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Supplementary Information for

The Contribution of Black Carbon to Global Ice Nucleating Particle Concentrations

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Figs. S1 to S5
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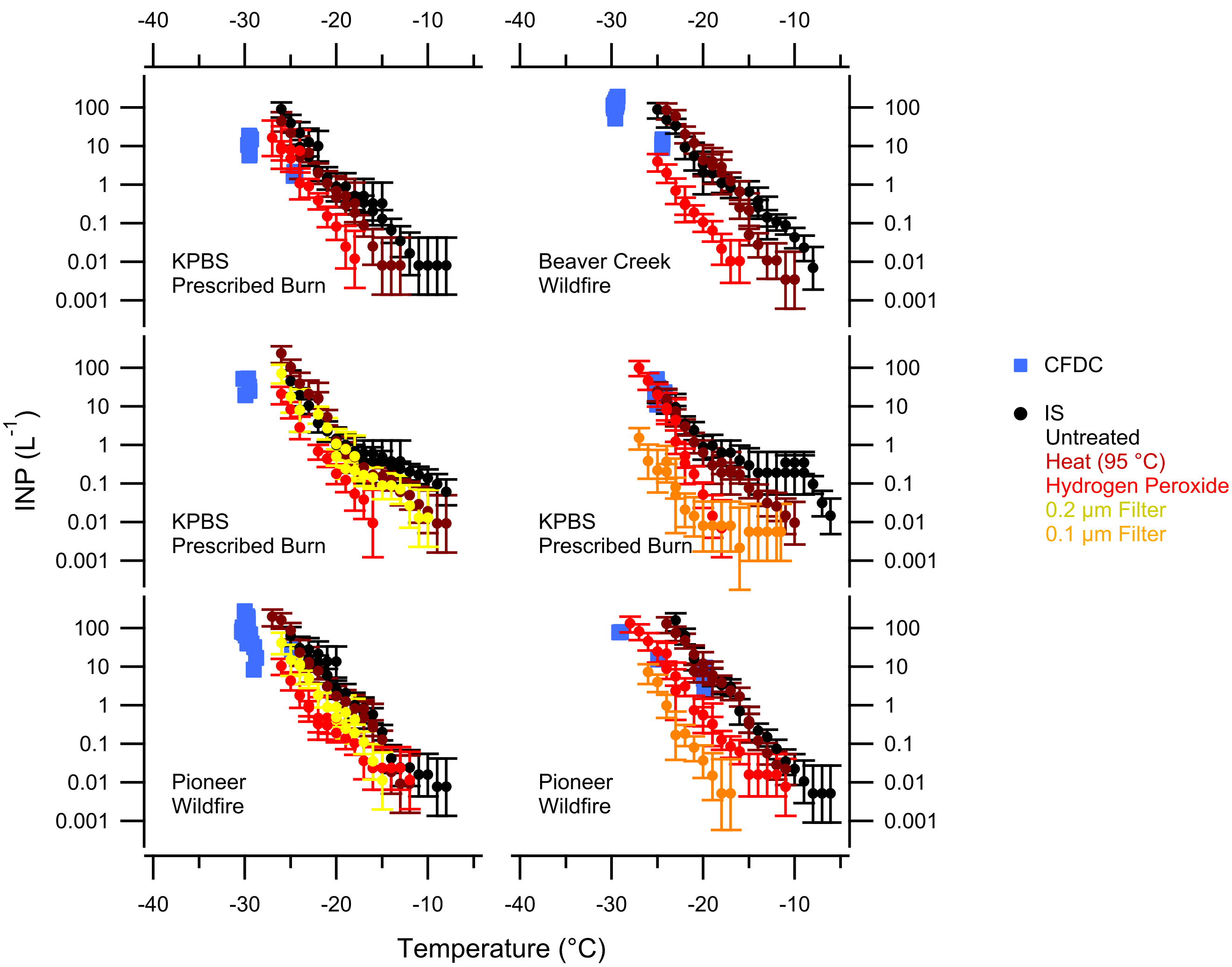

Fig. S1. Ice Spectrometer (IS) ice nucleating particle (INP) temperature spectra from Konza Prairie Biolgical Station (KPBS) prescribed burns and the Beaver Creek and Pioneer Wildfires (Table S1). Also shown are the effect of heat, peroxide, and size exclusion of particles > 0.1 or 0.2 μm. Continuous Flow Diffusion Chamber (CFDC) results from the same fire and similar time periods are shown for comparison.

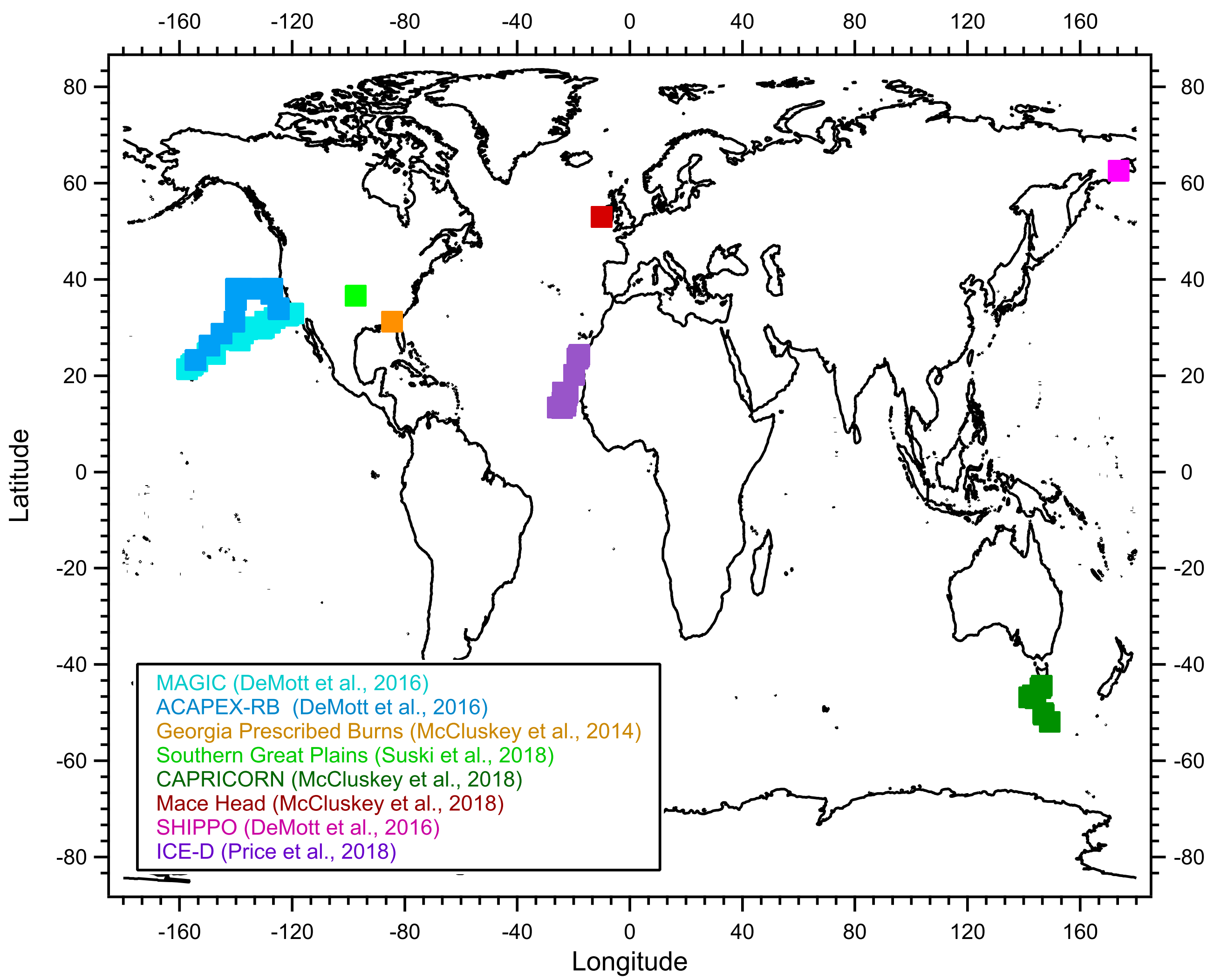

Fig. S2. The locations of eight different field studies used to test GEOS-Chem's skill in simulating ice nucleating particle (INP) concentrations. Except for ICE-D, which sampled from an aircraft platform, all other studies sampled near ground-level.

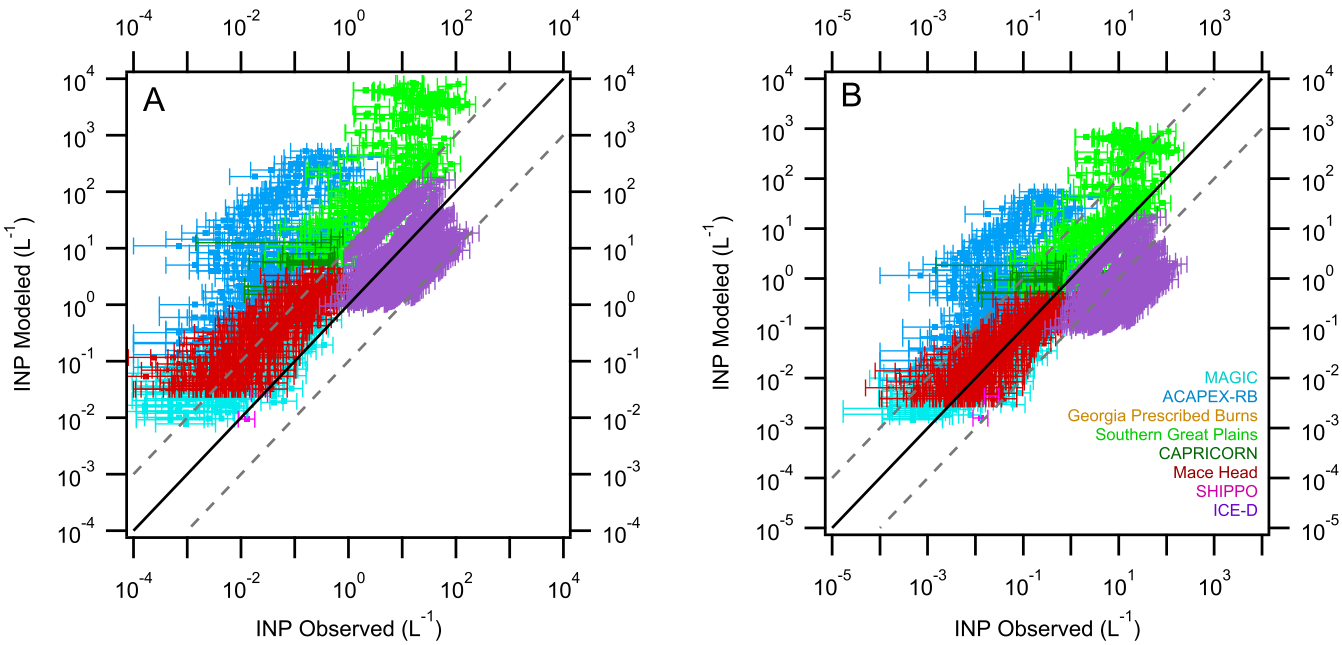

Fig. S3. Simulated potential ice nucleating particle (INP) concentrations compared to observations from eight different field studies using (A) the unaltered Niemand et al., (2012) ice nucleation active surface site density (n_s) parameterization and (B) the scaled Niemand et al., (2012) n_s parameterization.

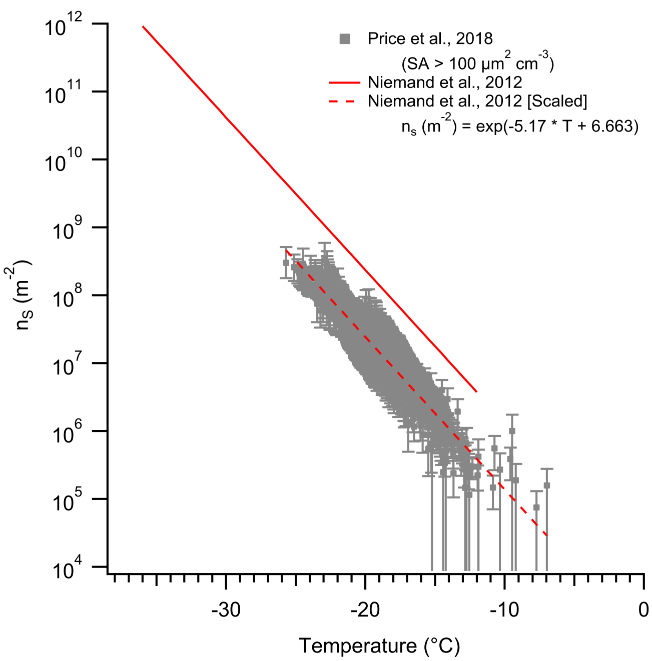

Fig. S4. Calculated ice nucleation active surface site density (n_s) values from time periods during ICE-D (Price et al., 2018) when aerosol surface area was >100 μm^2 cm^{-3}. Also shown are the unaltered and scaled Niemand et al., (2012) parameterizations. The scaled parameterization has the same functional form and slope as the original parameterization.

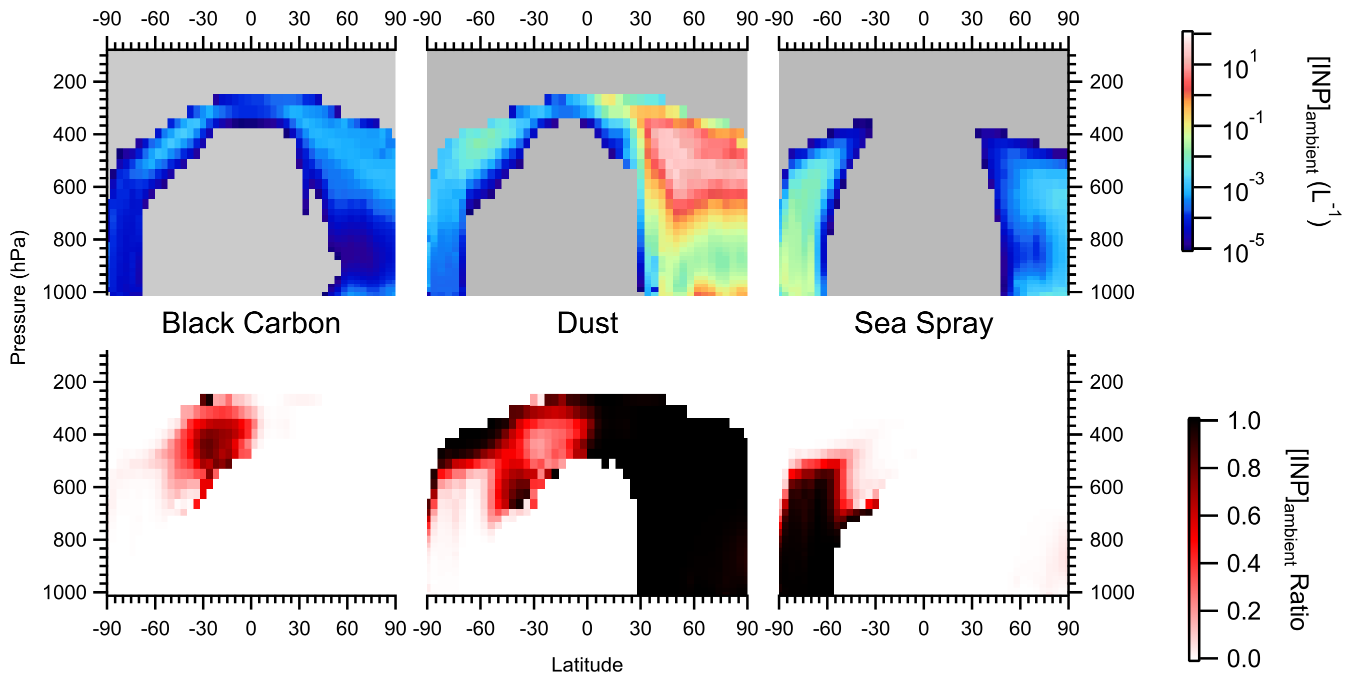

Fig. S5. Zonal mean plots of (top row) of simulated potential ice nucleating particle concentrations derived at the models ambient temperature ($[INP]_{ambient}$) for black carbon, dust and sea salt, and (bottom row) the ratio $[INP]_{ambient}$ to the sum of all simulated $[INP]_{ambient}$. Monthly mean temperatures were used for the ice nucleation active surface site density (n_s) parameterizations.

Table S1. Names, dates, GPS locations, proximity to fire, refractory black carbon (rBC) number concentrations, and major fuel types of all fires sampled in this work.

Name	Date	GPS Latitude	GPS Longitude	Proximity to Fire	Average rBC Conc.	Major Fuels
Konza Prairie Prescribed Burn	20160409	39° 06' N	96° 36' W	<3 km	207 cm^{-3}	Big Bluestem, Little Bluestem, Switchgrass, and Indian Grass
Konza Prairie Prescribed Burn	20190411	39° 06' N	96° 35' W	<1 km	800 cm^{-3}	Big Bluestem, Little Bluestem, Switchgrass, and Indian Grass
Konza Prairie Prescribed Burn	20190412	39° 06' N	96° 34' W	<1 km	900 cm^{-3}	Big Bluestem, Little Bluestem, Indian Grass, Dogwood, Plum, and Eastern Red Cedar
Beaver Creek Fire	20160621	40° 35' N	105° 08' W	130 km	70 cm^{-3}	Mixed Conifer Forest with Beetle-Kill Pine
Cliff Creek Fire	20160729	43° 09' N	110° 18' W	20 km	26 cm^{-3}	Mixed Conifer Forest with Beetle-Kill Pine
Arrowrock Dam	20190820	43° 36' N	115° 55' W	60 km	24 cm^{-3}	Ponderosa Pine, Douglas-Fir, Subalpine-Fir and Lodgepole Pine
Pioneer Fire	20190822	44° 03' N	96° 34' W	<1 km	1100 cm^{-3}	Ponderosa Pine, Douglas-Fir, Subalpine-Fir and Lodgepole Pine
Pioneer Fire	20190823	44° 03' N	115° 48' W	<1 km	1100 cm^{-3}	Ponderosa Pine, Douglas-Fir, Subalpine-Fir and Lodgepole Pine

Table S2. The fraction of black carbon (BC) ice nucleating particles (INP) relative to total aerosol counts (low/high of total range) during FLAME-4, southeastern U.S. prescribed burns, and this study.

Reference	Burn Type	Location	BC INP Fraction Low	BC INP Fraction High
Levin et al. 2016	Laboratory Burns	FLAME-4	3.3×10^{-8}	6.1×10^{-8}
McCluskey et al. 2014*	Prescribed Burns	Georgia, USA	1.2×10^{-9}	3.0×10^{-6}
This Study	Prescribed Burns and Wildfires	See Table S1	3.1×10^{-9}	6.2×10^{-7}

* Assumes 64% of INP were BC

References

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2. McCluskey CS, et al. (2014) Characteristics of atmospheric ice nucleating particles associated with biomass burning in the US: Prescribed burns and wildfires. *Journal of Geophysical Research: Atmospheres* 119(17):10458–10470.
3. Suski KJ, et al. (2018) Agricultural harvesting emissions of ice-nucleating particles. *Atmospheric Chemistry and Physics* 18(18):13755–13771.
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5. McCluskey CS, et al. (2018) Marine and Terrestrial Organic Ice-Nucleating Particles in Pristine Marine to Continentally Influenced Northeast Atlantic Air Masses. *Journal of Geophysical Research: Atmospheres* 123(11):6196–6212.
6. Price HC, et al. (2018) Atmospheric Ice-Nucleating Particles in the Dusty Tropical Atlantic. *Journal of Geophysical Research: Atmospheres* 123(4):2175–2193.