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Supplement of

Assessment of the ParFlow–CLM CONUS 1.0 integrated hydrologic model: evaluation of hyper-resolution water balance components across the contiguous United States

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Figures S1 through S8 show the probability of exceedance or non-exceedance of error metrics included in this study, for most of the modeled water balance components, including streamflow (evaluated relative to USGS stream gauges), ET (relative to FLUXNET sites and MODIS products), SWE (relative to SNOTEL site observations), and water table depth (relative to USGS well locations). Because GRACE total water storage and ESACCI soil moisture remote sensing products were aggregated to the major basin scale for comparisons to PFCONUSv1 output, the number of comparison points (major basins) were too few to appropriately represent results as an exceedance probability plot, so these are not included.

Figure S9 shows additional performance metrics for PFCONUSv1 performance relative to USGS streamflow observations, in the form of the commonly used Nash-Sutcliffe model efficiency coefficient (NSE, Nash and Sutcliffe, 1970) and the Kling-Gupta efficiency (KGE, Gupta et al., 2009). NSE is given for a set of observations *O* and corresponding model simulated values *S* at each time step *i* as

$$NSE = 1 - \frac{\sum_i^n (S_i - O_i)^2}{\sum_i^n (O_i - \bar{O}_i)^2}$$

where $\bar{O}_i$ is the mean of the observed values. In order to address some of the issues that are introduced when using NSE as a performance criterion, the main of which being that the use of the observed mean can cause overestimation of model skill for highly seasonal output, Gupta et al. (2009) proposed an alternative metric, KGE, which uses three parametric components β, α_{KG}, and r_p:

$$KGE = 1 - \sqrt{(\beta - 1)^2 + (\alpha - 1)^2 + \left(r_p - 1\right)^2}$$

where β is the ratio between the simulated and observed mean discharge, α is the ratio between the simulated and observed standard deviation, and r_p is the Pearson correlation. In this way, KGE represents an aggregate evaluation of mean, variability, and correlation.

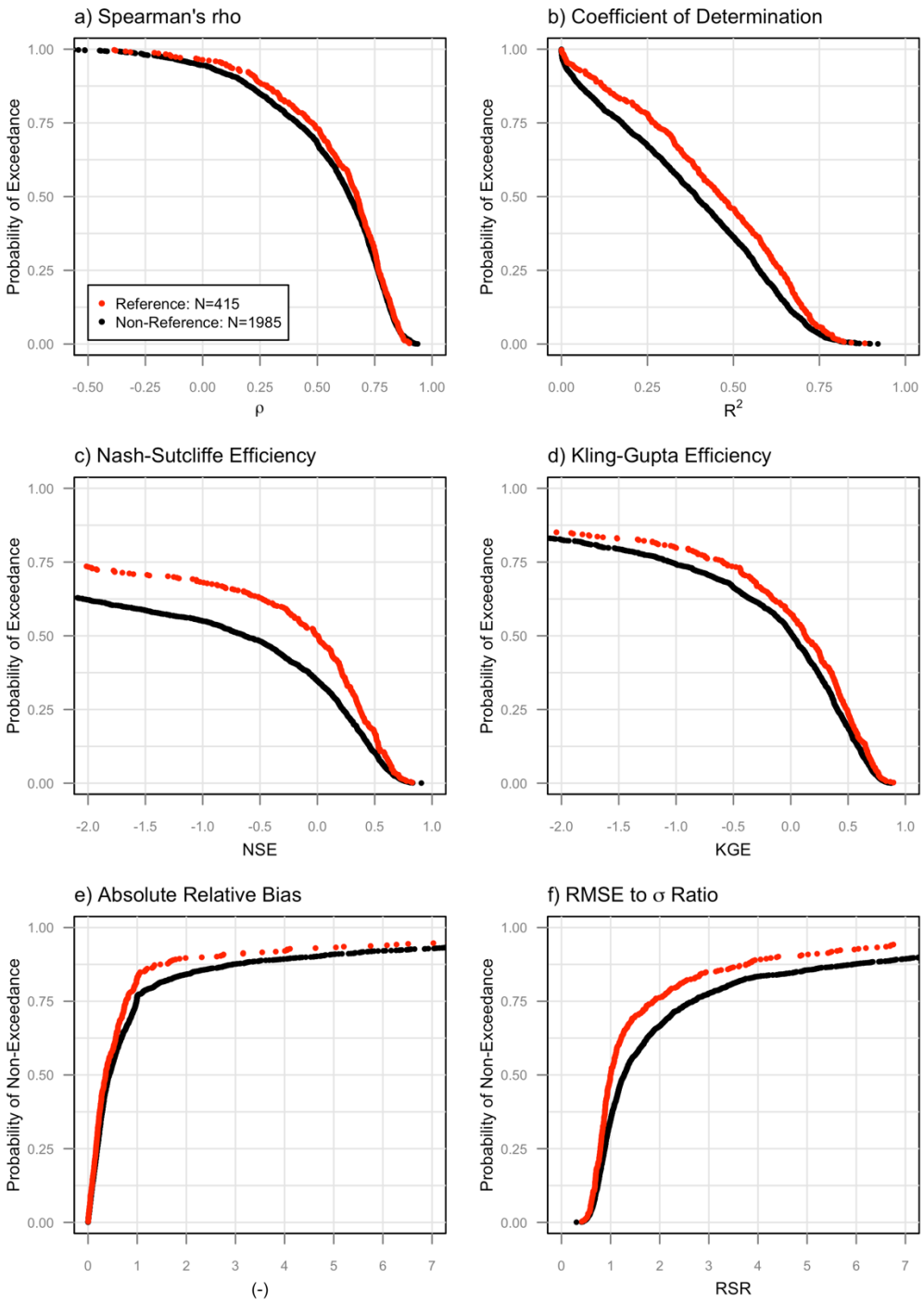

Figure S1: Probability of exceedance for a) Spearman's ρ, b) R^2, c) NSE, and d) KGE, and probability of non-exceedance for e) the absolute relative bias (the absolute value of percent bias expressed as a decimal) and f) RSR, for PFCONUSv1 daily values compared to USGS stream gauges. Results are shown for both non-reference (black) and reference (red) gauges based on the classification detailed in Maxwell et al. (2015), which distinguishes reference gauges to be those with least anthropogenic influence (groundwater abstractions, dams, diversions, etc.) to their upstream area based on the GAUGES-II dataset.

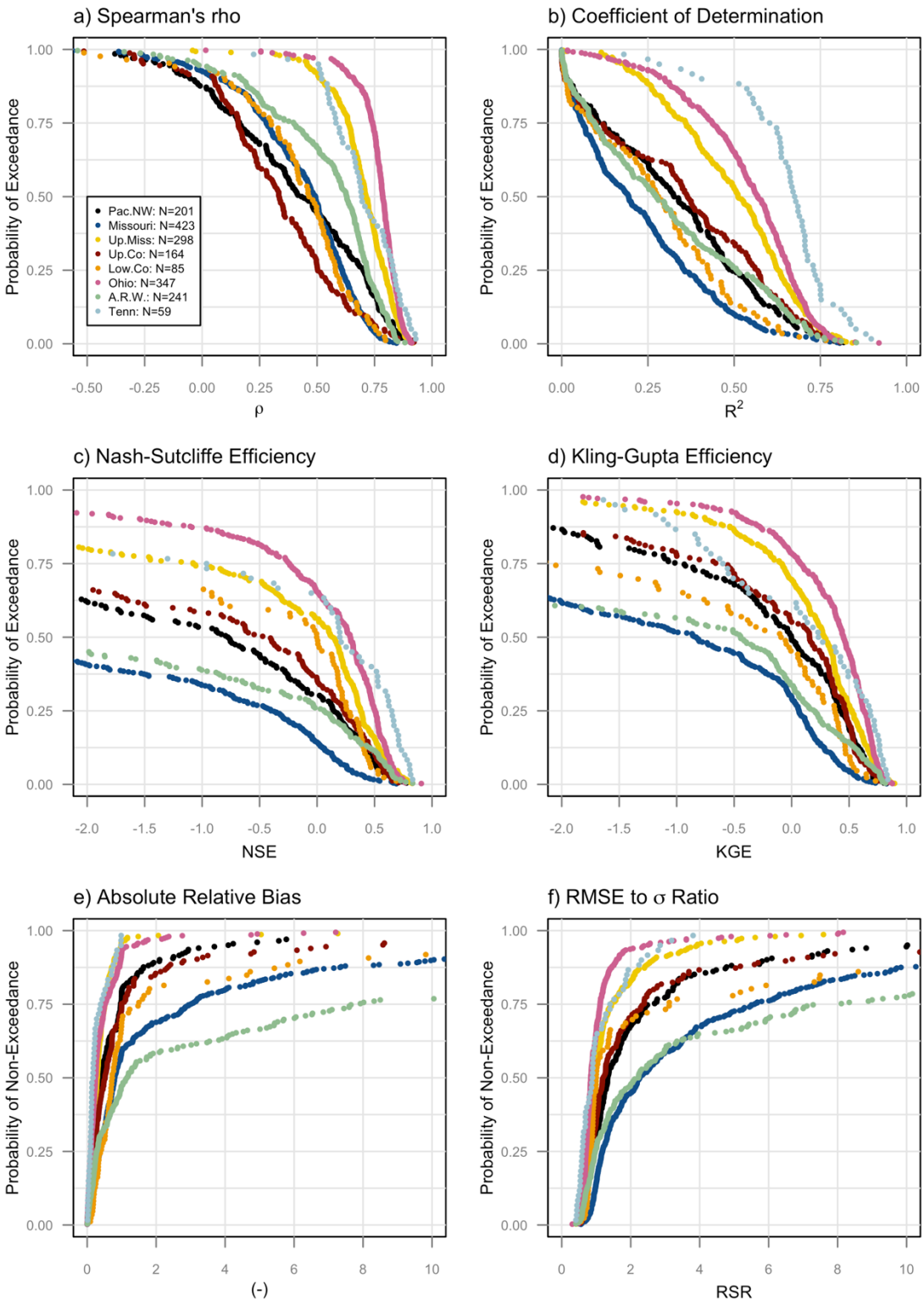

Figure S2: Same as Figure S1, colored by major basin.

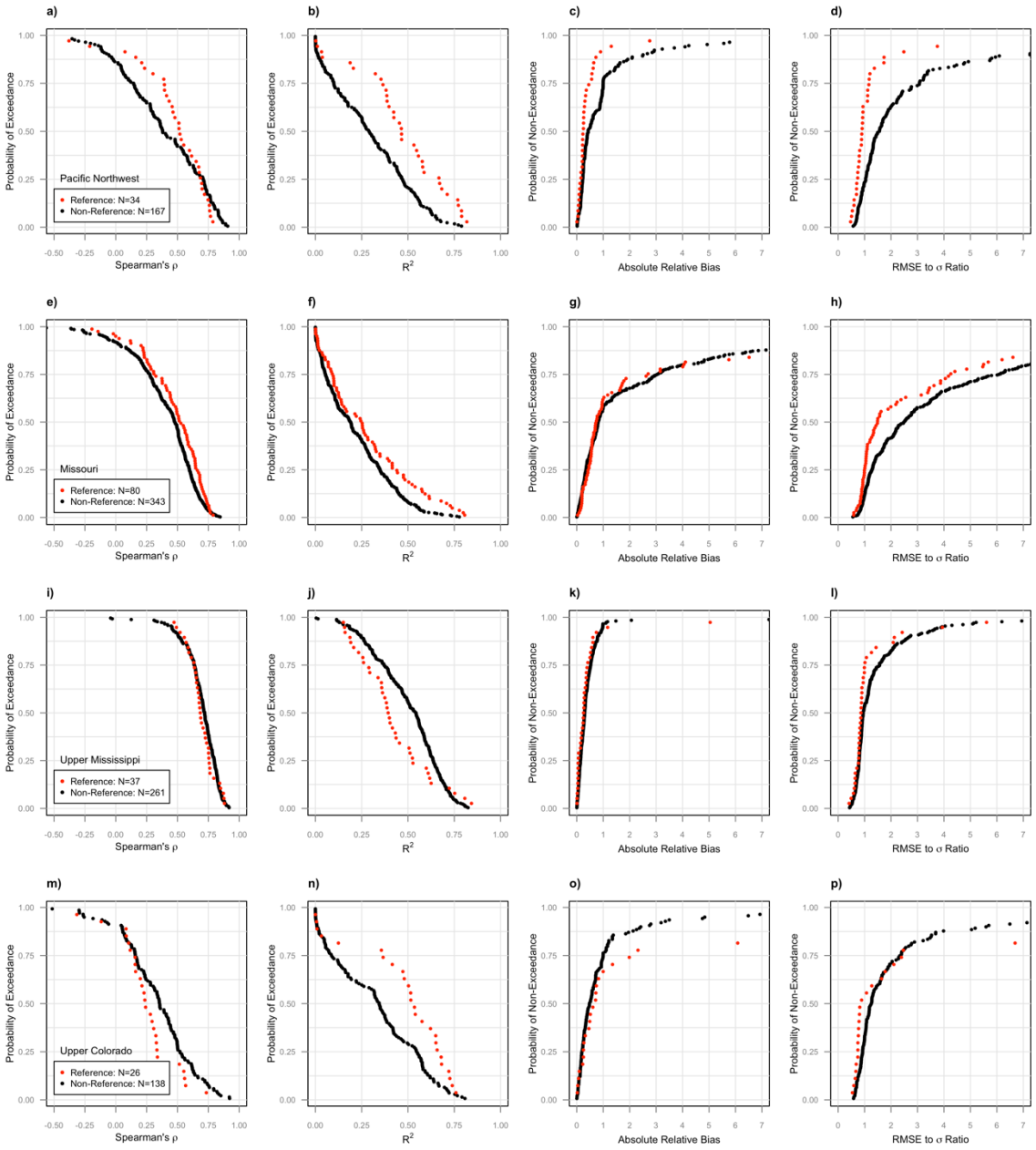

Figure S3: Left to right) Spearman's ρ, R^2, absolute relative bias, and RSR for PFCONUSv1 daily streamflow in (top to bottom) the Pacific Northwest, Missouri, Upper Mississippi, and Upper Colorado river basins, compared to USGS gauge observations. Results are shown for reference (red) and non-reference (black) gauge locations.

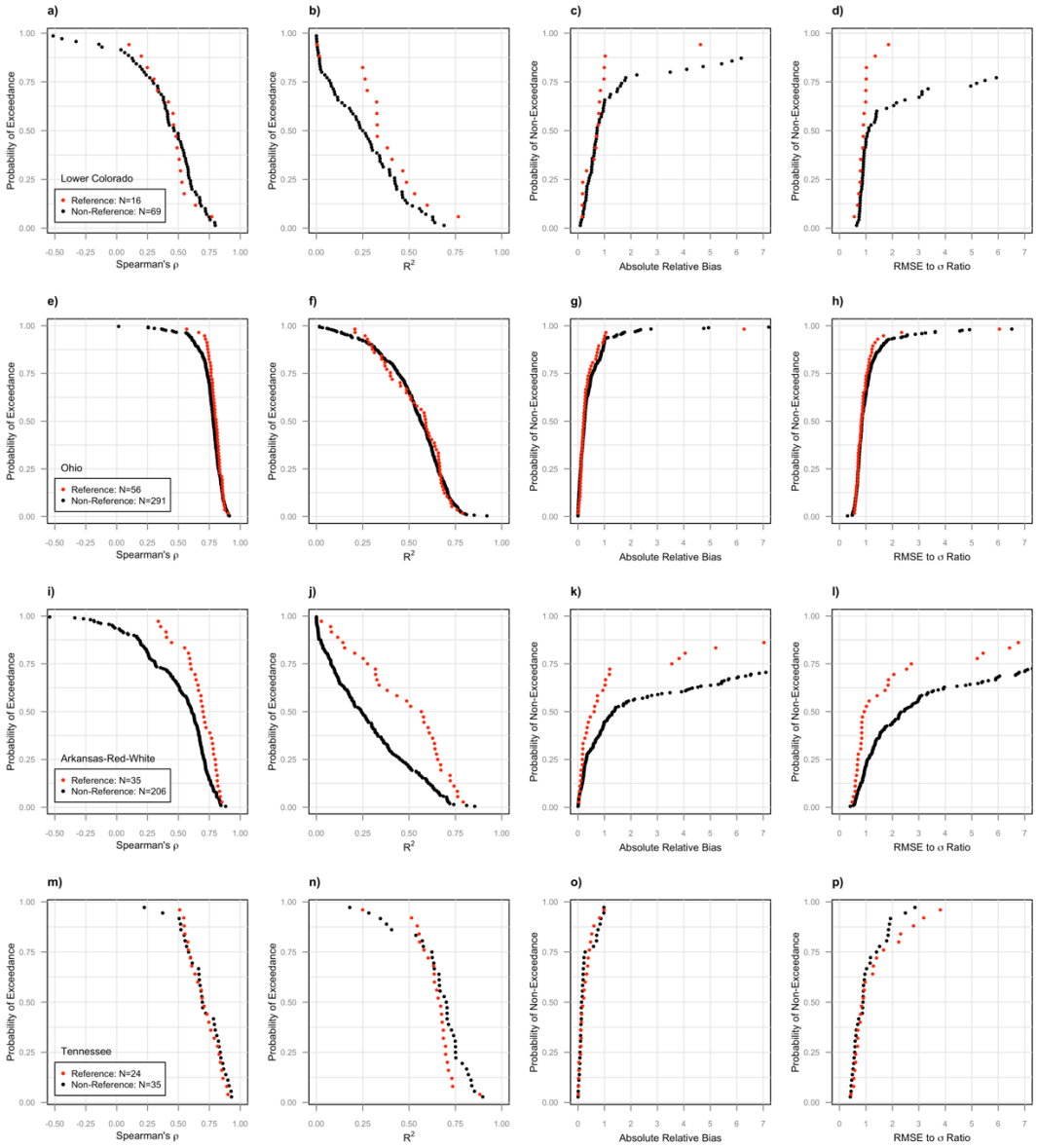

Figure S4: Same as figure S3, for (top to bottom) the Lower Colorado, Ohio, Arkansas-Red-White, and Tennessee river basins.

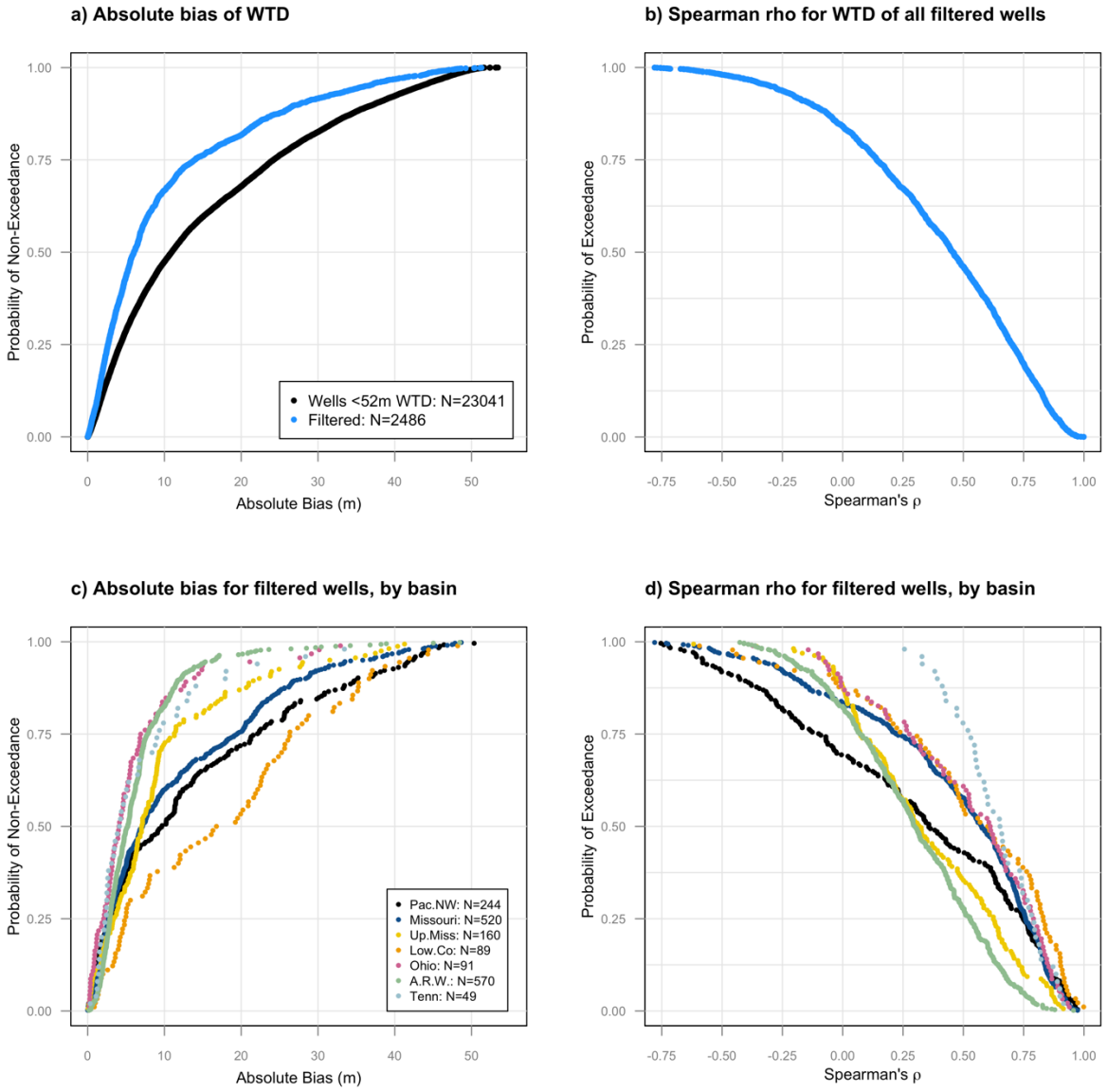

Figure S5: a) Probability of non-exceedance for absolute relative bias for PFCONUSv1 simulated water table depth at USGS well locations that show WTD less than 52 m (model thickness) depth. Results shown for all well locations (black), and those filtered (blue) with the criteria that they have more than 10 observations during the simulation timeframe, and were not flagged by USGS to be in a confined or mixed aquifer system nor flagged for pumping. b) Probability of exceedance for Spearman's ρ, for filtered locations only. c and d) Same as a and b, for filtered well locations and colored by major basin.

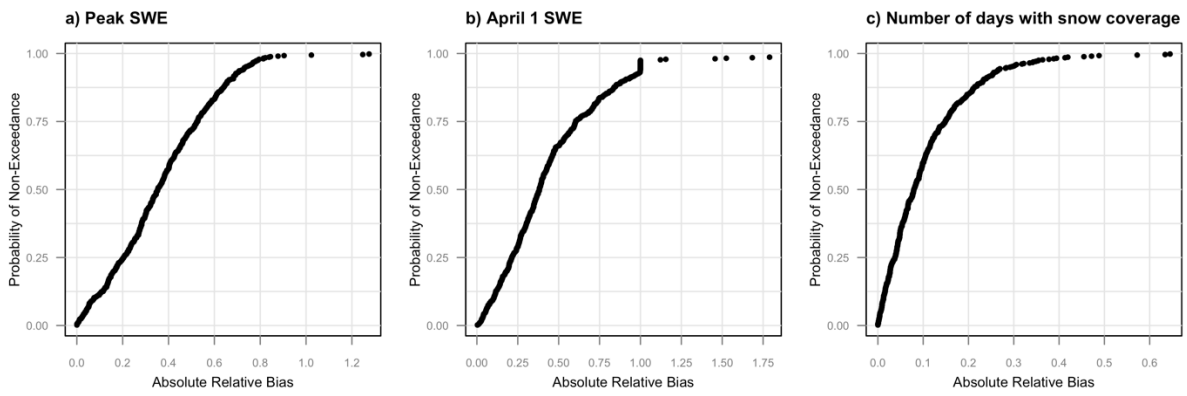

Figure S6: Probability of non-exceedance for absolute relative bias of PFCONUSv1 simulated a) peak annual SWE, b) April 1 SWE, and c) average number of days per year with snow coverage, with performance evaluated relative to SWE observed at SNOTEL locations during the simulation period.

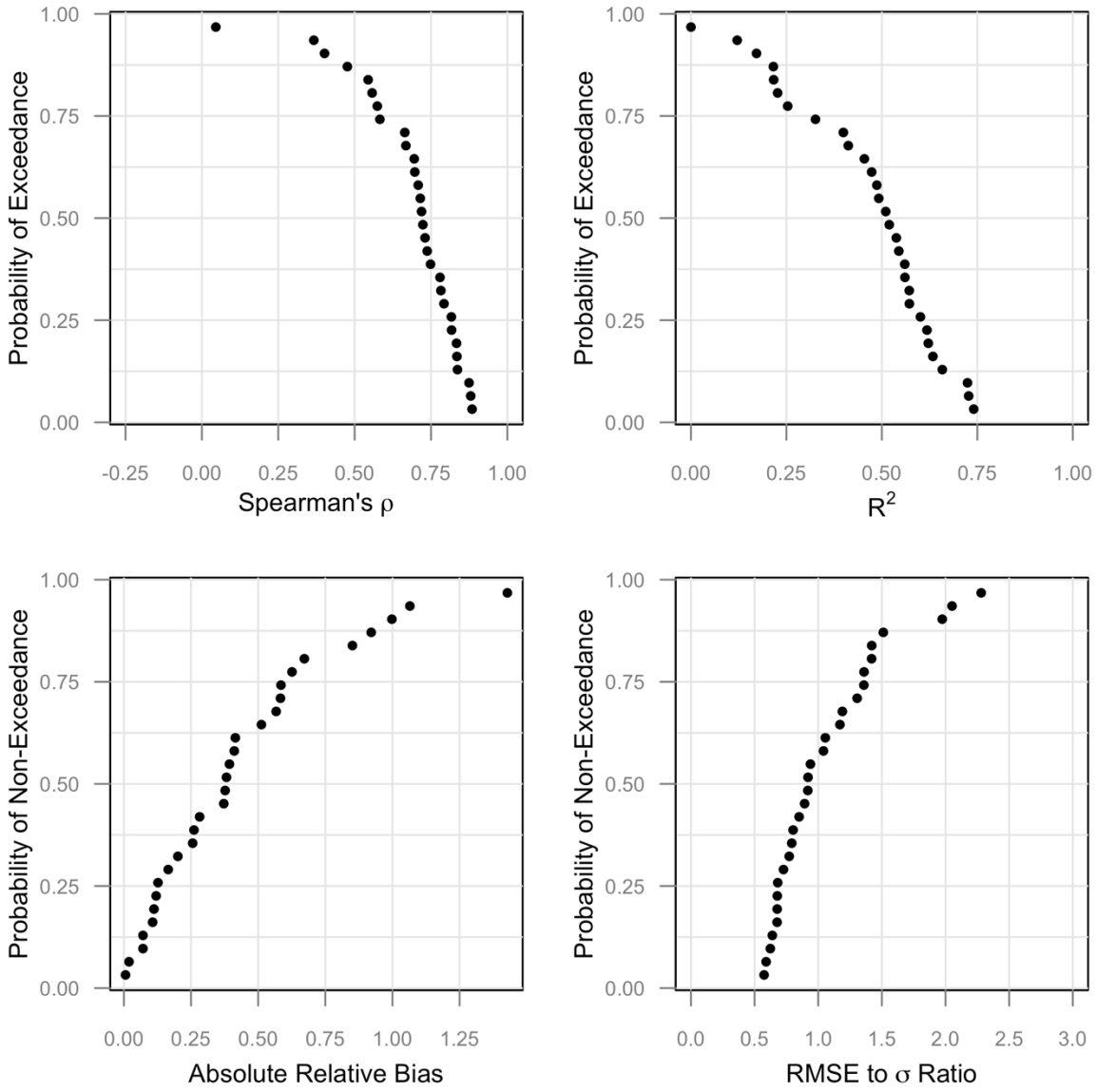

Figure S7: Probability of exceedance (top) and non-exceedance (bottom) for Spearman's ρ (top left), R^2 (top right), absolute relative bias (bottom left), and RSR (bottom right), for PFCONUSv1 daily ET output, with performance evaluated relative to ET observations at 30 FLUXNET locations across the domain.

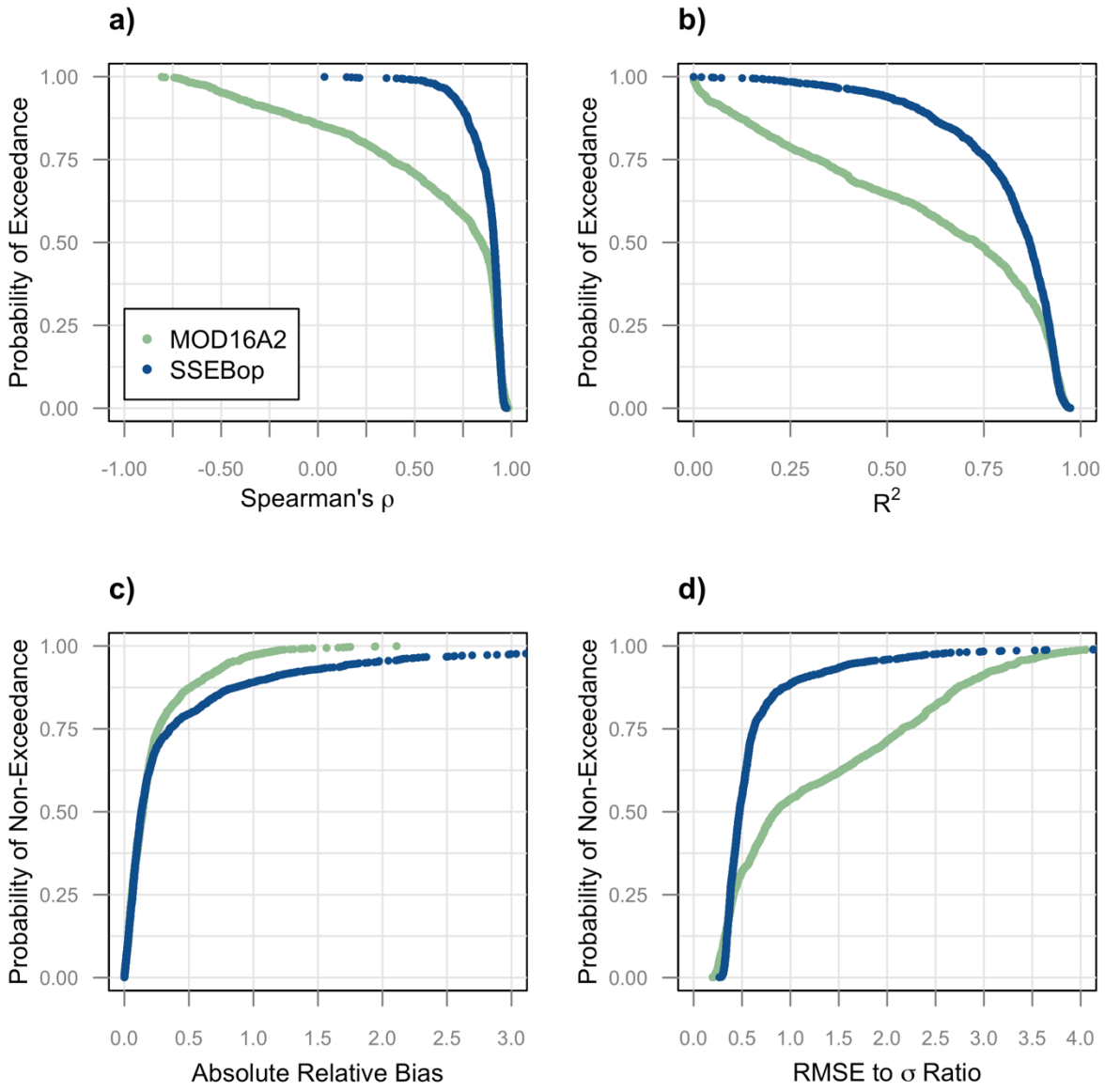

Figure S8: Probability of exceedance (top) and non-exceedance (bottom) for Spearman's ρ (top left), R^2 (top right), absolute relative bias (bottom left), and RSR (bottom right), for PFCONUSv1 monthly ET output, with performance evaluated relative to MODIS products aggregated at the HUC8 scale. Plots are colored by MODIS algorithm showing MOD16A2 and SSEBop.

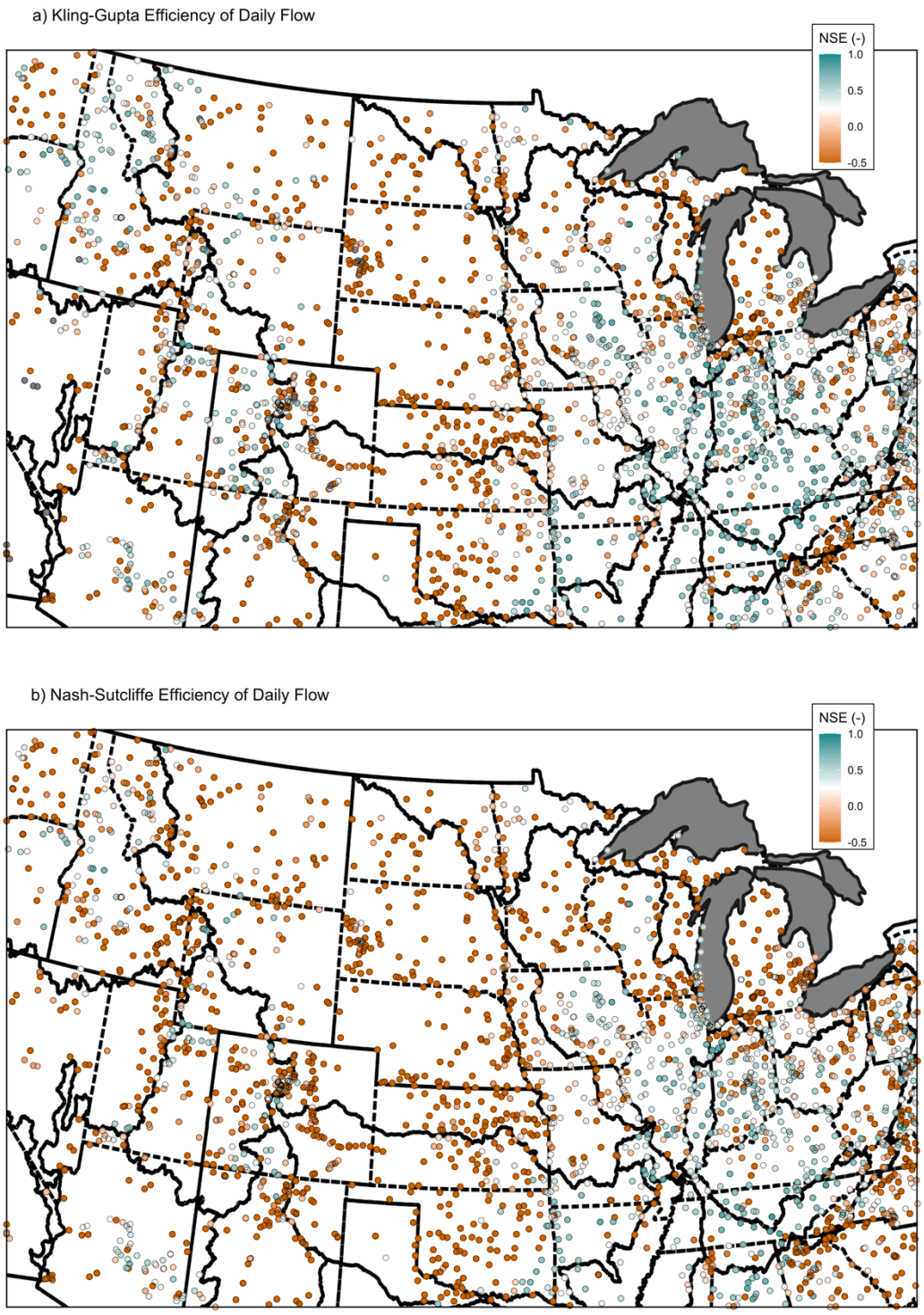

Figure S9: KGE (a) and NSE (b) evaluated at USGS stream gauges for PFCONUSv1 simulated daily streamflow.