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Salt lakes of Western Australia – Natural abiotic formation of volatile organic compounds

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Western Australia is a semi-/arid region that is heavily influenced by global climate change and agricultural land use. The area is known for its many ephemeral saline and hypersaline lakes with a wide range of hydrogeochemical parameters that have gradually changed over the last fifty years. Historically, the region was covered by eucalyptus trees and shrubs, but was cleared mainly within 10 years after WWII to make room for wheat and live stock. After the clearance of the deep rooted native plants the groundwater started to rise, bringing increased amounts of dissolved salts and minerals to the surface and discharging them into streams and lakes. Thus most of Western Australia is influenced by secondary salinisation (soil salting) [1]. Another problem is that the discharged minerals affect the pH of ground and surface water, which ranges from acidic to slightly basic. During the 2011 campaign surface water was measured with a pH between 2.5 and 7.1.

Another phenomenon in Western Australia is the decrease of rainfall over the last decades assumed to be linked to the secondary salinisation. The rising saline and mineral rich groundwater increases the biotical and abiotical activity of the salt lakes. Halogenated and non-halogenated volatile organic compounds emitted from those lakes undergo fast oxidation and chemical reactions to form small particles modifying cloud microphysics and thus suppressing rain events [2].

Our objective is to gain a better understanding of this extreme environment with its hypersaline acidic lakes with regard to the potential abiotic formation of volatile organic compounds and its impact on the local climate.

In spring 2011 fifty-three sediment samples from ten salt lakes in the Lake King region where taken, freeze-dried and ground. In order to simulate the abiotic formation of volatile organic compounds the soil samples were resuspended with water in gas-tight headspace vials. The headspace was measured using a purge and trap GC/MS. Especially the acidic lakes are sources for trihalomethanes in agreement with laboratory studies on model compounds like catechol [3]. Other compounds that are formed are chloromethane, -butane, -hexane and heptane as well as monocyclic terpenes and furan derivatives. Additionally, there are different sulphur compounds such as thiophene derivatives, carbon disulfide and dimethyl sulfide.

Western Australia offers a variety of hypersaline environments with various hydrogeochemical parameters that will help to understand the abiotic formation of different volatile organic compounds. The field of research includes the complex relationships between agriculture, secondary salinisation and particle formation from volatile organic compounds emitted from the salt lakes.

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[2] Junkermann et al., 2009, Atmos. Chem. Phys., 9, 6531-6539.
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