



Supplement of

Retrieving the global distribution of the threshold of wind erosion from satellite data and implementing it into the Geophysical Fluid Dynamics Laboratory land-atmosphere model (GFDL AM4.0/LM4.0)

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Supplement

No.	Sites	Lat/Long	Record length (year)
1	Cape Grim	40.68°S, 144.68°E	14
2	Marsh	62.18°S, 58.3°W	7
3	Mawson	67.6°S, 62.5°E	10
4	Palmer Station	64.77°S, 64.05°W	7
5	Norfolk Island	29.08°S, 167.98°E	14
6	American Samoa	14.25°S, 170.58°W	13
7	Midway Island	28.22°N, 177.35°W	16
8	Oahu Hawaii	21.33°N, 157.7°W	15
9	Cheju\Korea\Pem	33.52°N, 126.48°E	4
10	Fanning Island	3.92°N, 159.33°W	5
11	Ragged Point	13.17°N, 59.43°W	14
12	Izaña Tenerife	28.3°N, 16.5°W	11
13	Bermuda West & East	32.27°N, 64.87°W	9
14	Heimaey Iceland	63.4°N, 20.3°W	7
15	Mace Head	53.32°N, 9.85°W	6
16	RSMAS	25.75°N, 80.25°W	10

Table S1 Name and location of 16 RSMAS sites used in Figure 9.

Regions	Control	V _{thresh} Ann	V _{thresh} 12mn
Sahel	148	1185	970
Sahara	216	487	488
Arabian Peninsula	130	536	482
Northern China	74	78	73
India	55	438	239
US	4	78	37
South Africa	8	12	7
South America	25	169	103
Australia	44	556	434
Global land	978	5190	3562

Table S2 Annual mean dust emission (Tg yr⁻¹) averaged over nine regions and global land from the Control, $V_{thresh}Ann$, and $V_{thresh}12mn$ simulations.



Figure S1. A schematic of deriving $V_{threshold}$ at one grid point in the U.S. in March. (a) Determining the threshold percentage of cumulative frequency of DOD at $DOD_{thresh} = 0.02$ level; (b) matching the threshold percentage in (a) with the percentage of cumulative frequency distribution of surface wind speed to get the threshold of wind erosion.



Figure S2. Dust source function S in Eq. 4 used in the Control simulation (top) and unmasked source function S' used in the $V_{\text{thresh}}12\text{mn}$ and $V_{\text{thresh}}Ann$ simulations (bottom).



Figure S3. (a)-(d) Model simulated LAI from the $V_{thresh}12mn$ run, average from 2001 to 2015 for four seasons. (e)-(h) The difference between the $V_{thresh}12mn$ run and the Control run. Global land averages are listed at the bottom of each plot.



Figure S4. Same as Fig. S3, but for the $V_{thresh}Ann$ simulation.



Figure S5. Same as Fig. 2 but for $V_{threshold}$ using $DOD_{thresh}=0.5$ or 0.05.



(a) Record length of AERONET AOD (550nm)

Figure S6. Length of records (year) for AERONET (a) AOT stations and (b) SDA COD stations used in Figs. 5-6.

AERONET SDA sites (N. Africa)



Figure S7. Location of 12 AERONET SDA COD sites (filled circles with site numbers) and three LISA sites (black triangles with site names in purple). For SDA site, the filled color indicates the climatological values of COD during 2003-2015, and the names of the sites are listed on the right corner of the plot.



Figure S8. Daily anomalies (with reference to the 2000-2015 mean) of 850 hPa geopotential height (gpm; only values over land are plotted) and wind vectors (m s⁻¹) from Oct. 17 to Oct. 19, 2012 from the $V_{thresh}12mn$ simulation. Elevations higher than 850 hPa are masked in grey.



Figure S9. (a)-(e) The differences between the $V_{threshold}$ and default V_t (i.e., $V_t = 6 \text{ m s}^{-1}$ in Eq. 4) in the AM4.0/LM4.0. (f)-(j) $V_{threshold}$ over the area extend beyond the domain of the default dust source function (S). Unit: m s⁻¹.



Figure S10. The differences of dust emission $(g m^{-2} yr^{-1})$ between the V_{thresh}12mn and Control runs are decomposed into two parts: (a)-(e) within the domain of the default dust source function (*S*) and (f)-(j) over the extended area outlined by *V_{threshold}*. Black boxes denote nine dust source regions as listed in Table 1.