Atmospheric aerosol is a system of liquid and/or solid particles suspended in ambient air with small diameters. At the molecular level these particles are the complex chemical mixture of dynamically changing physico-chemical properties that affect the mankind and its environment. In a global scale, aerosol is behind climate changes having a strong effect on the Earth's radiation balance and the formation of cloud condensation nuclei. On the other hand, ambient particulate matter has a direct influence on our health and the quality of our lives, as indicated by numerous epidemiological studies. There is a clear tendency of increasing numbers of cardiovascular and/or lung diseases, including asthma and allergy, in correlation with decreasing sizes of particles. The rapidly growing population of the planet along with industrial developments, increasing transportation and biomass burning are behind long-lasting smog episodes that occur more and more frequently. During these events the aerosol mass concentration is rapidly peaking, including respirable $PM_{2.5}$ fraction, i.e., fractions containing aerosol particles of diameters lower than 2.5 µm, which worsen the air quality, disturb the comfort of the live and markedly reduce the visibility (figure beside).

During recent a few decades intense research efforts have been conducted to understand mechanisms of evolution of volatile organic compounds (VOC) to aerosol particles in the atmosphere. In rural and suburban sites with great contribution of plant vegetation (forests, bushes, green lands etc.) VOCs constitute one of the dominant aerosol source. These volatiles are massively released by plants to the lower atmosphere, where they undergo complex chemical reactions. These reactions lead to the offspring of novel compounds with lower vapor pressures which are capable of condensing on pre-existing particles, e.g., mineral dust, and form aerosol particles. The latter are referred to as *secondary organic aerosol* (SOA). Numerous data evidence the overwhelming contribution of SOA to ambient aerosol masses ranging up to 90%. The aforementioned processes are highly complex and hardly understandable, and thus there has been the continuous thrust to assess their role by applying mathematical modelling. The modelling on a global and/or local scale clearly reveal underestimation of the aerosol budget compared to the field data implying the existence of hitherto undiscovered mechanisms underlying formation and evolution (**aging**) of SOA particles.

In the project the PI and his team conduct an intense interdisciplinary research on the alternative mechanism of SOA formation and aging. According to this concept, the early VOCs oxidation products get uptaken to the droplets of atmospheric waters (rain, for etc.) and there they undergo further transformations, i.e., aging. The resultant products are of low vapor pressures, and therefore after water evaporation they can form novel SOA particles. A number of factors enhance the in-cloud aerosol aging. Through the project a series of simulation aging experiments are carried out in the diluted aqueous solutions with monoterpene-derived SOA using two atmospherically-relevant radical systems: hydroxyl (OH) and sulfate (SO_4) radicals. These radicals are ample oxidation agents of the lower atmosphere and are typical of pristine unpolluted regions and pollution (e.g., SO_2) impacted sites, respectively. The project aims at delivering the data to quantify the role of the aging processes. It encompasses *inter alia*: identification of aging products, rate constant of the in-cloud aging, reaction modeling and aerosol source apportionment. The results obtained in a laboratory framework will be confronted with the composition of environmental samples, i.e., ambient aerosol ($PM_{2.5}$ fraction) and precipitation. These samples are collected during two 30-day campaigns in environmentally different regions in Poland: *Borecka Forest* (forested rural site) and *Kampinos* (forested suburban site). An effort will be made to evaluate the potential impact of identified the in-cloud aged products on the environment and health. The results of the project will provide solid arguments in discussion on the role of atmospheric waters in aging of secondary organic aerosol. In addition, the data obtained will allow to extend mathematical models of pollution transport through the atmosphere and models assessing physico-chemical properties of the aerosol, e.g., CAPRAM model.