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Sampling the SML for traces gases: a case study of sampling technique and resulting correction factors

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The sea surface microlayer (SML) is the uppermost thin oceanic surface layer in the range of 100µm with properties that are distinct from the water below. With an ocean coverage of up to 70% it is supposed to have a significant impact on air-sea gas exchange rates. In global studies, the SML is often supposed to be a missing source of trace gases, when oceanic production and the subsequent emissions alone cannot explain observed atmospheric mixing ratios. Despite the attention in the past 20 years, also in the SOLAS science plan, it remains difficult to sample volatile trace gases from the SML with existing sampling techniques. Consequently, an incomplete process understanding of trace gas cycling within the SML inhibits its effect on air-sea gas exchange.

In this study, we focus on existing and common SML sampling methods (glass plate, Garrett screen) in order to ensure that trace gas samples are comparable to other parameters sampled with the same method. A series of laboratory experiments was set up to determine a correction factor which quantifies the loss of trace gases due to the sampling method itself. Dimethyl sulfide, isoprene and carbon disulfide were sampled with a glass plate and with a Garrett screen under varying surfactant concentrations and environmental conditions (salinity, temperature). Based on physiochemical properties of the examined trace gases, we extended the correction factor to nitrous oxide and methane. Losses are high, but not as variable as expected. Around 90% are lost due to sampling with small variations between different gases. The presence of surfactants has a small effect on the losses.

The lab-based correction factors are applied to in-field SML samples from a mesocosm study in May/June 2023 conducted within the DFG research unit BASS. Those results clearly indicate that the composition of the SML highly influences the correction factor for each trace gas individually. Comparing corrected SML concentrations with underlying bulk water concentrations reveal the accumulation of specific traces gases in the SML which highly influence the magnitude of trace gas emissions to the atmosphere.