Expose

Imarsys 06

Mini project:

creating and parameterizing a small ecosystem
NPZD-V model in R

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S5 SoSe2021

Introduction

We want to understand the fate of biomass produced by phytoplankton through carbon cycle when we add viral infection, zooplankton grazers or investigate how do they affect plankton population.

Phytoplankton are primary producers and they actually play an essential role in carbon cycle. so they are important because they are starting point of marine biogeochemical cycles, protistan (unicellular eukaryotic) phytoplankton have long been recognized as foundation al to fisheries and export of atmospheric CO2 to the deep ocean, (M. B. Higgins, et al 2012)(PG Falkowski - Photosynthesis research, 1994 – Springer). Phytoplankton convert CO2 to organic carbon via photosynthesis, simultaneously altering cycles of other elements linked to carbon by the stoichiometry of cellular composition. Thus, the carbon cycle interacts with biogeochemical cycles of nitrogen, silica, and many other elements (J. P. Zehr, R. M. Kudela, Nitrogen cycle of the open ocean: From genes to ecosystems.2011). (Joseph H. Street and Adina Paytan Marine Chemistry, 2008 - Elsevier). Phytoplankton populations are controlled both by bottom up (nutrient, light, temperature) and top-down mechanisms (viral infection, zooplankton grazing) which can influence the “distribution” of biomass within an ecosystem. (H.W.Harvey et al 11 may 2009) (M. R. Landry 1984).viruses (that affect phytoplankton) are also an important factor that influences the balance of phytoplankton productivity, export production how they keep food web running and keep the food available for higher trophic levels. Also, addition to sea water of particles in the 0.002–0.2 µm size range, concentrated from sea water by ultrafiltration, reduced primary productivity ([^{14}C] bicarbonate incorporation) by as much as 78%. These results (CA Suttle et al - Nature, 1990) (Borsheim, K. Y., *envir. Microbiool.* 1990)(Proctor, L. M. et al -*Nature* 1989) (Ian Hewson et al 2001) indicate that, in addition to grazing and nutrient limitation, infection by viruses could be a factor regulating phytoplankton community structure and primary productivity in the oceans. the quantity of virilizes is not what we know and measuring it in the way going out wild is a difficult work to be done then we look at it mathematically to investigate how rates effect this carbon cycle thus we need to create a small ecosystem model, parametrize it and run it inside the R software to follow the changes the food web with the new virilizes and grazing rates. For this purpose (providing a mathematical look) a variety of biological models have been developed (e.g., EvansandParslow,1985; Fasham et al,1990; SteeleandHenderson,1992; HurttandArmstrong,1999; Doney et al., 1996; Moore et al., 2001). These models differ in complexity, from simple models containing three biological state variables up to more complex ones with, presently, some thirty compartments. The nitrogen-based ecosystem model developed by Fasham et al. (1990) (hereafter named FDM-model) has become a standard model used in various studies ranging from zero-dimensional mixed-layer applications to fully three-dimensional coupled ecosystem circulation models. Nitrogen-based ecosystem model, composed of four state variables (NPZD model). (M Schartau, et al- Journal of Marine Research, 2003). Basic NPZD models can show the flow of biomass through the food web levels within an ecosystem. Within the mini project, we want to add a viral component to a NPZD model and thus build a NPZD-virus model. Such a model will be the basis for i) parametrization experiments of viral lysis and grazing experiments and ii) integration into water body models of the Baltic Sea. (Garrett and Loder 1981) (Rucheng Tian et al 2015 ICES journal)

Research questions

How do different viral infection rates influence the model outcome?

How do different zooplankton grazing rates influence the model outcome?

Planned material and methods

The whole work is to build a NPZD-V model in R, parametrize it and answering to research questions. The NPZD model consists of four state variables as mentioned.

-the first step to building the NPZD-V model is a representation of the model in diagram that contains all state variables and biomass flows through these state variables.

-writing equations for different components and listing the parameters needed

-building the model in R. Numerical method was isoda.

-literature search for parameters and parametrizing the model with constant parameters. Parameter definition, units, and values were described in detail in Ji et al. (2008) and Tian et al. (2001)

-running the model in R software

BIBLIOGRAPHY

(M. B. Higgins, et al 2012) (PG Falkowski - Photosynthesis research, 1994 – Springer)

(J. P. Zehr, R. M. Kudela, Nitrogen cycle of the open ocean: From genes to ecosystems.2011). (Joseph H. Street and Adina Paytan Marine Chemistry, 2008 - Elsevier)

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(Hendry and He, 1996). Data sources include the National Oceanographic Data Center (www.nodc.noaa.gov), the Canadian Marine Environmental Data Service (MESD, provided by Dr Pierre Clement) and the University of Maine Database (provided by Dr Dave Townsend)