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The effect of rainfall amount and timing on annual transpiration in a grazed savanna grassland

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S.1 Rainfall correction

The measured rainfall was corrected in 2011 for two months due to the tipping bucket's poor performance during high-intensity rainfall, which is evident from the short total rainfall time and large soil moisture changes. The annual rainfall estimate based on daily soil moisture changes was at least 100 mm higher for the year 2011 compared to any other year, while the total time of measured rainfall was the lowest in the year 2011. The measurement site precipitation was lower than the precipitation at the nearby weather station in Potchefstroom (NCEI, 2015) for most days from December 2011 to February 2012 (Fig. S1). Therefore, the rainfall measurement was corrected from December 1st to February 13th by replacing the measured rainfall with 1.044 times the Potchefstroom rainfall. This scaling factor was estimated from the relationship between monthly rainfall at the two stations (Fig. S2). On February 14th, the logging interval of the rainfall data was changed from 10 min to 1 min, and while no missing data periods were evident before this date, the lower logging frequency may have caused lost tip counts during high-intensity rainfall.

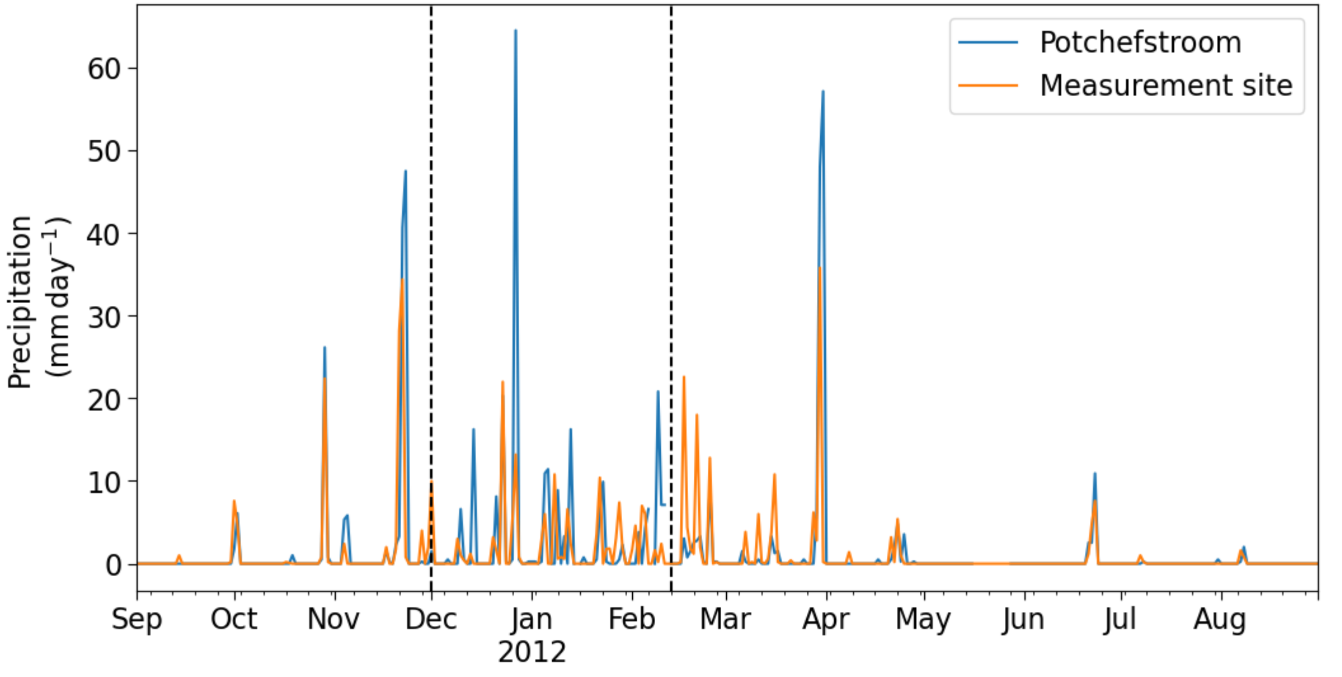

Figure S1. Time series of daily rainfall at the measurement site and nearby weather station in Potchefstroom. The dashed lines mark the period when the measurement site rainfall was corrected using the Potchefstroom rainfall.

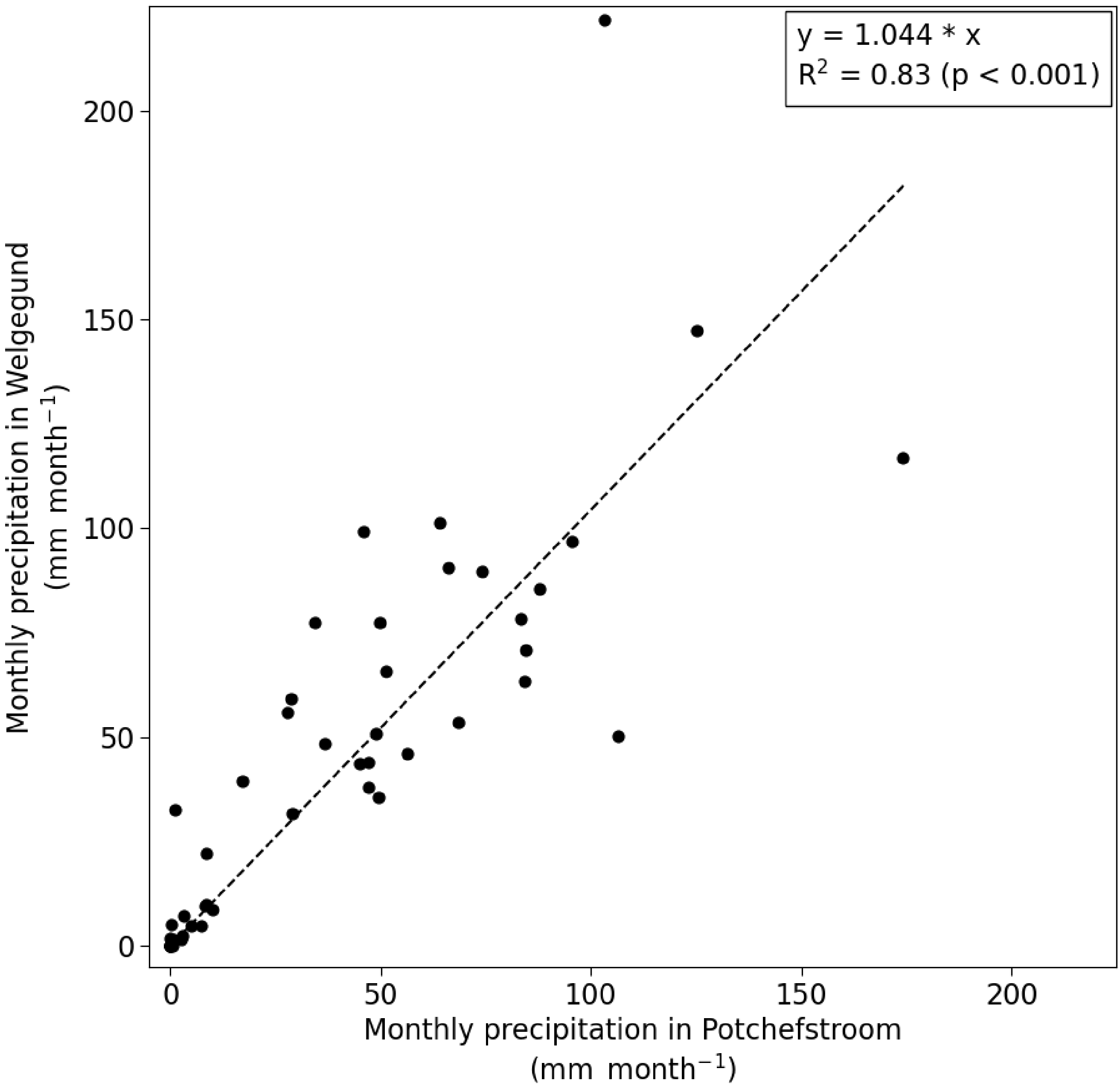

Figure S2. Relationship between monthly precipitation at the measurement site in Welgegund and at Potchefstroom station based on years 2012 to 2015.

S.2 Partitioning ET

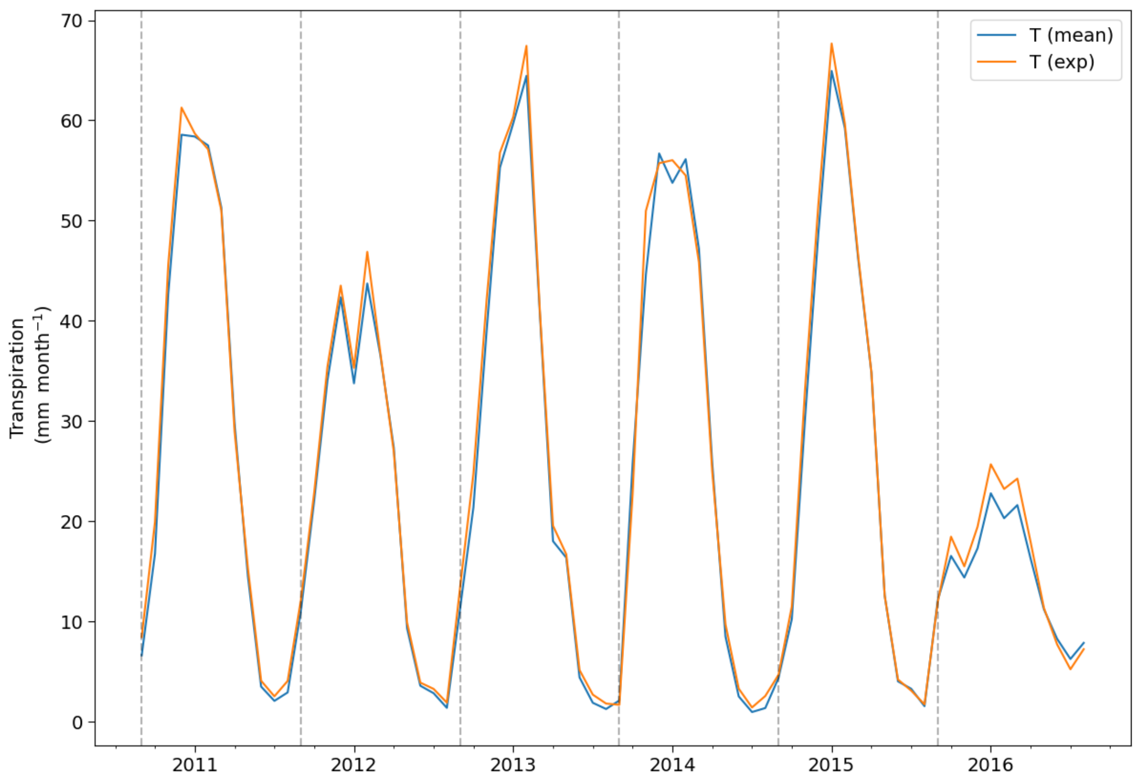

Figure S3. Monthly transpiration estimated using the B16 method with mean night-time respiration (blue) and with exponential temperature function (orange) used to determine daytime respiration (Räsänen et al., 2017).

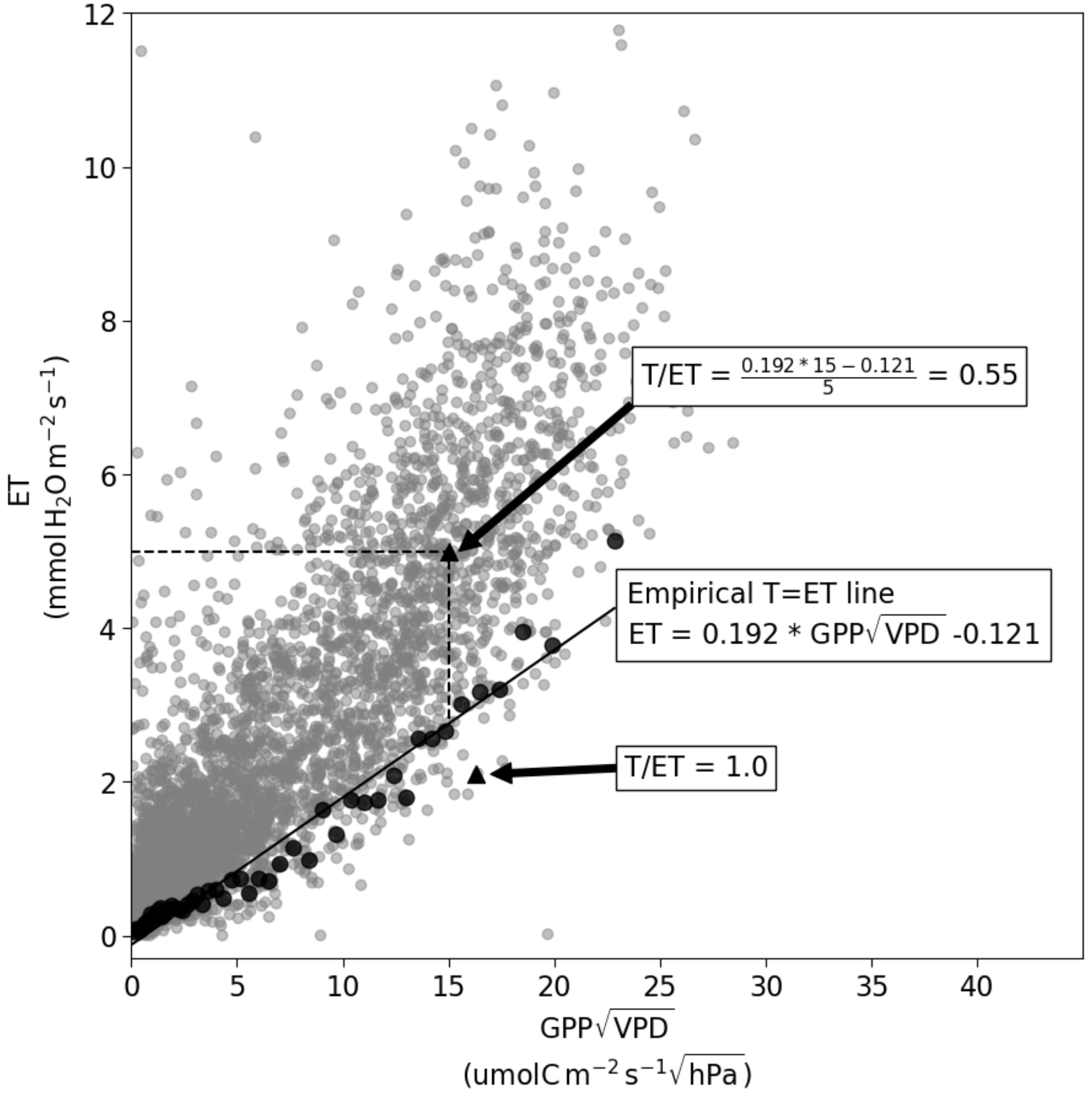

Figure S4. A fit of an annual *T*=ET line for the year 2010 and an example calculation of half-hour *T*/ET values for points indicated by triangles. The gray circles indicate all half-hour values, and black dots indicate fifth percentile points of each GPP × $VPD^{0.5}$ bin. The binning of x-axis values was conducted by dividing the values into 50 bins with an equal number of data points. The empirical *T*=ET line is a linear fit to the 5th percentile points.

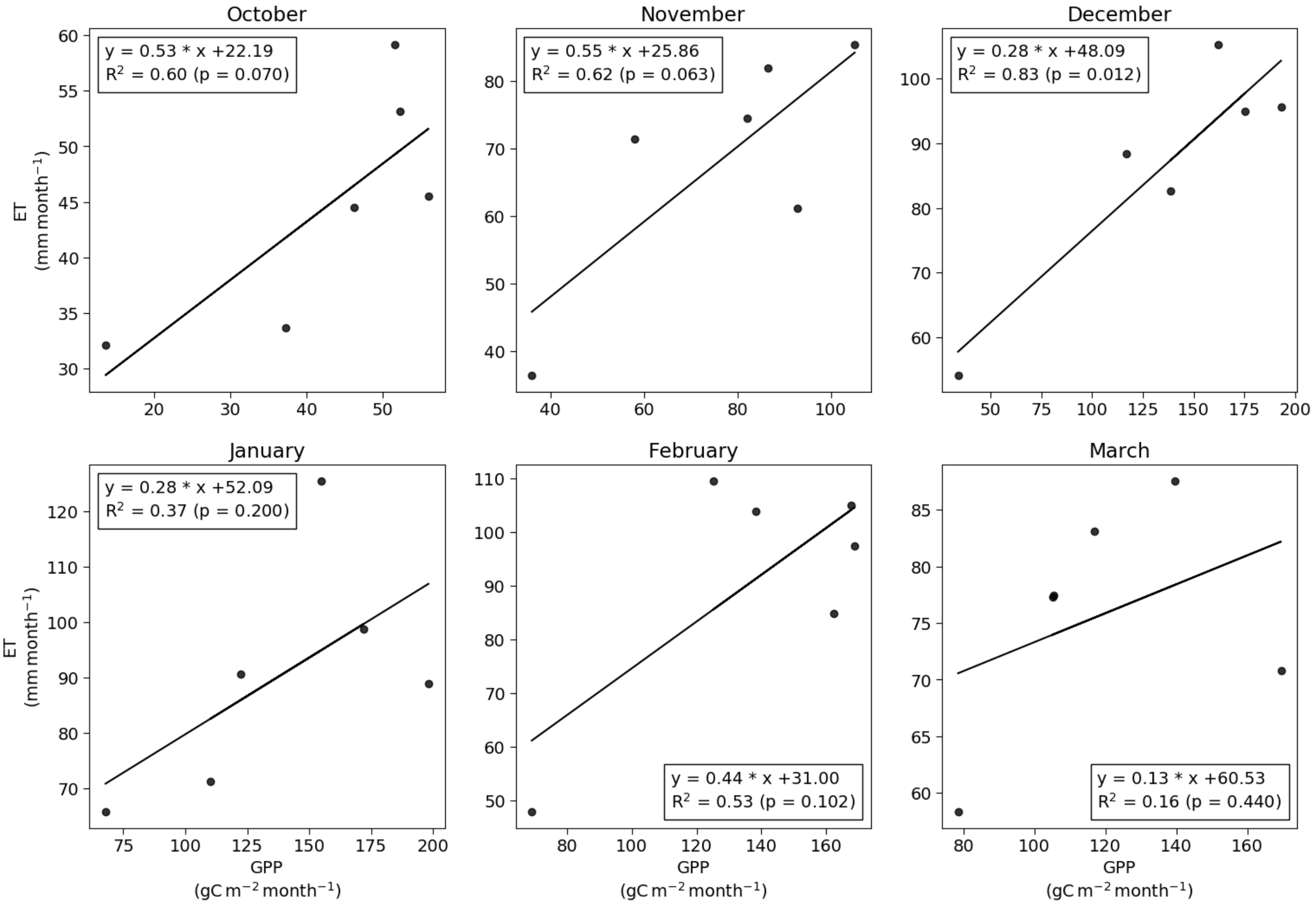

Figure S5. Relationship between multiyear monthly ET and GPP for a given month during the six-year measurement period.

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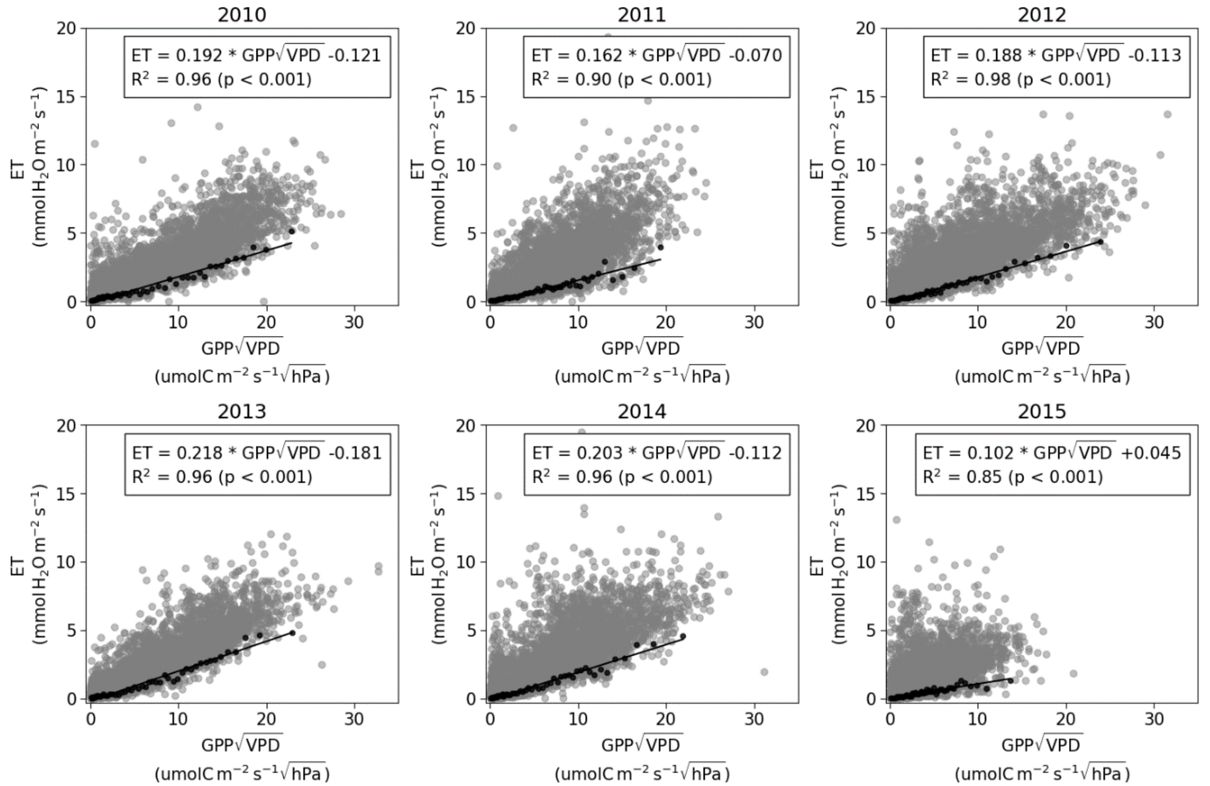

Figure S6. The determination of the *T*=ET line for each year (B16 method). The x-axis is discretized into 50 equal-sized bins, and one black dot is the minimum (fifth percentile) of the bin. Linear regression is fitted to these minimum values. The gray dots indicate the half-hour data points for which the *T*/ET ratio is determined.

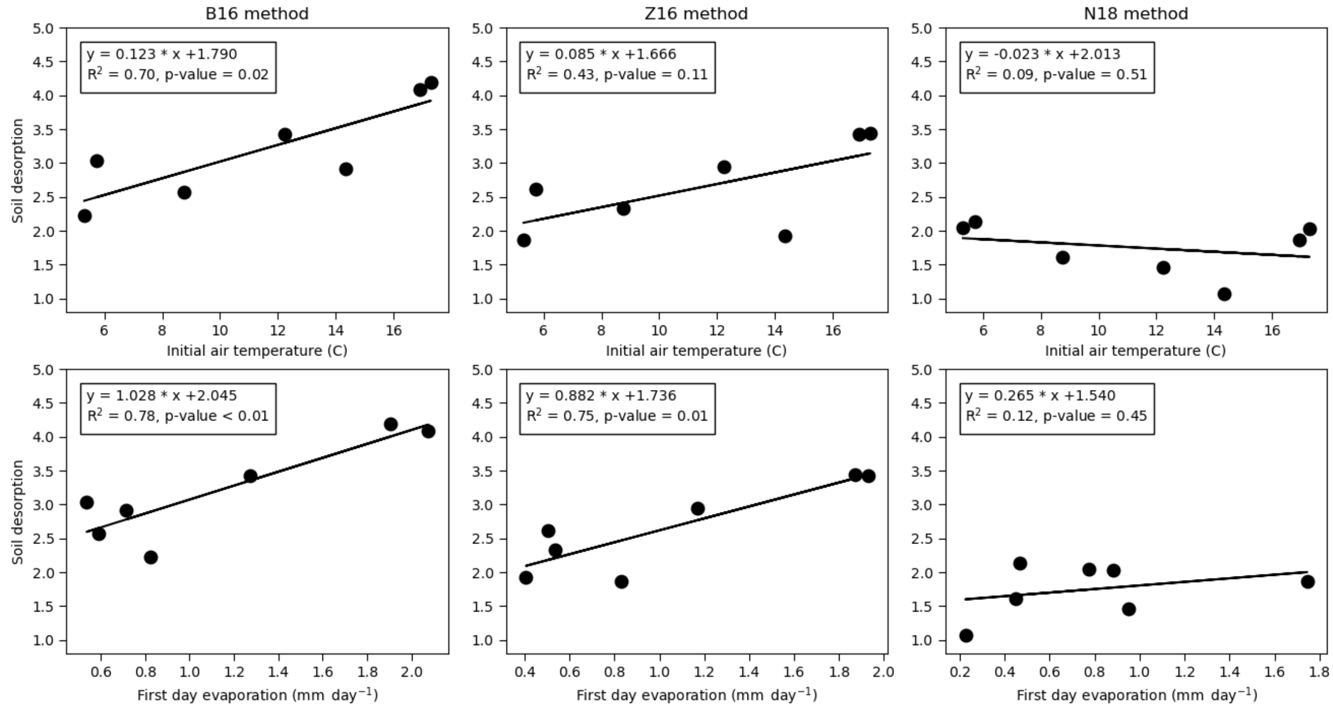

Figure S7. Relationship between soil desorption and initial air temperature and first day soil evaporation for the B16, Z16, and N18 methods.

S.3 Water balance

Table S1. Rainy season timing and tree green-up dates. The start day refers to the day of the hydrological year and the end day to the day of the subsequent year. Early wet season period spans from September to November.

Year	Tree green-up	Start of rain	End of rain	Rainy season length	Percentage of rainy season T=ET values	Mean θ_{5cm} of T=ET	Early wet season α	Early wet season λ
	(DOY)	(DOY)	(DOY)	(days)	(%)	($m^3 m^{-3}$)	(mm d^{-1})	(storms d^{-1})
2010–2011	238	309	127	183	75	0.10	5.4	0.44
2011–2012	230	302	112	176	67	0.07	7.3	0.21
2012–2013	242	250	109	224	84	0.05	6.6	0.35
2013–2014	254	294	90	161	81	0.06	7.4	0.47
2014–2015	241	298	108	175	81	0.08	7.0	0.38
2015–2016	241	247	207	326	84	0.07	6.5	0.14

Table S2. Water balance components for Z16 and B18 methods.

Year	ET	T_{Z16}/ET	T_{Z16}	E_{Z16}	T_{N18}/ET	T_{N18}	E_{N18}
2010–2011	658	0.52	344	315	0.65	431	228
2011–2012	608	0.46	281	328	0.65	395	217
2012–2013	667	0.51	338	330	0.64	424	244
2013–2014	600	0.57	343	258	0.62	372	228
2014–2015	642	0.49	316	326	0.57	366	277
2015–2016	463	0.40	186	277	0.54	250	213
Mean	606	0.49	301	306	0.61	373	234
SD	69	0.05	56	28	0.04	60	21

Table S3. Dry season (Jun-Aug) sum of water balance components. The *T* and *E* are estimated using the B16 method.

Dry season	*P*	ET	*T*	*E*
	(mm)	(mm)	(mm)	(mm)
2010	25	52	8	44
2011	18	40	7	33
2012	2	33	7	26
2013	7	29	4	25
2014	13	34	8	25
2015	66	47	20	27

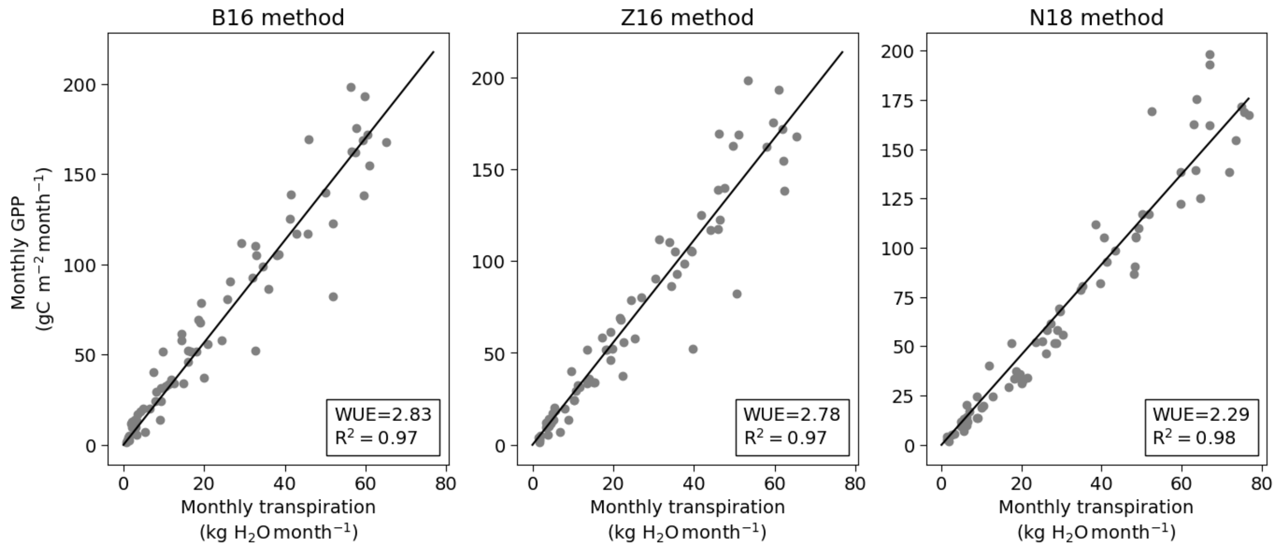

Figure S8. Monthly water use efficiency estimated from monthly transpiration and GPP with zero intercept for B16, Z16, and N18 methods.

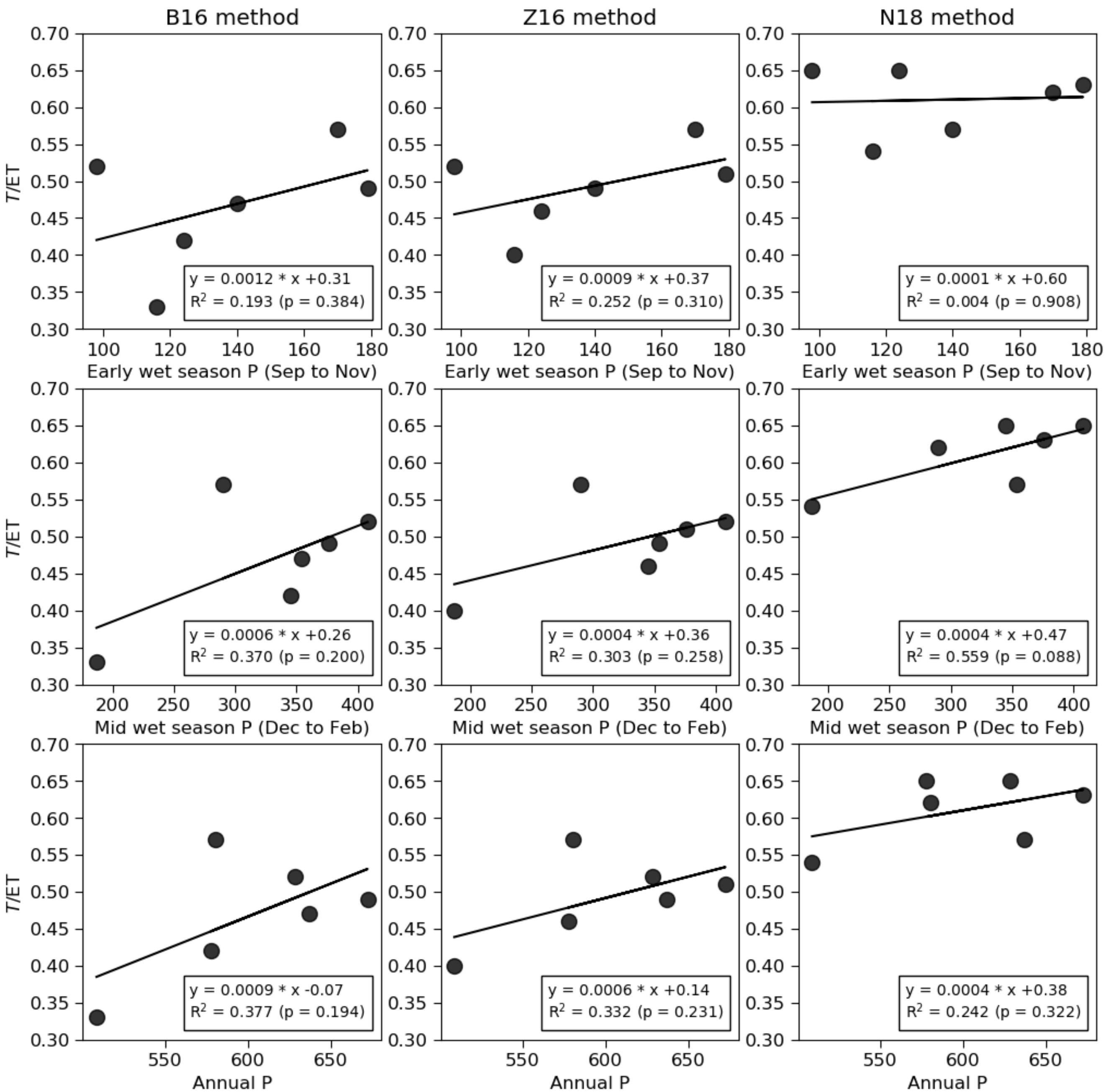

Figure S9. Relationship between early wet season, mid wet season and annual P to T/ET for B16, Z16 and N18 methods.

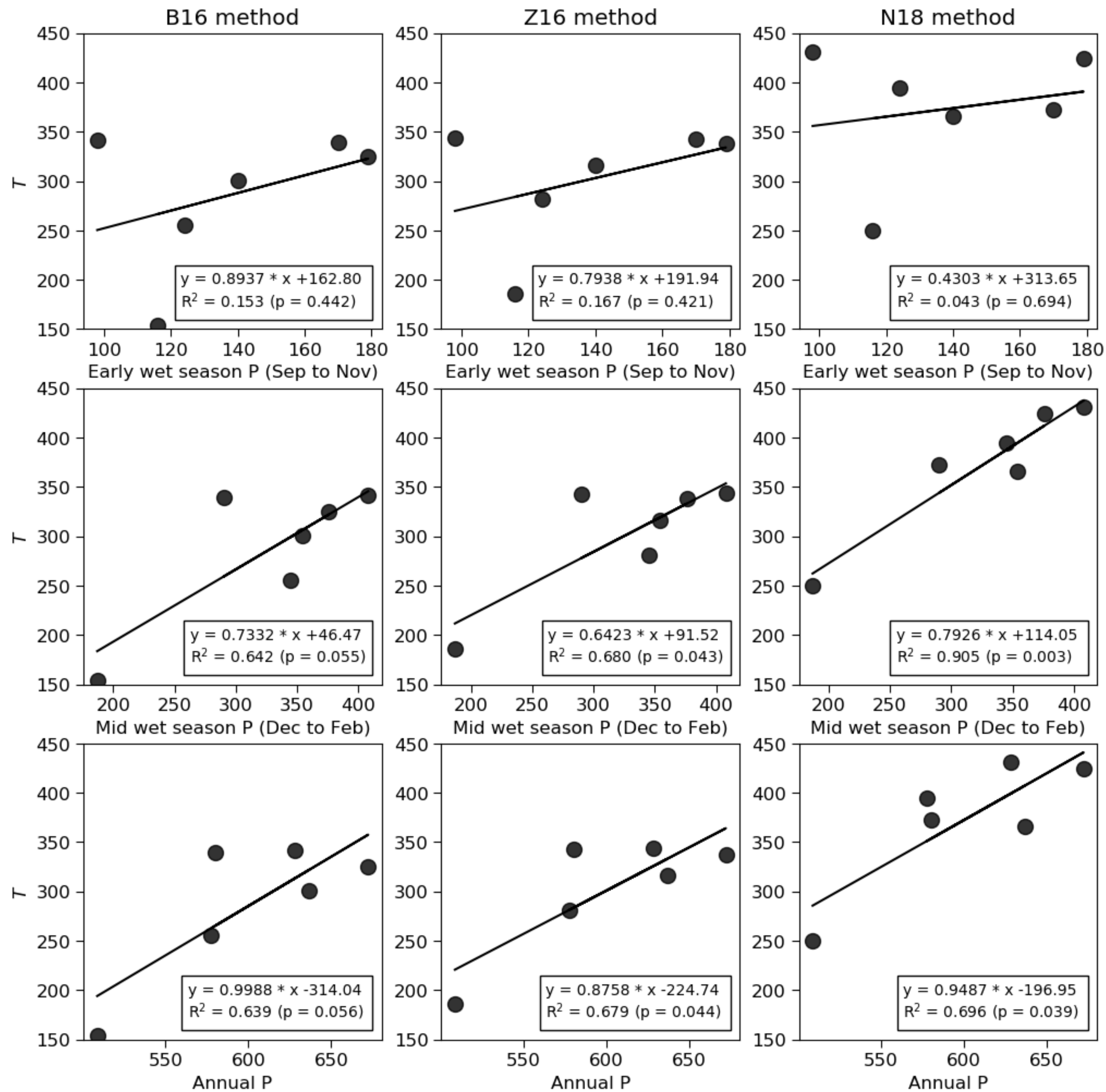

Figure S10. Relationship between early wet season, mid wet season and annual P to annual *T* for B16, Z16 and N18 methods.

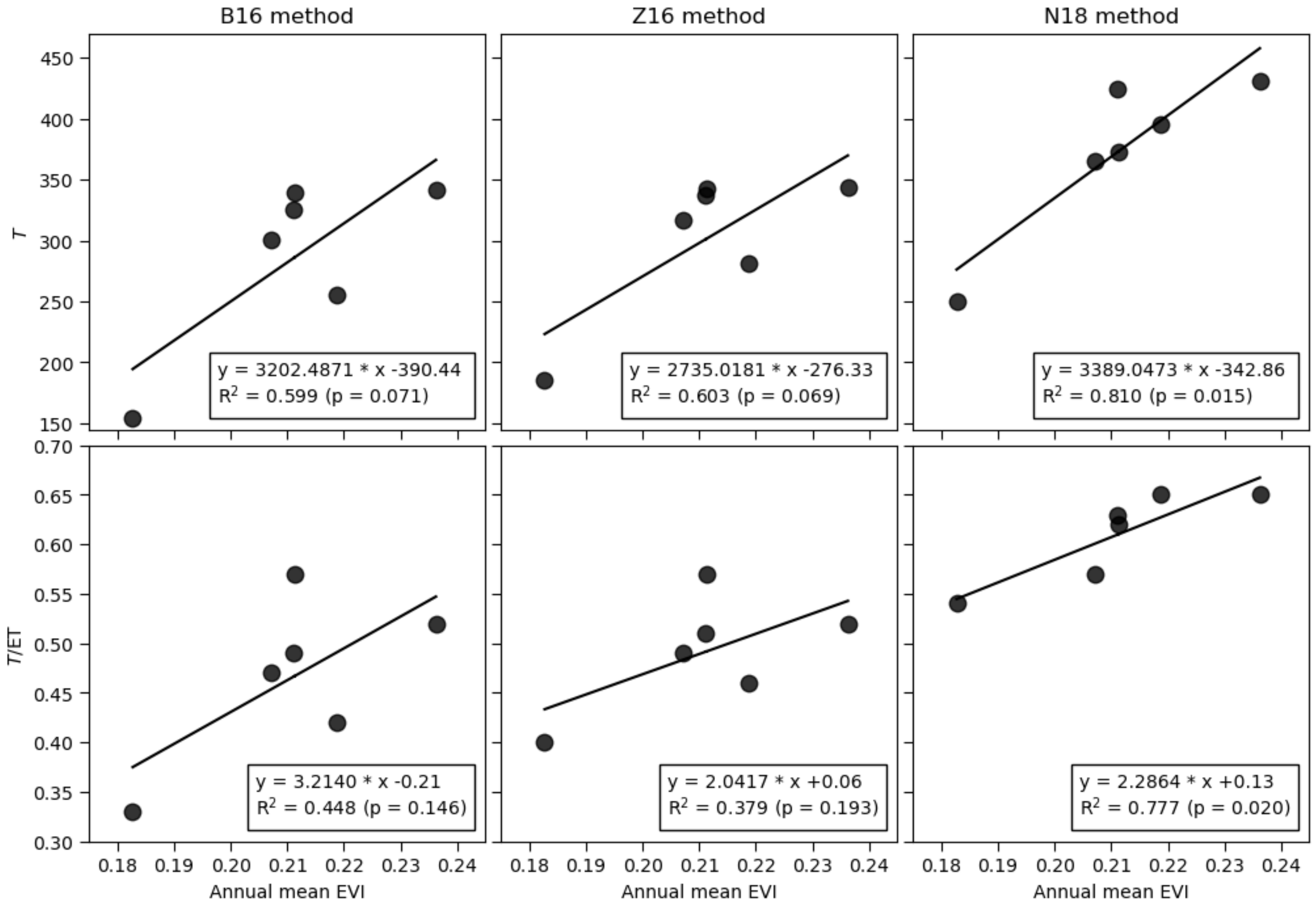

Figure S11. Relationship between annual mean EVI to *T*/ET for B16, Z16 and N18 methods.

References

NCEI: Global Surface Summary of the Day - GSOD, 2015.

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