Uncertainty in aerosol effective radiative forcing from anthropogenic and natural aerosol parameters in ECHAM6.3-HAM2.3

Yusuf A. Bhatti[1], Duncan Watson-Parris[2], Leighton A. Regayre[3,4], Hailing Jia[1], David Neubauer[5], Ulas Im[6], Carl Svenhag[6], Nick Schutgens[7], Athanasios Tsikerdekis[8], Athanasios Nenes[5,9], Irfan Muhammed[10], Bastiaan van Diedenhoven[1], Ardit Arifi[1], Guangliang Fu[1], and Otto P. Hasekamp[1]

[1]SRON Space Research Organisation Netherlands, Leiden, Netherlands
[2]Scripps Institution of Oceanography and Halıcıoğlu Data Science Institute, University of California San Diego, La Jolla, CA, USA
[3]Met Office Hadley Centre, Exeter, Exeter, UK
[4]School of Earth and Environment, University of Leeds, Leeds, UK
[5]ETH Zurich, Zurich, Switzerland
[6]Aarhus University, Roskilde, Denmark
[7]Vrije Universiteit Amsterdam, Amsterdam, Netherlands
[8]KNMI, Utrecht, Netherlands
[9]Institute of Chemical Engineering Sciences, ICE-HT, Patras, Greece
[10]Department of Technical Physics, University of Eastern Finland, Kuopio, Finland

Correspondence: Yusuf Bhatti (y.bhatti@sron.nl)

Figure S1. Map of regions used for analysis. The regions are: AO (Arctic Ocean), AL (Arctic Land), NPO (North Pacific Ocean), NA (North America), NAO (North Atlantic Ocean), EUR (Europe), ASIA (Asia), TPO (Tropical Pacific Ocean), TAO (Tropical Atlantic Ocean), AF (Africa), TIO (Tropical Indian Ocean), SPO (South Pacific Ocean), SA (South America), SAO (South Atlantic Ocean), SIO (South Indian Ocean), AUS (Oceania), ANO (Antarctic Ocean), and ANT (Antarctica). From Jia et al. (2021)

Figure S2. Probability distribution functions for the parameters in Table 1. The parameters display either the multiplication factor or absolute changes applied to each parameter, as labeled in Table 1. Scale factors to the baseline size are shown for the emission diameter parameters (e.g., EMI_CMR_FF). For example, the minimum emission diameter for fossil fuels is 30 nm * 0.5 = 25 nm.

Figure S3. 200,000 model variants and their respective contribution of uncertainties from individual parameters in (a) ERF, (b) ERFaci, (c) ERFari. Only parameters above 5% are shown. Identical to Figure 3 but *CDNC_min* is included in this analysis.

Figure S4. The standard deviation (uncertainty) of present-day aerosol optical depth (AOD) from variance-based sensitivity sampling across 500,000 model variants using Gaussian process emulator. Each plot represents the total AOD uncertainty when that parameter is sampled, while all other parameters are set to the control.

Figure S5. As in Figure S4, but showing Ångström exponent (AE)

Figure S6. As in Figure S4, but showing single scattering albedo (SSA)

Figure S7. Comparison with MODIS

Figure S8. The standard deviation (uncertainty) of effective radiative forcing (ERF) from variance-based sensitivity sampling across 500,000 model variants using Gaussian process emulator. Each plot represents the total ERF uncertainty when that parameter is sampled, while all other parameters are set to the control.

References

Jia, H., Ma, X., Yu, F., and Quaas, J.: Significant underestimation of radiative forcing by aerosol–cloud interactions derived from satellite-based methods, Nature Communications, 12, 3649, https://doi.org/10.1038/s41467-021-23888-1, publisher: Nature Publishing Group, 2021.