Long-term Global Warming Projection and Support for Adaptation

Background and Objective

There have been growing concerns about global warming since IPCC Fourth Assessment Report in 2007. However, many uncertainties remain regarding future projections of climate change, thus reliability of future climate information needs to be improved in order for planning mitigation and adaptation measures against global warming.

In this project, we address improvement of climate model projection, i.e. reduction and quantification of its uncertainties. In addition, various future emission pathways are explored based upon firm scientific knowledge about climate change, reflecting the actual situation and future prospects of energy supply. Furthermore, the impacts of global warming on power supply systems are being investigated based on regional scale climate change information downscaled from global scale projections.

Main results

1. Introduction of biogeochemical process models

An earth system model, in which a global climate model is coupled to biogeochemical process models, is being introduced through the international collaboration with National Center for Atmospheric Research, USA. This is to reveal the relationship between greenhouse gases emissions and climate change, and to quantify uncertainties in global warming projection. One of such biogeochemical models is the marine ecosystem model where zoo- and phytoplankton are explicitly represented, thus the seasonal variation of ocean CO_2 uptake and surface nutrient concentrations are improved (Figs. 1 and 2) [V09006]. Using this model, the influence of iron micronutrient to primary production was numerically evaluated. We also developed an experimental technique for on-ship incubation experiments using a natural plankton assemblage [V09006]. This is useful to investigate responses of marine organisms to ocean acidification, leading to further improvement of the marine ecosystem model. Concerning terrestrial ecosystem, the impacts of climate change and/or increase of atmospheric CO_2 to primary production and water/energy balance between atmosphere and land surface were evaluated through global warming experiments using the global dynamic vegetation model.

2. Development of a simple climate model

The SEEPLUS, a web application of simple climate model, has been developed (Figs. 3 and 4) [V09016]. It is a simple tool for global warming projection with improved operability and usability. It calculates atmospheric CO_2 concentration and change in globally averaged surface temperature from worldwide CO_2 emissions. One advantage of SEEPLUS is its extensive graphic function that enables users to understand important scientific knowledge such as time-delay of climate system response and uncertainty of future projections. In future, SEEPLUS will be coupled to socio-economic models and utilized to explore various future emission pathways. SEEPLUS will be publicly available on the CRIEPI website.

Other reports [V09015]

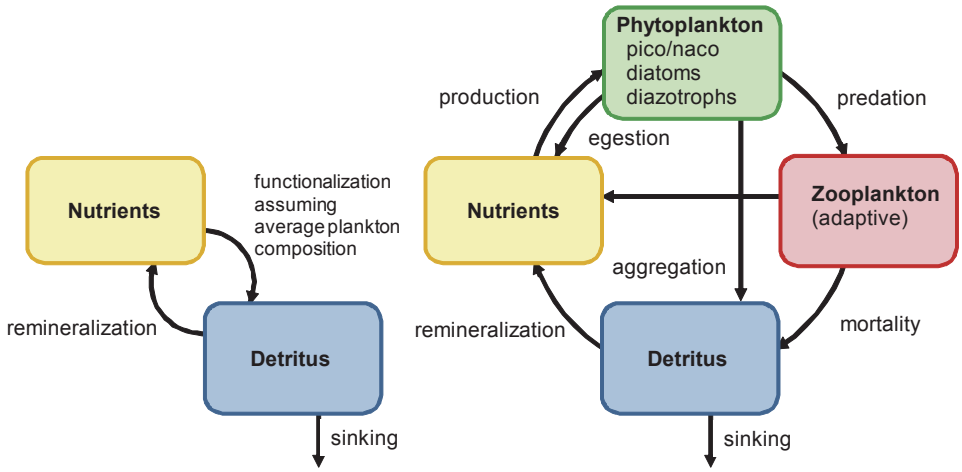

Fig. 1 Conventional ocean carbon cycle model (a) and newly introduced marine ecosystem model (b)
Zoo- and phytoplankton, their production and competition are explicitly represented in marine ecosystem model.

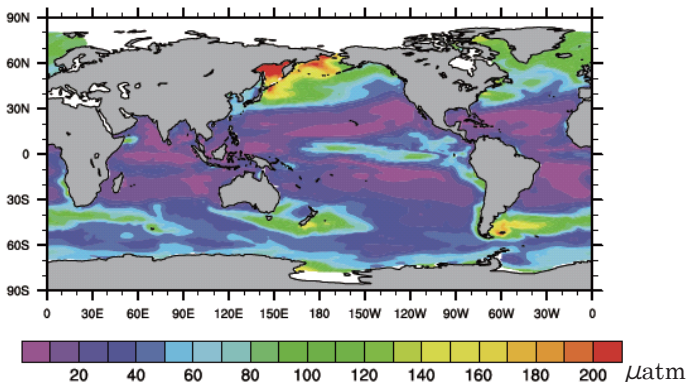

Fig. 2 Seasonal variation of surface CO_2 partial pressure (Result from marine ecosystem model)
Marine ecosystem model well reproduces seasonal variation in subarctic North Pacific where phytoplankton growth plays an important role.

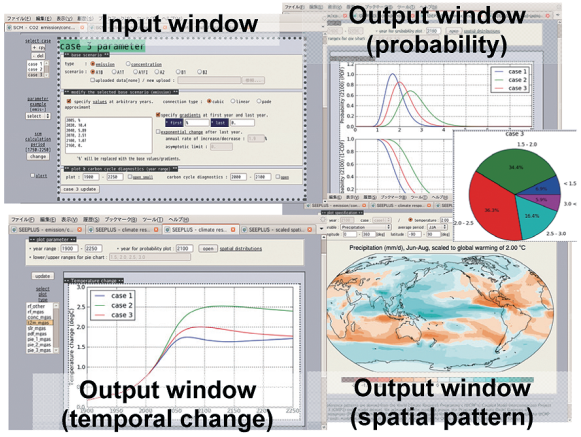

Fig. 3 A simple climate model application, SEEPLUS
For given inputs of CO_2 emission or concentration, SEEPLUS computes global mean temperature, its spatial pattern and probabilistic information about climate change.

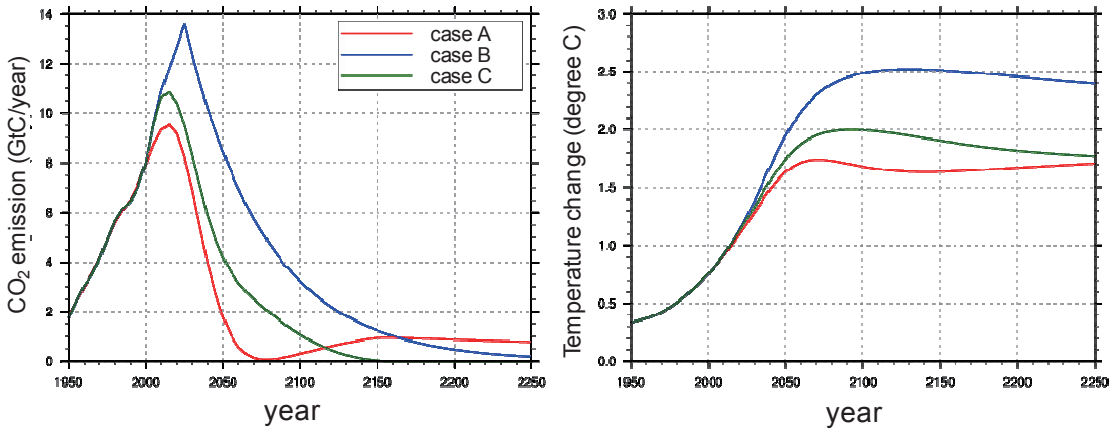

Fig. 4 Examples of emission pathway and corresponding temperature change calculated by SEEPLUS
(left) CO_2 emission pathways designed considering stabilized level of CO_2 concentration and allowable CO_2 emissions, (right) temporal change in globally averaged surface air temperature. The equilibrium climate sensitivity is assumed to 3 degree C, and the contribution from non-CO_2 greenhouse gases is assumed about half of present day.