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Particle formation above natural and simulated salt lakes

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Originally, Western Australia was covered with Eucalyptus trees. Large scale deforestation for agricultural purposes led to rising ground water levels and brought dissolved salts and minerals to the surface. Nowadays, Western Australia is known for a great plenty of salt lakes with pH levels reaching from 2.5 to 7.1. The land is mainly used for wheat farming and livestock and becomes drier due to the lack of rain periods. One possible reason could be the formation of ultrafine particles from salt lakes, which increases the number of cloud condensation nuclei, and thus potentially suppresses precipitation.

Several field campaigns have been conducted between 2006 and 2011 with car-based and airborne measurements, where new particle formation has been observed and has been related to the Western Australian salt lakes (Junkermann et al., 2009). To identify particle formation directly above the salt lakes, a 2.35 m^3 PTFE chamber was set up above several lakes in 2012 and 2013. Inside the chamber, photochemistry may take place whereas mixing through wind or advection of already existing particles is prevented. Salt lakes with a low pH level led to strongly increased aerosol formation. Also, the dependence on meteorological conditions has been examined. To obtain chemical information of the newly formed particles, during the chamber experiments also aerosol filter samples have been taken. The analysis of the anions by ion chromatography in 2012 showed an 8 to 17 times higher concentration of Cl- than SO42-, which led to the assumption that particle formation may have been influenced by halogens.

As reference experiments, laboratory based aerosol smog-chamber runs were performed to examine halogen induced aerosol formation under atmospheric conditions using simulated sunlight and the simplified chemical composition of a salt lake. The mixture included FeSO4, NaCl and Na2SO4. After adding α-pinene to the simulated salt lake, a strong nucleation event began comparable to the observed events in Western Australia. Also, IR spectroscopy of filter samples of a simulated salt lake showed an aerosol with C=O/C=C vibrations and a significant C-Cl vibration, which underlined this assumption.

In contrast, the filter analysis with FTIR microscopy of the aerosol collected in 2013 in Western Australia showed vibrations of organic and sulfate species. Further analyses are ongoing, which will allow a detailed analysis of the atmospheric aerosol based on high-resolution chemical imaging. The resulting elemental composition and vibrational information will help elucidating which compounds initiate the particle formation and which condense on already existing matter.

Reference:

Junkermann, W., Hacker, J., Lyons, T., and Nair, U.: Land use change suppresses precipitation, Atmos. Chem. Phys., 9, 6531–6539, 2009.