Inter-annual variability of the global terrestrial water cycle

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Supplementary Material

This Supplementary Material contains Figures S1-S10 and Table S1.

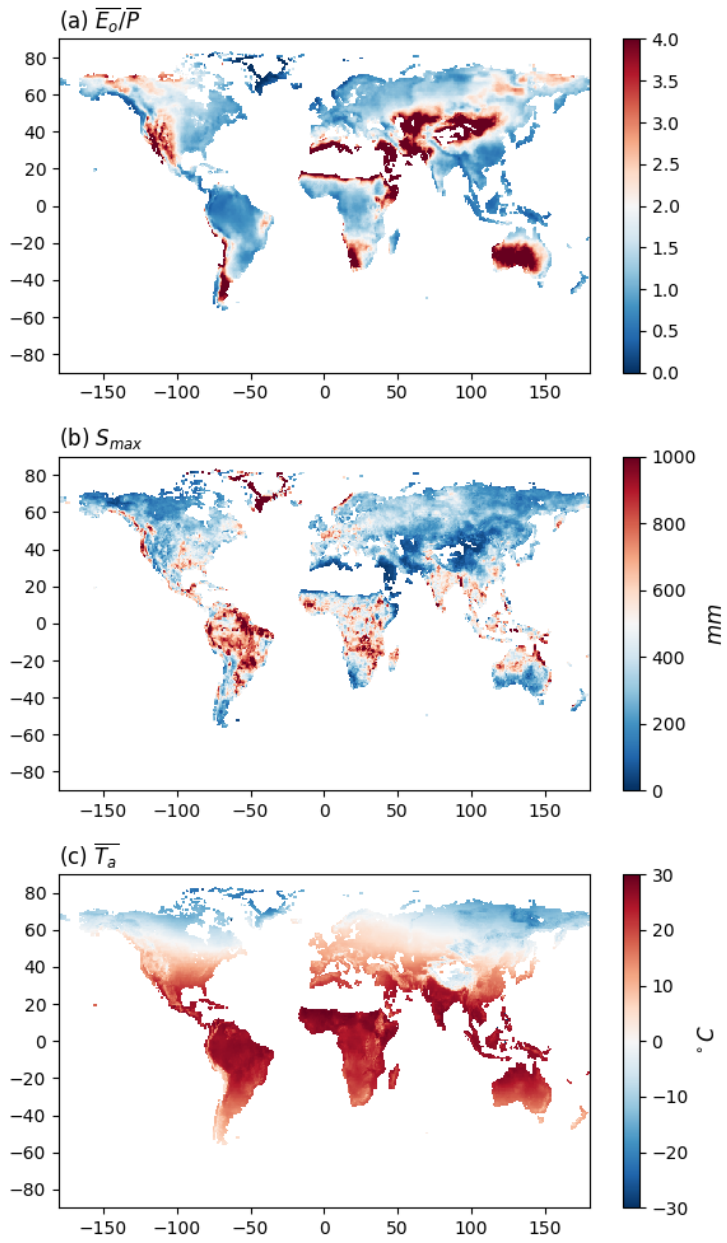

Figure S1. (a) Aridity index ($\overline{E_o}/\overline{P}$), (b) water storage capacity (S_{max}) and (c) mean annual air temperature ($\overline{T_a}$) used in the analysis.

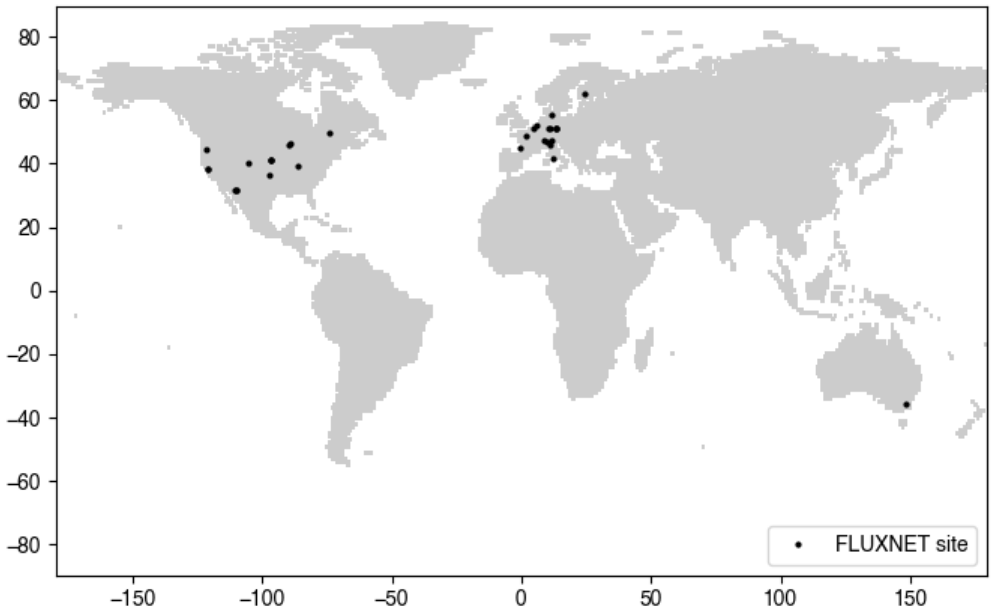

Figure S2. Location of the 32 FLUXNET sites compared with the Climate Data Record (CDR).

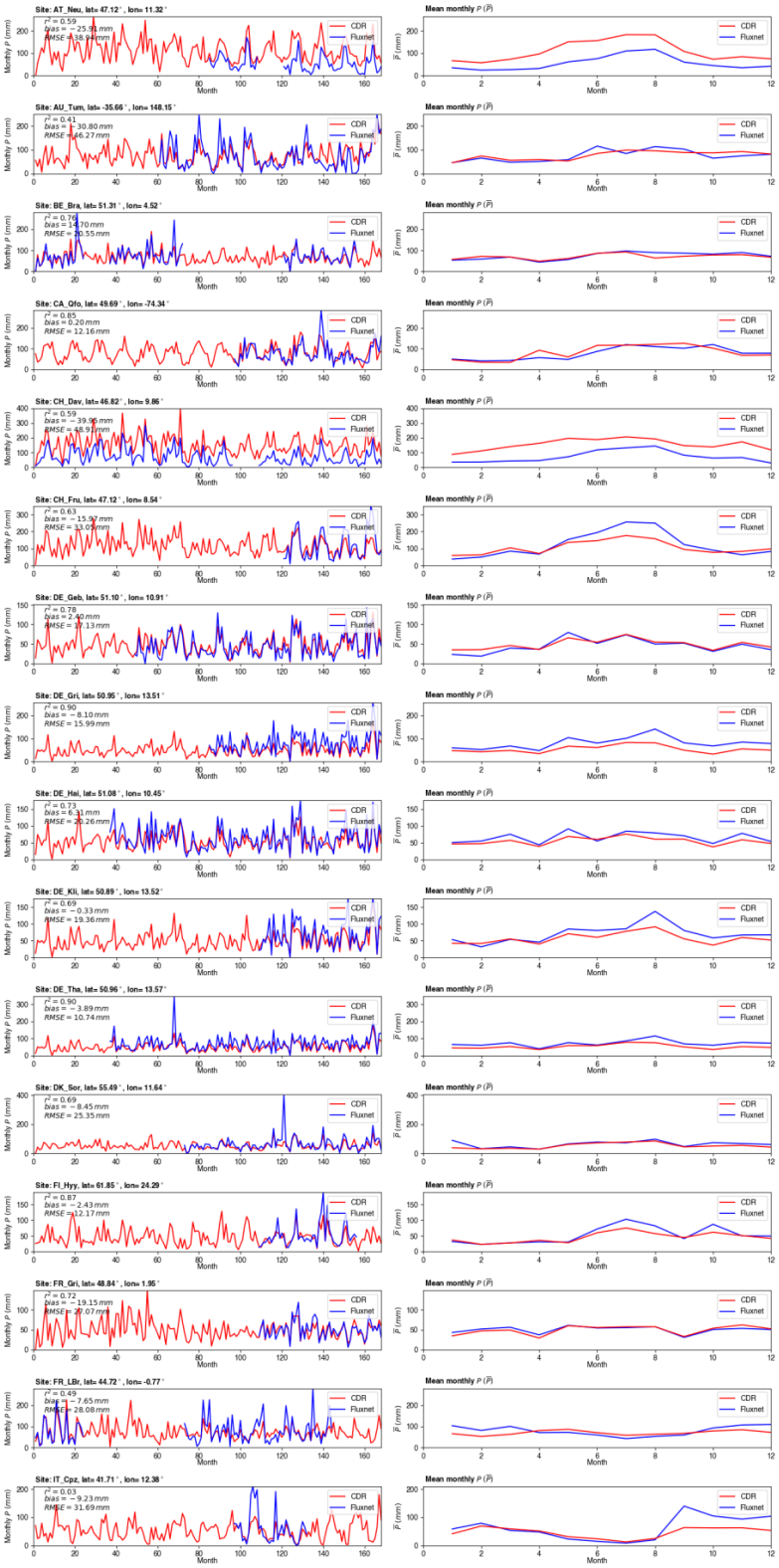

Figure S3. Comparison of monthly precipitation *P* time series (left panels) and mean monthly *P* (right panels) between FLUXNET site observations and the Climate Data Record (CDR).

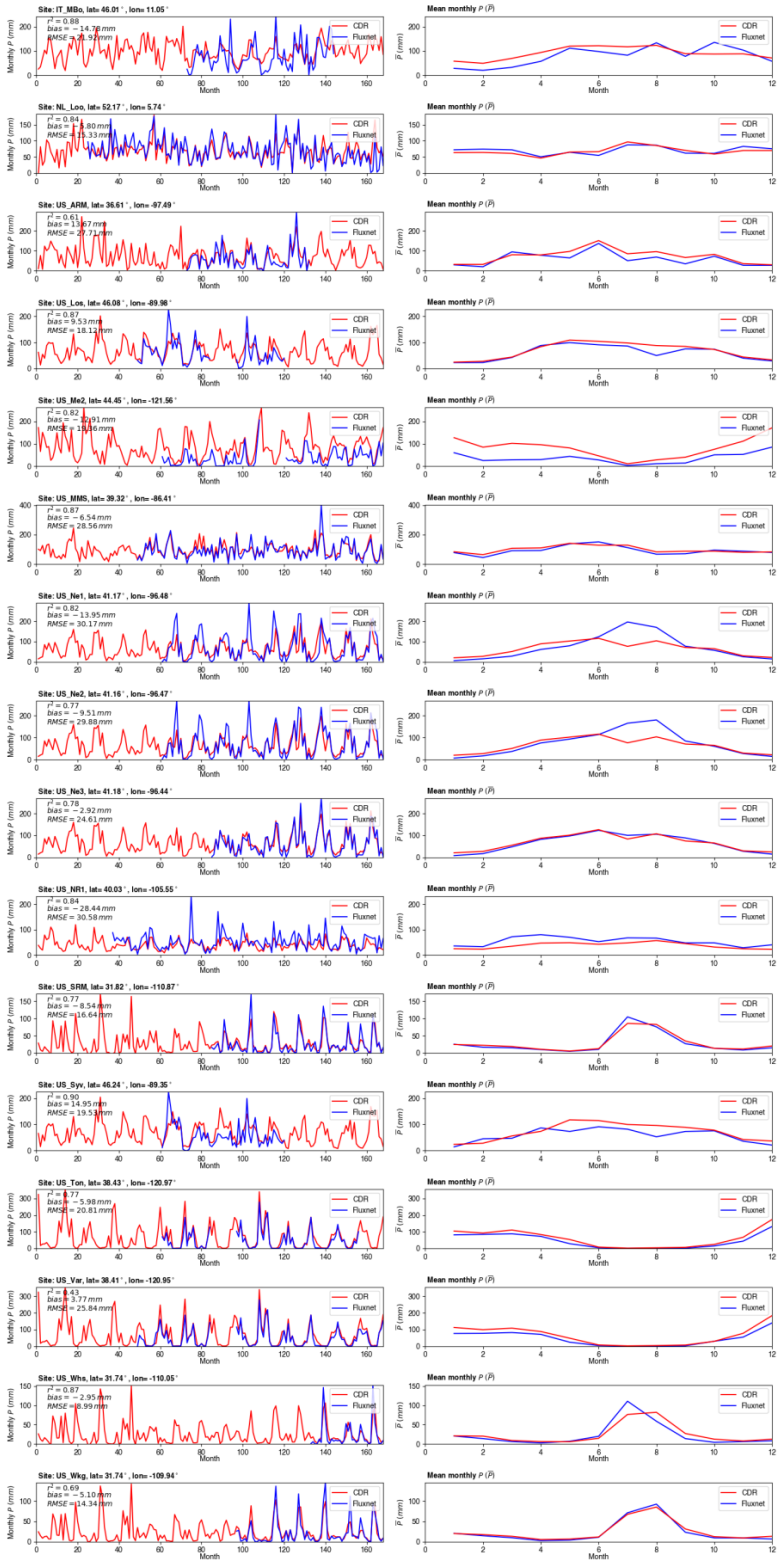

Figure S3 continued.

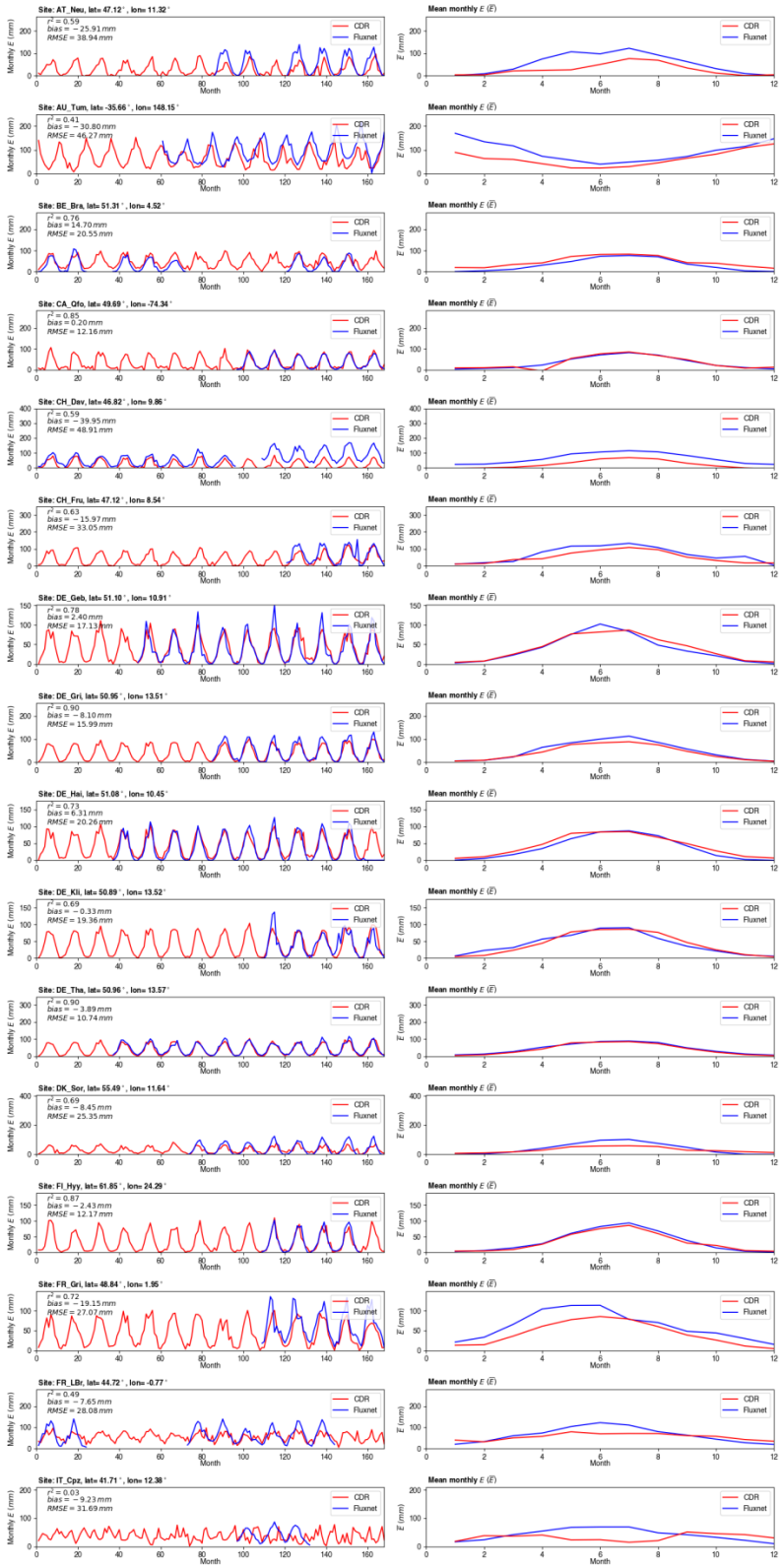

Figure S4. Comparison of monthly evapotranspiration *E* time series (left panels) and mean monthly *E* (right panels) between FLUXNET site observations and the Climate Data Record (CDR).

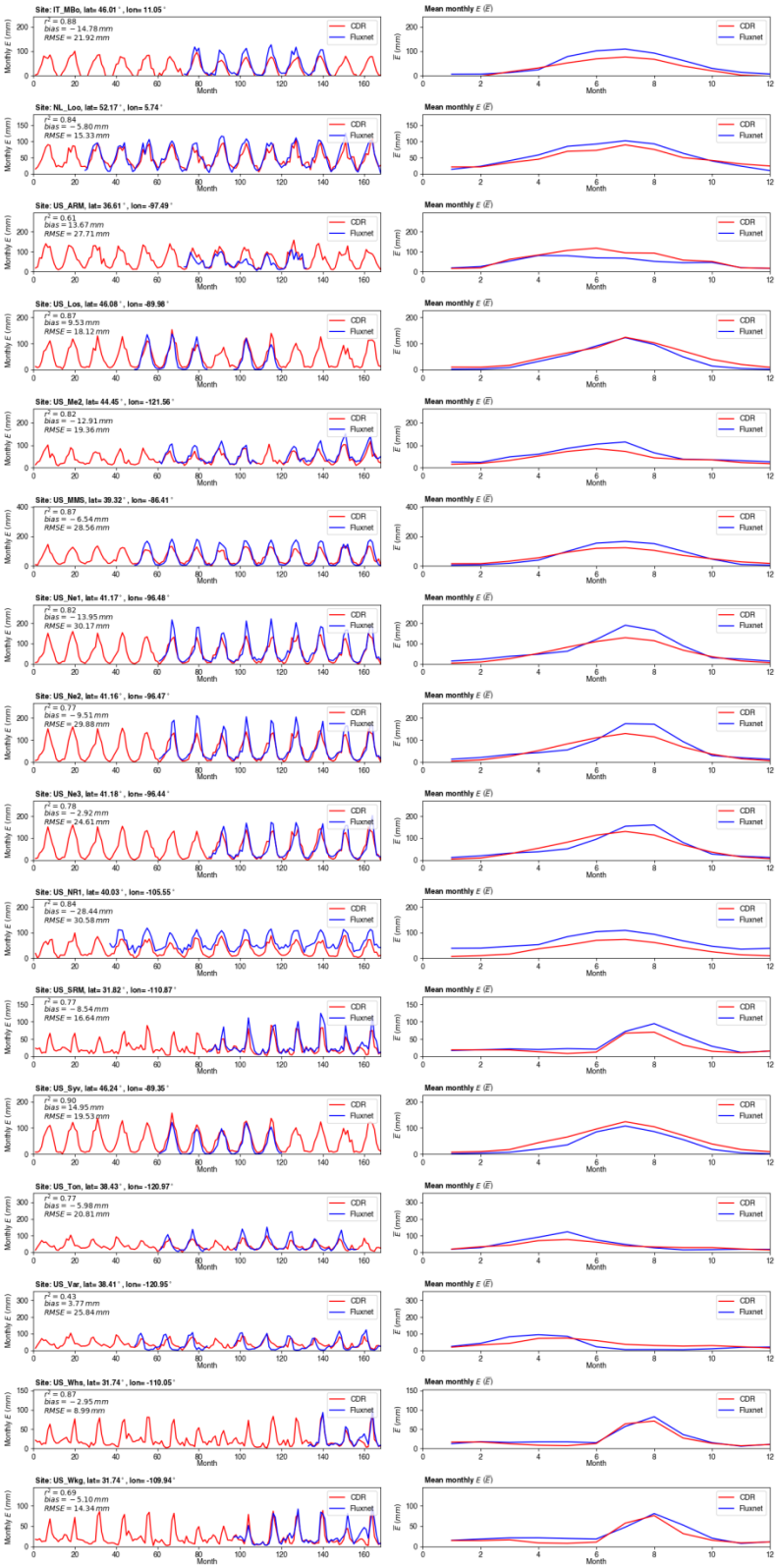

Figure S4 continued.

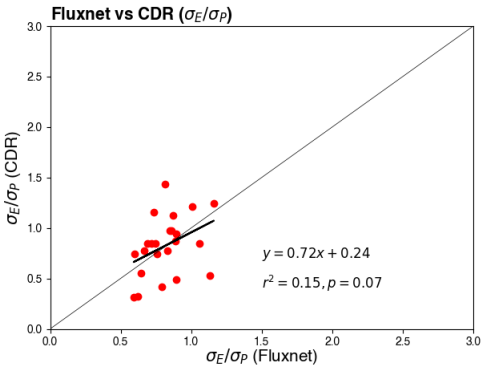

Figure S5. Comparison of ratio of standard deviation of monthly evapotranspiration *E* to precipitation *P* (σ_E/σ_P) between FLUXNET site observations and the Climate Data Record (CDR).

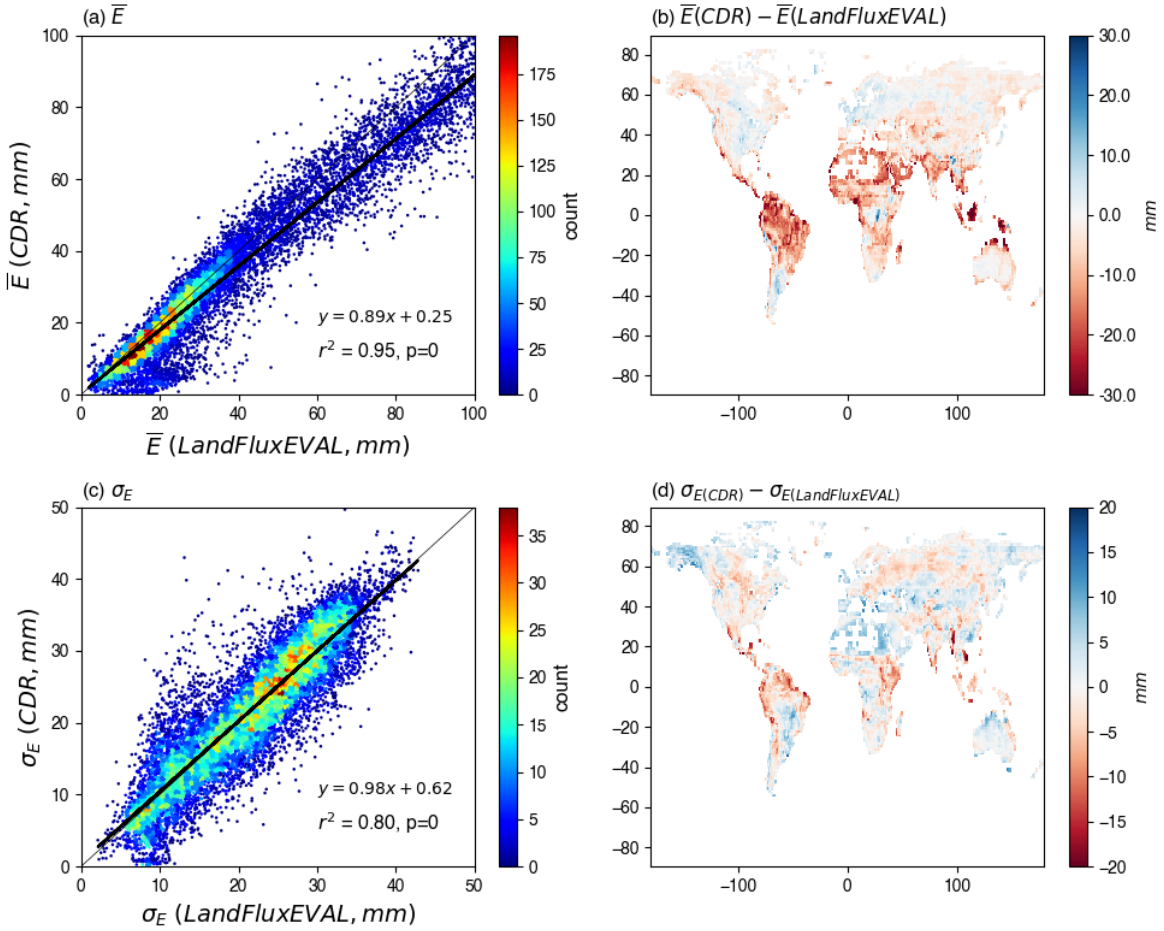

Figure S6. Comparison of monthly evapotranspiration *E* between LandFluxEVAL and Climate Data Record (CDR) databases. Top panels (a) (b) show comparison of the mean monthly ($\overline{E}$) while bottom panels (c) (d) show comparison of the standard deviation (σ_E) of monthly *E*.

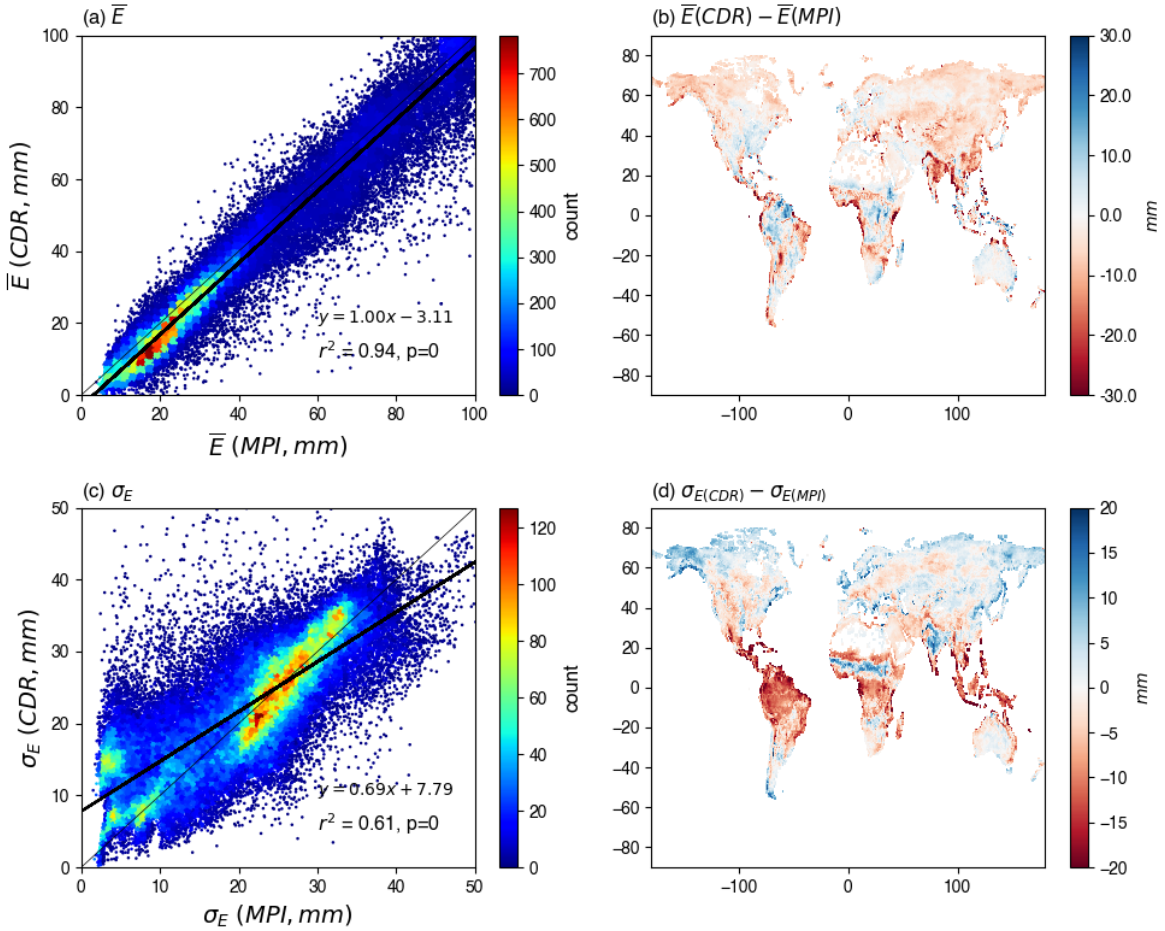

Figure S7. Comparison of monthly evapotranspiration *E* between Max Planck Institute (MPI) and Climate Data Record (CDR) databases. Top panels (a) (b) show comparison of the mean monthly ($\overline{E}$) while bottom panels (c) (d) show comparison of the standard deviation (σ_E) of monthly *E*.

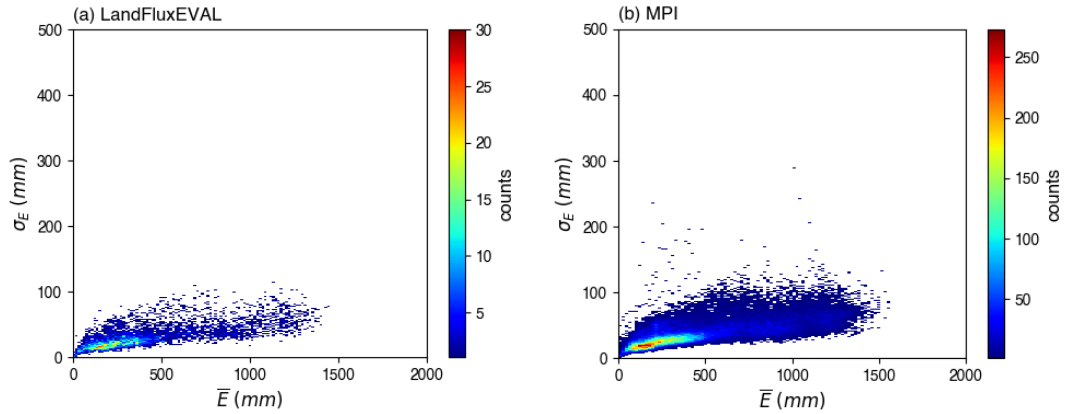

Figure S8. The same as Fig. 6b in main text but using evapotranspiration *E* data from the (a) LandFluxEVAL and (b) MPI databases.

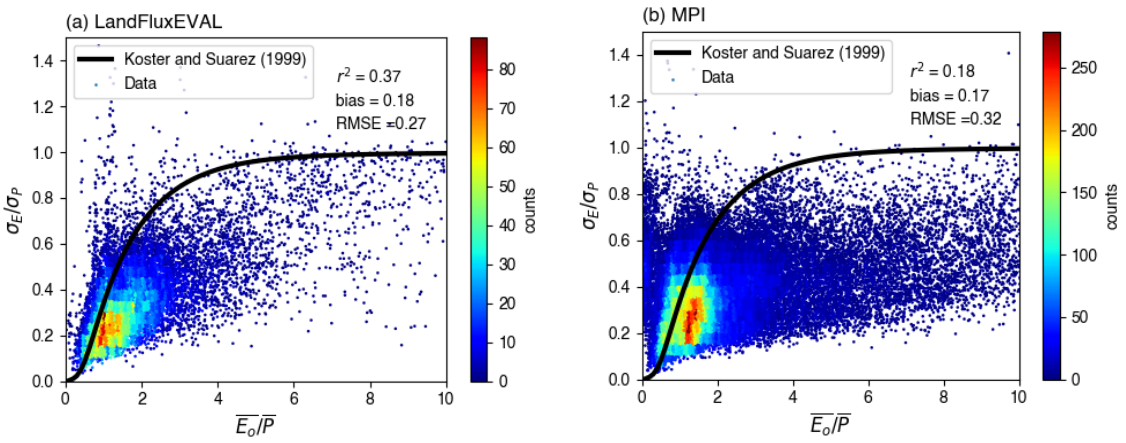

Figure S9. The same as Fig. 7a in main text but using evapotranspiration *E* data from the (a) LandFluxEVAL and (b) MPI databases.

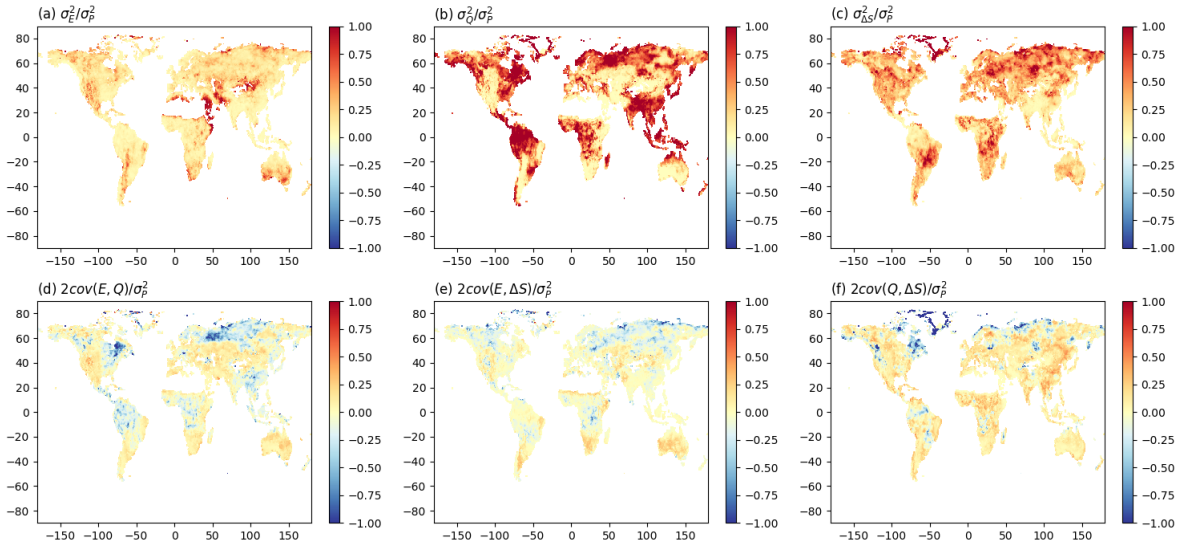

Figure S10. Inter-annual water cycle variances (σ_E^2, σ_Q^2, $\sigma_{\Delta S}^2$) and covariances ($cov(E,Q)$, $cov(E,\Delta S)$, $cov(Q,\Delta S)$) expressed as a fraction of the variance of P (σ_P^2). Note that we have multiplied the covariances by two (see Eq. 2).

Table S1. Summary of comparisons of monthly precipitation *P* and evapotranspiration *E* between observations at 32 FLUXNET sites and the CDR database.

Site ID	Site Name	Lat	Lon	Ref	Data period	r^2 (*P*)	bias (*P*, mm)	RMSE (*P*, mm)	r^2 (*E*)	bias (*E*, mm)	RMSE (*E*, mm)
AT_Neu	Neustift	47.1167	11.3175	Wohlfahrt et al., 2008	2004 - 2005, 2007 - 2010	**0.64**	53.54	61.53	**0.59**	-25.91	38.94
AU_Tum	Tumbarumba	-35.6566	148.1517	Leuning et al., 2005	2002 - 2010	**0.56**	1.08	39.34	**0.41**	-30.80	46.27
BE_Bra	Brasschaat	51.3076	4.5198	Carrara et al., 2004	1997 - 1998, 2000 -2002, 2007 - 2009	**0.64**	-3.05	26.66	**0.76**	14.70	20.55
CA_Qfo	Quebec - Eastern Boreal, Mature Black Spruce	49.6925	-74.3421	Bergeron et al., 2006	2005 - 2010	**0.57**	4.43	31.77	**0.85**	0.20	12.16
CH_Dav	Davos	46.8153	9.8559	Zielis et al., 2014	1997 - 2004, 2006 - 2010	**0.64**	82.53	91.39	**0.59**	-39.95	48.91
CH_Fru	Früebüel	47.1158	8.5378	Imer et al., 2013	2007 - 2010	**0.65**	-15.42	55.86	**0.63**	-15.97	33.05
DE_Geb	Gebesee	51.1001	10.9143	Anthoni et al., 2004	2001 - 2010	**0.69**	3.78	17.69	**0.78**	2.40	17.13
DE_Gri	Grillenburg	50.9500	13.5126	Prescher et al., 2010	2004 - 2010	**0.70**	-26.32	37.67	**0.90**	-8.10	15.99
DE_Hai	Hainich	51.0792	10.4530	Knohl et al., 2003	2000 - 2012	**0.70**	-10.35	23.17	**0.73**	6.31	20.26
DE_Kli	Klingenberg	50.8931	13.5224	Prescher et al., 2010	2006 - 2010	**0.68**	-13.61	28.05	**0.69**	-0.33	19.36
DE_Tha	Tharandt	50.9624	13.5652	Grünwald and Bernhofer, 2007	2000 - 2010	**0.66**	-18.71	32.35	**0.90**	-3.89	10.74
DK_Sor	Soroe	55.4859	11.6446	Pilegaard et al., 2011	2003 - 2010	**0.45**	-11.07	39.31	**0.69**	-8.45	25.35
FI_Hyy	Hyytiala	61.8474	24.2948	Suni et al., 2003	2006 - 2009	**0.78**	-7.07	20.43	**0.87**	-2.43	12.17
FR_Gri	Grignon	48.8442	1.9519	Loubet et al., 2011	2006 - 2010	**0.69**	-0.81	12.35	**0.72**	-19.15	27.07
FR_LBr	Le Bray	44.7171	-0.7693	Berbigier et al., 2001	1997 -1998, 2003 - 2008	**0.56**	-9.19	39.93	**0.49**	-7.65	28.08
IT_Cpz	Castelporziano	41.7053	12.3761	Garbulsky et al., 2008	2005 - 2007	**0.76**	-15.90	40.42	0.03	-9.23	31.69

IT_MBo	Monte Bondone	46.0147	11.0458	Marcolla et al., 2011	2003 - 2008	**0.36**	12.43	48.14	**0.88**	-14.78	21.92
NL_Loo	Loobos	52.1666	5.7436	Moors 2012	1999 - 2010	**0.56**	-2.16	24.78	**0.84**	-5.80	15.33
US_ARM	ARM Southern Great Plains site-Lamont	36.6058	-97.4888	Baldocchi and Sturtevant 2015	2003 - 2007	**0.71**	13.53	31.78	**0.61**	13.67	27.71
US_Los	Lost Creek	46.0827	-89.9792	Baker et al., 2003	2001 - 2003, 2005 - 2006	**0.52**	7.76	32.82	**0.87**	9.53	18.12
US_Me2	Metolius mature ponderosa pine	44.4523	-121.5574	Law (2002-2014)	2002 - 2005, 2007 - 2010	**0.54**	45.31	56.84	**0.82**	-12.91	19.36
US_MMS	Morgan Monroe State Forest	39.3232	-86.4131	Novick and Phillips (1999-2014)	2001 - 2010	**0.72**	6.60	31.44	**0.87**	-6.54	28.56
US_Ne1	Mead - irrigated continuous maize site	41.1651	-96.4766	Suyker (2001-2013a)	2002 - 2010	**0.45**	-6.64	51.86	**0.82**	-13.95	30.17
US_Ne2	Mead - irrigated maize-soybean rotation site	41.1649	-96.4701	Suyker (2001-2013b)	2002 - 2010	**0.56**	-8.77	46.45	**0.77**	-9.51	29.88
US_Ne3	Mead - rainfed maize-soybean rotation site	41.1797	-96.4397	Suyker (2001-2013c)	2004 - 2010	**0.88**	2.28	21.43	**0.78**	-2.92	24.61
US_NR1	Niwot Ridge Forest (LTER NWT1)	40.0329	-105.5464	Blanken (1998-2014)	2000 - 2010	**0.51**	-16.06	29.57	**0.84**	-28.44	30.58
US_SRM	Santa Rita Mesquite	31.8214	-110.8661	Barron-Gafford et al., 2011	2004 - 2010	**0.81**	1.34	15.40	**0.77**	-8.54	16.64
US_Syv	Sylvania Wilderness Area	46.2420	-89.3477	Desai et al., 2008	2002 - 2006	**0.33**	13.17	40.68	**0.90**	14.95	19.53
US_Ton	Tonzi Ranch	38.4316	-120.9660	Baldocchi et al., 2010	2002 - 2003, 2005 - 2009	**0.89**	14.68	27.44	**0.77**	-5.98	20.81

US_Var	Vaira Ranch- Ione	38.4133	-120.9507	Baldocchi et al., 2004	2001 - 2003, 2005 - 2010	**0.86**	16.91	30.92	**0.43**	3.77	25.84
US_Whs	Walnut Gulch Lucky Hills Shrub	31.7438	-110.0522	Biederman et al., 2016	2008 - 2010	**0.65**	1.89	21.26	**0.87**	-2.95	8.99
US_Wkg	Walnut Gulch Kendall Grasslands	31.7365	-109.9419	Biederman et al., 2016	2005 - 2010	**0.78**	1.59	15.66	**0.69**	-5.10	14.34

* Significant r^2 values (linear regression $p < 0.05$) are shown in bold.

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