Describing space-time multiscale patterns in aquatic ecology using stochastic approaches and IBMs

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Over the last decade, the increasing importance of individual based modeling has resulted in an exponential increase in the number of papers using these techniques in the field of ecology. The increase in computer power, object programming languages efficiency and modeling tools have undoubtedly contributed to the expansion of IBMs. However, this recent popularity of IBMs may hamper progress without reaching a consensus on how these models should be developed. One fundamental difficulty in the evaluation and comparison of IBMs in the literature comes from the absence of any theoretical formalism, such as differential equations, where one can express, conserve and compare one model to another, or to export it to another modeling tool.

In this paper a new simulation platform, *'Mobidyc'*, dedicated to non-computer expert end-users, is used to illustrate the advantages of this approach for simulating population dynamics. This represents a necessary step to guarantee the readability and comparison between several models and/or scenarios. Even if ecological systems do not follow common nor simple theory (e.g. physical laws), IBMs should be standardized according to some common rules. The platform *'Mobidyc'* is specifically dedicated to the field of population dynamics with 2D-discrete spatial representation. We show first how to build easily population dynamics models with increasing levels of complexity. This process is illustrated on the basis of an experimental parameterization of the population dynamic of the copepod *Eurytemora affinis*, the dominant species in most of estuaries in the Northern hemisphere, in the Seine estuary, France. We subsequently focused on the role of spatial representation and the possible sources of heterogeneity in copepod populations. The high spatio-temporal data of abundances of developmental stages simulated are analyzed statistically. Spatial and temporal patterns are investigated using models and data analysis techniques initially developed in the fields of turbulence and non-linear physics (e.g. scaling and multiscaling approaches for data analysis and stochastic simulation). The ecological relevance of our approach is finally tested comparing the stochastic nature and the parameters of the simulations to space-time patterns observed in the field in a wide range of ecological situations.

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