

Formation of nitrogen-containing low volatile compounds from biogenic carbonyl compounds-amine reactions: A laboratory and field study

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Atmospheric aerosols play an important role in regional air quality, have adverse health impacts and can affect directly or indirectly regional and global climate. Secondary organic aerosols (SOAs) represent the major part of aerosol in the atmosphere, and are formed through atmospheric oxidation and processing of volatile organic compounds (VOCs) via gas-to-particle partitioning. Among the atmospherically relevant compounds, amines have been demonstrated to play an important role in atmospheric new particle formation events (Yu et al., 2012; Almeida et al., 2013). Indeed, despite the high vapor pressures of low-molecular weight amines, these compounds can affect the chemistry and lifecycle of atmospheric aerosols, especially due to their unique acid-neutralizing capacity. Amines are emitted to the atmosphere from industry, combustion, biomass burning, animal husbandry and the oceans (Ge et al., 2011). In addition, soil and vegetation act as important sources too, especially during periods with high biological activity (Ge et al., 2011). The reactions between amines and carbonyl compounds may contribute to nanoparticle growth (Qiu and Zhang, 2013), and more knowledge is needed to estimate their role in the chemistry of atmospheric aerosols. In this context, the objective of this study was to provide mechanistic data describing amine reactivity with relevant biogenic carbonyl compounds in the atmosphere.

In this work, the reactivity between amine and carbonyl compounds from biogenic sources were investigated by flow tube reactor and Teflon bags. The approach proposed here is based on the chemical analysis at the molecular level of both volatile and condensable products. The gaseous phase was characterized on-line by mass spectrometry and the structures of gaseous products were determined using gas chromatography coupled to high resolution tandem mass spectrometry (GC-HRMS). Structures of condensable products were determined by ultra-high-performance liquid chromatography coupled to electrospray ionization Orbitrap mass spectrometry (UHPLC-HRMS). To support the results of laboratory experiments, ambient aerosol samples were collected from SMEAR II boreal forest site at Hyytiälä, Finland,

during August 2015 and analysed by the same analytical techniques.

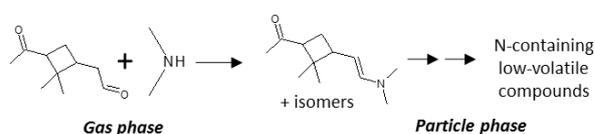


Figure 1: Formation of N-containing low-volatile compounds from pinonaldehyde-dimethylamine reaction (Duporté et al., 2016)

New evidence was achieved on the nitrogen-containing compounds originating from the reactions between amines and carbonyl compounds (Figure 1) in both laboratory experiments and ambient air sampled in the boreal forest at Hyytiälä, Finland. These nitrogen compounds identified in this work could be important for the formation and growth of SOAs in the atmosphere. In addition, the presence of brown carbon, confirmed by liquid chromatography-UV-Vis mass spectrometry, was also observed in this study.

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