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Sensitivity to new particle formation parameterization in the Norwegian Earth System Model (NorESM)

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Vegetation influences climate in several ways, one of which is through the emission of biogenic volatile organic compounds (BVOCs). When oxidized, these gases contribute to aerosol formation and growth and thus affect the atmospheric radiative balance directly and indirectly through cloud-aerosol interactions. As vegetation emits BVOCs dependent on environmental factors as sunlight, temperature, CO_2, soil moisture etc., the currently changing climate opens the door for several possible climate feedbacks through BVOC emissions.

The parametrization of nucleation and early growth of aerosols are in particular important in order to represent the climate effects of the BVOC emissions. This is because the influence of aerosols on clouds depends on the number of aerosols which can act as cloud condensation nuclei (CCN) and thus the number of cloud droplets formed.

Recent laboratory and field studies show that oxidation products from BVOCs can participate in the formation of the smallest molecular clusters (alone or with e.g. sulphuric acid or ammonia) and that condensation of these gases is important for the growth of clusters to CCN-sizes (Shrivastava et al 2017). Large uncertainties remain, however, with respect to the parametrization of these processes.

We present preliminary results on sensitivities to different nucleation schemes in the boundary layer in the Norwegian Earth System model. In particular, we investigate how the choice of parametrization influences the sensitivity to increased BVOC emissions, and thus the strength of the related feedbacks. The atmospheric component is the Community Atmospheric Model, with the OsloAero aerosol scheme (CAM5.3-Oslo). The formation of new particles in the boundary layer is currently parametrized as activation by either sulfuric acid or low volatile oxidation products of BVOCs (ORG_LV) in accordance with eq. 18 in Paasonen et al (2010) (nucleation rate $J = k_1[\mathrm{H_2SO_4}] + k_2[\mathrm{ORG\_LV}]$). We compare the current parameterization with kinetic theory nucleation parameterizations, both homo- and heteromolecular also from Paasonen et al (2010) (eq. 19, $J = k_1'[\mathrm{H_2SO_4}]^2 + k_2'[\mathrm{H_2SO_4}][\mathrm{ORG\_LV}]$, and eq. 20, $J = k_1^*[\mathrm{H_2SO_4}]^2 + k_2^*[\mathrm{H_2SO_4}][\mathrm{ORG\_LV}] + k_3^*[\mathrm{ORG\_LV}]^2$).

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