Reaction-diffusion-taxis model for spatio-temporal dynamics of five picophytoplankton populations

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Recently new models were devised to study spatio-temporal dynamics of phytoplankton populations in view of obtaining more precise predictions of the vertical biomass distributions in marine ecosystems. These studies and related results can be crucial from the point of view of fishery. Indeed the abundance of fish species is strictly connected with primary production, i.e. phytoplankton biomass, responsible for chlorophyll concentration.

In this work a one-dimensional deterministic reaction-diffusion-taxis model is used to reproduce the spatio-temporal dynamics, along a water column, of five picophytoplankton populations sampled in a real ecosystem. In our analysis, to better reproduce the spatio-temporal behaviour of picophytoplankton populations we take into account the periodical changes of the light intensity and profiles of vertical turbulent diffusivity, obtaining the time evolution of the system over a period of five years. Moreover, the seasonal variations of the depth of thermocline and the thickness of the upper mixed layer close to the water surface are considered. As a first step, the spatio-temporal behaviour of biomass concentration of each picophytoplankton population is calculated by numerically solving the equations of the model. Afterwards, the numerical results for biomass concentration, expressed in $cell/m^3$, are converted in total concentration of chlorophyll a (*chl a*) and divinil-chlorophyll a *Dvchl a*, obtaining the chlorophyll distributions along the whole water column. These theoretical profiles are compared with experimental data for chlorophyll concentration collected in a site of the Tyrrhenian Sea in four different days, corresponding to different seasons of the same year. Statistical analysis, based on χ^2 goodness-of-fit test, shows that numerical results are in a good agreement with real chlorophyll distributions for all seasons investigated. In particular, numerical results indicate that the primary production of phytoplankton biomass is strongly influenced by the light intensity and vertical turbulent diffusivity, which take on different values along the water column, depending also on seasonal variations. These findings could contribute to predict future changes in phytoplankton distributions due to global warming, and

to devise strategies which can prevent the decline of primary production and consequent decrease of fish abundance.

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