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Ice nucleation ability of biomass burning particles from wood combustion

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Soot particles are solid, carbonaceous products resulting from incomplete combustion of carbonaceous materials such as hydrocarbons, coal, wood and other fuels. They can affect human health due to their chemical composition and their small size but also affect cloud properties (Lohmann and Feichter, 2005). High concentration of smoke coming from biomass burning can potentially delay warm cloud precipitation onset and provide energy to convection, transporting water to supercooled temperatures (Andreae et al., 2004) where ice nucleation can occur. Ice nucleation can occur via two main pathways homogeneous and heterogeneous freezing. The latter requires an ice nuclei and can take place via four sub-processes : deposition mode, immersion, condensation and contact freezing. The presence of ice in mixed-phase clouds can accelerate precipitation due to the Bergeron-Findeisen process.

The IMBALANCE project aimed to characterize the physical and chemical properties of primary and aged biomass burning and assess the effect of ageing process on cloud formation, absorptivity, scattering and hygroscopic growth. Ice nucleation ability of primary and aged wood burning particles were investigated with the Portable Ice Nucleation Chamber (PINC) (Chou et al., 2010) at three different temperatures -30°C, - 35°C and -40°C during the Paul Scherrer Institut IMBALANCE campaign 2009 in Villigen, Switzerland.

Results showed that at -30°C, no ice crystals were forming for all the experiments. At -35°C, ice crystals were forming via condensation freezing mode at 158% and 106% relative humidity with respect ice (RHi) and water (RHw), respectively. No difference in the ice nucleation activity could be observed for primary emission particles and aged particles coated with organics. At -40°C, the primary and aged particles nucleated ice crystals via deposition mode at 140% RHi and 92% RHw. No difference in the onset of ice nucleation were observed for aged and non-aged particles.

References:

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