Supporting Information for: Global wetland contribution to 2000-2012 atmospheric methane growth rate dynamics

Table S1: Global wetland methane flux by model (Tg CH_4 yr^{-1}). Interannual variability is used to estimate standard deviation for each model. See Table 1 for model ensemble mean and standard deviation.

Model Name	2000-2006	2007-2012	2012	Contributor	Reference
CLM 4.5	206.2 ±5.6	205.7 ±5.7	208.4	Koven/Xu/Riley	(Riley et al. 2011)
CTEM	195.7 ±3.9	194.2 ±5.5	195.4	Melton/Arora	
DLEM	168.6 ±3.2	165.7 ±4	167.2	Tian/Zhang	(Tian et al. 2010)
JULES				Gedney/Jones	(Hayman et al. 2014)
	189.7 ±5.4	191.3 ±5.8	193.5	Wiltshire	
LPJ-MPI	222 ±8.9	226.8 ±8.5	234.2	Kleinen/Brovkin	(Kleinen et al. 2012)
LPJ-wsl	152.3 ±1.7	151.7 ±6.3	154.5	Poulter/Zhang	(Hodson et al. 2011)
LPX-Bern	173.4 ±1.5	172.9 ±4.6	172.1	Spahni/Joos	(Spahni et al. 2011)
ORCHIDEE	175 ±4.4	169.6 ±5.6	173.9	Peng, S.	(Ringeval et al. 2010)
SDGVM				Beerling/Hopcroft	(Hopcroft et al. 2011)
	190.5 ±4.5	190.2 ±6.4	190.1	Taylor/Wilton	
TRIPLEX-GHG	156.7 ±3.3	152.9 ±4.9	160.4	Peng, C./Zhu	(Zhu et al. 2015)
VISIT	194.1 ±3.6	197 ±2.4	192.7	Ito/Saito	(Ito and Inatomi 2012)

Table S2: Description of key wetland methane emission processes included by each model and also described in previous model comparisons (e.g., Wania et al. 2013, Xu et al. 2016). As outline in the modeling protocol, wildfire was not simulated, nor was land-cover change. In the Table, Rh=heterotrophic respiration, DOC=dissolved organic carbon, T=temperature, M=moisture, R=redox.

Model Name	CH4 substrate	Oxidation	Transport	Permafrost	Wetland PFTs	Notes
CLM 4.5	*f*(Rh, T, M, pH, R)	*f*(CH_4, O_2, T, M)	Diffusion, ebullition, aerenchyma	Yes	No	n/a
CTEM	*f*(Rh)	Net emissions are estimated	No	Yes	No	n/a
DLEM	*f*(DOC)	*f*(CH4, T, M)	Diffusion	No	No	n/a
JULES	*F*(cSoil)	Net emissions are estimated	No	No	No	n/a
LPJ-MPI	*f*(Rh)	*f*(CH4, T)	Diffusion, ebullition, aerenchyma	No	No	Based on Walter and Heimann (2000) scheme
LPJ-wsl	*f*(Rh)	Net emissions are estimated		Not enabled	No	Based on Christensen et al. 1996 scheme
LPX-Bern	*f*(Rh)					
ORCHIDEE	*f*(Rh*) for labile	*f*(CH4, T)	Diffusion, ebullition, aerenchyma	Not activated	No	Based on Walter and Heimann (2000) scheme
SDGVM	*f*(CH4, GPP)	Not enabled	Not enabled	No	Based on Cao et al. 1996	n/a
TRIPLEX-GHG	*f*(Rh, T, M, pH)	*f*(CH4, T, M)	Diffusion, ebullition, aerenchyma	Not enabled	Yes	Synthesized and based on Walter and Heimann (2000) scheme
VISIT	*f*(Rh)	*f*(CH4, T, M)	Diffusion, ebullition, aerenchyma	Not enabled	No	Based on Walter and Heimann (2000) scheme

Table S3: Sensitivity of tropical wetland methane emissions ($TgCH_4\ yr^{-1}$) to 'dry' grid cells, assuming thresholds for removing grid cells from the SWAMPS dataset with surface-inundation (Fw) ranging from less than 0.5 to 5.0%. A Student's t-test was carried out to test the differences between emissions for the full model ensemble (n=11) and at no level were the emissions statistically different, indicating that the filtering does not alter the change in emissions from 2000-2006 to 2007-2012.

***Fw* threshold**	**2000-2006**	**2007-2012**	**Difference**
None (original)	69.3±11.8	68.5±11.5	-0.88±0.4
0.5%	62.6±11.5	62.8±11.4	0.25±0.3
1.0%	55.1±10.8	55.9±11.0	0.82±0.2
2.5%	44.4±9.4	45.3±9.6	1.0±0.2
5.0%	34.3±7.7	35.2±8.0	1.0±0.2

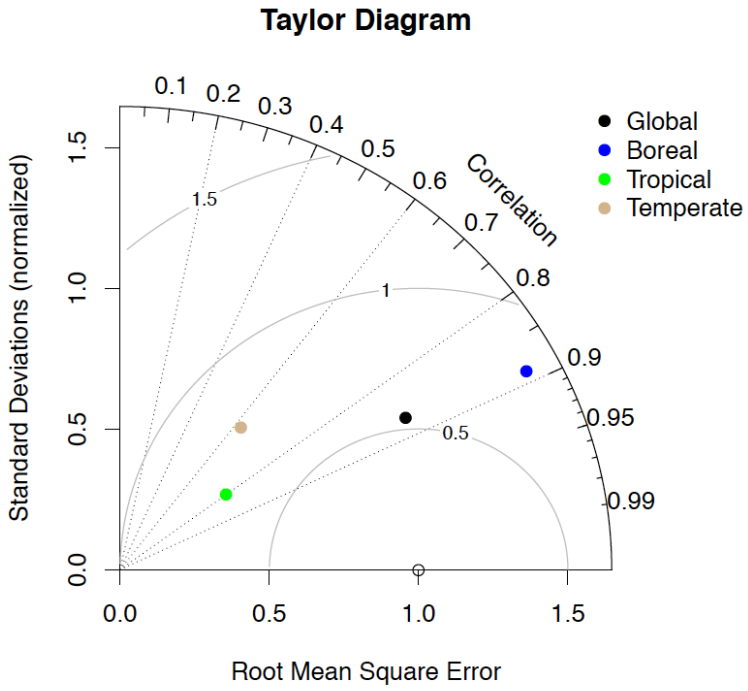


Figure S1: Taylor Diagram comparing SWAMPS-GLWD with GIEMS for monthly wetland area for the overlapping period of 2000 to 2007 at global and regional scale. To include the different regions, the ratio of variances and RMSE are normalized. The axes of the Taylor Diagram are interpreted such that the x-axis is the root-mean square error, or bias, between the GIEMS and SWAMPS-GLWD, the y-axis is the ratio of the variances, indicating similarity between the seasonal amplitudes, and the curved axis indicates the correlation coefficient. Global inundation dynamics show agreement with GIEMS, and the SWAMPS-GLWD tends to have greater wetland area than GIEMS in high latitudes and less in low-mid latitudes. The seasonal cycle is dampened in the SWAMPS-GLWD relative to GIEMS (indicated by the y-axis values being less than 1, where the variance is smaller in SWAMPS-GLWD).

Figure S2: Hovmöller diagrams for each wetland methane model showing mean latitudinal methane production (g CH_4 $month^{-1}$) from 2000-2012. Vertical dashed line indicates year 2007.

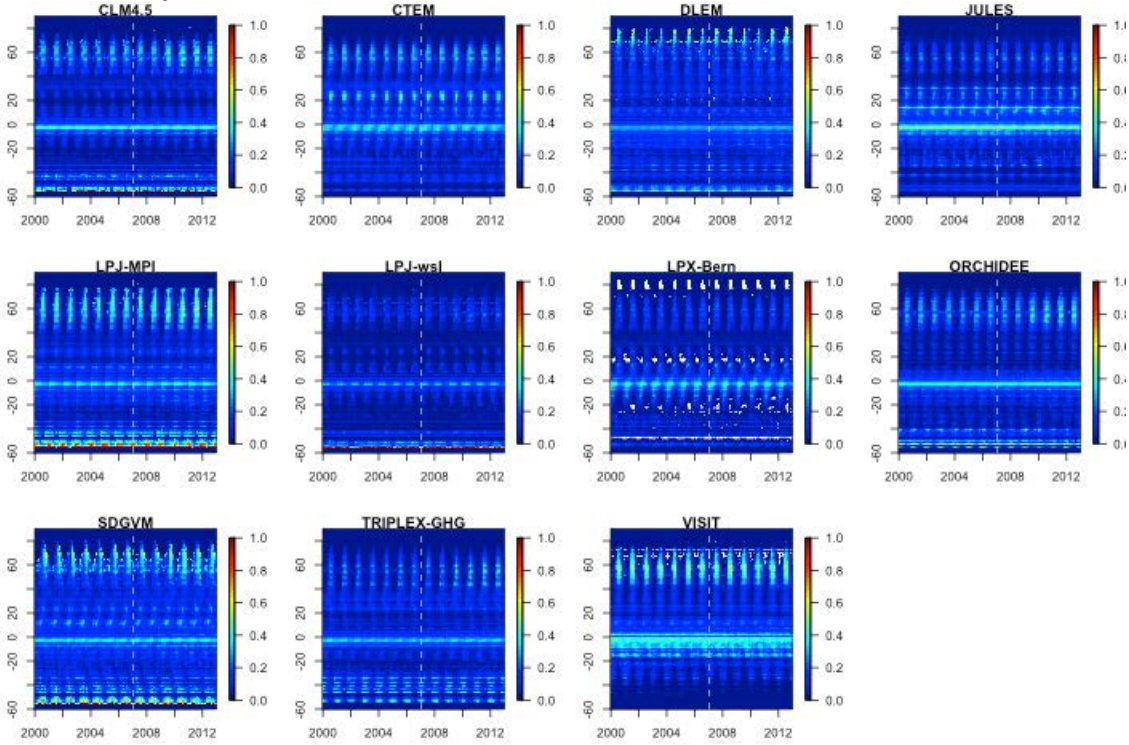


Figure S3: Hovmöller diagrams for each wetland methane model showing monthly methane production anomalies (g CH_4 $month^{-1}$) relative to long-term monthly means from 2000-2012. Vertical dashed line indicates year 2007.

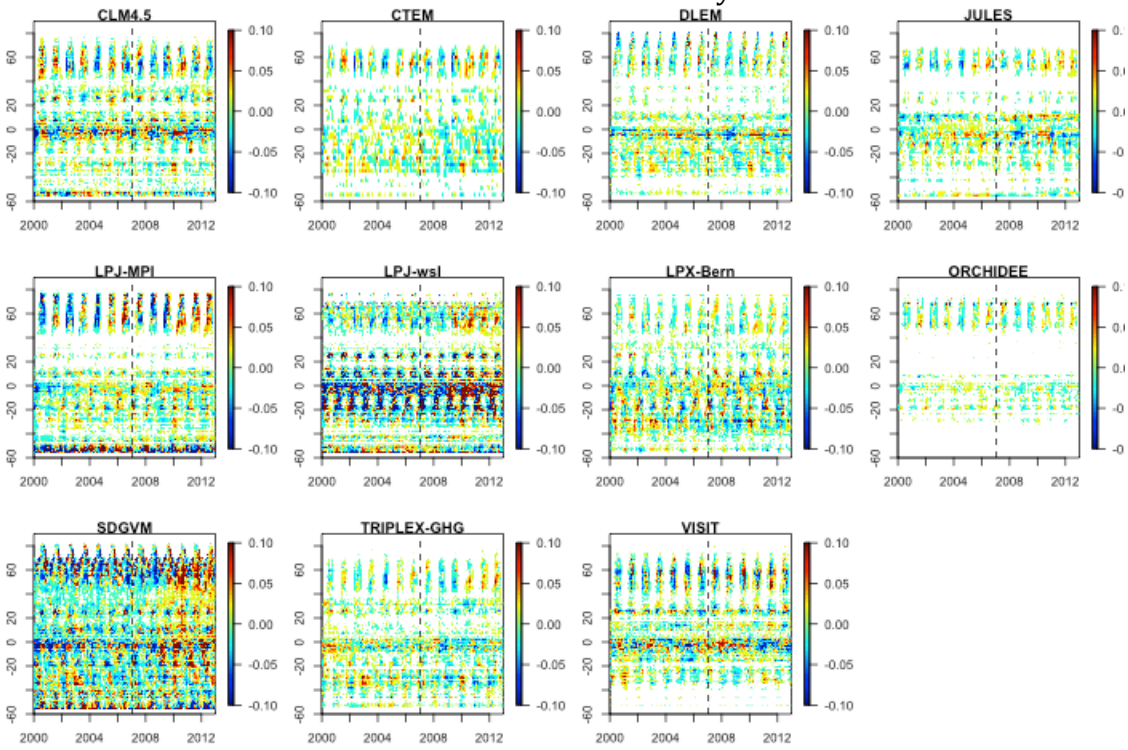
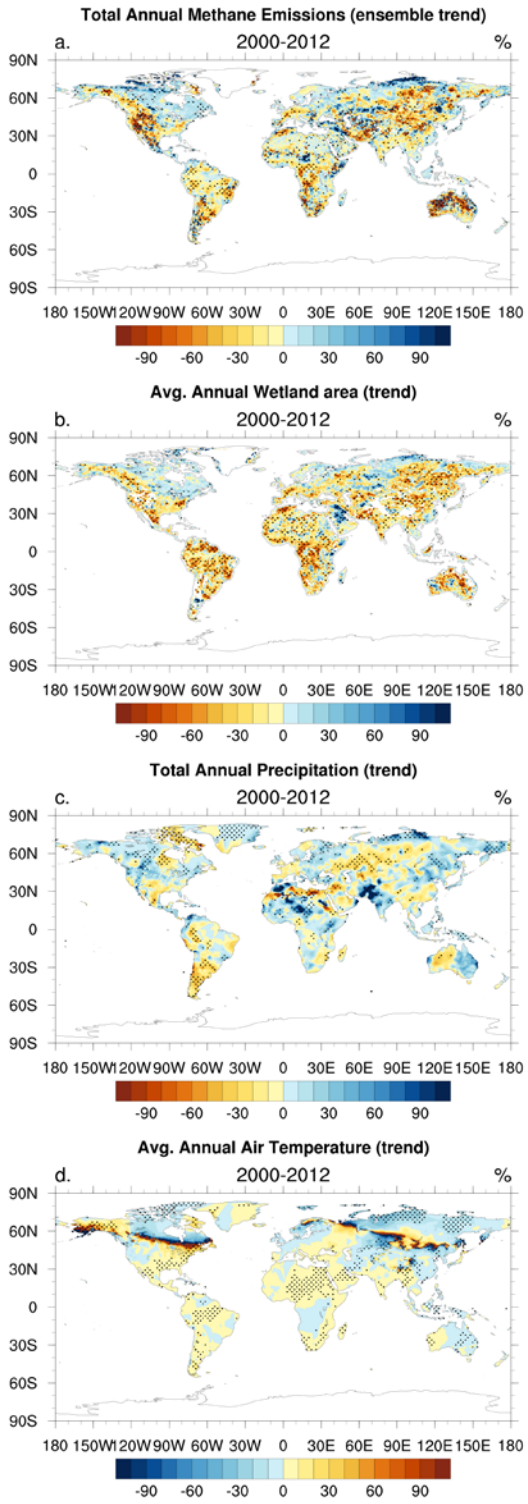


Figure S4: Annual trends in relative units (%), from 2000-2012, in (a) the ensemble averaged CH_4 emissions, (b) wetland area, (c) annual precipitation, and (d) air temperature. The black stippling highlights statistically significant trends ($p < 0.1$).



References

Hayman, G. D., F. M. O'Connor, M. Dalvi, D. B. Clark, N. Gedney, C. Huntingford, C. Prigent, M. Buchwitz, O. Schneising, J. P. Burrows, C. Wilson, N. Richards, and M. Chipperfield. 2014. Comparison of the HadGEM2 climate-chemistry model against in situ and SCIAMACHY atmospheric methane data. Atmos. Chem. Phys. **14**:13257-13280.

Hodson, E. L., B. Poulter, N. E. Zimmermann, C. Prigent, and J. O. Kaplan. 2011. The El Niño–Southern Oscillation and wetland methane interannual variability. Geophysical Research Letters **38**:doi:10.1029/2011GL046861.

Hopcroft, P. O., P. J. Valdes, and D. J. Beerling. 2011. Simulating idealized Dansgaard-Oeschger events and their potential impacts on the global methane cycle. Quaternary Science Reviews **30**:3258-3268.

Ito, A., and M. Inatomi. 2012. Use of a process-based model for assessing the methane budgets of global terrestrial ecosystems and evaluation of uncertainty. Biogeosciences **9**:759-773.

Kleinen, T., V. Brovkin, and R. J. Getzieh. 2012. A dynamic model of wetland extent and peat accumulation: results for the Holocene. Biogeosciences **9**:235-248.

Riley, W. J., Z. M. Subin, D. M. Lawrence, J. J. Swenson, M. S. Torn, L. Meng, N. M. Mahowald, and P. Hess. 2011. Barriers to predicting changes in global terrestrial methane fluxes: analyses using CLM4Me, a methane biogeochemistry model integrated inCESM. Biogeosciences **8**:1925-1953.

Ringeval, B., N. de Noblet-Ducoudre, P. Ciais, P. Bousquet, C. Prigent, F. Papa, and W. B. Rossow. 2010. An attempt to quantify the impact of changes in wetland extent on methane emissions on the seasonal and interannual time scales. Global Biogeochemical Cycles **24**:GB2003.

Spahni, R., R. Wania, L. Neef, M. Van Weele, I. Pison, P. Bousquet, C. Frankenberg, P. N. Foster, F. Joos, I. C. Prentice, and P. van Velthoven. 2011. Constraining global methane emissions and uptake by ecosystems. Biogeosciences **8**:1643-1665.

Tian, H., X. Xu, M. Liu, W. Ren, C. Zhang, G. Chen, and C. Lu. 2010. Spatial and temporal patterns of CH_4 and N_2O fluxes in terrestrial ecosystems of North America during 1979–2008: application of a global biogeochemistry model. Biogeosciences **7**:2673-2694.

Wania, R., J. R. Melton, E. L. Hodson, B. Poulter, B. Ringeval, R. Spahni, T. Bohn, C. A. Avis, G. Chen, A. V. Eliseev, P. O. Hopcroft, W. J. Riley, Z. M. Subin, H. Tian, V. Brovkin, P. M. van Bodegom, T. Kleinen, Z. C. Yu, J. S. Singarayer, S. Zurcher, D. P. Lettenmaier, D. J. Beerling, S. N. Denisov, C. Prigent, F. Papa, and J. O. Kaplan. 2013. Present state of global wetland extent and wetland methane modeling: Methodology of a model intercomparison project (WETCHIMP). Geoscientific Model Development **6**:617-641.

Xu, X., F. Yuan, P. J. Hanson, S. D. Wullschleger, P. E. Thornton, W. J. Riley, X. Song, D. E. Graham, C. Song, and H. Tian. 2016. Reviews and syntheses: Four decades of modeling methane cycling in terrestrial ecosystems. Biogeosciences **13**:3735-3755.

Zhu, Q., C. Peng, H. Chen, X. Fang, J. Liu, H. Jiang, Y. Yang, and G. Yang. 2015. Estimating global natural wetland methane emissions using process

modelling: spatio-temporal patterns and contributions to atmospheric methane fluctuations. Global Ecology and Biogeography **24**:959-972.