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Sensitivity of aerosol concentrations and cloud properties to nucleation and secondary organic distribution in ECHAM5-HAM global circulation model

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Abstract. The global aerosol-climate model ECHAM5-HAM was modified to improve the representation of new particle formation in the boundary layer. Activation-type nucleation mechanism was introduced to produce observed nucleation rates in the lower troposphere. A simple and computationally efficient model for biogenic secondary organic aerosol (BSOA) formation was implemented. Here we study the sensitivity of the aerosol and cloud droplet number concentrations (CDNC) to these additions. Activation-type nucleation significantly increases aerosol number concentrations in the boundary layer. Increased particle number concentrations have a significant effect also on cloud droplet number concentrations and therefore on cloud properties. We performed calculations with activation nucleation coefficient values of $2\times10^{-7}s^{-1}$, $2\times10^{-6}s^{-1}$ and $2\times10^{-5}s^{-1}$ to evaluate the sensitivity to this parameter. For BSOA we have used yields of 0.025, 0.07 and 0.15 to estimate the amount of monoterpene oxidation products available for condensation. The hybrid BSOA formation scheme induces large regional changes to size distribution of organic carbon, and therefore affects particle optical properties and cloud droplet number concentrations locally. Although activation-type nucleation improves modeled aerosol number concentrations in the boundary layer, the use of a global activation coefficient generally leads to overestimation of aerosol number. Overestimation can also arise from underestimation of primary emissions.

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