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Pairing FLUXNET sites to validate model representations of land-use/land-cover change

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Table S1. Detailed information about the paired sites. Pairs 6, 8, 12 and 16 are obtained from AmeriFlux; the rest of the pairs are from the FLUXNET2015 dataset. The pairs are grouped based on the type of LULCC: pairs 1~5, deciduous broadleaf forest – cropland; pair 6, deciduous broadleaf forest – grassland; pair 7, deciduous broadleaf forest – grassland; pairs 8~15, evergreen broadleaf forest – grassland; pairs 16~25, evergreen needleleaf forest – open shurbland; pairs 26~27, evergreen needleleaf forest – cropland; pair 28, mixed forest – cropland..

Pair ID	Name	Latitude (degrees N)	Longitude (degrees E)	Elevation (m)	Land cover type	Separation (km)	Period
1	IT-CA2	42.3772	12.026	200	Croplands	0.36	2011 – 2013
	IT-CA1	42.3804	12.0266	200	Deciduous Broadleaf Forests		
2	IT-CA2	42.3772	12.026	200	Croplands	0.44	2011 – 2013
	IT-CA3	42.38	12.0222	197	Deciduous Broadleaf Forests		
3	IT-CA2	42.3772	12.026	200	Croplands	8.75	2011 – 2012
	IT-Ro2	42.3903	11.9209	160	Deciduous Broadleaf Forests		
4	FR-Gri	48.8442	1.9519	125	Croplands	73.3	2005 – 2013
	FR-Fon	48.4764	2.7801	90	Deciduous Broadleaf Forests		
5	BE-Lon	50.5515	4.7461	165	Croplands	92.82	2004 – 2014
	BE-Vie	50.3050	5.9980	491	Deciduous Broadleaf Forests		
6	US-Dk1	35.9712	-79.0934	168	Grasslands	0.68	2003 – 2008
	US-Dk2	35.9736	-79.1004	168	Deciduous Broadleaf Forests		
7	AU-Rig	-36.6499	145.5759	152	Grasslands	48.82	2011 – 2013
	AU-Whr	-36.6732	145.0294	165	Evergreen Broadleaf Forests		
8	US-Dk1	35.9712	-79.0934	168	Grasslands	0.78	2004 – 2008
	US-Dk3	35.9782	-79.0942	163	Evergreen Needleleaf Forests		
9	CZ-BK2	49.4944	18.5429	855	Grasslands	0.96	2004 – 2006
	CZ-BK1	49.5021	18.5369	875	Evergreen Needleleaf Forests		

10	DE-Gri	50.9495	13.5125	385	Grasslands	4.12	2004 – 2010
	DE-Tha	50.9636	13.5669	380	Evergreen Needleleaf Forests		
11	DE-Gri	50.9495	13.5125	385	Grasslands	23.49	2008 – 2010
	DE-Obe	50.7836	13.7196	735	Evergreen Needleleaf Forests		
12	US-Fwf	35.4454	-111.7718	2270	Grasslands	33.91	2006 – 2010
	US-Fmf	35.1426	-111.7273	546	Evergreen Needleleaf Forests		
13	NL-Hor	52.2404	5.0713	2.2	Grasslands	46.55	2004 – 2011
	NL-Loo	52.1666	5.7436	25	Evergreen Needleleaf Forests		
14	AT-Neu	47.1167	11.3175	970	Grasslands	59.57	2002 – 2012
	IT-Ren	46.5869	11.4337	1730	Evergreen Needleleaf Forests		
15	US-Var	38.4133	-120.9507	129	Grasslands	60.29	2000 – 2007
	US-Blo	38.8953	-120.6328	1315	Evergreen Needleleaf Forests		
16	US-NC1	35.8118	-76.7119	5	Open Shrublands	4.03	2005 – 2009
	US-NC2	35.803	-76.6685	5	Evergreen Needleleaf Forests		
17	US-Wi6	46.6249	-91.2982	371	Open Shrublands	15.27	2002 – 2003
	US-Wi3	46.6347	-91.0987	411	Deciduous Broadleaf Forests		
18	US-Wi6	46.6249	-91.2982	371	Open Shrublands	16.22	2002 – 2003
	US-Wi4	46.7393	-91.1663	352	Evergreen Needleleaf Forests		
19	US-Wi6	46.6249	-91.2982	371	Open Shrublands	16.57	2002
	US-Wi0	46.6188	-91.0814	349	Evergreen Needleleaf Forests		
20	CA-SF3	54.0916	-106.0053	540	Open Shrublands	19.87	2001 – 2005
	CA-SF2	54.2539	-105.8775	520	Evergreen Needleleaf Forests		
21	CA-NS6	55.9167	-98.9644	244	Open Shrublands	27.43	2001 – 2005
	CA-NS2	55.9058	-98.5247	260	Evergreen Needleleaf Forests		
22	CA-NS6	55.9167	-98.9644	244	Open Shrublands	30.25	2001 – 2005
	CA-NS1	55.8792	-98.4839	260	Evergreen Needleleaf Forests		
23	CA-NS6	55.9167	-98.9644	244	Open Shrublands	30.48	2001 – 2005
	CA-NS5	55.8631	-98.485	260	Evergreen Needleleaf Forests		

24	CA-NS6	55.9167	-98.9644	244	Open Shrublands	36.29	2001 – 2005
	CA-NS3	55.9117	-98.3822	260	Evergreen Needleleaf Forests		
25	CA-SF3	54.0916	-106.0053	540	Open Shrublands	45.41	2003 – 2006
	CA-SF1	54.485	-105.8176	536	Evergreen Needleleaf Forests		
26	DE-Kli	50.8929	13.5225	480	Croplands	8.46	2004 – 2014
	DE-Tha	50.9636	13.5669	380	Evergreen Needleleaf Forests		
27	DE-Kli	50.8929	13.5225	480	Croplands	18.42	2008 – 2014
	DE-Obe	50.7836	13.7196	735	Evergreen Needleleaf Forests		
28	DE-RuS	50.8659	6.4472	102.76	Croplands	69.96	2011 – 2014
	BE-Vie	50.3051	5.9981	493	Mixed Forests		

Table S2. Model scheme settings for Noah-MP used in this study.

model options	**scheme used in this study**
dynamic vegetation	on
canopy stomatal resistance	Ball-Berry
soil moisture factor for stomatal resistance	Noah
runoff and groundwater	SIMGM
surface layer drag coefficient (CH & CM)	Monin-Obukhov
supercooled liquid water	Niu & Yang 06
frozen soil permeability	Niu & Yang 06
radiation transfer	gap=F(3D,cosz)
snow surface albedo	CLASS
rainfall & snowfall	Jordan91
lower boundary of soil temperature	Noah
snow/soil temperature time scheme	semi-implicit

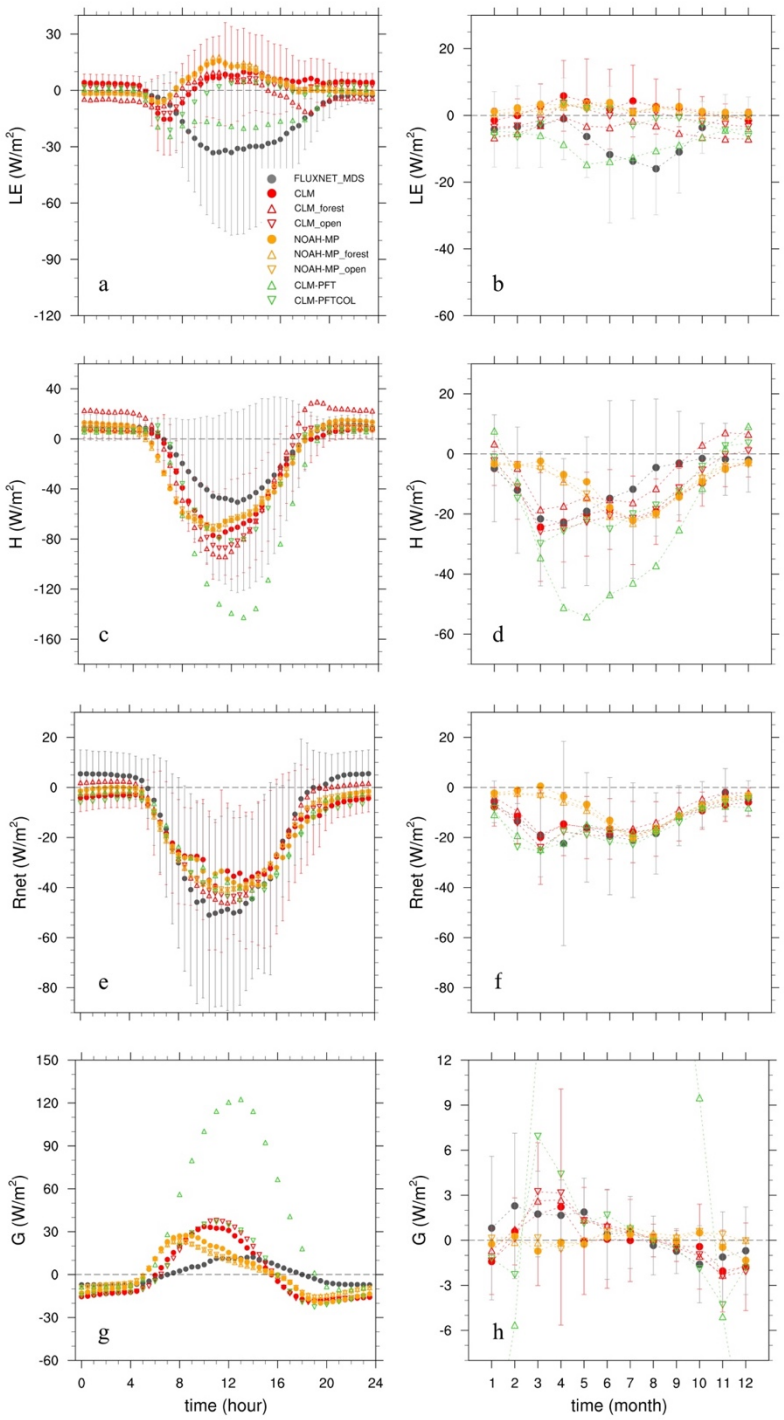

Figure S1. Change in the diurnal (left) and seasonal (right) cycle of *LE* (W/m^2, a-b), *H* (W/m^2, c-d), R_{net} (W/m^2, e-f), and *G* (W/m^2, g-h) from forest to open (open – forest) land excluding the pairs 3, 7, 12, and 15.

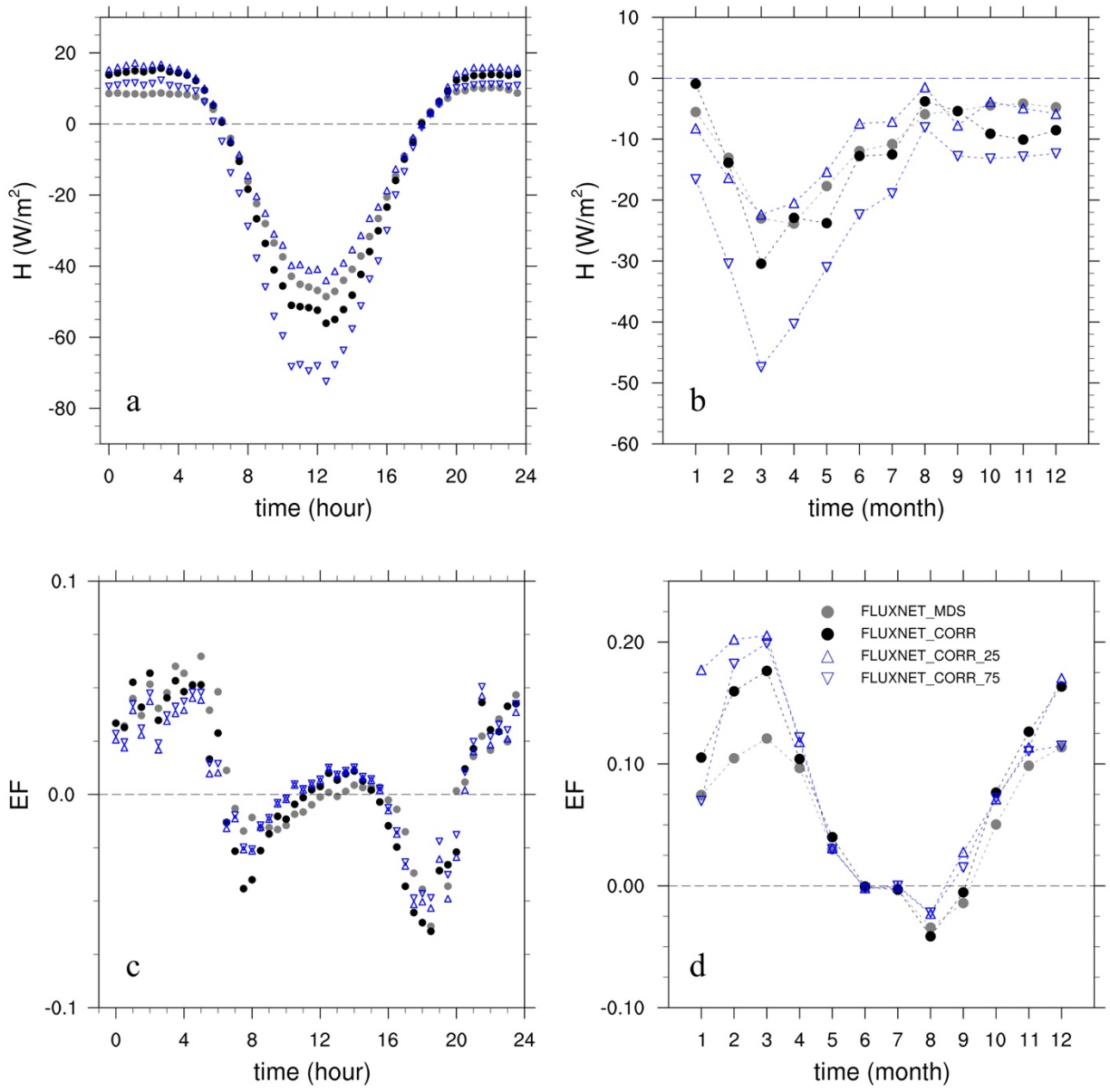

Figure S2. Change in the diurnal (left) and seasonal (right) cycle of *H* (W/m^2, a-b) and evaporative fraction (*EF*, c-d) from forest to open land (open – forest) in the four types of FLUXNET observations.

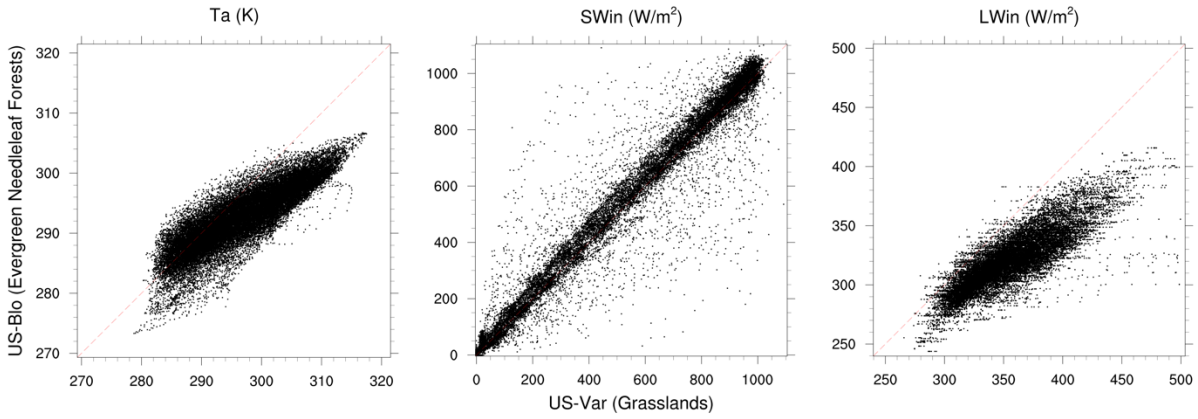

Figure S3. Comparison of air temperature (K, left), downwelling shortwave (middle) and longwave (right) radiations (W/m^2) between the paired sites No. 15. The horizontal axis shows the observations from the grassland site US-Var, and the vertical axis shows the observations from the evergreen needleleaf forest site US-Blo.

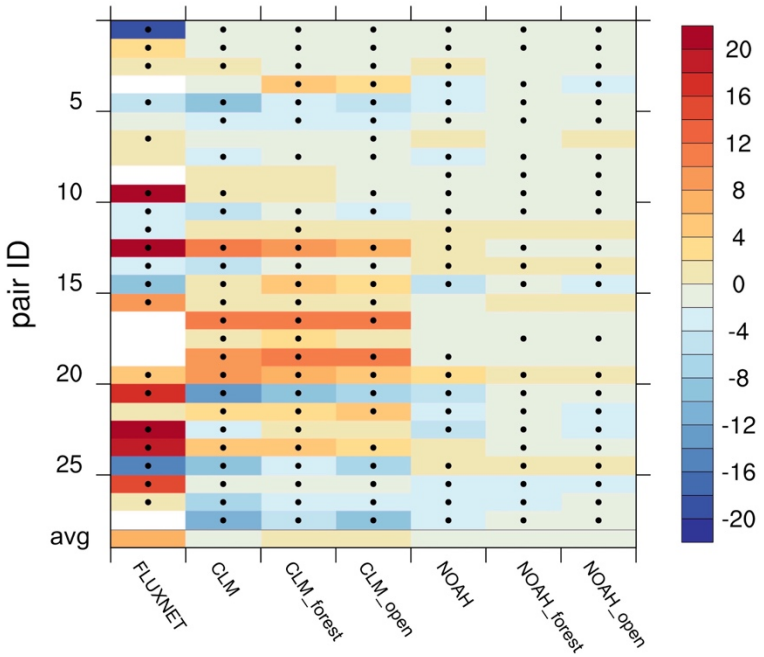

Figure S4. Change (open – forest) in observed and simulated daytime surface soil moisture (%) during summer (JJA, b). White areas indicate missing observations.