The natural aerosol field over Northern Europe - Implications of important climate feedbacks

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Aerosols in the atmosphere most likely have a large impact on climate due to both indirect and direct scattering of incoming solar radiation. The radiation forcing resulting from aerosol emissions (negative) and emission of greenhouse gases (positive) in the atmosphere is comparable in magnitude. Changes in particle emissions could therefore have substantial impact on earth’s climate. Still, both particle sources and determining atmospheric processes are poorly quantified. It is therefore not yet possible to make precise estimates of the particles impact on the radiation balance of the atmosphere. The carbon containing fraction of the atmospheric aerosol has a central role in the atmosphere, making up 10-90% of the fine particle mass, and where 85% of the Volatile Organic Compounds (VOC’s) comes from natural sources.

For the Scandinavian region, it has been shown that natural biogenic emissions of monoterpenes dominate VOC concentrations (Laurila and Lindfors, 1999). Monoterpenes emissions from pine and spruce are mainly controlled by temperature, and pool dependent emissions from spruce and pine are exponentially dependent on temperature (Guenther et al., 1995). There is increasing evidence that several of these compounds partake in gas-to-particle formation (Kavouras et al., 1998).

For the Scandinavian region, Tunved et al. (2006a, 2006b) have shown both qualitatively and quantitatively that the monoterpane emissions from the boreal forest at high latitudes in Europe potentially contribute to particle generation with an apparent yield in the range of approximately 5-10%. Oxidation products from monoterpenes have been identified in recently formed particles and several investigations of new particle formation events during the biologically active seasons indicate that biogenic aerosol precursor’s gases are necessary to support the observed mass increase during particle formation events (Kulmala et al., 2000). Anthropogenic sources in this area are sparse. Together, the results indicate the biogenic emissions (most likely monoterpenes) completely dominate the evolution of the aerosol during transport of clean marine air over Fennoscandia. Furthermore, increasing temperatures increase, at least initially, the monoterpane emission rates. Since the link between monoterpane emissions and aerosol formation is established it is also possible that increased forest emissions could provide cooling in times of a warming climate. The direct response of BVOC emissions to temperature is the result of enhanced production rate and increased vapour pressure of the compounds.

In this study we adopt a statistical approach to quantitatively investigate how the natural aerosol contributes to the regional aerosol fields over northern parts of Europe. We will make use of the simple but efficient parameterisation of particle formation potential resulting from monoterpane emissions described by Tunved et al (2006a). We will further investigate how the pool dependent monoterpane emissions changes with increased temperature, and thus move the knowledge forward towards projections on the future role of the boreal forest in a changing atmosphere.

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