Aerosol data assimilation as a tool to detect model errors

Athanasios Tsikerdekis*†[1], Nick A. J. Schutgens[2], and Otto Hasekamp[3]

[1]SRON Netherlands Institute for Space Research – SRON Utrecht, Sorbonnelaan 2, 3584 CA Utrecht, Netherlands

[2]Vrije Universiteit Department of Earth Science – de Boelelaan 1085, 1081 HV, Netherlands

[3]SRON Netherlands Institute for Space Research – SRON Utrecht, Sorbonnelaan 2, 3584 CA Utrecht, Netherlands

Abstract

An ensemble Kalman-filter smoother (LETKS) is used to estimate aerosol emission in the global climate/aerosol model ECHAM-HAM by assimilating retrievals from the multi-angle polarimeter POLDER. The assimilated observations (aerosol optical depth, angstrom exponent and single scattering albedo) provide a wealth of information in order to correct the aerosol amount, size and composition simultaneously. The emissions are estimated per species (dust, sea salt, organic carbon, black carbon, sulfates and sulfate precursor gases), per sector (biomass burning and fossil fuel) and by size (Aitken, Accumulation and Coarse). An evaluation of the data assimilation experiment reveals that the model errors are reduced for all the assimilated observables in most areas over the globe. Surprisingly, in the biomass burning outflow area of South Atlantic the aerosol optical depth error increases. This increase cannot be attributed to emission errors, since the model error (for all observables) over the biomass burning African sources is very low after the assimilation. Hence, we use the new corrected emissions and tune various model processes (e.g. emitted particle size, wet growth, emission height, removal processes) in order to improve the aerosol optical depth in the outflow and not affect it negatively in the sources. This application shows how data assimilation results can be used to highlight "hidden" model errors and promote future model development.

Keywords: aerosol, emission estimation, data assimilation, kalman filter, ensemble, model error

*Speaker

†Corresponding author: A.Tsikerdekis@sron.nl