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Recent trends and drivers of regional sources and sinks of carbon dioxide

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Figure S1. Box plot of Global NBP from S_L2 for the individual DGVMs and the ensemble mean.

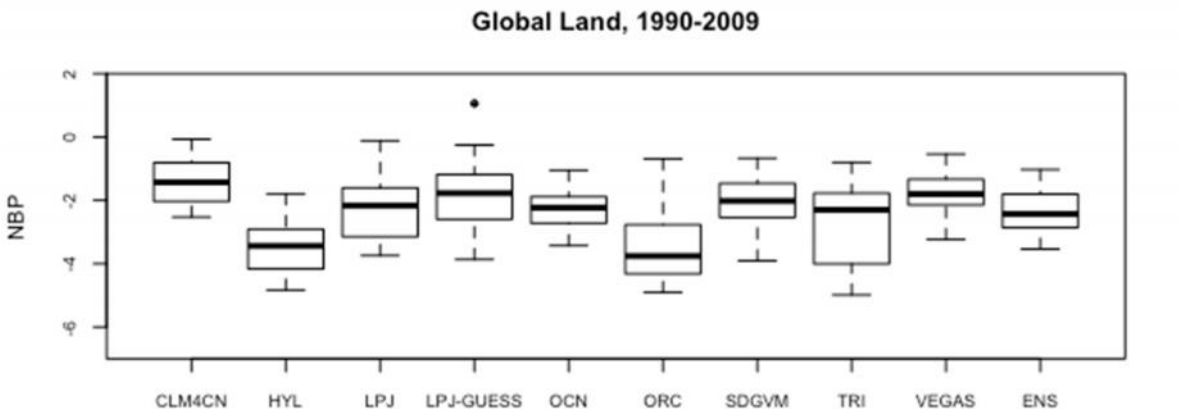

Figure S2. NBP trends compared against (a) NPP trends (b) RH trends

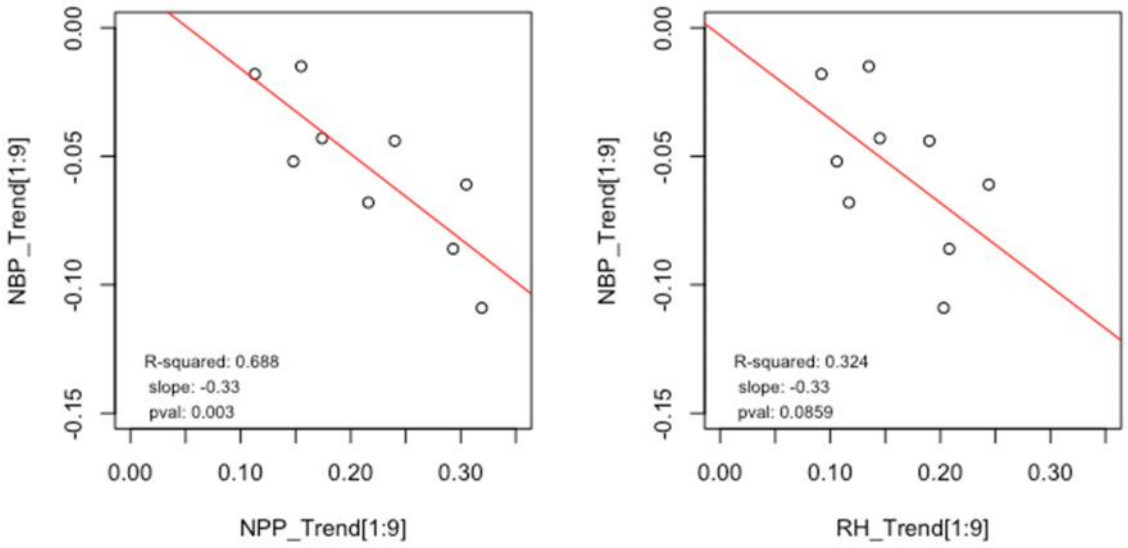

Figure S3. Trend in ensemble DGVM Mean Residence Time (MRT) calculated calculated as CSoil / RH.

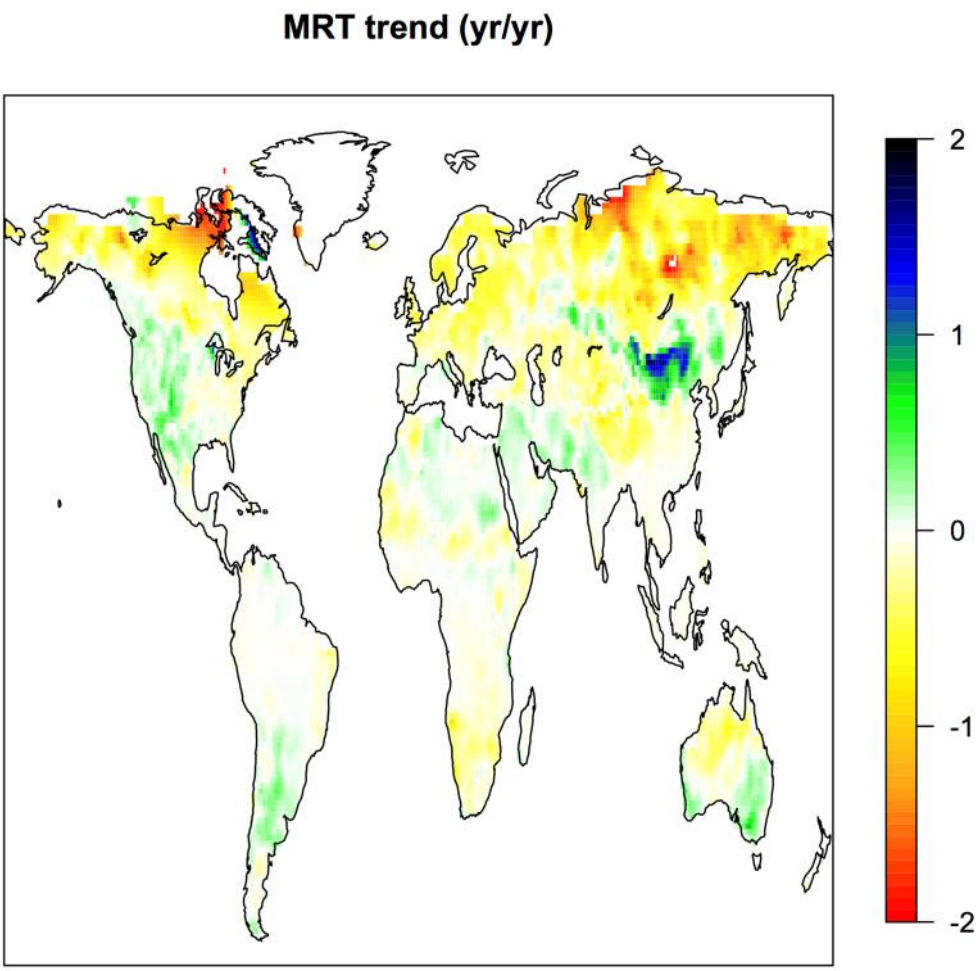

Figure S4. Box plot of regional NBP from S_L2 for the individual DGVMs and the ensemble mean.

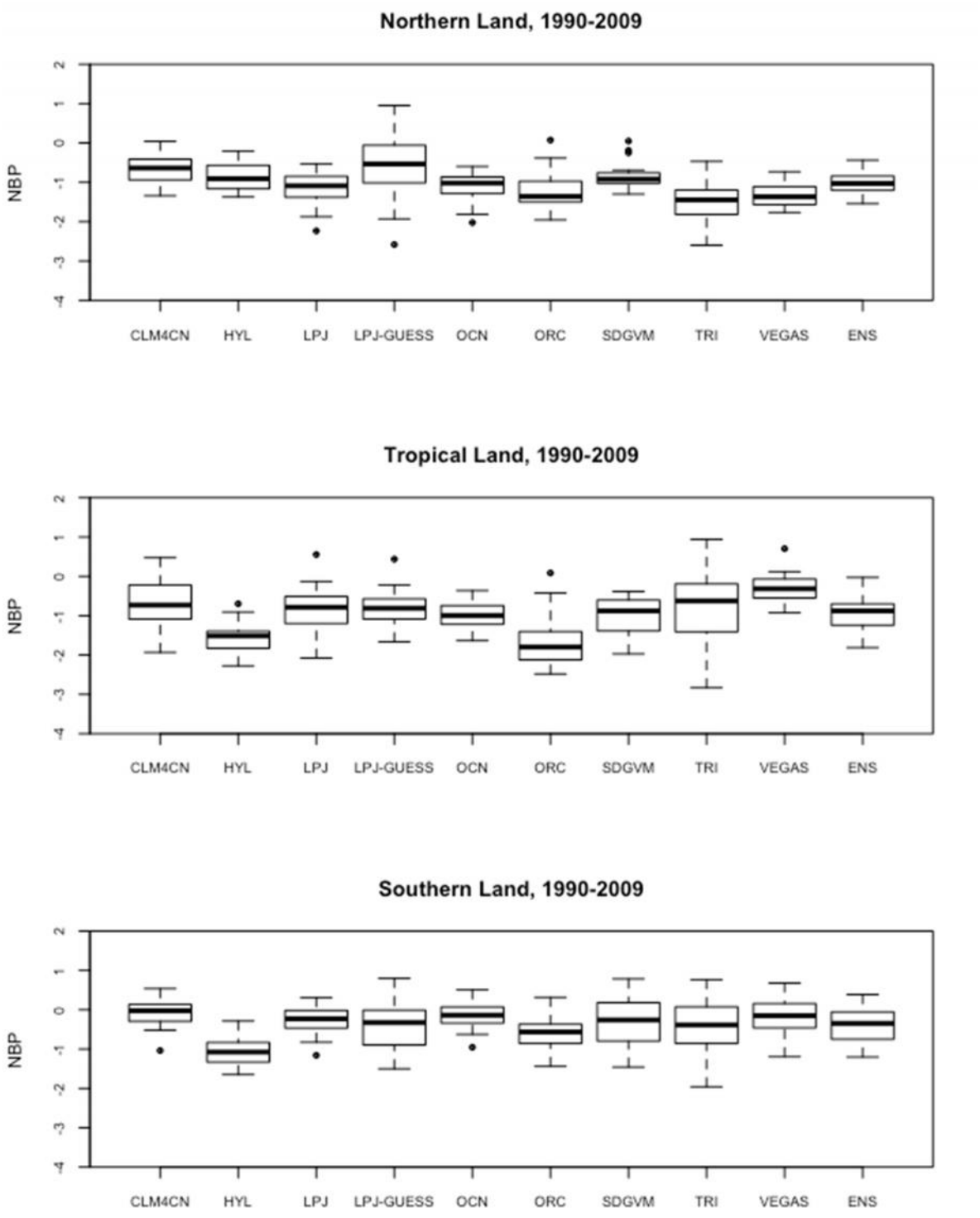

Figure S5. Ensemble DGVM NBP trends S_L2

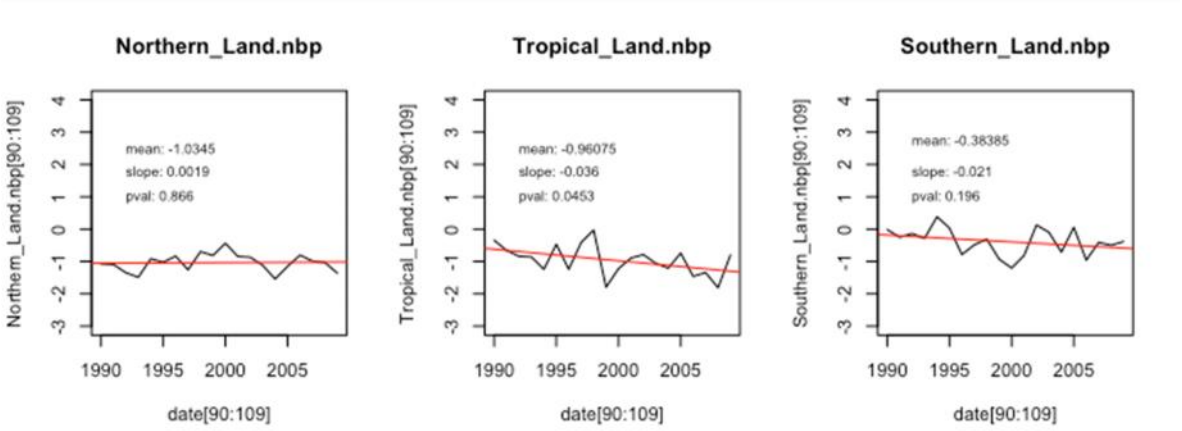

Table S1: Generic DGVM process descriptions

	CLM4-CN	HYLAND (HYL)	LPJ	LPJ-GUESS	TRIFFID (TRI)
Shortest time step	0.5 h	1d	1d	1d	1/2h
Physiology					
Photosynthesis	Farquhar et al. (1980)/Collatz et al. (1991, 1992)	Farquhar et al. (1980)	Farquhar et al. (1980)/Collatz et al. (1992)	Farquhar et al. (1980)/Collatz et al. (1992), Haxeltine & Prentice (1996)	Collatz et al. (1991)/ Collatz et al (1992)
Stomatal conductance	Ball et al. (1987)	Jarvis (1976)/Stewart (1998)	Haxeltine & Prentice (1996)	Haxeltine & Prentice (1996)	Cox et al. (1998)
Canopy scaling	N_{leaf} distribution with sunlit and shaded leaves	Optimum N_{leaf} distribution	Optimum N_{leaf} distribution	Optimum N_{leaf} distribution	Optimum N_{leaf} distribution. Sellers et al. 1992
Sapwood respiration	Dependent on temperature, sapwood mass and C:N ratio	f(Assimilation) Gifford (1995)	Dependent on sapwood mass and C:N ratio (Lloyd & Taylor 1994)	Dependent on sapwood mass and C:N ratio (Lloyd & Taylor 1994)	Pipe model to diagnose sapwood volume, then Q_{10} relationship
Fine root respiration	Dependent on temperature, root mass and C:N ratio	f(Assimilation)	f(T,C_{root})	f(T,C_{root})	f(T,N_{root})
Evapotranspiration	Transpiration, interception loss, soil evaporation and snow sublimation are computed from energy balance	Penman-Monteith transpiration (Monteith & Unsworth 1990)	Total evapotranspiration (Monteith 1995)	Transpiration, interception loss and evaporation (Monteith 1995)	Penman-Monteith transpiration (Monteith 1981) + interception (Fixed fraction)
Water balance	1 canopy water pool, snow (frozen and liquid pools for 5 layers), soil water (frozen and liquid pools for 10 layers), 1 groundwater pool	1 soil layer Bucket model (dynamic water holding capacity)	2 soil layers Modified bucket model from Neilson (1993) Surface runoff+drainage Snowpack	2 soil layers Leaking bucket model. Surface runoff+drainage Snowpack Gerten (2004)	4 soil layer Darcy's law
Canopy temperature	Diagnosed from energy balance	Canopy energy balance (Friend 1995)	n/a	n/a	Diagnosed from Energy balance
Aerodynamics	Log-wind profile	n/a	n/a	n/a	Neutral transfer coefficients using z_0 proportional to height
Radiation	Two-stream approximation	Beer's Law (applied to PFTs)	Beer's Law (applied to vegetation fraction)	Beer's Law, light attenuation through multiple canopy layers	Beer's Law (applied to vegetation fractions)
Ecosystem structure				Mixed PFTs within patches with age/size classes distinguished for trees and shrubs, herbaceous understory	

Phenology					
Cold deciduous	GDD requirement and daylength	n/a	GDD requirement Temperature threshold	GDD requirement Temperature threshold	Temperature sum with threshold
Dry deciduous	Soil moisture threshold	n/a	Soil moisture threshold	Water deficit stress threshold	n/a
Grass	Temperature and soil moisture	n/a	Soil moisture and carbon balance threshold	Water deficit stress and carbon balance threshold	n/a
Litter fall	Every model timestep (0.5 hour)	Daily litter carbon balance	Annual litter carbon balance	Annual litter carbon balance	Monthly litter
Decomposition	Thornton and Rosenbloom (2005)	CENTURY (Parton et al. 1993), modified by Comins & McMurtrie (1993)	$f(T,\theta_{top}$,tissue type)	$f(T,\theta_{top})$	$f(T,\theta,C_{soil})$ McGuire et al. (1992)
	CLM4-CN	HYLAND (HYL)	LPJ	LPJ-GUESS	TRIFFID (TRI)
C allocation	Allometric relationships	Allometric relationships	Annual allometric relationship for individuals	Annual allometric relationship for individuals	Partitioning into ‘spreading’ and ‘growth’ based on LAI leaf:root:wood partitioning from allometric relationships
N uptake	Based on soil N pool and plant requirement	n/a	n/a	n/a	n/a
N allocation	N uptake to meet fixed C:N and constrained by soil N	Fixed C:N	Implicit, dependent on demand	Implicit, dependent on demand	Fixed C:N
Interactive N-Cycle	Yes			n/a	
Pfts					
Trees Evergreen	Tropical broadleaf Temperate broadleaf Temperate needleleaf Boreal needleleaf	Broadleaf evergreen Needleleaf evergreen	Tropical evergreen Temperate broadleaf evergreen Temperate needleleaf evergreen Boreal needleleaf evergreen	Boreal evergreen shade tolerant needle-leaved Boreal evergreen shade intolerant needle-leaved Temperate evergreen shade tolerant broad-leaved Tropical evergreen shade tolerant broad-leaved Tropical evergreen shade intolerant broad-leaved	Broadleaf Needleleaf

Deciduous	Tropical broadleaf Temperate broadleaf Boreal broadleaf Boreal needleleaf		Tropical raingreen Temperate summergreen Boreal summergreen	Boreal summergreen shade intolerant needle-leaved Temperate summergreen shade tolerant broad-leaved Temperate summergreen shade intolerant broad-leaved Tropical raingreen shade intolerant broad-leaved	
Shrubs	Temperate evergreen Temperate deciduous Boreal deciduous	n/a	n/a	n/a	Shrubs
Grasses/forbs	C3 herbaceous C4 herbaceous	C3 herbaceous	C3 herbaceous C4 herbaceous	C3 herbaceous C4 herbaceous	C3 herbaceous C4 herbaceous
Vegetation dynamics					
Competition	Competition among PFTs for water and nitrogen	Competition between PFTs for light	Nonhomogeneous area-based competition for light (1-layer), H_2O (2 layers)	Individual-based competition for light (multiple-layers), H_2O (2 layers)	Lokta-Volterra in fractional cover
Establishment	Minimum 'seed' fraction	All PFTs establish uniformly as small individuals	Climatically favoured PFTs establish in proportion to area available, as small individuals	Climatically favoured PFTs establish stochastically as small individuals in proportion to past NPP and a fixed background rate.	Minimum 'seed' fraction for all PFTs
Mortality	Prescribed turnover and gap disturbance rate; fire	Dependent on carbon pools	Deterministic baseline self-thinning carbon balance Fire Extreme temperatures	PFT longevity, PFT growth efficiency, high temperature stress, fire, extreme temperatures and stochastic disturbance	Prescribed disturbance rate for each PFT

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	O-CN (OCN)	ORCHIDEE (ORC)	SDGVM (SHE)	VEGAS
Shortest time step	0.5h	0.5h	1d	1 d
Physiology				
Photosynthesis	Farquhar et al. (1980)/Collatz et al. (1992)/Friend & Kiang (2005)	Farquhar et al. (1980)/Collatz et al. (1992)	Farquhar et al. (1980)/Collatz et al. (1992)	Jarvis with modified Collatz (1992) colimiting function
Stomatal conductance	Friend & Kiang (2005)	Ball et al. (1987)	Leuning (1995)	Tie
Canopy scaling	Empirical Nleaf scaling with sunlit and shaded leaves;Nleaf simulated dynamically (Zaehle& Friend, 2010)	Optimum N_{leaf} distribution	Optimum N_{leaf} distribution	Exponential function of LAI (Sellers 1991)
Sapwood respiration	Dependent on sapwood mass and C:N ratio (Lloyd & Taylor 1994), capped by labile C availability (Zaehle& Friend 2010)	Dependent on temperature, sapwood mass and C:N ratio	Annual sapwood increment, C:N f(T)	Sapwood mass and temperature
Fine root respiration	$f(T,N_{root,})$	$f(T,C_{root})$	$f(T,C_{root})$	Fine root carbon and temperature
Evapotranspiration	Transpiration, interception loss, bare ground evaporation and snow sublimation are computed using Monteith-type formulations (Ducoudré et al., 1993)	Transpiration, interception loss, bare ground evaporation and snow sublimation are computed using Monteith-type formulations(Ducoudré et al., 1993)	Penman-Monteith transpiration (Monteith 1981) + interception + evaporation from soil surface	Transpiration, interception loss, bare soil evaporation. Bulk transfer formulae. Zeng et al. (2000)
Water balance	2 soil layers (deep bucket layer and upper layer of variable depth) Surface runoff+drainage Snowpack	2 soil layers (deep bucket layer and upper layer of variable depth) Surface runoff+drainage Snowpack	3 soil + 1 litter layer Modif. Bucket model Drainage Snowpack	2 soil layers with full evapotraspiration, surface and subsurface runoff
Canopy temperature	n.a.	n/a	n/a	n/a
Aerodynamics	Log-wind profile	Log-wind profile	Log-wind profile	
Radiation	Two stream approximation (Spitters et	Beer's Law (applied to vegetation fractions)	Beer's Law (applied to total vegetation)	Beer's Law

	al. 1986a,b)			
Ecosystem structure	LPJ type	Fixed cover fractions		Dynamic fraction based on competition
Phenology	Botta et al. 2000; Zaehle& Friend 2010	Botta et al., 2000		Dynamically determined based on temperature limitation, cold stress
Cold deciduous	GDD requirement Temperature threshold	GDD requirement Temperature threshold	Temperature threshold	Temperature, cold stress
Dry deciduous	Soil moisture threshold	Soil moisture threshold	Soil moisture threshold	
Grass	Dependent on climate zone. Botta et al., 2000	Dependent on climate zone. Botta et al., 2000	Growth threshold	Compete with trees by height and growth strategy. C3 and C4
Litter fall			Monthly litter carbon balance	Two pools: metabolic and structural
Decomposition	Based on Parton et al.(1993)	Based on Parton et al.(1988)	Similar to CENTURY (Parton et al. 1993)	Decomposer pool
	O-CN	ORCHIDEE (ORC)	SDGVM (SHE)	VEGAS
C allocation	Daily allocation based on allometric relationships (Zaehle& Friend 2010)	Based on resource optimization (Friedlingstein et al., 1998)	Daily allocation by demand in order of priority LAI>roots > wood	Allocation priority by order leaf, root, wood but with smooth transition
N uptake	f(Croot, Nsoil, T, C:Nplant)	n/a	Based on soil C and N decomposition also dependent on soil T and moisture	n/a
N allocation	Prognostic leaf C:N, C:N of root and sapwood fixed fraction of leaf C:N	n/a	Variable N with light	n/a
Interactive N-Cycle	Yes			n/a
Pfts				5
Trees Evergreen	Tropical broadleaf evergreen Temperate broadleaf evergreen Temperate needleleaf evergreen	Tropical broadleaf evergreen Temperate broadleaf evergreen Temperate needleleaf evergreen	Broadleaf evergreen Needleleaf evergreen	Whether evergreen or deciduous is dynamically determined, not prescribed. Both broadleaf and needleleaf can be

	Boreal needleleaf evergreen	Boreal needleleaf evergreen		evergreen
Deciduous	Tropical broadleaf raingreen Temperate broadleaf summergreen Boreal broadleaf summergreen Boreal needleleaf summergreen	Tropical broadleaf raingreen Temperate broadleaf summergreen Boreal broadleaf summergreen Boreal needleleaf summergreen	Broadleaf deciduous Needleleaf deciduous	Dynamically determined
Shrubs	n/a	n/a	Shrubs	n/a
Grasses/forbs	C3 herbaceous C4 herbaceous	C3 herbaceous C4 herbaceous	C3 herbaceous C4 herbaceous	C3 herbaceous C4 herbaceous
Vegetation dynamics	Fixed cover fraction, hence no between PFT competition, but within PFT dynamics through establishment and mortality			Full competition based on biomass increment and vegetation height
Competition	Nonhomogeneous area-based competition for light (1-layer), H_2O (2 layers), soil N (1 layer)	Nonhomogeneous area-based competition for light (1-layer), H_2O (2 layers)	Nonhomogeneous area-based competition for light (1-layer), H_2O (3 layers)	Full competition based on biomass increment and vegetation height (light)
Establishment	Establishment according to LPJ criteria (but no dynamics across PFTs)	Climatically favoured PFTs establish in proportion to area available, as small individuals	Climatically favoured PFTs establish in proportion to area available, as small individuals	Seeds assumed always available. Compete according to growth
Mortality	Carbon balance, Self-thinning.	Deterministic baseline self-thinning carbon balance Fire Extreme temperatures	Carbon balance, Age Wind throw Fire Extreme temperatures	Carbon balance Cold and drought stress Fire
Land Use and Land Cover Description	Hurtt et al. 2011, updated annually			Hurtt et al. harmonized

Table S2. Mean and Trends in NPP, RH, NBP as simulated by individual DGVMs and the Ensemble mean (S_L1), CO_2 only

MODEL	NPP (PgC/yr)	Trend (PgC/yr2)	P-value	RH (PgC/yr)	Trend (PgC/yr2)	P-value	NBP (PgC/yr)	Trend (PgC/yr2)	P-value
Global_Land									
CLM4CN	50.778	0.083	0.003	47.035	0.058	0.000	-1.463	-0.029	0.312
HYLAND	73.030	0.217	0.000	68.639	0.162	0.000	-3.300	-0.050	0.000
LPJ	59.226	0.177	0.000	45.769	0.108	0.000	-3.258	-0.034	0.000
LPJ-GUESS	62.522	0.220	0.000	54.641	0.095	0.000	-2.642	-0.131	0.002
OCN	53.275	0.174	0.000	49.637	0.120	0.000	-2.624	-0.047	0.013
ORCHIDEE	77.107	0.319	0.000	72.355	0.199	0.000	-4.753	-0.119	0.000
SDGVM	60.226	0.200	0.000	53.100	0.123	0.000	-2.253	-0.065	0.017
TRIFFID	72.110	0.250	0.000	68.406	0.189	0.000	-3.704	-0.061	0.000
VEGAS	56.802	0.046	0.000	51.685	0.036	0.000	-1.873	-0.009	0.000
ENSEMBLE	**62.786**	**0.187**	**0.000**	**56.807**	**0.121**	**0.000**	**-2.875**	**-0.061**	**0.000**
Std	**9.265**	**0.083**		**10.184**	**0.055**		**1.003**	**0.040**	
Northern_Land									
CLM4CN	16.962	0.027	0.208	15.732	0.023	0.010	-0.607	-0.003	0.896
HYLAND	18.269	0.066	0.000	16.827	0.051	0.000	-0.800	-0.012	0.000
LPJ	23.131	0.071	0.000	17.726	0.033	0.000	-1.641	-0.018	0.000
LPJ-GUESS	28.056	0.098	0.000	24.853	0.036	0.040	-1.134	-0.064	0.001
OCN	20.010	0.072	0.004	18.359	0.045	0.000	-1.060	-0.023	0.199
ORCHIDEE	30.499	0.123	0.000	28.549	0.081	0.000	-1.949	-0.042	0.001
SDGVM	24.309	0.058	0.001	21.748	0.031	0.011	-0.856	-0.025	0.022
TRIFFID	27.563	0.081	0.000	25.961	0.054	0.000	-1.602	-0.027	0.000
VEGAS	20.508	0.011	0.000	18.076	0.007	0.000	-1.004	-0.003	0.000
ENSEMBLE	**23.256**	**0.067**	**0.000**	**20.870**	**0.040**	**0.000**	**-1.184**	**-0.024**	**0.000**
Std	**4.714**	**0.034**		**4.586**	**0.021**		**0.448**	**0.019**	
Tropical_Land									
CLM4CN	26.326	0.051	0.000	24.427	0.031	0.001	-0.726	-0.025	0.025
HYLAND	35.020	0.093	0.000	33.225	0.067	0.000	-1.552	-0.024	0.000
LPJ	26.840	0.080	0.000	21.339	0.060	0.000	-1.196	-0.011	0.000
LPJ-GUESS	22.494	0.092	0.000	19.660	0.053	0.000	-1.098	-0.040	0.002
OCN	23.193	0.077	0.000	21.576	0.061	0.000	-1.327	-0.014	0.105
ORCHIDEE	32.536	0.141	0.000	30.444	0.083	0.000	-2.092	-0.058	0.002
SDGVM	23.713	0.094	0.000	20.958	0.062	0.000	-1.059	-0.024	0.028
TRIFFID	30.980	0.114	0.000	29.596	0.092	0.000	-1.385	-0.022	0.000
VEGAS	24.131	0.028	0.000	22.421	0.021	0.000	-0.591	-0.006	0.000
ENSEMBLE	**27.248**	**0.085**	**0.000**	**24.850**	**0.059**	**0.000**	**-1.225**	**-0.025**	**0.000**
Std	**4.536**	**0.033**		**4.939**	**0.022**		**0.446**	**0.016**	
Southern_Land									
CLM4CN	7.521	0.005	0.574	6.904	0.004	0.339	-0.130	-0.001	0.945
HYLAND	19.826	0.058	0.000	18.664	0.044	0.000	-0.953	-0.014	0.000
LPJ	9.284	0.026	0.000	6.725	0.015	0.000	-0.424	-0.005	0.000
LPJ-GUESS	11.995	0.030	0.087	10.147	0.007	0.266	-0.411	-0.027	0.195
OCN	10.110	0.025	0.101	9.738	0.015	0.013	-0.239	-0.010	0.433
ORCHIDEE	14.092	0.055	0.002	13.379	0.036	0.000	-0.712	-0.019	0.111
SDGVM	12.245	0.047	0.033	10.429	0.030	0.000	-0.340	-0.016	0.490
TRIFFID	13.615	0.055	0.000	12.896	0.043	0.000	-0.719	-0.012	0.000
VEGAS	12.194	0.008	0.000	11.217	0.007	0.000	-0.278	-0.001	0.651
ENSEMBLE	**12.320**	**0.034**	**0.000**	**11.122**	**0.022**	**0.000**	**-0.467**	**-0.012**	**0.033**
Std	**3.507**	**0.021**		**3.633**	**0.016**		**0.270**	**0.009**	

Table S3. Mean and Trends in NPP, RH, NBP as simulated by individual DGVMs and the Ensemble mean (S_L2 – S_L1), Climate Effect

MODEL	NPP (PgC/yr)	Trend (PgC/yr2)	P-value	RH (PgC/yr)	Trend (PgC/yr2)	P-value	NBP (PgC/yr)	Trend (PgC/yr2)	P-value
Global_Land									
CLM4CN	0.730	0.066	0.031	0.633	0.048	0.029	0.004	-0.022	0.459
HYLAND	0.392	0.102	0.000	0.197	0.041	0.196	-0.166	-0.059	0.019
LPJ	0.080	0.039	0.296	1.843	0.009	0.743	1.008	-0.034	0.337
LPJ-GUESS	-0.015	-0.045	0.187	0.807	0.050	0.178	0.840	0.088	0.113
OCN	0.666	-0.019	0.601	0.974	0.015	0.549	0.352	0.033	0.304
ORCHIDEE	-1.591	-0.026	0.381	-0.318	0.008	0.732	1.274	0.034	0.276
SDGVM	0.739	0.040	0.429	0.679	0.067	0.022	0.126	0.021	0.612
TRIFFID	-0.181	0.055	0.277	0.761	0.056	0.138	0.942	0.000	0.995
VEGAS	0.506	0.067	0.080	0.245	0.056	0.002	0.090	-0.009	0.772
ENSEMBLE	**0.147**	**0.031**	**0.231**	**0.647**	**0.039**	**0.090**	**0.497**	**0.006**	**0.817**
Std	**0.734**	**0.050**		**0.599**	**0.022**		**0.523**	**0.044**	
Northern_Land									
CLM4CN	0.561	0.016	0.594	0.483	0.013	0.247	-0.063	-0.004	0.916
HYLAND	0.870	0.032	0.010	0.764	0.029	0.088	-0.075	-0.002	0.905
LPJ	1.435	0.008	0.702	1.852	0.028	0.174	0.472	0.012	0.521
LPJ-GUESS	0.428	-0.059	0.022	1.030	0.032	0.292	0.501	0.087	0.030
OCN	0.999	-0.028	0.359	0.905	0.003	0.880	-0.057	0.030	0.177
ORCHIDEE	-0.161	-0.054	0.105	0.563	-0.017	0.412	0.724	0.036	0.086
SDGVM	0.835	0.004	0.864	0.850	0.034	0.157	0.028	0.030	0.141
TRIFFID	0.912	0.007	0.821	1.045	0.049	0.066	0.133	0.043	0.054
VEGAS	1.387	0.037	0.046	0.839	0.036	0.004	-0.318	0.003	0.772
ENSEMBLE	**0.807**	**-0.004**	**0.815**	**0.926**	**0.023**	**0.160**	**0.149**	**0.026**	**0.044**
Std	**0.491**	**0.035**		**0.395**	**0.020**		**0.341**	**0.029**	
Tropical_Land									
CLM4CN	0.074	0.040	0.087	0.037	0.028	0.046	0.035	-0.014	0.577
HYLAND	-0.531	0.020	0.008	-0.530	-0.001	0.963	-0.008	-0.020	0.104
LPJ	-1.010	0.020	0.437	-0.115	-0.025	0.010	0.379	-0.038	0.088
LPJ-GUESS	-0.572	-0.014	0.412	-0.328	-0.002	0.863	0.312	0.004	0.831
OCN	-0.443	0.008	0.684	-0.100	0.004	0.570	0.345	-0.003	0.862
ORCHIDEE	-1.223	0.011	0.618	-0.805	0.025	0.019	0.419	0.014	0.459
SDGVM	-0.208	0.024	0.313	-0.281	0.013	0.312	0.075	-0.014	0.474
TRIFFID	-1.179	0.027	0.356	-0.670	0.004	0.742	0.509	-0.023	0.526
VEGAS	-0.659	0.013	0.523	-0.427	0.012	0.269	0.313	-0.004	0.777
ENSEMBLE	**-0.639**	**0.016**	**0.334**	**-0.358**	**0.006**	**0.304**	**0.264**	**-0.011**	**0.532**
Std	**0.436**	**0.015**		**0.278**	**0.016**		**0.184**	**0.016**	
Southern_Land									
CLM4CN	0.096	0.010	0.441	0.113	0.007	0.334	0.032	-0.004	0.821
HYLAND	0.048	0.051	0.002	-0.040	0.013	0.277	-0.082	-0.037	0.001
LPJ	-0.344	0.011	0.584	0.107	0.005	0.392	0.157	-0.008	0.565
LPJ-GUESS	0.129	0.028	0.283	0.107	0.020	0.019	0.026	-0.003	0.912
OCN	0.112	0.002	0.938	0.170	0.008	0.472	0.065	0.006	0.742
ORCHIDEE	-0.207	0.018	0.487	-0.076	0.001	0.915	0.131	-0.017	0.385
SDGVM	0.113	0.012	0.726	0.110	0.020	0.046	0.023	0.005	0.881
TRIFFID	0.093	0.022	0.476	0.395	0.003	0.750	0.302	-0.020	0.492
VEGAS	-0.223	0.016	0.548	-0.168	0.009	0.385	0.096	-0.008	0.685
ENSEMBLE	**-0.020**	**0.019**	**0.342**	**0.080**	**0.010**	**0.179**	**0.083**	**-0.010**	**0.562**
Std	**0.184**	**0.014**		**0.162**	**0.007**		**0.108**	**0.013**	

Table S4 Ensemble DGVM regional NBP mean and trend over the period, 1990 – 2009. Grey area denotes significant trend at the 95% confidence level. Units are given in both PgC/yr and gC/m2/yr

Region	Mean NBP (PgC/yr)	Std	Trend (PgC/yr2)	Std	P-Value
Global Land	**-2.378**	**0.721**	**-0.055**	**0.030**	**0.048**
Northern Land	**-1.034**	**0.295**	**0.002**	**0.012**	**0.865**
North America	-0.402	0.133	-0.001	0.005	0.833
Europe	-0.179	0.092	-0.000	0.003	0.984
North Asia	-0.454	0.110	0.003	0.009	0.578
Boreal North America	-0.209	0.101	-0.003	0.005	0.183
Temperate North America	-0.193	0.077	0.002	0.005	0.762
Boreal Asia	-0.215	0.081	-0.003	0.004	0.436
Temperate Asia	-0.239	0.096	0.006	0.009	0.267
Tundra	-0.128	0.117	-0.003	0.005	0.073
Tropical Land	**-0.961**	**0.428**	**-0.036**	**0.013**	**0.045**
Tropical South America Forest	-0.472	0.211	-0.013	0.007	0.234
North African Savanna	-0.071	0.057	0.001	0.004	0.884
Equatorial Africa	-0.173	0.138	-0.008	0.006	0.047
Tropical Asia	-0.245	0.072	-0.016	0.007	0.000
Southern Land	**-0.384**	**0.285**	**-0.021**	**0.017**	**0.196**
South America Savanna	-0.101	0.065	-0.001	0.003	0.804
Temperate South America	-0.054	0.039	0.005	0.005	0.052
Southern Africa	-0.159	0.122	-0.022	0.011	0.010
Australia & New Zealand	-0.070	0.078	-0.003	0.004	0.685

Region	Mean NBP (gC/m2/yr)	Std	Trend (gC/m2/yr2)	Std	P-Value
Global Land	**-15.82**	**4.80**	**-0.37**	**0.20**	**0.048**
Northern Land	**-14.14**	**4.03**	**0.03**	**0.16**	**0.865**
North America	-17.58	5.83	-0.05	0.21	0.833
Europe	-16.55	8.54	-0.01	0.27	0.984
North Asia	-11.49	2.78	0.08	0.23	0.578
Boreal North America	-14.65	7.06	-0.20	0.35	0.183
Temperate North America	-22.54	9.02	0.19	0.59	0.762
Boreal Asia	-14.39	5.45	-0.17	0.24	0.436
Temperate Asia	-9.73	3.89	0.23	0.37	0.267
Tundra	-10.92	10.00	-0.24	0.42	0.073
Tropical Land	**-23.79**	**10.60**	**-0.88**	**0.33**	**0.045**
Tropical South America Forest	-38.92	17.38	-1.04	0.57	0.234
North African Savanna	-4.72	3.80	0.04	0.28	0.884
Equatorial Africa	-25.78	20.57	-1.19	0.85	0.047
Tropical Asia	-37.75	11.16	-2.42	1.07	0.0003
Southern Land	**-10.44**	**7.73**	**-0.58**	**0.45**	**0.196**
South America Savanna	-23.61	15.09	-0.30	0.71	0.804
Temperate South America	-14.92	10.84	1.47	1.29	0.052
Southern Africa	-20.33	15.70	-2.80	1.43	0.010
Australia & New Zealand	-8.65	9.61	-0.42	0.50	0.685

Table S5 Ensemble DGVM regional NPP mean and trend over the period, 1990 – 2009. Grey area denotes significant trend at the 95% confidence level. Units are given in both PgC/yr and gC/m2/yr

Region	Mean NPP (PgC/yr)	Std	Trend (PgC/yr2)	Std	P-Value
Global Land	**62.934**	**8.729**	**0.218**	**0.076**	**0.000**
Northern Land	**24.064**	**4.484**	**0.063**	**0.022**	**0.001**
North America	7.779	1.375	0.021	0.008	0.023
Europe	5.082	1.404	0.018	0.006	0.002
North Asia	11.203	1.993	0.024	0.015	0.008
Boreal North America	3.566	1.209	0.014	0.007	0.024
Temperate North America	4.224	0.834	0.007	0.005	0.264
Boreal Asia	4.121	1.456	0.018	0.006	0.012
Temperate Asia	7.086	1.030	0.006	0.014	0.378
Tundra	2.098	1.294	0.013	0.009	0.002
Tropical Land	**26.609**	**4.350**	**0.102**	**0.034**	**0.000**
Tropical South America forest	12.041	2.050	0.038	0.015	0.002
North African Savanna	2.807	0.672	0.009	0.008	0.073
Equatorial Africa	5.552	1.428	0.024	0.010	0.000
Tropical Asia	6.209	0.979	0.031	0.011	0.000
Southern Land	**12.300**	**3.528**	**0.053**	**0.031**	**0.011**
South America Savanna	4.045	1.157	0.004	0.006	0.524
Temperate South America	1.419	0.478	-0.004	0.005	0.264
Southern Africa	4.669	1.489	0.041	0.018	0.000
Australia & New Zealand	2.167	0.792	0.012	0.010	0.216

Region	Mean NPP (gC/m2/yr)	Std	Trend (gC/m2/yr2)	Std	P-Value
Global Land	**418.59**	**58.06**	**1.45**	**0.50**	**0.000**
Northern Land	**328.86**	**61.28**	**0.87**	**0.29**	**0.001**
North America	340.45	60.19	0.93	0.33	0.023
Europe	470.23	129.88	1.68	0.59	0.002
North Asia	283.49	50.44	0.61	0.38	0.008
Boreal North America	249.32	84.53	1.01	0.49	0.024
Temperate North America	494.28	97.63	0.80	0.59	0.264
Boreal Asia	276.10	97.53	1.19	0.41	0.012
Temperate Asia	288.13	41.88	0.26	0.58	0.378
Tundra	179.03	110.37	1.11	0.76	0.002
Tropical Land	**659.04**	**107.75**	**2.52**	**0.83**	**0.000**
Tropical South America forest	993.19	169.12	3.12	1.24	0.002
North African Savanna	186.45	44.65	0.60	0.55	0.073
Equatorial Africa	827.27	212.74	3.51	1.55	0.000
Tropical Asia	957.53	150.98	4.84	1.77	0.000
Southern Land	**334.26**	**95.87**	**1.44**	**0.83**	**0.011**
South America Savanna	941.12	269.06	0.94	1.38	0.524
Temperate South America	394.72	132.88	-1.25	1.28	0.264
Southern Africa	598.40	190.88	5.30	2.27	0.000
Australia & New Zealand	266.74	97.45	1.51	1.26	0.216

Table S6 Ensemble DGVM regional RH mean and trend over the period, 1990 – 2009. Grey area denotes significant trend at the 95% confidence level. RH includes Rh term, i.e. does not represents other C loss terms, wildfire, DOC, Harvest. Units are given in both PgC/yr and gC/m2/yr.

Region	Mean RH (PgC/yr)	Std	Trend (PgC/yr2)	Std	P-Value
Global Land	**57.454**	**9.791**	**0.160**	**0.053**	**0.000**
Northern Land	**21.796**	**4.562**	**0.063**	**0.020**	**0.001**
North America	7.026	1.376	0.020	0.006	0.004
Europe	4.659	1.420	0.018	0.007	0.001
North Asia	10.111	1.974	0.025	0.011	0.006
Boreal North America	3.255	1.079	0.012	0.003	0.016
Temperate North America	3.782	0.930	0.008	0.005	0.014
Boreal Asia	3.784	1.352	0.015	0.004	0.008
Temperate Asia	6.330	1.133	0.010	0.009	0.080
Tundra	1.932	1.197	0.011	0.006	0.000
Tropical Land	**24.492**	**4.752**	**0.065**	**0.025**	**0.000**
Tropical South America Forest	11.114	2.219	0.023	0.010	0.000
North Africa Savanna	2.554	0.699	0.009	0.005	0.000
Equatorial Africa	5.118	1.450	0.017	0.007	0.000
Tropical Asia	5.705	1.013	0.016	0.007	0.000
Southern Land	**11.202**	**3.597**	**0.032**	**0.016**	**0.000**
South America Savanna	3.733	1.270	0.002	0.005	0.443
Temperate South America	1.286	0.451	0.000	0.002	0.956
Southern Africa	4.227	1.502	0.021	0.007	0.000
Australia & New Zealand	1.956	0.668	0.009	0.007	0.009

Region	Mean RH (gC/m2/yr)	Std	Trend (gC/m2/yr2)	Std	P-Value
Global Land	**382.15**	**65.12**	**1.06**	**0.35**	**0.000**
Northern Land	**297.86**	**62.34**	**0.86**	**0.28**	**0.001**
North America	307.50	60.21	0.88	0.28	0.004
Europe	431.05	131.43	1.62	0.64	0.001
North Asia	255.86	49.95	0.64	0.29	0.006
Boreal North America	227.56	75.42	0.87	0.23	0.016
Temperate North America	442.52	108.84	0.90	0.53	0.014
Boreal Asia	253.52	90.60	1.03	0.29	0.008
Temperate Asia	257.42	46.08	0.41	0.37	0.080
Tundra	164.81	102.10	0.90	0.53	0.000
Tropical Land	**606.60**	**117.69**	**1.62**	**0.62**	**0.000**
Tropical South America Forest	916.75	183.07	1.93	0.83	0.000
North Africa Savanna	169.65	46.40	0.60	0.35	0.000
Equatorial Africa	762.66	216.13	2.48	1.11	0.000
Tropical Asia	879.80	156.14	2.51	1.14	0.000
Southern Land	**304.43**	**97.75**	**0.86**	**0.43**	**0.000**
South America Savanna	868.58	295.47	0.44	1.18	0.443
Temperate South America	357.71	125.58	-0.03	0.68	0.956
Southern Africa	541.79	192.47	2.73	0.92	0.000
Australia & New Zealand	240.75	82.20	1.06	0.85	0.009

Table S7. Mean and Trends in NPP, RH, NBP as simulated by individual DGVMs and the Ensemble mean for Southern Africa

MODEL	NPP (PgC/yr)	Trend (PgC/yr2)	P-value	RH (PgC/yr)	Trend (PgC/yr2)	P-value	NBP (PgC/yr)	Trend (PgC/yr2)	P-value
CO2 + Climate (S2)									
CLM4CN	2.562	0.012	0.008	2.321	0.007	0.018	-0.031	-0.009	0.110
HYLAND	8.052	0.065	0.000	7.536	0.033	0.000	-0.428	-0.031	0.000
LPJ	3.688	0.040	0.000	2.877	0.018	0.000	-0.114	-0.020	0.006
LPJ-GUESS	4.367	0.039	0.000	3.496	0.019	0.000	-0.193	-0.027	0.009
OCN	3.991	0.031	0.013	3.885	0.022	0.000	-0.090	-0.009	0.263
ORCHIDEE	4.927	0.057	0.000	4.730	0.026	0.000	-0.197	-0.031	0.001
SDGVM	4.429	0.034	0.017	3.749	0.025	0.000	-0.136	-0.015	0.256
TRIFFID	4.994	0.064	0.002	4.779	0.024	0.000	-0.215	-0.041	0.035
VEGAS	5.008	0.031	0.030	4.668	0.019	0.005	-0.025	-0.014	0.102
ENSEMBLE	**4.669**	**0.041**	**0.000**	**4.227**	**0.021**	**0.000**	**-0.159**	**-0.022**	**0.010**
Std	**1.489**	**0.018**		**1.502**	**0.007**		**0.122**	**0.011**	
CO2 only (S1)									
CLM4CN	2.625	0.004	0.298	2.368	0.001	0.799	-0.033	-0.004	0.514
HYLAND	8.460	0.024	0.000	7.945	0.018	0.000	-0.425	-0.006	0.000
LPJ	3.904	0.011	0.000	2.848	0.006	0.000	-0.191	-0.002	0.000
LPJ-GUESS	4.413	0.012	0.081	3.541	0.008	0.040	-0.166	-0.004	0.647
OCN	4.108	0.017	0.107	3.970	0.012	0.004	-0.120	-0.005	0.508
ORCHIDEE	5.193	0.018	0.018	4.937	0.015	0.000	-0.256	-0.003	0.625
SDGVM	4.468	0.012	0.240	3.796	0.007	0.033	-0.112	-0.003	0.755
TRIFFID	5.100	0.022	0.000	4.782	0.016	0.000	-0.318	-0.006	0.000
VEGAS	4.864	0.004	0.000	4.498	0.003	0.000	-0.084	-0.001	0.029
ENSEMBLE	**4.793**	**0.014**	**0.000**	**4.298**	**0.010**	**0.000**	**-0.189**	**-0.004**	**0.077**
Std	**1.578**	**0.007**		**1.610**	**0.006**		**0.124**	**0.002**	
Climate effect (S2- S1)									
CLM4CN	-0.063	0.008	0.055	-0.047	0.006	0.122	0.002	-0.005	0.454
HYLAND	-0.408	0.041	0.000	-0.409	0.015	0.011	-0.003	-0.026	0.000
LPJ	-0.217	0.029	0.006	0.029	0.011	0.008	0.078	-0.018	0.013
LPJ-GUESS	-0.045	0.026	0.009	-0.045	0.012	0.003	-0.027	-0.023	0.057
OCN	-0.117	0.013	0.290	-0.085	0.010	0.114	0.030	-0.004	0.687
ORCHIDEE	-0.266	0.039	0.000	-0.207	0.011	0.012	0.059	-0.028	0.000
SDGVM	-0.039	0.022	0.215	-0.047	0.018	0.002	-0.025	-0.012	0.487
TRIFFID	-0.106	0.042	0.030	-0.003	0.008	0.051	0.103	-0.034	0.068
VEGAS	0.144	0.027	0.056	0.170	0.016	0.017	0.059	-0.014	0.114
ENSEMBLE	**-0.124**	**0.027**	**0.007**	**-0.072**	**0.012**	**0.002**	**0.031**	**-0.018**	**0.017**
Std	**0.158**	**0.012**		**0.161**	**0.004**		**0.047**	**0.010**	

Table S8. Mean and Trends in NPP, RH, NBP as simulated by individual DGVMs and the Ensemble mean for Temperate South America

MODEL	NPP (PgC/yr)	Trend (PgC/yr2)	P-value	RH (PgC/yr)	Trend (PgC/yr2)	P-value	NBP (PgC/yr)	Trend (PgC/yr2)	P-value
CO2 + Climate (S2)									
CLM4CN	0.714	-0.002	0.455	0.654	0.002	0.252	-0.004	0.005	0.258
HYLAND	2.261	0.003	0.249	2.103	-0.001	0.734	-0.116	-0.004	0.188
LPJ	0.854	-0.006	0.236	0.717	0.001	0.475	-0.032	0.007	0.071
LPJ-GUESS	1.648	-0.003	0.495	1.394	0.000	0.888	-0.053	0.007	0.104
OCN	1.096	-0.011	0.053	1.052	-0.004	0.270	-0.019	0.006	0.032
ORCHIDEE	1.754	-0.001	0.762	1.647	0.001	0.471	-0.107	0.003	0.327
SDGVM	1.492	-0.002	0.546	1.252	0.001	0.611	-0.033	0.006	0.104
TRIFFID	1.568	-0.011	0.237	1.489	0.002	0.430	-0.079	0.014	0.085
VEGAS	1.381	-0.007	0.035	1.261	-0.004	0.078	-0.041	0.004	0.038
ENSEMBLE	**1.419**	**-0.004**	**0.264**	**1.286**	**0.000**	**0.956**	**-0.054**	**0.005**	**0.052**
Std	**0.478**	**0.005**		**0.451**	**0.002**		**0.039**	**0.005**	
CO2 only (S1)									
CLM4CN	0.653	-0.002	0.536	0.594	0.001	0.563	-0.012	0.004	0.423
HYLAND	2.236	0.007	0.000	2.074	0.006	0.000	-0.121	-0.001	0.000
LPJ	0.866	0.003	0.000	0.700	0.002	0.000	-0.049	-0.001	0.000
LPJ-GUESS	1.598	-0.005	0.207	1.342	-0.002	0.221	-0.047	0.003	0.519
OCN	0.958	-0.009	0.085	0.921	-0.006	0.035	-0.018	0.003	0.443
ORCHIDEE	1.519	0.005	0.095	1.436	0.004	0.003	-0.083	-0.001	0.734
SDGVM	1.403	0.008	0.040	1.172	0.004	0.031	-0.035	-0.005	0.132
TRIFFID	1.133	0.005	0.000	1.055	0.004	0.000	-0.079	-0.001	0.000
VEGAS	1.304	0.000	0.214	1.192	0.000	0.000	-0.033	0.000	0.966
ENSEMBLE	**1.297**	**0.001**	**0.062**	**1.165**	**0.001**	**0.008**	**-0.053**	**0.000**	**0.882**
Std	**0.471**	**0.006**		**0.440**	**0.004**		**0.035**	**0.003**	
Climate effect (S2- S1)									
CLM4CN	0.061	0.000	0.992	0.060	0.001	0.546	0.008	0.001	0.889
HYLAND	0.025	-0.005	0.064	0.029	-0.007	0.082	0.005	-0.003	0.385
LPJ	-0.013	-0.009	0.085	0.018	-0.001	0.491	0.017	0.008	0.049
LPJ-GUESS	0.050	0.002	0.679	0.052	0.003	0.375	-0.006	0.005	0.383
OCN	0.138	-0.002	0.783	0.132	0.002	0.578	0.000	0.003	0.410
ORCHIDEE	0.235	-0.006	0.249	0.211	-0.003	0.274	-0.024	0.004	0.333
SDGVM	0.089	-0.010	0.067	0.080	-0.003	0.331	0.002	0.011	0.037
TRIFFID	0.434	-0.016	0.096	0.434	-0.002	0.545	0.000	0.015	0.065
VEGAS	0.078	-0.007	0.025	0.069	-0.004	0.057	-0.008	0.004	0.026
ENSEMBLE	**0.122**	**-0.006**	**0.128**	**0.120**	**-0.002**	**0.404**	**-0.001**	**0.005**	**0.061**
Std	**0.137**	**0.006**		**0.131**	**0.003**		**0.012**	**0.005**	

Table S9. Mean and Trends in global NBP over the time periods, 1960-1988, and 1989-2009

MODEL Global_Land	NBP (PgC/yr)	Trend (PgC/yr2)	P-value	NBP 1989-2009 (PgC/yr)	Trend (PgC/yr2)	P-value	Change mean NBP
CLM4CN	-0.863	-0.038	0.049	-1.525	-0.027	0.337	0.661
HYLAND	-1.538	-0.057	0.000	-3.474	-0.092	0.001	1.936
LPJ	-1.020	-0.038	0.123	-2.277	-0.051	0.125	1.257
LPJ-GUESS	-1.252	-0.008	0.772	-1.843	-0.026	0.535	0.591
OCN	-1.566	-0.033	0.060	-2.288	-0.008	0.720	0.722
ORCHIDEE	-0.625	-0.092	0.000	-3.524	-0.062	0.127	2.899
SDGVM	-1.056	-0.034	0.131	-2.152	-0.031	0.293	1.096
TRIFFID	-2.302	0.001	0.979	-2.807	-0.040	0.425	0.505
VEGAS	-1.510	0.004	0.862	-1.864	0.007	0.833	0.353
ENSEMBLE	**-1.304**	**-0.033**	**0.074**	**-2.417**	**-0.037**	**0.168**	**1.113**
Std	**0.495**	**0.030**		**0.710**	**0.029**		**0.826**

Table S10 List of Abbreviations

Abbreviation	
AVHRR	Advanced Very High Resolution Radiometer
CSoil	Soil Carbon Content
DGVM	Dynamic Global Vegetation Model
FACE	Free-Air-Carbon-Enrichment Experiments
GIMMS	Global Inventory Modeling and Mapping Studies
GCM	General Circulation Model
IPCC	Intergovernmental Panel on Climate Change
LAI	Leaf Area Index
LUC	Land Use Change
MRT	Mean Residence Time of Soil Carbon
NBP	Net Biospheric Production
NCEP	National Centers for Environmental Prediction
NDVI	Normalized Difference Vegetation Index
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Production
OBGCM	Ocean Biogeochemical General Circulation Model
Onset	Leaf onset, beginning of the growing season
Offset	End of growing season, beginning of leaf senescence
pCO_2	CO_2 partial pressure
RECCAP	Regional Carbon Cycle Assessment and Processes
RH	Heterotrophic Respiration
RLS	Residual Land Sink
SST	Sea Surface Temperature

Table S11 Correlations and test of significance for trend in flux vs trend in driver (spatial correlation, weighted by grid-size).

	Temperature	Precipitation
Correlation		
NBP	-0.17	0.36
NPP	-0.1	0.5
RH	-0.01	0.48
R^2		
NBP	0.19	<0.0001
NPP	0.36	<0.0001
RH	0.47	<0.0001
P-value		
NBP	0.03	0.13
NPP	0.03	0.25
RH	<0.0001	0.23

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