Study Sites

All sites were located in closed-canopy forest environments that were unglaciated during the last glacial maximum (Figure S1). Well-drained silt loam soils that are primarily derived from limestone and sandstone parent materials were present at all sites.

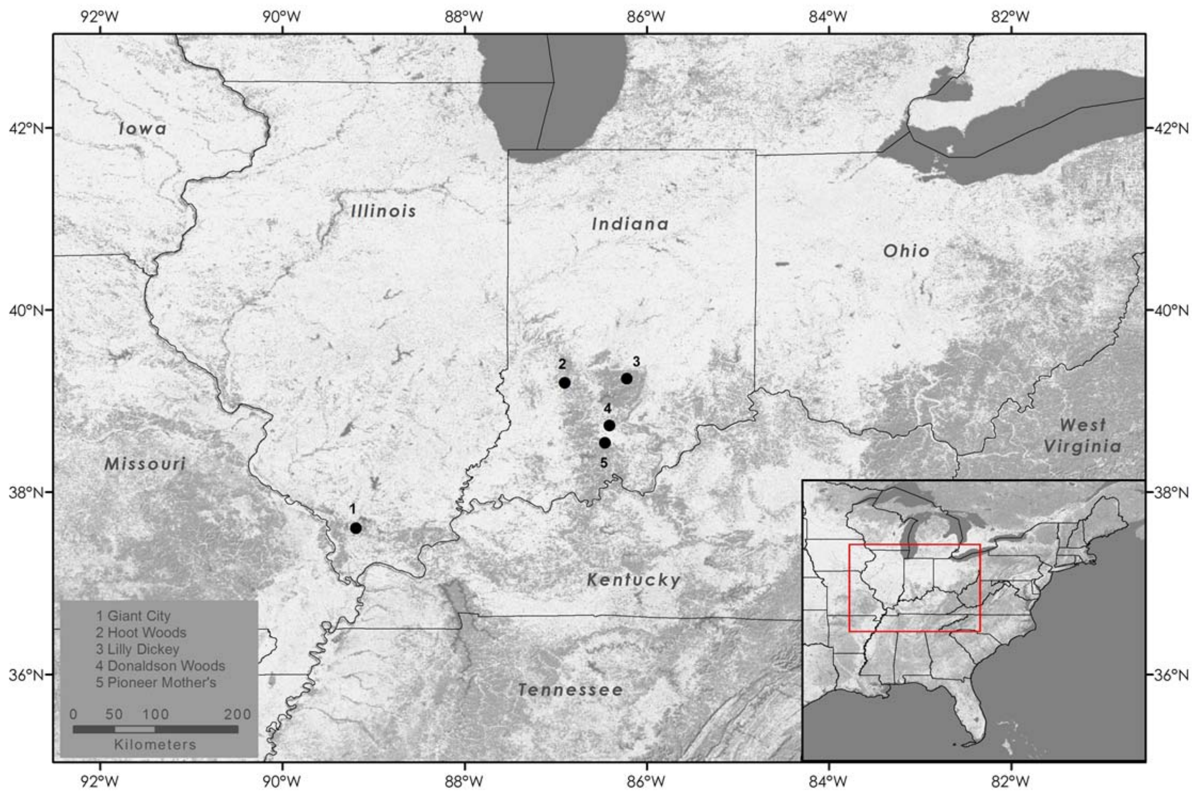

Figure S1: Map of Sample Sites: 1) Giant City, 2) Hoot Woods, 3) Lilly-Dickey, 4) Pioneer Mothers, 5) Donaldson Woods.

Tree Ring Sample Collection and Analyses

We used methods standard to dendrochronology to collect two increment cores from opposing sides of each tree parallel to the slope at breast height (~1.3 m) using a handheld borer for all sites except DW where we collected cross-sections from recently downed logs due to sampling restrictions (Stokes and Smiley 1968; Speer 2010). All sampled trees were free from visual anthropogenic disturbance (e.g., axe marks, cut limbs) and were canopy-dominant trees that exhibited morphological characteristics that typify older trees in the eastern deciduous forest (Pederson 2010). Tree species sampled included: *Juglans nigra* L. (black walnut; JUNI), *Quercus alba* L. (white oak; QUAL), *Quercus rubra* L. (northern red oak; QURU), *Quercus velutina* Lam. (black oak; QUVE), *Quercus prinus* L. (chestnut oak; QUPR), and *Liriodendron tulipifera* L.(tulip tree; LITU).

All tree cores were sanded using progressively finer sandpaper until the ring structure was visible. Next, the cores were visually crossdated each tree ring sample using the list method (Yamaguchi 1991). All growth rings for jmax each core sample were measured using a Velmex measuring stage (Voorhess 2000). For each site and species, sample measurement series were combined to create 15 distinct chronologies. The accuracy of the visual crossdating was confirmed using the program COFECHA (Holmes 1983). We detrended using signal-free standardization (Melvin and Briffa 2008) with a 2/3rds smoothing spline as the base curve. We used a data-adaptive power transformation (Cook and Peters 1997) to stabilize the variance of the standardized chronologies. Importantly, our use of moving-window correlation removes the mean of the standardized chronologies from each window so even if any systematic under- or over-estimation of ring widths resulting from "trend distortion" (Melvin and Briffa 2008) remains, this will not bias the estimated correlation coefficients.

Split-Period Calibration and Verification

Initially, model validation was performed using a split-period calibration-verification procedure that is common in dendroclimatic reconstructions. The common period between the instrumental data and tree growth was split into half, creating an early and late period. The common periods differed for some species due to differences in the year of collection (e.g., 2012 to 2013) or because the sampled species was from dead wood. We developed a model predicting PDSI from tree rings using the late period as calibration and then compared the predicted and observed PDSI values for the early period. The same procedure was performed using the early period as calibration and verifying on the late period.

Principal Component Regression

We used principal components (PC) regression analysis (Meko 1997; Cook et al. 1999) to development multiple-species JJA PDSI reconstruction models for each site and regional reconstruction model, we used the current year's (t) and the following year's ($t + 1$) tree growth as potential predictors of current-year PDSI in the PC regression model. The following year is included because the following year's ring widths are associated with energy and resources gained during the current year's growing season (Fritts 1976). The significant ($p \leq 0.05$) predictors from a correlation analysis between PDSI and all tree-ring predictors (t and $t + 1$) were selected and reduced to PCs using a rotated (varimax) PC analysis (Richman 1986). PCs with an eigenvalue greater than one (Guttman 1954; Kaiser 1960) were selected as predictors for the model.

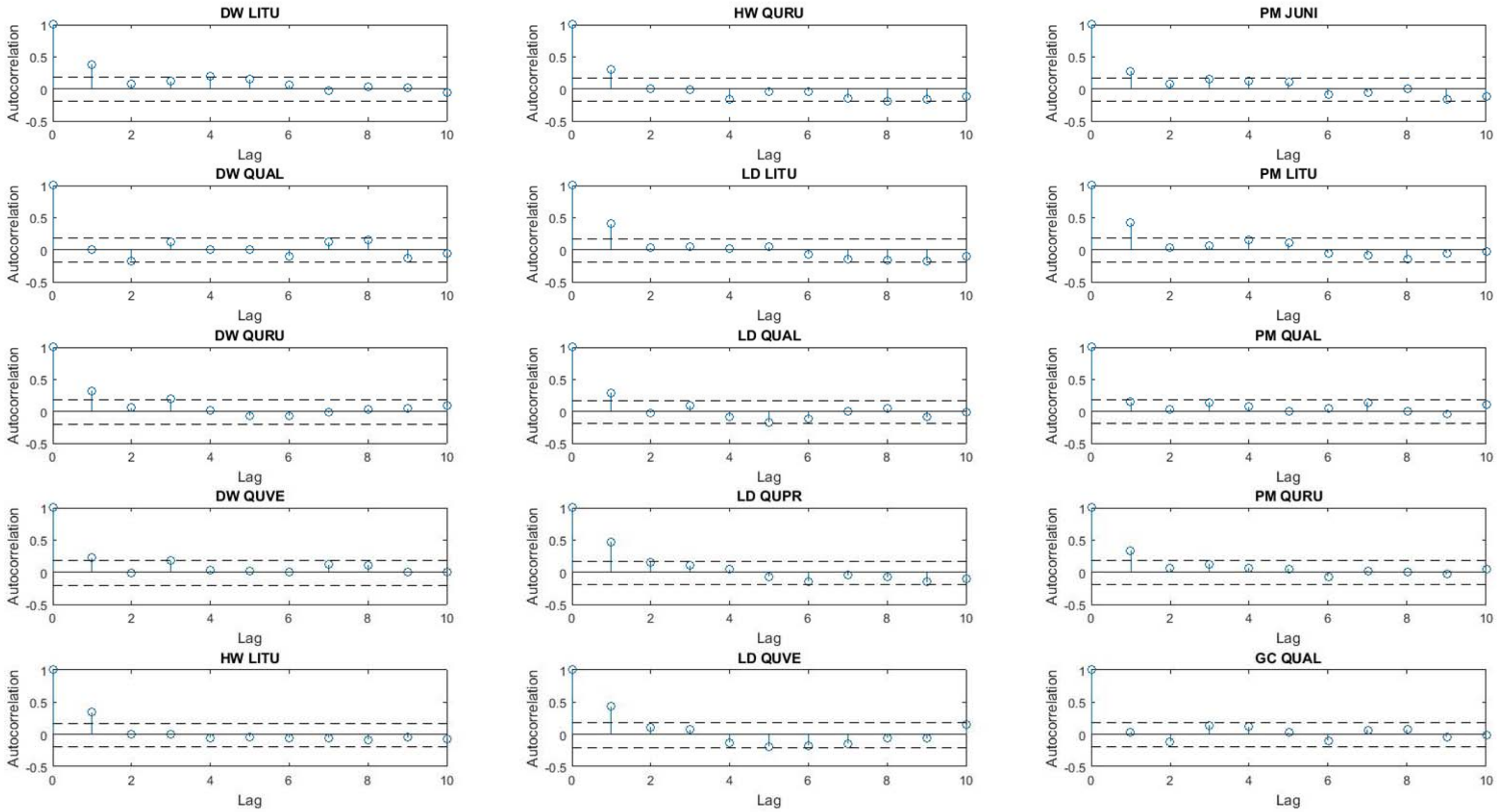

Figure S2: The autocorrelation function for each standardized species chronology. Each panel represents a particular species at a given site (e.g., DW LITU is *Liriodendron tulipifera* at Donaldson Woods).

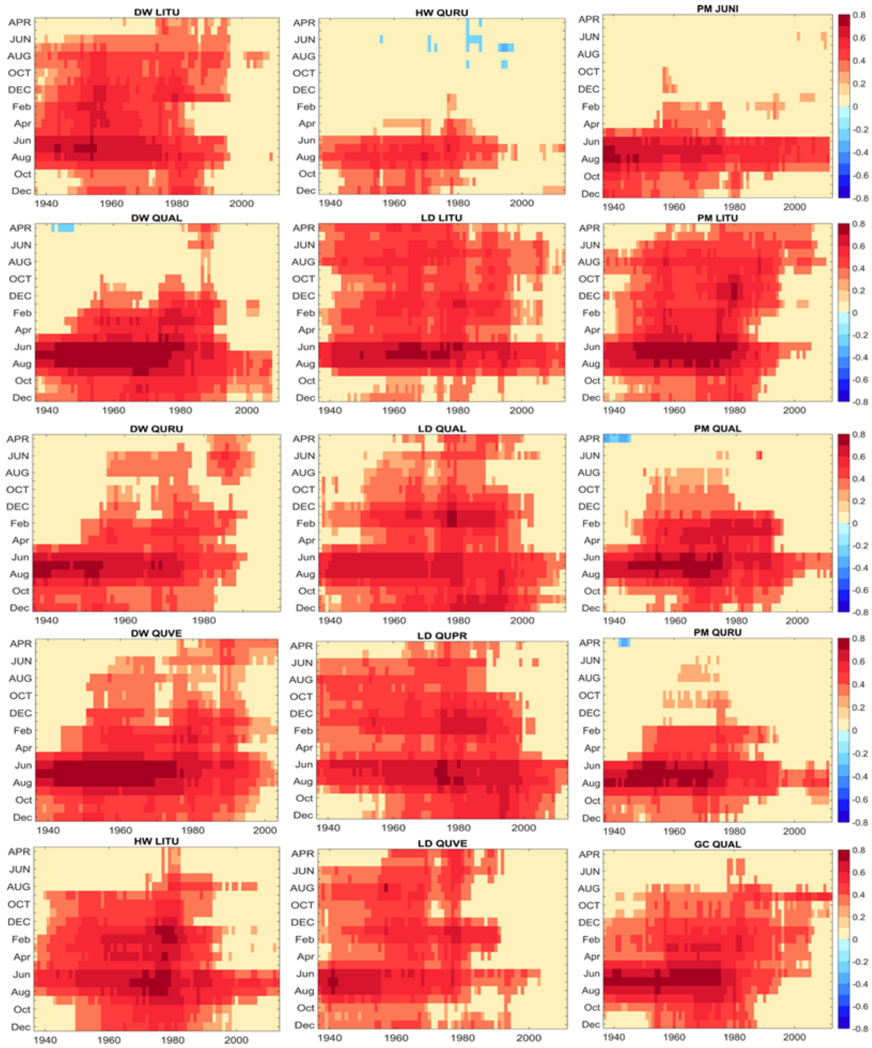

Figure S3: Moving-window correlations of standardized tree-ring widths with monthly PDSI from the NOAA climate division where the site was located. The year represents the end of each 42-year moving window. Months in all capitals represent the previous growing season. Only significant (*p* <0.05) values are shown. Each panel represents a particular species at a given site (e.g., DW LITU is *Liriodendron tulipifera* at Donaldson Woods).

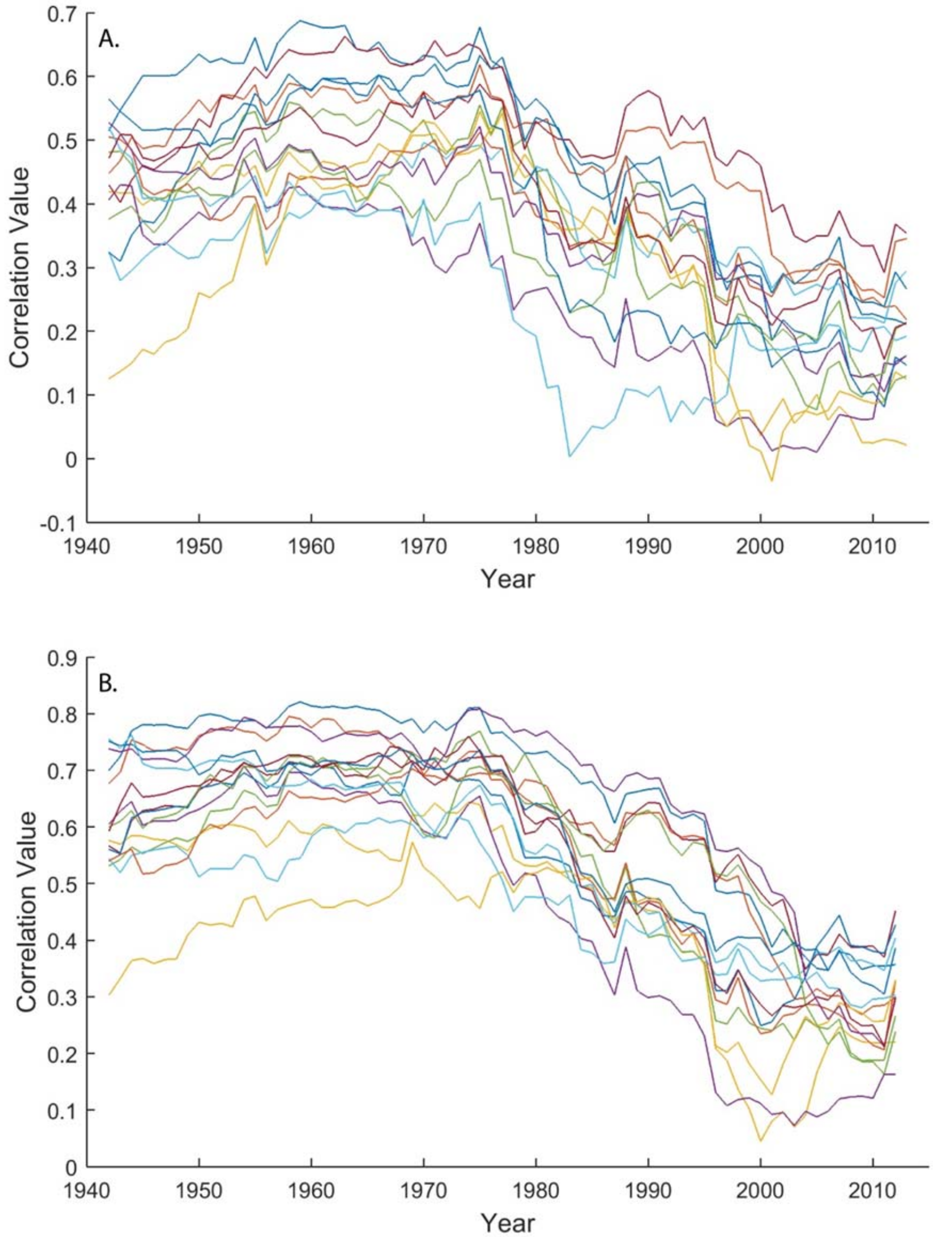

Figure S4: Moving correlations of standardized radial growth with JJA A) 6-month SPEI and B) scPDSI. The year represents the last year of a 42-year moving window.

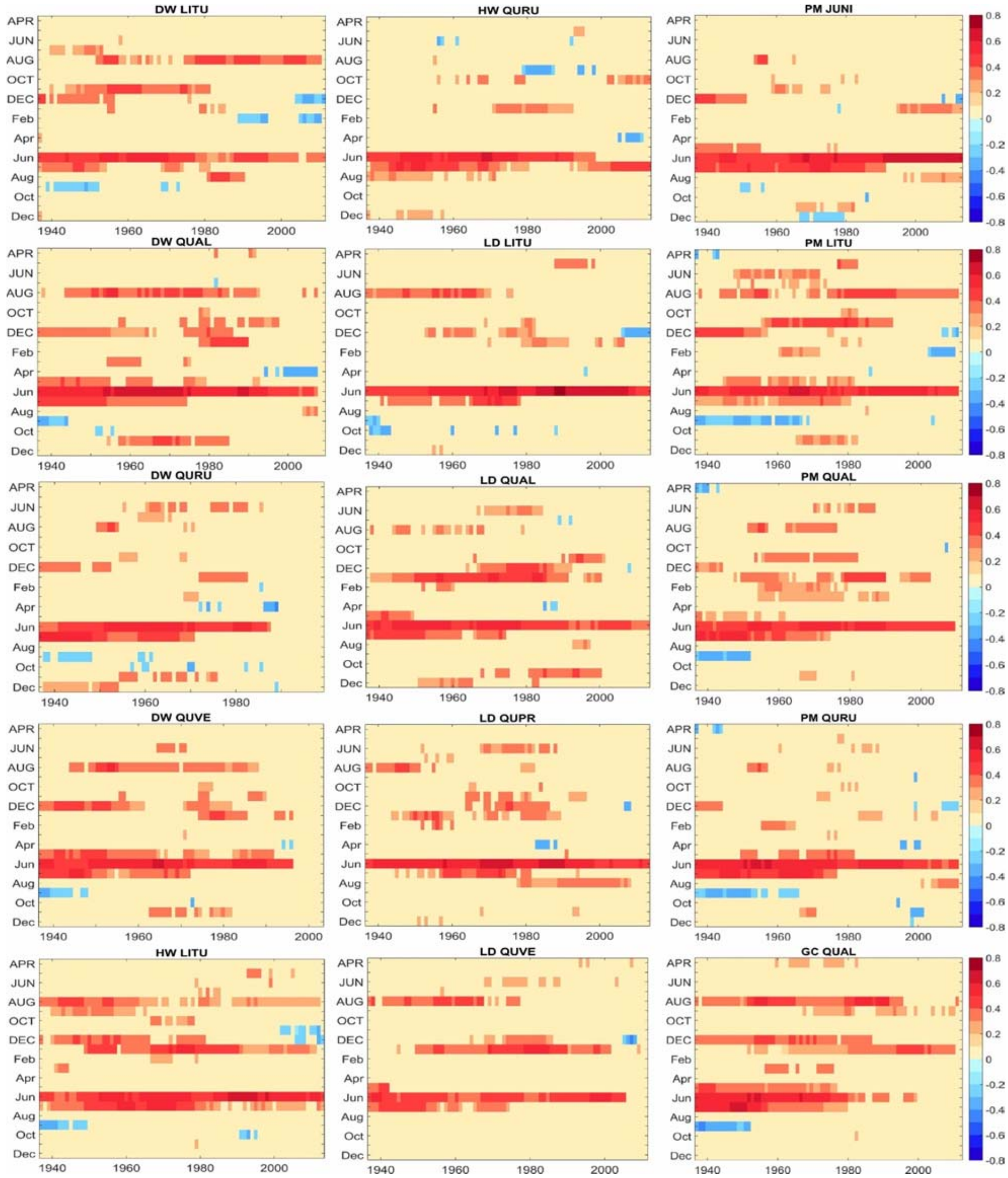

Figure S5: Moving-window correlation of standardized tree-ring widths with monthly precipitation from the NOAA climate division where the site was located. The year represents the end of each 42-year moving window. Months in all capitals represent the previous growing season. Only significant (p <0.05) values are shown. Each panel represents a particular species at a given site (e.g., DW LITU is *Liriodendron tulipifera* at Donaldson Woods).

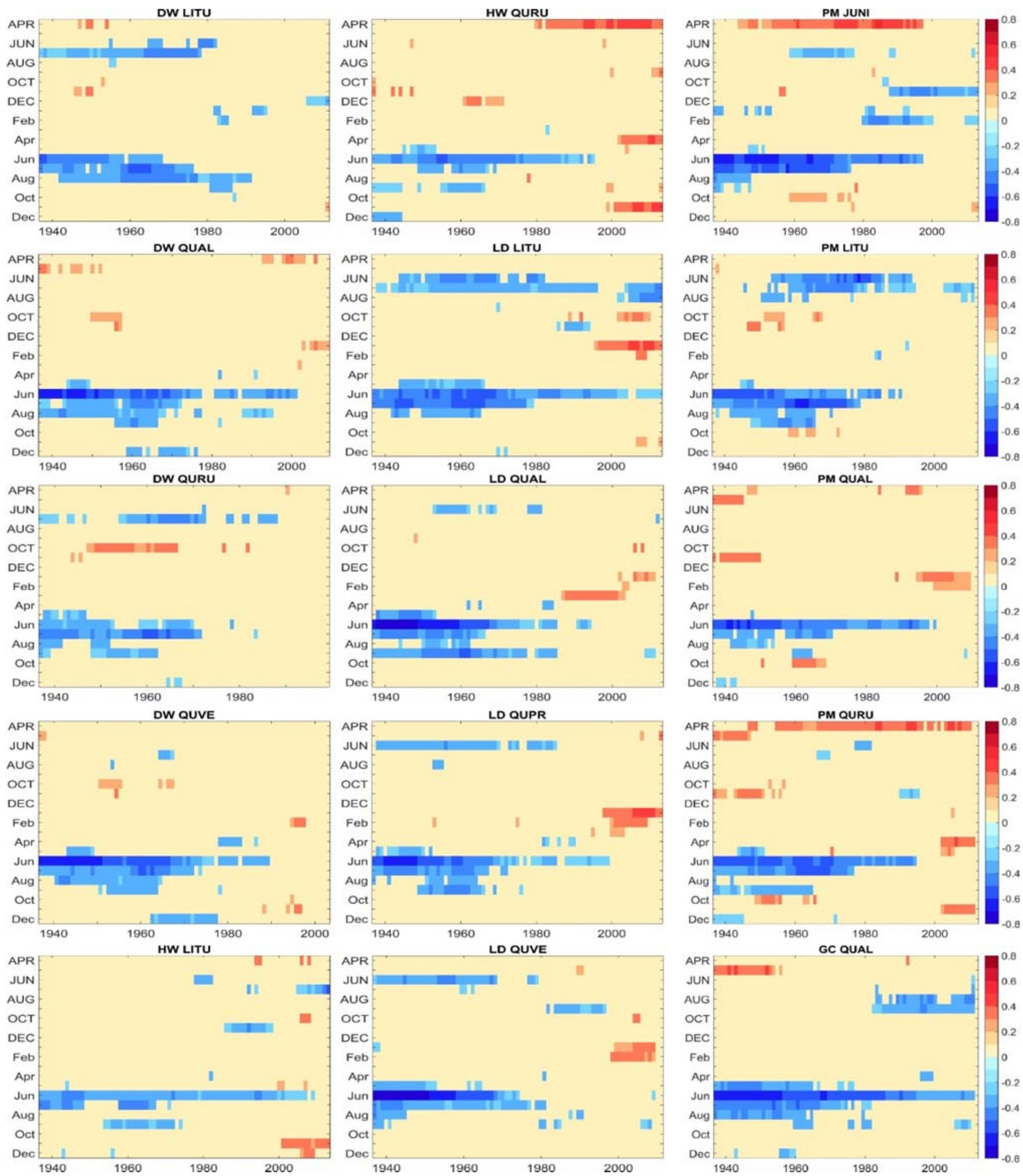

Figure S6: Moving-window correlations of standardized tree-ring widths with monthly mean temperature from the NOAA climate division where the site was located. The year represents the end of each 42-year moving window. Months in all capitals represent the previous growing season. Only significant (p <0.05) values are shown. Each panel represents a particular species at a given site (e.g., DW LITU is *Liriodendron tulipifera* at Donaldson Woods).

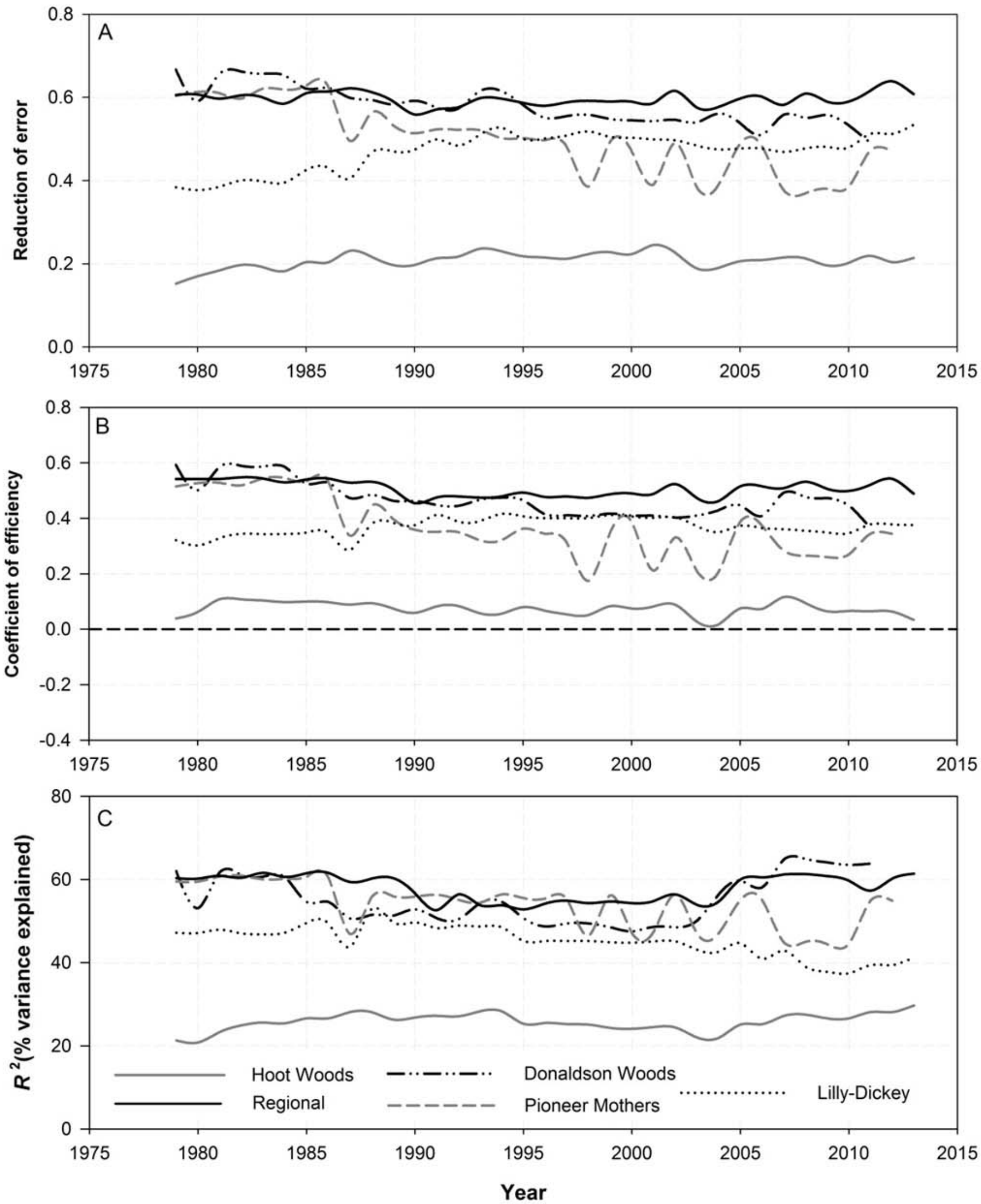

Figure S7: Validation statistics from the iterative climate reconstructions using the late calibration period for RE (A), CE (B), and R^2 (C) for the multiple co-occurring PDSI reconstructions for each site and regionally ("Regional").

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