

Supplementary information

1. Supplemental data and equations

Table S1: Description of the main climatic characteristics of each Brazilian biome according to Köppen-Geiger classification system (Peel et al. 2007).

Biome	Mean rainfall (mm)	Mean temperature (°C)	Köppen-Geiger	Description
Amazon	2000 - 3000	26.0	Af	Tropical, rainy with hot summer
Caatinga	500 - 700	27.4	BSh	Tropical, semi-arid with hot summer
Cerrado	1300 - 1600	20.1	Aw	Tropical, rainy, with hot summer and dry winter
Atlantic Forest	2000 - 2500	21.1	Af	Tropical, rainy with hot summer
Pantanal	1000 - 1400	24.8	Aw	Tropical, rainy with hot summer and dry winter
Pampa	1300 - 1700	20.0	Cfa	Subtropical, moist with hot summer

Table S2: List of variables used in the development of TrBS (Tropical Broadleaved Savanna tree) PFT with their respective collection sites and responsible researchers. Variables collected in the field include Tree Diameter at Breast Height (DSH), Tree Height (TH), Canopy Height (CH), Canopy Area (CA), Canopy Volume (CV), and Specific Leaf Area (SLA).

Site	Year	Data collected	Reference
Silvânia - GO	2009	DSH, TH, CH, CA & CV	Gomes et al., (2024)
São Desidero - BA	2009	DSH, TH, CH, CA & CV	Gomes et al., (2024)
Correntina - BA	2009	DSH, TH, CH, CA & CV	Gomes et al., (2024)
Alto Paraíso de Goiás - GO	2009	DSH, TH, CH, CA & CV	Gomes et al., (2024)
Parque Nacional de Brasília - DF	2013	DSH, TH, CH, CA & CV	Not published (responsible: Felipe Lenti and Mercedes Bustamante)
Rota Farm at Nova Xavantina - MT	2015	DSH & TH	Gomes et al., (2024)
Farm at Sinop - MT	2018	DSH & TH	Gomes et al., (2024)
Parque Municipal do Bacaba - MT	2019	DSH, TH e TH/DSH	Gomes et al., (2024)
Jardim Botânico de Brasília - DF	2019	DSH, TH, CH, CA, CV & SLA	Gomes et al., (2024); Machida et al., (2021)
FLONA de Brasília - DF	2019	DSH & TH	Schüler, Jéssica (2020)
Parque Nacional da Chapada dos Veadeiros - GO	2020	DSH, TH, CH, CA & CV	Gomes et al., (2024)
Reserva Ecológica do IBGE - DF	2022	DSH, TH, CH, CA, CV & SLA	Gomes et al. (2024); Costa, Lucas (2020)

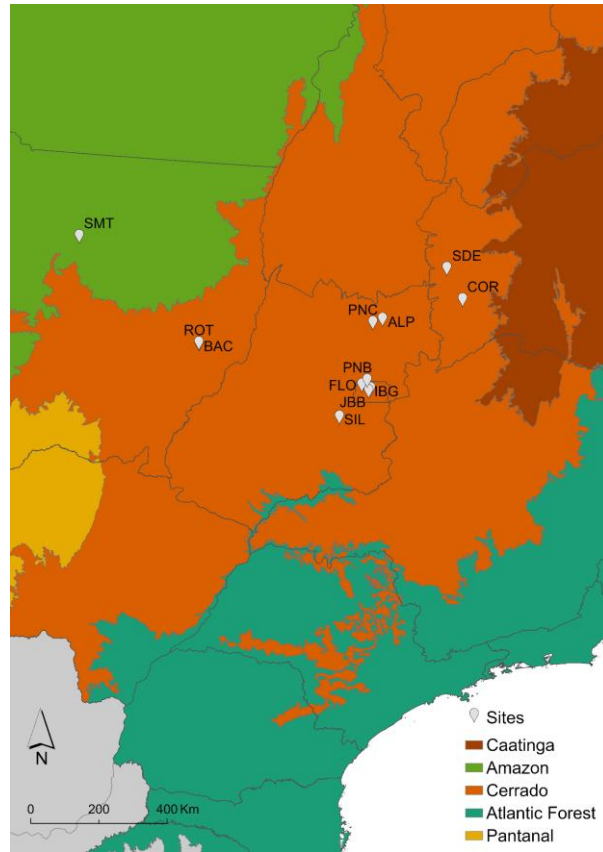


Fig. S1: Map showing the locations where field data, referred on Table S1, were collected. Farm at Sinop (SMT), Rota Farm at Nova Xavantiva (ROT), Parque Municipal do Bacaba (BAC), São Desiderio (SDE), Correntina (COR), Parque Nacional da Chapada dos Veadeiros (PNC), Alto Paraíso de Goiás (ALP), Parque Nacional de Brasília (PNB), FLONA de Brasília (FLO), Reserva Ecológica do IBGE (IBG), Jardim Botânico de Brasília (JBB), and Silvânia (SIL).

Equation S1: Allometric relation between crown area and stem diameter in LPJmL-VR-SPITFIRE (Schaphoff et al. 2018).

$$CA_{ind} = \min(allom1 * D^{k_{rp}}, CA_{max})$$

Equation S2: Allometric relation between tree height and stem diameter in LPJmL-VR-SPITFIRE (Schaphoff et al. 2018).

$$H = allom2 * D^{allom3}$$

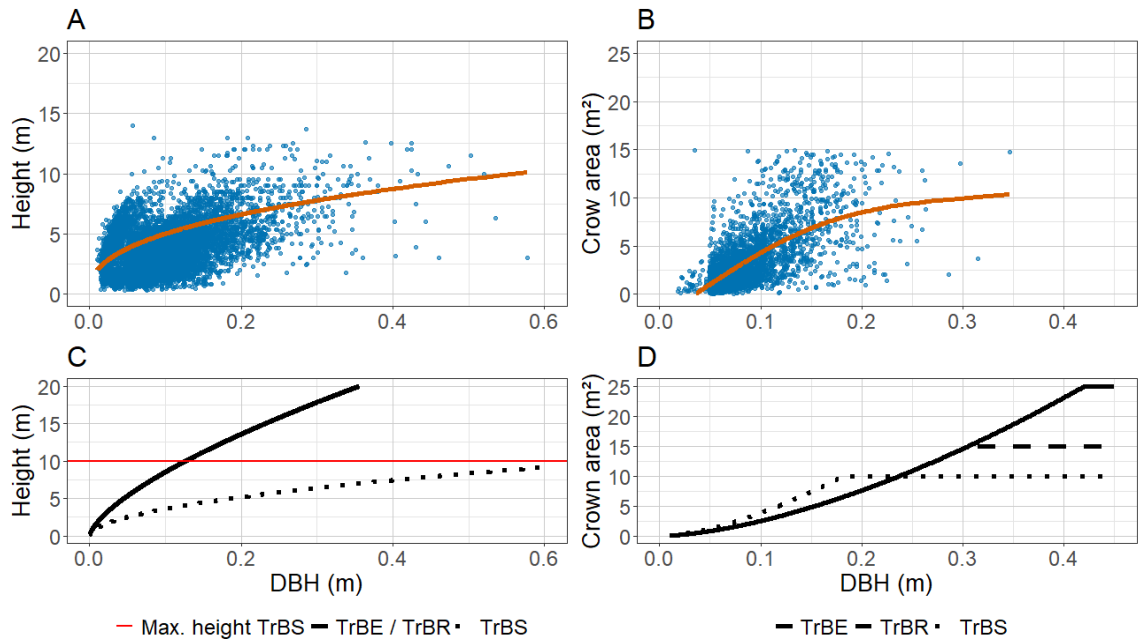


Fig. S2. Allometric relation between tree height and stem diameter (DBH) (A and C), and between crown area and DBH (B and D), for different PFTs (TrBE = tropical broadleaved evergreen, TrBR = tropical broadleaved raingreen, TrBS = tropical broadleaved savanna). Graphs A and B are fitted curves based on field data, and C and D are the allometric curves for each PFT.

Equation S3: Investment in leaf vs. root biomass related to water stress (Schaphoff et al. 2018)

$$C_{leaf,ind} = l_{r_{max}} * \omega * C_{root,ind}$$

where $C_{leaf,ind}$ is the leaf mass per individual [gC indiv-1], $C_{root,ind}$ the fine root mass per individual [gC indiv-1], ω a water stress index (from 1 = no water stress, to 0 = maximum water stress), and $l_{r_{max}}$ is the PFT-specific maximum leaf to root mass ratio.

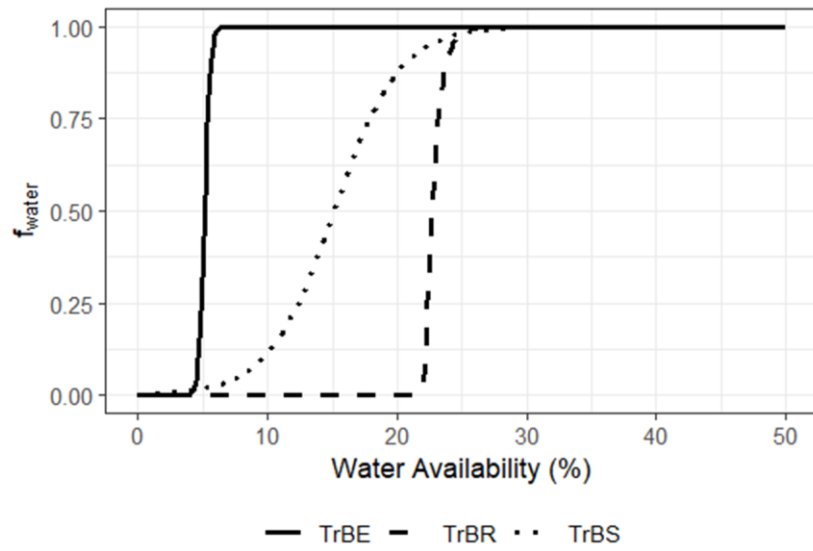


Fig. S3: Water limited component f_{water} of the phenology status (0 = no leaves, 1 = full leaf cover) for the three tropical PFTS TrBE (Tropical Broadleaved Evergreen tree), TrBR (Tropical Broadleaved Raingreen tree) and the new TrBS (Tropical Broadleaved Savanna tree).

Equation S4: Calculation for bark thickness related to stem diameter

$$bark\ thickness = barkpar1 * D * 100 * barkpar2$$

where bark thickness [cm] is calculated from the PFT-specific parameters barkpar1 and barkpar2 (Table 2), and D = stem diameter [m]

Equation S5: Calculation of PFT-specific scorch height

$$SH = F * I^{2/3}$$

where SH is the scorch height [m], F is a PFT-specific scaling parameter (Table x), and I is the fireline intensity [kWm-1]

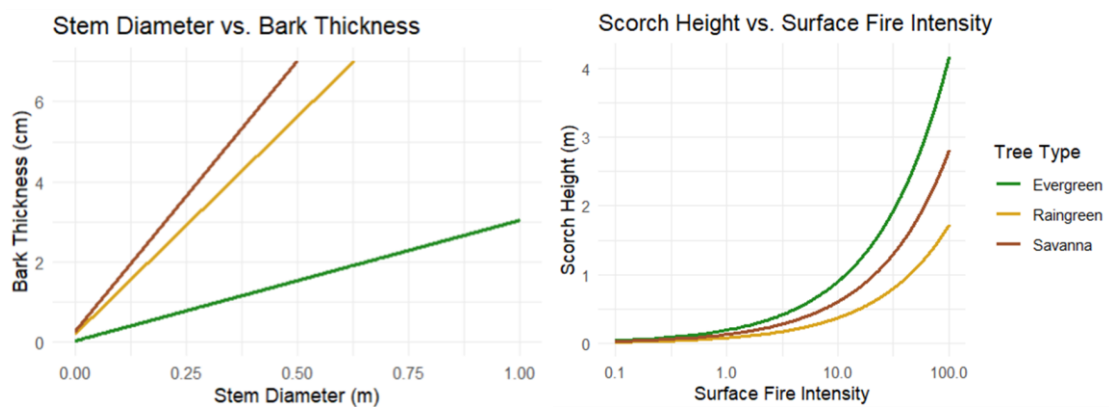


Fig. S4: Graphs showing PFT specific parameters mediating fire mortality for the tropical trees PFTs. The relationship between bark thickness and stem diameter (right) was based on Hoffmann et al. (2009), and the relationship between scorch height and surface fire intensity (left).

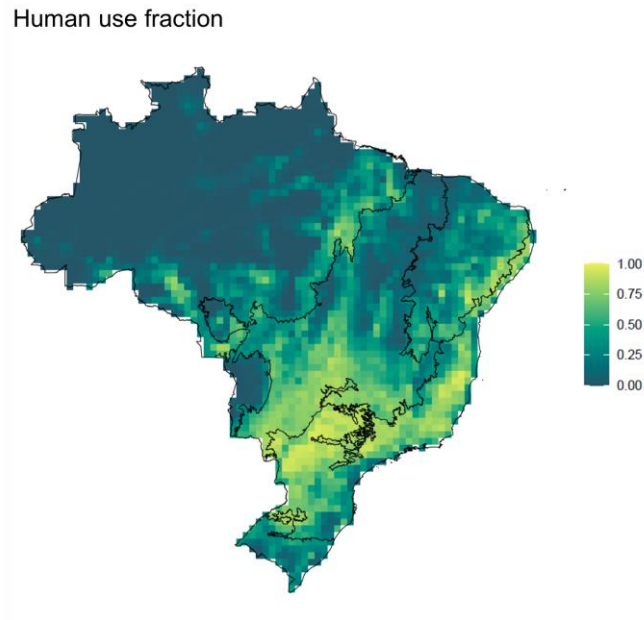


Fig. S5: Human land-use fraction map used to weigh burned area and fire C emission (MapBiomass, 2024).

2. Supplemental Results

2.1 PFT distribution

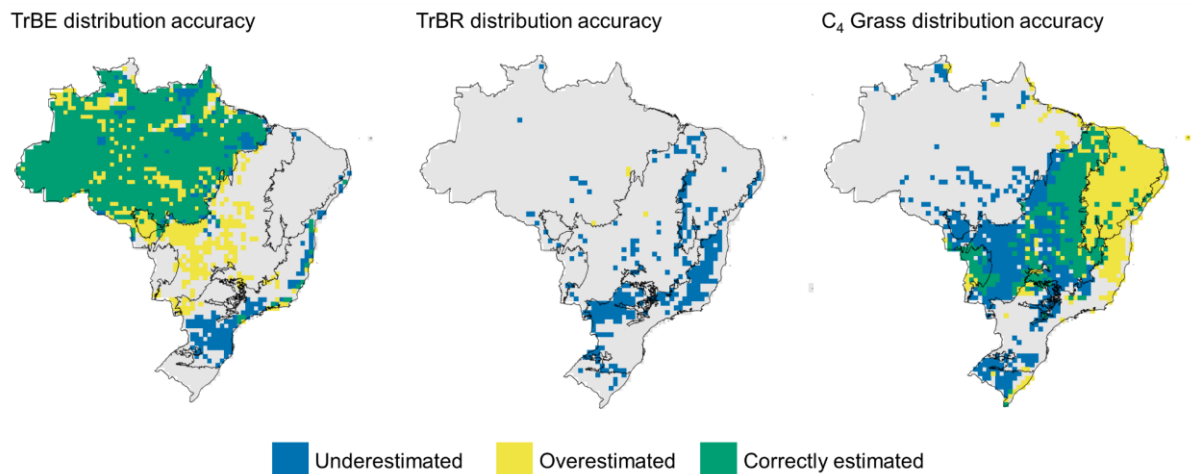


Fig. S6: Simulated distribution accuracy, according to IBGE vegetation map, for Tropical Broadleaved Evergreen Tree (TrBE), Tropical Broadleaved Raingreen Tree (TrBR) and C₄ Grass PFTs with the introduction of the new Tropical Broadleaved

Savanna Tree (TrBS). To determine accuracy, we used a threshold of 30% FPC cover for each PFT.

2.2 Above and belowground structure

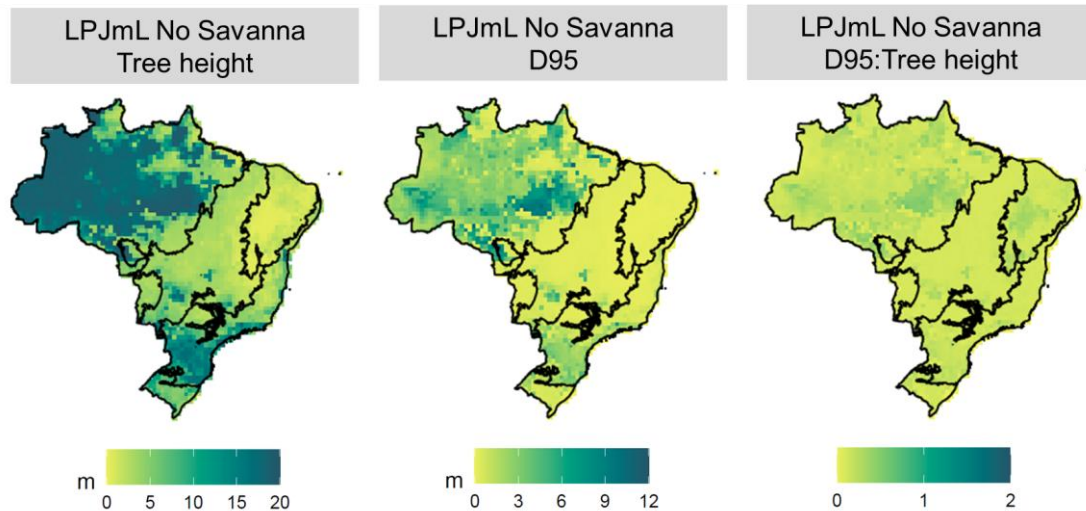


Fig. S7: FPC-weighted tree height and D95, and their ratio (D95:Tree height) from LPJmL ‘No Savanna’ simulation.

2.3 Global Simulations

To test the implementation of the new savanna TrBS PFT, we performed a global simulation using LPJmL-VR-SPITFIRE (Fig. S9). Comparison with estimates of tropical savanna biome extent from Hengl et al. (2018) shows good agreement with the simulated global extent of TrBS. In the Caatinga region, our model simulates a predominance of C₄ grass cover (see Fig. 2, main manuscript), which does not accurately reflect the region’s characteristic vegetation. Similarly, the savanna classification observed in Hengl et al. (2018) also misrepresents the Caatinga, which is more accurately described as a seasonal dry tropical forest (de Queiroz et al 2017).

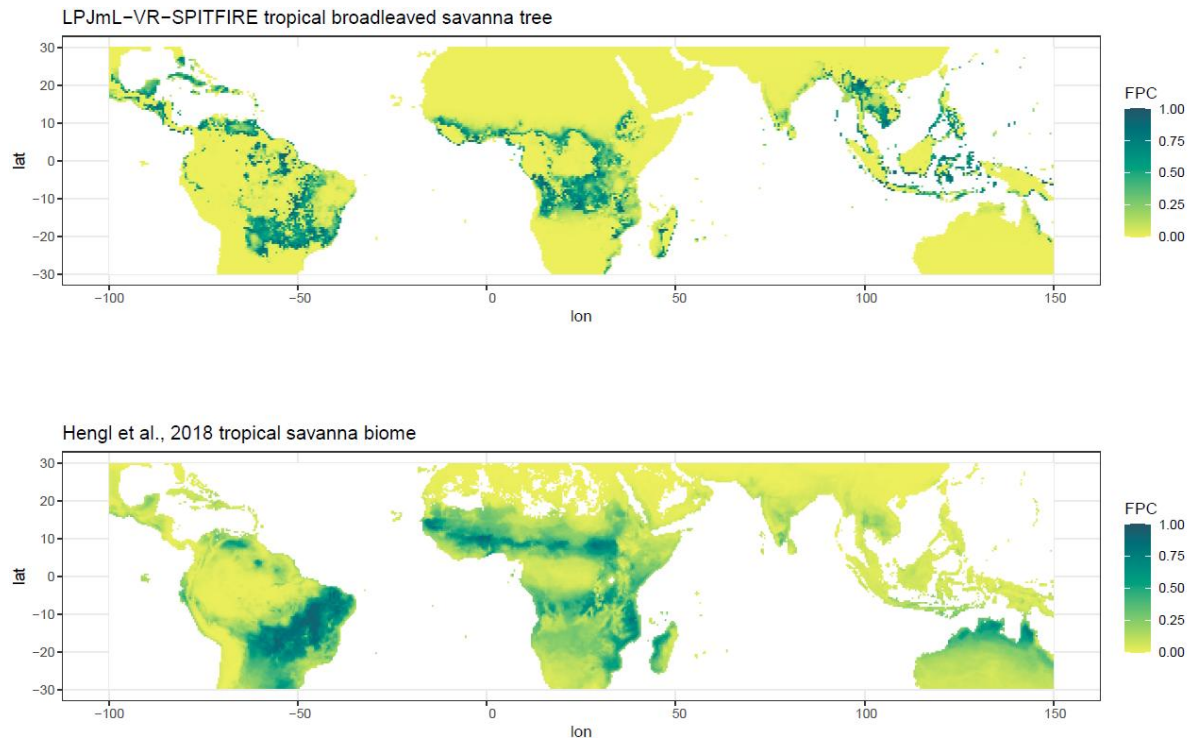


Fig S8: Comparison of the foliage projective cover (FPC) of the new Tropical Broadleaved Savanna tree PFT (TrBS) from a LPJmL-VR-SPITFIRE global simulation with the estimated biome distribution of tropical savannas from Hengl et al. (2018).

2.4 Validation of Gross Primary Production (GPP) and evapotranspiration (ET)

We compared the mean annual sum of GPP and ET of both model versions ('no savanna' and 'savanna') with the respective validation data sets (Fig. S9). Both models show good performance relative to the reference data for GPP ($NME < 1$), with the savanna model having a marginally lower error compared to the 'no savanna' model (Table S3). For ET, deviations from the validation dataset are large for both models, with the 'no savanna' simulation run having a slightly better performance ($NME = 1.56$) compared to the savanna run ($NME = 1.89$) (Table S3).

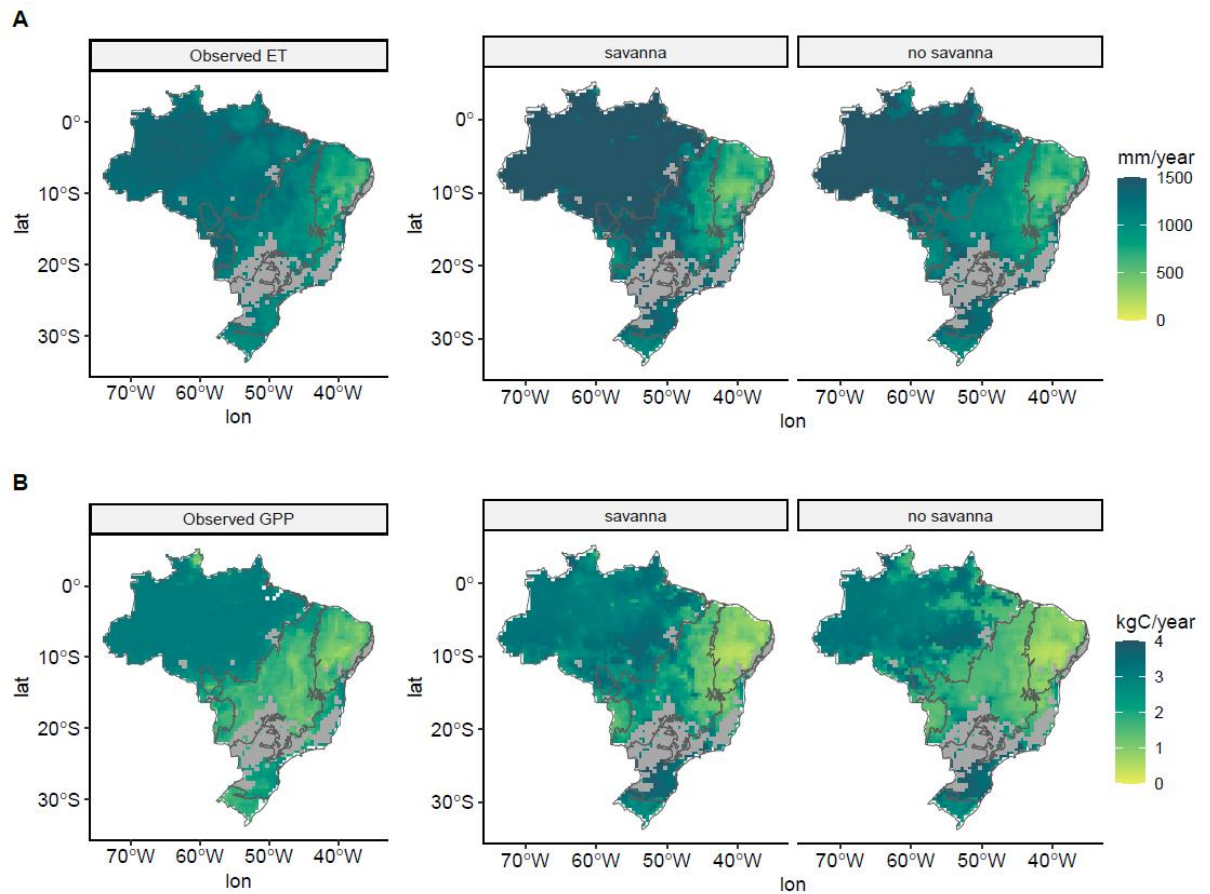


Fig S9: A) Comparison of the mean annual sum of evapotranspiration (years 1990-2019) of the model versions (right panel) with data from ERA-Interim-Land (Balsamo et al., 2015; see also Sakschewski et al., 2021). B) Comparison of the mean annual sum of GPP (years 1990-2019) of the model versions (right panel) with data from Carvalhais et al., 2014. Grid cells where the human land use fraction according to MapBiomas (Fig. S5) was $\geq 75\%$ are masked in gray and should be excluded from the comparison, as we simulated PNV (potential natural vegetation) only.

Table S3: Normalized mean error (NME) and Pearson correlation (R^2 and p-value) calculated for modelled evapotranspiration (ET) and gross primary production (GPP) for Brazil, excluding cells with $\geq 75\%$ human land use fraction according to MapBiomas (Fig. S5).

Variable	Statistic	‘no savanna’	‘savanna’
ET	NME	1.56	1.89
	R ²	0.620	0.691
	p-value	< 0.001	< 0.001
GPP	NME	0.714	0.686
	R ²	0.512	0.525
	p-value	< 0.001	< 0.001

3. Supplemental references

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