



## Direct radiative feedback due to biogenic secondary organic aerosol estimated from boreal forest site observations

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The direct radiative feedback parameter associated with the formation of biogenic secondary organic aerosol (BSOA) was estimated at a remote continental site at the edge of the boreal forest zone in Northern Finland. The feedback parameter was estimated from two independent in situ measurements, from aerosol optical depth and aerosol scattering coefficient. Our two independent estimates ( $f_{AOD} = -97 \pm 66 \text{ mW m}^{-2} \text{ K}^{-1}$  and  $f_{\sigma} = -63 \pm 40 \text{ mW m}^{-2} \text{ K}^{-1}$ ) represent upper-limit values for this feedback over the summer period, because the temperature range used in our analysis was somewhat higher than the typical summer temperatures at our site and because the observed temperature-dependent BSOA formation was evidently biased by air mass transport effects. Compared with our measurement site, the magnitude of the direct radiative feedback associated with BSOA is expected to be larger in warmer continental regions with more abundant biogenic emissions, and even larger in regions where biogenic emissions are mixed with anthropogenic pollution. Future changes in the atmospheric BSOA and their precursor loadings, either due to changing climate or land use, may trigger additional feedback mechanisms that lead to considerable radiative effects. Such feedbacks might arise, for example, via changes in atmospheric chemistry, in the ratio between diffuse and direct radiation entering the Earth's surface, or in the carbon and water cycles. These issues bring up the need to extend these kind of analyses to other continental sites from which long-term observations are available, to complement such analyses with model simulations whenever feasible, and to look for additional feedback mechanisms that might be relevant for the climate system.