

# Tree-ring Cellulose $\delta^{18}\text{O}$ Records Similar Large-scale Climate Influences as Precipitation $\delta^{18}\text{O}$ in the Northwest Territories of Canada

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## Research Article

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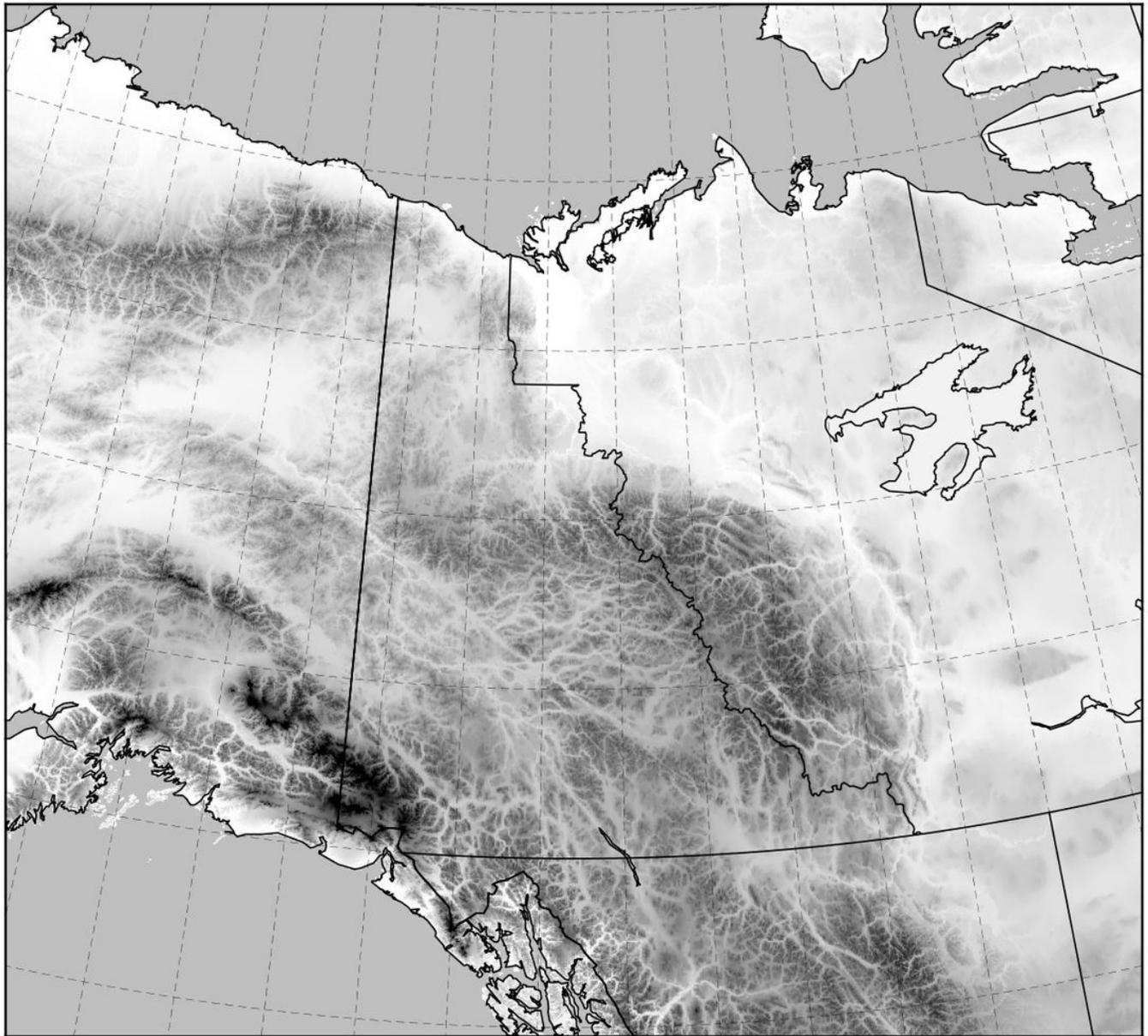
## Abstract

Oxygen stable isotopes measured in tree rings have been useful for reconstructing climate variability and explaining changes in physiological processes occurring in forests, complementing other more widely studied tree-ring parameters such as ring width. Here, we analyzed the relationships between different climate parameters and annually resolved tree-ring  $\delta^{18}\text{O}$  records (d18OTR) from white spruce (*Picea glauca* [Moench]Voss) trees located near Tungsten, Northwest Territories, Canada, and used the NASA GISS ModelE2 isotopically equipped general circulation model (GCM) to interpret the relationships in an idealized sense. The d18OTR series were primarily related to temperature variations in spring and summer, likely through temperature effects on the precipitation  $\delta^{18}\text{O}$  with a combination of evaporative enrichment at leaf level in summer. The GCM simulations showed significant positive relationships between modelled precipitation  $\delta^{18}\text{O}$  over the study region and surface temperature and geopotential height over northwestern North America, with stronger patterns during fall winter than during spring-summer. The modelled precipitation  $\delta^{18}\text{O}$  was only significantly associated with moisture transport during the fall-winter season. The d18OTR showed similar correlation patterns to modelled precipitation  $\delta^{18}\text{O}$  during spring-summer, with significant positive correlations with surface temperature and geopotential height, but no correlations with moisture transport. Overall, the d18OTR records for northwestern Canada reflect the same significant large-scale climate patterns as precipitation  $\delta^{18}\text{O}$  for spring-summer, and therefore have potential for reconstructions past atmospheric dynamics in addition to temperature variability.

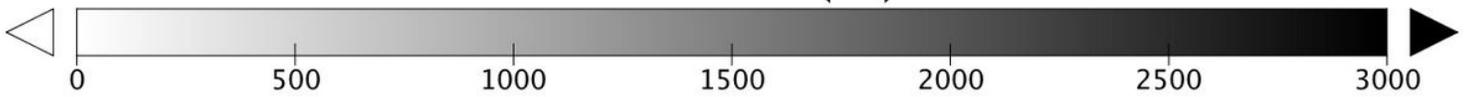
## Full Text

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## Figures

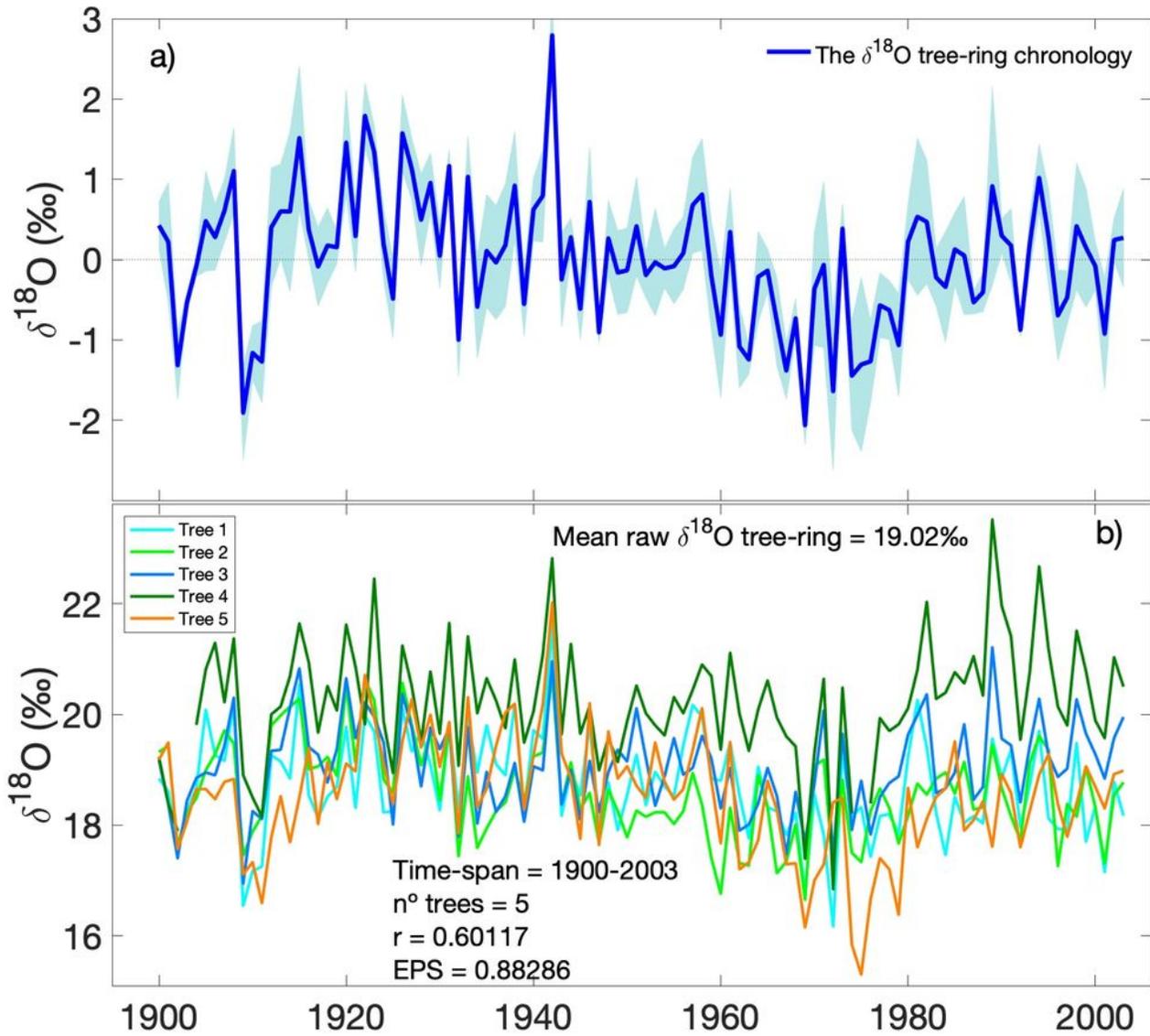


Elevation (m)



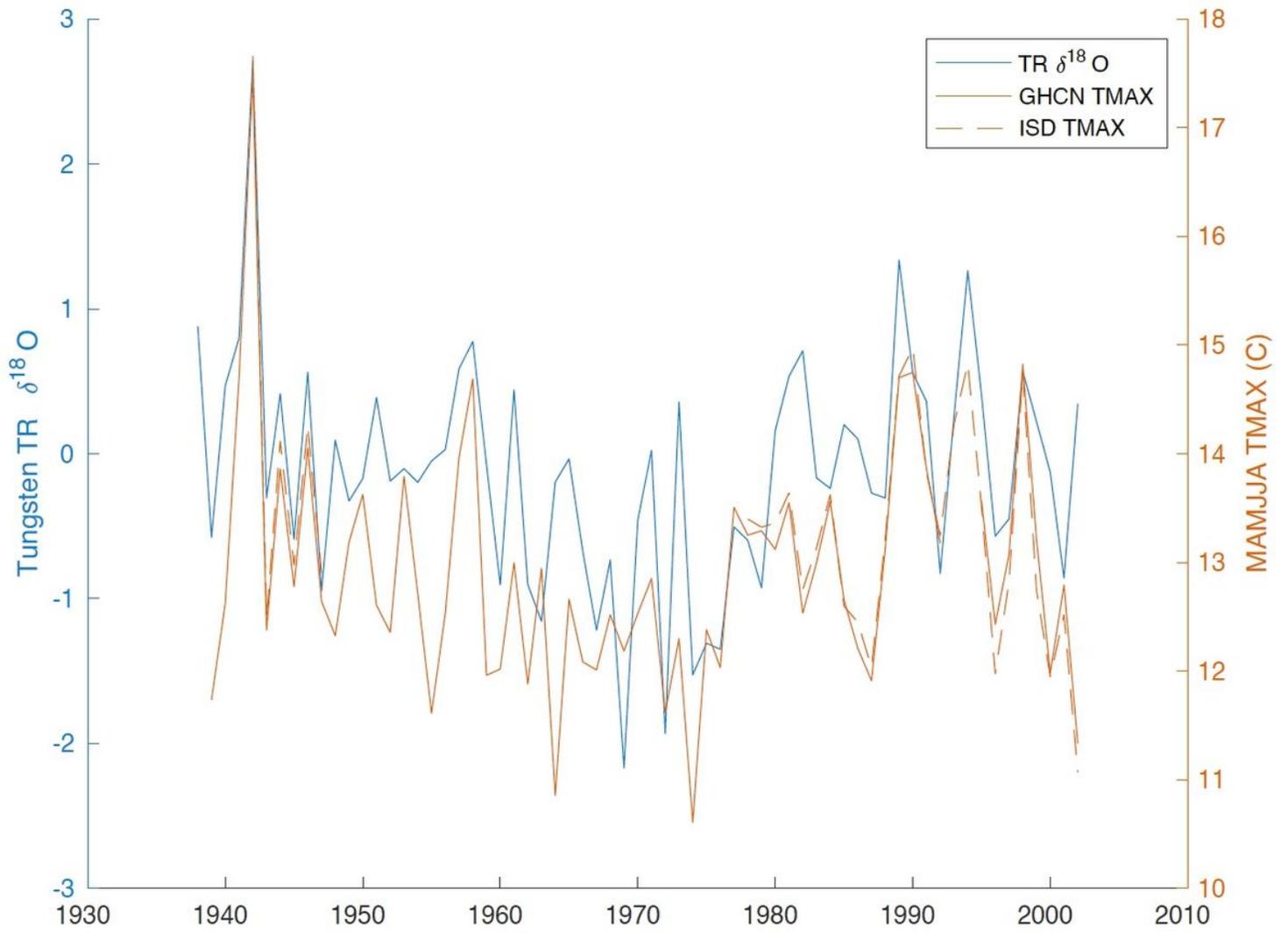
**Figure 1**

Location of the tree-ring chronology at Tungsten (61.98°N; 128.25°W) and the Watson Lake Global Historical Climatological Network (GHCN) weather station (60.117°N, 128.817°W).



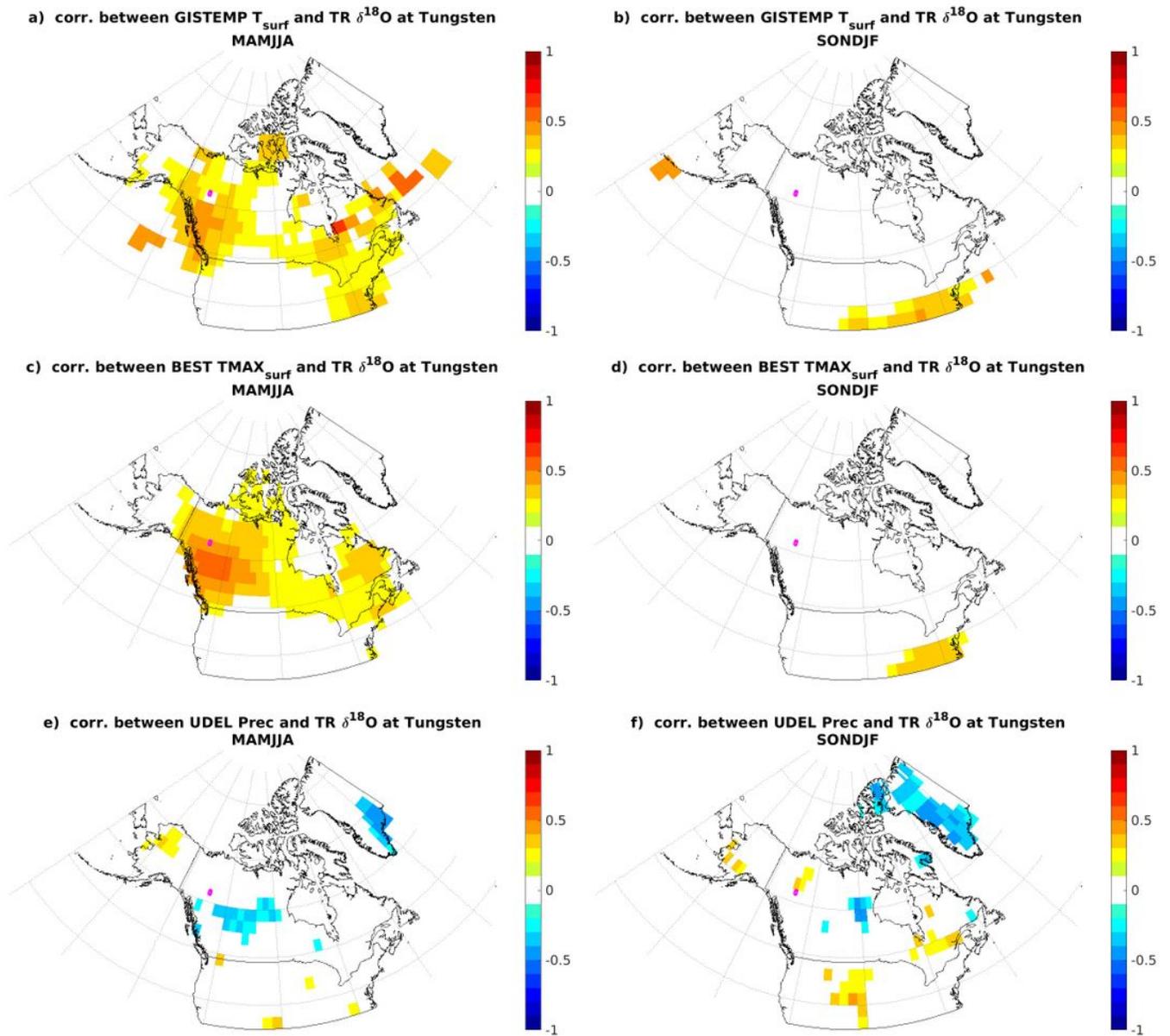
**Figure 2**

(a) The  $\delta^{18}\text{O}$  tree-ring chronology for the Tungsten site which was calculated averaging the zscores of the  $\delta^{18}\text{O}$ TR individual timeseries. (b) The raw  $\delta^{18}\text{O}$  TR individual timeseries ( $r$  = averaged Pearson's correlation coefficient between the five trees; EPS = Expressed Population Signal).



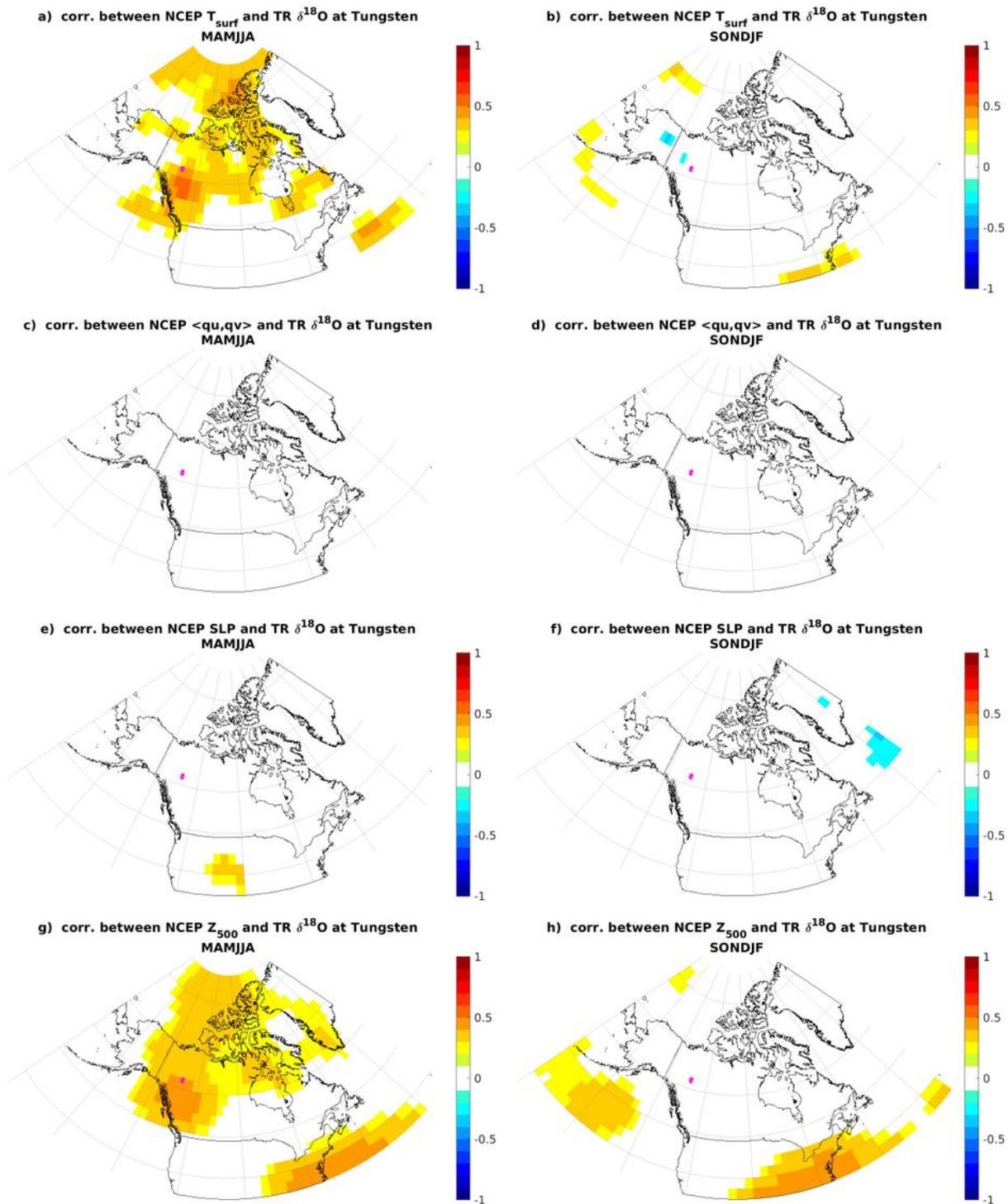
**Figure 3**

Tree-ring d18O chronology (z-scores) and average spring-summer (March-August MAMJJA) TMAX at GHCN and ISD Watson Lake A weather station.



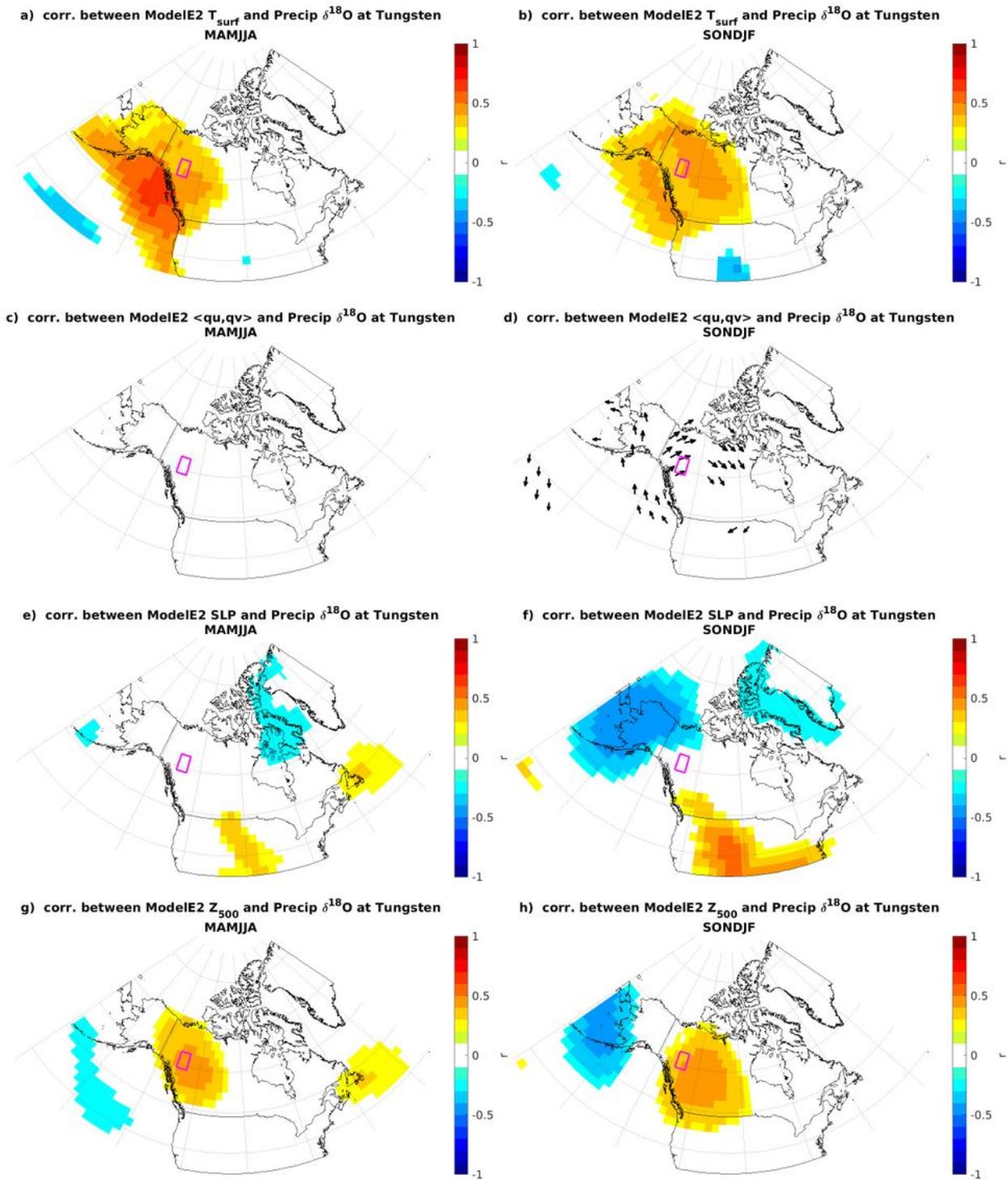
**Figure 4**

Spatial field correlations between annual tree-ring d18O and BEST maximum surface temperature (top), GISTEMP surface temperature anomaly (middle), and University of Delaware (UDEL) precipitation (bottom) over land for spring-summer (March-August, MAMJJA, left) and autumn-winter (September of the previous year to February (SONDJF, right), over 1938-2002. Correlations with pvalues < 0.05 have been excluded. The location of the Tungsten site is shown by the small magenta box.



**Figure 5**

Spatial field correlations between annual tree-ring  $\delta^{18}\text{O}$  and NCEP surface temperature ( $T_{\text{surf}}$ ), moisture transport at 500 hPa ( $\langle qu, qv \rangle$ ), sea-level pressure (SLP), and geopotential height at 500 hPa ( $Z_{500}$ ) for spring-summer (March-August, MAMJJA, left) and autumn-winter (September-February, SONDJF, right), over 1948-2012. Correlations with p-values  $< 0.05$  have been excluded.



**Figure 6**

Spatial field correlations between annual ModelE2 precipitation  $\delta^{18}\text{O}$  over the Tungsten site and surface temperature ( $T_{\text{surf}}$ ), moisture transport at 500 hPa ( $\langle qu, qv \rangle$ ), sea-level pressure (SLP), and geopotential height at 500 hPa ( $Z_{500}$ ) for spring-summer (March-August, MAMJJA, left) and autumnwinter (September-February, SONDJF, right), over 1952-2012. Correlations with p-values  $< 0.05$  have been excluded.

## Supplementary Files

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- [20210203FieldetalClimateDynamicsSUPPLEMENTARYMATERIAL.pdf](#)