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Rapid change detection and salt classification as a promising tool to estimate emission of naturally produced organohalogens from saline ecosystems

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Due to their negative water budget most recent semi-/arid regions are characterized by vast evaporites (salt lakes) and salty soils. We identified those hyper-saline environments as novel sources for volatile halogenated organic compounds (VOX), such as halomethanes (e.g. CHCl3, CH3Cl, CH3Br) or halogenated alkenes (e.g. C2H2Cl2, C2H3Cl3). VOX have been considered for a long time of industrial origin only, but to date more than 4,700 organohalogens are known to be naturally produced through bio- and geochemical processes. They are of outstanding importance since they affect the ozone budget of the planetary boundary layer and play a key role in the production of aerosols. Effectively linked to atmospheric chemistry cycles, their occurrence leads to potentially significant feedbacks on cloud formation, earth's albedo and eventually the regional and global climate. Emission and deposition of VOX to and from the atmosphere can strongly influence the functioning of terrestrial ecosystems because some of the VOX possess strong phytotoxic potential.
In consequence of higher temperature, lower rainfall and higher evaporation the forcast of climate change will for some regions lead to an increase in quantity and scale of (hyper-) saline environments - especially in Central Asia, the Middle East, Northern and Southern Africa and Australia. Since number and size of saline ecosystems will increase from the time when deserts and semi-deserts start spreading, it has to be questioned whether and how the recent and future formation of saline soil systems will have an impact on global VOX budget.

This work exemplifically shows specific VOX emission characteristics of different types of saline sediments, collected during field expeditions in Central Asia, Southern and Northern Africa.
We identified the main driving forces behind the VOX production as pH-level, salt composition (halite, sulphate, carbonate), organic content, soil humidity and temperature. Thus it is of special importance to follow certain steps of desertification and degradation e.g. from fresh water ecosystem to hypersaline salt lakes, as well as short-term climatic effects and fluctuations, such as rainfall and recrystallization.
Linking the identified driving forces to certain land-cover classes, which can be distinguished and monitored by means of remote sensing, is a prerequisite for upscaling of VOX emission from local measurements to landscape scale. More specifically the classification of different salt types (e.g. sulphate versus halide) as well as detection and verification of the effects of rapid changing climate condition – e.g. recrystallization following rain events will be adressed.
In the scope of the presented pilot study a remote sensing based analysis was performed in the southern Aral Sea Basin, Uzbekistan. Using hypertemporal MODIS time series and advanced image classification approaches different stages of salinization in the Aral Kum dessert were classified. It could be shown that the recession of the Aral Sea results in a quick build up of extensive salt crusts directly adjacent to the sea. Almost all of these salt crusts converted into a series of different Solonchak types and then, in some parts of the study area, further into almost sand free bare areas. This was found out to happen within 8 years at some places, giving raise to the question how this rapid land cover change influences the VOX budget in the Aral Sea Basin.
Opportunities, limits and requirements of the usage of different sensors (multisensor approach), including an assessment of the potantials of the upcomming EnMap mission will be discussed, aiming an enhanced analysis of soil salinization and short-term changes of saline soil surfaces and salt crusts. In order to enhance understanding of small-scale surface heterogeneities and their influence on regional VOX emission budgets, a multiscale classification system will be implemented, including sensors with different spatial and temporal as well as hyperspectral sensors.