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A New Trait-Based Auto-Emergent Model for Zooplankton and Confrontation with Size-Structured Observations from the Bay of Biscay

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Zooplankton plays a significant role in marine ecosystems bridging the gap between primary producers and top consumers and interacting with the particle flux through complex dynamics. Scarcity of data and complexity of observing zooplankton make it difficult to integrate it in biogeochemical models where it is most often formulated in a simpler manner, i.e. classic box models with usually two compartments (micro and meso/macro zooplankton). Recent advances in automatic sizing, counting and identification allow better estimates of the dynamics and distribution of zooplankton, notably through the measurement of its size structure, and for zooplankton size matter. Most zooplankton physiological rates as well as predator:prey interactions can be significantly relied to individuals size through allometric relations. Such size-dependency was used in recent models. Yet, these models were neither confronted to observations nor integrated in 3D biogeochemical models. Here we propose a newly developed model of zooplankton dynamics based on size-dependent allometric relations but which allows various diet types regardless of the size. A size and a degree of herbivory is randomly drawn for each zooplankton species generated within the model (up to 400 here, limited by actual computational costs). By generating random degree of herbivory zooplankton species of same size could have various diet (from herbivore to carnivore). Other parameters leading to various reproductive strategies or vertical migration could also be drawn randomly (not tested here). The zooplankton model is coupled to the 3D biogeochemical model MARS3D on a test case representing a simplified view of the Bay of Biscay (i.e. continental shelf, estuary, tides). The model shows auto-emergent properties with the selection of size/diet most adapted to local conditions (here offshore vs. coastal, estuary...). Then, patterns of the modeled size-structure of the zooplankton are confronted to the ones observed during Spring-time cruises in the Bay of Biscay. The usefulness of the proposed zooplankton model for large scale biogeochemical models is further discussed.