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Modeling of marine biogeochemical and ecosystem in Japan: future perspective and review during the last 20 years

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The first global 3-D marine biogeochemical modeling was developed by Bacastow and Maier-Reimer(1990), and marine ecosystem model was developed by Fasham(1993) as pioneer works, such as Yamanaka and Tajika (1996) and Kawamiya et al.(2000) in Japan. Around 2000, most of marine biogeochemical models have the explicit ecosystem components as well as ecosystem model with focusing short-termed changes in nutrient concentration and pCO_2 associated with spring bloom in sub-arctic regions. And representation of iron cycle was an important issue for both modeling, and trial of coupling between climate and carbon cycles was also started.

Everybody wish to develop the ultimate model explicitly and detailed representing hundreds, thousands, millions of plankton and nekton groups. As the first step, Plankton Functional Types (PFTs) models dealing with relatively small number of plankton and nutrient were introduced (e.g., Le Quere, 2005; Kishi et al., 2007). We have two directions as future model developments for marine biological cycles and marine ecosystem. Former focuses on grouping of phytoplankton having large energy (material) flow, and latter focuses on grouping of zooplankton having the linkage to higher trophic levels such as fish as wood web. If both two directions were covered by the almighty model, we would need unlimited number of prognostic values as plankton number multiplied by elemental components (and grazing-grazed relations proportional to square of plankton numbers). Therefore, model developing along two directions are separated necessarily. We are easily focusing on number of prognostic values as a discussion of model complexity (e.g., Friedrichs et al., 2007). But, we do not forget important improvements leaded by studying individual process and trade-off problem between parameters. For example, recent studies discussed formulation using affinity instead of half saturation constant as classical Michaelis-Menten fomula, unrestricted nutrient uptake optimized by the parameter of restricted nutrient, and different impacts by the global warming between these formulations (Smith and Yamanaka, 2007; Smith et al., 2009). Many people are interesting in another type of models relevant to biodiversity are recently developed (Follows, 2007)

I would like to mention another view such as developing researcher community developing biogeochemical cycles and ecosystem model. Pioneers for marine biogeochemical modeling launched Ocean Carbon cycle Model Intercomparison Project (OCMIP). Studies are leaded by the pioneers at earlier periods but by young researchers relevant to OCMIP around the end of Phase 2. It goes without say that they are the present world-leading scientists in this academic field (such as Le Quere, Follows, Gruber etc.). MARine Ecosystem Model Intercomparison Project (MAREMIP) as going project is designed based on OCMIP experiences, and next generations figure just in this field. I should mention other groups. I think developing NEMURO, a marine ecosystem model, in North Pacific marine Science Organization (PICES) as another good international collaboration. As for formulating specific processes such as trade-off problem, North Germany group are leading. Finally, I would like to express my wish that next generation in Japan friendly and positively get chance to lead international research projects one of world-leading scientists with their beautiful lives.

Keywords: marine biogeochemical cycles, marine ecosystem, modeling, international research project, OCMIP, MAREMIP