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Atmospheric new particle formation and the potential role of organic peroxides

Katrin Trawny (1), Boris Bonn (1), and Stefan Jacobi (2)

(1) Frankfurt University, Institute for Atmospheric and Environmental Sciences, Frankfurt/Main, Germany (Bonn@iau.uni-frankfurt.de, +49 69798 40245), (2) Hessian Agency for the Environment and Geology, Air Quality Department, Wiesbaden, Germany

New particle formation in the atmosphere belongs to the currently most discussed aspects of atmospheric aerosols with significant implications for cloud formation and microphysics, once these particles have grown beyond about 50 nm in particle diameter. If these particles act as cloud condensation or ice nuclei they can affect the radiation budget at the Earths surface and cause climate couplings important to understand when aiming to predict climate change scenarios. One aspect widely discussed is the potential contribution of organic trace gases from anthropogenic and biogenic sources. In this study we analysed datasets from a Central European measurement station in Germany in a spruce forest approximately 800 m above sea level and a distance of about 20 km to Frankfurt (southeast). Continuous particle size distribution measurements were classified in nucleation-event or not and unidentified and intercompared to meteorological and basic trace gas observations. Additionally meteorological backtrajektories calculated by the German Weather Service for the station every 12 hours have been considered. These led to the following conclusions: Nucleation was most likely if (A) the air has not get significantly into touch with the surface within the last days, or if (B) at least human impact was minor and the air faced forest surfaces mainly (northwest). As observed already in Hyytiälä (Finland) nucleation appeared, when the relative humidity and ambient water vapour mixing ratio were low, ozone was high and the condensation sink was small. A further important point was the amount of global radiation measured at the Taunus Observatory (Mt. Kleiner Feldberg). The higher the radiation, the more likely a nucleation event and the more intense. Temperature impacted on the intensity of nucleation, i.e. the higher the temperature the more intense the event, but did not directly affect the occurrence of an event or not, if a threshold value of ca. -6 °C was exceeded. This latter observation indicates a potential role of biogenic volatile organic compounds (VOCs) as their emission is strongly coupled to temperature. Because of our observations in the laboratory and beacuse of observed nighttime events, we approximated the concentration of different radicals, e.g. OH, HO_2 and RO_2. The values of RO_2 and especially the ones of biogenic (e.g. terpene) origin showed a good correlation with new particle formation occurrence and seemed to be one essential point of several to allow new particle formation to occur. This might be an indication of the important role of the biosphere and its stress effects for the particle formation process. The seasonality observed for the time period since February 2008 displayed two maxima in May and August, September with a minimum in June, when the weather conditions were more humid and is in line with the observations made above. July and August displayed the higest HO_2 concentrations, which will act as a sink for the organic peroxy radicals. In connection to the supressive effect of water vapour on terpene induced nucleating molecules (secondary ozonides) this might serve as an explanation for the commonly observed summer minimum in nucleation events.