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Surfactant-Associated Bacteria in the Near Surface Layer of the Ocean

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It has recently been realized that biogeochemical processes in the ocean are, to a large extent, the result of nanoscale processes in the microbial part of the pelagic food web. Bacteria found in thin near-surface layers of the ocean – bacterioneuston – are of special interest due to a number of practical applications, including air-sea gas exchange, production of climate-active marine aerosols and remote sensing of the ocean. In particular, bacteria involved in the production of the surface active materials resulting in slicks on the sea surface can potentially be observed from space using high-resolution remote sensing techniques. In this work done by a multidisciplinary team, we demonstrate a direct connection between surfactant-associated bacteria, identified with an advanced DNA analysis, and fine-scale features on the sea surface in synthetic aperture radar (SAR) imagery. Experiments were conducted in the Straits of Florida during RASRASAT 2 satellite overpasses. The sea surface microlayer sampling method was designed to enable aseptic bacterial sampling. A 47 mm polycarbonate membrane was utilized at each sampling site to obtain a snapshot of the bacteria community structure at a specific space and time. Microbial composition was determined using DNA analysis of 16S rRNA genes. A new generation high-throughput sequencing method (454) was employed to compensate for the small sample size. A total of 27,006 nucleotide sequences with an average 437.8 bp in length were analyzed. From in situ samples taken during satellite overpasses, we found a higher abundance of surfactant-associated bacteria in slick (visible in SAR from space) as compared to non-slick areas; furthermore, higher abundance of this type of bacteria was observed in subsurface samples than in those taken from the sea surface. These observations suggest that surfactants are produced by marine bacteria mostly in the water column and migrate up to the sea surface by diffusion, air bubbles, or advection. A better understanding of the effects of surfactant-associated bacteria on sea surface properties may help in discriminating oil spills from natural slicks in SAR.