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Coherence of global hydroclimate classification systems

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Introduction

This supporting information contains expanded information on climate classification systems creation and comparison through 11 figures and 2 tables. The figures support four main themes: 1) validation data independence, 2) sine fit method and measures of performance, 3) novel climate classification system formation, and 4) comparison of all assessed classification systems. The first table details the coherence and complexity results of WEC with 20 zones (WEC_{20}), while the second table describes the clustering centers of mean annual potential evapotranspiration, PET, and precipitation, P, used for forming the zone boundaries of the WEC framework.

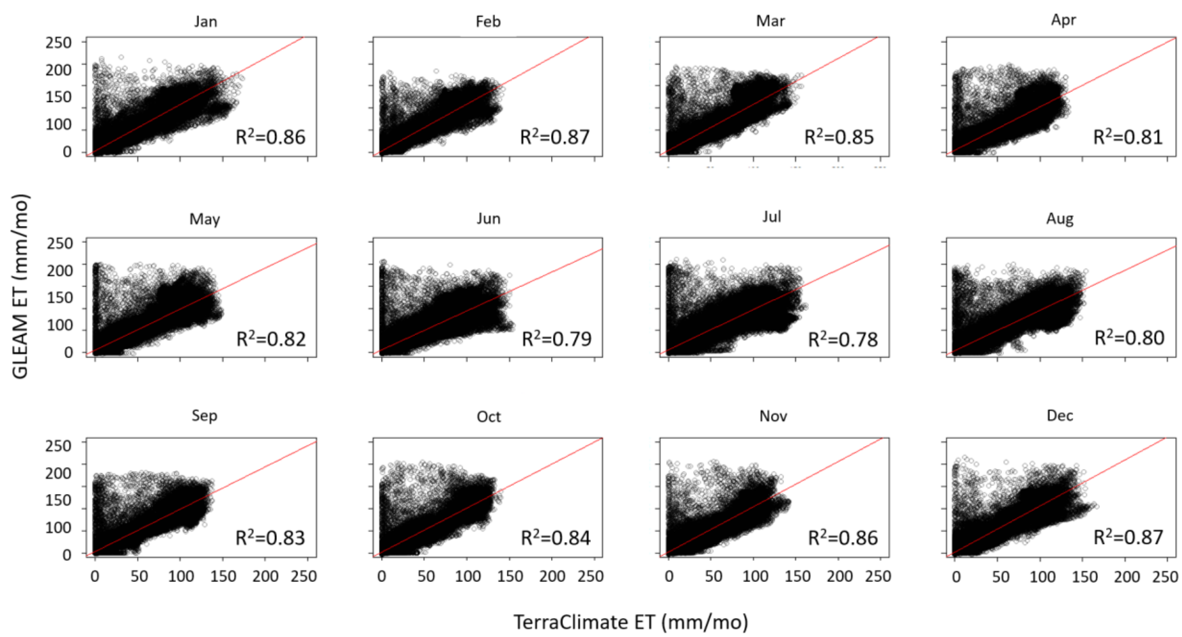

Figure S1. Linear models of long-term TerraClimate ET (mm/month) versus long-term GLEAM ET (mm/month) (1980-2014).

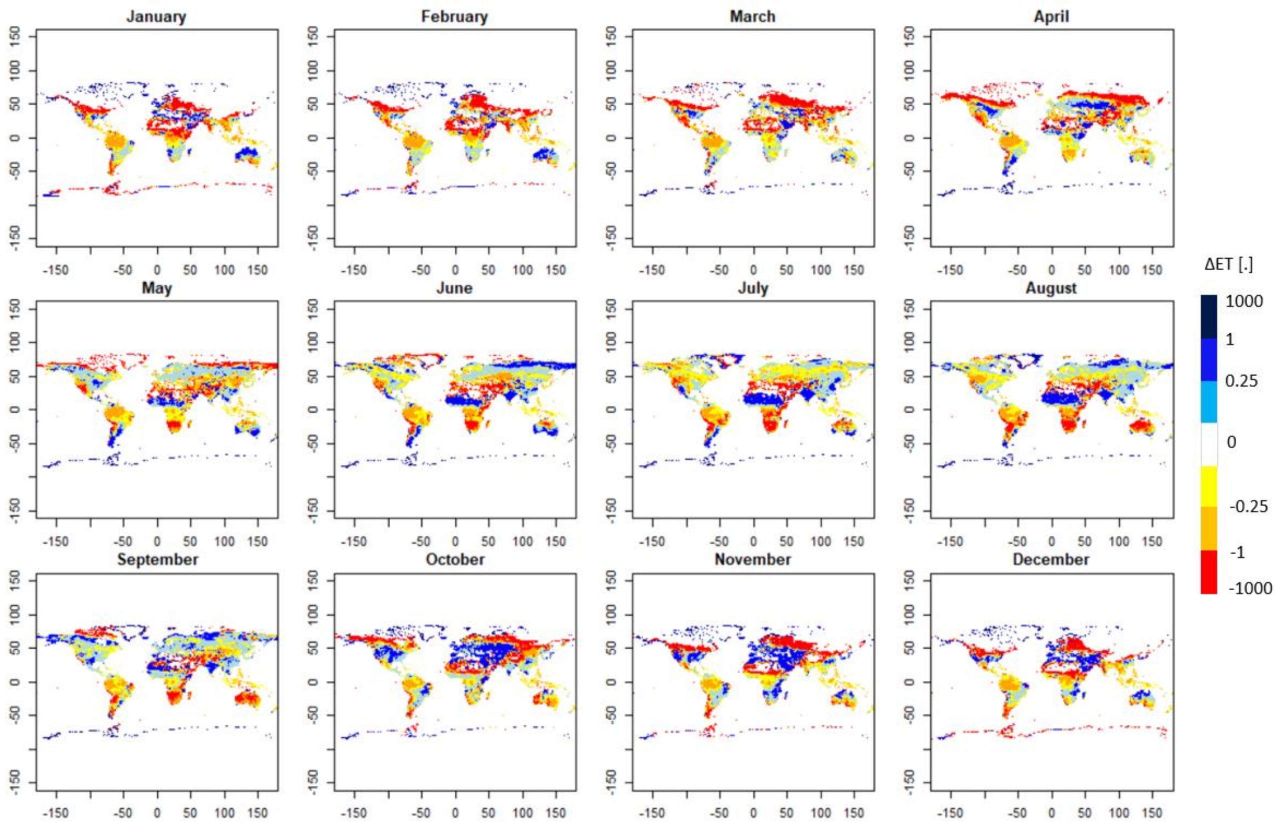

Figure S2. Relative long-term difference between ET derived from the TerraClimate dataset and ET from the GLEAM dataset ($\Delta ET = (ET_{TerraClimate} - ET_{GLEAM})/ ET_{TerraClimate}$).

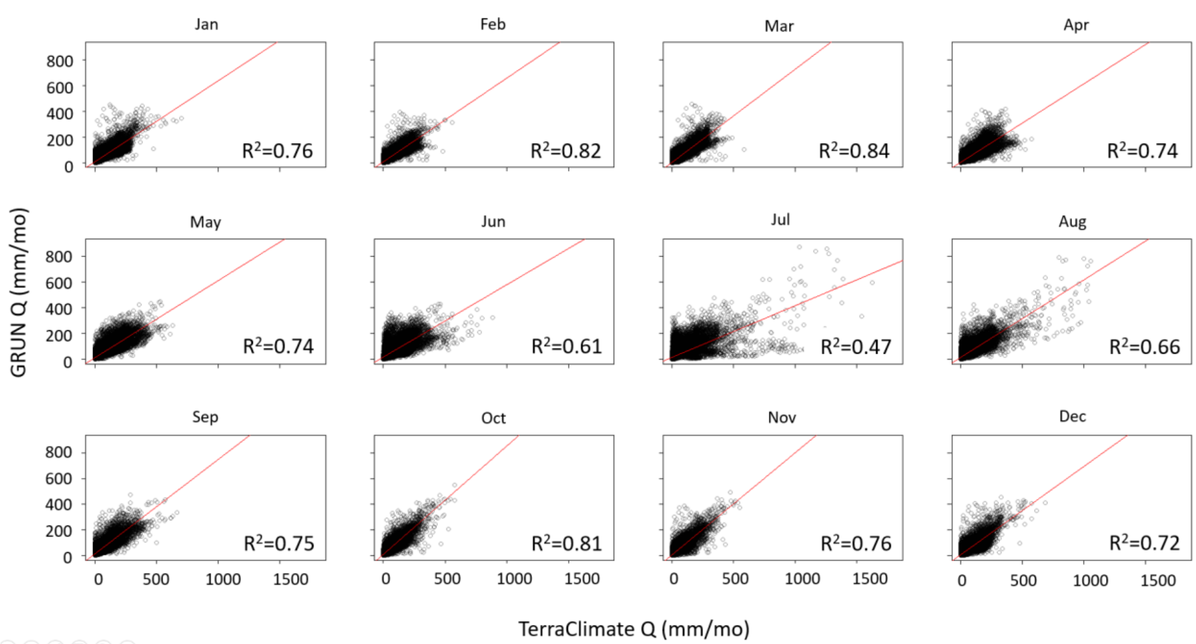

Figure S3. Linear models of long-term TerraClimate Q (mm/month) versus long-term GRUN Q (mm/month) (1980-2014).

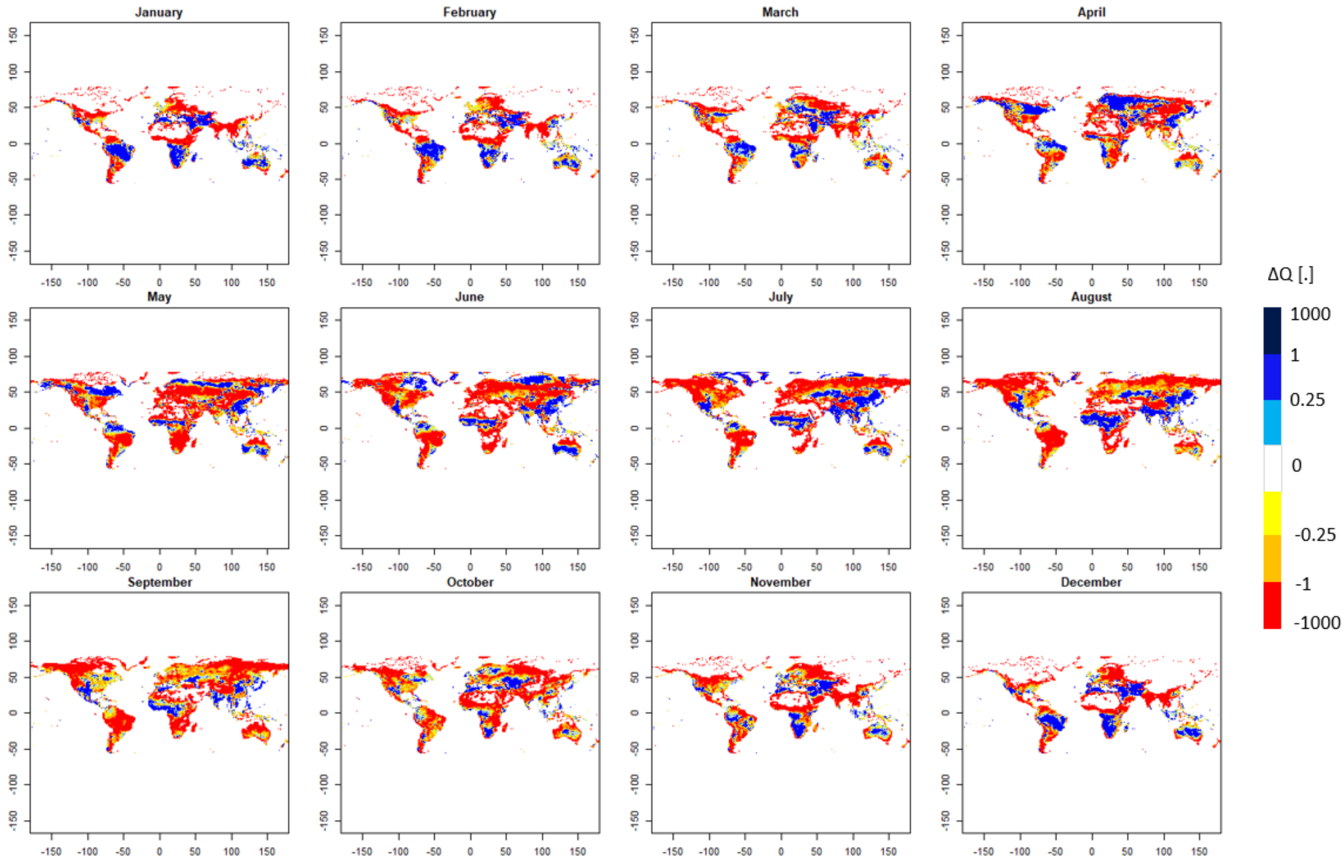

Figure S4. Relative difference between Q derived from the TerraClimate dataset and Q from the GRUN dataset ($\Delta Q = (Q_{TerraClimate} - Q_{GRUN})/Q_{TerraClimate}$).

Phase difference, Δt, describes the synchronization of P and PET throughout the year as

$$\Delta t = \begin{cases} t_{PET} - t_P, & -6 \le t_{PET} - t_P \le 6 \\ t_{PET} - t_P - 12, & t_{PET} - t_P > 6 \\ t_{PET} - t_P + 12, & t_{PET} - t_P < 6 \end{cases} \tag{S1}$$

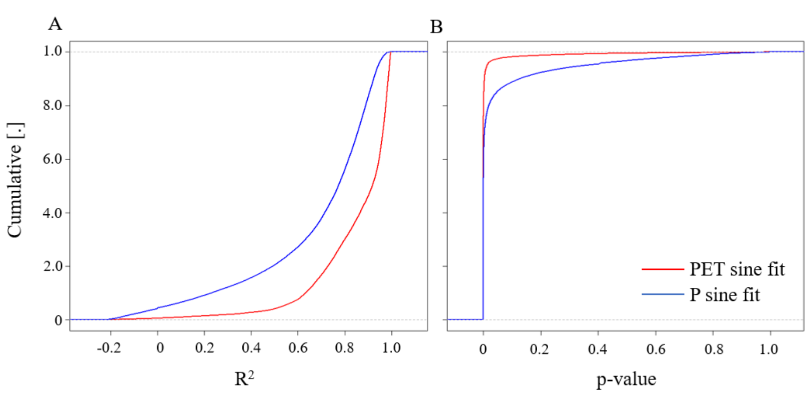

Figure S5. Cumulative distribution functions of R^2 (A) and p-value (B) for PET (red) and P (blue) sine fits.

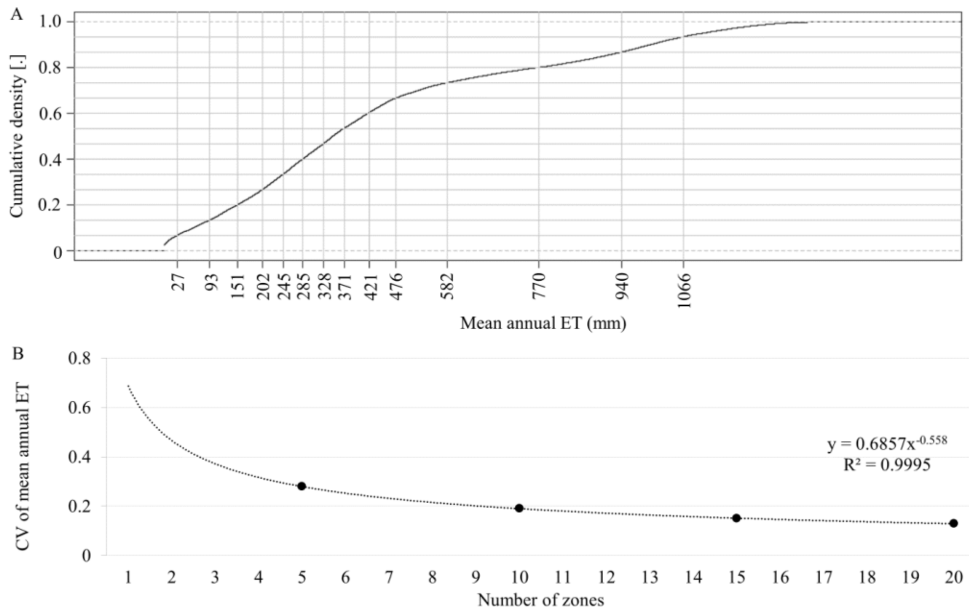

Figure S6. Method for determining zone boundaries for ET Area-optimizing classification system, ETA. (A) Cumulative distribution of global mean annual ET (mm) divided into 15 zones that result in an approximately equal number of pixels in each zone. (B) CV of mean annual ET as a function of number of zones.

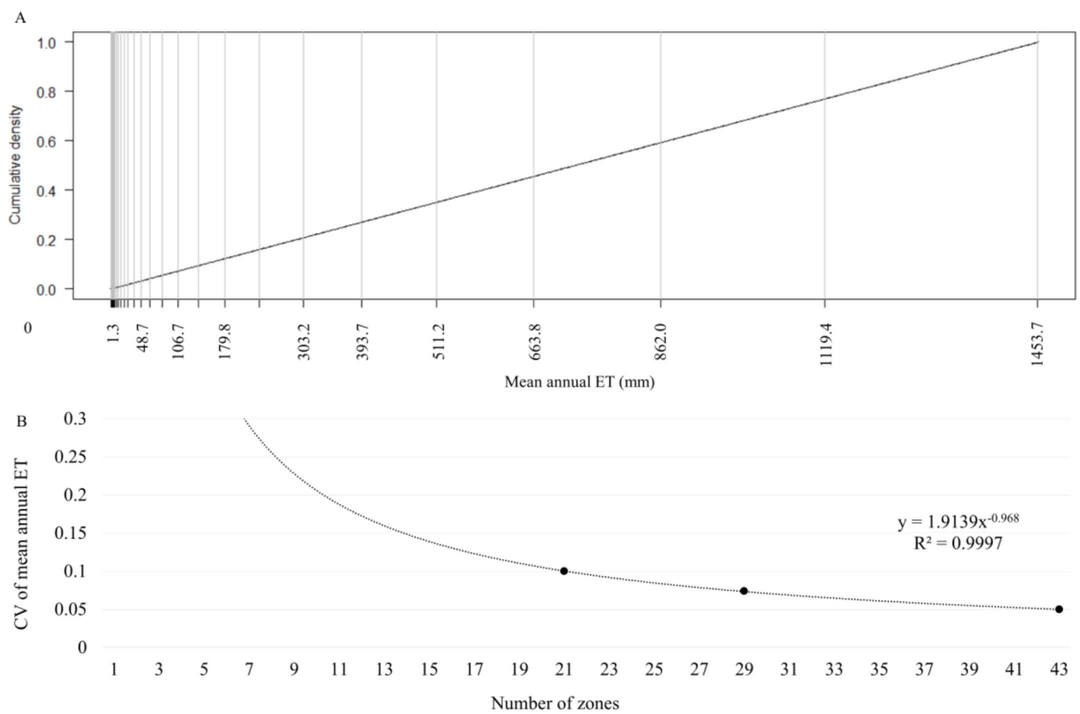

Figure S7. ET zone boundaries assuming a uniform CDF (A) and CV of ET as a function of number of zones (B) for the ET Variability-optimizing classification system (ETV).

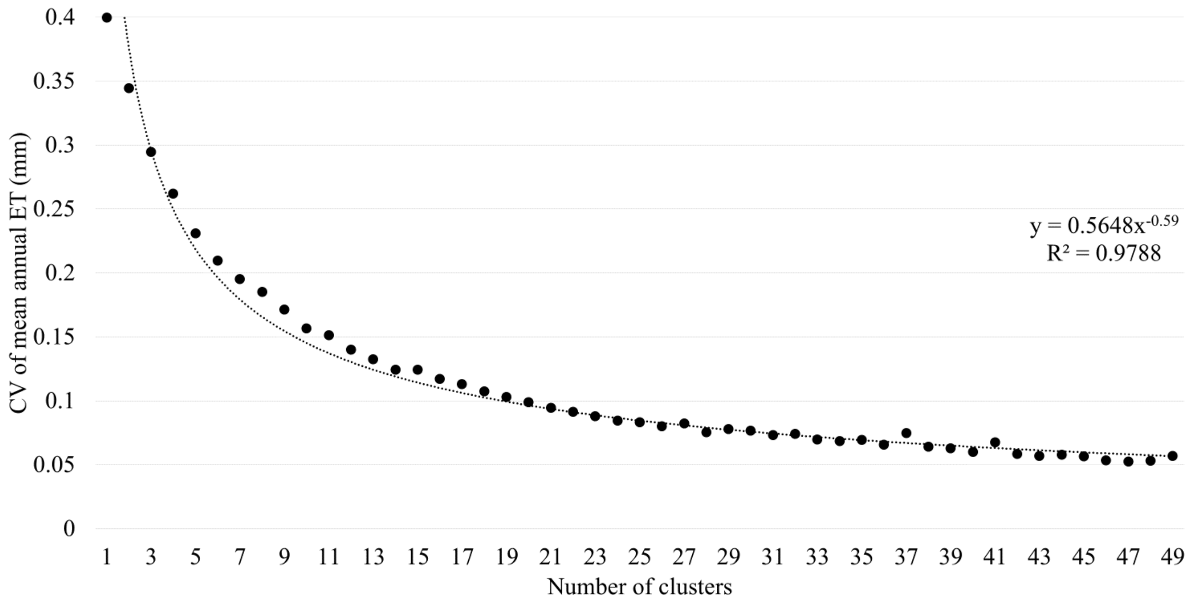

Figure S8. CV of ET as a function of number of clusters for the ET Clustering classification system (ETC), fitted by an exponential distribution.

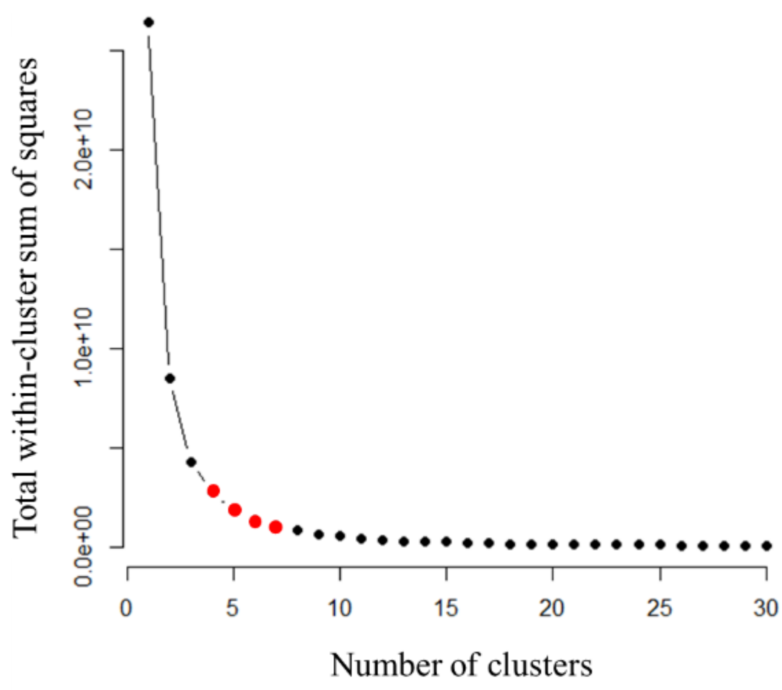

Figure S9. Total within-cluster sum of squares for each possible number of clustered zones (built from clustering mean annual P and PET) ranging from 2 to 30. The number of clusters at the “elbow” are shown in red.

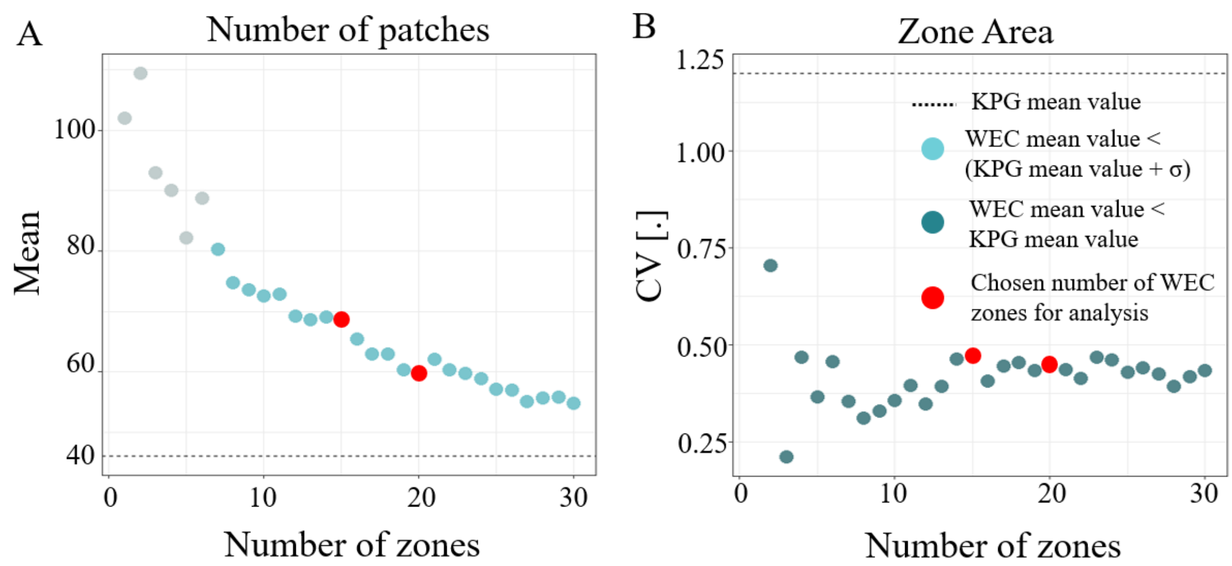

Figure S10. Mean number of patches (A) and CV of zone area (B) for a given number of zones in the WEC systems. Corresponding KPG value for its 30-zone system is shown as a dashed line. Number of zones that yielded a mean CV value lower than that of KPG (gridded horizontal line) are shown in dark blue, number of zones that yielded a mean CV value that was lower than that of KPG plus one standard deviation (σ) are shown in light blue, number of zones that yielded a mean CV value that was higher than that of KPG plus σ are shown in light grey, and the final number of zones chosen for further evaluation are in red.

Results

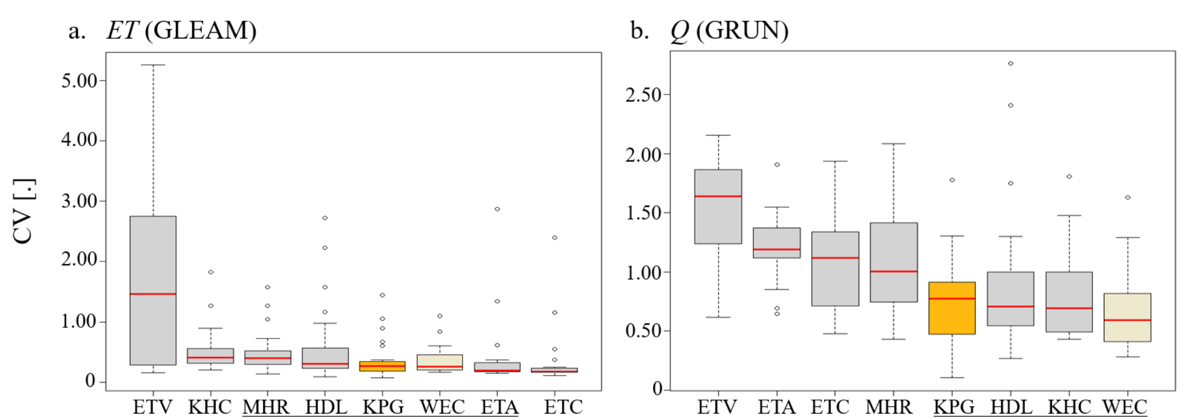

Figure S11. Boxplots of GLEAM ET (A) and GRUN Q (B) coherence for each assessed climate classification system, with KPG shown in gold and WEC in light beige. The Kolmogorov–Smirnov test was used to determine whether the distributions were different from WEC. Systems whose distributions were not statistically different from that of WEC are underlined.

Table S1. Coherence and complexity metrics for WEC_{20}.

Coherence Metric	**CV mean(±standard deviation)**
PET	0.14(0.69)
P	0.26(0.23)
Δt	0.24(0.07)
ET (TerraClimate)	0.31(0.23)
ET (GLEAM)	0.37(0.27)
Q (TerraClimate)	0.76(0.39)
Q (GRUN)	0.66(0.35)
Number of patches	60(0.38)
Complexity Metric	**Value**
CV of Area	0.45
Number of Zones	20

Table S2. Clustering PET and P centers for WEC zones and their associated groups, which are based on increasing zonal mean P/PET.

Group	**Zone**	**PET (mm y^{-1})**	**P (mm y^{-1})**
Superhumid	1	1159.10	4298.07
Superhumid	2	1318.97	1223.93
Superhumid	3	1189.53	1691.61
Humid	4	926.74	326.91
Humid	5	688.02	1416.37
Humid	6	1153.93	2276.86
Temperate	7	1185.81	3016.73
Temperate	8	1372.62	275.08
Temperate	9	2277.64	150.62
Arid	10	298.72	268.53
Arid	11	1596.86	757.30
Arid	12	1836.06	205.83
Hyperarid	13	497.80	537.56
Hyperarid	14	443.20	896.87
Hyperarid	15	967.59	807.23