EGU2020-11662
https://doi.org/10.5194/egusphere-egu2020-11662
EGU General Assembly 2020

Composition and Properties of the Natural Aerosol over the Boreal and Tropical Forests

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We, together with 50 of our colleagues present a review on the interaction between tropical and boreal forests and the atmosphere, especially addressing their influence in the climate system. With its emissions of VOCs, aerosols and trace gases, with strong atmosphere interactions, forests are a key component of the climate system. These emissions and atmospheric processing regulates atmospheric chemistry and are the major source of cloud condensation nuclei (CCN) affecting cloud formation and development, and thus temperature and precipitation. Emissions from forests are thus closely connected to the hydrological and the carbon cycles, being an essential integrated part of the climate system.

In terms of meteorology, tropical and boreal forests are very different. Temperature, solar radiation, precipitation, evapotranspiration, albedo, cloud structure and cover, convection etc., are all very different. However, the aerosols in the two systems show similarities as Primary Biological Aerosol Particles are the major component (70%) of coarse mode particles in Amazonia while Secondary Organic Aerosol in the tropics are mainly isoprene driven giving a slightly more hygroscopic SOA than the boreal monoterpene driven SOA. The organics constitutes 70 to 85% of PM1 mass for both boreal and tropical forests. In Amazonia, sulfates, nitrates and BC shows very low concentrations, while the boreal sites shows 2-3 times higher concentrations. The Siberian continental site and Amazonian site show remarkable similarities in the lack of new particle formation (NPF) which will be discussed.

In the tropics dry season and boreal spring and early summer, increasing biomass burning emissions in both forest types dominates the aerosol composition, with high OC and BC concentrations while anthropogenic pollution influences boreal forest atmospheric composition during wintertime. The changes in diffuse to direct radiation due to scattering aerosols has important effects in tropical forests but minor in boreal, enhancing the net ecosystem exchange by 30% and 10% respectively. Thus the natural forest emissions affects the direct as well as the indirect forcing.

An Amazonia high altitude NPF process chain was recently observed at the top of the troposphere, and is an interesting interaction between forest emissions, cloud transport and processing and

particle formation and aging at high altitudes that are brought back to the boundary layer, populating the CCN. For boreal forests, the complex relationship between GPP, BVOC, SOA, CCN, clouds, radiation, temperature and CO_2 show multiple pathways and feedbacks, and some of them can be quantified. All showing the complexity of the interaction between forests, atmosphere and climate.