



Supplement of

An improved dust emission model – Part 2: Evaluation in the Community Earth System Model, with implications for the use of dust source functions

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Supplementary Information for: “An improved dust emission model. Part 2: Evaluation in the Community Earth System Model, with implications for the use of dust source functions“

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Supplementary Tables

Table S1. Sensitivity of the comparison of simulation results with AERONET AOD, surface concentration, and dust deposition measurements to changes in the soil moisture sensitivity tuning parameter b (see Eq. 4). Statistically significant improvements (see Section 2.4) of Simulations II-IV relative to the ‘control’ Simulation I are indicated with bold font. Additionally, simulation results that are statistically significantly improved over the results of each of the other three simulations are both bold and underlined. The results are given in the format Simulation I / II / III / IV. For computational efficiency, all runs were performed for the period 2000 – 2011 and the simulation data for the period 2001 - 2011 was used. Results in the main text are based on runs from for the period 1995 – 2011.

Soil moist. par. (b)	AERONET clim., r	AERONET clim., RMSE	AERONET seas., r	AERONET daily var., r	Dust conc. clim., r	Dust conc. clim., RMSE	Dust conc. seas., r	Dep. flux clim., r	Dep. flux clim., RMSE
0.5	0.46 / 0.76 / 0.48 / 0.77	0.20 / 0.11 / 0.21 / <u>0.11</u>	0.77 / 0.73 / 0.76 / 0.81	0.36 / 0.38 / 0.35 / 0.44	0.94 / 0.91 / 0.93 / 0.95	0.32 / 0.37 / 0.33 / 0.25	0.61 / 0.59 / 0.60 / 0.62	0.78 / 0.80 / 0.77 / 0.72	0.92 / 0.87 / 0.93 / 0.98
1	0.60 / 0.64 / 0.64 / <u>0.75</u>	0.14 / 0.13 / 0.13 / <u>0.11</u>	0.80 / 0.75 / 0.80 / 0.82	0.43 / 0.43 / 0.43 / 0.47	0.93 / 0.89 / 0.92 / 0.93	0.32 / 0.40 / 0.37 / 0.32	0.61 / 0.59 / 0.60 / 0.63	0.78 / 0.80 / 0.78 / 0.77	0.89 / 0.84 / 0.87 / 0.88
2	0.53 / 0.54 / 0.62 / 0.66	0.15 / 0.15 / 0.14 / 0.13	0.77 / 0.73 / 0.78 / 0.80	0.42 / 0.42 / 0.42 / 0.45	0.93 / 0.88 / 0.92 / 0.94	0.33 / 0.41 / 0.34 / 0.29	0.58 / 0.57 / 0.57 / 0.59	0.79 / 0.80 / 0.79 / 0.78	0.90 / 0.86 / 0.88 / 0.92
$1/f_{\text{clay}}$	0.52 / 0.54 / 0.62 / 0.66	0.15 / 0.15 / 0.13 / 0.13	0.77 / 0.73 / 0.78 / 0.80	0.42 / 0.42 / 0.42 / 0.45	0.94 / 0.90 / 0.93 / 0.95	0.32 / 0.38 / 0.30 / 0.29	0.53 / 0.50 / 0.54 / 0.53	0.79 / 0.80 / 0.79 / 0.77	0.92 / 0.87 / 0.89 / 0.95

Table S2. Statistical p-values for the model comparisons reported in Tables 1 and 2. For each table entry, the p-value of the comparison of the Simulation (listed in the left column) with the other three simulations are listed in sequence of increasing simulation number. Underlined font denotes a statistically significant improvement at the 5% level.

Simulation	AERONET clim., r	AERONET clim., RMSE	AERONET seas., r	AERONET daily var., r	Dust conc. clim., r	Dust conc. clim., RMSE	Dust conc. seas., r	Dep. flux clim., r	Dep. flux clim., RMSE
II	0.38 / 0.69 / 0.98	0.36 / 0.65 / 0.99	1.00 / 0.99 / 1.00	0.38 / 0.26 / 1.00	0.9 / 0.7 / 0.73	0.84 / 0.65 / 0.71	0.94 / 0.76 / 0.77	0.03 / 0.13 / 0.01	<0.001 / 0.04 / 0.02
III	0.12 / 0.31 / 0.97	0.16 / 0.35 / 1.00	0.6 / <u>0.01</u> / 1.00	0.73 / 0.74 / 1.00	0.65 / 0.3 / 0.92	0.84 / 0.35 / 0.97	0.43 / 0.24 / 0.46	0.65 / 0.87 / 0.04	0.38 / 0.96 / 0.62
IV	<0.001 / 0.02 / 0.03	<0.001 / 0.01 / 0.002	<0.001 / <0.001 / <0.001	<0.001 / <0.001 / <0.001	0.37 / 0.27 / 0.08	0.40 / 0.29 / 0.03	0.47 / 0.23 / 0.54	0.21 / 0.99 / 0.96	0.99 / 0.98 / 0.38

Supplementary Figures

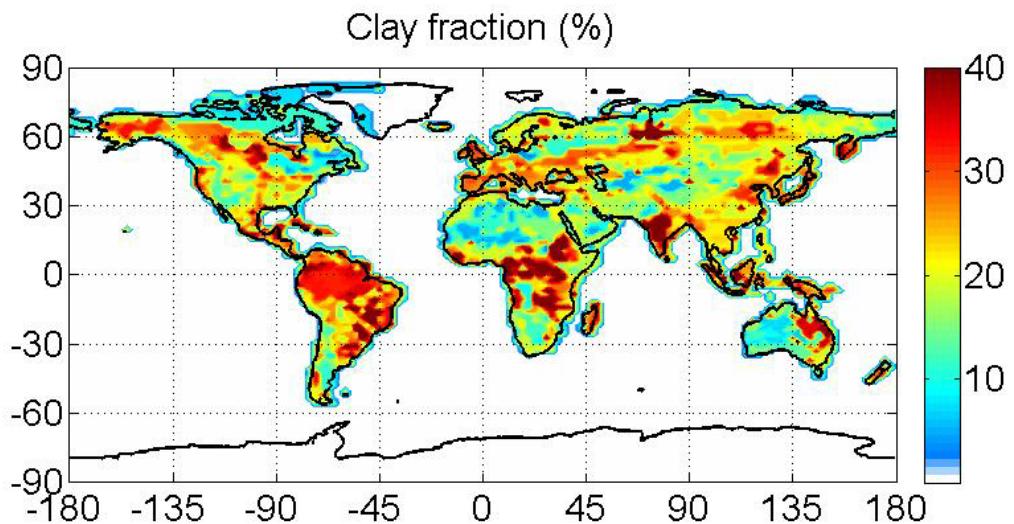
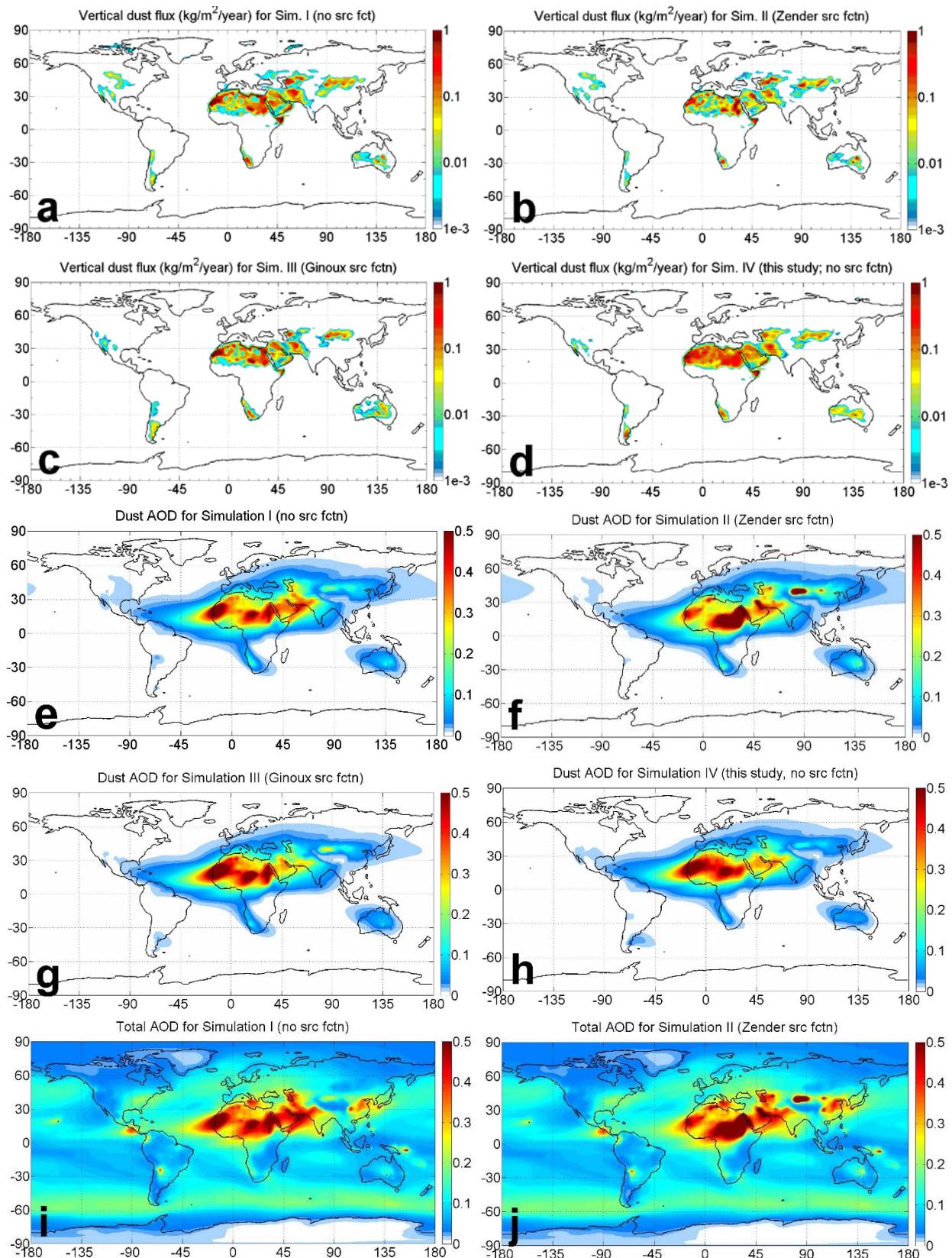


Figure S1. Map of the FAO (2012) clay fraction of the top soil layer, which is used in CESM's dust emission scheme (see Section 2.1.2).



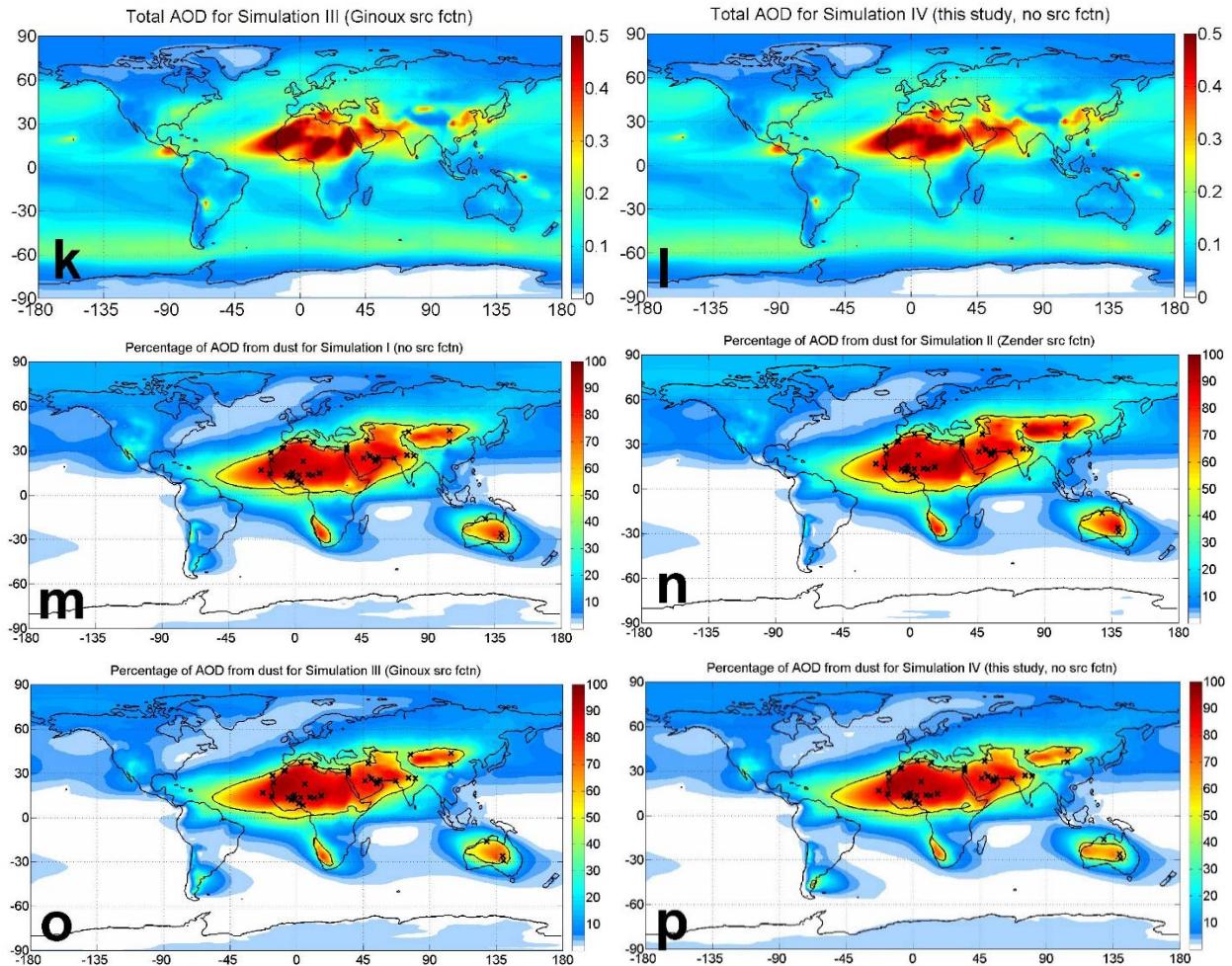


Figure S2. Global maps for each of the four simulations of (a – d) the vertical dust flux, (e - h) optical depth produced only by dust aerosols for Simulations I – IV, (i - l) total aerosol optical depth produced by all aerosols for Simulations I – IV, and (m – p) percentage of aerosol optical depth due to dust aerosols. The areas within the black lines denotes the regions for which dust aerosols contribute more than 50% of the total aerosol optical depth, which we used as a criteria for selecting dust-dominated AERONET stations (black crosses). All results are annually-averaged over the simulation period (2001 – 2011).

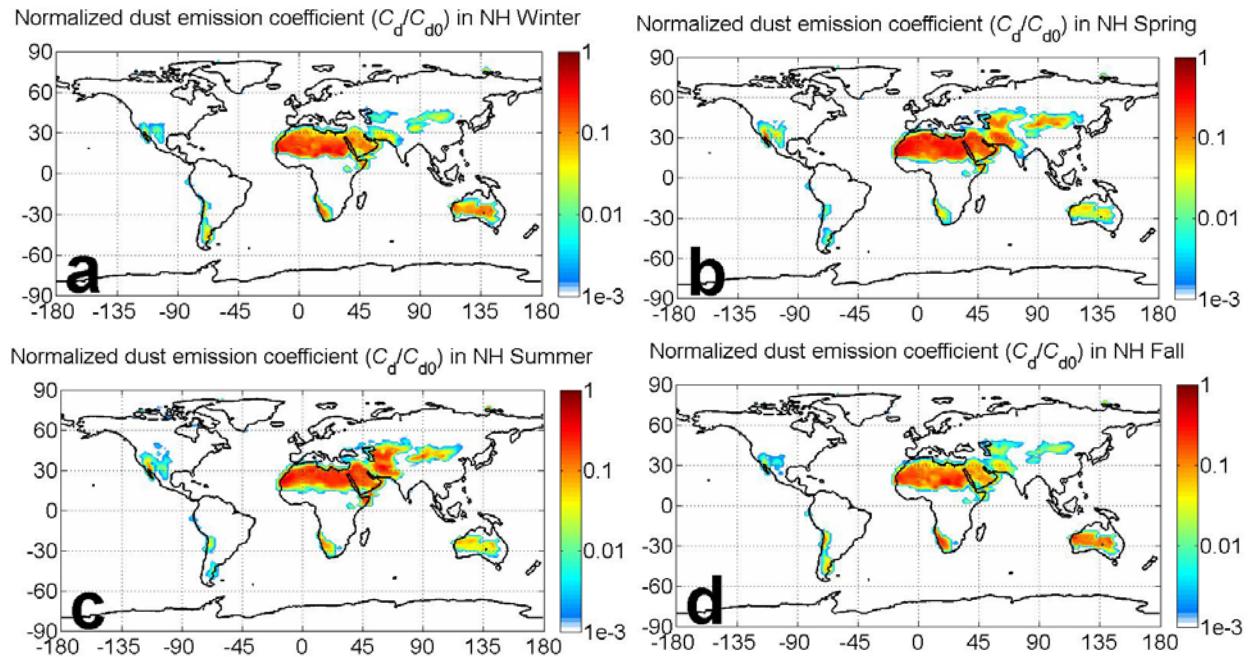


Figure S3. Seasonal cycle of the dust emission coefficient C_d , obtained from Simulation IV over the years 1995–2011.

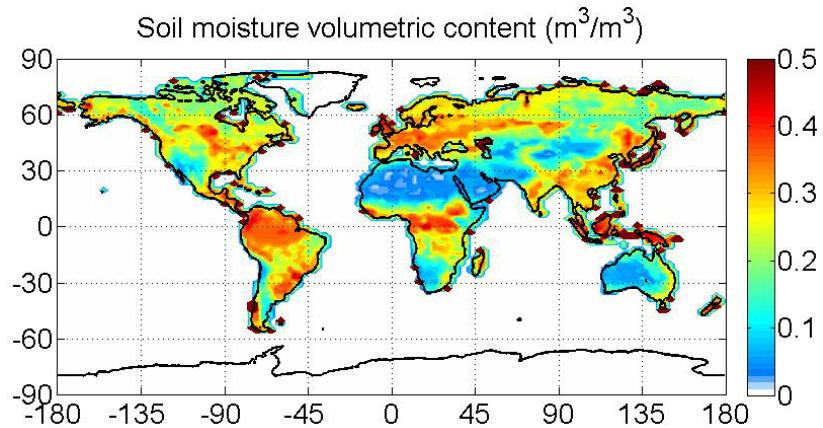


Figure S4. Global map of soil moisture in the top soil layer of CLM4 (1.75 cm thick; Oleson et al. (2010)), averaged over the model runs from 1995 – 2011.

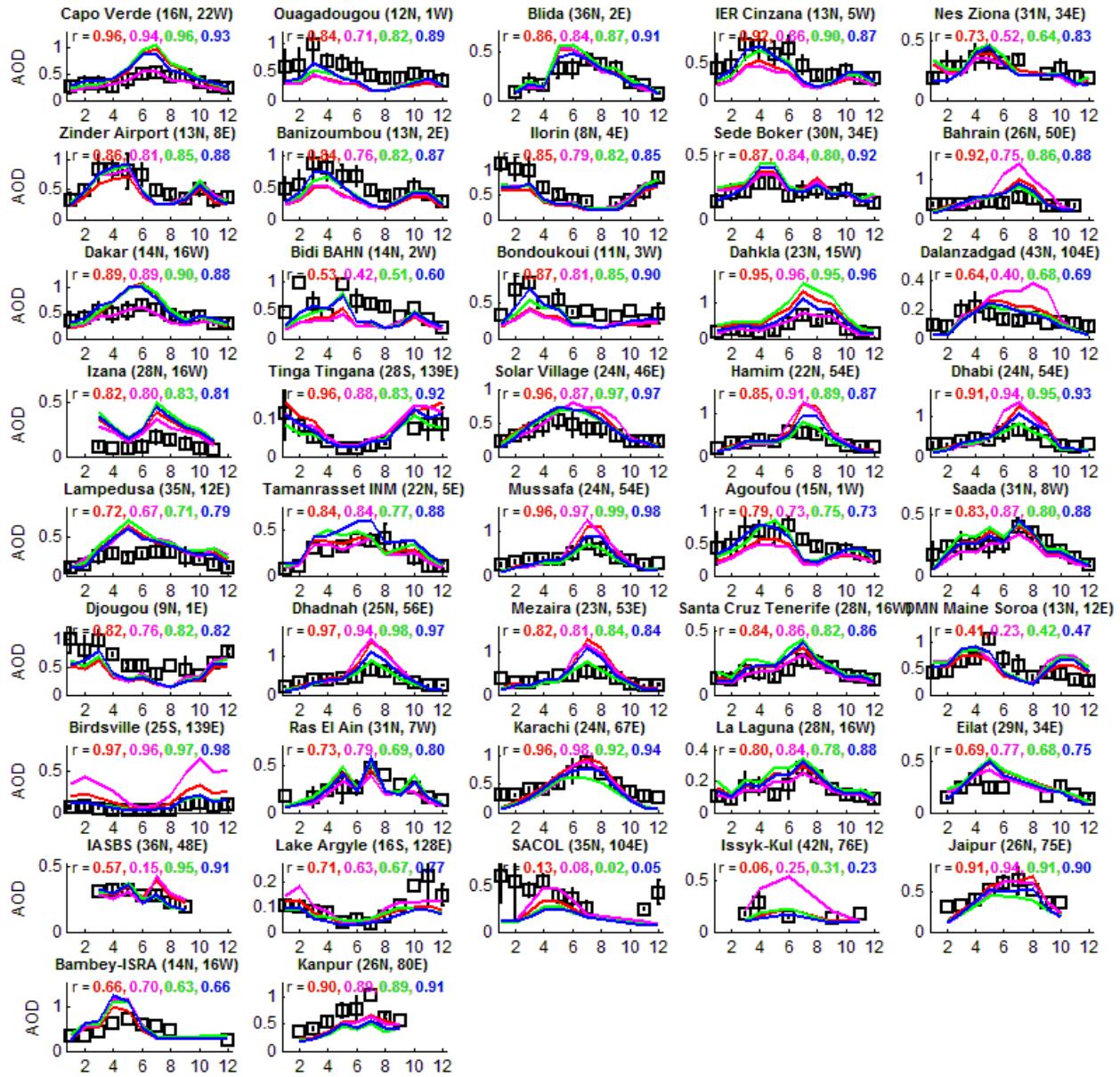


Figure S5. Comparison of measured (black squares) and simulated (colored lines) AOD at the 42 dusty AERONET stations. The red, magenta, green, and blue lines correspond to the results from Simulations I, II, III, and IV, respectively. The correlation coefficient (r) is noted in correspondingly colored font for each simulation, and the average correlation coefficient for the 42 stations is noted in Table 1. Error bars on the measurements represent the standard deviation of the monthly-averaged AOD over the number of months with sufficient data.

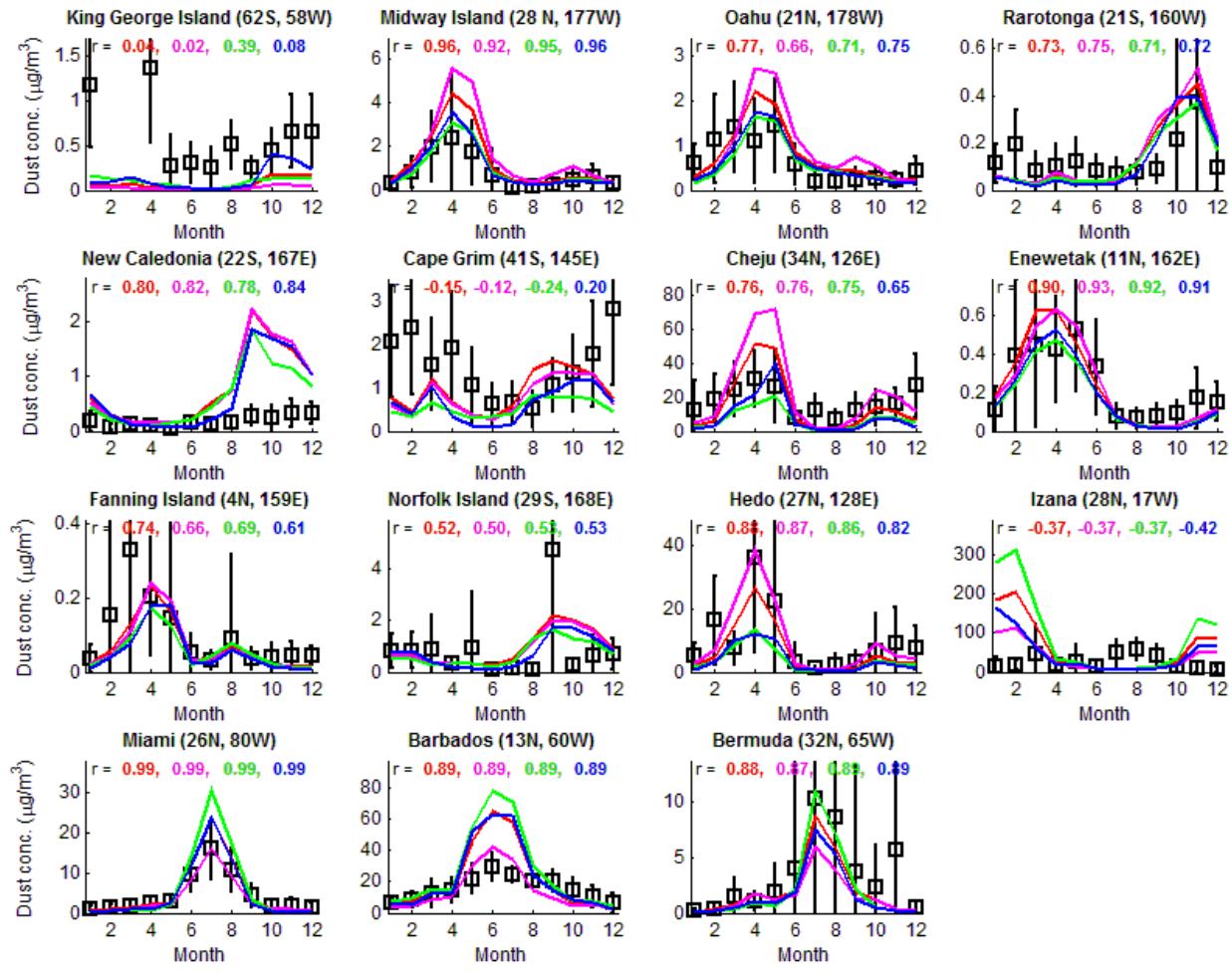


Figure S6. Comparison of measured (black squares) and simulated (colored lines) dust surface concentration at 15 stations. The red, magenta, green, and blue lines correspond to the results from Simulations I, II, III, and IV, respectively. The correlation coefficient (r) is noted in correspondingly colored font for each simulation, and the average correlation coefficient for the 15 stations is noted in Table 2. Error bars on the measurements represent the standard deviation of the monthly-averaged dust concentration over the number of months with sufficient data.

References

FAO: Harmonized World Soil Database (version 1.2), FAO, Rome, Italy and IIASA, Laxenburg, Austria, 2012.

Oleson, K. W., Lawrence, D. M., Gordon, B. B., Flanner, M. G., Kluzeck, E., Lawrence, P. J., Levis, S., Swenson, S. C., Thornton, P. E., Dai, A., Decker, M., Dickinson, R., Feddema, J., Heald, C. L., Hoffman, F., Lamarque, J.-F., Mahowald, N., Niu, G.-Y., Qian, T., Randerson, J., Running, S., Sakaguchi, K., Slater, A., Stockli, R., Wang, A., Yang, Z.-L., Zeng, Z., and Zeng, X.: Technical Description of version 4.0 of the Community Land Model (CLM), 2010.