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Modelling the response of net primary productivity of the Zambezi teak forests to climate change along a rainfall gradient in Zambia

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Supplementary information

Table S1. Soil physical and chemical properties used for the simulations in LPJ-GUESS model

Site	Horizon (cm)	0 - 10	10 -20.	20 - 30	30 - 50	50 - 100	100 - 120	120 - 150	Average value
Sesheke	Nitrogen (%)	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Clay (%)	0.43	0.43	0.43	0.60	0.60	0.60	0.60	0.53
	Silt (%)	0.46	0.49	0.46	0.60	0.60	0.60	0.60	0.54
	Fine sand (%)	36.07	36.15	36.74	35.20	36.40	35.50	32.50	35.51
	Course sand (%)	63.04	62.94	62.37	63.60	62.40	63.30	66.30	63.42
	pH-H2O	5.60	5.60	5.60	5.61	5.43	5.43	5.60	5.55
	Organic carbon (%)	0.75	0.68	0.64	1.16	0.78	0.67	0.74	0.77
	Bulky density (g/m3)	1.46	1.50	1.55	1.57	1.60	1.56	1.56	1.54
Namwala	Nitrogen (%)	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03
	Clay (%)	0.60	0.56	0.60	0.60	0.51	0.51	0.51	0.56
	Silt (%)	0.34	0.46	0.53	0.69	0.69	0.60	0.57	0.55
	Fine sand (%)	59.81	62.77	62.81	63.74	61.77	63.96	67.67	63.22
	Course sand (%)	39.26	36.21	36.11	35.11	37.03	34.94	31.24	35.70
	pH-H2O	5.76	5.77	5.72	5.67	5.69	5.74	5.80	5.74
	Organic carbon (%)	0.98	0.60	0.86	0.83	0.53	0.71	0.60	0.73
	Bulky density (g/m3)	1.53	1.58	1.53	1.52	1.51	1.53	1.50	1.53
Kabompo	Nitrogen (%)	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04
	Clay (%)	0.29	0.41	0.36	0.26	0.09	0.09	0.17	0.31
	Silt (%)	0.60	0.47	0.63	0.37	0.60	0.71	0.63	0.43
	Fine sand (%)	25.57	24.74	26.41	25.87	23.99	27.36	26.56	24.89
	Course sand (%)	73.54	74.36	72.60	73.50	75.33	71.84	72.73	74.31
	pH-H2O	5.88	6.02	5.96	5.80	5.91	5.84	5.63	5.86
	Organic carbon (%)	1.13	1.10	1.01	1.06	0.66	0.58	0.76	0.90
	Bulky density (g/m3)	1.56	1.65	1.70	2.00	1.98	2.09	2.12	1.87

Table S2. Resolutions of all Global Circulation Models (GCMs) and characteristics of RCP 4.5 and RCP 8.5

Global Circulation Models (GCMs) resolution					
Model	**CNRM-CM5.1**	**EC-Earth**	**HADGEM2-ES**	**IPSL-CM5A-LR**	**MPI-ESM-LR**
Development Centre	CNRM-GAME & CERFACS	ECMWF	Met Office Hadley	ICMC	MPI
Horizontal resolution	T127 ~ 1.4°~ 155km	T159 ~ 1.125° ~ 125km	1.25°×1.875° ~ 139km×208km	1.9°×3.75° ~ 211km×416km	T63 ~ 1.9° ~ 211km
Vertical resolution	L31	L62	L38	L39	L47
References	(Voldoire et al., 2013)	(Hazeleger et al., 2011)	(Collins et al., 2011)	(Dufresne et al., 2013)	(Giorgetta et al., 2016; Jungclaus et al., 2013)
Representative Concentration Pathways (RCPs)					
RCP	**RCP 8.5**		**RCP 4.5**		
Radiative forcing	>8.5 W/m² in 2100		~ 4.5 W/m² at stabilization by 2100		
Concentration (ppm)	>1370 CO_2 -equiv. in 2100		~650 CO_2 -equiv. (at stabilization after 2100)		
Pathway	Rising		Stabilization without overshoot		
Characteristics	Lower rate of technology development, heavy reliance on fossil fuels, high energy intensity, and increased use of croplands and grassland driven by an increase in population		Lower energy intensity, strong reforestation programmes, decreasing use of croplands and grasslands due to yield increases and dietary changes, strong climate policies and stable methane emissions. CO2 emissions increase only slightly before decline commences around 2040.		
Reference	(Moss et al., 2010; Riahi et al., 2011; Vuuren et al., 2011)		(Moss et al., 2010; Riahi et al., 2011; Vuuren et al., 2011)		
Meaning of acronyms:					
CNRM-CM5.1 - Centre National de Recherches Météorologiques -Circulation Model version 5					
EC-EARTH - European Centre Earth model					
HADGEM2-ES - Hadley Global Environment Model 2 - Earth System					
IPSL-CM5A-LR - Institute Pierre Simon Laplace – Circulation Model 5A- Running on low resolution grid					
MPI-ESM-LR - Max-Planck-Institut für Meteorologie – Earth System Models - Running on low resolution grid					
ECMWF - European Centre for Medium-Range Weather Forecasts					
MPI - Max-Planck-Institut für Meteorologie					
ICMC - Institut Pierre Simon Laplace Climate Modelling Centre					
CNRM-GAME & CERFACS - Centre National de Recherches Météorologiques - Groupe d'étude de l'Atmosphère Météorologique and Centre Européen de Recherche et de Formation Avancée					
T – Triangular truncation (horizontally) at wave numbers 127, 159, and 63 for the respective models					
L – Level – Verticle distance from the ground level					

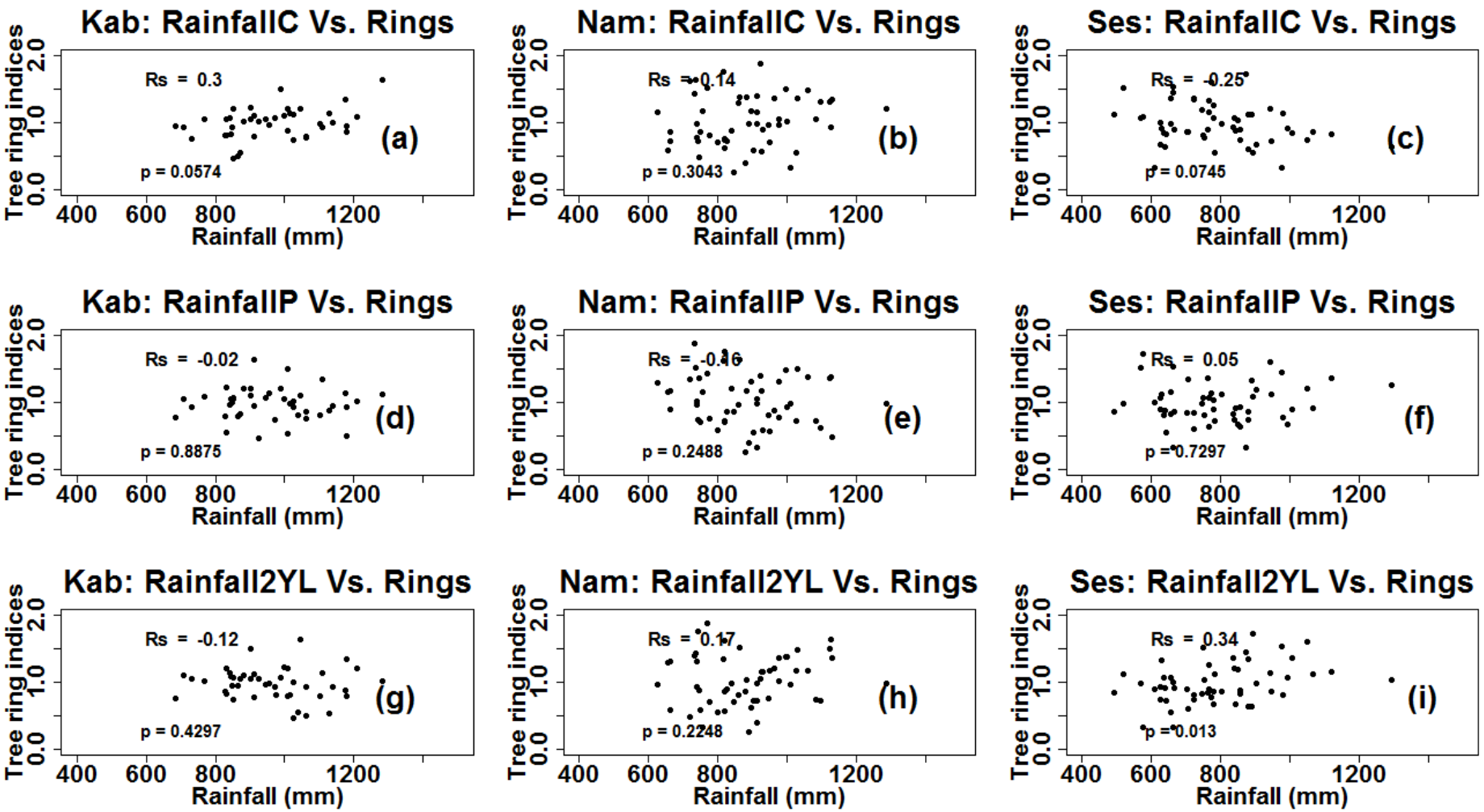

Figure S1. Spearman's correlations (Rs) between tree-ring indices and observed local total annual rainfall of the current year (a, b, and c), previous year (d, e, and f), and of the previous two years (g, h, and i) at Kabompo, Namwala and Sesheke. Kab stands for Kabompo, Nam denotes Namwala, and Ses means Sesheke. C denotes current year rainfall, P is previous year rainfall, and 2YL stands for the rainfall of previous two years.

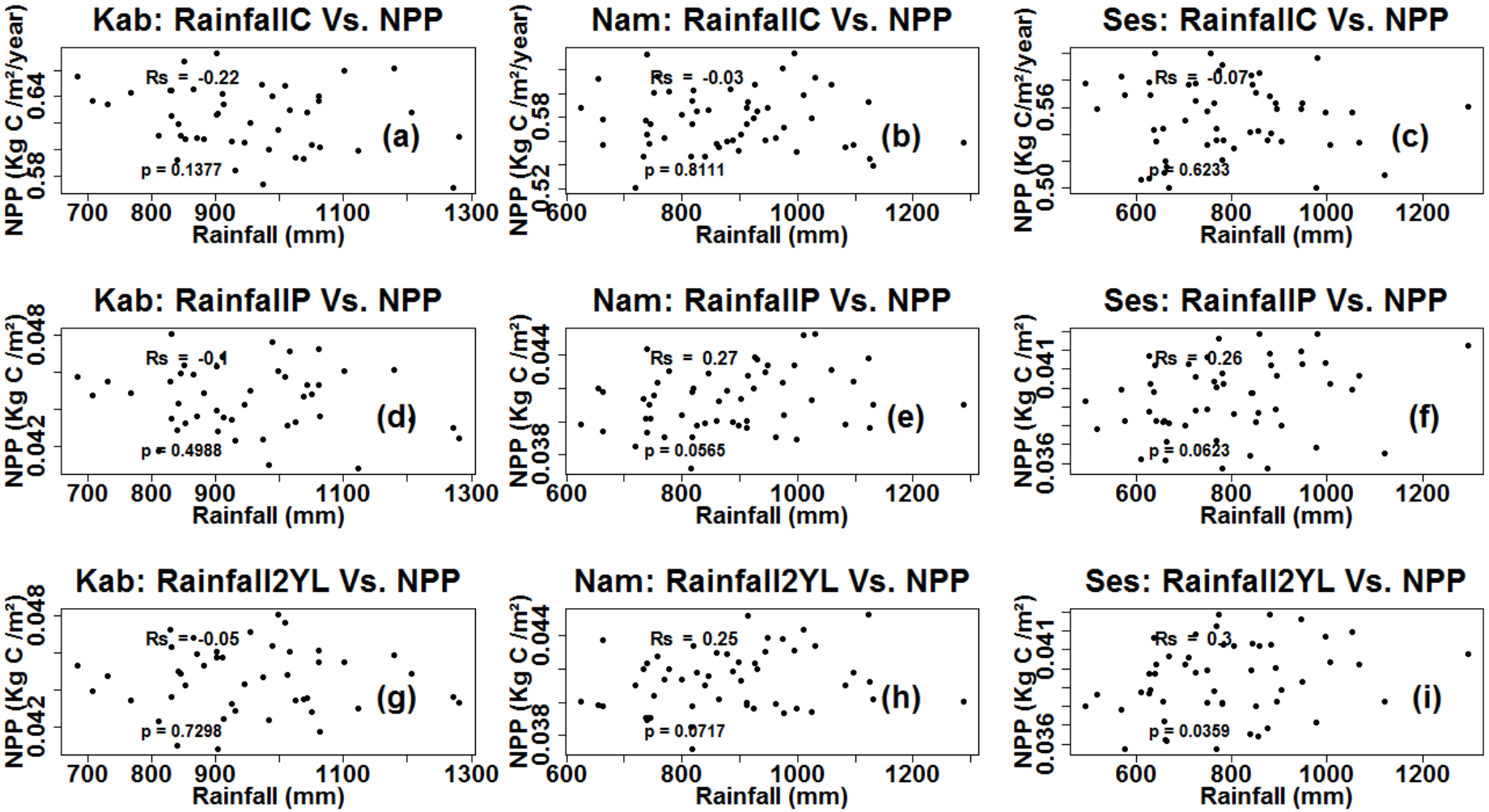

Figure S2. Spearman's correlations (Rs) between NPP and observed local total annual rainfall of the current year (a, b, and c), previous year (d, e, and f), and of the previous two years (g, h, and i) at Kabompo, Namwala and Sesheke. Kab stands for Kabompo, Nam denotes Namwala, and Ses means Sesheke. C denotes current year rainfall, P is previous year rainfall, and 2YL stands for the rainfall of previous two years.

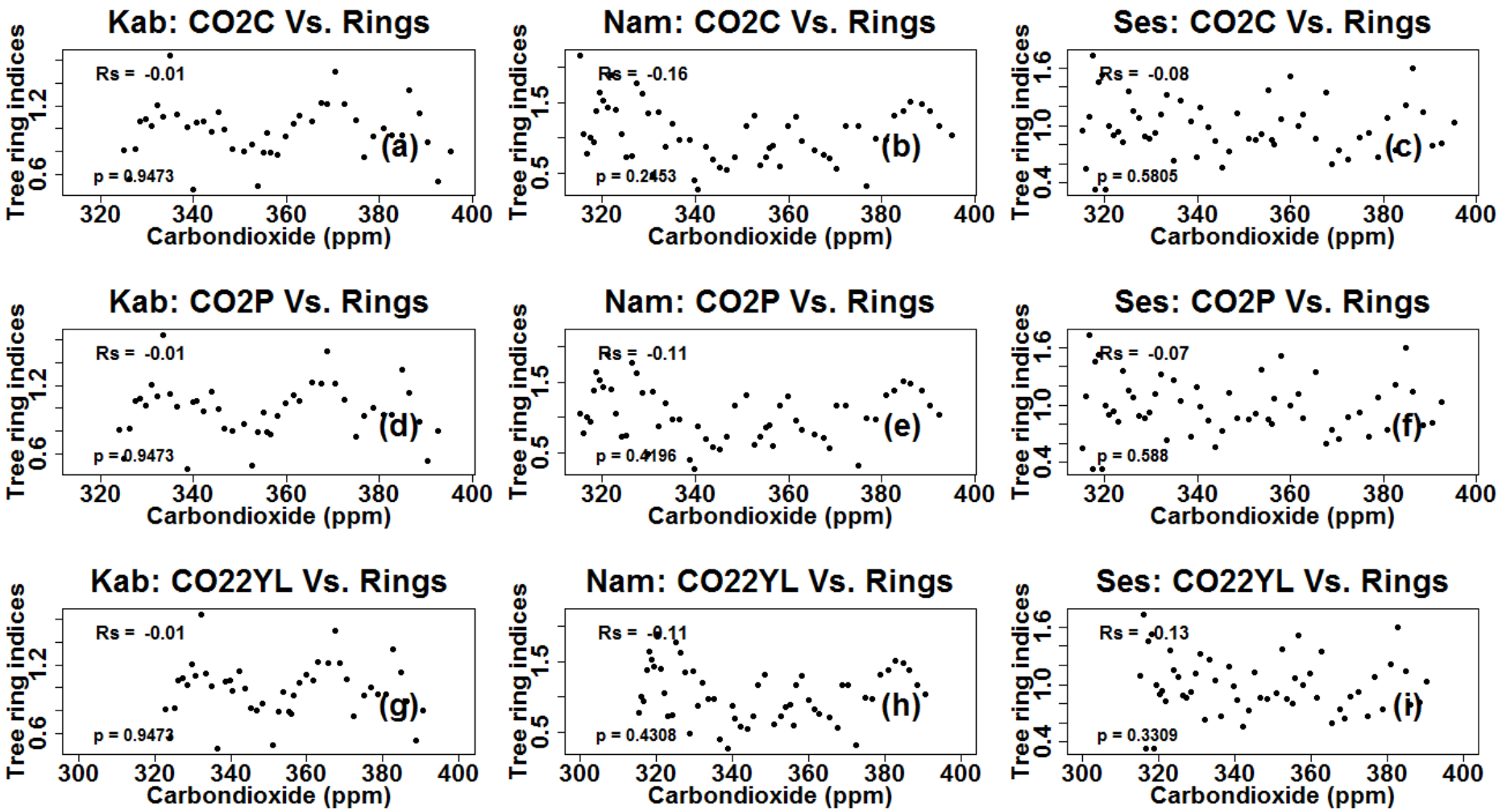

Figure S3. Spearman's correlations (Rs) between tree-ring indices and carbon dioxide (CO_2) of the current year (a, b, and c), previous year (d, e, and f), and of the previous two years (g, h, and i) at Kabompo, Namwala and Sesheke. Kab stands for Kabompo, Nam denotes Namwala, and Ses means Sesheke. C denotes current year CO_2, P is previous year CO_2, and 2YL stands for the CO_2 of previous two years.

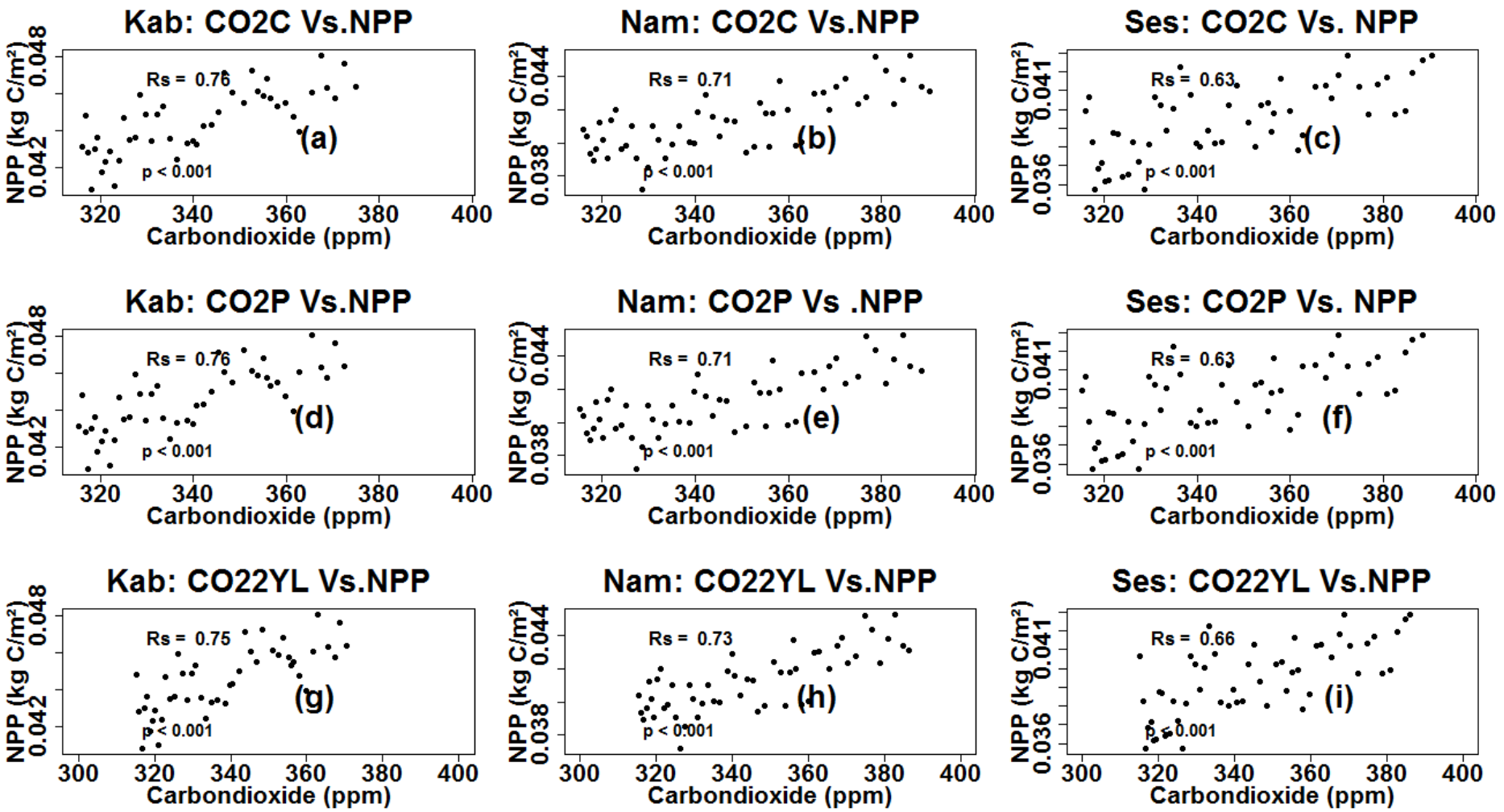

Figure S4. Spearman's correlations (Rs) between NPP and carbon dioxide (CO_2) of the current year (a, b, and c), previous year (d, e, and f), and of the previous two years (g, h, and i) at Kabompo, Namwala and Sesheke. Kab stands for Kabompo, Nam denotes Namwala, and Ses means Sesheke. C denotes current year CO_2, P is previous year CO_2, and 2YL stands for the CO_2 of previous two years.

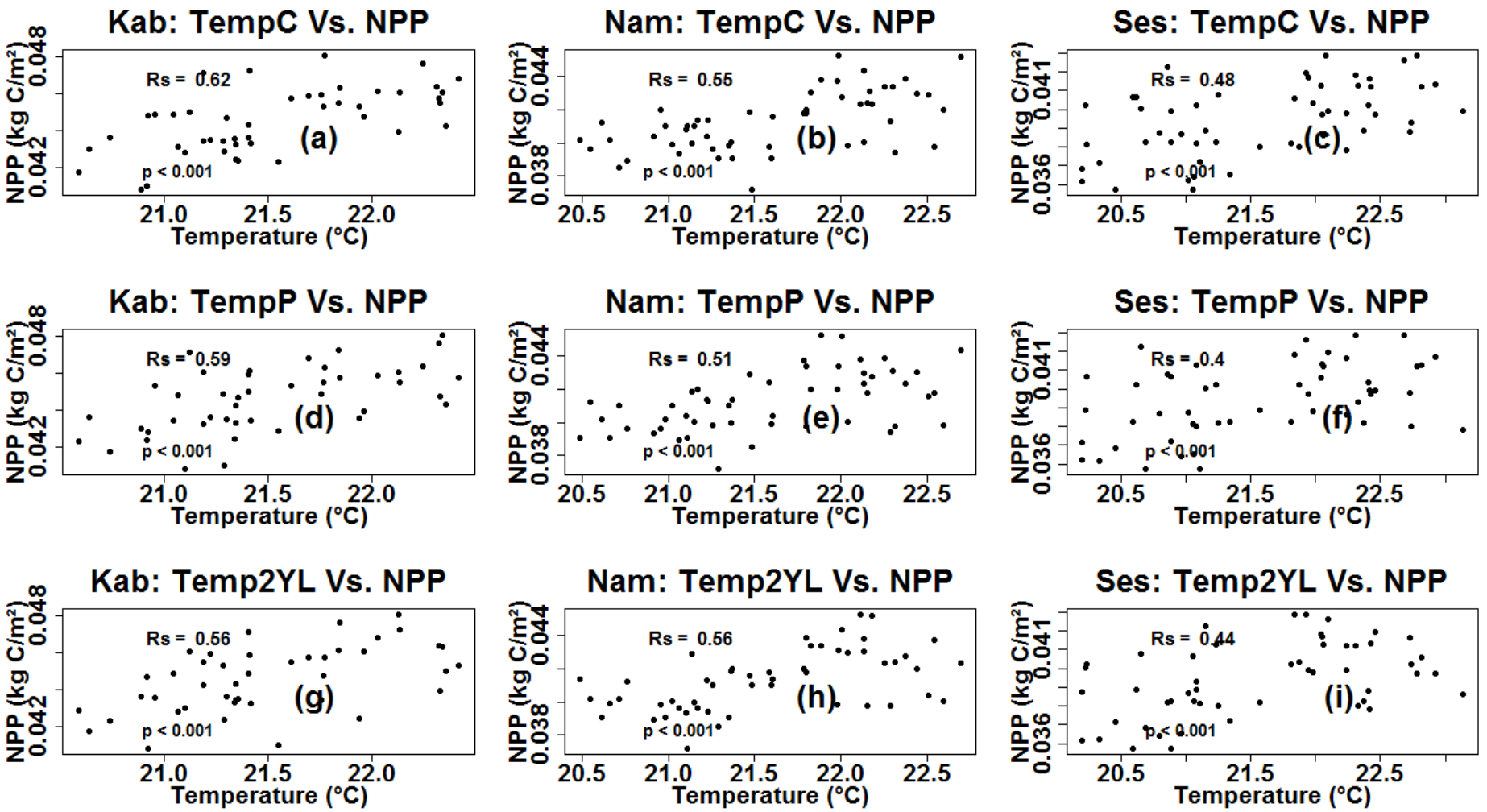

Figure S5. Spearman's correlations (Rs) between NPP and observed local mean annual temperature of the current year (a, b, and c), previous year (d, e, and f), and of the previous two years (g, h, and i) at Kabompo, Namwala and Sesheke. Kab stands for Kabompo, Nam denotes Namwala, Ses means Ses heke, and Temp stands for temperature. C denotes current year temperature, P is previous year temperature, and 2YL stands for the temperature of previous two years.

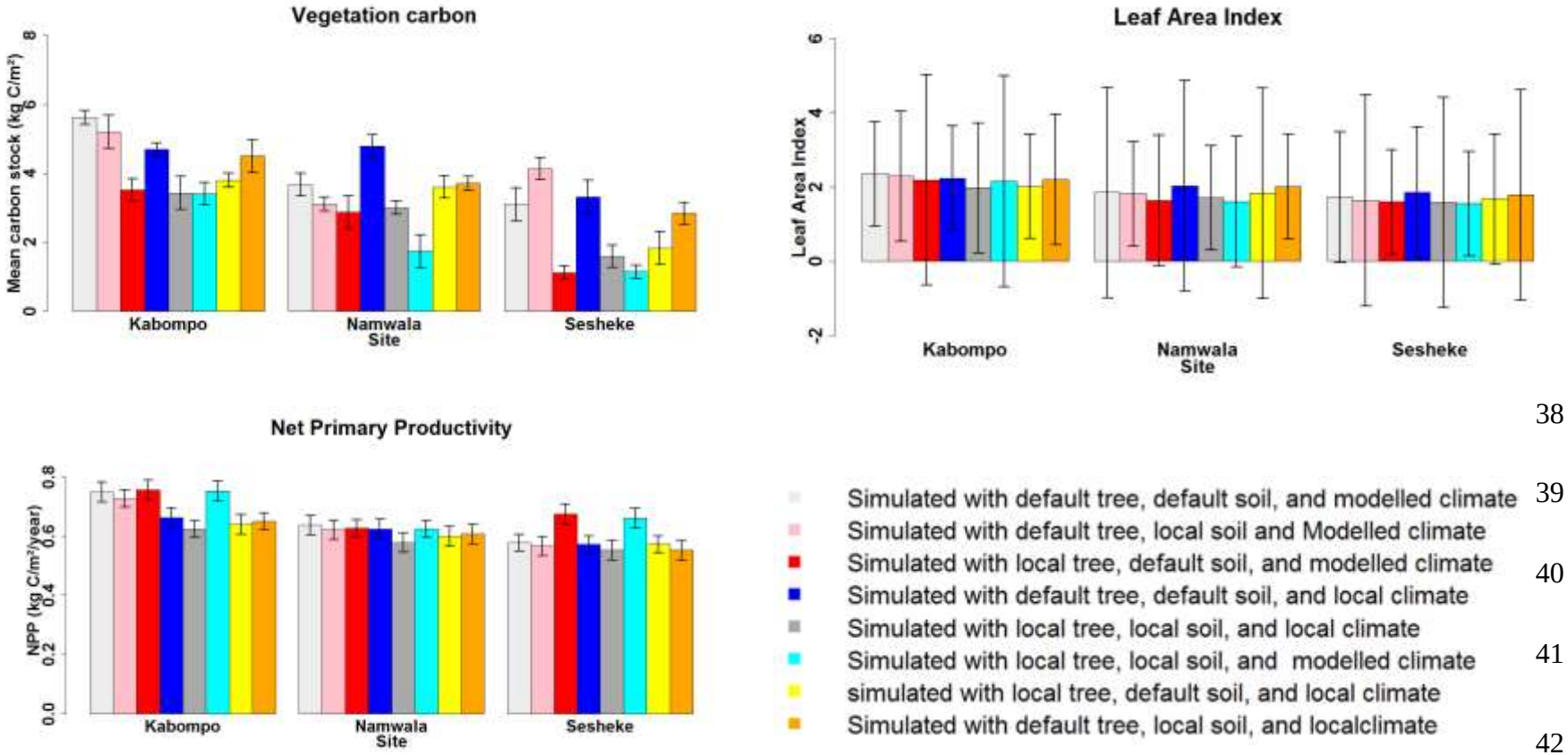

Figure S6. Mean annual vegetation carbon stocks , LAI and NPP simulated with local and default soil and tree parameter values, and forcing the model with local and modelled climate data. Simulations were done for the period 1959-2003

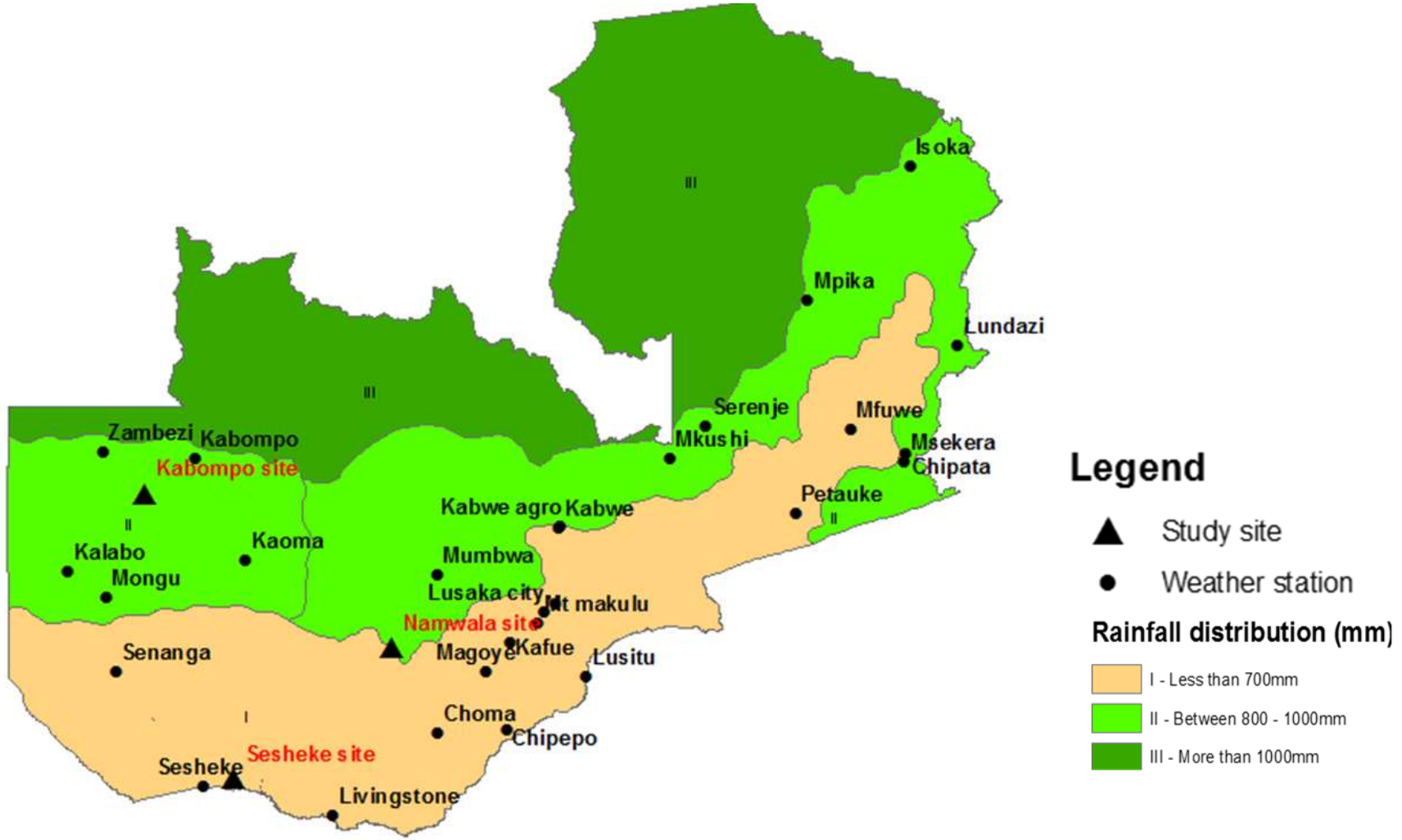

Figure S7. Study sites, weather stations and distribution of rainfall in the three ecological zones (I, II, and III). This map only shows weather stations in the two ecological zones (I and II) where we conducted our studies. These are the weather stations that supplied local climate data.

Supplementary References

Collins, W. J., Bellouin, N., Doutriaux-Bouche, M., Gedney, N., Halloran, P., Hinton, T., Hughes, J., Jones, C. D., Joshi, M., Liddicoat, S., Martin, G., O'Connor, F., Rae, J., Senior, C., Sitch, S., Totterdell, I., Wiltshire, A., and Woodward, S.: Development and evaluation of an Earth-System model - HadGEM2, Geoscientific Model Development 4, 1051–1075, 2011.

Dufresne, J.-L., Foujols, M.-A., Denvil, S., Caubel, A., Marti, O., Aumont, O., Balkanski, Y., Bekki, S., Bellenger, H., Benshila, R., Bony, S., Bopp, L., Braconnot, P., Brockmann, P., Cadule, P., Cheruy, F., Codron, F., Cozic, A., Cugnet, D., de Noblet, N., Duvel, J.-P., Ethé, C., Fairhead, L., Fichefet, T., Flavoni, S., Friedlingstein, P., Grandpeix, J.-Y., Guez, L., Guilyardi, E., Hauglustaine, D., Hourdin, F., Idelkadi, A., Ghattas, J., Joussaume, S., Kageyama, M., Krinner, G., Labetoulle, S., Lahellec, A., Lefebvre, M.-P., Lefevre, F., Levy, C., Li, Z. X., Lloyd, J., Lott, F., Madec, G., Mancip, M., Marchand, M., Masson, S., Meurdesoif, Y., Mignot, J., Musat, I., Parouty, S., Polcher, J., Rio, C., Schulz, M., Swingedouw, D., Szopa, S., Talandier, C., Terray, P., Viovy, N., and Vuichard, N.: Climate change projections using the IPSL-CM5 Earth System Model: from CMIP3 to CMIP5, Climate Dynamics, 40, 2123-2165, 2013.

Giorgetta, M. A., Jungclaus, J., Reick, C. H., Legutke, S., Bader, J., Böttinger, M., Brovkin, V., Crueger, T., Esch, M., Fieg, K., Glushak, K., Gayler, V., Haak, H., Hollweg, H. D., Ilyina, T., Kinne, S., Kornblueh, L., Matei, D., Mauritsen, T., Mikolajewicz, U., Mueller, W., Notz, D., Pithan, F., Raddatz, T., Rast, S., Redler, R., Roeckner, E., Schmidt, H., Schnur, R., Segschneider, J., Six, K. D., Stockhause, M., Timmreck, C., Wegner, J., Widmann, H., Wieners, K. H., Claussen, M., Marotzke, J., and Stevens, B.: Climate and carbon cycle changes from 1850 to 2100 in MPI-ESM simulations for the Coupled Model Intercomparison Project phase 5, J. Adv. Model. Earth Syst., 5, 572-597, 2016.

Hazeleger , W., Wang, X., Severijns, C., tefa˘nescu, S. S., Bintanja, R., Sterl, A., Wyser, K., Semmler, T., Yang, S., Van den Hurk, B., Van Noije, T., Van der Linden, E., and Van der Wiel, K.: EC-Earth V2.2: description and validation of a new seamless earth system prediction model, Climate Dynamics, doi: 10.1007/s00382-011-1228-5, 2011. 2011.

Jungclaus, J. H., Fischer, N., Haak, H., Lohmann, K., Marotzke, J., Matei, D., Mikolajewicz, U., Notz, D., and Storch, J. S.: Characteristics of the ocean simulations in the Max Planck Institute Ocean Model (MPIOM) the ocean component of the MPI-Earth system model, J. Adv. Model. Earth Syst., 5, 422-446, 2013.

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., Carter, T. R., Emori, S., Kainuma, M., Kram , T., Meehl, G. A., Mitchell, J. F., Nakicenovic, N., Riahi, K., Smith, S. J., Stouffer, R. J., Thomson, A. M., Weyant, J. P., and Wilbanks, T. J.: The next generation of scenarios for climate change research and assessment, Nature, 463, 747-756, 2010.

Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., Kindermann, G., Nakicenovic, N., and Rafaj, P.: RCP 8.5-A scenario of comparatively high greenhouse gas emissions, Climatic Change, 109, 33-57, 2011.

Voldoire, A., Sanchez-Gomez, E., Salas y Mélia, D., Decharme, B., Cassou, C., Sénési, S., Valcke, S., Beau, I., Alias, A., Chevallier, M., Déqué, M., Deshayes, J., Douville, H., Fernandez, E., Madec, G., Maisonnave, E., Moine, M.-P., Planton, S., Saint-Martin, D., Szopa, S., Tyteca, S., Alkama, R., Belamari, S., Braun, A., Coquart, L., and Chauvin, F.: The CNRM-CM5.1 global climate model: description and basic evaluation, Climate Dynamics, 40, 2091-2121, 2013.

Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G. C., Kram, T., Krey, V., Lamarque, J.-F., Masui, T., Meinshausen, M., Nakicenovic, N., Smith, S. J., and Rose, S. K.: The representative concentration pathways: an overview, Climatic Change, 109, 5-31, 2011.