The role of land-surface interactions for surface climate in the EC-Earth3 earth system model

Supplement

The first part of the supplement includes figures in relation to the three different data sets of surface soil moisture, ESA CCI, GLEAM 3.5b and GLEAM 3.5b (see Table 1).
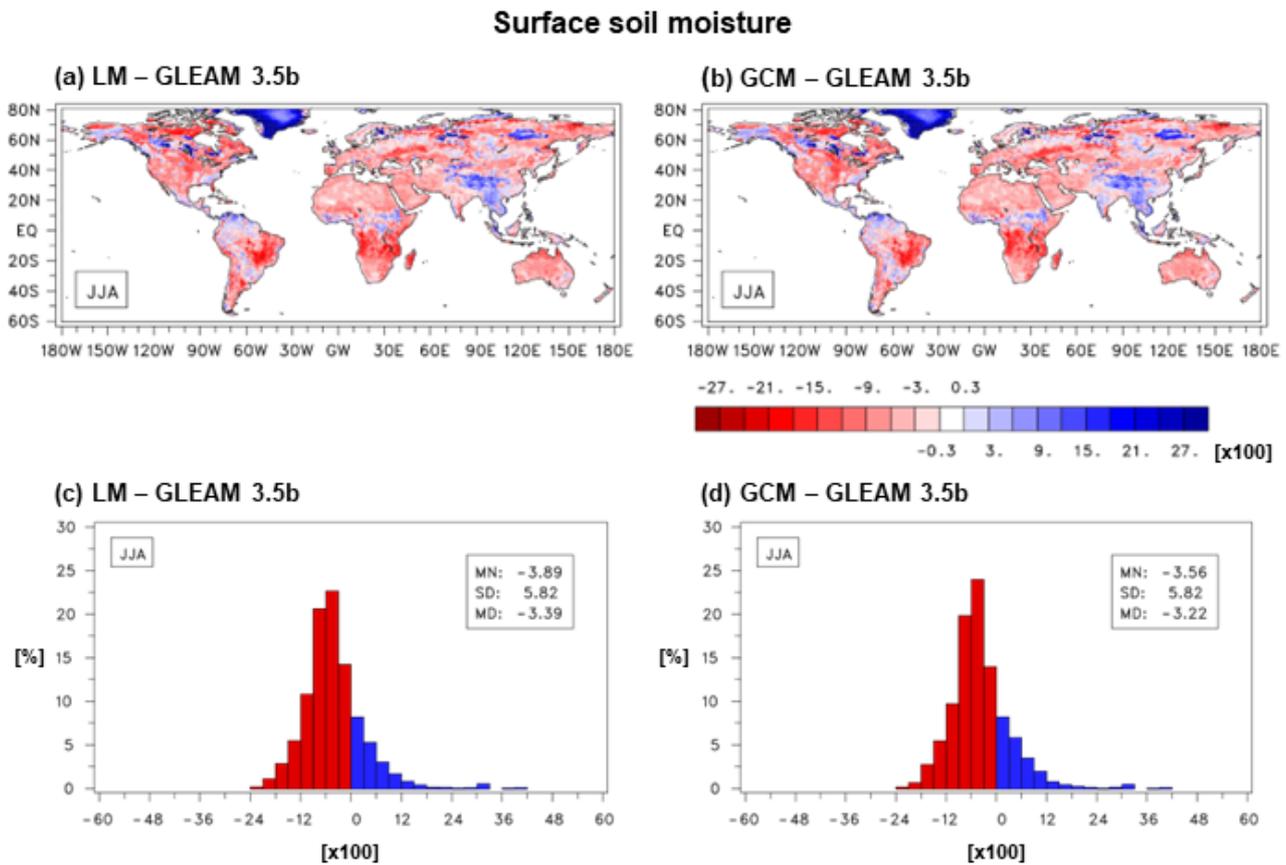
Figure S1: Differences in the seasonal (June through August; JJA) mean values of surface soil moisture for 2003-2017 (a) between the simulation with the land component forced with ERA5 (LM) and GLEAM 3.5b (LM – GLEAM 3.5b) and (b) between the simulation with the atmospheric component of EC-Earth with the land-surface conditions prescribed from LM (GCM) and GLEAM 3.5b (GCM – GLEAM 3.5b) as well as the distributions of the area-weighted seasonal mean differences (c) between LM and GLEAM 3.5b (LM – GLEAM 3.5b) and (d) between GCM and GLEAM 3.5b (GCM – GLEAM 3.5b). Units for the maps are m^3/m^3 (x100); the contour interval is 3 m^3/m^3 (x100) in (a-b). For the distributions, units are m^3/m^3 (x100) on the abscissa and % on the ordinate, respectively (c-d). The mean, standard deviation and median of the distribution are given in the box; units are m^3/m^3 (x100).
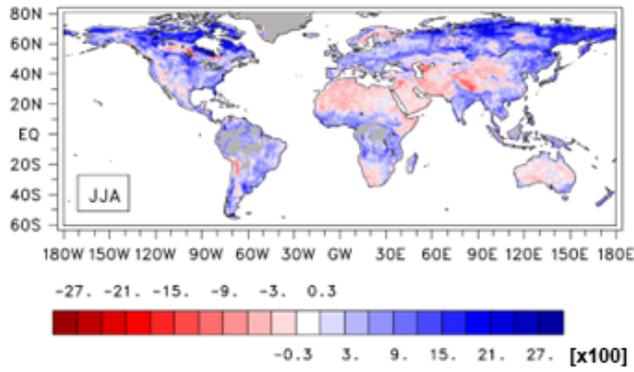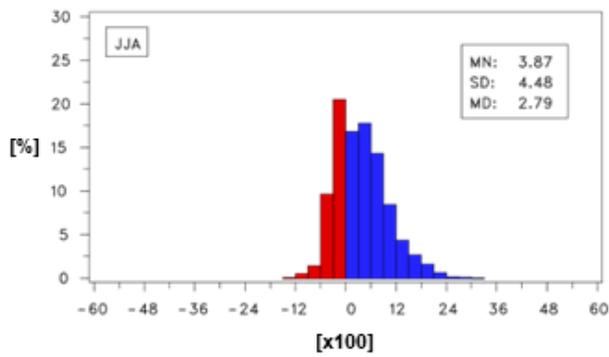
Figure S2: Differences in the seasonal mean values of surface soil moisture for 2003-2017 (a) between GLEAM 3.5b and ESA CCI (GLEAM 3.5b – ESA CCI) and (b) the distribution of the area-weighted seasonal mean differences between GLEAM 3.5b and ESA CCI (GLEAM 3.5b – ESA CCI). Units for the map are m^3/m^3 (x100); the contour interval is 3 m^3/m^3 (x100) in (a). For the distribution, units are m^3/m^3 (x100) on the abscissa and % on the ordinate, respectively (b). The mean, standard deviation and median of the distribution are given in the box; units are m^3/m^3 (x100). Missing data in ESA CCI are marked in grey.

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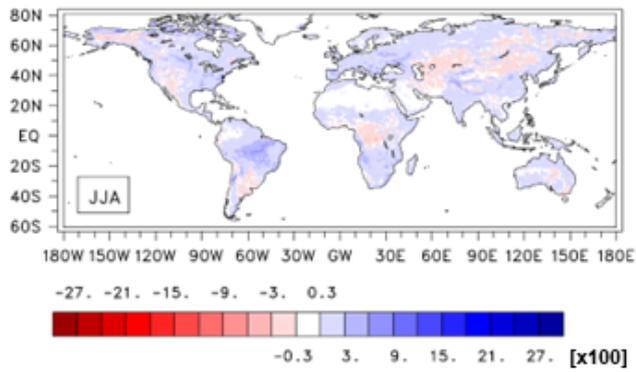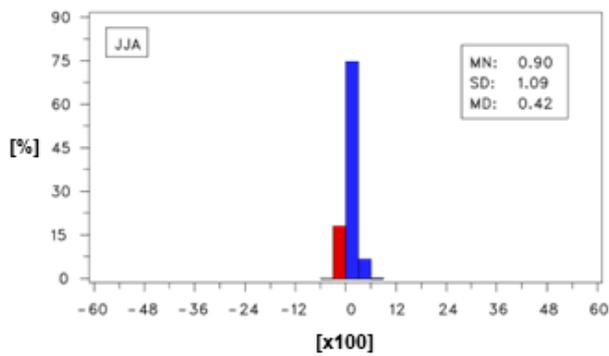
Figure S3: Differences in the seasonal mean values of surface soil moisture for 2003-2017 for (a) between GLEAM 3.5a and GLEAM 3.5b (GLEAM 3.5a – GLEAM 3.5b) and (b) the distribution of the area-weighted seasonal mean differences between GLEAM 3.5a and GLEAM 3.5b (GLEAM 3.5a – GLEAM 3.5b). Units for the map are m^3/m^3 (x100); the contour interval is 3 m^3/m^3 (x100) in (a). For the
55 distribution, units are m^3/m^3 (x100) on the abscissa and % on the ordinate, respectively (b). The mean, standard deviation and median of the distribution are given in the box; units are m^3/m^3 (x100).

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75 The second part of the supplement includes figures in relation to the two different data sets of surface soil moisture, FLUXCOM SAT and FLUCOM MET (see Table 1).
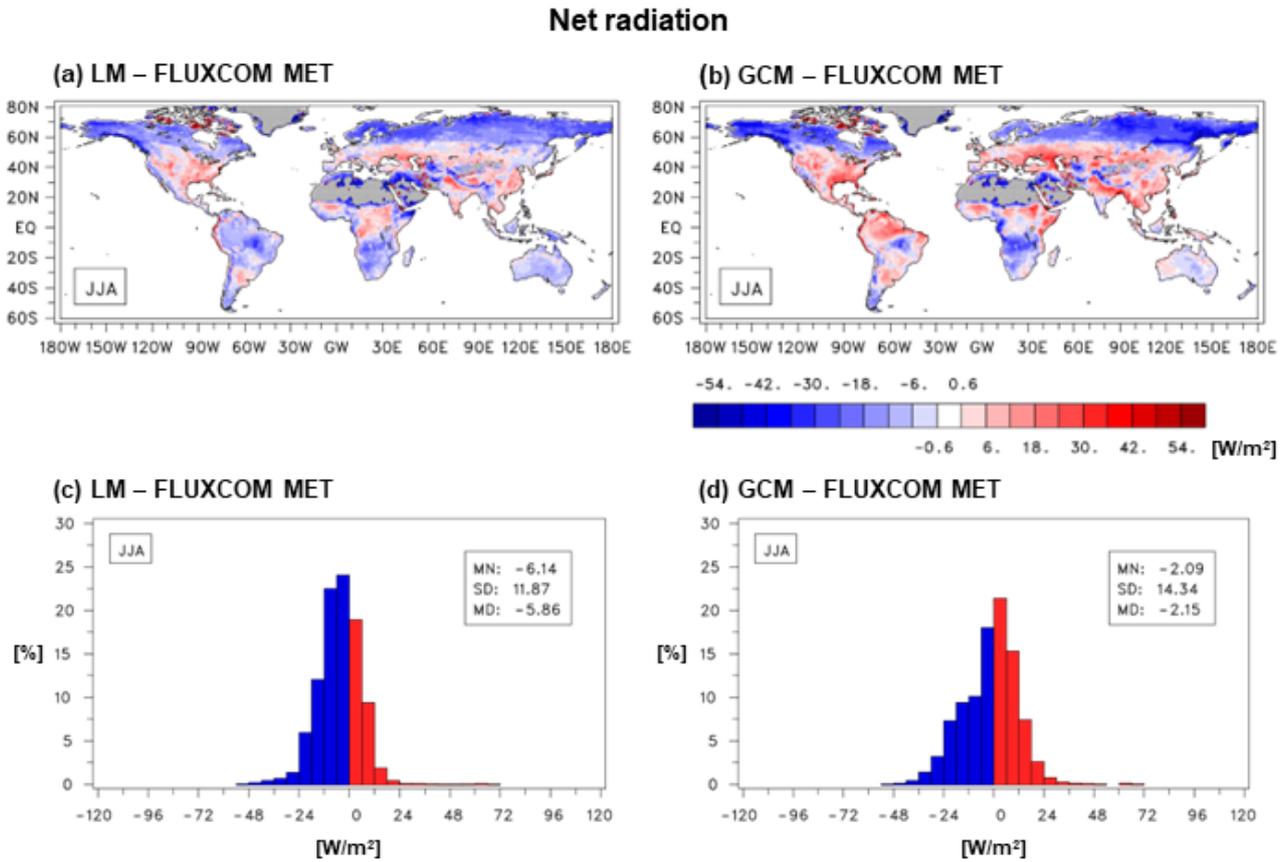
Figure S4: Differences in the seasonal mean values of net radiation (incoming) for 1979-2014 (a) between LM and FLUXCOM MET
80 (LM – FLUXCOM MET) and (b) between GCM and FLUXCOM MET (GCM – FLUXCOM MET) as well as the distributions of the area-weighted seasonal mean differences (c) between LM and FLUXCOM MET (LM – FLUXCOM MET) and (d) between GCM and FLUXCOM MET (GCM – FLUXCOM MET). Units for the maps are W/m²; the contour interval is 6 W/m² in (a-b). For the distributions, units are W/m² on the abscissa and % on the ordinate, respectively (c-d). The mean, standard deviation and median of the distribution are given in the box; units are W/m². Missing data in FLUXCOM MET are marked in grey.

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Sensible heat flux
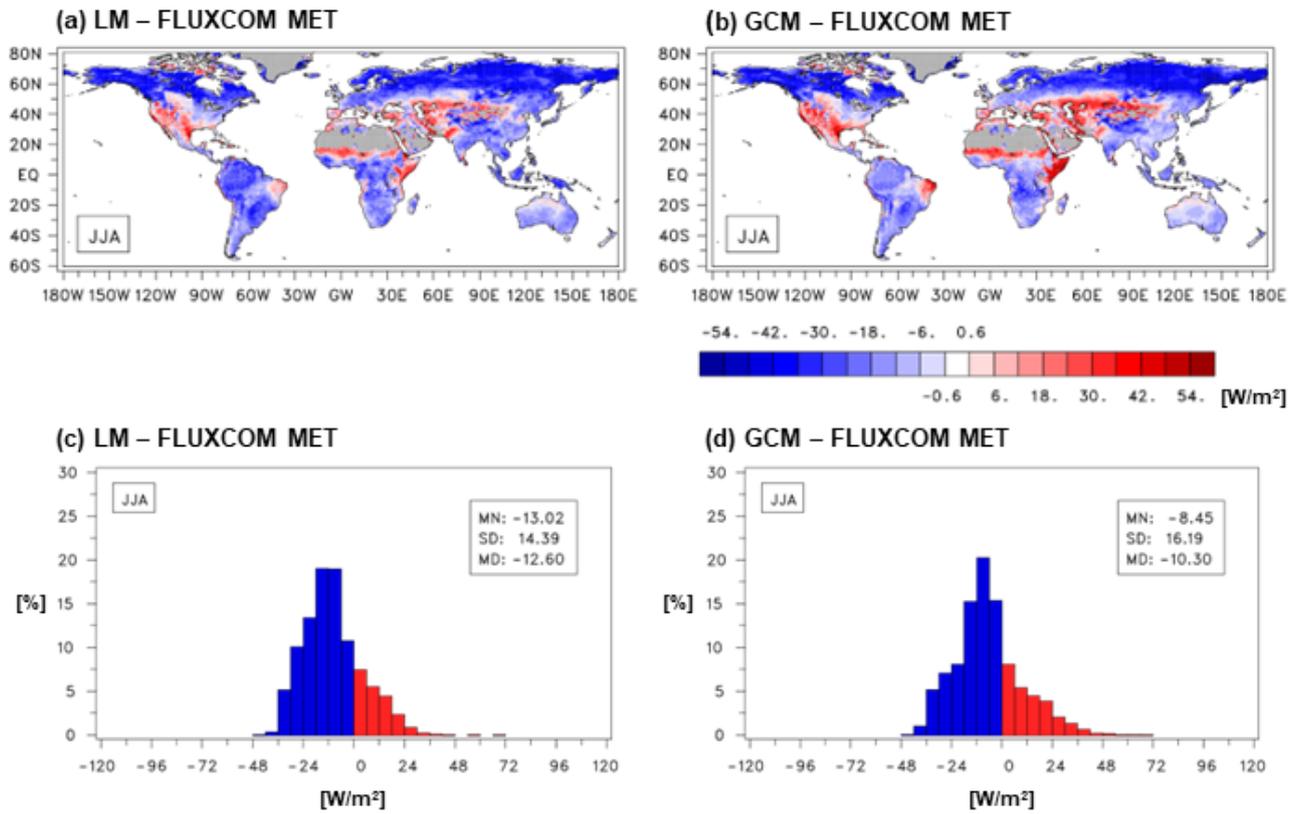
Figure S5: As Fig. S4 but for sensible heat flux.

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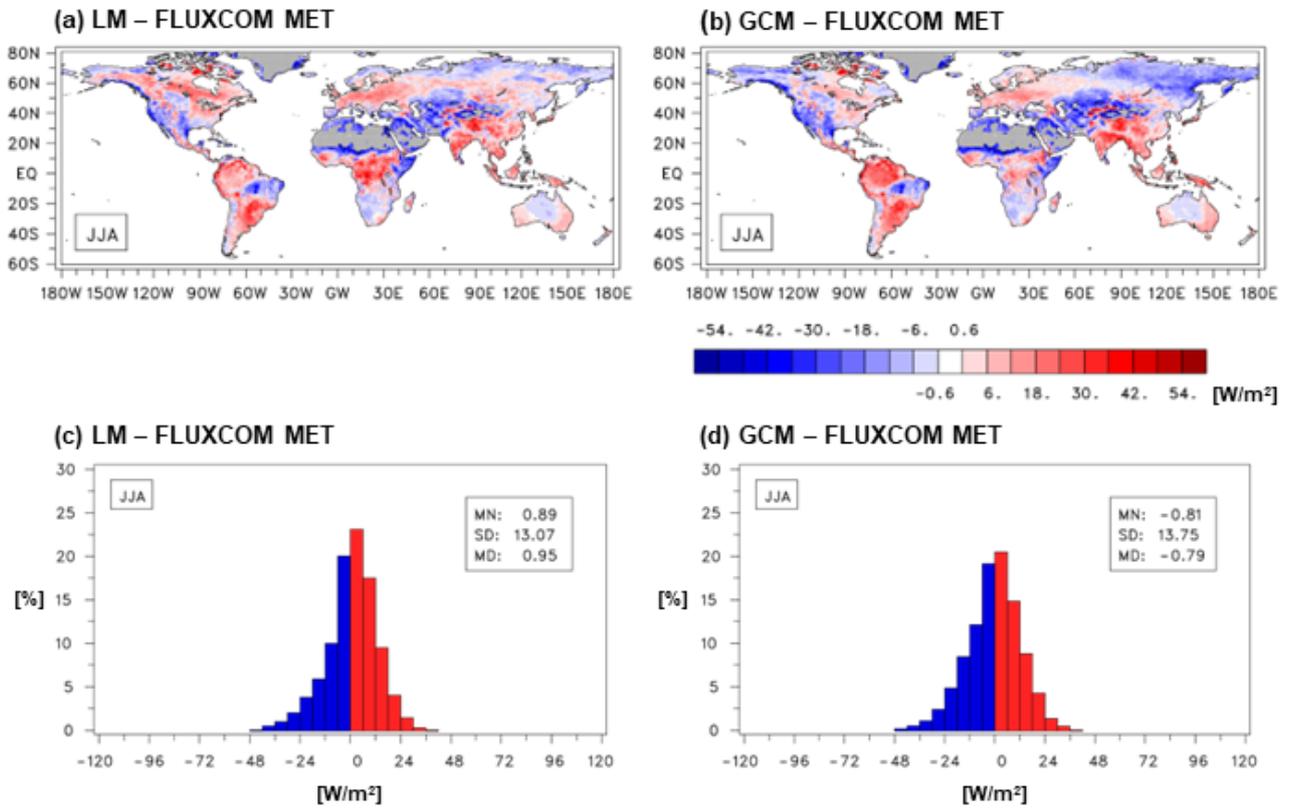
Figure S6: As Fig. S4 but for latent heat flux.

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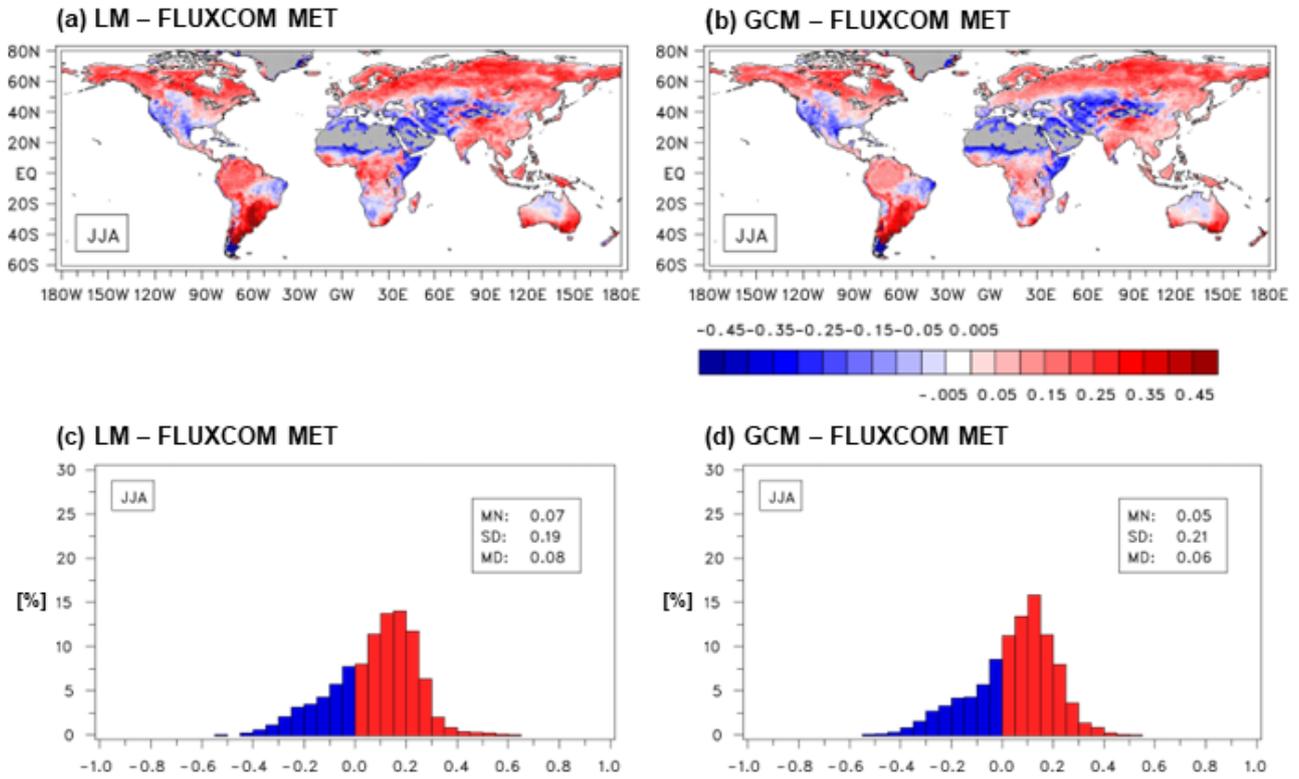
Figure S7: Differences in the seasonal mean values of the evaporative fraction for 1979-2014 (a) between LM and FLUXCOM MET (LM – FLUXCOM MET) and (b) between GCM and FLUXCOM MET (GCM – FLUXCPM MET) as well as the distributions of the area-weighted seasonal mean differences (c) between LM and FLUXCOM MET (LM – FLUXCOM MET) and (d) between GCM and FLUXCOM MET (GCM – FLUXCOM MET). Units for the maps are standard unit; the contour interval is 0.05 in (a-b). For the distributions, units are standard unit on the abscissa and % on the ordinate, respectively (c-d). The mean, standard deviation and median of the distribution are given in the box; units are standard unit. Missing data in FLUXCOM MET are marked in grey.
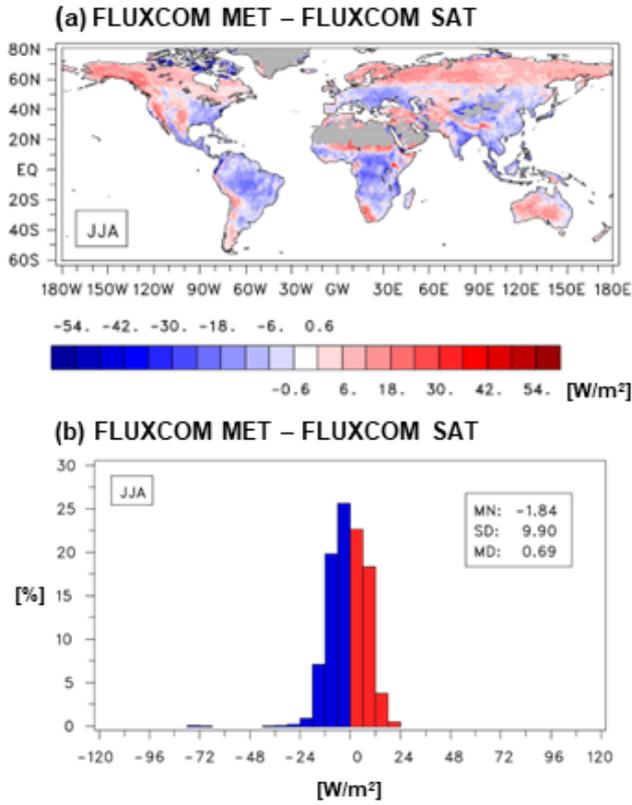
Figure S8: Differences in the seasonal mean values of net radiation (incoming) for 2001-2014 (a) between FLUXCOM MET and FLUXCOM SAT (FLUXCOM MET – FLUXCOM SAT) and (b) the distribution of the area-weighted seasonal mean differences between FLUXCOM MET and FLUXCOM SAT (FLUXCOM MET – FLUXCOM SAT). Units for the map are W/m²; the contour interval is 6 W/m² in (a). For the distribution units are W/m² on the abscissa and % on the ordinate, respectively (b). The mean, standard deviation and median of the distribution are given in the box; units are W/m². Missing data in FLUXCOM MET or FLUXCOM SAT are marked in grey.

Figure S9: As Fig. S8 but for sensible heat flux.

Latent heat flux

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Figure S10: As Fig. S8 but for latent heat flux.

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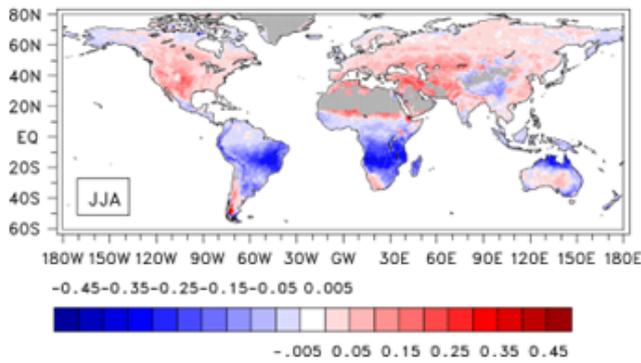
Evaporative fraction

(a) FLUXCOM MET – FLUXCOM SAT

(b) FLUXCOM MET – FLUXCOM SAT

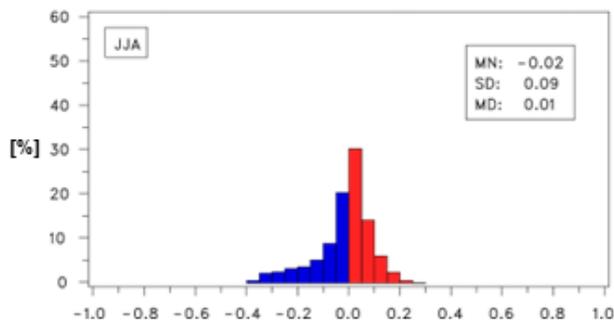



Figure S11: Differences in the seasonal mean values of the evaporative fraction for 2001-2014 (a) between FLUXCOM MET and FLUXCOM SAT (FLUXCOM MET – FLUXCOM SAT) and (b) the distribution of the area-weighted seasonal mean differences between FLUXCOM MET and FLUXCOM SAT (FLUXCOM MET – FLUXCOM SAT). Units for the map are standard unit; the contour interval is 0.05 in (a). For the distribution, units are standard unit on the abscissa and % on the ordinate, respectively (b). The mean, standard deviation and median of the distribution are given in the box; units are standard unit. Missing data in FLUXCOM MET or FLUXCOM SAT are marked in grey.

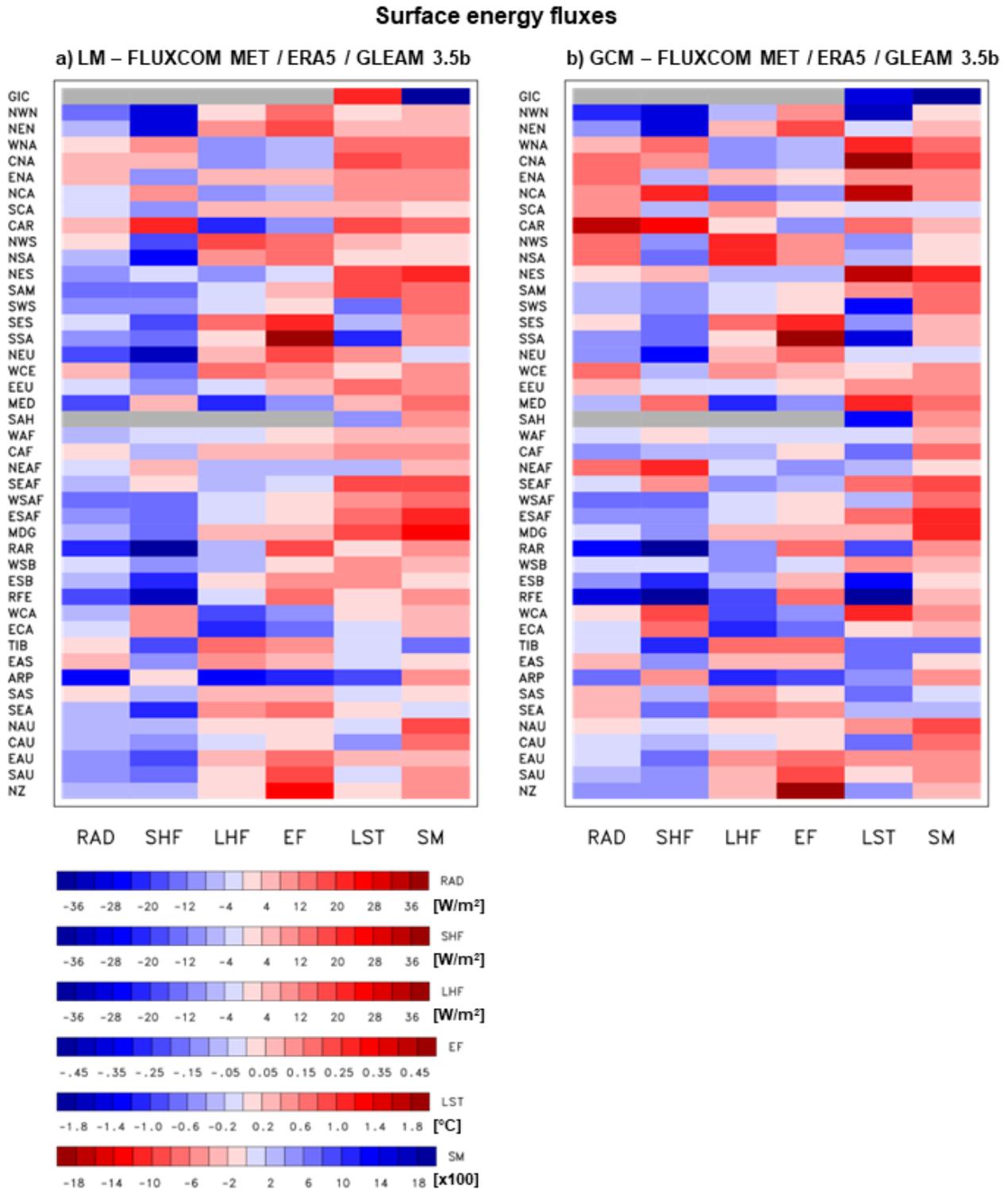
The third part of the supplement includes a table with the acronyms and names of the 44 land regions considered.

Acronym	Name	Acronym	Name	Acronym	Name
GIC	Greenland/Iceland	SSA	S.-South-America	ESB	E.Siberia
NWN	N.W.North-America	NEU	N.Europe	RFE	Russian-Far-East
NEN	N.E.North-America	WCE	Western&Central-Europe	WCA	W.C.Asia
WNA	W.North-America	EEU	E.Europe	ECA	E.C.Asia
CAN	C.North-America	MED	Mediterranean	TIB	Tibetan-Plateau
ENA	E.North-America	SAH	Sahara	EAS	E.Asia
NCA	N.Central-America	WAF	Western-Africa	ARP	Arabian-Peninsula
SCA	S.Central-America	CAF	Central-Africa	SAS	S.Asia
CAR	Caribbean	NEAF	N.Eastern-Africa	SEA	S.E.Asia
NWS	N.W.-South-America	SEAF	S.Eastern-Africa	NAU	N.Australia
NSA	N.-South-America	WSAF	W.Southern-Africa	CAU	C.Australia
NES	N.E.-South-America	ESAF	E.Southern-Africa	EAU	E.Australia
SAM	South-American-Monsoon	MDG	Madagascar	SAU	S.Australia
SWS	S.W.South-America	RAR	Russian-Arctic	NZ	New-Zealand
SES	S.E.South-America	WSB	W.Siberia		

Table S1: Acronyms and names of the 44 land regions from the updated IPCC reference regions used here according to Iturbide et al. (2020).

The fourth part of the supplement includes a figure of the regional mean differences for an alternative choice of reference data sets.

Surface energy fluxes

a) LM – FLUXCOM MET / ERA5 / GLEAM 3.5b
b) GCM – FLUXCOM MET / ERA5 / GLEAM 3.5b

305   **Figure S12:** Differences in the regional seasonal means of surface energy fluxes, i.e., net radiative flux (RAD), fluxes of sensible (SHF) and latent heat (LHF) and the evaporative fraction (EF), as well as land-surface temperature (LST) and surface soil moisture (SM) (a) between LM and the reference data sets and (b) between GCM and the reference data sets, i.e., ERA5 for LST, GLEAM 3.5b for SM and FLUXCOM MET for the surface energy fluxes for 2003-2014. Units and contour intervals can be seen in the corresponding bars. Areas with missing data in the respective reference data sets are marked in grey.