Supplementary material for

Standardised drought indices in ecological research: why one size does not fit all

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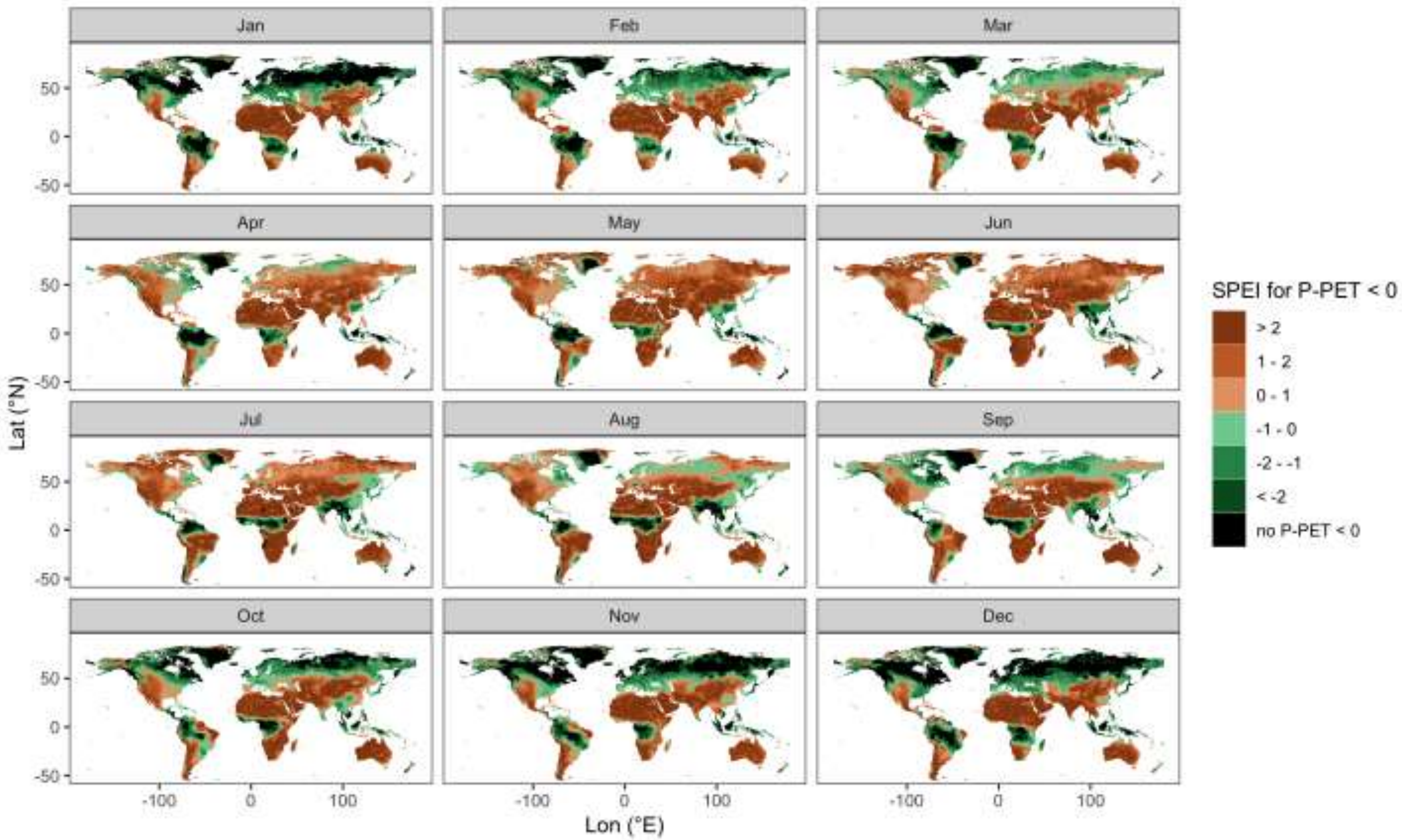

Figure S1. *Representation of water supply by a standardised drought index (SPEI1: SPEI at 1 month integration, Vicente-Serrano, Beguería, & López-Moreno, 2010). Shown are critical SPEI values for January to December that mark the transition from negative to positive P-PET, i.e. from water shortage to water surplus. Depending on season and climate zone, for a considerable part of the Earth's surface SPEI only indicates water shortage for values below -2. In large parts of the boreal zone and the tropics, a negative SPEI value may even never indicate water shortage in terms of negative P-PET. SPEI1 is extracted from the Global SPEIbase v2.5; Vicente-Serrano, Beguería, López-Moreno, Angulo, & El Kenawy, 2010), P-PET (sometimes referred to as climatic water balance, Stephenson & Das, 2011) is computed as precipitation – potential evapotranspiration (both from CRU TS 3.24.01, Mitchell & Jones, 2005, the data set underlying SPEIbase v2.5).*

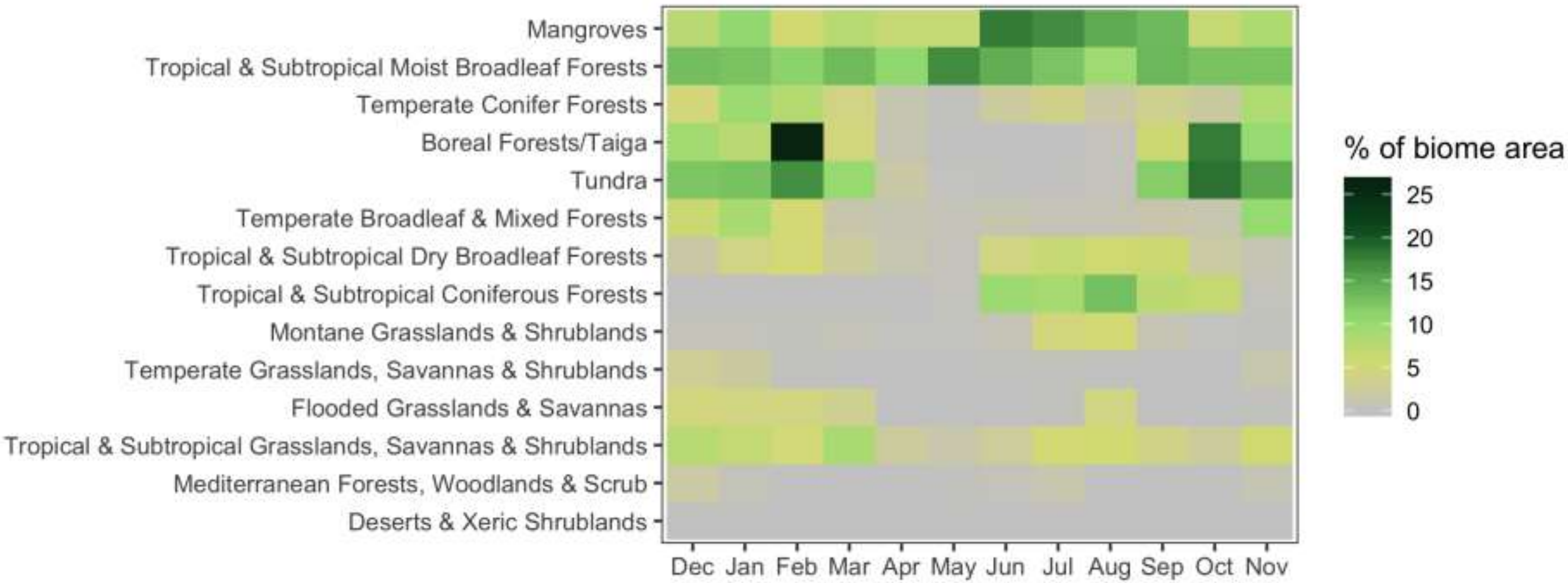

Figure S2*. Percentage of biome area for which SPEI1 <= -2 does not indicate negative P-PET, by month. Biomes are demarcated according to Olson et al. (2001) and ordered by increasing aridity (decreasing mean P-PET) from top to bottom. The area fractions include areas where for the respective month P-PET is always positive (c.f. Figure S1).*

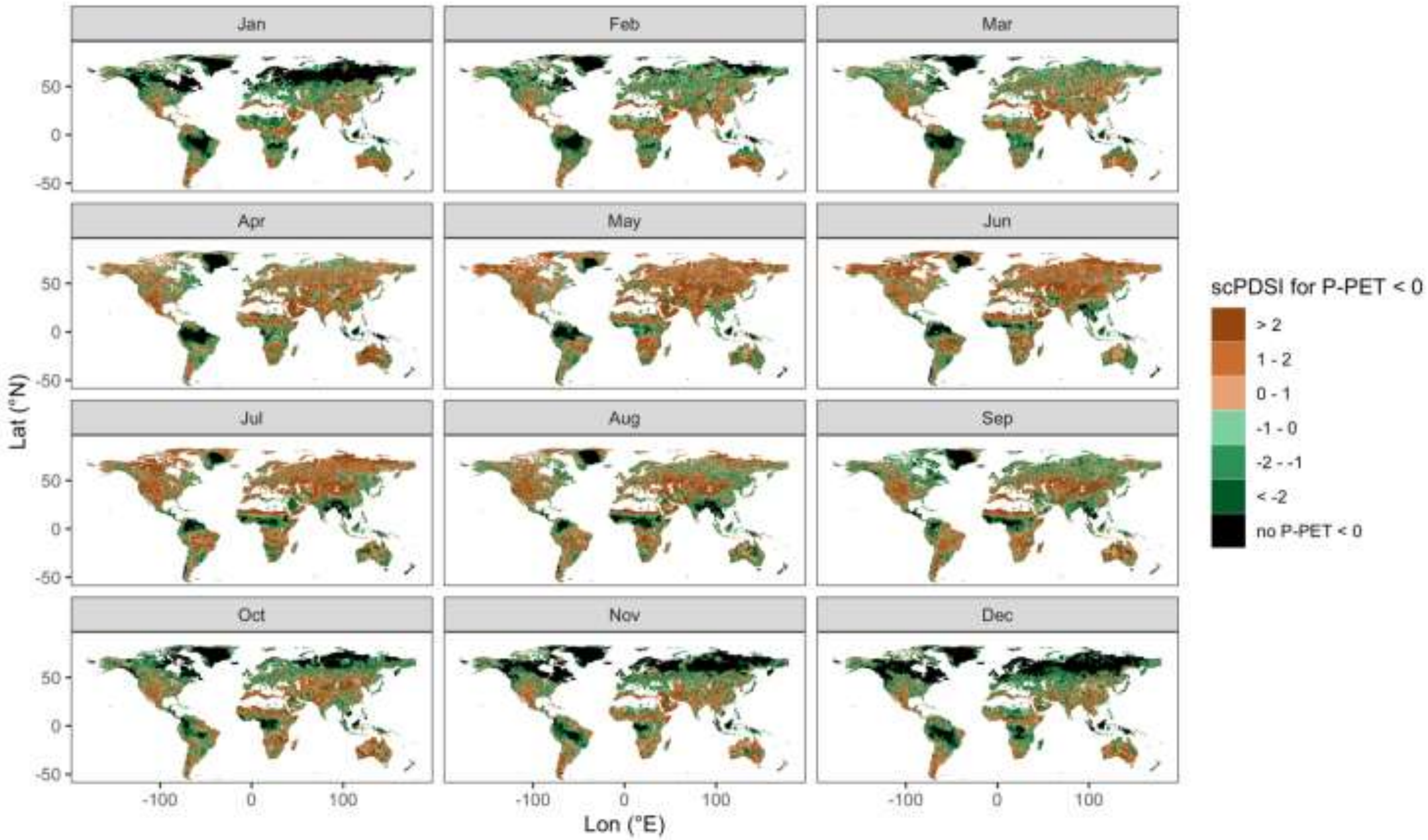

Figure S3. *Representation of water supply by a standardised drought index (scPDSI: self-calibrating Palmer Drought Severity Index, Wells, Goddard, & Hayes, 2004). Shown are critical scPDSI values for months January to December that mark the transition from negative to positive P-PET, i.e. from water shortage to water surplus. In contrast to SPEI (Figure 1, Figure S1), scPDSI is not directly computed from the distribution of P-PET, but involves a more complex climatic balance, including a simple dynamic representation of soil water status. Therefore, the direct comparison of scPDSI with P-PET needs a more careful interpretation than the comparison of SPEI and P-PET, but still shows a similar regional decoupling of negative index values with actual water shortage (negative P-PET). scPDSI is based on CRU TS 3.24 (Osborn, Barichivich, Harris, Van Der Schrier, & Jones, 2016).*

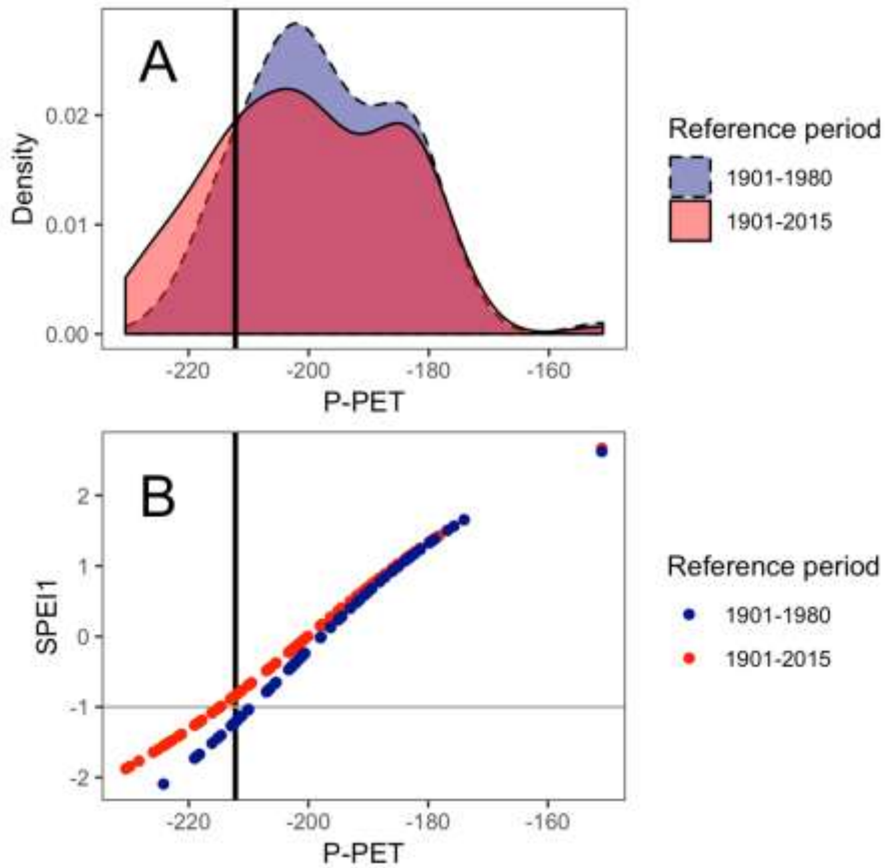

Figure S4. *Consequences of changes in reference period for the computation of SPEI: (A) Distribution of July P-PET for the Sierra Valley, California, USA, for two different reference periods: 1901-1980 and 1901-2015. The vertical line shows P-PET for July 1977, i.e. during one of the most severe drought events in the state's history. For the longer reference period, the distribution gains more mass on the left tail towards more negative P-PET. (B) As a consequence, SPEI1 (SPEI integrated over 1 month) for the longer reference period is less negative for low P-PET (indicating less severe drought) for identical events. A change in reference periods for this site can consequently even change the classification of a particular drought like July 1977 (vertical line), which would shift from < -1 (outside the range of normal variability sensu Slette et al. 2019) to > -1 (within the range of normal variability, horizontal grey line at -1). Precipitation and potential evapotranspiration were extracted from CRU TS 3.24.01 (Mitchell & Jones, 2005), SPEI1 was computed using the R (R Core Team, 2019) package SPEI (Beguería & Vicente-Serrano, 2017).*

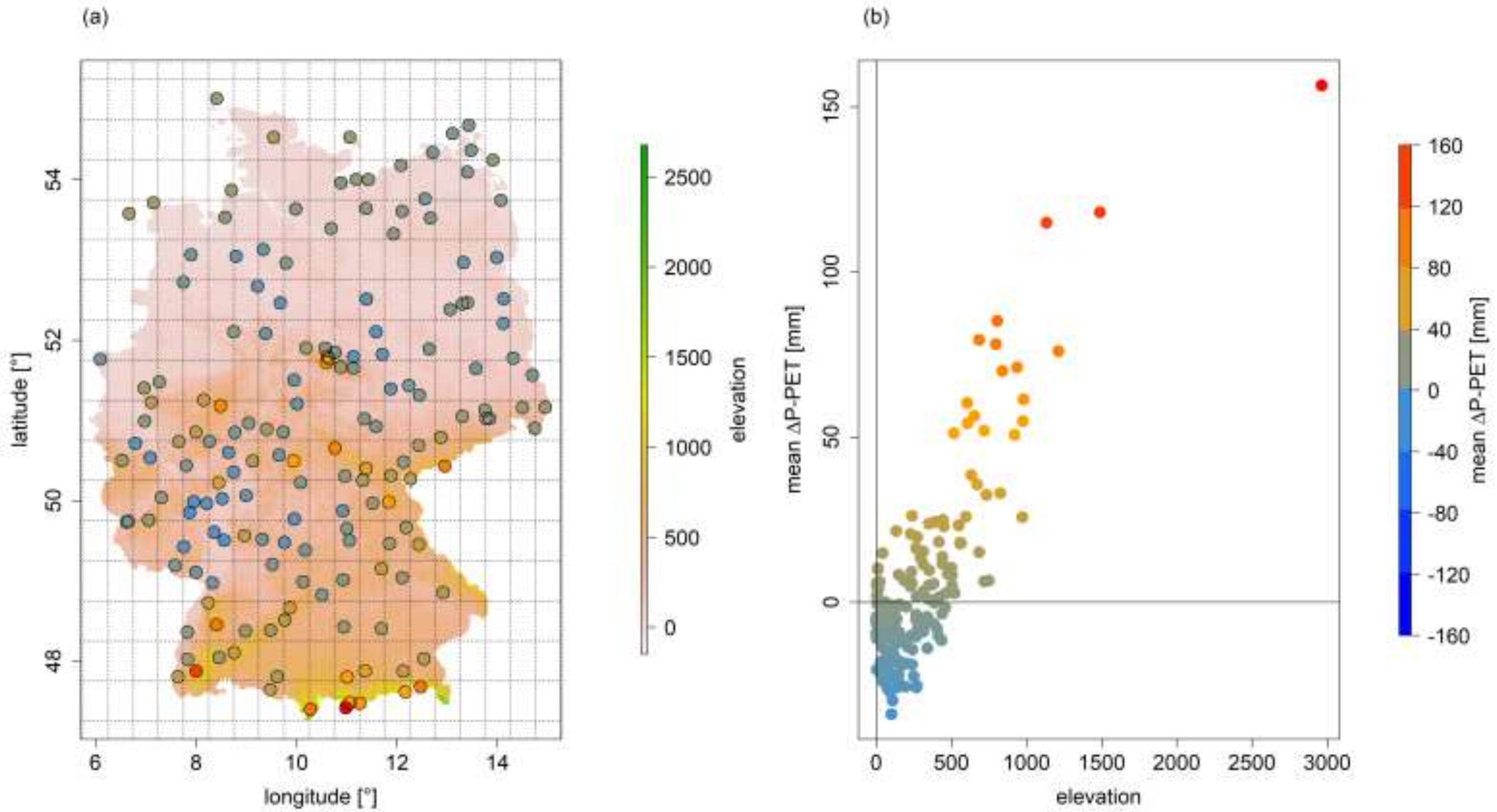

Figure S5. *Mean differences of P-PET (mean Δ P-PET) estimates as derived from DWD (German meteorological service) climate station data as well as gridded climate products (CRU TS v 3.24.01). The map (a) depicts the location of climate stations (colored dots with color scale referring to the legend in (b)) on top of a digital terrain model (background colors with color scale referring to the legend in (a)). Dashed lines demarcate the nodes of the CRU 0.5° grid. The scatterplot (b) reflects the dependence of mean Δ P-PET on elevation. Coloration of the dots corresponds to the same colors as in (a). Positive values indicate that P-PET as derived from gridded climate data underestimates the climate station based estimate. Thus, overestimation of P-PET (blue dots, negative values) largely occurs at low elevations while underestimation (orange and red dots, positive values) mostly occurs at high elevations.*

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