Effects of spatio-temporal variability of upwelling events on primary productivity.

C. Pasquero, A. Provenzale, A. Bracco

Simple empirical ecological models are coupled to a fluid dynamical model of geostrophic turbulence to explore the effects of advection on the dynamics of the ecosystem, and in particular on primary productivity. The effects of the spatio-temporal scales of the upwelling events that provide the nutrient supply for the planktonic growth are explored. It is found that the variability significantly increases primary productivity in a large range of parameters. Results indicate that any process that increases the average surface area of frontal regions (defined as regions of large nutrient gradients) greatly modifies the ecosystem response to the nutrient input. Effects on the average concentration of nutrients are also explored.

The advection-reaction equations of the ecosystem model are solved in a semi-Lagrangian framework, that allows for a large number of experiments for different configurations of the biological model at low computational costs; the method also allows the control of the diffusivity and does not present the problems common to the integration of evolution equations for positive-definite quantities.

Figure: from left to right, concentration of nutrients, phytoplankton, and zooplankton in the horizontal model domain of size (256Kmx256Km). The system is in a statistically stationary state with upwelling occurring at large scales.