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OH reactivity measurements from Boreal tree species in a plant chamber

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Boreal forest covers a large area (ca. 15 million km^2) comparable in size to the Tropical rain forest (ca. 17 million km^2). The vegetation in Boreal regions is typically conifer forest which is known to emit significant amounts of biogenic volatile organic compounds (BVOCS), such as monoterpenes, sesquiterpenes, methanol and acetone. Many of these organic chemicals react rapidly with hydroxyl (OH) radicals to produce aerosols or secondary pollutants such as ozone. The total effect of the emitted species on the OH radical can be determined by measuring the total OH reactivity directly. Therefore a new measurement method was recently devised (Sinha et al., 2008).

The Jülich plant atmosphere chamber (JPAC) at the Forschungszentrum-Jülich was used to investigate the overall reactivity of emissions from several Boreal tree species under controlled conditions in October 2009. Vegetation, temperature and light intensities typical of the Hyytiälä measurement station in Finland were used in these experiments and the levels of CO_2, humidity and NO_x were controlled. In addition to the reactivity measurement, a gas chromatograph (GC), a proton transfer reaction mass spectrometer (PTRMS) and a time-of-flight PTRMS (TOF-PTRMS) were used to quantify individual organic chemicals emitted by the plants for comparison with the overall reactivity.

Experiments were performed under three different conditions. 1) Lower temperatures (T=20˚C) resulted in low plant emissions with no diurnal variation. The total measured OH reactivity ranged from below detection limit (3 sec^{-1}) to 7 sec^{-1} during the day and overnight rose to 8-13 sec^{-1}. 2) Higher temperatures (T=35˚C) produced higher emissions of volatile organic compounds and a clear diurnal trend. Reactivity data matched well with these results rising to 30-50 sec^{-1} by day and during the night sinking again to 8-13 sec^{-1}. 3) Finally a control experiment was performed without trees in the plant chamber. In this experiment, reactivity showed no nocturnal or diurnal variation and measured values remained below detection limit.

Significant fractions of the diurnal reactivity could be explained by the individual VOC measurements; however, for all measured organic species we found higher emissions during periods of illumination than during periods of darkness. Also subsequent laboratory tests have eliminated interferences and influences of CO_2 and water vapor concentrations as a possible explanation. The elevated nighttime values can be attributed to the presence of the plants and not to a chamber related artefact. The cause of the high nocturnal reactivity remains unexplained.