Influence of Atmospheric Teleconnections on Interannual Variability of Arctic-boreal Fires

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This presentation participates in OSPP

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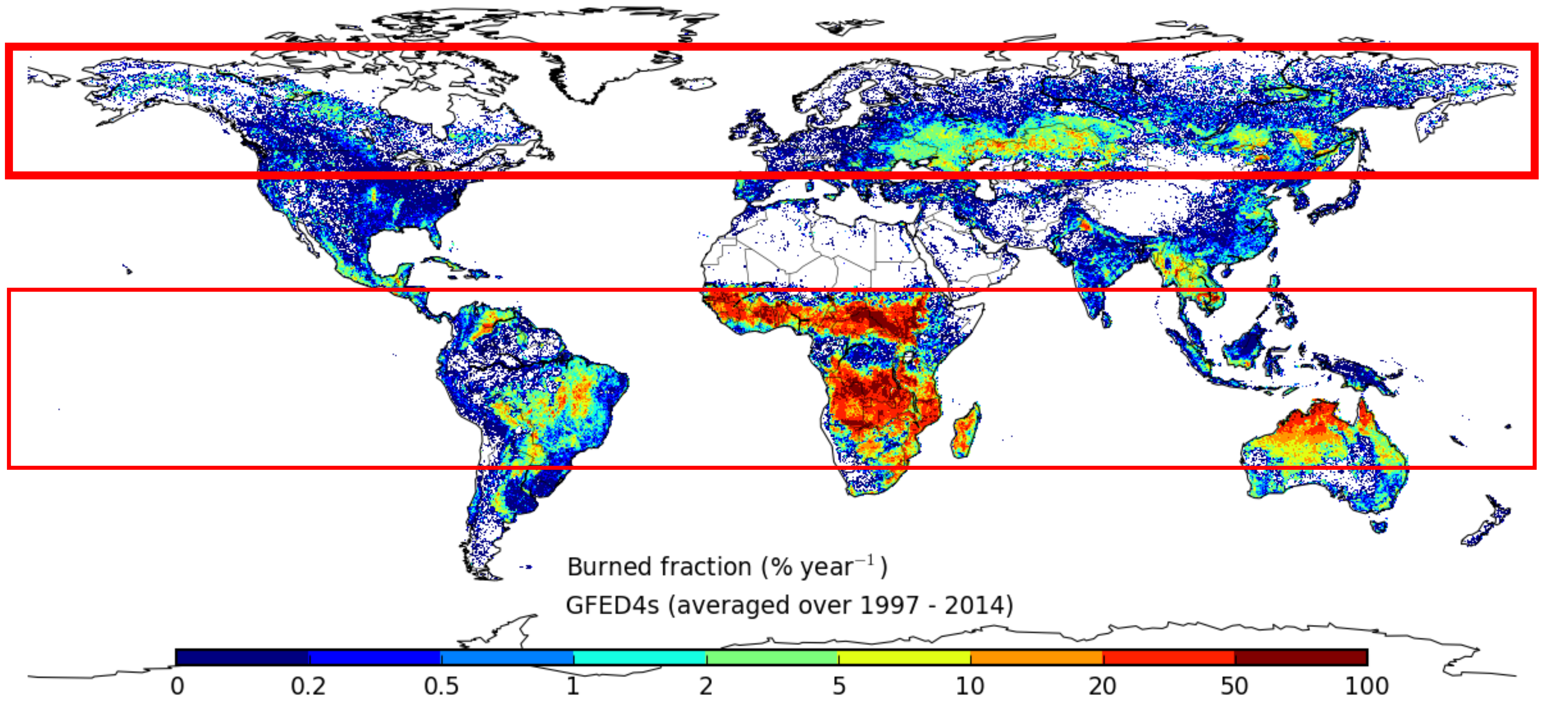
1 Background

Annual burned area fraction（%/yr）



(https://daac.ornl.gov/VEGETATION/guides/fire_emissions_v4.html)

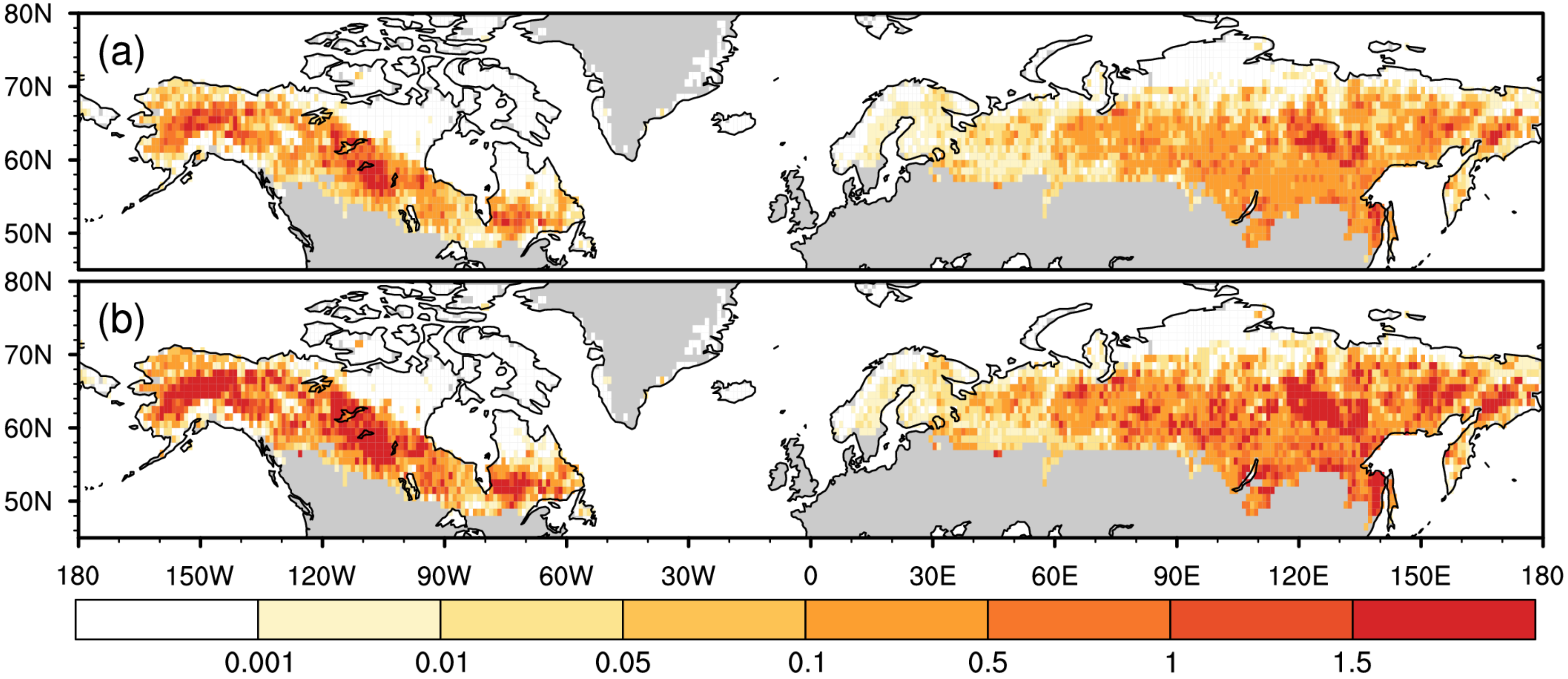
- **Arctic-boreal zone fire:**
- **Carbon cycle**
- **Climate change**

1 Background

1. Highest values located：

Alaska, central Canada, and eastern Siberia

2. Large interannual variability



Climatology

Interannual variability

Summer(JJA)-sum burned area fraction (BAF) (%)

1 Background

- Impacts of local surface climate:

Temperature
Relative humidity
Precipitation
Wind

fuel、fire spread ⟹ **Fire**

(Flannigan et al., 2005; Krawchuk et al., 2009 ; Li et al., 2012; Parks et al., 2014 ; Sedano & Randerson, 2014; Abatzoglou et al., 2018)

- Ways of affecting regional fires:

Regional fire
（Alaska, Canada, Siberia）

⟸ *T、RH…*

Large-scale circulation
（NAO、AO、PNA）

Sea temperature
（ ENSO、PDO、AMO ）

(Johnson and Wowchuk, 1993; Anyamba et al., 2003; Balzte et al., 2005, 2007; van der Werf et al., 2006; Sibold and Veblen, 2006; Macias Fauria and Johnson, 2006, 2008; Kitzberger et al., 2007; Dixon, Goodrich et al., 2008; Beverly et al., 2011; Chen et al., 2016, 2017; Shen et al., 2019; Kim et al., 2020; Hanes et al., 2020)

1 Background

Question:

➢ Large-scale atmospheric circulation $\xrightarrow{\textbf{?\%}}$ Arctic-boreal fires

2 Data

- **Extra-tropical atmospheric teleconnection indices:** CPC

  1. NAO **5. PNA**

  2. EA **6. EA/WR**

  3. WP **7. SCA**

  4. EP/NP **8. POL**

- **Burned area (BA): 1997-2016,** GFED4s
- **Climate:**

  1. Surface climate data:

  a. temperature **(T):** CRU

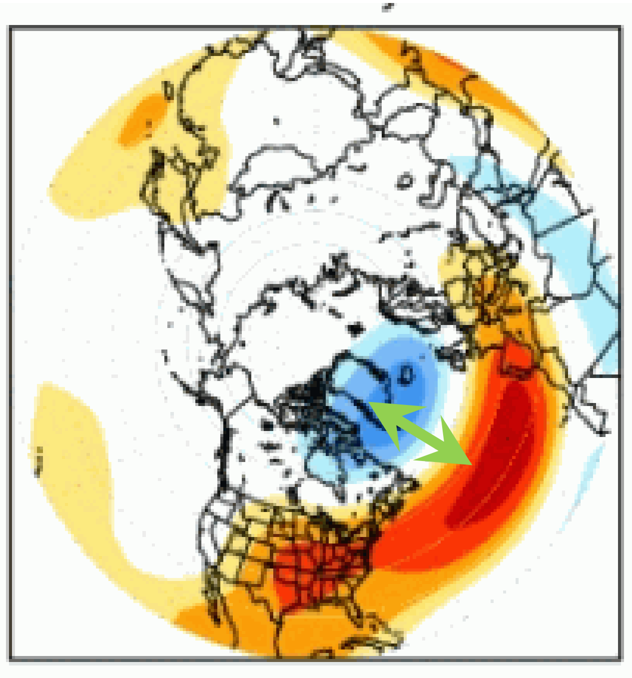
  b. relative humidity **(RH),** wind speed **(WS):** NCEP/NCAR

  c. cloud-to-ground **lightning:** WWLLN

  2. Atmospheric circulation data:

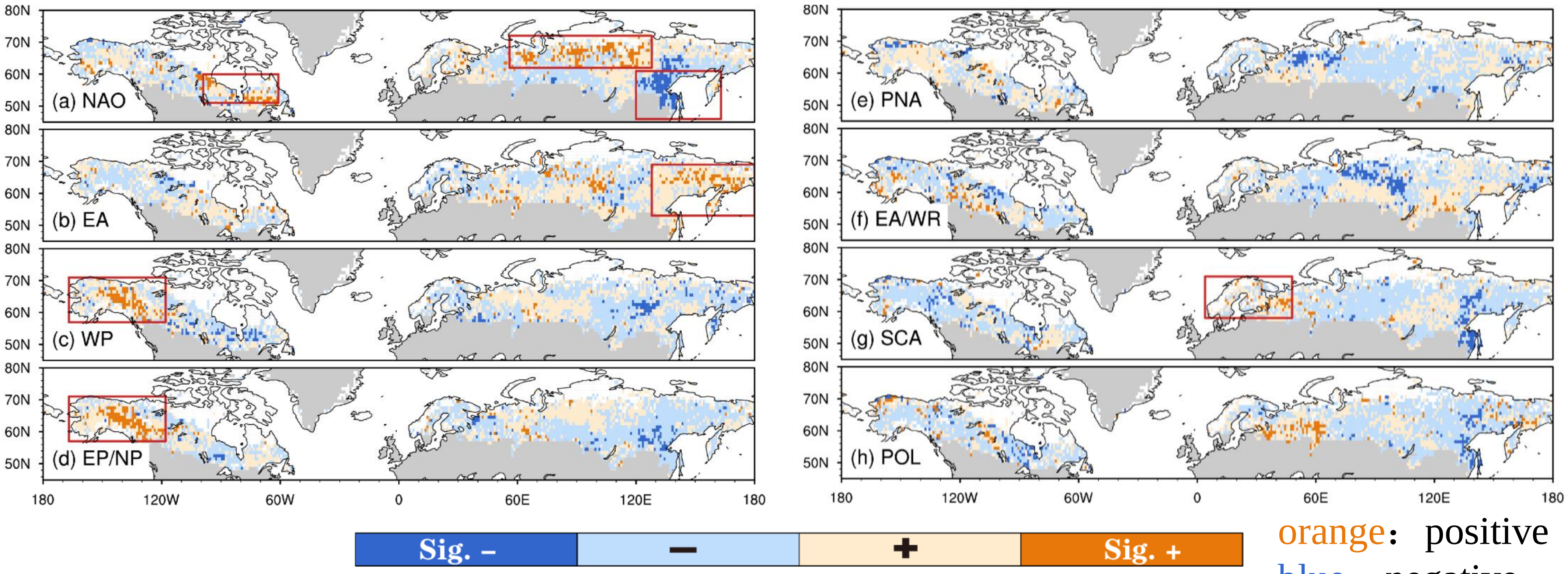
  zonal and meridional wind and geopotential height at 500/850 hPa: NCEP/NCAR

NAO pattern



3 Results—Key teleconnection patterns

The influence of different teleconnections is highly regional

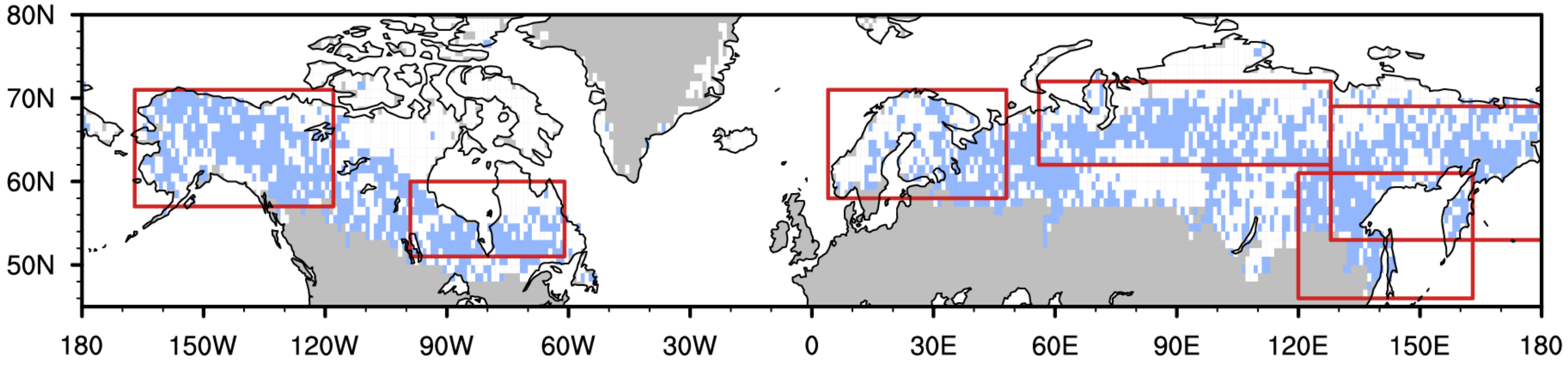


orange： positive
blue： negative

Shading: correlation between teleconnections and burned area in summer

3 Results—Key teleconnection patterns

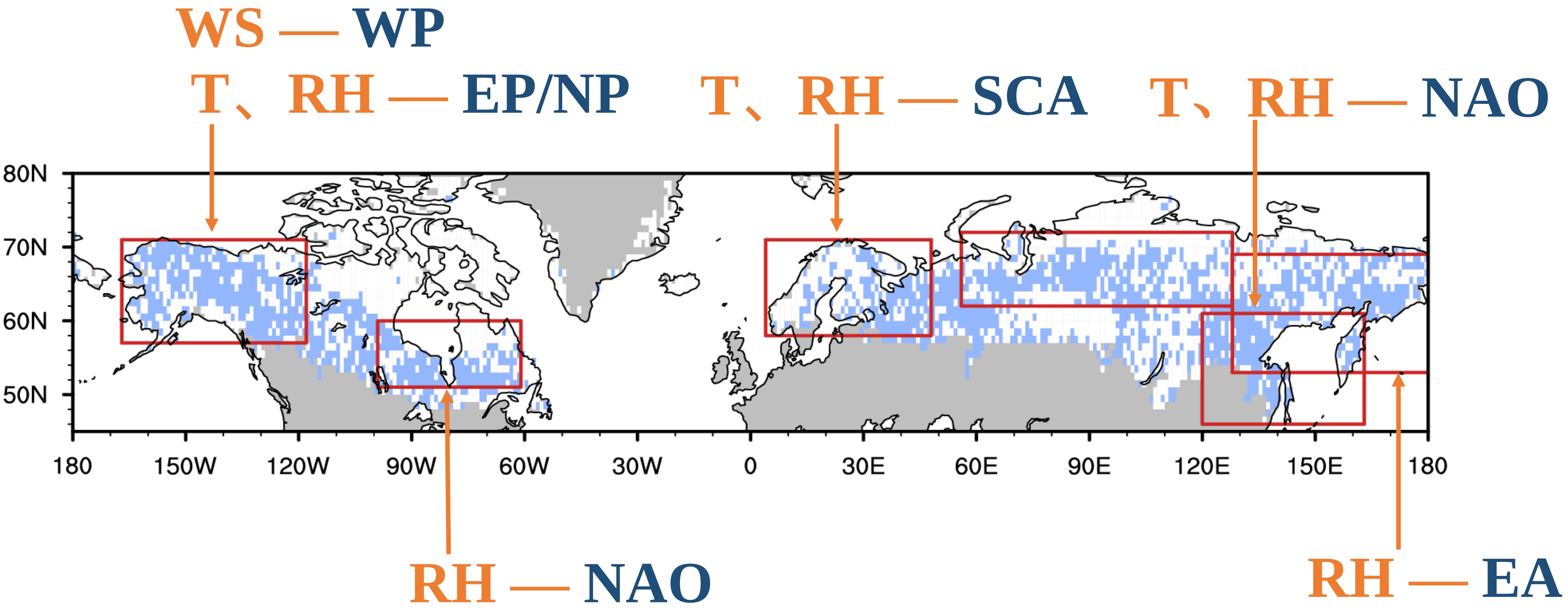
Extra-tropical teleconnections significantly affect 63% of Arctic-boreal burned area



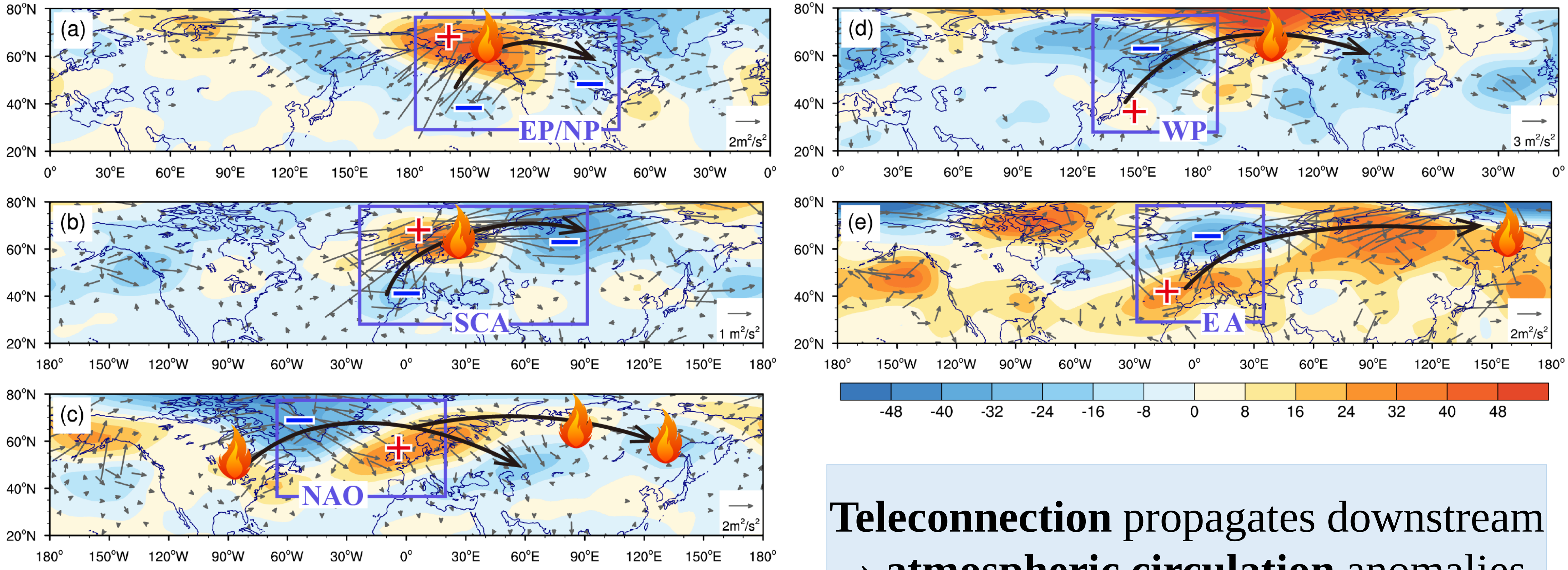
Shading: regions where BA significantly affected by the eight teleconnections

3 Results—Key climate factors linking teleconnections and fire

Temperature, relative humidity and **wind speed** are three key factors of fires



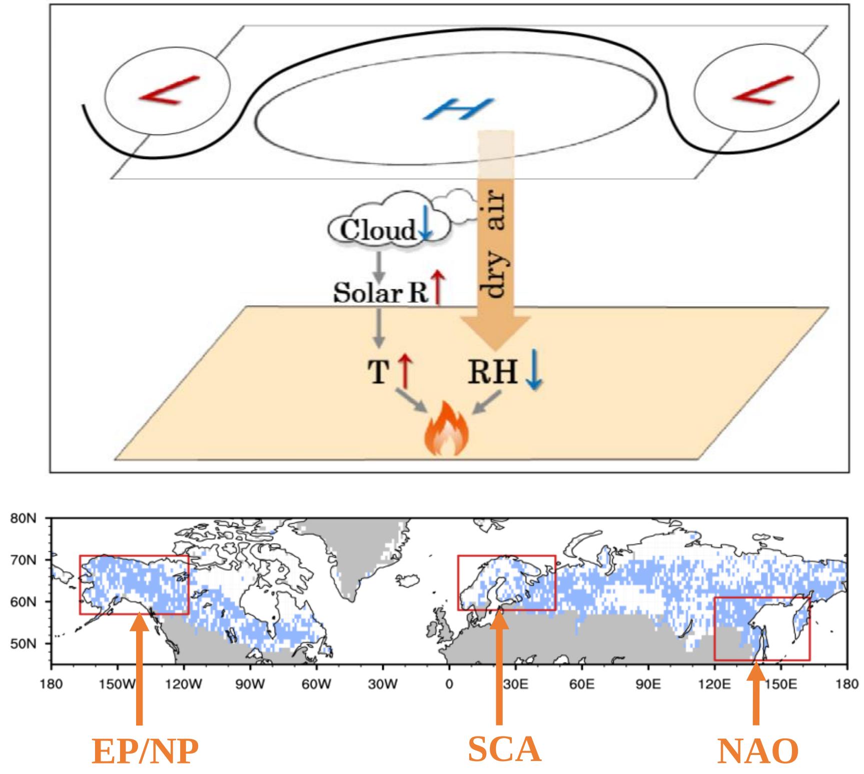
3 Results—Teleconnections affecting climate factors



Black curve: the path of wave propagation
Shading: regressed anomalies of H500
Vector: 500-hPa wave activity flux

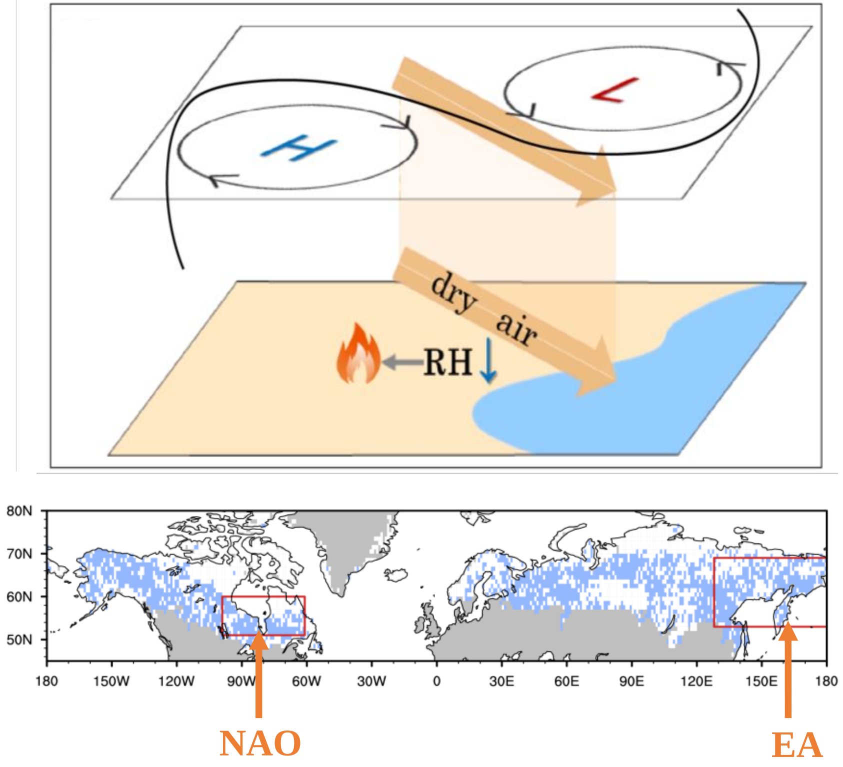
Teleconnection propagates downstream
→ **atmospheric circulation** anomalies
→ changes in local **climate factors**

3 Results—Three mechanisms of teleconnections affecting fire



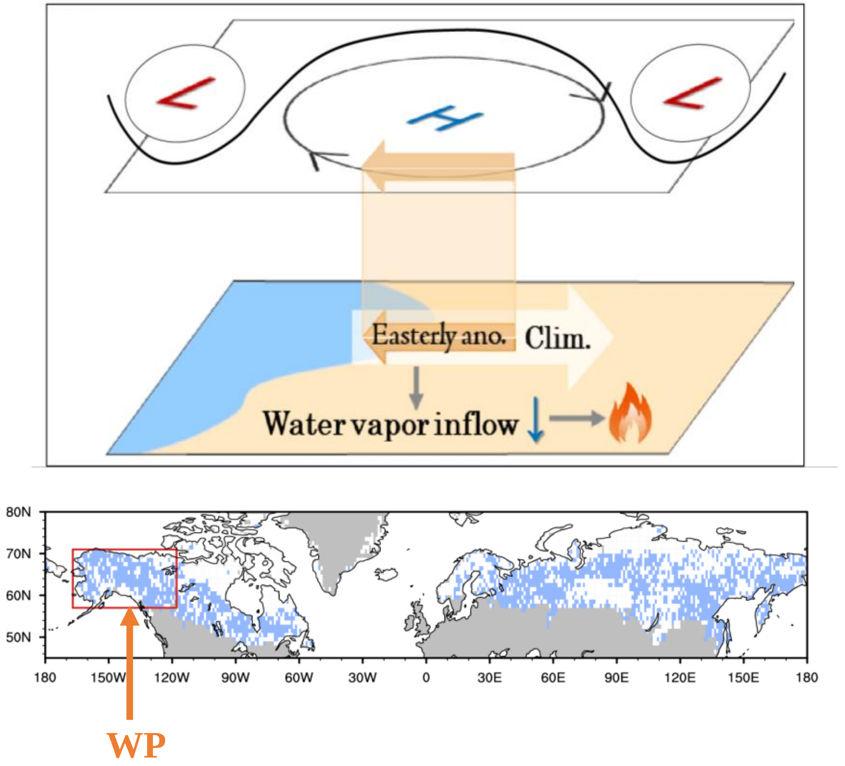
High pressure anomaly in the middle troposphere

→ T↑、RH↓ → Fire↑



Large wind speed between high and low pressure carries cold and dry air from land to sea

→ RH↓→ Fire↑



Water vapor inflow ↓

→ fuel dries → Fire↑

4 Conclusions

- Eight northern hemisphere extra-tropical teleconnections significantly affect **63%** of Arctic-boreal burned area in summer——stronger than ENSO **(11%)**.

- Key teleconnections impact Arctic-boreal fires through three pathways.

Thanks !