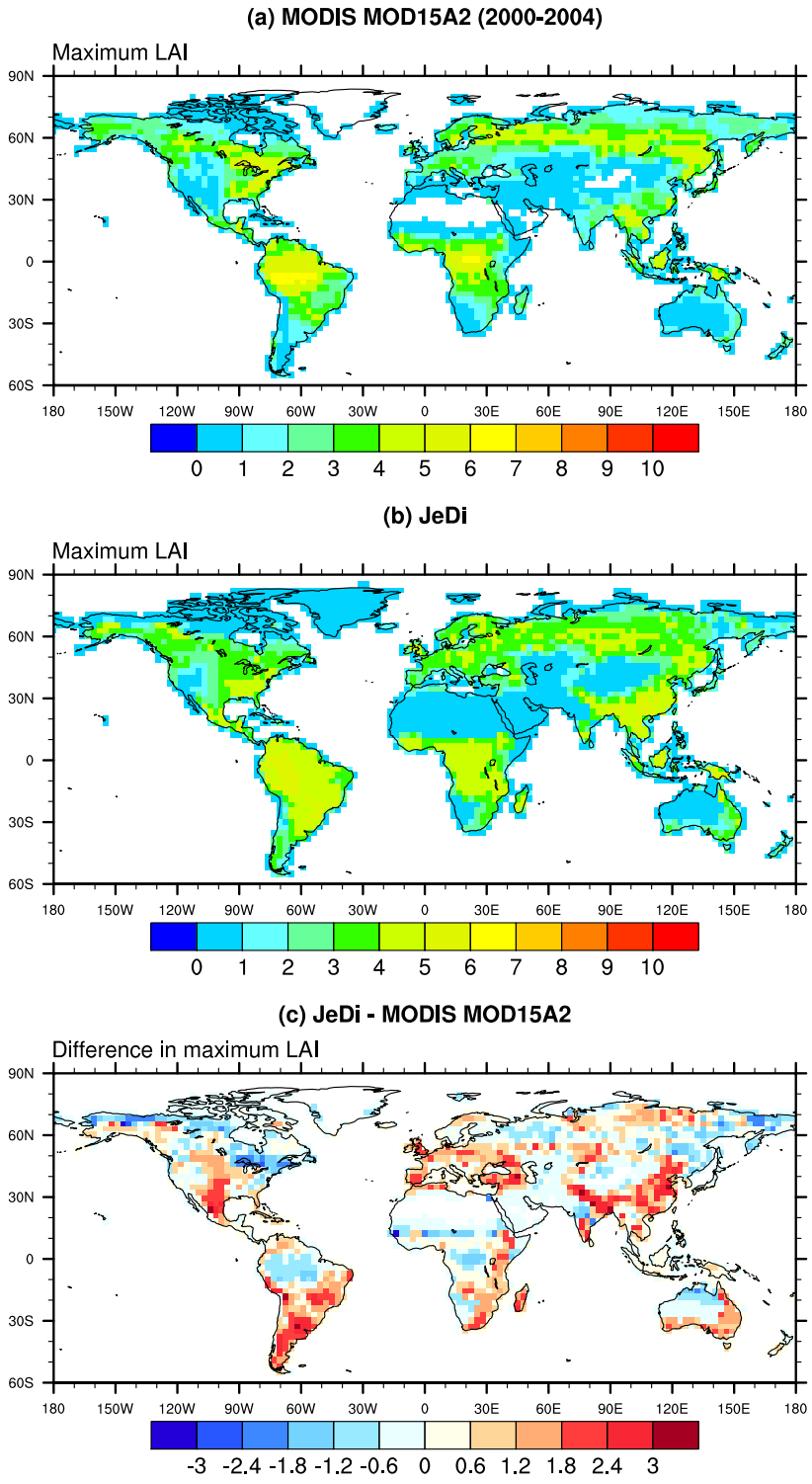

Figure S1: Mean intra-annual maximum leaf area index for years 2000–2004 from **(a)** MODIS MOD15A2 Collection 4 LAI product (Myneni et al., 2002; Zhao et al., 2005); **(b)** as simulated by JeDi-DGVM; and **(c)** the difference between the MODIS observations and the JeDi-DGVM model output.

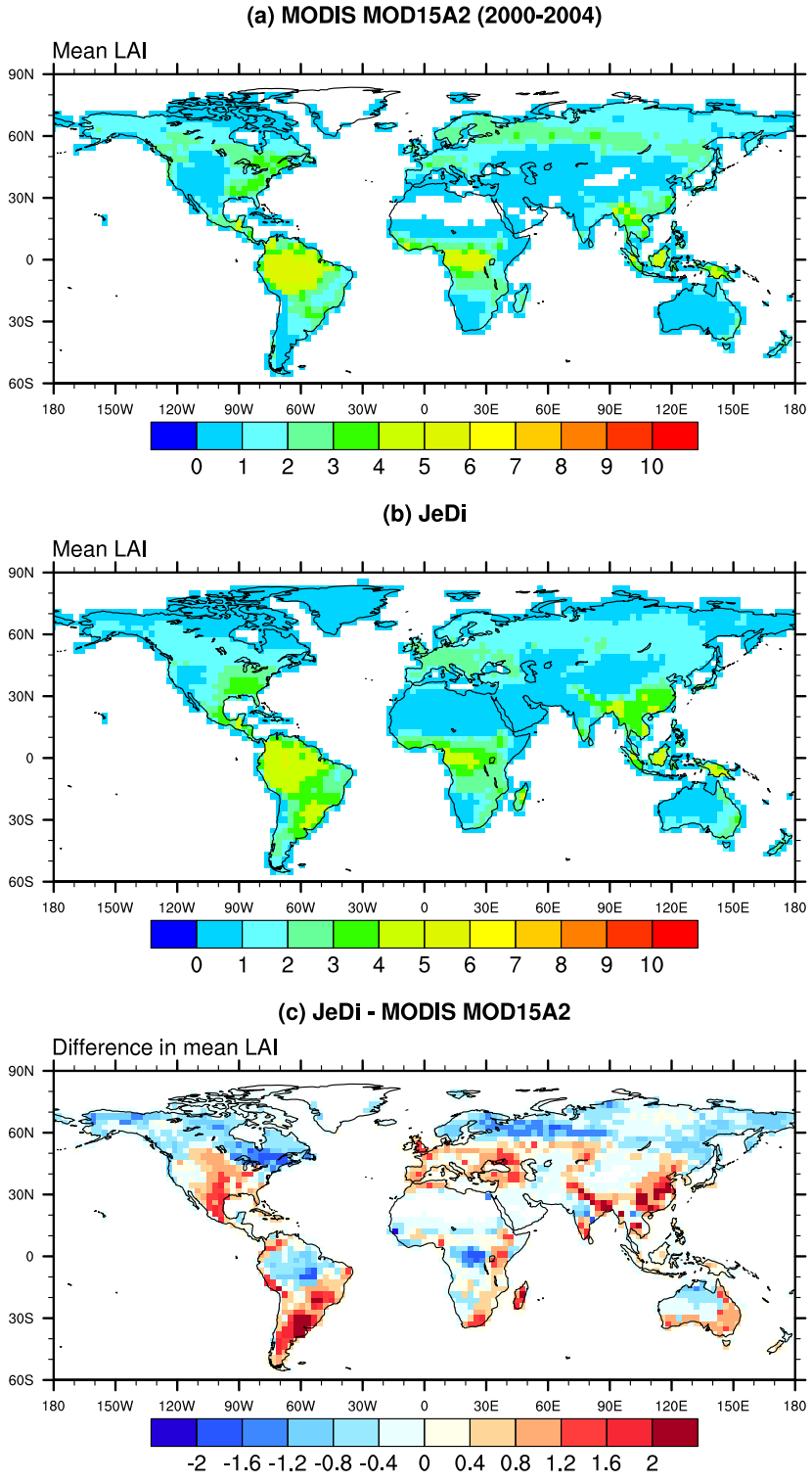

Figure S2: Mean leaf area index for years 2000–2004 from **(a)** MODIS MOD15A2 Collection 4 LAI product (Myneni et al., 2002; Zhao et al., 2005); **(b)** as simulated by JeDi-DGVM; and **(c)** the difference between the MODIS observations and the JeDi-DGVM model output.

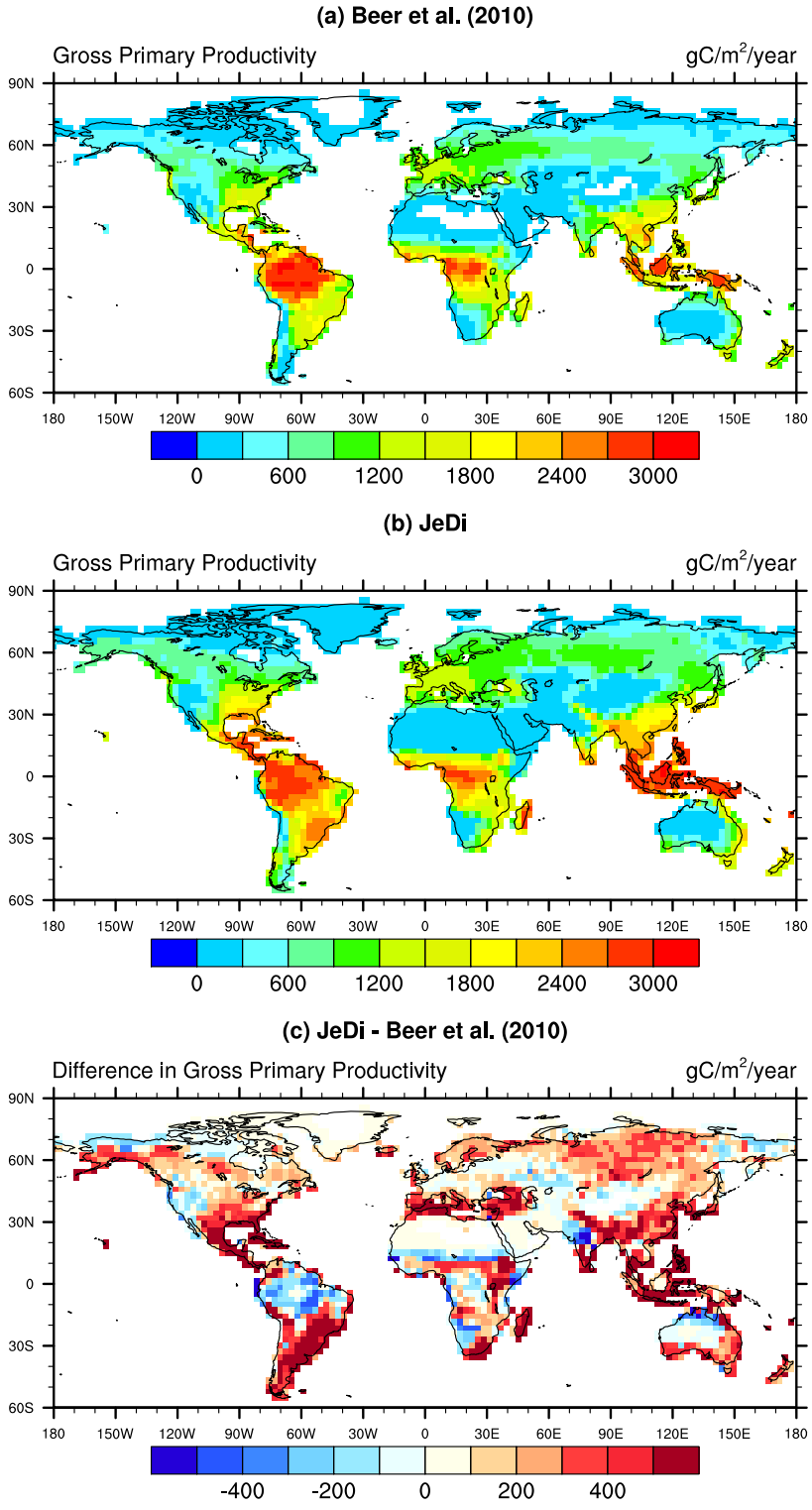

Figure S3: **(a)** Data-driven model estimate of mean annual gross primary productivity for years 1998–2005 (Beer et al., 2010); **(b)** mean annual terrestrial gross primary productivity from JeDi-DGVM for years 1998–2004; and **(c)** the difference between the data-driven model estimate and the JeDi-DGVM model output.

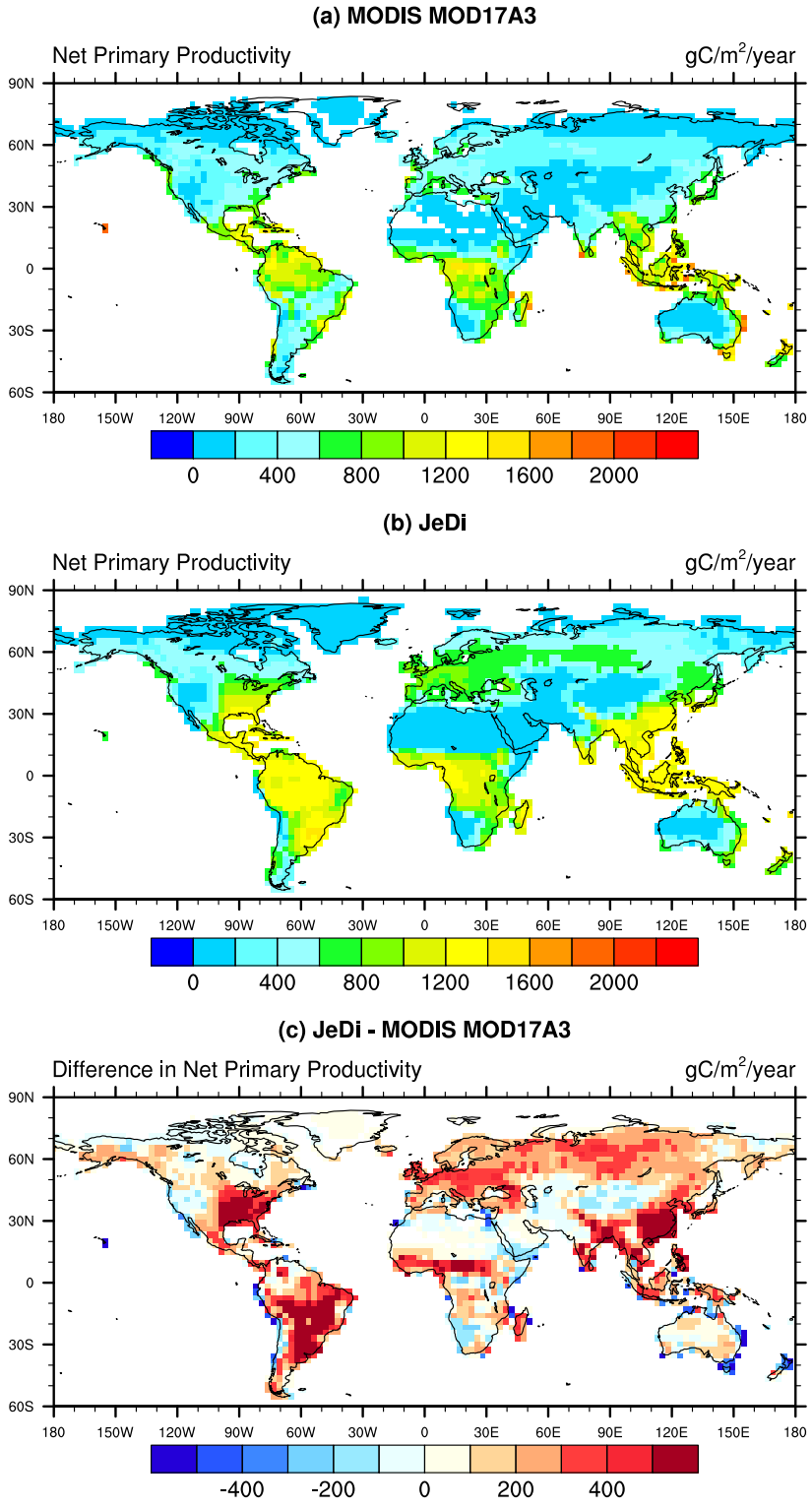

Figure S4: Mean annual net primary productivity for years 2000–2004 from **(a)** MODIS MOD17A3 Collection 4.5 product (Heinsch et al., 2006; Zhao et al., 2005, 2006); **(b)** as simulated by JeDi-DGVM; and **(c)** the difference between the MODIS product and the JeDi-DGVM model output.

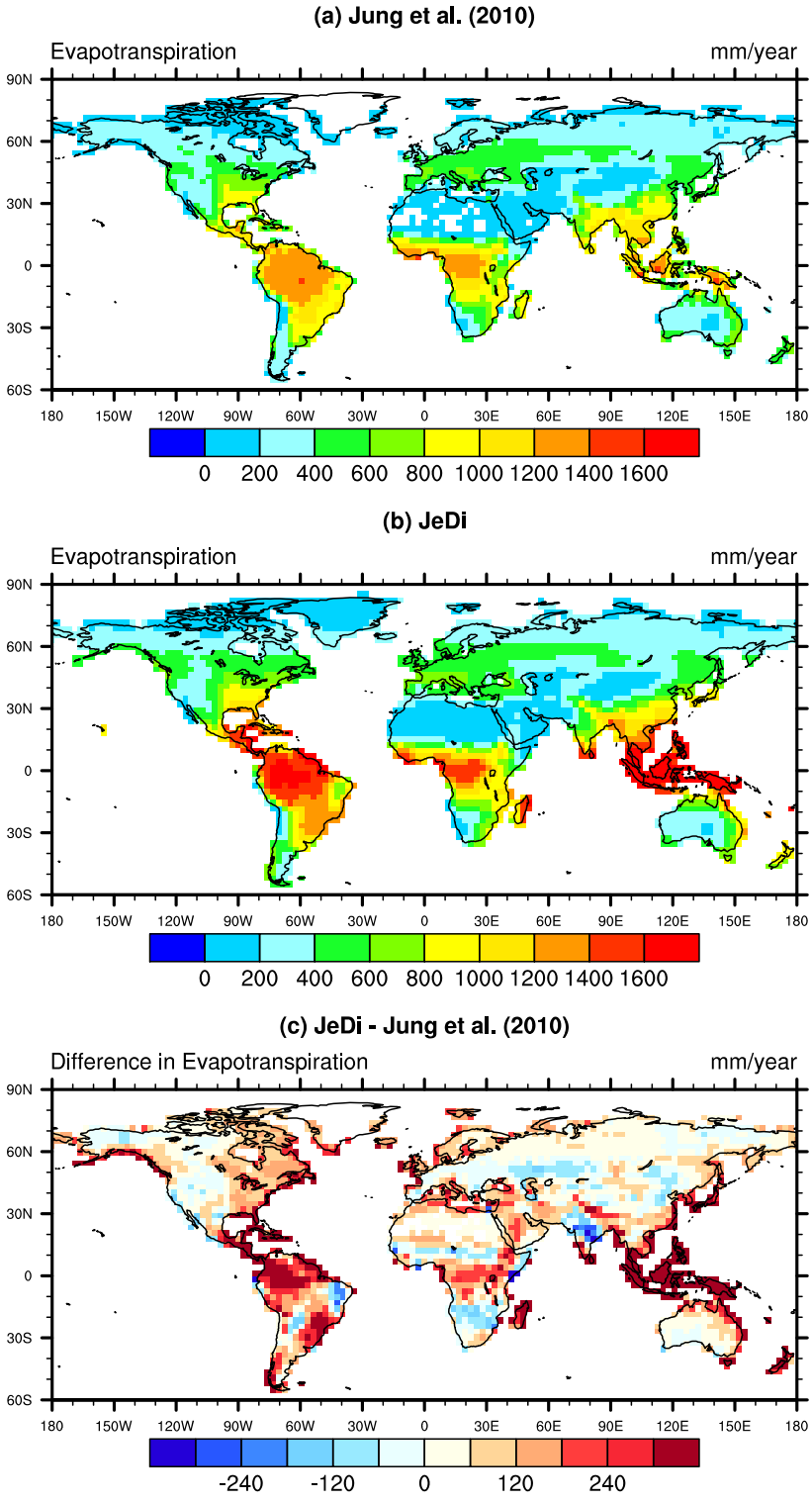

Figure S5: **(a)** Data-driven model estimate of mean annual evapotranspiration for years 1982–2008 (Jung et al., 2010); **(b)** mean annual evapotranspiration as simulated by JeDi-DGVM for years 1982–2004; and **(c)** the difference between the data-driven model estimate and the JeDi-DGVM model output.

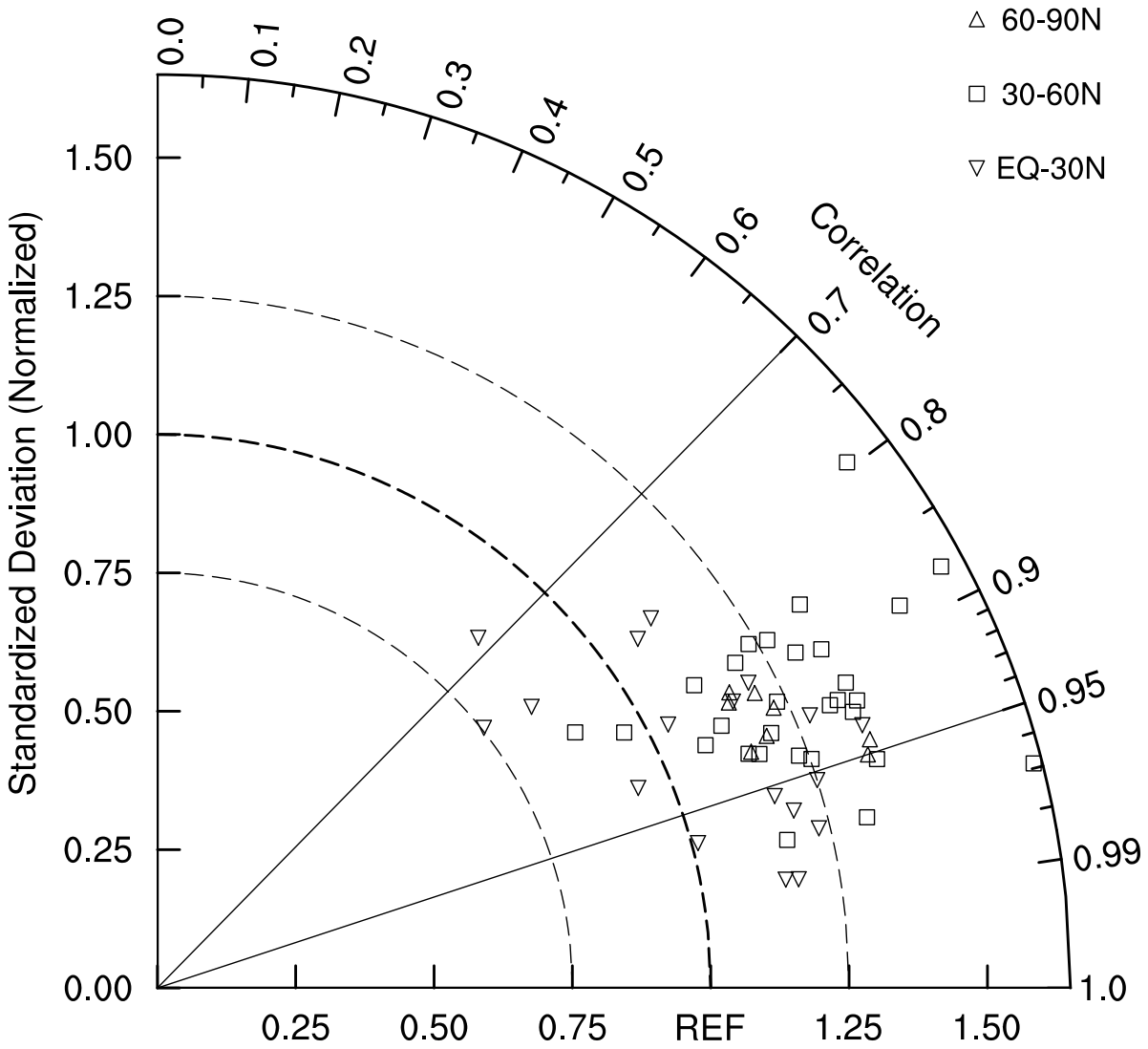

Figure S6: Taylor diagram comparing the simulated mean annual cycle of atmospheric CO_2 for years 1991–2000 to GLOBALVIEW observations at 57 stations in the Northern Hemisphere. The annual cycle of atmospheric CO_2 was computed by applying TRANSCOM impulse response functions (Gurney et al. 2004) to the monthly NEE fluxes simulated by JeDi-DGVM.

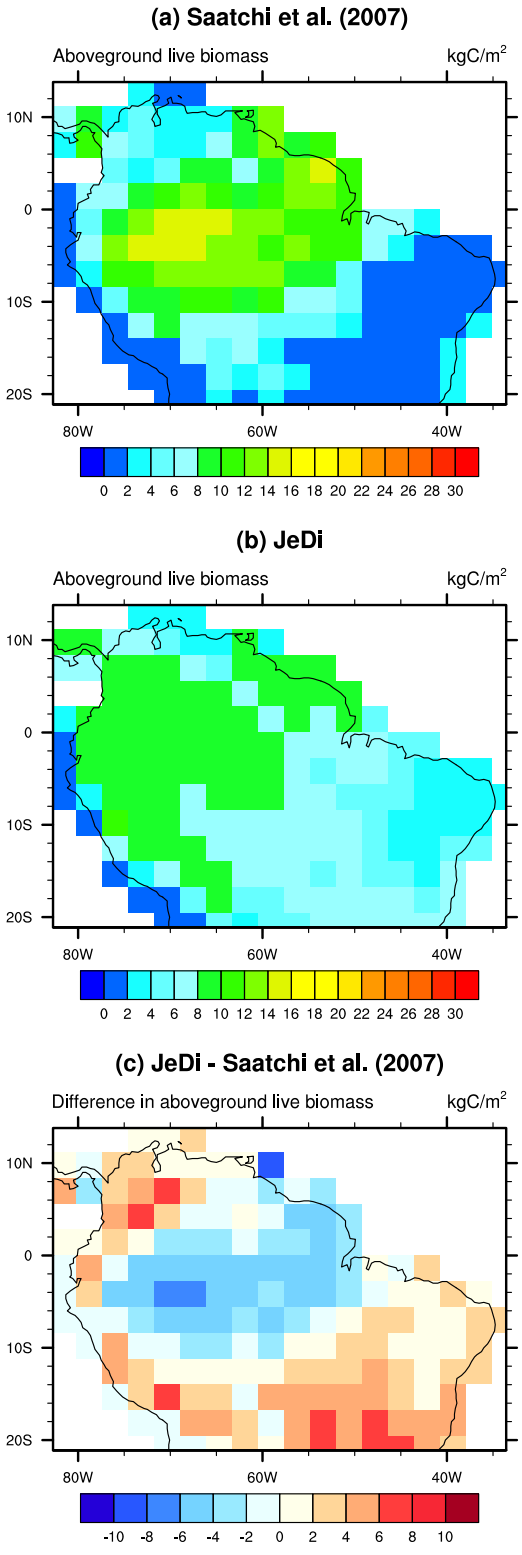

Figure S7: Aboveground live biomass in the Amazon Basin from **(a)** observation-based estimates using plot measurements and remote sensing data (Saatchi et al., 2007); **(b)** as simulated by JeDi-DGVM at model year 2000; and **(c)** the difference between the observation-based estimates and the JeDi-DGVM model output.

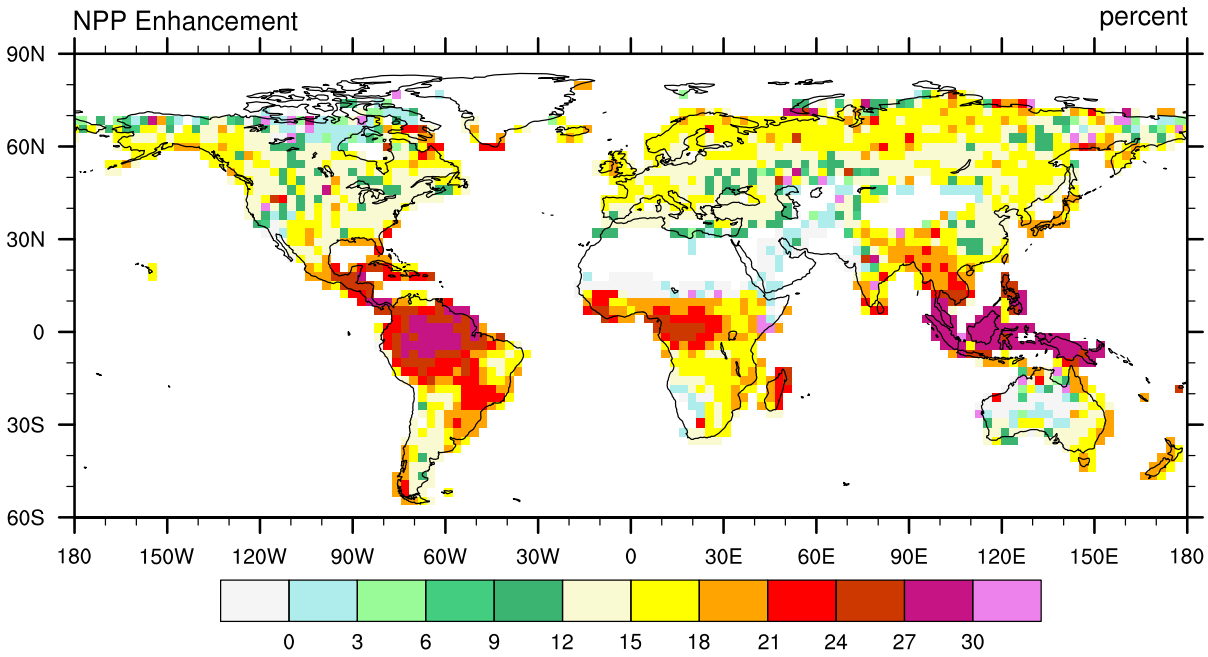

Figure S8: Geographic pattern of the simulated enhancement of net primary productivity (NPP) due to a step increase of atmospheric CO_2 concentrations from ambient to 550 ppm. NPP values averaged over the period 1997–2001.

References

Beer, C., Reichstein, M., Tomelleri, E., Ciais, P., Jung, M., Carvalhais, N., Rodenbeck, C., Arain, M. A., Baldocchi, D. D., Bonan, G., Bondeau, A., Cescatti, A., Lasslop, G., Lindroth, A., Lomas, M., Luyssaert, S., Margolis, H., Oleson, K. W., Roupsard, O., Veenendaal, E., Viovy, N., Williams, C., Woodward, F. I., and Papale, D.: Terrestrial gross carbon dioxide uptake: global distribution and covariation with climate, Science, 329, 834–838, 2010.

Gurney, K., Law, R., Denning, A., Rayner, P., Pak, B., Baker, D., Bousquet, P., Bruhwiler, L., Chen, Y., Ciais, P., Fung, I., Heimann, M., John, J., Maki, T., Maksyutov, S., Peylin, P., Prather, M., and Taguchi, S.: Transcom 3 inversion intercomparison: model mean results for the estimation of seasonal carbon sources and sinks, Global Biogeochem. Cy., 18, GB1010, doi:10.1029/2003GB002111, 2004.

Heinsch, F., Zhao, M., Running, S. W., Kimball, J. S., Nemani, R. R., Davis, K. J., Bolstad, P. V., Cook, B. D., Desai, A. R., Ricciuto, D. M., Law, B. E., Oechel, W. C., Kwon, H., Luo, H., Wofsy, S. C., Dunn, A. L., Munger, J. W., Baldocchi, D. D., Xu, L., Hollinger, D. Y., Richardson, A. D., Stoy, P. C., Siqueira, M. B. S., Monson, R. K., Burns, S. P., and Flanagan, L. B.: Evaluation of remote sensing based terrestrial productivity from MODIS using regional tower eddy flux network observations, IEEE T. Geosci. Remote, 44, 1908–1925, 2006.

Jung, M., Reichstein, M., Ciais, P., Seneviratne, S. I., Sheffield, J., Goulden, M. L., Bonan, G., Cescatti, A., Chen, J., de Jeu, R., Dolman, A. J., Eugster, W., Gerten, D., Gianelle, D., Gobron, N., Heinke, J., Kimball, J., Law, B. E., Montagnani, L., Mu, Q., Mueller, B., Oleson, K. W., Papale, D., Richardson, A. D., Roupsard, O., Running, S., Tomelleri, E., Viovy, N., Weber, U., Williams, C., Wood, E. F., Zaehle, S., and Zhang, K.: Recent decline in the global land evapotranspiration trend due to limited moisture supply, Nature, 467, 951–954, 2010.

Myneni, R., Hoffman, S., Knyazikhin, Y., Privette, J. L., Glassy, J., Tian, Y., Wang, Y., Song, X., Zhang, Y., Smith, G., Lotsch, A., Friedl, M., Morisette, J., Votava, P., Nemani, R. R., and Running, S.: Global products of vegetation leaf area and fraction absorbed PAR from year one of MODIS data, Remote Sens. Environ., 83, 214–231, 2002.

Saatchi, S. S., Houghton, R. A., Alvala, R. C. D. S., Soares, J. V., and Yu, Y.: Distribution of aboveground live biomass in the Amazon Basin, Glob. Change Biol., 13, 816–837, 2007.

Zhao, M., Heinsch, F., Nemani, R. R., and Running, S.: Improvements of the MODIS terrestrial gross and net primary production global data set, Remote Sens. Environ., 95, 164–176, 2005.

Zhao, M., Running, S. W., and Nemani, R. R.: Sensitivity of Moderate Resolution Imaging Spectroradiometer (MODIS) terrestrial primary production to the accuracy of meteorological reanalyses, J. Geophys. Res.-Biogeo., 111, G01002, doi:10.1029/2004JG000004, 2006.