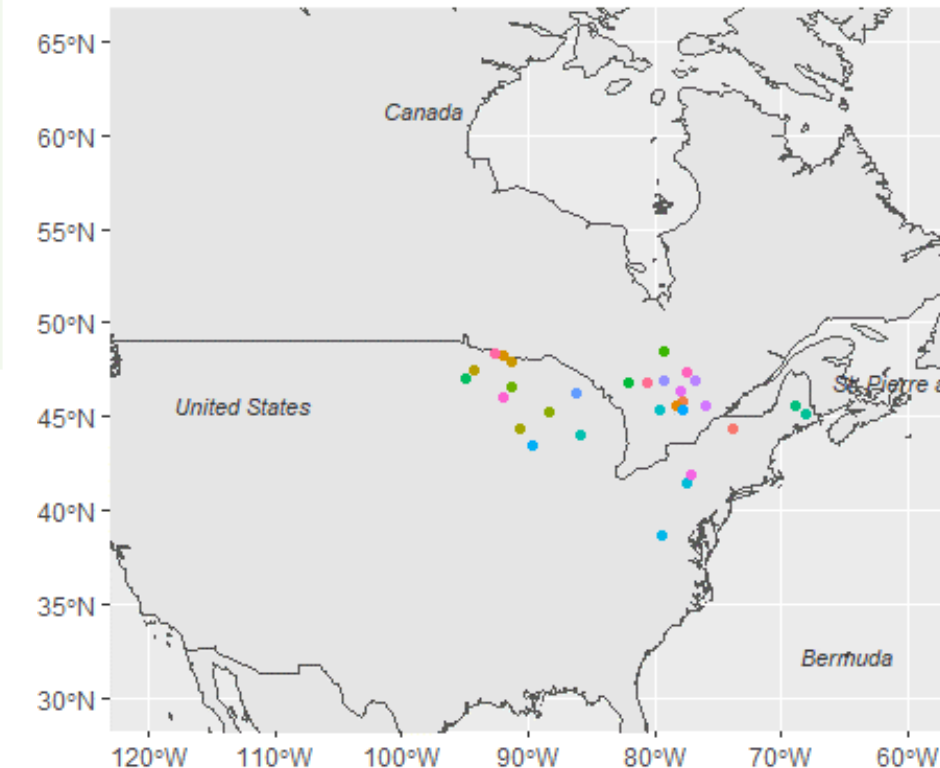
Positive NAO

Reconstructed record (1675-1900)

NAO mean value per bin
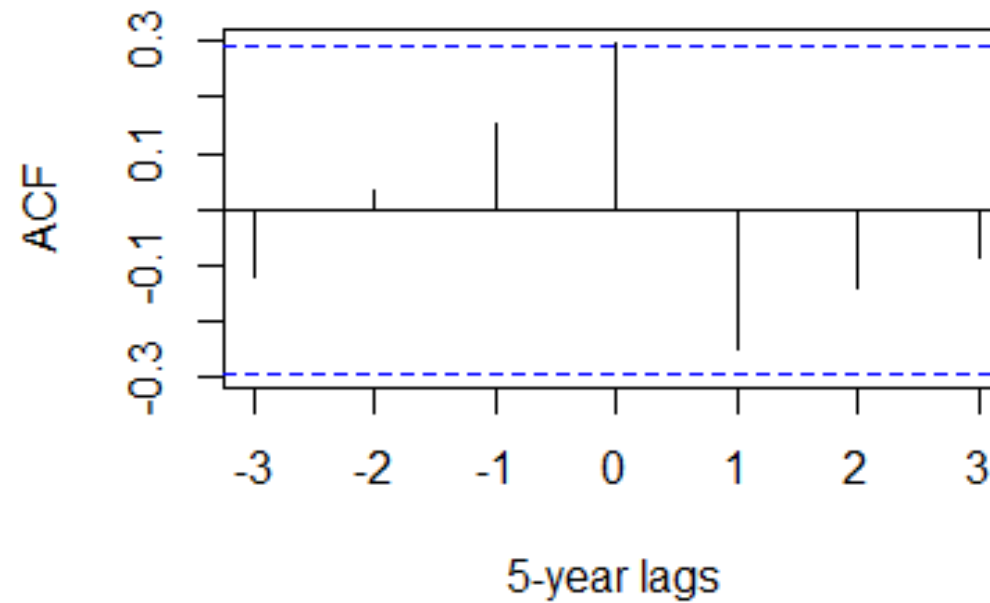
Positive NAO

Mid-troposphere SLP
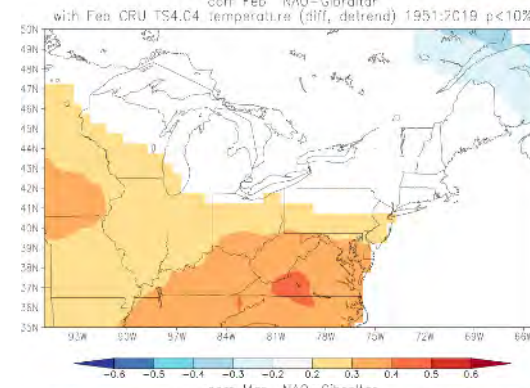
Temperature

January
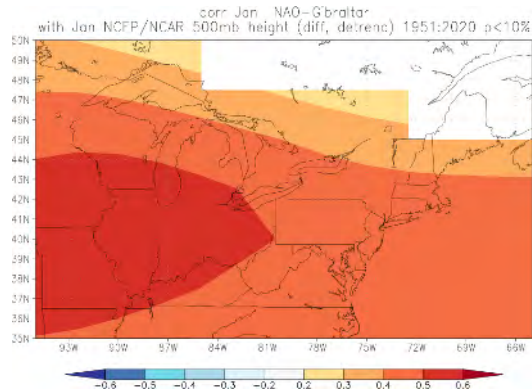
February
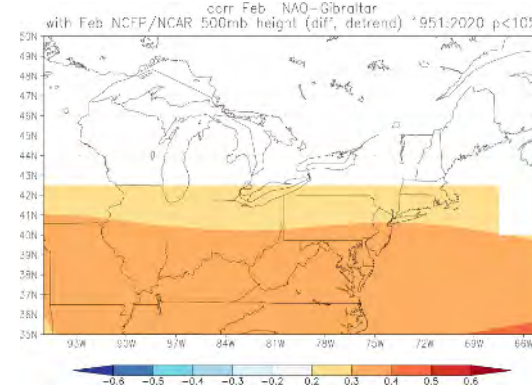
March
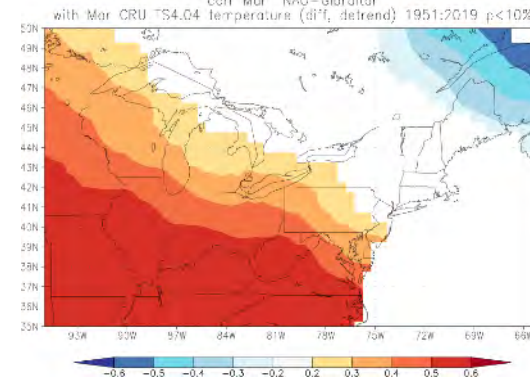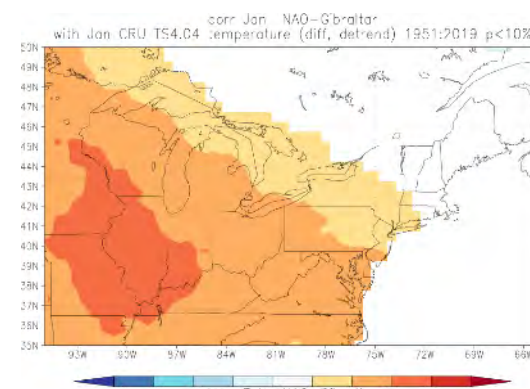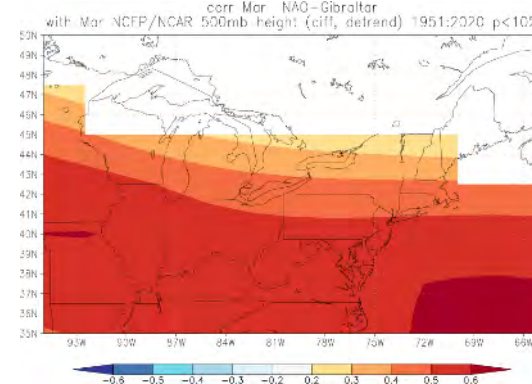
El Niño

Reconstructed record (1675-1900)
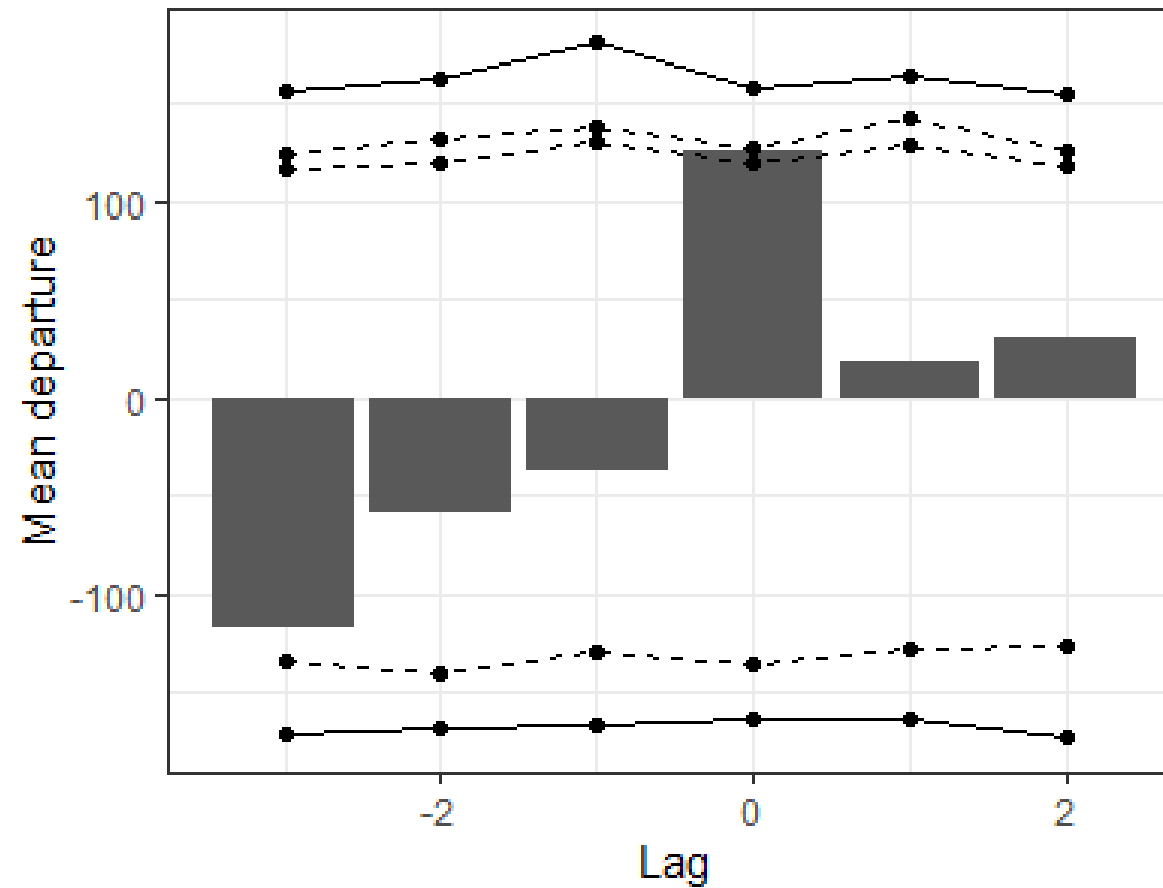
La Niña/PDO neutral

Mid-troposphere SLP

Temperature
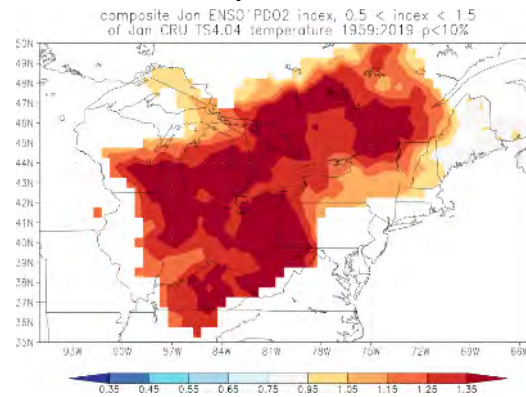
January

February

March

Reconstructed record (1675-1900)

ENSO	PDO	N	Observed	Expected	Significance percentile
La Niña	PDO neutral	23	0.217	0.0877	0.979

Modern record (1959-2020)
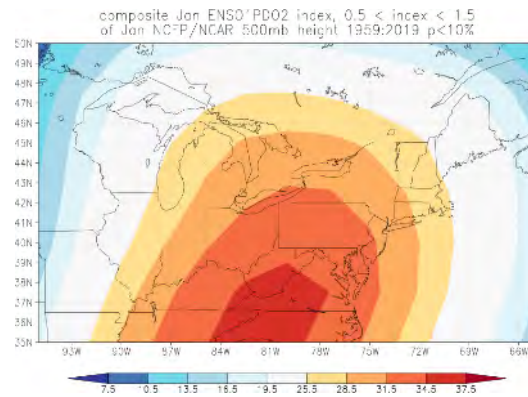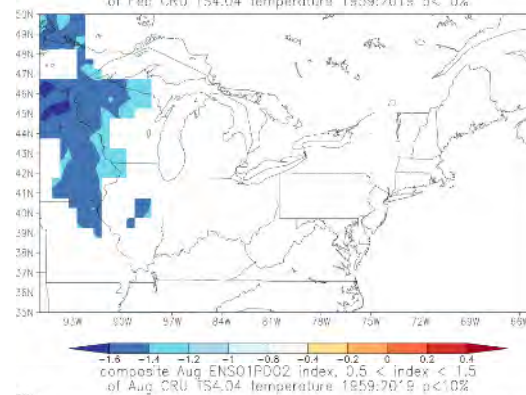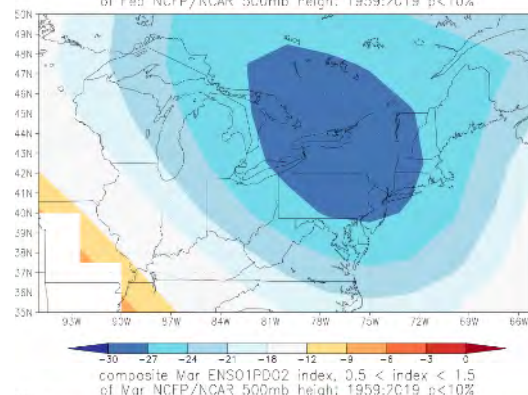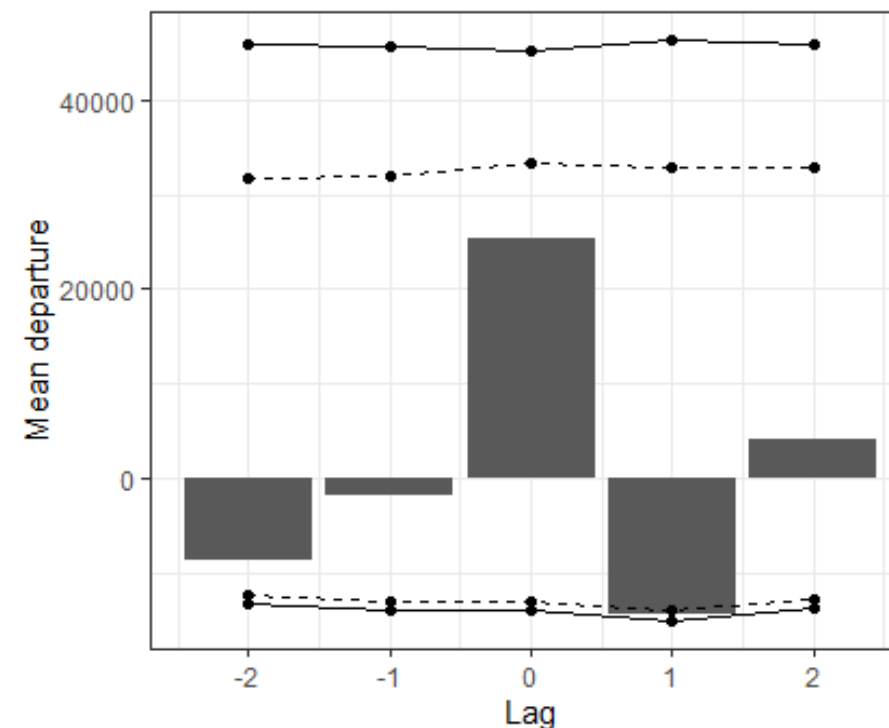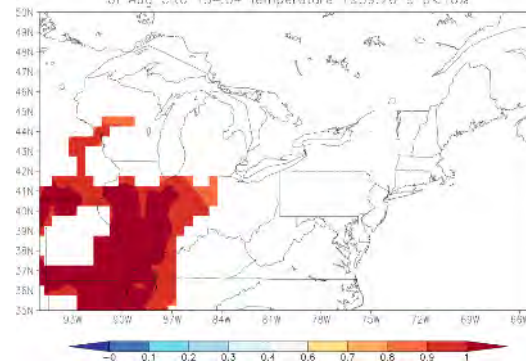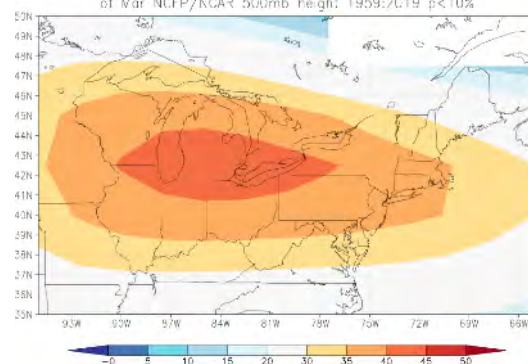
Nonlinear weather responses to ENSO
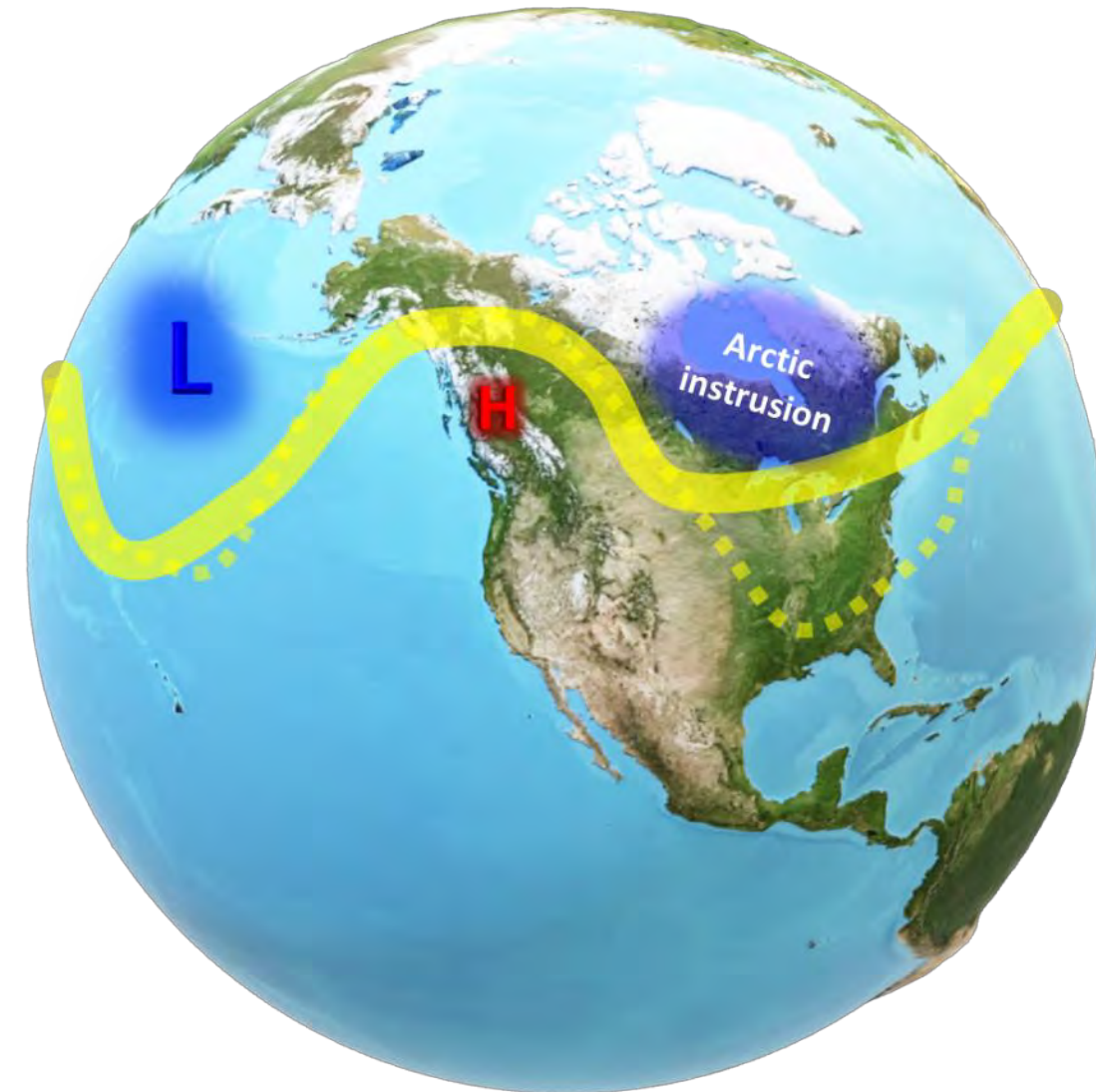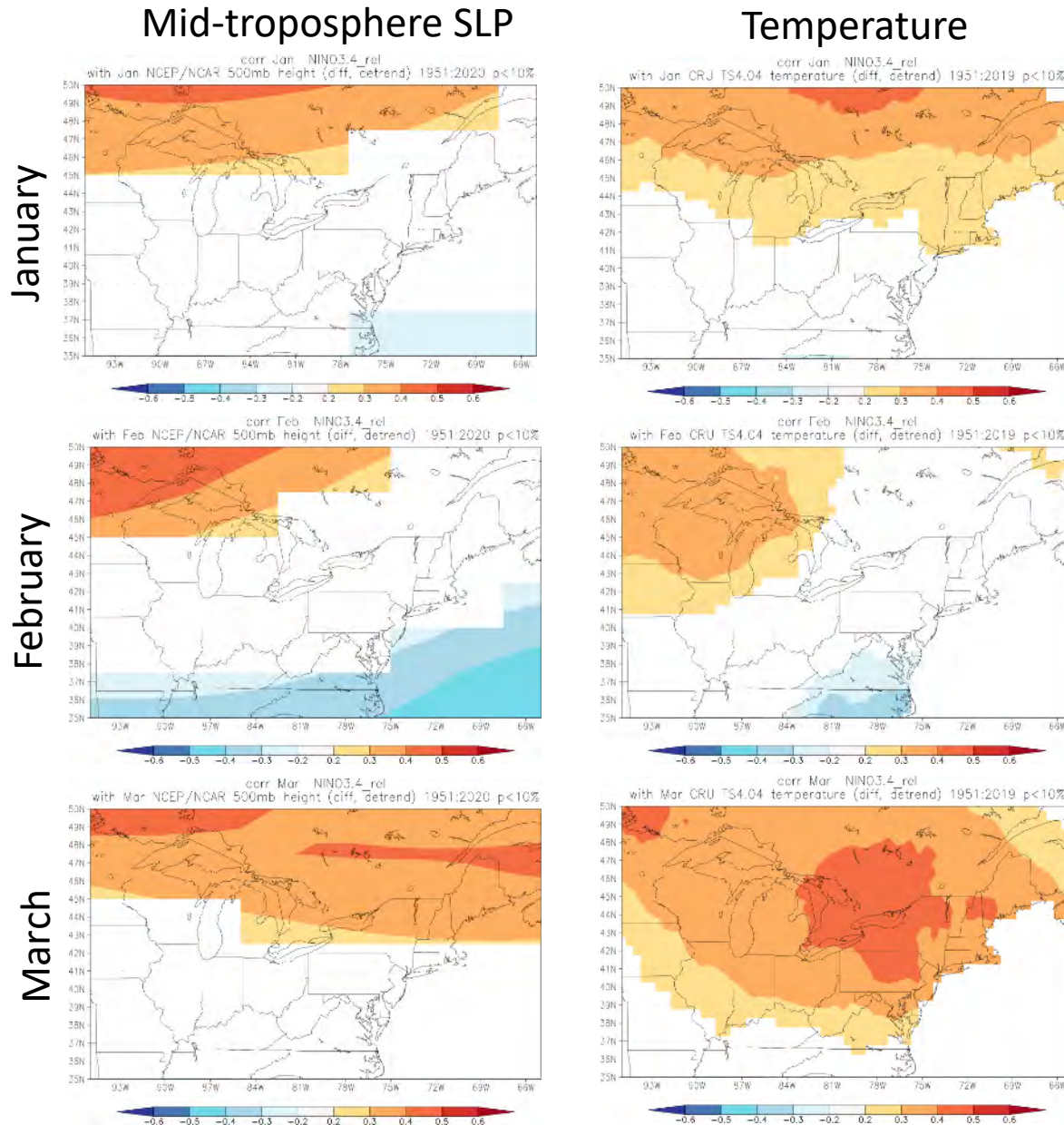
In general, less fire-prone weather in eastern North America since the mid 20th cent.
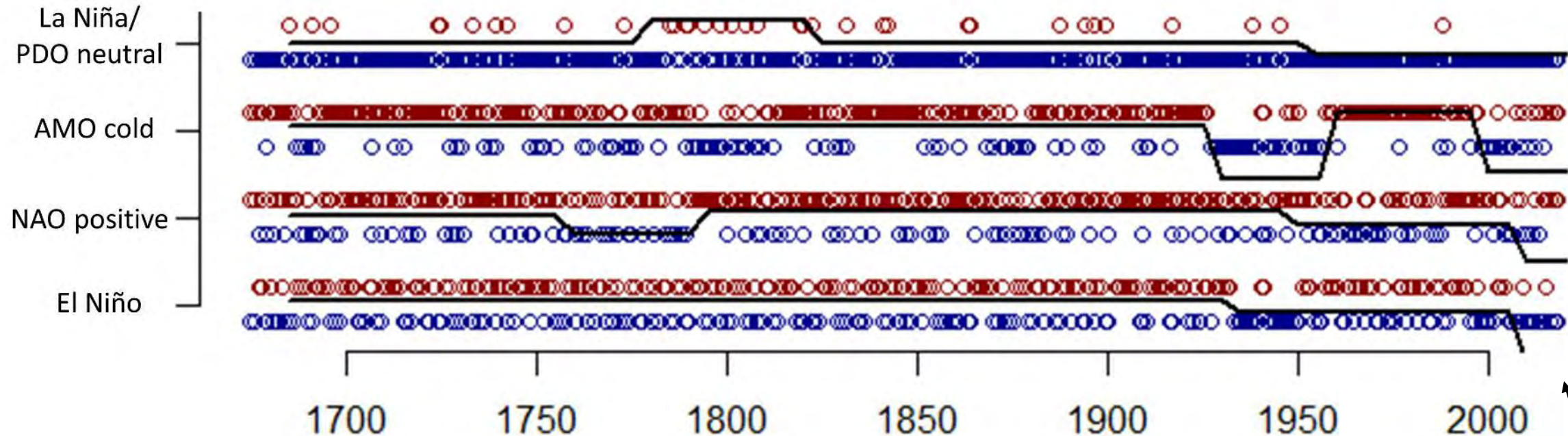
Decrease in the frequency of potentially fire-prone climate states