Table S1. Model attributes related to energy flux formulation and parameterization.

	Biome-BGC	CABLE-JPL	CLASS-CTEM-N+	CLM	CLM4-VIC	DLEM	ECOSYS	GTEC	HYLAND-JPL	ISAM	JULES-JPL	LPJ-wsl	MC1	ORCHIDEE-LSCE	ORCHIDEE-JPL	SiB3-JPL	SiBCASA	TEM6	TRIPLEX-GHG	VEGAS	VISIT
Calculates canopy radiation transfer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
RTS = 3-D	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RTS = 2-stream	0	0	0	1	1	0	0	1	0	1	1	0	0	0	0	1	1	0	1	0	0
RTS = Beer's law	1	0	1	0	0	1	0	0	1	0	0	1	0	1	1	0	0	0	0	1	1
RTS = Albedo	1	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Other	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Represents canopy gaps wrt canopy radiative transfer	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Partitions net radiation into latent & sensible heat	0	1	1	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0	1	1	1
Simulates ground heat flux	0	1	1	1	1	0	1	0	0	1	1	0	0	1	1	1	1	0	1	0	0
Simulates canopy heat storage	0	1	1	1	1	0	1	0	0	1	1	0	0	1	1	1	1	0	1	0	0
Computed from canopy temperature	0	1	1	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1	0	0
Vegetation heat storage term	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Prognostic change in canopy heat	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Residual	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parameterizes turbulent processes	0	1	1	1	1	0	1	0	0	1	1	0	0	1	1	1	1	0	1	0	0
Parameterizes in-canopy diffusive processes	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0
Parameterizes stomatal conduct. for sunlit/shaded leaves	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Parameterizes stomatal conductance whole canopy	1	0	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	0	1	1	1
Stomatal conductance scheme = Jarvis-type	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Stomatal conductance scheme = Ball Berry	0	1	1	1	1	1	0	1	0	1	1	0	0	1	1	1	1	0	1	0	1
Stomatal conductance scheme = Other	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Stomatal conductance connected to photosynthesis	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1

Table S2. Model attributes related to carbon flux formulation and parameterization.

	Biome-BGC	CABLE-JPL	CLASS-CTEM-N+	CLM	CLM4-VIC	DLEM	ECOSYS	GTEC	HYLAND-JPL	ISAM	JULES-JPL	LPJ-wsl	MC1	ORCHIDEE-LSCE	ORCHIDEE-JPL	SiB3-JPL	SiBCASA	TEM6	TRIPLEX-GHG	VEGAS	VISIT
Water stress limits photosynthesis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temperature stress limits photosynthesis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
Light limits photosynthesis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Simulates autotrophic respiration	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Simulates maintenance respiration	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Simulates growth respiration	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1
Separate live carbon pools	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Aboveground heartwood biomass pool	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1
Leaves biomass pool	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Generic roots biomass pool	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	0	1
Coarse / fine roots biomass pool	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	0	1	1
Sapwood above ground biomass pool	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	1	1
Sapwood below ground biomass pool	0	0	0	1	1	0	1	0	0	1	0	1	0	1	1	0	0	1	0	0	1
Fruits and flowers biomass pool	0	0	0	0	0	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0
Carbohydrate reserve biomass pool	1	0	1	1	1	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0	1
Other	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0
Carbon allocation is dynamic	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1
Includes litter pool	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1
Structural	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1
Metabolic	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	1	0	1	1	1
Above ground	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1
Below ground	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1
Includes soil carbon pool(s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Moisture influences heterotrophic resp.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temp. influences heterotrophic resp.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table S3. Model attributes related to vegetation dynamics.

	Biome-BGC	CABLE-JPL	CLASS-CTEM-N+	CLM	CLM4-VIC	DLEM	ECOSYS	GTEC	HYLAND-JPL	ISAM	JULES-JPL	LPJ-wsl	MC1	ORCHIDEE-LSCE	ORCHIDEE-JPL	SiB3-JPL	SiBCASA	TEM6	TRIPLEX-GHG	VEGAS	VISIT
Includes fire disturbance	1	0	0	1	1	0	1	0	1	0	0	1	1	0	0	0	0	1	1	1	1
Includes land use change disturbance	0	0	0	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1
Considers tree mortality	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	0	1	1	0
Considers senescence	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1
Vegetation types compete for light	0	0	1	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	0
Vegetation types compete for water	0	0	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0	1	1	0
LAI dynamically calculated	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1
LAI assimilated from remote sensing	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Optimum max rubisco-limited potential photosyn. capacity	1	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1
Optimum photosynthetic temperature	1	0	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1
Max LAI beyond which no allocation of biomass to leaves	0	1	1	0	0	1	0	1	0	0	1	0	0	1	1	0	1	1	1	0	1
Exponential root distribution explicitly specified	0	0	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	1	0	1
Maximum rooting zone depth	0	0	1	1	1	1	0	1	0	1	1	1	1	0	0	1	1	1	1	0	1
Prescribed leaf albedo	1	0	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	1
Prescribed vegetation height	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
Critical leaf age for senescence	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1
Temp thresholds for leaf shedding	1	1	1	1	1	0	0	1	0	1	1	0	1	1	1	0	1	0	0	1	0
Moisture thresholds for leaf shedding	1	1	1	1	1	0	0	0	0	1	0	1	1	1	1	0	1	1	0	1	1
Nonzero threshold above which photosynthesis starts	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Dynamic global vegetation model	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	1	0

Table S4. Model attributes related to nitrogen cycling dynamics.

	Biome-BGC	CABLE-JPL	CLASS-CTEM-N+	CLM	CLM-VIC	DLEM	ECOSYS	GTEC	HYLAND-JPL	ISAM	JULES-JPL	LPJ-wsl	MC1	ORCHIDEE-LSCE	ORCHIDEE-JPL	SiB3-JPL	SiBCASA	TEM6	TRIPLEX-GHG	VEGAS	VISIT
Include prognostic/explicit N cycle in model structure	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Is it an open N cycle	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0
C-N coupling included in model	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
N deposition included	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Chemical N fertilizer use considered for cropland	0	0	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Manure application considered for cropland	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0
N fixation considered	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
GPP limited by N availability	1	1	1	1	1	1	1	1	0	1	0	0	1	0	0	0	0	1	1	0	0
Plant autotrophic respiration limited by N availability	1	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Heterotopic respiration (soil) limited by N availability	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Carbon allocation limited by N availability	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Model considers plant uptake of N	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0
Microbial activity included for modifying N cycle	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0

Table S5. Required output variables from MsTMIP simulations.

Category	Long name	Variable Name	Units	3-hourly	Description
Carbon Fluxes	Autotrophic Respiration	AutoResp	kg C m^{-2} s^{-1}	Yes	Autotrophic respiration rate
	Fire emissions	Fire_flux	kg C m^{-2} s^{-1}	Yes	Flux of carbon due to fires
	Gross Primary Productivity	GPP	kg C m^{-2} s^{-1}	Yes	Rate of photosynthesis
	Heterotrophic Respiration	HeteroResp	kg C m^{-2} s^{-1}	Yes	Heterotrophic respiration rate
	Total Respiration	TotalResp	kg C m^{-2} s^{-1}	Yes	Total respiration (TotalResp=AutoResp+heteroResp)
	Net Primary Productivity	NPP	kg C m^{-2} s^{-1}	Yes	Net Primary Productivity (NPP=GPP-AutoResp)
	Net Ecosystem Productivity	NEP	kg C m^{-2} s^{-1}	Yes	NEP= GPP –(HeteroResp+AutoResp)
	Net Ecosystem Exchange	NEE	kg C m^{-2} s^{-1}	Yes	NEE=(HeteroResp+AutoResp) + Disturbance_Emissions_(CO2) + Product_Emissions_(CO2) – GPP
Carbon Pools	Above ground woody biomass	AbvGrndWood	kg C m^{-2}	No	Total above ground wood biomass
	Size of each carbon pool	CarbPools	kg C m^{-2}	No	Size of each carbon pool
	Number Carbon Pools	npool	na	No	Total number of carbon pools
	Name of each Carbon Pool	poolname	na	No	Name of each carbon pool (i.e., "wood," or Coarse Woody Debris")
	Total living biomass	TotLivBiom	kg C m^{-2}	No	Total carbon content of the living biomass (leaves+roots+wood)
	Total Soil Carbon	TotSoilCarb	kg C m^{-2}	No	Total soil and litter carbon content integrated over the entire soil profile
Driver	Near surface CO$_2$ concentration	CO2air	µmol mol^{-1}	No	Near surface dry air CO2 mole fraction
	Surface incident longwave radiation	LWdown	W/m2	No	Surface incident longwave radiation
	Surface pressure	Psurf	Pa	No	Surface pressure
	Near surface specific humidity	Qair	kg kg^{-1}	No	Near surface specific humidity
	Rainfall rate	Rainf	kg m^{-2} s^{-1}	No	Rainfall rate
	Surface incident shortwave radiation	SWdown	W m^{-2}	No	Surface incident shortwave radiation
	Near surface air temperature	Tair	K	No	Near surface air temperature
	Near surface module of the wind	Wind	m s^{-1}	No	Near surface module of the wind
Energy Fluxes	Longwave Albedo	LW_albedo	(-)	No	Longwave Albedo
	Net Longwave Radiation	Lwnet	W m^{-2}	No	Incident longwave radiation minus the simulated outgoing longwave radiation, averaged over a grid cell
	Sensible heat	Qh	W m^{-2}	Yes	Sensible heat flux averaged over a grid cell
	Latent heat	Qle	W m^{-2}	Yes	Latent heat flux, averaged over a grid cell
	Shortwave Albedo	SW_albedo	(-)	No	Shortwave albedo
	Net shortwave radiation	SWnet	W m^{-2}	No	Incoming solar radiation less the simulated outgoing shortwave radiation, averaged over a grid cell

| Category	Long name	Variable Name	Units	3-hourly	Description
Other	Frozen Layer Thickness	Fdepth	m	No	Total freeze depth; depth to zero centigrade isotherm in non-permafrost
	Absorbed fraction incoming PAR	fPAR	(-)	No	absorbed fraction incoming photosynthetically active radiation
	Leaf Area Index	LAI	$m^2 m^{-2}$	No	Area of leaves per area ground
Physical Variables	Total Evapotranspiration	Evap	$kg\,m^{-2}\,s^{-1}$	No	Sum of all evaporation sources, averaged over a grid cell
	Number Soil Layers	nsoil	na	No	Total number of soil layers
	Surface runoff	Qs	$kg\,m^{-2}\,s^{-1}$	No	Runoff from the landsurface and/or subsurface stormflow
	Subsurface runoff	Qsb	$kg\,m^{-2}\,s^{-1}$	No	Gravity drainage and/or slow response lateral flow. Ground water recharge will have the opposite sign.
	Total snow depth	SnowDepth	m	No	Total snow depth
	Average Layer Soil Moisture	SoilMoist	$kg\,m^{-2}$	No	Soil water content in each user-defined soil layer (3D variable). Includes the liquid, vapor and solid phases of water in the soil.
	Average Layer Soil Temperature	SoilTemp	K	No	Average soil temperature in each user-defined soil layer (3D variable)
	Total Soil Wetness	SoilWet	(-)	No	Vertically integrated soil moisture divided by maximum allowable soil moisture above wilting point.
	Snow Water Equivalent	SWE	$kg\,m^{-2}$	No	Total water mass of snow pack (ice plus liquid water)
	Active Layer Thickness	Tdepth	m	No	Total thaw depth; depth to zero centigrade isotherm in permafrost
	Transpiration	Veg	$kg\,m^{-2}\,s^{-1}$	No	Total Plant transpiration
	Soil Layer Bottom Depth	z_bottom	m	No	Depth from soil surface to bottom of soil layer
	Soil Layer Node Depth	z_node	m	No	Depth from soil surface to layer prognostic variables; typically center of soil layer
	Soil Layer Top Depth	z_top	m	No	Depth from soil surface to top of soil layer
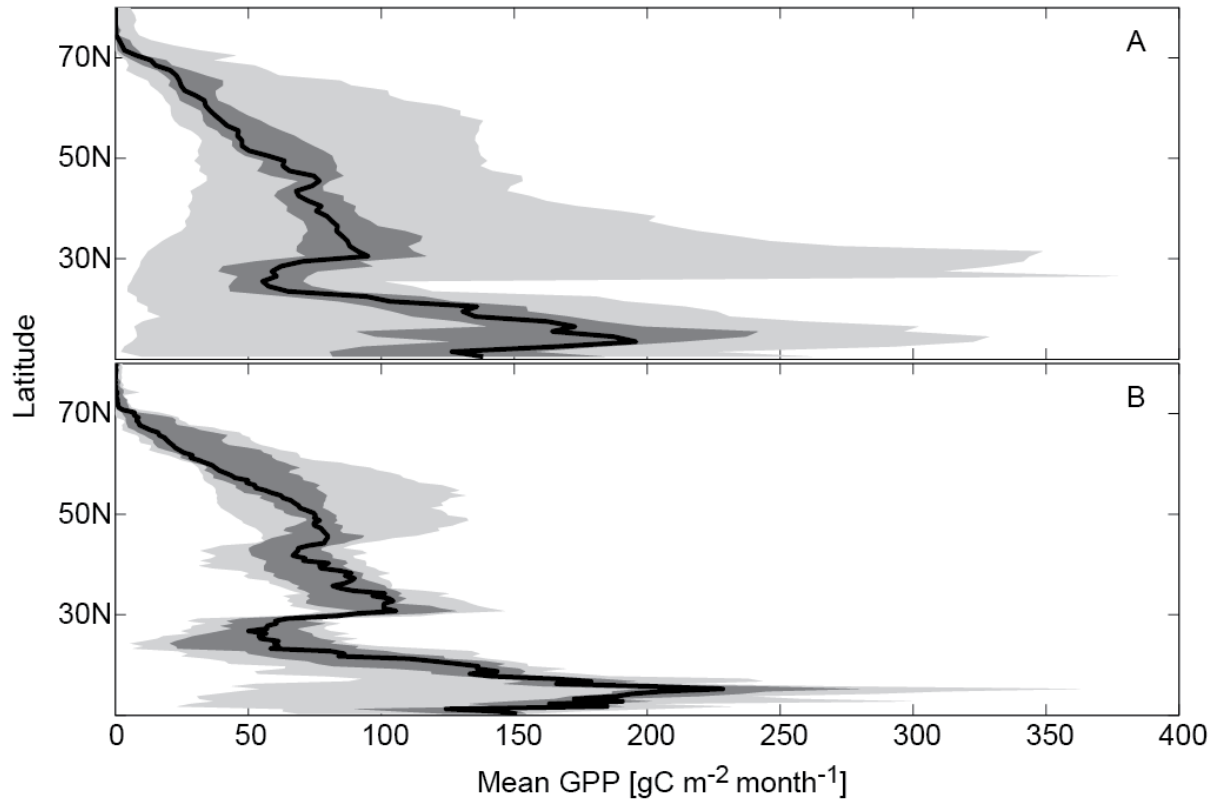
Figure S1 North American long-term mean (2000-2005) GPP from (A) the NACP regional interim synthesis and (B) the MsTMIP simulations for all models participating in each study. On each panel, the solid line shows the median of the multi-model ensemble, the darker shaded area shows the interquartile range; and the lighter band shows the full range in estimates.