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Hydrodynamic drivers of Vibrio spp. dynamics and associated health risks in the German Bight, Southern North Sea

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In recent years, massive mortalities of oysters are frequently reported and have been associated with bacteria of the genus Vibrio. Some of these bacteria are also potentially pathogenic for humans and can cause harmful infections either by direct contact with seawater or by consumption of contaminated shellfish. Since population dynamics of these bacteria are greatly influenced by environmental factors, such as temperature and salinity, it is anticipated that under global warming conditions, the risk of the occurrence of (human-) pathogenic bacteria in summer seasons will further increase.

Here, we introduce a model based on ordinary differential equations to study the population dynamics of Vibrio spp. in the water column. Coupling this biological model to a hydrodynamic model of the Southern North Sea, based on the Regional Ocean Modeling System (ROMS), we investigate the temporal and spatial distribution of pathogens along the German North Sea coast. Moreover, we identify hot spots of growth and pathways of transport and finally predict the impact of environmental scenarios on distribution patterns and Vibrio spp. concentrations.

In a first study, this modeling system has been applied to a hot summer season in 2014. Our simulations show that the spatial distribution of Vibrio spp. in the German North Sea correlates with salinity, while the local temporal patterns correlate with temperature. However, results indicate that transport of Vibrio spp. by coastal river plumes is a crucial driver that favors the presence of Vibrio spp. outside their ecological niche. These spots also include locations of oyster banks and recreational beaches.

Finally, we used a published dose-response model to calculate the illness risk per swimming event in recreational waters along the German North Sea coast. This application in combination with the underlying coupled biological-hydrodynamic model may be a useful tool in public health management to evaluate the potential alteration of health risk in the context of climate change and environmental disturbance.