Supplement for 'Biochar-Induced Soil Property Changes May Reduce Temperature and Precipitation Extremes: Insights from Earth System Model Experiments'

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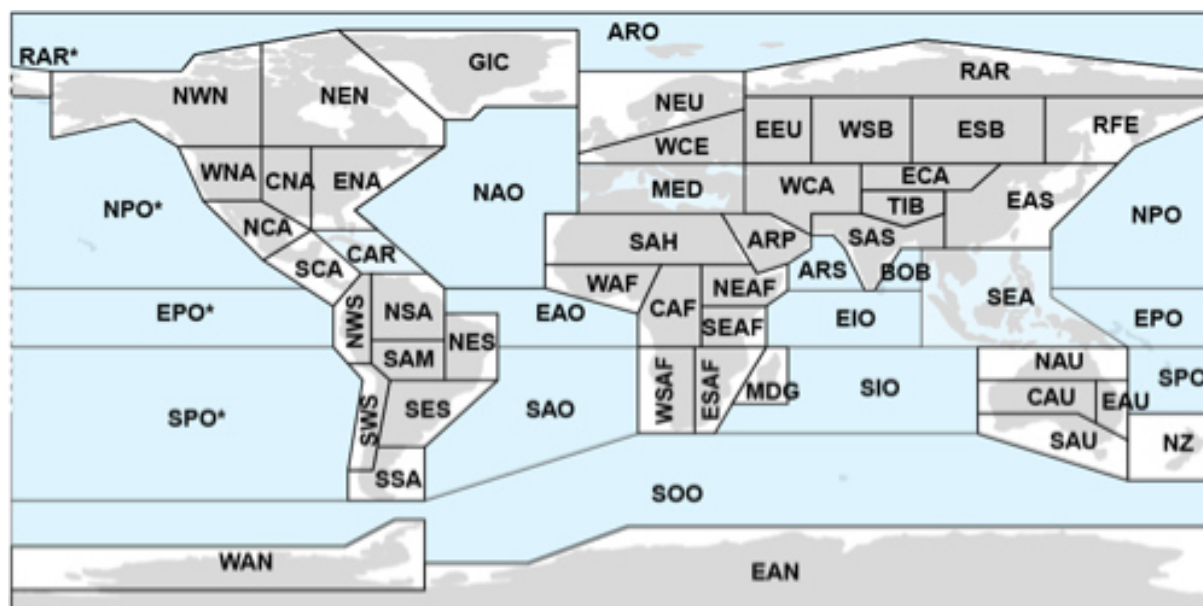
1	GIC	Greenland/Iceland	21	SAH	Sahara	40	NAU	N.Australia
2	NWN	N.W.North-America	22	WAF	Western-Africa	41	CAU	C.Australia
3	NEN	N.E.North-America	23	CAF	Central-Africa	42	EAU	E.Australia
4	WNA	W.North-America	24	NEAF	N.Eastern-Africa	43	SAU	S.Australia
5	CNA	C.North-America	25	SEAF	S.Eastern-Africa	44	NZ	New-Zealand
6	ENA	E.North-America	26	WSAF	W.Southern-Africa	45	EAN	E.Antarctica
7	NCA	N.Central-America	27	ESAF	E.Southern-Africa	46	WAN	W.Antarctica
8	SCA	S.Central-America	28	MDG	Madagascar	47	ARO	Arctic-Ocean
9	CAR	Caribbean	29	RAR	Russian-Arctic	48	NPO	N.Pacific-Ocean
10	NWS	N.W.South-America	30	WSB	W.Siberia	49	EPO	Equatorial.Pacific-Ocean
11	NSA	N.South-America	31	ESB	E.Siberia	50	SPO	S.Pacific-Ocean
12	NES	N.E.South-America	32	RFE	Russian-Far-East	51	NAO	N.Atlantic-Ocean
13	SAM	South-American-Monsoon	33	WCA	W.C.Asia	52	EAO	Equatorial.Atlantic-Ocean
14	SWS	S.W.South-America	34	ECA	E.C.Asia	53	SAO	S.Atlantic-Ocean
15	SES	S.E.South-America	35	TIB	Tibetan-Plateau	54	ARS	Arabian-Sea
16	SSA	S.South-America	36	EAS	E.Asia	55	BOB	Bay-of-Bengal
17	NEU	N.Europe	37	ARP	Arabian-Peninsula	56	EIO	Equatorial.Indic-Ocean
18	WCE	Western&Central-Europe	38	SAS	S.Asia	57	SIO	S.Indic-Ocean
19	EEU	E.Europe	39	SEA	S.E.Asia	58	SOO	Southern-Ocean
20	MED	Mediterranean						

10   **Figure S1: Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6) Reference Land and Ocean Regions.**
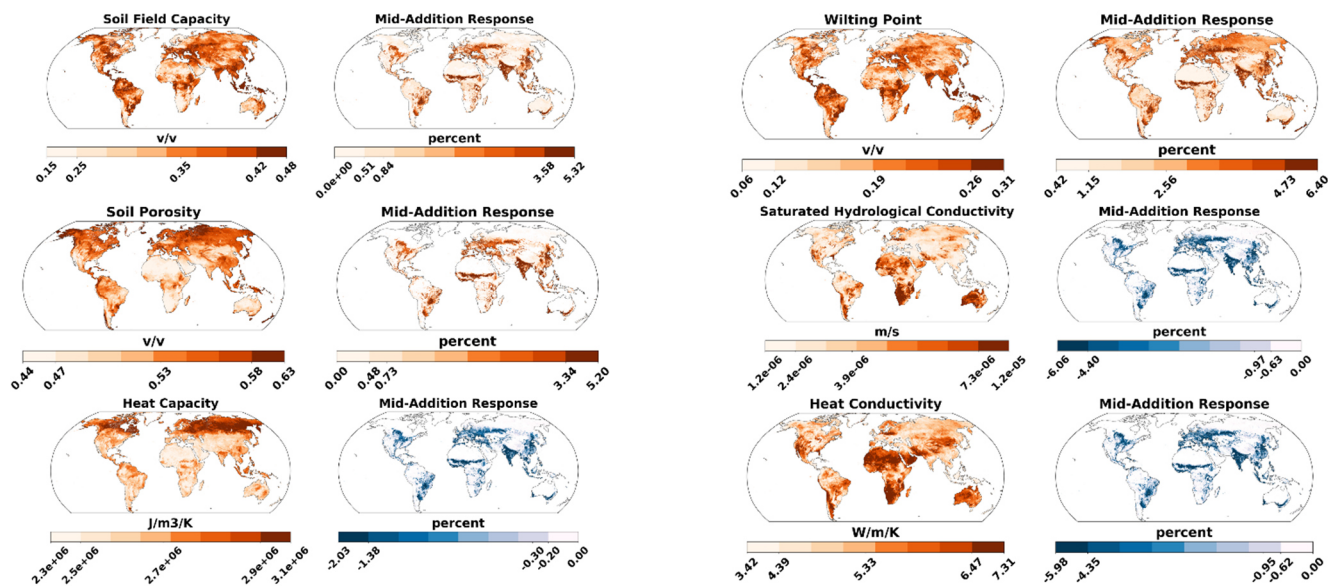
Figure S2: Global estimation of soil field capacity, permanent wilting point, soil porosity, saturated hydrological conductivity, heat capacity and heat conductivity by the pedo-transfer function (section 2.3) and the estimated percentage changes in response to Middle (Sce_2: 30 t/ha) biochar additions in agricultural areas.

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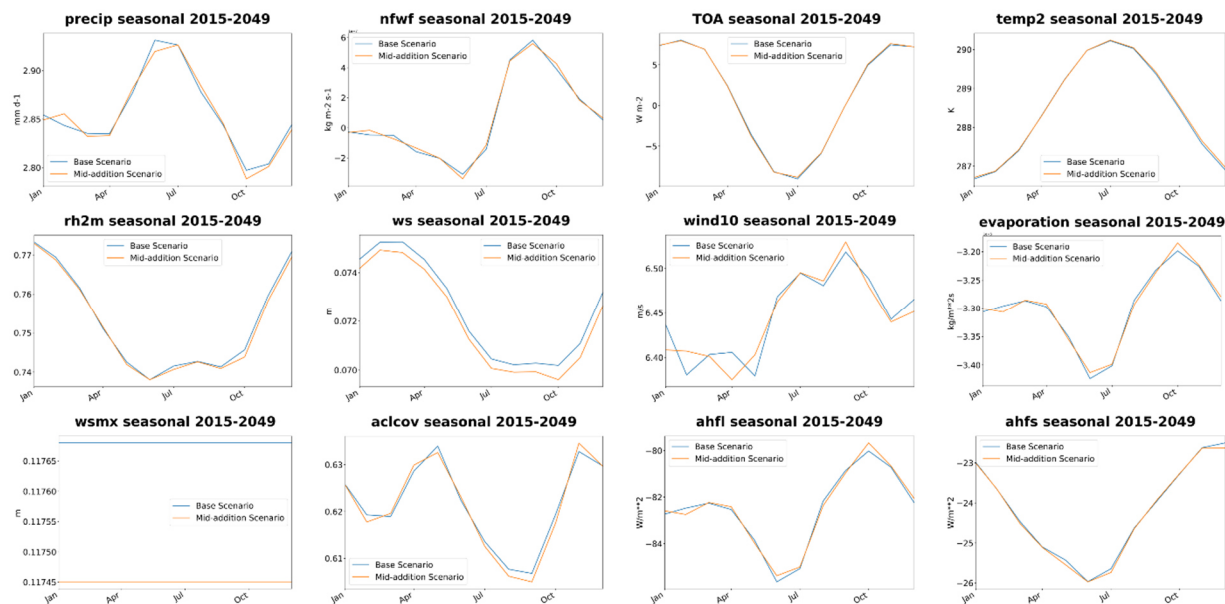
Figure S3: Modeled Monthly Variability of Water and Energy Cycle Variables in the Base and Medium-Addition Biochar Scenarios (2040–2049). Top panel: total precipitation, net fresh water flux, net top radiation, and 2m temperature; Middle panel: 2m relative humidity, soil wetness, 10m windspeed, and evaporation; Bottom panel: soil field capacity, total cloud cover, latent heat flux, and sensible heat flux.

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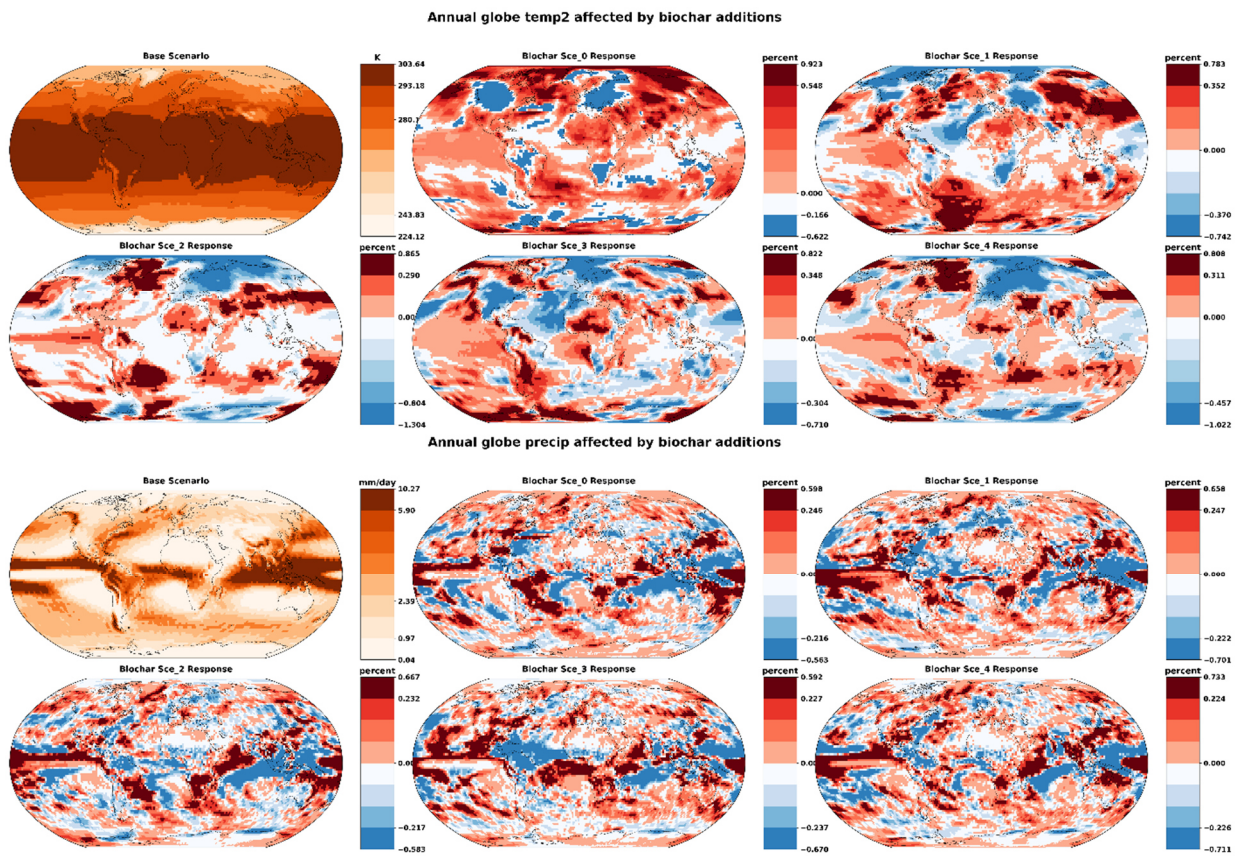
Figure S4: Global map of simulated 2m temperature and precipitation in the base scenario and absolute changes in global 2m temperature and precipitation in response to all biochar addition scenarios (2040—2049).
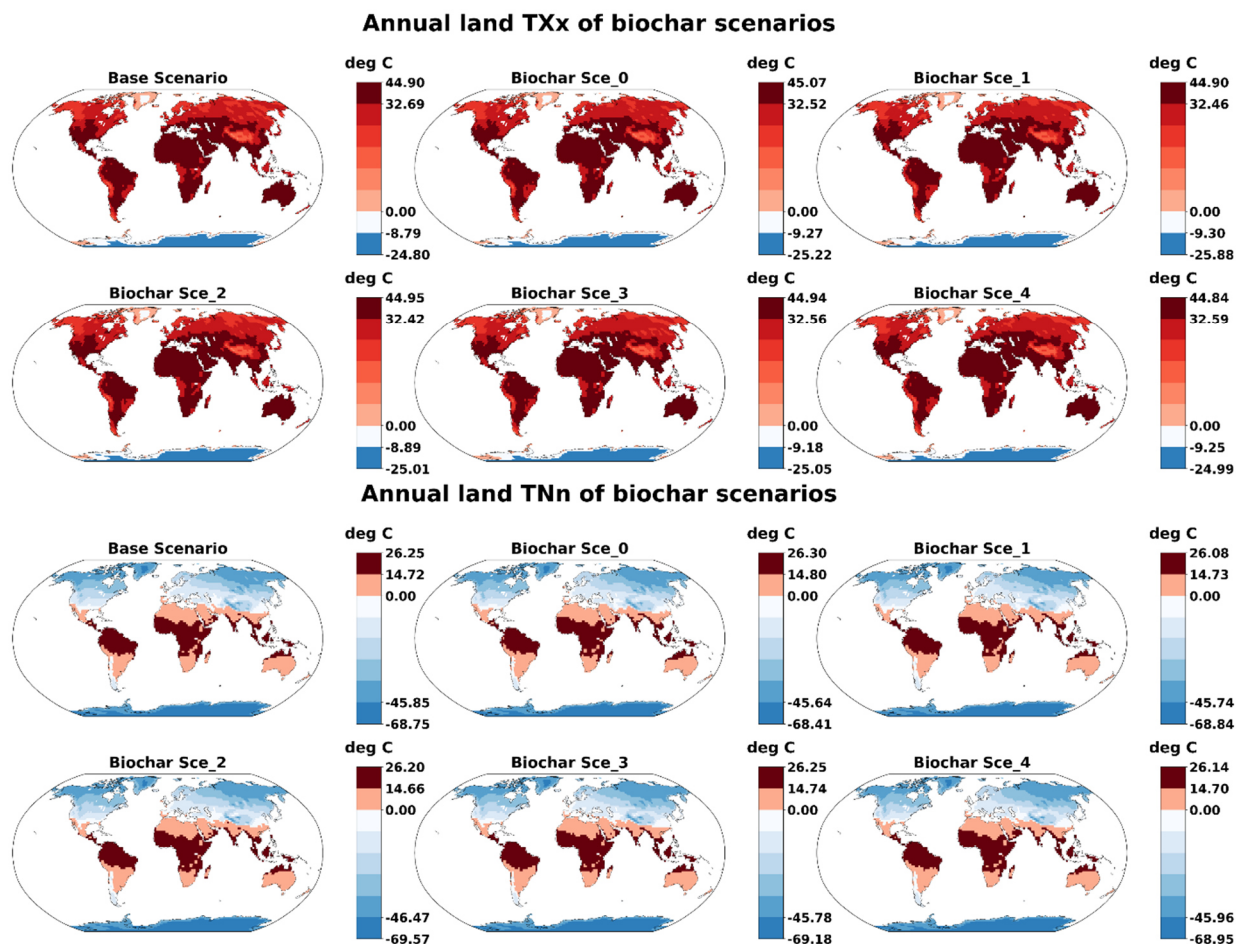
Figure S5: Maximum Daily Maximum Temperature (TXx) and Minimum Daily Minimum Temperature (TNn) in the Base Scenario and Their Responses to all Biochar Addition Scenarios over Land areas. All maps presenting climate indices for the period 2040—2049, calculated with simulation data of the period and calibrated against the base scenario from 2005–2014. Color scales are standardized for comparability: the first color band represents values between the 95th percentile and the maximum; the last band covers the range from the 5th percentile to the minimum. All intermediate bands are evenly divided between the 5th and 95th percentiles, except for the boundary nearest to zero, which is explicitly set to zero to clearly distinguish between positive and negative values.

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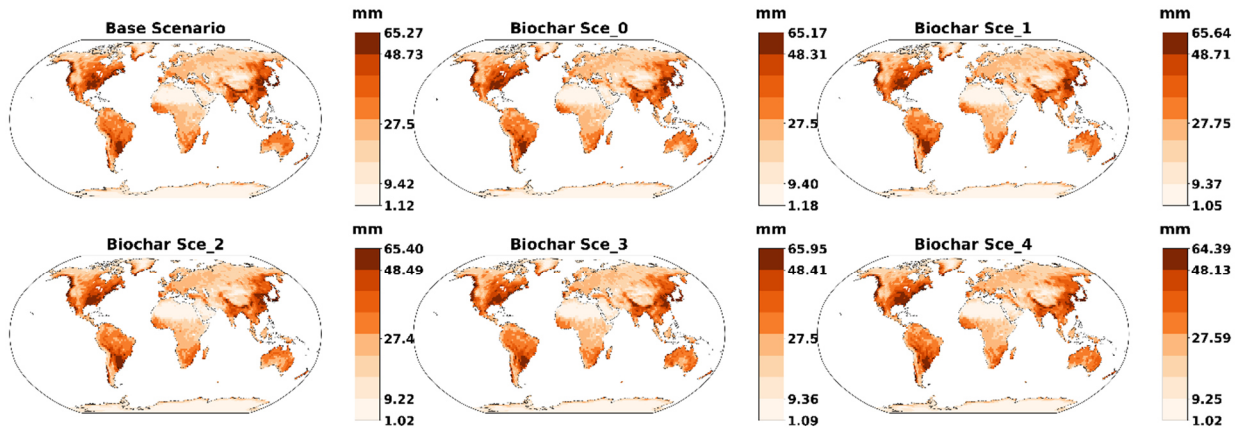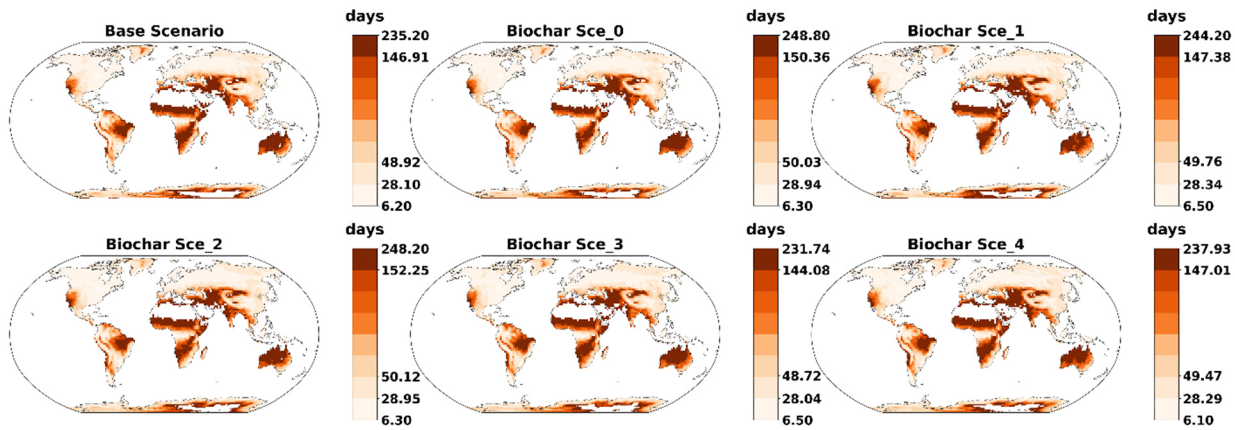
Figure S6: Maximum 1-Day Precipitation (Rx1day) and Consecutive Dry Days (CDD) in the Base Scenario and Their Responses to all Biochar Addition Scenarios over Land areas. All maps presenting climate indices for the period 2040—2049, calculated with simulation data of the period and calibrated against the base scenario from 2005–2014. Color scales are standardized for comparability: the first color band represents values between the 95th percentile and the maximum; the last band covers the range from the 5th percentile to the

35 minimum. All intermediate bands are evenly divided between the 5th and 95th percentiles, except for the boundary nearest to zero, which is explicitly set to zero to clearly distinguish between positive and negative values.

Climate responses of Mid-addition scenario
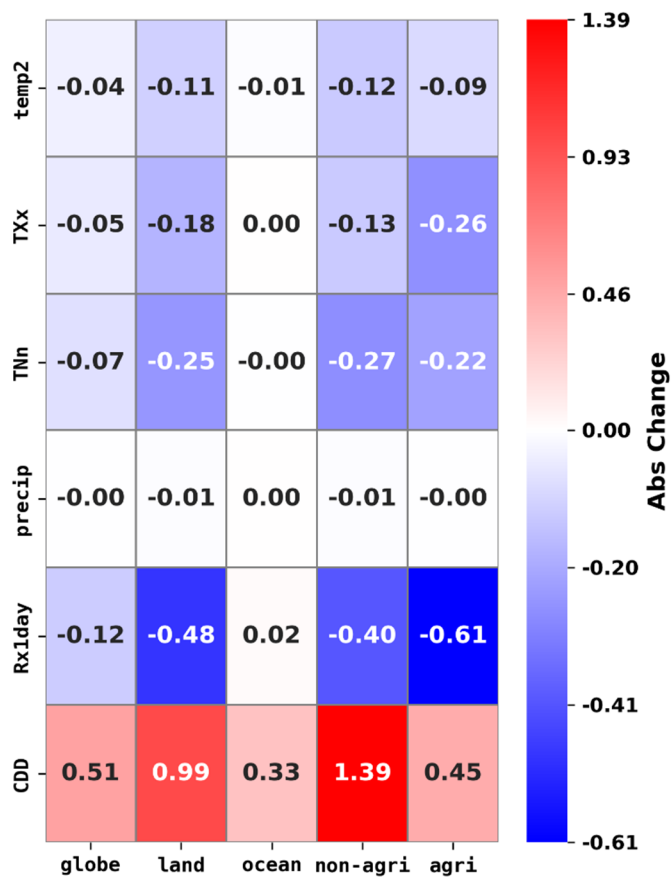
Figure S7: Surface-type Responses to Medium Biochar Addition (2040–2049) in Temperature and Precipitation Metrics. Each panel shows the absolute changes in: 2 m temperature (temp2, in K), maximum daily maximum temperature (TXx, in deg C), minimum daily minimum temperature (TNn, in deg C), precipitation (precip, in mm/day), maximum 1-day precipitation (Rx1day, in mm), and consecutive dry days (CDD, in days).

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Figure S8: Regional Climate Extremes Responses to Medium Biochar Addition in Europe (30 t/ha). Maps on the left show spatial changes in maximum daily maximum temperature (TXx), minimum daily minimum temperature (TNn), maximum 1-day precipitation (Rx1day), and consecutive dry days (CDD) over Asia. Color scales are standardized across all maps: the top band represents values between the 95th percentile and the maximum, and the bottom band covers the 5th percentile to the minimum. Intermediate bands are evenly spaced between the 5th and 95th percentiles, with the boundary nearest zero fixed at zero to clearly separate positive and negative values. The heatmap on the right summarizes the regional mean responses (based on IPCC AR6 reference regions; see Fig. S1). Cell colors show absolute changes; arrows indicate each region's contribution to the response of Asia: ↑ (positive contribution) or ↓ (negative contribution) with 1 to 4 arrows representing: ↑↑↑↑/↓↓↓↓ > 100%, ↑↑↑/↓↓↓ = 50–100%, ↑↑/↓↓ = 25–50%, ↑/↓ = 5–25%; – indicates minor contribution (±5%). European-wide responses: TXx = –0.30 °C, TNn = –0.27 °C, Rx1day = –0.13 mm, CDD = –0.67 days.