Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AOS25-01 Room:203 Time:May 19 14:15-14:30

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 subarctic 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

Japan Geoscience Union Meeting 2013
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AOS25-02 Room:203 Time:May 19 14:30-14:45

Modelling of ocean biogeochemical cycles toward understanding paleo climate changes

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The ocean stores large amount of carbon (60 times larger than that of the atmosphere) and various chemical tracers, and the deep ocean circulation significantly affects the carbon and biogeochemical cycles in the climate system. Actually, the deep ocean circulation, especially the Atlantic meridional overturning circulation (AMOC), is believed to have an important role in the changes in atmospheric CO2 concentration from glacial to interglacial periods.

Paleo proxy data such as d13C and 231Pa/230Th ratio suggest that the AMOC became shallower and reduced by up to 30 % during the LGM compared with the present climate, and it is widely believed that the AMOC during the LGM is weaker than that at the present climate. However, a couple of studies using another paleo proxy data, Nd isotope ratio, imply that the AMOC during the LGM may be almost the same or even slightly stronger than the present one. This means that there is discrepancy among paleo proxy data themselves or their interpretation. Distribution of these proxy tracers is controlled by not only ocean circulation but biological and chemical processes, and careful interpretation on changes in these proxy tracers is necessary. Explicit simulation of these proxy data with ocean biogeochemical model is very helpful for interpretation of proxy data because they can quantitatively evaluate which processes are important for controlling the distribution of paleo proxy. Such simulations are also useful for validating climate model simulations directly with paleo proxy data.

In this talk, recent attempts for simulation of paleo proxy with biogeochemical model are introduced.

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AOS25-03 Room:203 Time:May 19 14:45-15:00

Three-dimensional budget analysis of global carbon cycle estimated from a coarse-resolution global OGCM

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Recent observational and model studies have begun to clarify natural and anthropogenic carbon cycle in the global ocean. In the observational studies, Sabine et al. (2004) estimate the inventory of anthropogenic carbon. Mikalloff-Fletcher et al. (2006, 2007) and Gruber et al. (2009) evaluate the basin-scale barotropic carbon transport using the inverse method. Combining these estimations and the imformations from the physical oceanography, Three-dimensional structure of carbon cycle has been discussed. It is, however, very hard to estimate how the carbon is transported through particular density bins from the limited observational data. On the other hand, model outputs can basically offer precise budget analysis even though these outputs have large uncertainty especially for the biochemical part as well as the physical part.

In this study, we estimate the three-dimensional structures of carbon cycle using OGCM output data obtained by Nakano et al. (2011, JO). The model incorporate a NPZD model. The resolution of the OGCM is 1 degree in latitude and 0.5 degree in longitude. There are 51 levels. The OGCM is forced by the COREv2 reanalysis data. Two experiments are conducted for evaluating the carbon cycle. One experiment is forced under the constant, preindustrial atmospheric pCO2 and the other is forced under the historically increasing one. The difference between these two experiment is defined as the anthropogenic carbon. The obtained results such as CO2 budget and pCO2 flux are largely the same as those of the previous model studies and consistent with the observational estimation.

We conduct three-dimensional budget analysis for each region and each month in the densities ranges with 0.1 sigma bins. We calculate the inventory (A), surface flux (B, surf in the figure), and divergence by the transport across the regional boundaries (C). The inner transport is calculated by dA/dt - B -C (Inn in the figure). We follow the regional division of Mikalloff-Fletcher et al. (2006, 2007) and Gruber et al.(2009) which is used for Regional Carbon Cycle Assessment and Processes (RECCAP). We use the monthly output because using the 5 days output gives nearly the same results in this coarse-resolution model. To the best of my knowledge, this is the first attempt to evaluate the three-dimensional budget analysis of global carbon cycle.

From the budget analysis, we can see the following three dimensional structures. In the Pacific, carbon is transfered in the shallow layer from the equatorial region to the midlatitues regions. In the midlatitude regions, the cooling of the ocean leads to the absorption of carbon from the atmosphere especially in the density range of Mode Waters. In addition to the direct absorption from the atmosphere, the cooling induce the movement of the carbon from the shallow layer to the Mode Waters. The carbon in the Mode Waters moves to the equatorial region through the subtropical cells. In the equatorial region, the carbon moves to the lighter densities through the eastward equatorial current. At the surface in the equatorial region, the carbon is released but the anthropogenic carbon is still absorbed due to the increase of the atmospheric carbon. In the Atlantic ocean, the barotropic movement of the anthropongeic carbon is know to be northward even though the movement of North Atlantic Deep Water (NADW), where the anthropogenic carbon is most accumulated. Here, we can explicitly show that this somewhat counterintuitive estimation is due to the larger northward shallow transport than the southward small transport of NADW. Even though the analysis is not so much new interpretation as our common understanding of the global carbon cycle, we think that explicit estimation of the budget analysis help understand the three-structure of the carbon cycle.

Keywords: carbon cycle, OGCM

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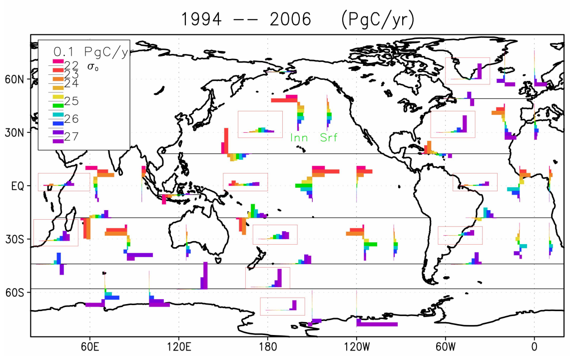

AOS25-04 Room:203 Time:May 19 15:00-15:15

Effect of seasonal change in gas transfer coefficient on air-sea CO2 flux in the western North Pacific

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Introduction

In the subtropical North Pacific, seasonal change in the partial pressure of CO2 at the sea surface (hereafter, pCO2) is primarily controlled by temperature, where maximum (minimum) pCO2 is found in summer (in winter). Whereas in the subarctic North Pacific, seasonal change in pCO2 is dominated by biological as well as physical mixing processes and temperature. The pCO2 is high in winter and low in summer due to mixing with deep waters and biological uptake. As the winter monsoon occurs in the western North Pacific (WNP). We developed a three-dimensional ocean ecosystem model including the carbon cycle, and apply it to WNP to understand seasonal variations and horizontal distributions of the net air-sea CO2 flux and the dpCO2, especially the effect of the winter monsoon on the net air-sea CO2 flux.

Model and experiment design

We applied our 3-D ecosystem model, COCO-NEMURO (the CCSR Ocean Component Model coupled with the North Pacific Ecosystem Model Used for Regional Oceanography to the first 1500 m in WNP (about 110-180E, 10-60N) with an offline calculation method. The horizontal resolution is 0.28 degree (longitude) and 0.19 degree (latitude). We used daily-mean data during 10 years, which is calculated in the pre-industrial simulation in the climate model, Model for Interdisciplinary Research on Climate (MIROC). The initial conditions and boundary conditions of ocean total carbon dioxide, total alkalinity and nutrients are taken from the annual mean of the Global Ocean Data Analysis Project (GLODAP) 3-D data set and monthly mean of World Ocean Atlas 2005, respectively. At the sea surface, the daily absolute wind speeds is taken from MIROC. The air-sea CO2 flux is estimated by multiplying the dpCO2 (pCO2sea - pCO2air) by the CO2 gas transfer coefficient (Takahashi et al., 2009). The gas transfer piston velocity is based on Wanninkhof et al. (1992). The experiment was conducted for 10 years after a 10 year spin-up, where the MIROC data during 10 years were used. We analyzed the annual and monthly mean during the 10 years.

Result and Discussion

Positive (negative) values of the annually averaged dpCO2 are found in the subtropical region and in small areas of the subarctic region (in areas near Japan). Approximately the distribution of the annually averaged net CO2 flux is the same as the annually averaged dpCO2. However, larger (less) intensity of the net CO2 flux appears in the subarctic region (in the subtropical region) against the intensity of dpCO2 in those areas due to large (small) coefficient of CO2 gas transfer in the subarctic region (in the subtropical region). Interestingly, the negative dpCO2 areas are not enhanced by larger coefficients of CO2 gas transfer around 40N, and the area of positive net CO2 flux is enlarged compared with that of dpCO2 in the subarctic region. Moreover the areas with different signs between the net CO2 flux and the dpCO2 are found both in the subtropical region and in the subarctic region. This is because that seasonal change in coefficients of CO2 gas transfer is correlated with that in dpCO2. Strong winter monsoon caused the coefficient of gas transfer is high (low) in winter (in summer). Therefore, even if the annual average dpCO2 is zero in an area, but the area is still a sink for atmospheric CO2. We showed the distribution of the correlated effect term in WNP, which have negative (positive) values in the subtropical region (in the subarctic region). In the subtropical (subarctic) region, the seasonal variations of coefficients of CO2 gas transfer and dpCO2 lead to a weakened emission (absorption) of CO2 gas to (from) the atmosphere.

References

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Keywords: gas transfer coefficient, pCO2, air-sea CO2 flux, Ecosystem model, North Pacific, seasonal change

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Insights into the production processes of N2O in the western north Pacific by using a marine ecosystem isotopomer model

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Nitrous Oxide (N_2O) is a significant anthropogenic greenhouse gas and a stratospheric ozone destroyer. Although the estimation of global N_2O flux from ocean to the atmosphere is 3.8 $TgNyr^{-1}$, the estimation varies greatly, from 1.8 to 5.8 $TgNyr^{-1}$. This is because previous models had estimated N_2O concentration from oxygen concentration indirectly. In fact, marine N_2O production processes are very complicated; hydroxylamine oxidation during nitrification, nitrite reduction during nitrifier denitrification and nitrite reduction during denitrification produce N_2O and N_2O deduction during denitrification consumes N_2O. Therefore marine N_2O production processes are poorly understood quantitatively. N_2O isotopomers (oxygen isotope ratio (delta-^{18}O), difference in abundance of $^{14}N^{15}N^{16}O$ and $^{15}N^{14}N^{16}O$ (SP), and average nitrogen isotope ratio (delta-^{15}N)) are useful tracers to distinguish these processes and had revealed N_2O production processes in various ocean environments.

In this study, a marine ecosystem model including the two N_2O production processes (hydroxylamine oxidation during nitrification and nitrite reduction during nitrifier denitrification) and isotopomers cycle is developed, in order to understand the N_2O production processes quantitatively and make the equations of N_2O production processes. We applied this model to the water above the 220m depth at the JAMSTEC time-series subarctic and subtropical sites (K2 and S1) in the western north Pacific. The observed N_2O in the waters above the depth of 1000m at K2 show high concentrations, nearly 33 permill of SP values, isotopically heavy delta-^{15}N values and isotopically heavy delta-^{18}O values compared to S1. These results suggest that the age of water mass above 1000m at K2 is high and the water accumulates N_2O with progression of nitrification compared to S1.

Our model is constrained by the observed nitrate, chlorophyll a and N_2O concentrations and delta-^{15}N values of nitrate, phytoplankton, zooplankton and N_2O and SP values of N_2O at K2 and S1. In the case applied to K2, the observed subsurface N_2O profile cannot be represented just by abiological N_2O processes (gas exchange and vertical water exchanges). This result suggests that biological N_2O processes occur in the subsurface water at K2. Moreover, from the results of sensitivity studies about SP values of N_2O, we estimate that N_2O is produced only by nitrification at K2 and the ratio of N_2O production to nitrate production during nitrification is 0.22%, which is within the range of previous studies, from 0.13 to 0.37%. Furthermore, the results of sensitivity studies about delta-^{15}N values of N_2O suggest a higher contribution of archaeal ammonia oxidation during nitrification than bacterial ammonia oxidation. In this presentation, we will also show the simulated results applied to S1, where the observed isotopomer ratios suggests both contributions of hydroxylamine oxidation during nitrification and nitrite reduction during nitrifier denitrification to the subsurface N_2O production.

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AOS25-06 Room:203 Time:May 19 15:30-15:45

Model simulation of plankton bloom driven by riverine inputs of nutrient and fresh water in coastal regions

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Rivers transport nutrients and suspended sediment matter (SSM) as well as fresh water from land to coastal regions, where biological productivity is high. The buoyancy by fresh water forms horizontal anticyclonic gyres (Kubokawa, 1991; McCreary et al., 1997; Yankovsky, 2000; Magome and Isobe, 2003) and vertical estuary circulations (Rattray and Hansen, 1962), which affect the variation of biological production such as plankton bloom.

We developed an ocean general circulation model (OGCM) including a simple ecosystem model, to investigate the three-dimensional and temporal changes in phytoplankton bloom caused by riverine input such as flooding.

Distribution patterns of nutrients and phytoplankton are significantly different from that of fresh water. The high concentration of phytoplankton shifts downstream (right-hand side from river mouth) to upstream regions (left-hand side). The shift that occurs is categorized by the different nitrate origins: (1) river-originated nitrate in the downstream region, (2) subsurface-originated nitrate in the upstream region, transported by upwelling associated with vertical estuary circulation and horizontal anticyclonic gyre, and (3) regenerated nitrate in the upstream region.

High concentration of SSM supplied from river shades sunlight and reduces phytoplankton photosynthesis efficiency. Net primary production is lower than that without flooding, until around ten days after the high SSM discharge. After SSM is removed from sea water, phytoplankton increase with the shift from downstream to upstream, and the plankton bloom is delayed.

Keywords: coastal ocean, biogeochemical cycles, 3-D modeling, riverine input, nutrient supply, phytoplankton bloom

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AOS25-07 Room:203 Time:May 19 15:45-16:00

Lower-trophic level ecosystem dynamics in the western Seto Inland Sea, Japan

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We studied the ecosystem and nutrient dynamics in the western part of the Seto Inland Sea from the both field observation and numerical modeling. We investigated spatiotemporal variations in the group composition of phytoplankton and the nutrient concentrations in the Iyo-Nada, Hoyo strait and Bungo channel (parts of the Seto Inland Sea) with monthly field observations in 2009. From the spring to early summer, nano- and pico-phytoplankton dominated in all the three regions. From the late summer to autumn, micro-phytoplankton (diatom) was blooming in the Iyo-Nada and Hoyo strait, while distinguished bloom was not observed in the Bungo channel. This autumn diatom bloom was probably caused by nutrient supply associated with breakdown of the cold water dome. For understanding the mechanisms of the nutrient cycle and plankton dynamics, we developed a plankton functional types model eNEMURO (4Nutrient, 4Phytoplankton, 4Zooplankton, 4Detritous), which was an extend version of NEMURO [a standard lower-trophic-level marine ecosystem model of PICES (The North Pacific Science Organization)] by introducing the microbial food web and the phosphorous cycles and dividing diatoms to two compartments according to temperature dependency. eNEMURO was coupled with 5box physical models (2boxes in the Iyo-Nada, 1box in the Hoyo strait, and 2boxes in the Bungo channel). Model successfully reproduced the nutrients and phytoplankton dynamics observed in the both Iyo-Nada and Bungo channel. Difference between the ecosystems in the Iyo-Nada and Bungo channel was mainly caused by nutrient supply mechanism. Nutrients supply in the Iyo-Nada might be dominated by the horizontal transport from the Hoyo strait, on the other hands, those in the Bungo channel might be dominated by the vertical transport from the deep layer. We also introduce results from observations in 2012, especially in ecosystem responses to the torrential rain in the summer.

Keywords: meteorological disturbance, ecosystem, phytoplankton, Seto Inland Sea, ecosystem model

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AOS25-08 Room:203 Time:May 19 16:15-16:30

Modeling North Pacific lower trophic ecosystem. I: Coupling an eddy-resolving OGCM with a PFT model

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An eddy-resolving ecosystem model of the North Pacific is used to investigate the impact of mesoscale eddies on the basin-scale nitrate circulation and supply to the euphotic zone. A simple Plankton Functional Type (PFT) model, i.e., a NPZD ecosystem model with iron limitation on nutrient uptake is coupled to a three dimensional off-line ocean circulation model. The model horizontal resolution is about 10 km in latitude and longitude. The focus is on the North Pacific Subtropical Gyre (NPSG) where nitrate in the euphotic zone is low by downwelling due to the Ekman convergence. Recent observational and model studies reveal that the mesoscale eddies have significant impact on oceanic biological production in subtropical gyres. Although there are many studies on mesoscale eddies, a basin-scale picture of impact of mesoscale eddies on nitrate circulation and supply to the euphotic zone is presently poorly known. In the Kuroshio Extension (KE) region, the mesoscale eddies exchange water across the front and affect the biological production. In addition, recent model studies show that the mesoscale eddies contribute to the formation and transport of the Subtropical Model Water (STMW). Although it is suggested that the STMW forms in the KE region and is transported to the NPSG, the effect of the STMW on the nitrate circulation and impact on the biological production in the NPSG is not clear. In addition, the STMW is thought to be important in forming of the Subtropical Countercurrent (STCC) which has large mesoscale eddy activities in the NPSG. It is expected that the seasonal variability of the STCC dominates the seasonal variability of biological production. The results from the eddy-resolving model are compared with results from a low-resolution model. The results of sensitivity experiments to model parameters model parameters are also shown. It is expected that tracer experiments and analysis of nutrient budged reveal eddy effect on the basin-scale nutrient circulation and supply to the euphotic zone in the NPSG.

Keywords: North Pacific, eddy-resolving model, NPZD model

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AOS25-09 Room:203 Time:May 19 16:30-16:45

Phytoplankton competition during the spring bloom in four Plankton Functional Type Models

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We considered the mechanisms of phytoplankton competition during the spring bloom, one of the most dramatic seasonal events in lower-trophic level ecosystems, in four current Plankton Functional Types (PFTs) models: PISCES, NEMURO, PlankTOM5 and CCSM-BEC. In particular, we investigated the relative importance of each ecophysiological process on the determination of the community structure, focusing both on the bottom-up and the top-down controls. The models reasonably reproduced the observed global distributions and seasonal variations of phytoplankton biomass. The percentage of diatoms with respect to the total phytoplankton increases with the magnitude of the spring bloom in all models. However, the governing mechanisms differ among models, despite the fact that current PFT models are representing ecophysiological processes using the same types of parameterization. The increasing trend in the percentage of diatoms is mainly caused by the difference in nutrient dependency of photosynthesis between diatoms and nanophytoplankton (bottom-up control). The difference in the maximum photosynthesis rate plays on an important role in NEMURO and PlankTOM5 and determines the absolute values of percentage of diatom. In CCSM-BEC, light dependency of photosynthesis plays an important role in the North Atlantic and the Southern Ocean. The grazing pressure by zooplankton (top-down control), however, strongly contributes to the dominance of diatoms in PISCES and CCSM-BEC. The regional differences of percentage of diatom in PlankTOM5 are mainly determined by top-down control. These differences in the mechanisms suggest that the response of marine ecosystems to climate change could significantly differ among models, even if the present-day ecosystem is reproduced to a similar degree of confidence. For further understanding of plankton competition, it is important to understand the relative differences in each physiological property in the bottom-up and the top-down controls between PFTs.

Keywords: Marine Ecosystem Model, Model Intercomparison, Spring Bloom, Phytoplankton Competition, Global Ocean Model

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AOS25-10 Room:203 Time:May 19 16:45-17:00

Vertical profiles of phytoplankton derived from marine ecosystem models

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Observations of marine ecosystems are usually difficult due to vast spatial extent of the ocean (both horizontally and vertically). Even if satellite observation technology develops, it usually observes only an ecological state of a surface layer of the ocean. Marine ecosystem modeling is a powerful method to overcome the issue, and expected to fill gaps of scientific knowledge hard to obtain by the observation. Numerous marine ecosystem models have been developed within a scientific community, but there exist only some models that cover the global oceans to describe a detailed phytoplankton community structure (Phytoplankton Functional Types). We hereby compare vertical profiles of phytoplankton structure on a global scale, derived from numerical models, that cannot usually be obtained from the observations.

Keywords: Marine Ecosystem, Phytoplankton, Modelling

AOS25-11 Room:203 Time:May 19 17:00-17:15

Modeling North Pacific lower trophic ecosystem. II: A selection-based model and phytoplankton diversity

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Structure and variability of marine ecosystems vary from region to region, under the influences of solar radiation, physical circulation and mixing, and input of terrestrial materials. The North Pacific is latitudinally partitioned into the equatorial area, the subtropical gyre, and the subarctic gyres, driven by the large-scale wind system. Whereas, basic fields are also contrastive longitudinally due to the western intensification, the coastal upwelling, mode waters, eddy activities, and dust flux. For the lower trophic ecosystem of the North Pacific, various Plankton Functional Type (PFT) models have been developed, which aggregates various planktonic species into lesser number of compartments based on their function. One of representative PFT models for the lower trophic ecosystem of the subarctic North Pacific, NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography), well reproduces plankton productions within the western and eastern subarctic gyres. PFT models including NEMURO have also been applied to various regions by changing model parameters to suit the local ecosystems. However, observational data are often insufficient to determine the model parameters especially in regions south of the subarctic areas. In addition, adjusting the parameters by region preclude the model from evaluating the inter-region movement of materials and biota. Recently, an alternative approach was proposed that express various planktonic species explicitly, instead of tuning the parameters region by region. This approach assuming ubiquitousness and selectivity of planktonic species inhibits arbitrary parameter tuning and is expected to improve reproductivity of the model for multiple ecological provinces. In the present study, we develop a selection-based ecosystem model by including phytoplankton community of various cell-sizes. Selectivity and diversity of phytoplankton in ecological provinces of the North Pacific, and its impact on the carbon cycle are investigated. In the presentation, we will focus on variability within the subtropical and subarctic gyres, and discuss their differences in diversity.

Keywords: selection-based model, biodiversity, North Pacific

AOS25-12 Room:203 Time:May 19 17:15-17:30

Evaluation of Global Change effect on Pacific saury using ecosytem models

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To evaluate global warming effects on Pacific saury, three-box ocean domain model which including Kuroshio, mixed water and Oyashio regions had been used with an ecosystem based bioenergetics model NEMURO.FISH (NEMURO for Including Saury and Herring). The model was forced by the sea surface temperature (SST) of global warming conditions generated by climate model outputs which contributed to IPCC-AR4 (Intergovernmental Panel on Climate Change 4th Assessment Report). Twelve climate models, which reproduced the Pacific Decadal Oscillation, were selected and B1, A1B, A2 carbon emission scenarios were used. Totally, thirty-three ensemble simulations were conducted and twenty-four (73%) results showed a decrease of wet weight of Pacific saury. The egg production was enhanced in eleven (33%) cases. However, the model did not include east-west migration of Pacific saury. We conducted numerical simulations including two dimensional horizontal migration of Pacific saury. Sea surface temperature, velocity and prey plankton fields were obtained by simulations with CHOPE-eNEMURO (Max-Planck-Institute Ocean Model coupled with extended NEMURO) using current and future climate forcings. A NEMURO.FISH type fish growth and migration model was forced with the current and future conditions. As a result, southward migration of saury was restricted by higher temperature under future climate. The number of saury advected by the Kuroshio Extension was increased and hence the distribution center was moved offshore. The restrict of southern migration diminish lower growth saury and uniform offshore condition stabilize the growth. However, the model predictability of prey zooplankton density has much uncertainty. Improvement of zooplankton predictability and evaluation of uncertainty with ensemble experiments are required as a future task.

Keywords: marine ecosystem model, fish growth - migration model, Pacific saury, Global Change

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Development of a fish migration model for pelagic species

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The Kuroshio and Oyashio regions in the western North Pacific are important spawning and nursery grounds of various fish species, such as sardine, anchovy and chub mackerel, and also good fishing ground. The environmental conditions affect fish productivity in the regions. For example, in the Pacific stock of Japanese sardine, both of temperature during the larval stage and prey availability during the early juvenile stage are important factors regulating their survival and recruitment processes. Growth rates during the larval and juvenile stages are directly affected by environmental conditions, such as temperature and forage density, playing a key role in survival dynamics. Predation is recognized as the major source of mortality during these stages, although environmental factors are linked to survival potential. Therefore, survival process is controlled by multiple factors. This complexity makes it difficult to understand survival dynamics in relation to environmental fluctuations. In the present study, we tried to develop a fish migration model considering the prey-predator interaction between anchovy (prey) and skipjack tuna (predator) with environmental conditions in the western North Pacific, and discussed the importance of prey-predator interaction as a determinant of fish distributions.

Keywords: fish migration model, anchovy, skipjack tuna, prey-predator interaction