



Supplement of

Advancing the BRAMS wildfire–atmosphere modelling system: application to an extreme wildfire event

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Table S1: Diagnostic statistics for the Sertã wildfire period comparing simulated Smoke Optical Depth (SOD) and MERRA-2 Aerosol Optical Depth (AOD). The table lists the results for the BASELINE phase, for each simulation scenario, spatial mask (ALL or percentile thresholds P70), and background-subtraction condition (background, TRUE = background removed; FALSE = absolute values), the corresponding mean SOD and AOD, bias (SOD – AOD), mean absolute error (MAE), root-mean-square error (RMSE), Pearson correlation coefficient (r) and Spearman’s rank correlation coefficient (ρ), and coefficient of determination (R^2) and linear-regression slope and intercept between SOD and AOD.

phase	scenario	mask	background	Mean SOD	Mean AOD	Bias	MAE	RMSE	r	ρ	R^2	slope	intercept
mixed	BASE	ALL	FALSE	27.28	1.17	26.10	27.75	100.75	0.01	0.42	0.00	0.000	1.17
mixed	BASE	ALL	TRUE	27.28	0.57	26.71	27.40	100.88	0.06	0.55	0.00	0.000	0.56
mixed	BASE	P70	FALSE	90.17	1.63	88.54	89.97	183.95	-0.32	-0.41	0.10	-0.001	1.76
mixed	BASE	P70	TRUE	90.17	1.00	89.16	90.02	184.19	-0.28	-0.30	0.08	-0.001	1.10
mixed	BASE	P80	FALSE	128.27	1.63	126.63	127.90	224.68	-0.41	-0.46	0.17	-0.002	1.84
mixed	BASE	P80	TRUE	128.27	1.01	127.26	128.00	224.97	-0.37	-0.37	0.13	-0.001	1.15
mixed	BASE	P90	FALSE	200.70	1.57	199.13	200.11	305.70	-0.49	-0.47	0.24	-0.001	1.84
mixed	BASE	P90	TRUE	200.70	0.94	199.76	200.30	306.03	-0.43	-0.37	0.18	-0.001	1.12
mixed	ABSORBING	ALL	FALSE	25.35	1.17	24.17	25.82	93.53	0.01	0.42	0.00	0.000	1.17
mixed	ABSORBING	ALL	TRUE	25.35	0.57	24.78	25.48	93.66	0.06	0.56	0.00	0.000	0.56
mixed	ABSORBING	P70	FALSE	83.80	1.63	82.18	83.62	170.76	-0.32	-0.41	0.10	-0.002	1.76
mixed	ABSORBING	P70	TRUE	83.80	1.00	82.80	83.66	171.01	-0.28	-0.30	0.08	-0.001	1.10
mixed	ABSORBING	P80	FALSE	119.26	1.63	117.63	118.89	208.58	-0.41	-0.46	0.16	-0.002	1.84
mixed	ABSORBING	P80	TRUE	119.26	1.01	118.25	119.00	208.87	-0.37	-0.37	0.13	-0.001	1.15
mixed	ABSORBING	P90	FALSE	186.74	1.57	185.17	186.16	283.91	-0.48	-0.46	0.23	-0.001	1.84
mixed	ABSORBING	P90	TRUE	186.74	0.94	185.80	186.34	284.24	-0.43	-0.37	0.18	-0.001	1.13
mixed	WIDE_SIGMA	ALL	FALSE	18.15	1.17	16.98	18.65	66.56	0.02	0.42	0.00	0.000	1.17
mixed	WIDE_SIGMA	ALL	TRUE	18.15	0.57	17.58	18.30	66.69	0.06	0.56	0.00	0.001	0.56
mixed	WIDE_SIGMA	P70	FALSE	60.01	1.63	58.38	59.86	121.51	-0.32	-0.40	0.10	-0.002	1.76
mixed	WIDE_SIGMA	P70	TRUE	60.01	1.00	59.01	59.89	121.75	-0.28	-0.30	0.08	-0.002	1.10
mixed	WIDE_SIGMA	P80	FALSE	85.43	1.63	83.80	85.10	148.43	-0.41	-0.46	0.17	-0.002	1.84
mixed	WIDE_SIGMA	P80	TRUE	85.43	1.01	84.42	85.19	148.72	-0.37	-0.37	0.14	-0.002	1.16
mixed	WIDE_SIGMA	P90	FALSE	134.06	1.57	132.49	133.50	202.18	-0.49	-0.47	0.24	-0.002	1.84
mixed	WIDE_SIGMA	P90	TRUE	134.06	0.94	133.11	133.68	202.51	-0.43	-0.37	0.19	-0.001	1.13
mixed	SMALL_RG	ALL	FALSE	27.35	1.17	26.17	27.82	101.58	0.01	0.41	0.00	0.000	1.17
mixed	SMALL_RG	ALL	TRUE	27.35	0.57	26.78	27.48	101.71	0.06	0.55	0.00	0.000	0.56
mixed	SMALL_RG	P70	FALSE	90.37	1.63	88.75	90.21	185.45	-0.32	-0.41	0.10	-0.001	1.76
mixed	SMALL_RG	P70	TRUE	90.37	1.00	89.37	90.24	185.70	-0.28	-0.31	0.08	-0.001	1.10
mixed	SMALL_RG	P80	FALSE	128.48	1.63	126.85	128.13	226.51	-0.40	-0.47	0.16	-0.002	1.83
mixed	SMALL_RG	P80	TRUE	128.48	1.01	127.47	128.23	226.79	-0.37	-0.37	0.13	-0.001	1.15

mixed	SMALL_RG	P90	FALSE	200.57	1.57	199.00	200.00	307.98	-0.48	-0.46	0.23	-0.001	1.83
mixed	SMALL_RG	P90	TRUE	200.57	0.94	199.62	200.18	308.31	-0.42	-0.37	0.18	-0.001	1.12
mixed	LARGE_RG	ALL	FALSE	25.53	1.17	24.35	26.00	93.92	0.01	0.42	0.00	0.000	1.17
mixed	LARGE_RG	ALL	TRUE	25.53	0.57	24.96	25.66	94.06	0.06	0.56	0.00	0.000	0.56
mixed	LARGE_RG	P70	FALSE	84.40	1.63	82.77	84.20	171.48	-0.32	-0.40	0.10	-0.002	1.76
mixed	LARGE_RG	P70	TRUE	84.40	1.00	83.40	84.24	171.73	-0.28	-0.30	0.08	-0.001	1.10
mixed	LARGE_RG	P80	FALSE	120.12	1.63	118.49	119.74	209.47	-0.41	-0.46	0.17	-0.002	1.84
mixed	LARGE_RG	P80	TRUE	120.12	1.01	119.11	119.85	209.75	-0.37	-0.37	0.14	-0.001	1.16
mixed	LARGE_RG	P90	FALSE	188.34	1.57	186.77	187.75	285.19	-0.49	-0.47	0.24	-0.001	1.84
mixed	LARGE_RG	P90	TRUE	188.34	0.94	187.40	187.94	285.52	-0.43	-0.37	0.19	-0.001	1.13

Table S2: Diagnostic statistics for the Sertã wildfire period comparing simulated Smoke Optical Depth (SOD) and MERRA-2 Aerosol Optical Depth (AOD). The table lists the results for the CONSERVATIVE phase, for each simulation scenario, spatial mask (ALL or percentile thresholds P70), and background-subtraction condition (background, TRUE = background removed; FALSE = absolute values), the corresponding mean SOD and AOD, bias (SOD – AOD), mean absolute error (MAE), root-mean-square error (RMSE), Pearson correlation coefficient (r) and Spearman’s rank correlation coefficient (ρ), and coefficient of determination (R^2) and linear-regression slope and intercept between SOD and AOD.

phase	scenario	mask	background	Mean SOD	Mean AOD	Bias	MAE	RMSE	r	ρ	R^2	slope	intercept
mixed	BASE	ALL	FALSE	29.52	1.17	28.35	29.99	109.69	0.01	0.41	0.00	0.000	1.17
mixed	BASE	ALL	TRUE	29.52	0.57	28.96	29.65	109.82	0.06	0.55	0.00	0.000	0.56
mixed	BASE	P70	FALSE	97.59	1.63	95.96	97.40	200.27	-0.32	-0.41	0.10	-0.001	1.76
mixed	BASE	P70	TRUE	97.59	1.00	96.58	97.44	200.51	-0.28	-0.31	0.08	-0.001	1.09
mixed	BASE	P80	FALSE	138.75	1.63	137.12	138.39	244.60	-0.40	-0.47	0.16	-0.001	1.83
mixed	BASE	P80	TRUE	138.75	1.01	137.75	138.49	244.89	-0.36	-0.37	0.13	-0.001	1.15
mixed	BASE	P90	FALSE	216.59	1.57	215.02	216.01	332.59	-0.48	-0.46	0.23	-0.001	1.83
mixed	BASE	P90	TRUE	216.59	0.94	215.65	216.20	332.92	-0.42	-0.37	0.18	-0.001	1.12
mixed	ABSORBING	ALL	FALSE	28.02	1.17	26.84	28.49	103.96	0.01	0.42	0.00	0.000	1.17
mixed	ABSORBING	ALL	TRUE	28.02	0.57	27.45	28.15	104.09	0.06	0.55	0.00	0.000	0.56
mixed	ABSORBING	P70	FALSE	92.64	1.63	91.01	92.46	189.80	-0.31	-0.41	0.10	-0.001	1.76
mixed	ABSORBING	P70	TRUE	92.64	1.00	91.64	92.50	190.04	-0.28	-0.30	0.08	-0.001	1.09
mixed	ABSORBING	P80	FALSE	131.78	1.63	130.15	131.42	231.83	-0.40	-0.46	0.16	-0.002	1.83

mixed	ABSORBING	P80	TRUE	131.78	1.01	130.77	131.52	232.11	-0.36	-0.37	0.13	-0.001	1.15
mixed	ABSORBING	P90	FALSE	205.91	1.57	204.34	205.32	315.36	-0.48	-0.46	0.23	-0.001	1.83
mixed	ABSORBING	P90	TRUE	205.91	0.94	204.96	205.51	315.69	-0.42	-0.37	0.18	-0.001	1.12
mixed	WIDE_SIGMA	ALL	FALSE	23.57	1.17	22.39	24.05	86.99	0.01	0.42	0.00	0.000	1.17
mixed	WIDE_SIGMA	ALL	TRUE	23.57	0.57	23.00	23.70	87.12	0.06	0.55	0.00	0.000	0.56
mixed	WIDE_SIGMA	P70	FALSE	77.92	1.63	76.29	77.75	158.83	-0.32	-0.41	0.10	-0.002	1.76
mixed	WIDE_SIGMA	P70	TRUE	77.92	1.00	76.92	77.78	159.07	-0.28	-0.30	0.08	-0.001	1.10
mixed	WIDE_SIGMA	P80	FALSE	110.87	1.63	109.23	110.52	194.00	-0.41	-0.46	0.16	-0.002	1.84
mixed	WIDE_SIGMA	P80	TRUE	110.87	1.01	109.86	110.61	194.29	-0.37	-0.37	0.13	-0.001	1.15
mixed	WIDE_SIGMA	P90	FALSE	173.54	1.57	171.97	172.96	264.03	-0.48	-0.46	0.23	-0.002	1.84
mixed	WIDE_SIGMA	P90	TRUE	173.54	0.94	172.59	173.15	264.36	-0.43	-0.37	0.18	-0.001	1.13
mixed	SMALL_RG	ALL	FALSE	25.62	1.17	24.45	26.11	95.60	0.01	0.41	0.00	0.000	1.17
mixed	SMALL_RG	ALL	TRUE	25.62	0.57	25.05	25.76	95.73	0.06	0.55	0.00	0.000	0.56
mixed	SMALL_RG	P70	FALSE	84.68	1.63	83.05	84.54	174.53	-0.32	-0.42	0.10	-0.002	1.76
mixed	SMALL_RG	P70	TRUE	84.68	1.00	83.67	84.56	174.77	-0.28	-0.31	0.08	-0.001	1.09
mixed	SMALL_RG	P80	FALSE	120.34	1.63	118.70	120.01	213.16	-0.40	-0.47	0.16	-0.002	1.83
mixed	SMALL_RG	P80	TRUE	120.34	1.01	119.33	120.10	213.45	-0.36	-0.37	0.13	-0.001	1.15
mixed	SMALL_RG	P90	FALSE	187.50	1.57	185.93	186.96	289.73	-0.48	-0.46	0.23	-0.001	1.83
mixed	SMALL_RG	P90	TRUE	187.50	0.94	186.56	187.13	290.06	-0.42	-0.37	0.18	-0.001	1.12
mixed	LARGE_RG	ALL	FALSE	30.77	1.17	29.60	31.24	113.93	0.01	0.42	0.00	0.000	1.17
mixed	LARGE_RG	ALL	TRUE	30.77	0.57	30.21	30.90	114.06	0.06	0.55	0.00	0.000	0.56
mixed	LARGE_RG	P70	FALSE	101.73	1.63	100.11	101.53	208.01	-0.32	-0.41	0.10	-0.001	1.76
mixed	LARGE_RG	P70	TRUE	101.73	1.00	100.73	101.57	208.25	-0.28	-0.30	0.08	-0.001	1.10
mixed	LARGE_RG	P80	FALSE	144.72	1.63	143.08	144.33	254.06	-0.41	-0.46	0.16	-0.001	1.83
mixed	LARGE_RG	P80	TRUE	144.72	1.01	143.71	144.44	254.35	-0.37	-0.37	0.13	-0.001	1.15
mixed	LARGE_RG	P90	FALSE	226.28	1.57	224.71	225.67	345.62	-0.48	-0.46	0.23	-0.001	1.84
mixed	LARGE_RG	P90	TRUE	226.28	0.94	225.33	225.87	345.95	-0.43	-0.37	0.18	-0.001	1.12

Table S3: Diagnostic statistics for the Sertã wildfire period comparing simulated Smoke Optical Depth (SOD) and MERRA-2 Aerosol Optical Depth (AOD). The table lists the results for the LOWER ENVELOPE phase, for each simulation scenario, spatial mask (ALL or percentile thresholds P70), and background-subtraction condition (background, TRUE = background removed; FALSE = absolute values), the corresponding mean SOD and AOD, bias (SOD – AOD), mean absolute error (MAE), root-mean-square error (RMSE), Pearson correlation coefficient (r) and Spearman’s rank correlation coefficient (ρ), and coefficient of determination (R^2) and linear-regression slope and intercept between SOD and AOD.

phase	scenario	mask	background	Mean SOD	Mean AOD	Bias	MAE	RMSE	r	ρ	R^2	slope	intercept
mixed	BASE	ALL	FALSE	26.24	1.17	25.07	26.72	97.51	0.01	0.41	0.00	0.000	1.17
mixed	BASE	ALL	TRUE	26.24	0.57	25.67	26.38	97.65	0.06	0.55	0.00	0.000	0.56
mixed	BASE	P70	FALSE	86.75	1.63	85.12	86.59	178.04	-0.31	-0.41	0.10	-0.001	1.76

mixed	BASE	P70	TRUE	86.75	1.00	85.75	86.62	178.28	-0.28	-0.31	0.08	-0.001	1.09
mixed	BASE	P80	FALSE	123.36	1.63	121.72	123.01	217.45	-0.40	-0.47	0.16	-0.002	1.83
mixed	BASE	P80	TRUE	123.36	1.01	122.35	123.11	217.74	-0.36	-0.37	0.13	-0.001	1.15
mixed	BASE	P90	FALSE	192.56	1.57	190.99	191.99	295.72	-0.48	-0.46	0.23	-0.001	1.83
mixed	BASE	P90	TRUE	192.56	0.94	191.61	192.17	296.04	-0.42	-0.37	0.18	-0.001	1.12
mixed	ABSORBING	ALL	FALSE	25.52	1.17	24.35	26.01	94.73	0.01	0.42	0.00	0.000	1.17
mixed	ABSORBING	ALL	TRUE	25.52	0.57	24.95	25.66	94.86	0.06	0.55	0.00	0.000	0.56
mixed	ABSORBING	P70	FALSE	84.40	1.63	82.77	84.23	172.95	-0.31	-0.41	0.10	-0.002	1.76
mixed	ABSORBING	P70	TRUE	84.40	1.00	83.40	84.27	173.19	-0.28	-0.30	0.08	-0.001	1.09
mixed	ABSORBING	P80	FALSE	120.06	1.63	118.43	119.71	211.25	-0.40	-0.46	0.16	-0.002	1.83
mixed	ABSORBING	P80	TRUE	120.06	1.01	119.05	119.81	211.54	-0.36	-0.37	0.13	-0.001	1.15
mixed	ABSORBING	P90	FALSE	187.59	1.57	186.02	187.02	287.39	-0.48	-0.46	0.23	-0.001	1.83
mixed	ABSORBING	P90	TRUE	187.59	0.94	186.65	187.20	287.72	-0.42	-0.37	0.18	-0.001	1.12
mixed	WIDE_SIGMA	ALL	FALSE	22.83	1.17	21.65	23.32	84.37	0.01	0.42	0.00	0.000	1.17
mixed	WIDE_SIGMA	ALL	TRUE	22.83	0.57	22.26	22.97	84.50	0.06	0.55	0.00	0.000	0.56
mixed	WIDE_SIGMA	P70	FALSE	75.47	1.63	73.84	75.31	154.04	-0.31	-0.41	0.10	-0.002	1.76
mixed	WIDE_SIGMA	P70	TRUE	75.47	1.00	74.47	75.34	154.28	-0.28	-0.30	0.08	-0.001	1.09
mixed	WIDE_SIGMA	P80	FALSE	107.39	1.63	105.75	107.04	188.15	-0.40	-0.46	0.16	-0.002	1.83
mixed	WIDE_SIGMA	P80	TRUE	107.39	1.01	106.38	107.14	188.44	-0.37	-0.37	0.13	-0.001	1.15
mixed	WIDE_SIGMA	P90	FALSE	168.01	1.57	166.43	167.44	256.05	-0.48	-0.46	0.23	-0.002	1.84
mixed	WIDE_SIGMA	P90	TRUE	168.01	0.94	167.06	167.62	256.38	-0.43	-0.37	0.18	-0.001	1.12
mixed	SMALL_RG	ALL	FALSE	21.48	1.17	20.31	21.99	80.04	0.01	0.41	0.00	0.000	1.17
mixed	SMALL_RG	ALL	TRUE	21.48	0.57	20.91	21.63	80.16	0.06	0.55	0.00	0.000	0.56
mixed	SMALL_RG	P70	FALSE	71.00	1.63	69.37	70.88	146.12	-0.31	-0.41	0.10	-0.002	1.76
mixed	SMALL_RG	P70	TRUE	71.00	1.00	70.00	70.90	146.36	-0.28	-0.31	0.08	-0.001	1.09
mixed	SMALL_RG	P80	FALSE	100.92	1.63	99.29	100.62	178.47	-0.40	-0.47	0.16	-0.002	1.83
mixed	SMALL_RG	P80	TRUE	100.92	1.01	99.91	100.70	178.76	-0.36	-0.37	0.13	-0.001	1.15
mixed	SMALL_RG	P90	FALSE	157.33	1.57	155.76	156.81	242.64	-0.48	-0.46	0.23	-0.002	1.83
mixed	SMALL_RG	P90	TRUE	157.33	0.94	156.38	156.97	242.97	-0.42	-0.37	0.18	-0.001	1.12
mixed	LARGE_RG	ALL	FALSE	28.84	1.17	27.66	29.31	106.85	0.01	0.42	0.00	0.000	1.17
mixed	LARGE_RG	ALL	TRUE	28.84	0.57	28.27	28.97	106.98	0.06	0.55	0.00	0.000	0.56
mixed	LARGE_RG	P70	FALSE	95.34	1.63	93.71	95.15	195.09	-0.31	-0.41	0.10	-0.001	1.76
mixed	LARGE_RG	P70	TRUE	95.34	1.00	94.34	95.19	195.33	-0.28	-0.30	0.08	-0.001	1.09
mixed	LARGE_RG	P80	FALSE	135.63	1.63	133.99	135.25	238.28	-0.40	-0.46	0.16	-0.001	1.83
mixed	LARGE_RG	P80	TRUE	135.63	1.01	134.62	135.36	238.57	-0.37	-0.37	0.13	-0.001	1.15
mixed	LARGE_RG	P90	FALSE	211.99	1.57	210.42	211.40	324.15	-0.48	-0.46	0.23	-0.001	1.84
mixed	LARGE_RG	P90	TRUE	211.99	0.94	211.05	211.59	324.48	-0.42	-0.37	0.18	-0.001	1.12