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Diurnal dynamics at the sea-atmosphere interface: The Central Adriatic campaign

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Nowadays, various environmental compartments are under increasing pressure from anthropogenic impact, and we as a society, have a duty, to understand the extent of the changing environment and how this may affect the functioning of global earth processes. More than 70% of the Earth's surface is covered by the ocean whose uppermost layer, the sea surface microlayer (SML), is a specific environment at the air-sea interface, that is highly susceptible to increasing human impacts and climate change. SML has short- and long-term impacts on a range of planetary processes, including global biogeochemical cycling, air-sea exchange of gases and particles, and climate regulation. The SML is highly enriched in organic matter (OM) and has biofilm-like properties, and due to direct solar radiation, provides a challenging habitat for a wide variety of auto- and heterotrophic organisms. This makes SML a site of unique photochemical reactions that result in significant abiotic production of unsaturated and functionalized volatile organic compounds acting as precursors for the formation of marine secondary organic aerosols. The cycling of OM through the microbial food web at the sea surface determines the accumulation and enrichments of OM at SML, which directly affects the gas exchange rates and chemical composition of aerosols released from the sea surface to the atmosphere. Although the SML is involved in all ocean-atmosphere exchange processes, especially for climate-relevant gases and aerosol particles, its biogeochemical functioning during diurnal cycles is poorly characterized.

Therefore, in the summer of 2020, a multidisciplinary field campaign was conducted in the central Adriatic Sea, which included three full diurnal cycles of simultaneous sampling of the SML, with a special sampler, underlying water (ULW) and atmospheric aerosols (particulate matter < 10 μm, PM_{10}). The results of biochemical analyses of SML and ULW including dissolved (DOC) and particulate organic carbon (POC), nutrients (NO_3^-, NH_4^+, PO_4^{3-}), lipids, transparent exopolymeric particles (TEP) and Coomassie stainable particles (CSP), surface active substances (SAS),

phytoplankton and heterotrophic bacteria abundance as well as results of mass concentrations and total organic carbon (OC), water soluble organic carbon (WSOC), SAS and ions (Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) determined in PM_{10} samples were correlated and statistically analysed depending on their solar radiation exposure. The comprehensive data-set will be discussed to investigate diurnal variations in the coupling between meteorological forcing, SML physicochemical and biological properties, and air–sea exchange of aerosol particles. This interdisciplinary diurnal study represents a promising approach in contributing to the fundamental current knowledge of ocean–atmosphere feedbacks, crucial for exploring global biogeochemical cycles, as well as predicting human impact on future climate changes.

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