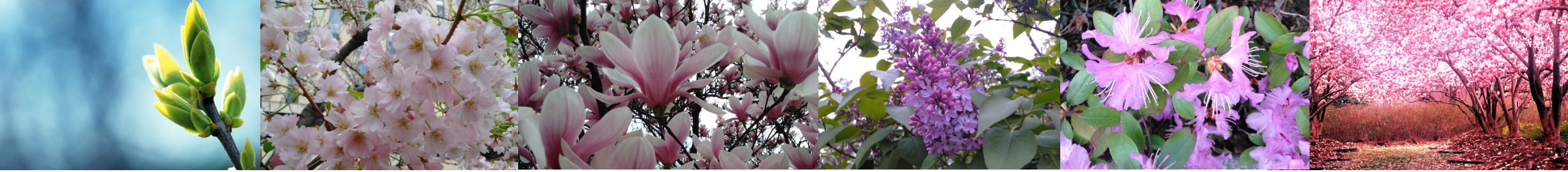

Northern hemisphere land-atmosphere feedback from prescribed plant phenology in CESM

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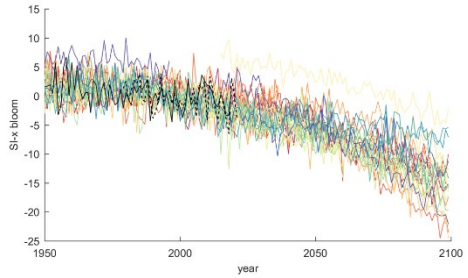
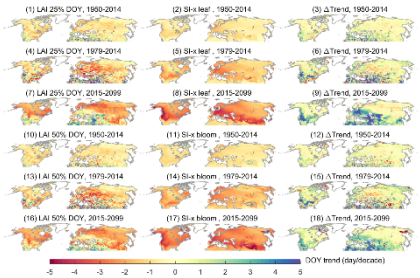
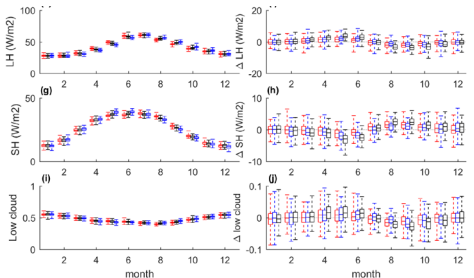
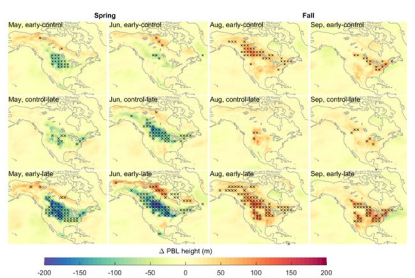
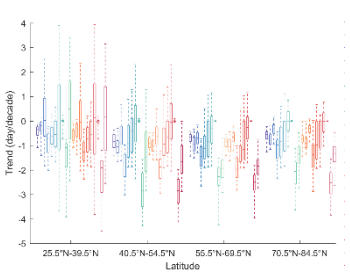
Li X., Ault, T. R., Richardson, A. D., Frolking, S., Herrera, D. A., Friedl, M. A., Carrillo, C. M., and Evans, C. P. (Under review). Northern hemisphere land-atmosphere feedback from prescribed plant phenology in CESM. *Journal of Climate*. Under review

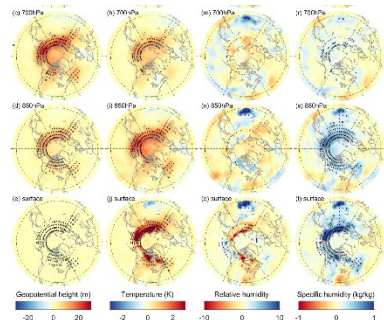






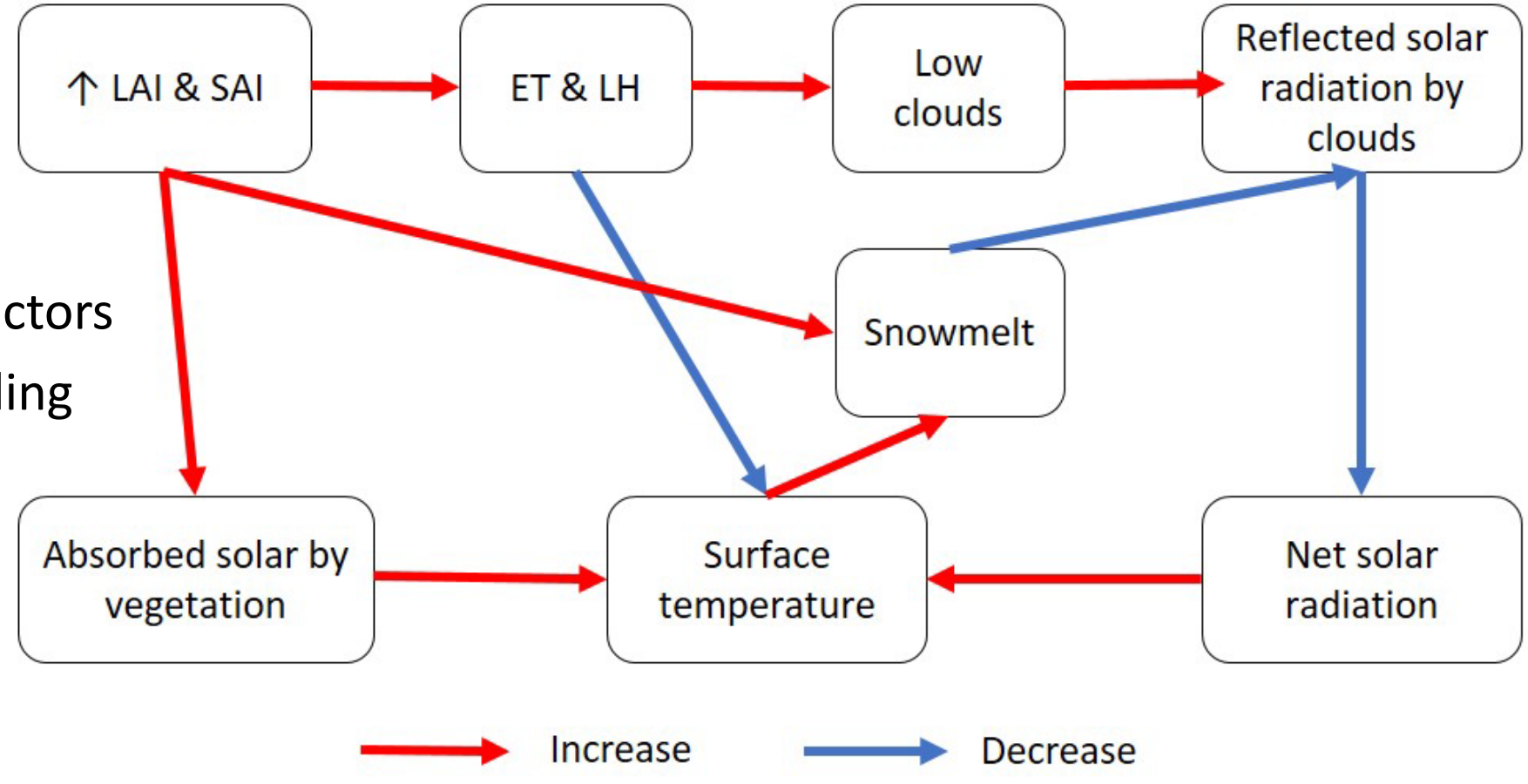




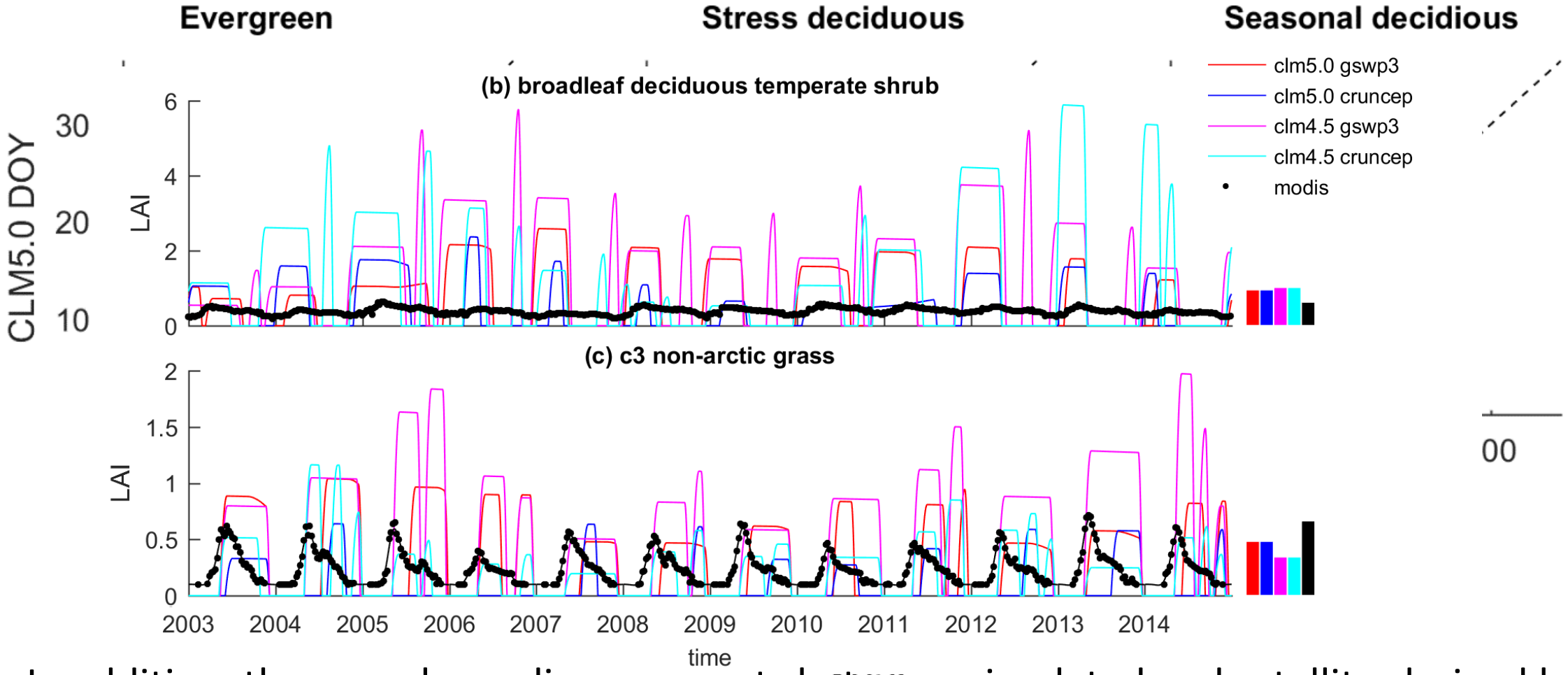


Phenology is important for both the carbon cycle and land-atmosphere coupling:

- Phenology modifies land-atmosphere coupling significantly at seasonal scale (Li et al., 2023):
  - Directly influences energy and water exchanges;
  - Indirectly changes cloud cover and albedo;
  - Modulate controlling factors of land-atmosphere coupling



- However, phenology varies with the changing environment:
  - Interannual variability of spring onset can be as large as 14 days;



- In addition, there are large disagreements between simulated and satellite-derived leaf phenology

Phenology is important for both the carbon cycle and land-atmosphere coupling:

- Phenology modifies land-atmosphere coupling significantly at seasonal scale (Li et al., 2023);

- Phenology can exhibit large differences between model simulations and remote sensing derived records, but the discrepancy in LAI results in a relatively small bias in GPP (Li et al., 2022);

Therefore, we wonder to what extent would phenology biases influence land-atmosphere coupling and larger-scale atmospheric circulations.

Discrepancies in LAI result in relatively small biases in GPP, but phenology also modulates L-A coupling and potentially have large influences, so we wonder:

1. to what extent would phenology biases influence land-atmosphere coupling;

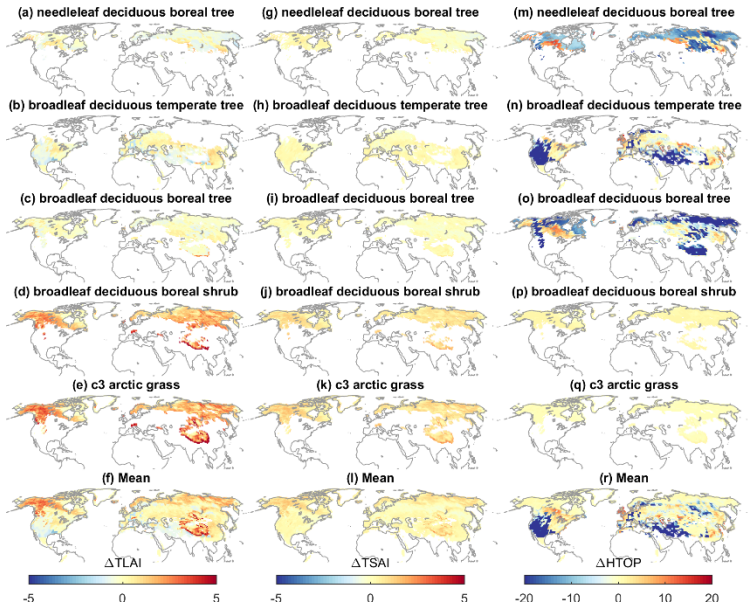
2. when, where, and what these influences are;

3. which phenoPFT has the largest influences.

Methods:

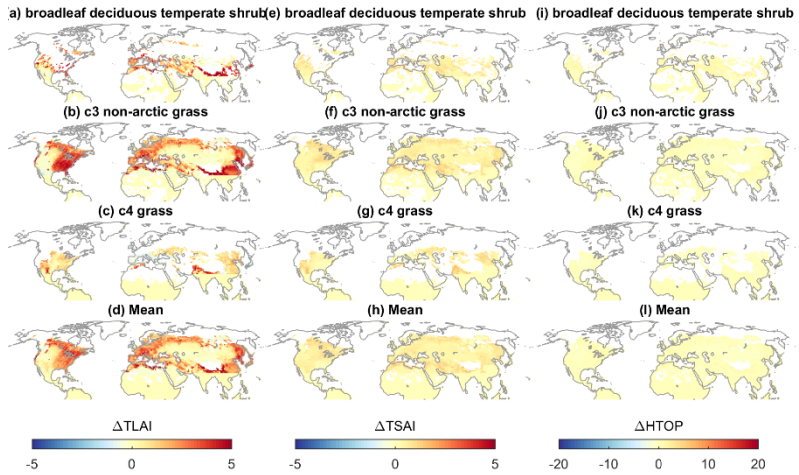
- Replace satellite phenology (SP) with CLM-simulated phenology in the Northern Hemisphere (North of 25N)
  - Coupled land-atmosphere component configurations (F2000Climo): CAM6 + CLM5 SP
  - Climatological ocean conditions (HadSST 1995-2005 climatology)
  - Modifying leaf area index (LAI), stem area index (SAI), vegetation height top (HTOP)
- 100-year control and modified phenology simulations

Seasonal deciduous



+

Stress deciduous



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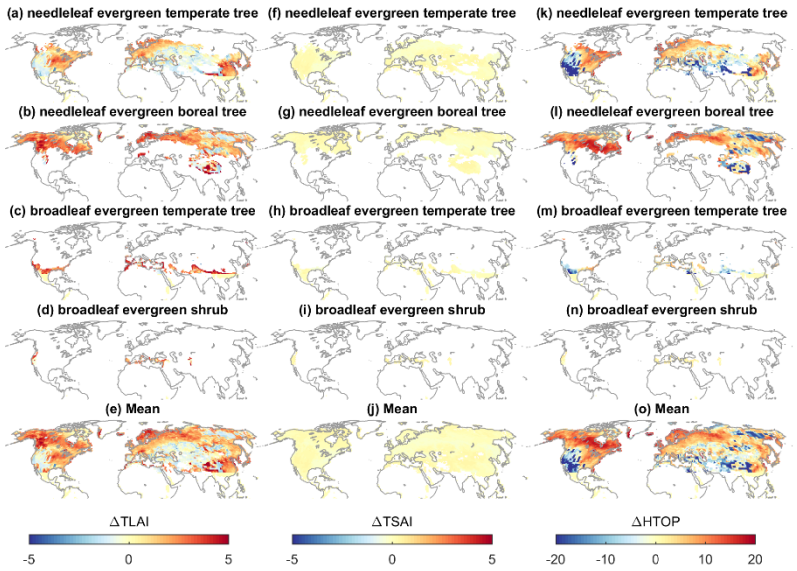
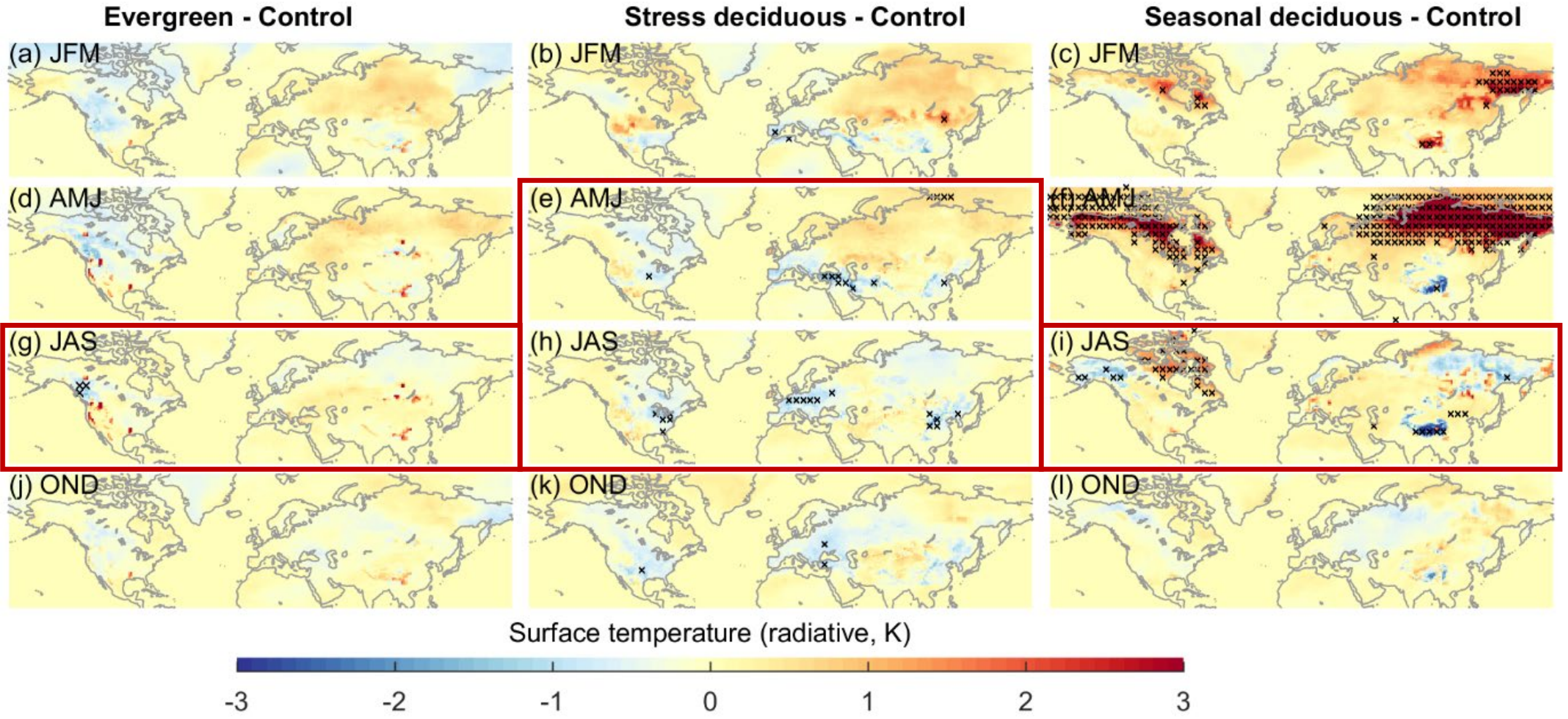
Evergreen

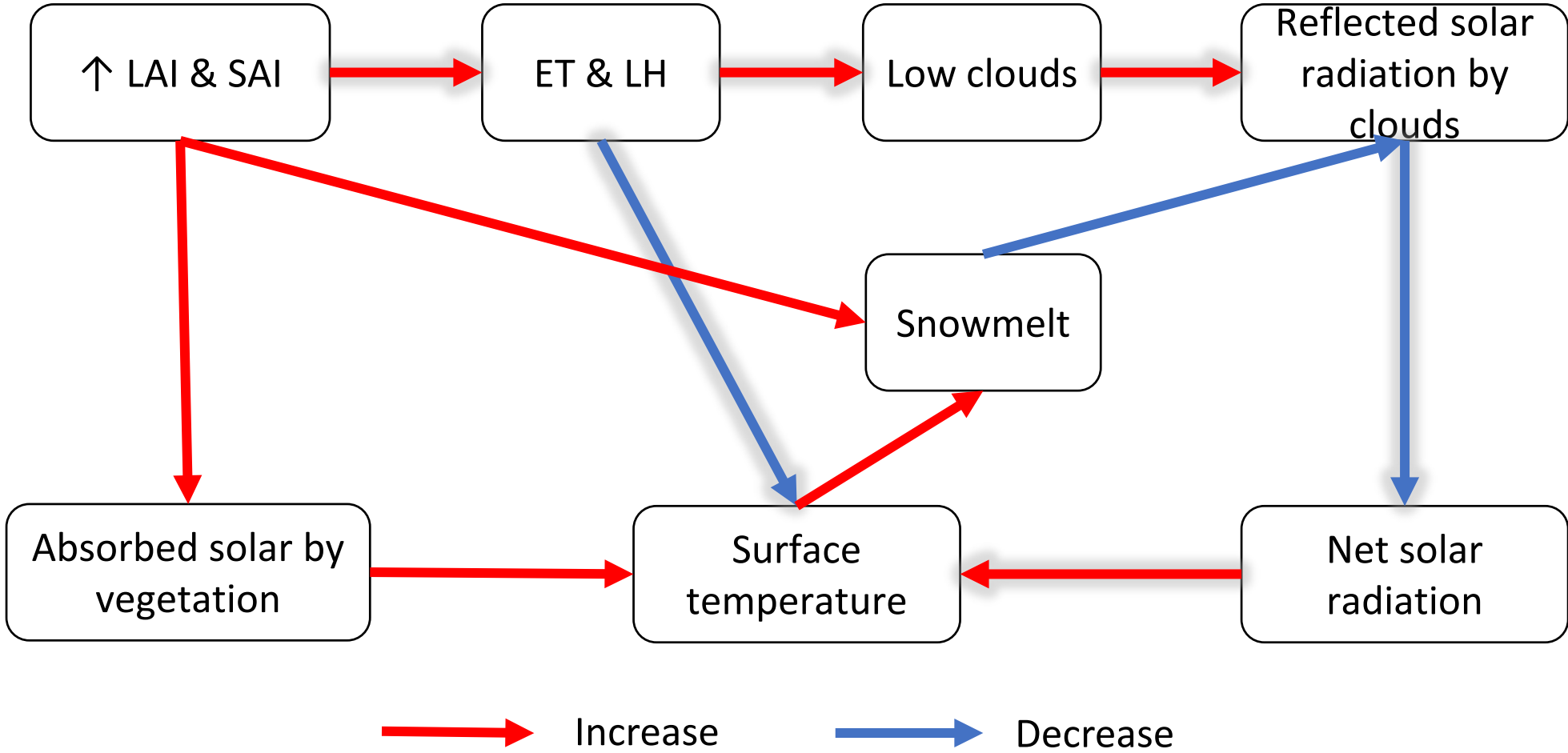


Results:


Evergreen - Control
Stress deciduous - Control
Seasonal deciduous - Control
(a) JFM
(b) JFM
(c) JFM
(d) AMJ
(e) AMJ
(f) AMJ
(g) JAS
(h) JAS
(i) JAS
(j) OND
(k) OND
(l) OND
Surface temperature (radiative, K)
-3
-2
-1
0
1
2
3

Results:

- Late-winter to spring changes in surface albedo and snow feedback
- Changes during the growing season
- Changes in the upper atmosphere



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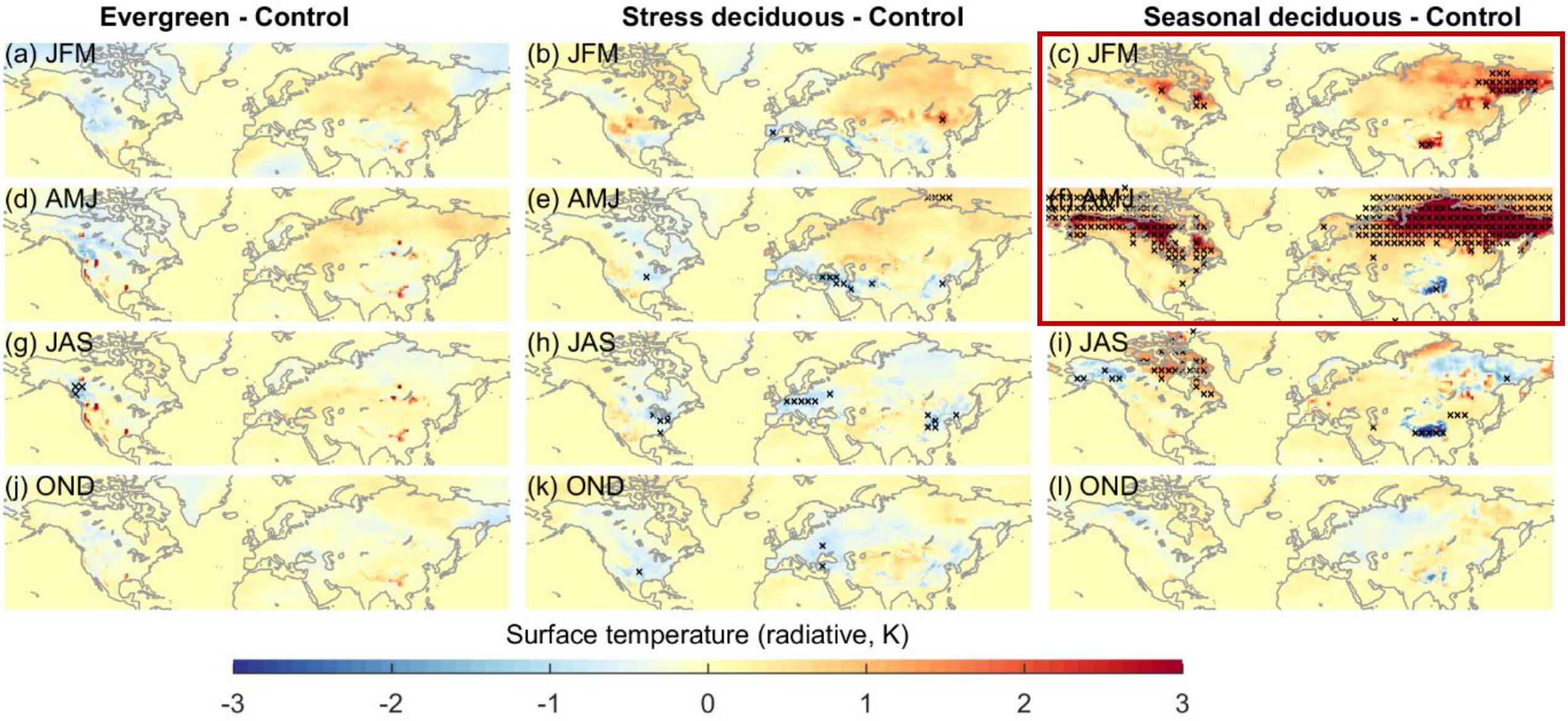
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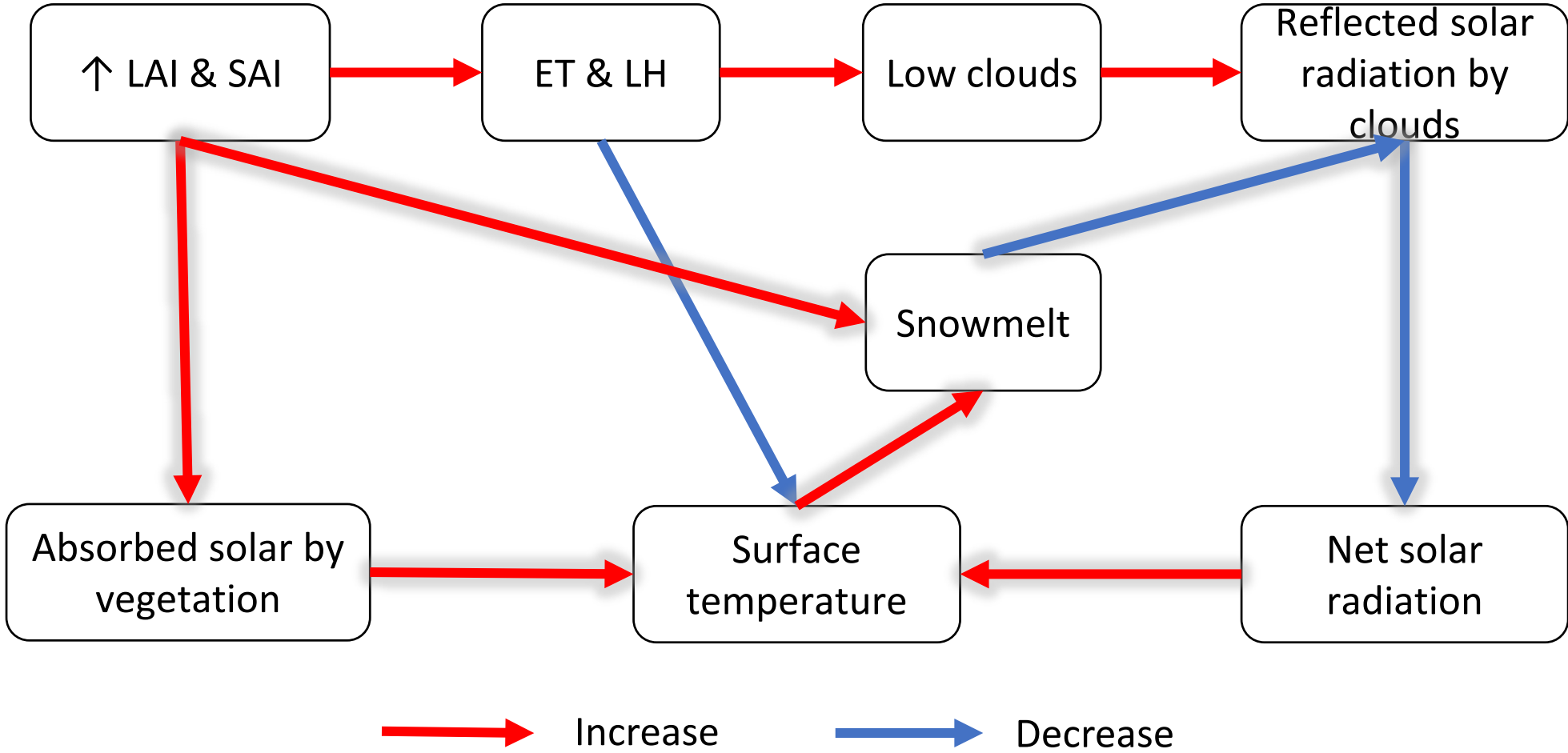

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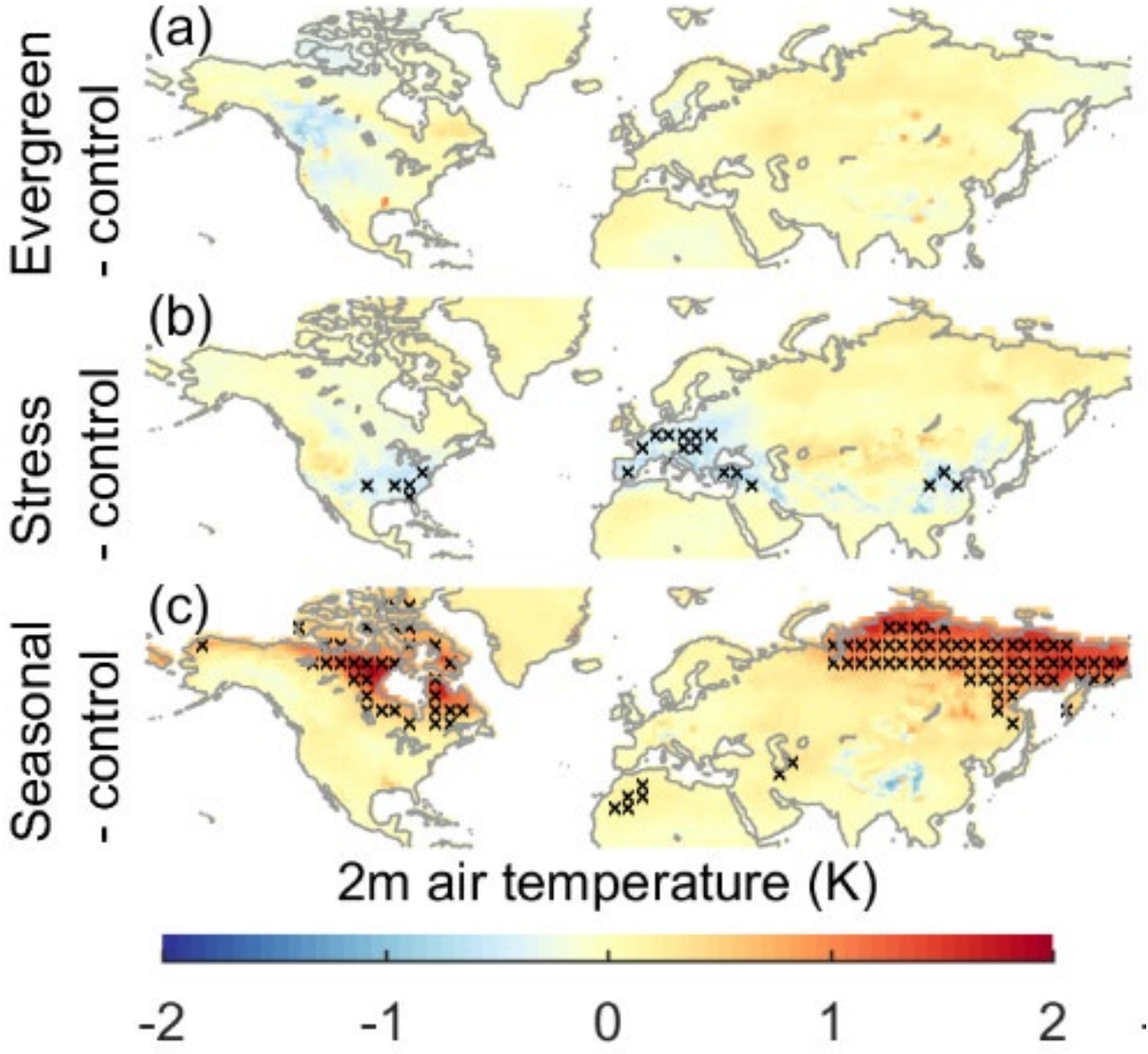

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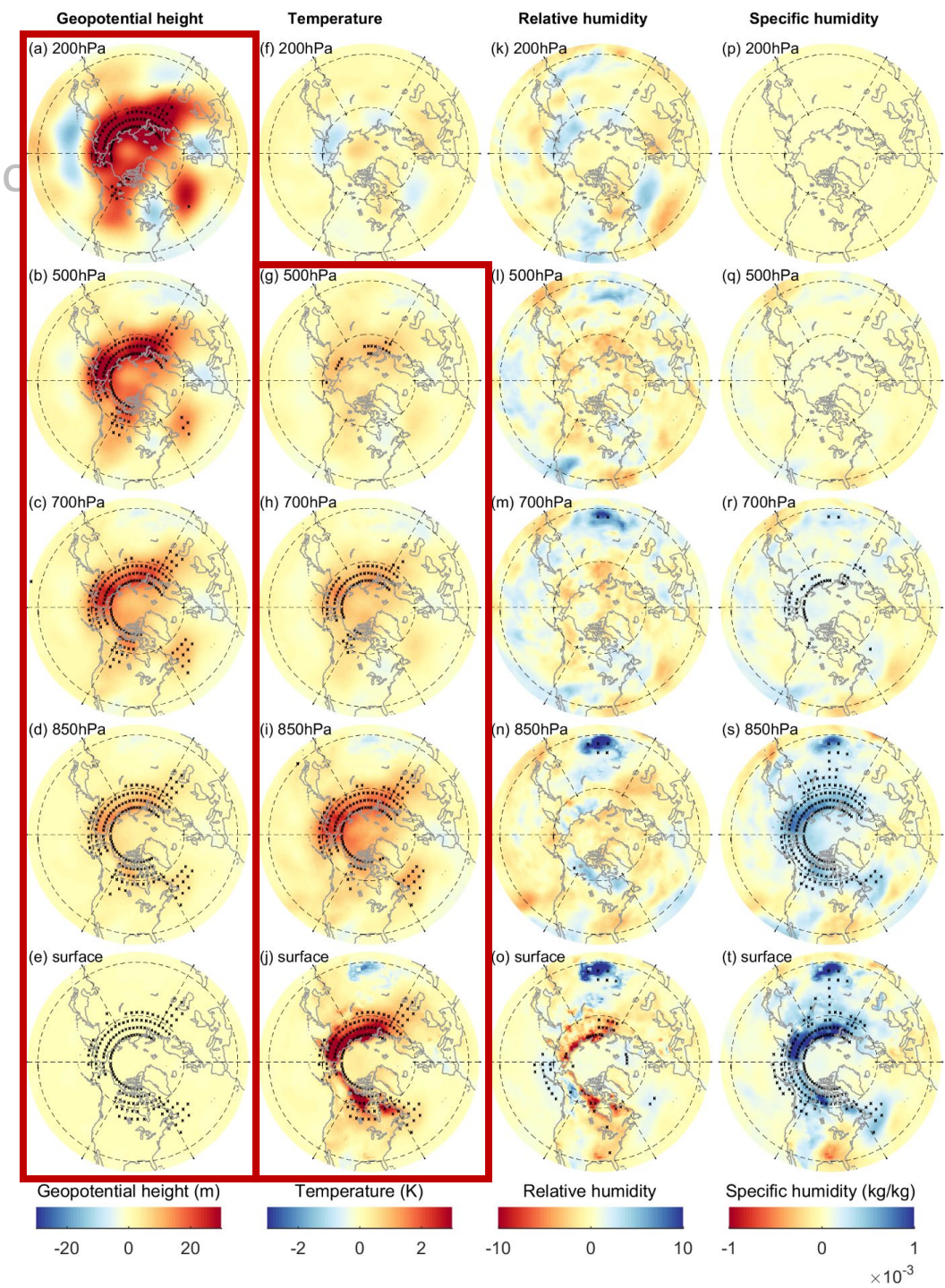

Conclusions:

- phenology influences the land surface and land-atmosphere interactions through both direct influences on fluxes and momentum exchanges and indirect influences via snow-albedo feedback and cloud feedback;
- Influences induced by phenology discrepancies are the largest and most significant in seasonal deciduous phenology in the late winter to spring season, when temperatures in high latitude regions can increase over 3K at the surface and propagate to 500hPa or higher, potentially altering large-scale atmospheric circulations;
- Changes during the growing season depend on soil moisture availability and differ by phenology type, and plants in arid or semi-arid regions may face higher moisture stress and potentially shorter growing season;
- Discrepancies in phenology simulations not only affect the land surface and boundary layer, but can potentially influence the mean state of the upper atmospheric layers and large-scale circulation.

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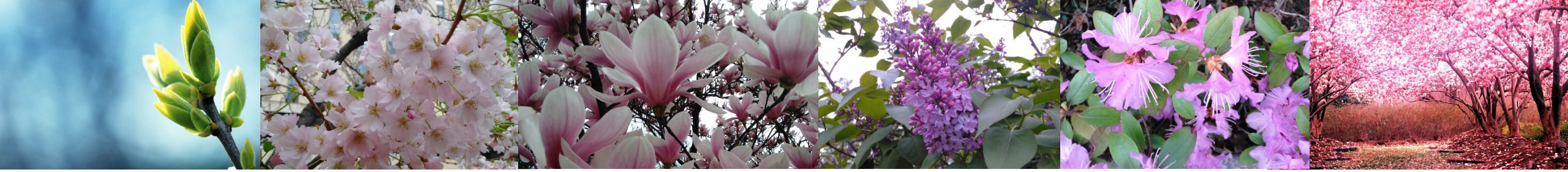

Thank you!

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