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Spatio-temporal patterns in simple models of marine systems

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Spatio-temporal patterns in marine systems are a result of the interaction of population dynamics with physical transport processes. These physical transport processes can be either passive like diffusion processes in marine sediments or in the water column or active like transport mediated by larger species. We study the dynamics of one population of bacteria and its nutrient in a simplified model of a marine sediment, taking into account that the considered bacteria possess an active as well as an inactive state, where activation is processed by signal molecules. Furthermore the nutrients are transported actively by bioirrigation and passively by diffusion. It is shown that under certain conditions Turing patterns can occur which yield heterogeneous spatial patterns of the species. The influence of bioirrigation on Turing patterns leads to the emergence of ”hot spots‘‘, i.e. localized regions of enhanced bacterial activity. All obtained patterns fit quite well to observed patterns in laboratory experiments. Spatio-temporal patterns appear in a predator-prey model, used to describe plankton dynamics. These patterns appear due to the simultaneous emergence of Turing patterns and oscillations in the species abundances in the neighborhood of a Turing-Hopf bifurcation. We observe a large variety of different patterns where i) stationary heterogeneous patterns (e.g. hot and cold spots) compete with spatio-temporal patterns, ii) slowly moving patterns are embedded in an oscillatory background, iii) moving fronts and spiral waves appear.