Supplementary material for Consistent estimates from satellites and models for the first aerosol indirect forcing by Joyce E. Penner, Cheng Zhou, and Li Xu

Table S1. Total CCN number concentration at 930hPa and 0.2% supersaturation and percentages associated with sulfate, biomass burning aerosols and sea salt.

	Sulfate (acc.)	BB OM/BC	Sea Salt	Percentage of total Num.	Total CCN number concentration (cm^{-3})
PI NPO JJA	74.72%	16.30%	6.79%	97.80%	78.79
PD SPO DJF	78.53%	7.68%	13.20%	99.41%	81.79
PI NPO DJF	54.15%	12.66%	20.52%	87.32%	49.62
PD SPO JJA	43.51%	16.06%	39.33%	98.90%	38.04

Differences between the observation-based forcing and the model forcing based on Eq. 2 can only be attributed to differences in the change in albedo from PI to PD between the satellite and the model methods, since all other variables in Eq. 2 are kept constant. To explore the possible reasons for these differences, we examined the observed and modeled aerosol optical depths that lead to these forcings (Table S2). The means of the observed optical depths for NPO JJA and SPO DJF only differ by 0.02 units, while the observed difference between NPO DJF and SPO JJA is 0.05. Both differences are statistically significant, given the large sample sizes (see Table S2). The modeled increase in τ_a in JJA is substantially larger than that in the observations, and this is reflected in the larger estimates of forcing. The increase in modeled τ_a in DJF is similar to that from the observations, and the forcing is also similar. Thus, if our method is accurate, it appears that SPO DJF may not be as good a surrogate for PI conditions in the NPO in JJA as originally estimated (Table 1), or that the estimated increase in aerosols from PI to PD in NPO JJA is too high in the model.

Table S2. Aerosol optical depths from the observations and model that lead to the estimates of forcing in Table 2.

	Observations			Model		
	# of data points	τ_a mean	stddev	# of data points	τ_a mean	stddev
NPO JJA PD	823777	0.15	0.23	75345	0.13	0.06
NPO JJA PI				75345	0.07	0.03
SPO DJF	1698205	0.13	0.12	105309	0.07	0.04
Change in τ_a		0.02			0.06	
NPO DJF PD	1223835	0.13	0.09	74488	0.11	0.08
NPO DJF PI				74488	0.07	0.02
SPO JJA	1348782	0.08	0.05	105309	0.06	0.03
Change in τ_a		0.05			0.05	

Table S3. Observed and modeled average cloudy sky albedo and cloud fractions.

Albedo:	NPO JJA	NPO DJF
Model	0.490	0.586
Satellite Obs (f>99%)	0.395	0.483
Cloud fraction:	NPO JJA	NPO DJF
Model	67.3%	56.4%
Satellite Obs	72.0%	77.2%

Figure S1. Albedo for all-sky conditions in (a) NPO DJF and (b) SPO JJA. Albedo for only those liquid clouds with f>99% in (c) NPO DFJ and (d) SPO JJA. Note the change in scale between panels (a, b) and (c, d).