

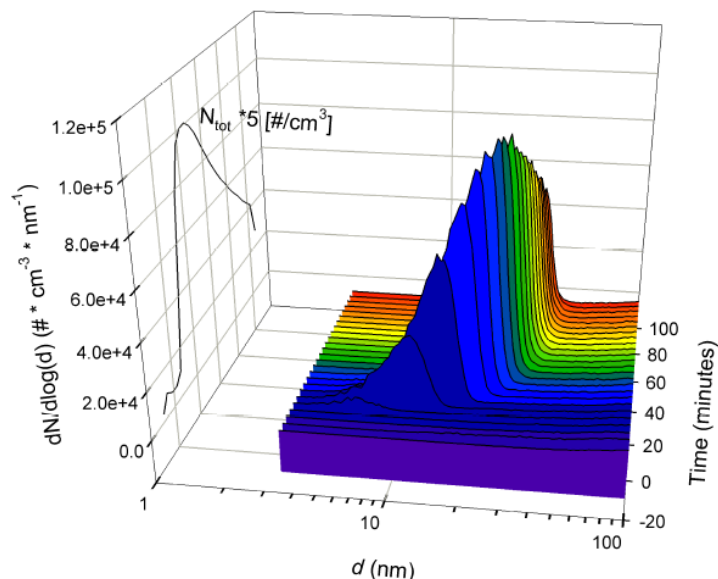
## Research Interests

### Reactive Indoor Air Chemistry

The chemistry occurring in indoor air is fundamentally the same as occurring outdoors; the time available for chemical reactions indoors is determined by the ventilation rate of the building. Indoor organic air pollutants arise from number of sources such as building materials, carpets, paints, cleaning products, plants and flowers. The organic compounds indoors are present at higher levels compared with that outdoors. The atmospheric reaction initiators are free radicals such as hydroxyl (OH) or nitrate ( $\text{NO}_3$ ) radicals or ozone. Ozone is infiltrated via the ventilation systems together with  $\text{NO}_2$ , usually at comparable concentration levels indoors as outdoors. OH radicals normally require sunlight for their formation; however they might be formed in specific reactions between terpenes and ozone indoors in levels comparable to ambient concentrations.  $\text{NO}_3$  radical is formed in the reaction between  $\text{O}_3$  and  $\text{NO}_2$  and reacts, in turn, especially with unsaturated hydrocarbons such as limonene.

The main research of our group is ozone-initiated reactive indoor air chemistry. Formation of ultrafine particles from the gas-phase chemical reaction between ozone and terpenes under conditions relevant for indoor environments has been studied using the available chambers. The goal of the project: "Chemical reactions in indoor air as a source of ultrafine particles" was to develop a simple mathematical model that describes and quantifies the fraction of ultrafine particles formed indoors in the reaction of ozone and limonene.

Figure 1. Particles formation and growth from the reaction between ozone and limonene. Ozone 5.7 ppb, limonene 27.3 ppb, ACR =  $0.1 \text{ h}^{-1}$ , chamber: STORA.



### Characterization of organic content of aerosol particles

Organic compounds in samples of SOA formed in reaction of various unsaturated organic precursors with ozone have been determined by Direct Thermal Extraction/Gas Chromatography/Mass Spectrometry/Flame Ionization Detection. The SOA is formed in the chamber "LILLA" and sampled on cleaned glass fibre filters. The filters are then heated in Automated Thermal Desorber and the

released compounds are injected into a chromatographic column. The compounds are identified by mass spectrometry and quantified by flame ionization detector.

Figure 2. SOA formed in the reaction of ozone with longifolene. Ozone 1.5 ppm, longifolene 1.5 ppm, ACR = 0 h<sup>-1</sup>, chamber: LILLA.

Longifolene 2009-07-31

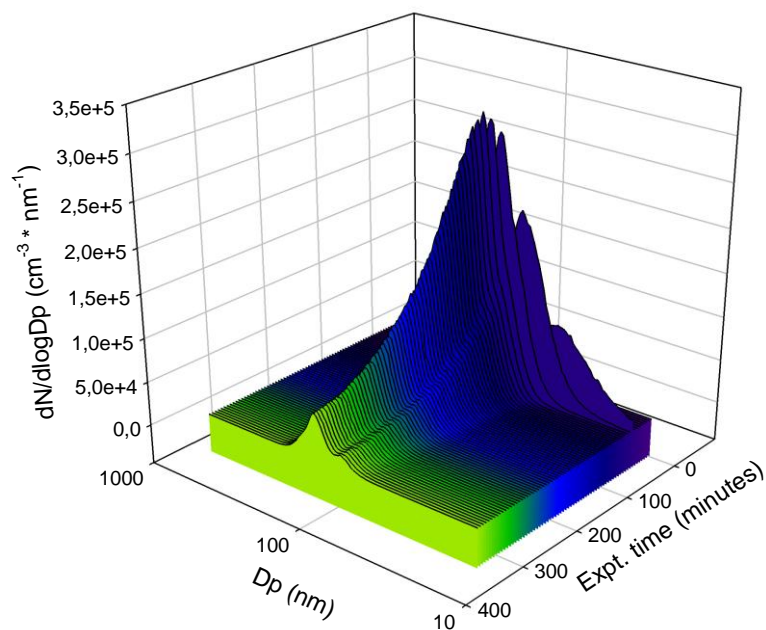
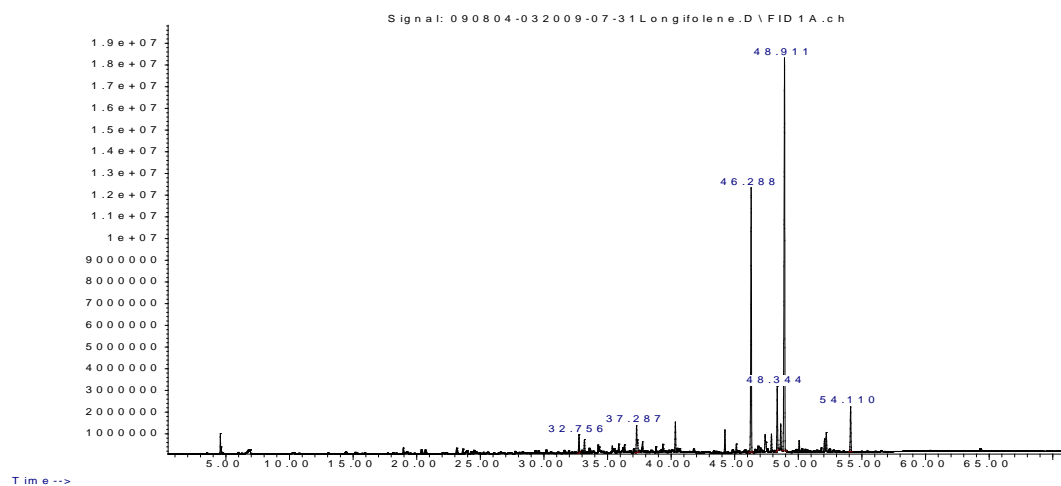


Figure 3. FID chromatogram of organic compounds present in the particles formed in the reaction between ozone and longifolene.

Abundance



## Relevant articles:

Carslaw N., Langer S., Wolkoff P. *Where is the link between reactive indoor air chemistry and health effects?* Atmospheric Environment **2009**, 43, 3808-3809.

Giorgi R., Chelazzi D., Frantini E., Langer S., Niklasson A., Rådemar M., Svensson J.-E., Baglioni P. *Nanoparticles of Calcium Hydroxide for Wood Deacidification: Decreasing the emissions of organic acid vapours in church organ environments*. *Journal of Cultural Heritage* **2009**, 10(2), 206-213.

Langer S., Moldanová J., Arrhenius, K., Ljungström E., Ekberg,, L. *Ultrafine Particles Produced by Ozone/Limonene Reactions in Indoor Air under Low/Closed Ventilation Conditions*. *Atmospheric Environment* **2008**, 42(18), 4149-4159.