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Aerosols at the poles: an AeroCom Phase II multi-model evaluation

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Table S1: Model description

Model	Resolution	Meteorology	Mixing assumption, size distribution, and humidity growth factor
CAM4-Oslo	2.5°×1.8°, 26 levels	GCM-generated	Internal vs. external mixing is determined on growth mechanism: coagulation, condensation, and cloud processing gives internal mixing with pre-existing particle. Maxwell-Garnett mixing for absorbing and transparent constituents, otherwise volume mixing. For internally mixed aerosols growth factor calculated from Kohler theory, taking hygroscopicity of each mixed constituent into account
HadGEM2	1.8°×1.2°, 38 levels	Nudged to ERA Interim data	External mixing. Size distributions prescribed for each aerosol component. Aitken, accumulation, coarse, and dissolved modes. Size distributions assumed lognormal for interaction with radiation. Hygroscopic growth is parametrized as a function of RH following Fitzgerald (1975)
ECHAM5-HAM	1.8°×1.8°, 31 levels	Nudged to ECMWF analysis	4 of total 7 modes are internally mixed; volume weighted mixing of refractive indices. Internal mixing for aerosol compositions within each mode, while external mixing is assumed among different aerosol modes. The humidity growth is based on Kappa-Koehler theory
OsloCTM2	2.8°×2.8°, 60 levels	ECMWF reanalysis	8 bin sizes for SS and dust, log-normal size distributions in calculations of optical properties Hydrophilic BC is internal mixed; core shell type of mixing and an increase in absorption by 50%. The humidity growth is parameterized based on Fitzgerald (1975)
SPRINTARS	1.1°×1.1°, 56 levels	Nudged to NCEP/NCAR reanalysis	6 bins for dust, 4 bins for sea salt, 1 bin for sulfate, BC, and OA, with log-normal size distributions and particle growth as a function of relative humidity; 50% BC FF internally BC from other sources are internally mixed with POM. Other aerosols are externally mixed. The growth factors are according to Tang and Munkelwitz (1994) for sulfate, and Hobbs et al. (1997) for carbonaceous particles
GISS-MATRIX	2.5°×2.0°, 40 levels	Nudged to NCEP winds	Mixing state is taken into consideration. Particles including BC have core shell structure; other particles use volume mixing approach. The size is prognostic and the mixing state assumption follows the population definitions in Bauer et al. (2008). Uptake of water calculated following the thermodynamical model EQSAM and for SS using the Lewis parameterization (Lewis and Schwartz 2004)
GISS-modelE	2.5°×2.0°, 40 levels	Nudged to NCEP winds	Aerosol are externally mixed. Size distributions are prescribed. Sea salt, nitrate and sulfate get humidified following Lacis and Oinas 1991 and depends on ambient RH
CAM5.1	2.5°×1.8°, 30 levels	CAM5.1	Internal mixing within each of 3 log-normal modes. Size varies with mass/number. Volume mixing of refractive indices of components within mode. Kappa Kohler theory using volume mean kappa. Dry if RH<RH_crystalization. Wet if RH>RH_deliquescence. Linear in RH between
BCC	2.8°×2.8°, 26 levels	NCEP/NCAR reanalysis	Aerosols are externally mixed. The size spectrum of each aerosol is divided into 12 size bins. Kohler theory is used to calculate the humidity growth
GMI-MERRA-v3	2.5°×2.0°, 72 levels	Nudged to GEOS-5 MERRA reanalysis	External mixing. 5 bin sizes for dust, 4 bin sizes for seasalt, 3 bin size for nitrate and sulfate. All aerosols with log-normal size distributions. Based on Tang and Munkelwitz (1996) water activity formula for ammonium nitrate and ammonium sulfate. All others based on GADS OPAC
GEOS-Chem	5.0°×4.0°, 47 levels	Nudged to GEOS-5 reanalysis	Optical properties calculated over 6 externally mixed species; inorganic ions (sulfate + nitrate + ammonium), OC (primary and secondary), BC, SS, and soil dust (4 size bins). 40 bins for secondary particles, 20 bins for sea salt, 15 bins for

			dust, 4 log-normal modes for BC and primary OC. A log-normal size distribution (except dust, gamma-distributions in the 4 size bins). The size distribution varies by hygroscopic growth
GOCART-v4	2.5°×2.0°, 30 levels	NASA GEOS-4 DAS reanalysis	External mixing. Parameterized with prescribed dry particle sizes: 8 bins for dust, 4 bins for sea salt, 1 bin for sulfate, BC, and OA, with log-normal distributions, particle growth parameterized as a function of RH. Humidity growth based on GADS (OPAC)
NCAR-CAM3.5	2.5°×1.9°, 26 levels	GCM-generated	Bulk-aerosol model, except 4-bins for SS and mineral dust
IMPACT	5.0°×4.0°, 46 levels	DAO assimilation fields, reanalysis	4 bin sizes for SS and mineral dust, 2 modes for pure sulfate with explicitly resolved size and coagulation and condensation of SO_4 with other aerosols
INCA	3.8°×1.9°, 19 levels	ECMWF IFS reanalysis	2 insoluble and 3 soluble modes with lognormal distribution. Size varies with number and mass affected by mixing, source and removal processes. Internal mixing is assumed with respect to removal by sedimentation and wet scavenging. Optical properties are calculated assuming external mixing. Optical properties assume mean size for each mode. 11 tabulated growth factors between 0 and 90% RH and 1 growth factor at 95% RH
TM5-V3	3.0°×2.0°, 34	ECMWF ERA-Interim reanalysis	Five out of seven modes are internally mixed. Volume weighted mixing of refractive indices within each mode, using non-linear mixing rules. The median radius for each mode is taken to infer optical properties. The soluble particles are assumed to be in equilibrium with water vapor. Only sulfate and SS are influencing the water uptake

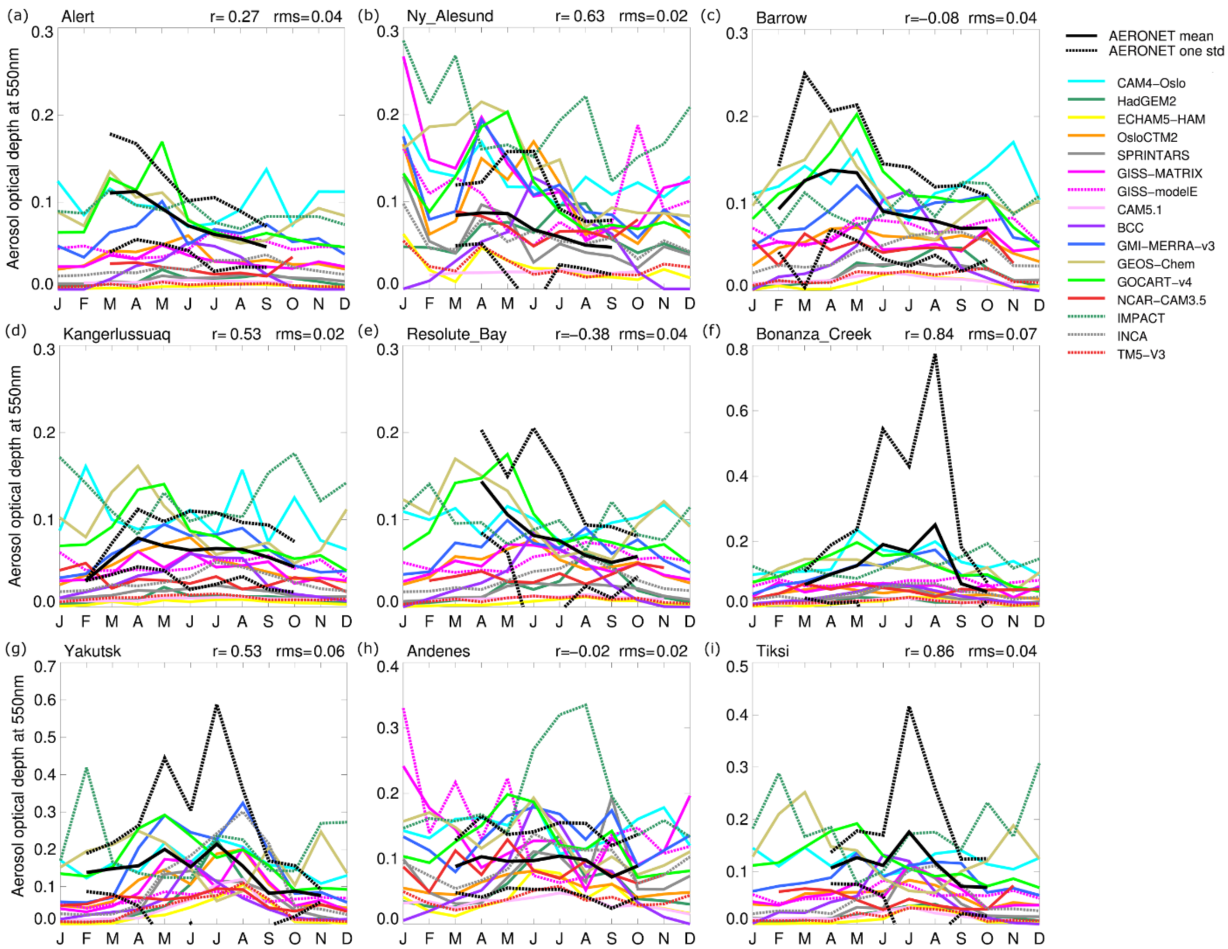

Figure S1: As in Fig 2, but with colors for the different models compared to AERONET. The black solid line is the AERONET mean, and the black dashed line is one standard deviation. R and rms is the correlation and root-mean-square between AERONET and the model median (model median is not shown in this plot).

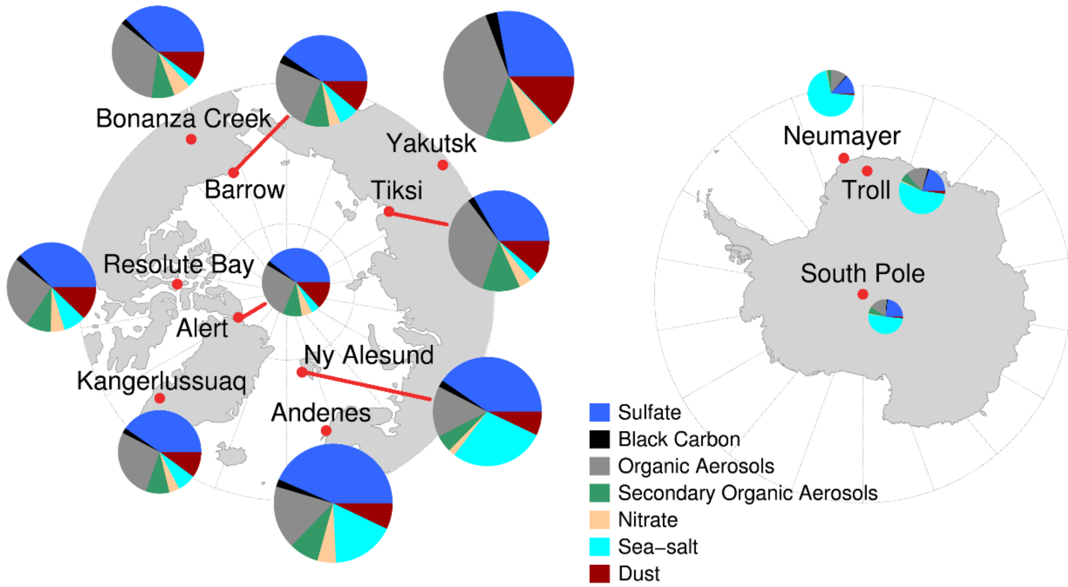

Figure S2: As in Figure 3, but for JJA. The circles show the modelled AOD species JJA average for each station. The area of the circles is scaled to the model median total AOD.

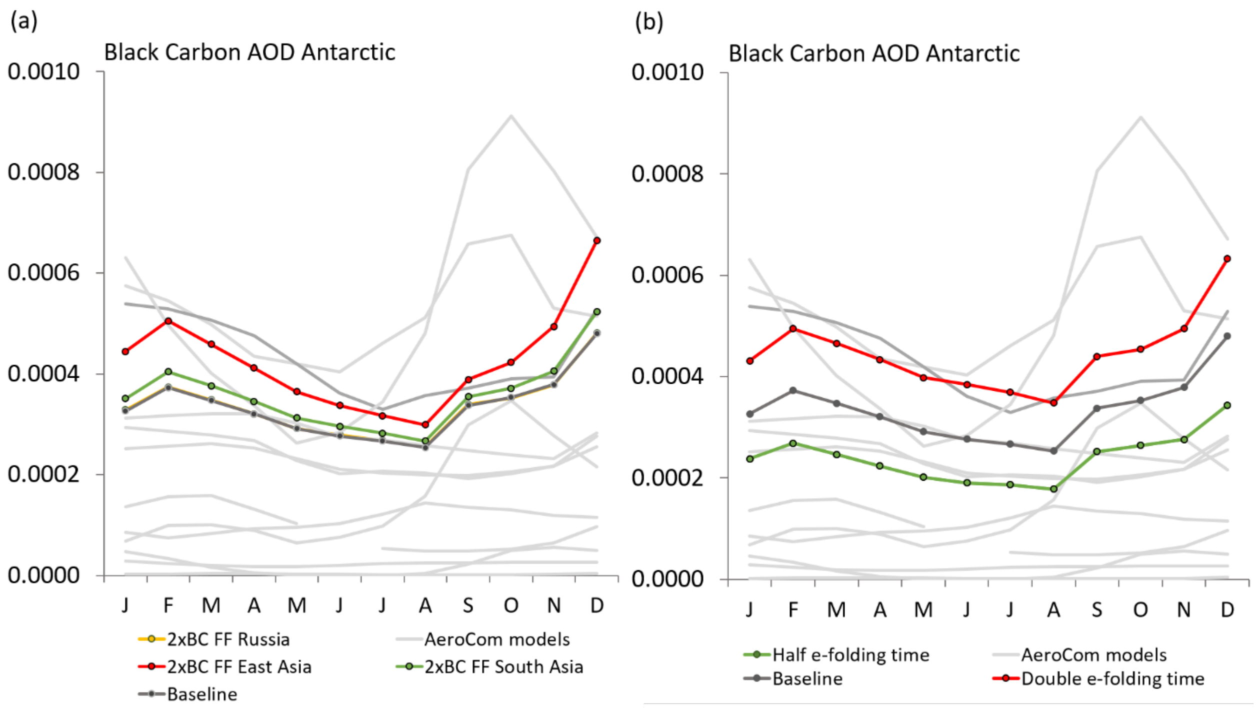

Figure S3: Antarctic mean seasonal cycle of (total) BC AOD for simulations with GISS modelE (in colors) compared to the AeroCom models (in light grey). The darker grey AeroCom model is the GISS modelE AeroCom run. (a) shows emission perturbations for a doubling of BC emissions (fossil fuel and biofuel) in South Asia (green), East Asia (red), and Russia (yellow). (b) shows double (red) and half (green) of the e-folding time from hydrophobic to hydrophilic BC.

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