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Coupling of biogenic volatile organic compound emission with leaf surface temperature, phenology and species characteristics in tundra shrubs

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Biogenic Volatile Organic Compounds (BVOCs) are reactive hydrocarbons emitted by living organisms, mainly by vegetation, in numerous physiological processes. BVOCs interact with the atmosphere in various ways, and are important for the regional air quality and climate because they can contribute to tropospheric ozone, prolong the lifetime of methane, and enhance aerosol formation and growth.
Production and emission of BVOCs from plant leaves is highly regulated by temperature. As the Arctic region currently experiences drastic increases in air temperatures due to the climate warming, it is important to understand how the arctic plants respond to this warming. Arctic plants do not regulate their leaf temperature as well as temperate or tropical plants do and effectively heat up during sunny days. Our aim was to evaluate whether their BVOC emissions follow accordingly.
In this project we assessed the influence of leaf temperature on BVOC emission of four common tundra shrubs, deciduous Salix myrsinites and Betula nana, evergreen Cassiope tetragona and Rhododendron lapponicum, over the course of the 2018 growing season on a mesic subarctic tundra heath in Abisko, Sweden. In addition to sampling of volatile emissions over a range of temperatures, we measured various plant traits, such as photosynthesis, stomatal conductance, chlorophyll fluorescence, leaf surface structures, specific leaf area, branch height from the ground and leaf temperature. Climate data were collected from a nearby weather station. The BVOCs were sampled in adsorbent cartridges from a branch enclosed in a leaf cuvette of LI 6400 XT photosynthesis system (Licor, Lincoln, NE, USA) and analyzed using Gas Chromatography – Mass Spectrometry (GC-MS).
Results showed that the investigated plants responded differently to increasing temperatures in terms of their BVOC emissions. For instance, the sesquiterpene emissions from Betula had a maximum at around 31°C, above which they decreased drastically, closely following the temperature response of photosynthesis. Monoterpene emissions, however, continued to increase up to the last measurement temperature of around 40°C. This suggests that the monoterpene emissions from Betula were mainly stored VOCs, while sesquiterpenes were newly synthesized. Salix, which is a strong isoprene emitter, showed an increase in isoprene emission even at the highest measurement temperature (above 38°C). This shows, that leaf temperature strongly regulates isoprene emission and that the emission is likely to continue increasing with climate change in the Arctic. Multiple regression will be used to find more relationships between BVOC emission and the measured plants traits.

To conclude, the species investigated and the different BVOC groups showed different responses to temperature, suggesting altered BVOC emissions from the arctic ecosystems under climatic warming. The new knowledge acquired in this project will be used to improve the models for BVOC emission to better account for the responses of the Arctic to global environmental change.