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Investigation of short-term effective radiative forcing of fire aerosols over North America using nudged hindcast ensembles

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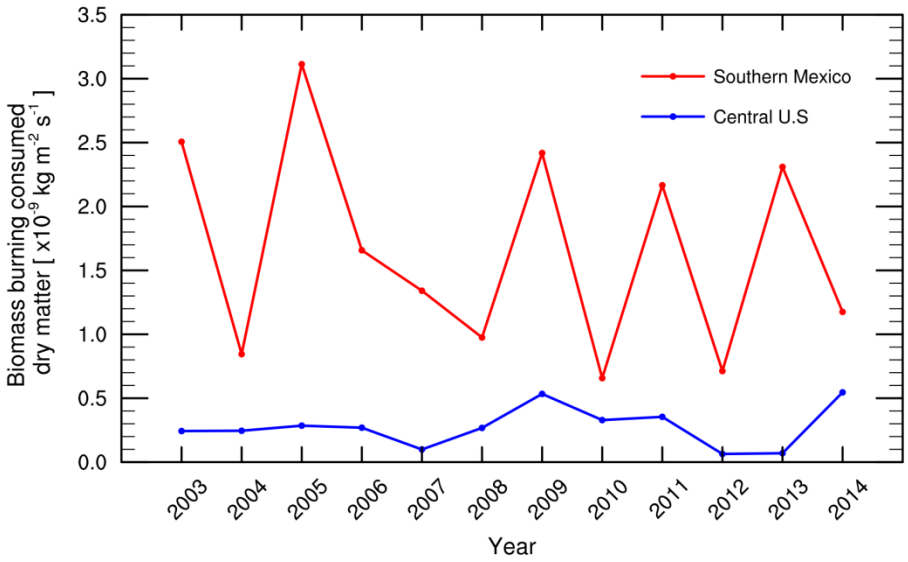

Fig.S1. Time series of regional mean biomass burning consumed dry matter during April in central U.S (blue) and Mexico (red) from GFED v4.1.

Table S1 Regional mean emissions of fire aerosols in April, 2009 from three emission inventories (Unit: $x10^{-12}$ kg $m^{-2}s^{-1}$). Numbers in the parentheses show results averaged in April 1-10.

	BC		OC		SO2	
	Central U.S.	Southern Mexico	Central U.S.	Southern Mexico	Central U.S.	Southern Mexico
GFED v3.1	0.25(0.38)	0.69(0.82)	1.82(3.58)	5.60(6.77)	1.35(2.01)	3.69(4.35)
GFED v4.1s	0.23(0.34)	1.17(1.44)	1.75(3.24)	8.80(10.76)	1.21(1.81)	6.25(7.69)
QFED v2.4	2.63(3.29)	3.87(3.87)	23.54(32.25)	36.81(36.58)	14.04(17.59)	20.62(20.65)

Table S2 Regional mean total AOD, fire AOD (difference in total AOD between simulations with and without fire) and the contributions of fire AOD (fire AOD divided by total AOD in the S_NF simulation)during April, 2009 in group A simulations.

	Central U.S.			Southern Mexico		
	Total AOD	Fire AOD	Percentage	Total AOD	Fire AOD	Percentage
S_NF	0.066			0.130		
S_GF3	0.068	0.002	3.42%	0.141	0.011	8.10%
S_GF4	0.070	0.004	5.63%	0.145	0.015	11.20%
S_QF	0.099	0.033	49.33%	0.194	0.064	48.84%

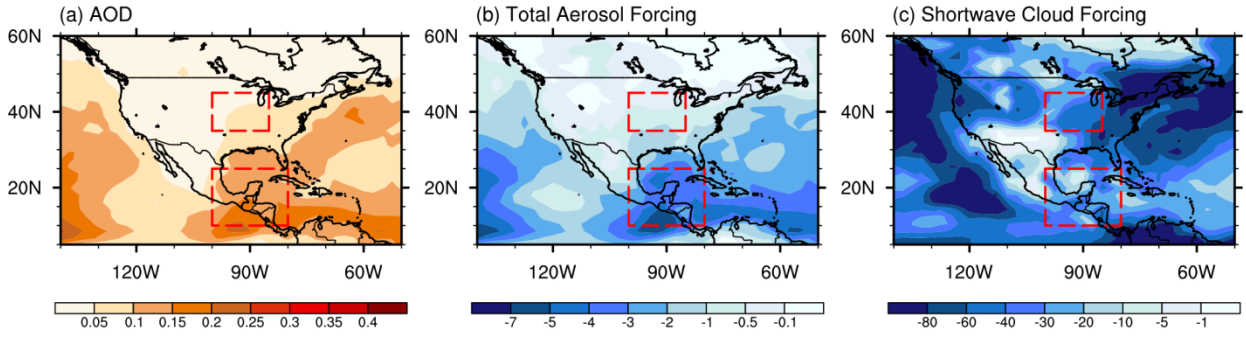

Fig.S2. Spatial distributions of 10-day average (Apr. 1-10) ensemble mean a) AOD, b) total aerosol forcing and c) total shortwave cloud forcing(W m^{-2}) in the simulation without fire emissions (E_NF).

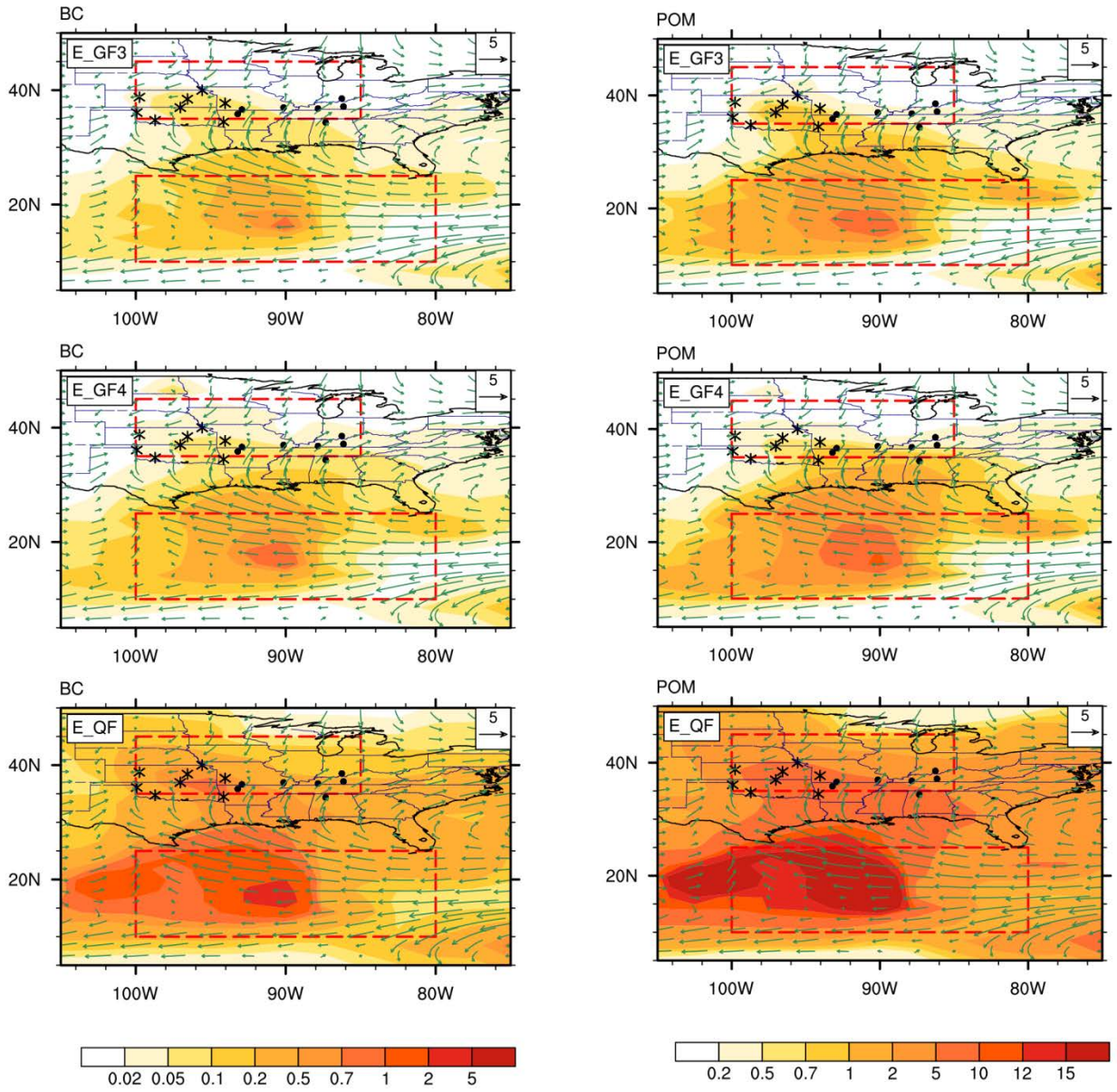

Fig.S3. Spatial distributions of April mean fire BC and fire POM burden (shaded) on IMPROVE observation days in group B simulations (E_GF3/E_GF4/E_QF – E_NF). Vectors denote horizontal winds near 850hPa in group B fire simulations (E_GF3/E_GF4/E_NF). IMPROVE data sites are marked with asterisks for sites near the source region and with dots for sites in the downwind region.

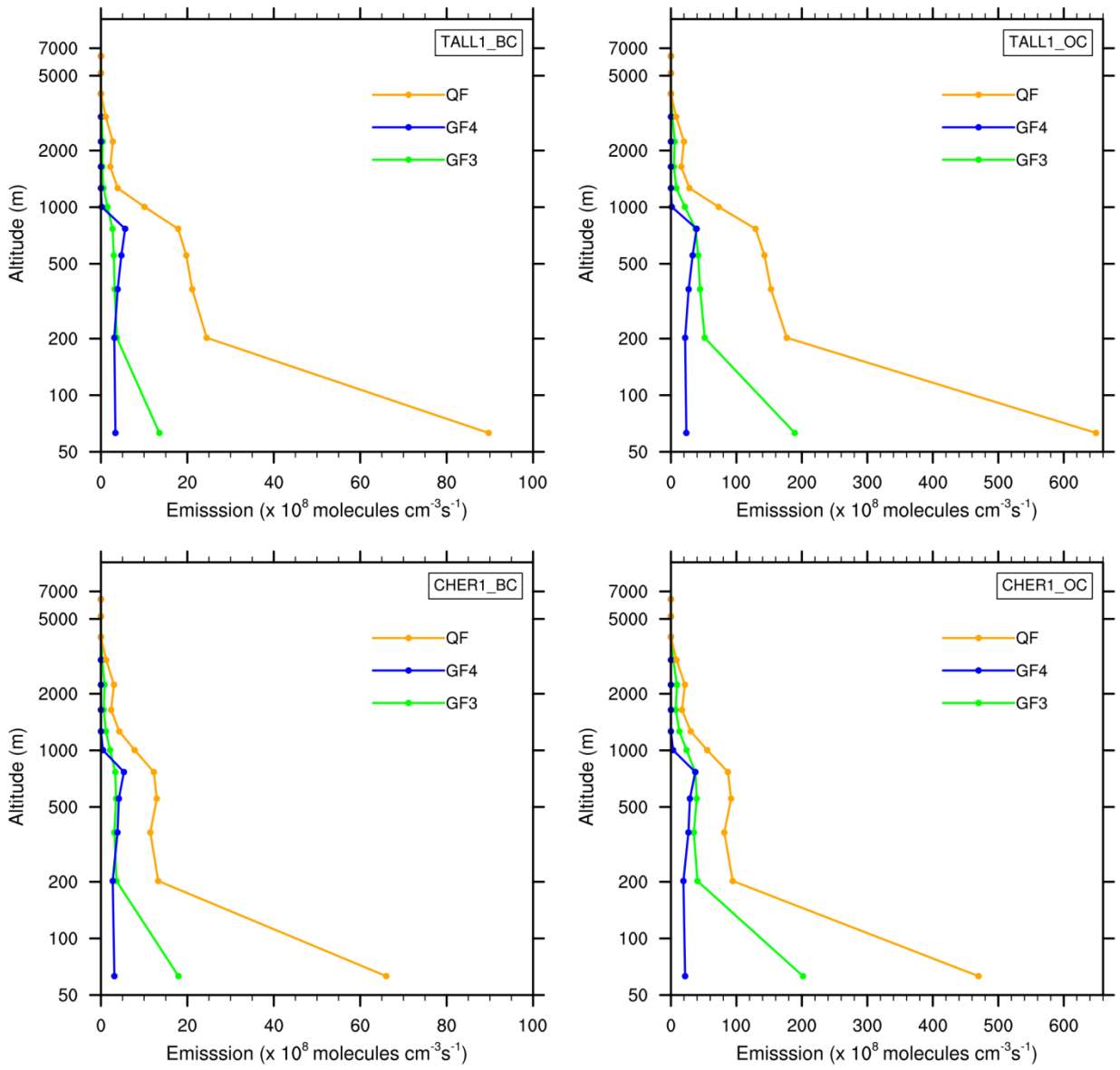

Fig.S4. Vertical profiles of fire emissions of BC and OC used in simulations at sites TALL1 (38.43°N, 96.56°W) and CHER1 (38.77°N, 99.76°W).

Table S3 Regional mean total AOD, fire AOD (differences in AOD between simulations with and without fire) and radiative effects of fire aerosols during April 1-10, 2009 in group B simulations (Unit: $W\ m^{-2}$). Total fire aerosol radiative effect is decomposed into shortwave direct radiative effect (SDRE), shortwave cloud radiative effect (SCRE), longwave cloud radiative effect (LCRE) and surface albedo effect (SAE).

	Total AOD	Fire AOD	SDRE	SCRE	LCRE	Total SAE
Central U.S.						
E_NF	0.047					
E_GF3	0.050	0.003	0.02	-0.86	0.04	0.02
E_GF4	0.050	0.003	-0.01	-0.39	0.002	-0.003
E_QF	0.08	0.033	-0.10	-0.56	-0.76	0.12
Southern Mexico						
E_NF	0.135					
E_GF3	0.149	0.014	-0.18	-1.91	-0.21	0.06
E_GF4	0.153	0.018	-0.20	-2.06	-0.23	0.11
E_QF	0.202	0.067	-0.86	-3.02	-0.47	0.14

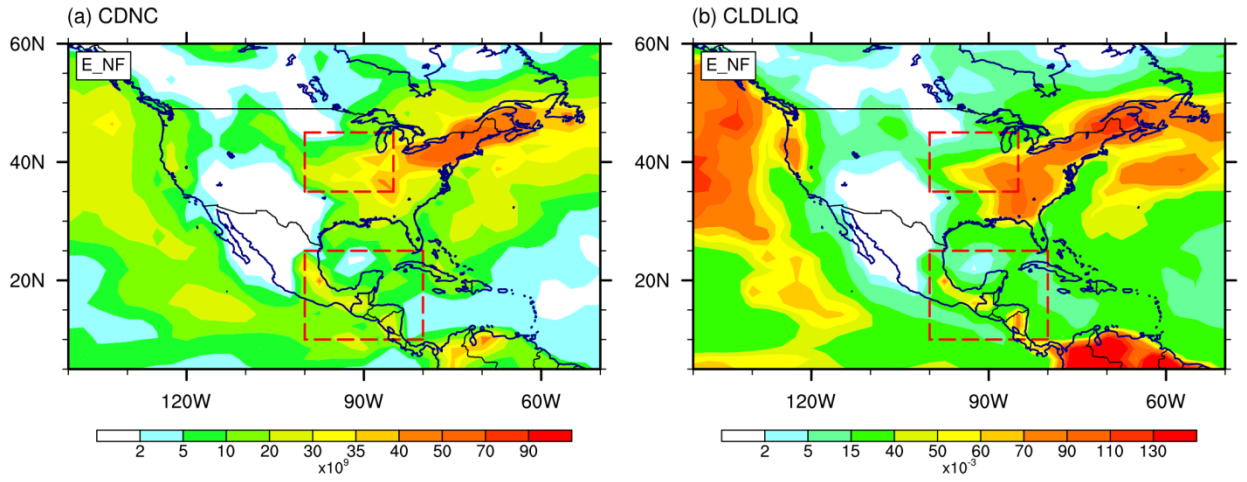

Fig.S5. Spatial distributions of 10-day average (Apr. 1-10) ensemble mean a) column-integrated droplet number concentrations (m^{-2}) and b) liquid water path (g m^{-2}) in the E_NF simulations.

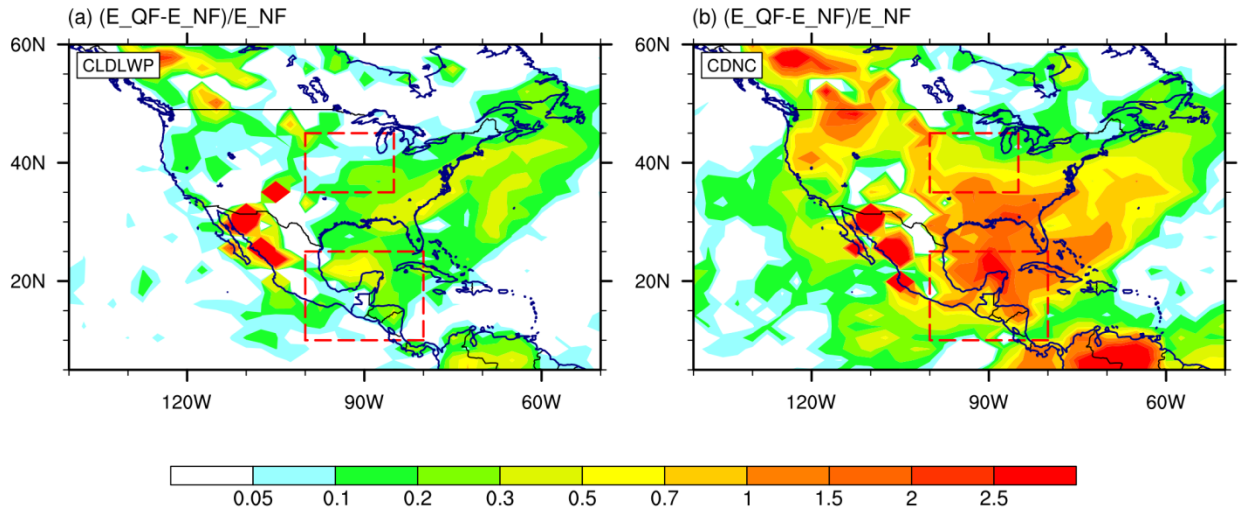

Fig.S6. Relative changes of 10-day average ensemble mean cloud properties between the E_NF and E_QF simulations. a) cloud liquid water path, b) column-integrated droplet number concentration

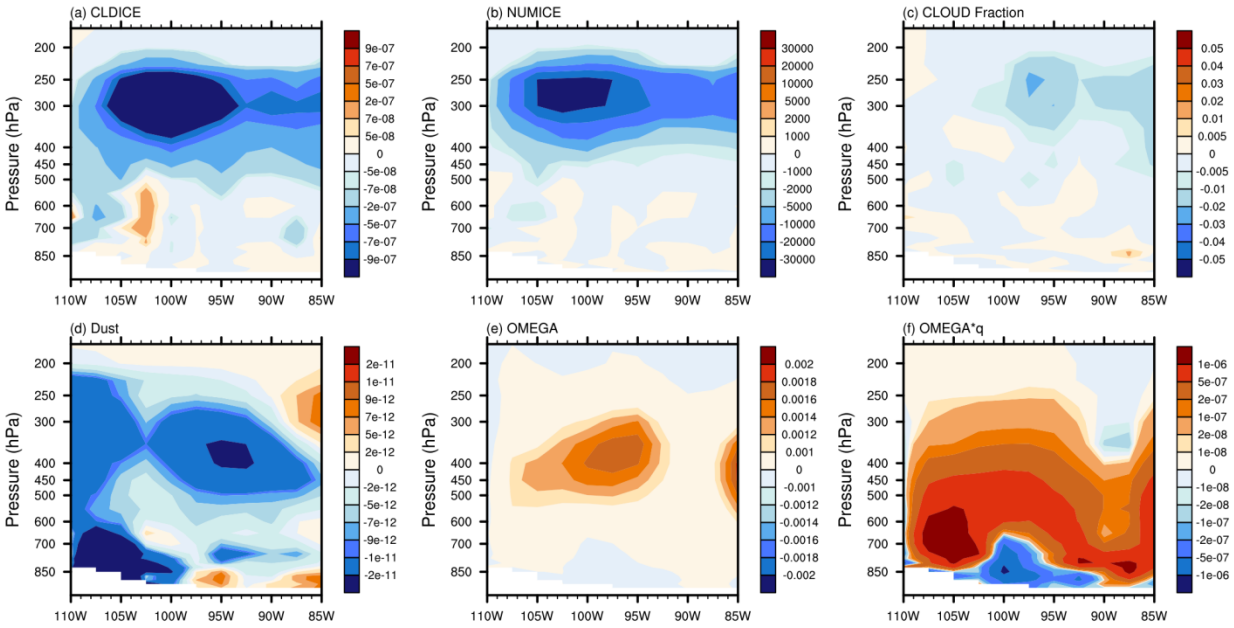

Fig.S7. Pressure and longitude distribution of meridional mean (40-45 ° N) difference of 10-day average (April 1 -10) ensemble mean between simulation E_NF and E_QF: a) cloud ice amount ($kg \cdot kg^{-1}$) b) cloud ice number concentration (kg^{-1}) c) cloud fraction (1) d) Coarse mode dust concentration ($kg \cdot kg^{-1}$) e) vertical velocity ($Pa \cdot s^{-1}$) f) vertical moisture transport ($kg \cdot kg^{-1} \cdot Pa \cdot s^{-1}$)

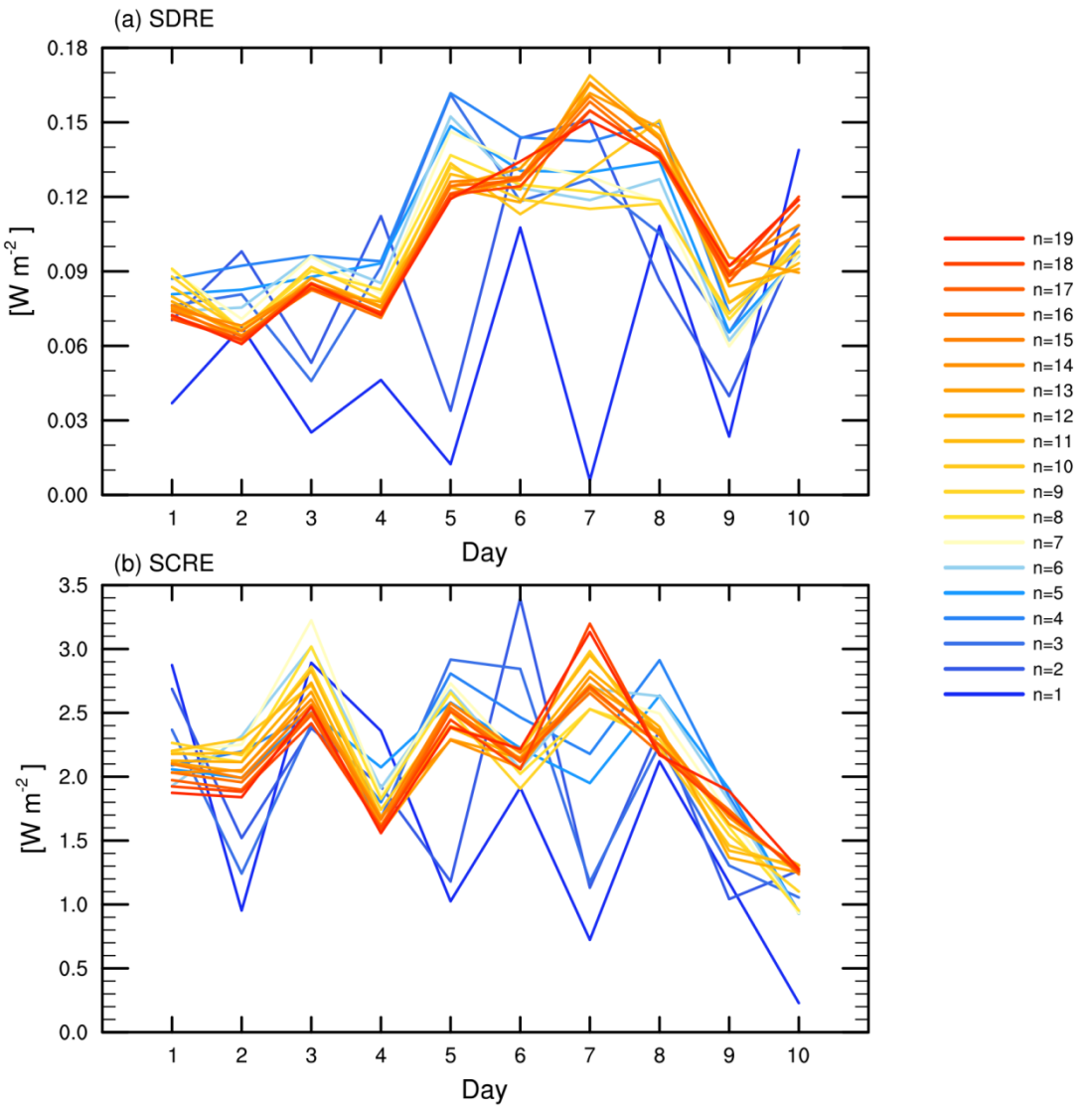

Fig.S8. Time series of ensemble spread of daily regional mean fire aerosol a) SDRE and b) SCRE in Southern Mexico during Apr. 1-10, 2009 in QFED forced ensemble simulations with varying the total number of ensemble member (n=1-20).