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The Dynamics of Biological Fronts

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In upper ocean marine ecosystems, phytoplankton blooms and associated peaks in zooplankton grazing are relatively frequent. When represented with simple mathematical ecosystem models in a system containing a background flow, the nonlinear dynamics of the ecosystem model can give rise to an apparent propagation of the transient biological activity at rates that are significantly different from the flow speed. This effect is analyzed in a purely mathematical model and illustrated in a more complete numerical simulation of the Black Sea. The dependence of frontal propagation speed on several characteristic rates in ecosystem dynamics is derived. In an idealized model, the generation of patchiness by eddies and by intrinsic dynamics are compared and the spectrum of variability is contrasted with that for a stirred passive tracer.