Modelling carbon dynamics in Lagrangian oceanic ecosystems: applications to fertilization experiments

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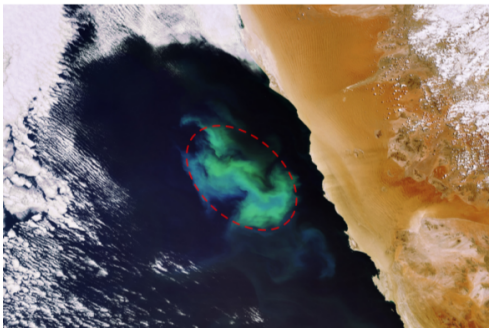
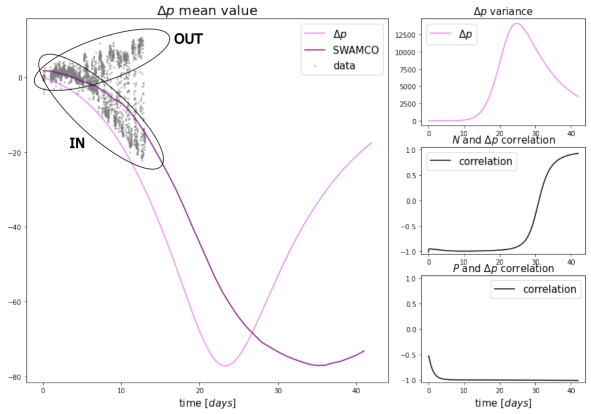
Abstract

Plankton is a key component of the marine environment and provides invaluable ecosystem services, ranging from carbon sequestration to biodiversity preservation. Planktonic ecosystems are embedded in patches of water that are continuously moving, stretching, and diluting under the effect of turbulent oceanic currents (Fig. 1a). In this work, we present an ecosystem model that describes biomass production and carbon dynamics within a Lagrangian patch in the ocean. We describe a consumer-resource dynamic in which a generic type of phytoplankton is limited by a single specific nutrient. The model extends some previous works on two-dimensional patches in order to account for vertical processes, which have not been yet addressed [1]. Moreover, carbon sequestration is linked naturally to nutrient and phytoplankton interaction, as well as to the air-sea flux of carbon dioxide, which is a key regulating factor for ocean acidity [2]. We show how the theory is able to reproduce observed biogeochemical patterns in real planktonic blooms like the SOIREE fertilization experiment [3]. In particular, the predicted CO_2 partial pressure anomaly is compared with in-situ measurement and other modelling frameworks present in the literature [4] (Fig. 1b). Finally, we consider and analyze some simulation ensembles obtained from different combinations of the model parameters, in order to explore their physical dynamic and biological response.



(a)



(b)

References

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