Supplementary information

Table S1. Set of differential equations used in GEOS-Chem/Fe_d

$$\frac{dFe(II)}{dt} = j_1 Fe(OH)^{2+}] + j_2[Fe(C_2O_4)_2^-] + j_3[Fe(C_2O_4)_3^{3-}] + k_7[Fe(OH)^{2+}][O_2^{-\cdot}] + k_8[Fe(OH)^{2+}][HO_2^{\cdot}] + k_{17}[Fe(C_2O_4)_n^{3-2n}][O_2^{-\cdot}] + k_{18}[Fe(C_2O_4)_n^{3-2n}][HO_2^{\cdot}] - k_1[Fe^{2+}][H_2O_2] - k_2[FeC_2O_4][H_2O_2] - k_3[Fe^{2+}][O_2^{-\cdot}][H^+]^2 - k_4[Fe^{2+}][HO_2^{\cdot}][H^+] - k_5[Fe^{2+}][NO_3] - k_6[Fe^{2+}][NO_2][H^+] - k_9[Fe^{2+}][O_3]$$

$$\frac{dFe(III)}{dt} = -\frac{dFe(II)}{dt}$$

$$\frac{d[FeO^{2+}]}{dt} = k_9[Fe^{2+}][O_3] - k_{10}[FeO^{2+}][H_2O] - k_{11}[FeO^{2+}][OH^{\cdot}][H^+] - k_{12}[FeO^{2+}][H_2O_2] - k_{13}[FeO^{2+}][HO_2^{\cdot}]$$

$$\frac{d[C_2O_4^{2-}]}{dt} = j_2[Fe(C_2O_4)_2^-] + j_3[Fe(C_2O_4)_3^{3-}] - k_{19}[C_2O_4^{2-}][OH^{\cdot}] - k_{20}[C_2O_4^{2-}][NO_3] - k_{21}[C_2O_4^{2-}][O_2]$$

$$\frac{d[H_2O_2]}{dt} = k_3[Fe^{2+}][O_2^{-\cdot}][H^+]^2 + k_4[Fe^{2+}][HO_2^{\cdot}][H^+] + k_{11}[FeO^{2+}][OH^{\cdot}][H^+] + k_{14}[HO_2^{\cdot}][HO_2^{\cdot}] + k_{15}[HO_2^{\cdot}][O_2][H^+] - k_1[Fe^{2+}][H_2O_2] - k_2[FeC_2O_4][H_2O_2] - k_{12}[FeO^{2+}][H_2O_2]$$

$$\frac{d[HO_2^{\cdot}]}{dt} = k_{12}[FeO^{2+}][H_2O_2] - k_4[Fe^{2+}][HO_2^{\cdot}][H^+] - k_8[Fe(OH)^{2+}][HO_2^{\cdot}] - k_{13}[FeO^{2+}][HO_2^{\cdot}] - k_{14}[HO_2^{\cdot}][HO_2^{\cdot}] - k_{15}[HO_2^{\cdot}][O_2][H^+] - k_{18}[Fe(C_2O_4)_n^{3-2n}][HO_2^{\cdot}]$$

$$\frac{d[OH^{\cdot}]}{dt} = j_1 Fe(OH)^{2+}] + k_1[Fe^{2+}][H_2O_2] + k_2[FeC_2O_4][H_2O_2] + k_{10}[FeO^{2+}][H_2O] - k_{11}[FeO^{2+}][OH^{\cdot}][H^+] - k_{19}[C_2O_4^{2-}][OH^{\cdot}]$$

$$\frac{d[O_2^{-\cdot}]}{dt} = k_{16}[CO_2^{-\cdot}][O_2] + k_{21}[C_2O_4^{2-}][O_2] - k_3[Fe^{2+}][O_2^{-\cdot}][H^+]^2 - k_7[Fe(OH)^{2+}][O_2^{-\cdot}] - k_{17}[Fe(C_2O_4)_n^{3-2n}][O_2^{-\cdot}]$$

$$\frac{d[C_2O_4^{-\cdot}]}{dt} = j_2[Fe(C_2O_4)_2^-] + j_3[Fe(C_2O_4)_3^{3-}] + k_{19}[C_2O_4^{2-}][OH] + k_{20}[C_2O_4^{2-}][NO_3] + k_{21}[C_2O_4^{2-}][O_2]$$

Table S2. Fe-species absorption cross-sections used in GEOS-Chem/Fe_d

Absorption cross-section (cm^2 $molecule^{-1}$)			
Wavelength (nm)*	$Fe(OH)^{2+}$	$Fe(C_2O_4)_2^-$	$Fe(C_2O_4)_3^{3-}$
294	8.8×10^{-18}	1.7×10^{-17}	1.7×10^{-17}
303	8.4×10^{-18}	1.5×10^{-17}	1.5×10^{-17}
310	7.6×10^{-18}	1.1×10^{-17}	1.1×10^{-17}
316	6.5×10^{-18}	8.9×10^{-18}	8.9×10^{-18}
333	4.8×10^{-18}	6.7×10^{-18}	6.7×10^{-18}
380	1.1×10^{-18}	2.5×10^{-18}	2.5×10^{-18}
574	3.8×10^{-21}	3.8×10^{-21}	3.8×10^{-21}

*Effective wavelengths used in Fast-J.

Absorption cross-section (σ) calculated by: $\sigma = \varepsilon * 3.82 \times 10^{-21}$.

ε is the molar extinction coefficient (M^{-1} cm^{-1}) derived from Zuo and Holgne (1992).

Table S3. Comparison of model-predicted Fe_d (goethite simulations) values to ambient data

	Fe(III) (ng m^{-3})			
Measurement Campaign	R	Bias	RMSE	NMB[a]
MP01 (Atlantic Ocean)[b]	0.75	-0.14	0.03	-31.46
MP02 (Pacific Ocean)[c]	0.59	-0.19	0.06	-41.07
MP03 (Atlantic Ocean)[b]	0.76	0.96	1.09	86.72
MP05 (Pacific Ocean)[c]	0.53	-0.10	0.01	-79.34
	Fe(II) (ng m^{-3})			
Measurement Campaign	R	Bias	RMSE	NMB[a]
MP01 (Atlantic Ocean)[b]	0.44	-0.19	0.37	-33.89
MP02 (Pacific Ocean)[c]	0.63	-0.36	0.83	-31.75
MP03 (Atlantic Ocean)[b]	0.74	0.17	0.31	43.76
MP05 (Pacific Ocean)[c]	0.70	-0.16	0.02	-57.95

[a] NMB is in percent.

[b] Chen and Siefert (2004).

[c] Chen (2004).

Table S4. Comparison of model-predicted Fe_d values (illite simulations) to ambient data

	Fe(III) (ng m^{-3})			
Measurement Campaign	R	Bias	RMSE	NMB[a]
MP01 (Atlantic Ocean)[b]	0.64	0.27	0.24	47.87
MP02 (Pacific Ocean)[c]	0.60	0.04	0.02	9.33
MP03 (Atlantic Ocean)[b]	0.87	2.12	3.74	191.93
MP05 (Pacific Ocean)[c]	0.69	-0.02	0.01	-19.27
	Fe(II) (ng m^{-3})			
Measurement Campaign	R	Bias	RMSE	NMB[a]
MP01 (Atlantic Ocean)[b]	0.43	0.05	0.32	8.19
MP02 (Pacific Ocean)[c]	0.58	0.24	0.91	22.14
MP03 (Atlantic Ocean)[b]	0.74	0.51	0.27	136.35
MP05 (Pacific Ocean)[c]	0.81	-0.05	0.02	-21.08

[a] NMB is in percent.

[b] Chen and Siefert (2004).

[c] Chen (2004).

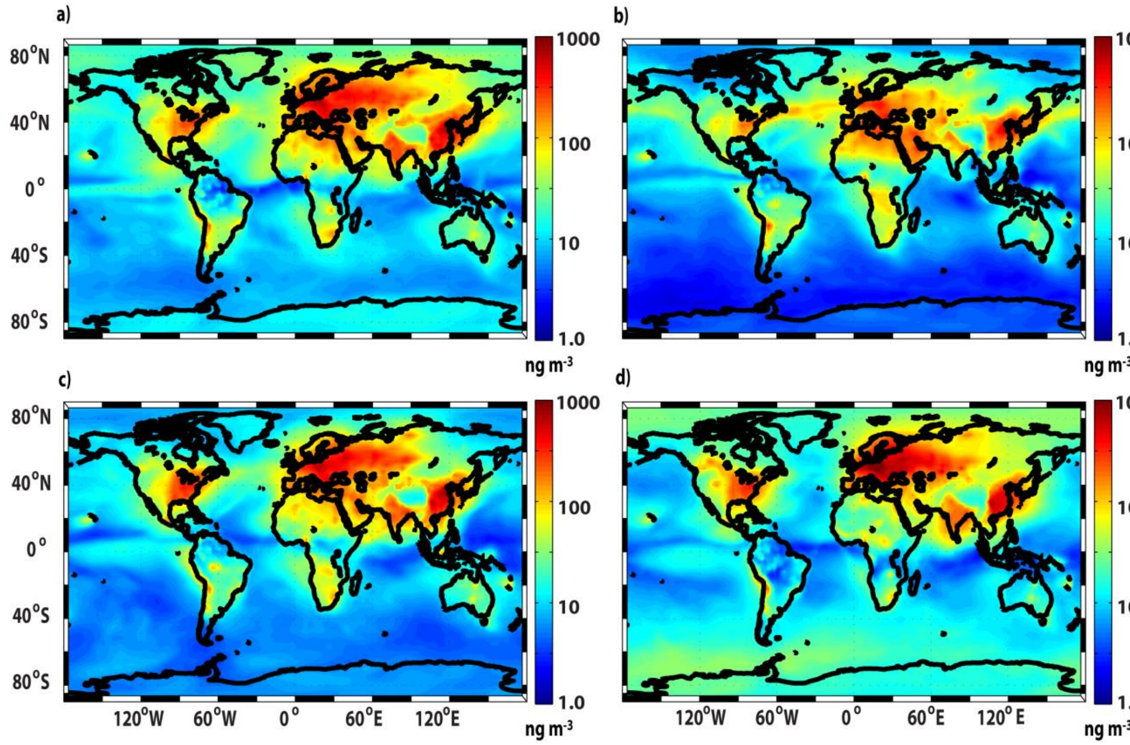

Figure S1. GEOS-Chem-predicted seasonally-averaged surface level total oxalate concentration (ng m^{-3}) for a) March-May (MAM), b) June-August (JJA), c) September-November (SON), and d) December-February (DJF).

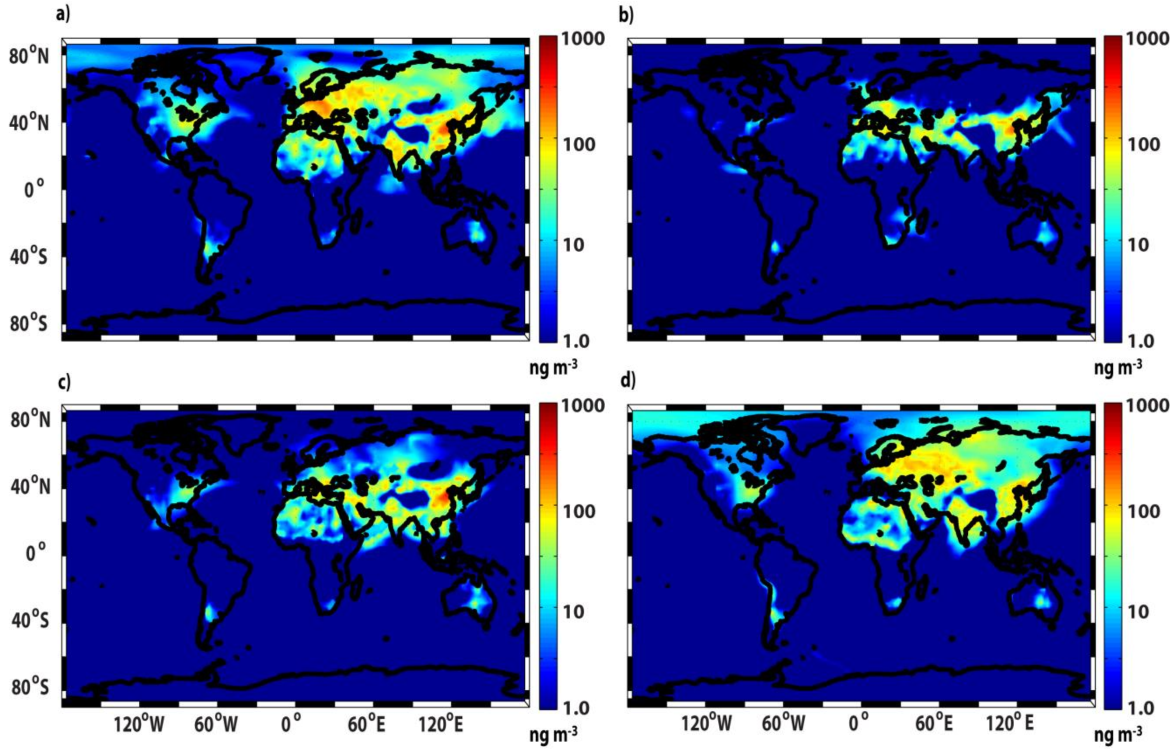

Figure S2. GEOS-Chem-predicted seasonally-averaged surface level dust-oxalate concentration (ng m^{-3}) for a) March-May (MAM), b) June-August (JJA), c) September-November (SON), and d) December-February (DJF).