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Studying Diel Light Effects on the Air–Sea Interface - The MILAN Campaign

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The sea-surface microlayer (SML) is located at the air-sea interface and experiences instantaneous meteorological forcing by e.g. solar radiation, wind, and precipitation. Although solar radiation and wind-driven turbulence are known drivers of SML biogeochemical and physical properties, surprisingly little is known about the SML response to solar radiation. The latter is, however, important given that the SML is involved in all air–sea exchanges of mass and energy, especially in relation to how it regulates the air–sea exchange of climate-relevant gases and aerosols.

The international and multidisciplinary campaign MILAN (Sea Surface Microlayer at Night) was designed to characterize the SML during full diel cycles. MILAN addressed the scientific fields of marine (micro)biology, biogeochemistry, marine chemistry, atmospheric chemistry and physics, and physical oceanography using diverse approaches in the field and in the laboratory to study the diel properties of the SML and their effects on the air–sea exchange of climate-relevant gases and aerosols.

In spring 2017, the radio-controlled catamaran Sea Surface Scanner (S^3) and research vessels followed a passively drifting CO2 buoy during diel cycles in the coastal North Sea. Meteorological conditions and water currents were recorded continuously, supported by observations from land-based weather stations. Water column physical properties were profiled every hour. S^3 continuously measured physicochemical properties of the SML and from 1 m water depth, and collected large-volume water samples for subsequent analyses in the laboratory, for laboratory experiments using a gas-exchange tank, a solar simulator, and a sea spray simulation chamber, and for microsensor experiments. A land-based aerosol sampler collected aerosol samples continuously throughout the campaign.

This presentation will highlight initial results of the MILAN campaign, which point to a radiation dependence of several SML processes, such as increasing lipid degradation in the SML during the night, or the dose-dependent enrichment of specific phytoplankton groups in the SML. Other, seemingly contradictors results will be discussed, such as the finding of highest surfactant concentrations in the field during night, while experiments with the solar simulator clearly implied

daytime surfactant production. The diel dynamics of SML organisms and organic material will be put into the context of air–sea exchange processes, as one important finding shows different day and night CO_2 fluxes under low wind speed conditions (<2.5 m s^{-1}). Taken together, MILAN underlines the value and the need of multidisciplinary campaigns for integrating SML complexity into the context of air–sea processes that have important implications for biogeochemical cycles and climate regulation.

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