D-3.4 Study of Oceanic Surface Mixed Layer and Current System for Evaluation of Satellite Ocean Color Data

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Abstract Purpose of the project is to evaluate quantitatively effect of global distribution of phytoplankton to physical environment such as ocean water upwelling and surface mixing with the use of global water circulation numerical models. A numerical model employed is a standard global ocean circulation model driven by the climatological wind stress temperature and salinity with realistic bottom and coastal topography. Embedded in the model is a mixed layer model which has a turbulent closure scheme. The circulation model with annual forcing is integrated with time until it reaches to a quasi-steady state. Upwelling in the equatorial and high latitude area and downwelling in the middle latitude are typical results with climatological forcing. Other variables such as horizontal currents, convective mixing frequency and depth of surface mixed layer are also calculated.

Key Word Circulation Model, Surface Mixed Layer, Satellite Ocean Color Data, Plankton Distribution

1. Introduction

Satellite ocean color is becoming a more and more important measure of global link between natural/anthropogenic physical and biological change. It is an indicator of ocean surface content of chlorophyll or phytoplankton. Its global data set accumulating in daily basis so far reveals a clear relationship with physical environment such as upwelling of ocean water and change of sun light in the ocean surface layer. Anticipating future massive storage of ocean color data through SeaWiFS (1994-) and OCTS/ADEOS (-1995), it is urgent to prepare assimilation system which provides near-operational mapping of global chlorophyll. Simulation of the past data set should precedes this.

In the present project, the goal is set to re-evaluate quantitatively the discussion of cause and effect of phytoplankton to physical environment such as ocean water upwelling and surface mixing with the use of global water circulation numerical models. Present advantage is in our availability of the past/near future ocean color data of several years as seasonal climatology of global chlorophyll distribution.

2. Results with annual mean forcing[1)]

A numerical model employed is a standard global ocean circulation model driven by the climatological wind stress (Hellerman & Rosenstein,1983[2)]), temperature and salinity (Levitus,1982[3)]) with realistic bottom and coastal topography and resolution of 2.5° x 2° x 21 levels. Embedded in the model is a turbulent mixed layer model which has a closure scheme of level 2[4)] with 5 meters resolution in the upper 20 meters. It gives a set of turbulent mixing coefficients of temperature/salinity and momentum, which actually mixes water in the vertical direction and predicts new temperature/salinity and current.

As a preliminary calculation, the model with annual forcing as mentioned above is integrated with time until it reaches to a quasi-steady state . Fig.1 indicates a global distribution of surface upwelling. This is practically determined by the local Coriolis parameter(, function of latitude) and the wind stress distribution. Upwelling in the equatorial and high latitude area and downwelling in the middle latitude are typical components of the result with climatological forcing.

Fig.2 shows a distribution of vertical mixing coefficient produced in the mixing closure scheme in the model. In general, the large value around 20 to 60 cm^2/s, is found along the latitudinal belt of strong easterlies and westerlies.

Other variables such as horizontal currents, convecting mixing frequency and depth of surface mixed layer are reasonable. Relatively small value for the mixing is indicated due to the use of annual mean wind stress. High latitude overshooting of the western boundary currents in the model northern hemisphere results in the too strong convecting mixing in the high latitude.

3. Improvements in the future

In the future study, calculation with seasonal forcing will be conducted. Improvement in the closure scheme in the mixed layer model to level 2.5 is planned. More close study of related physical variables is made along with preparation of the global ocean color digital data to be compared directly with the model results.

References

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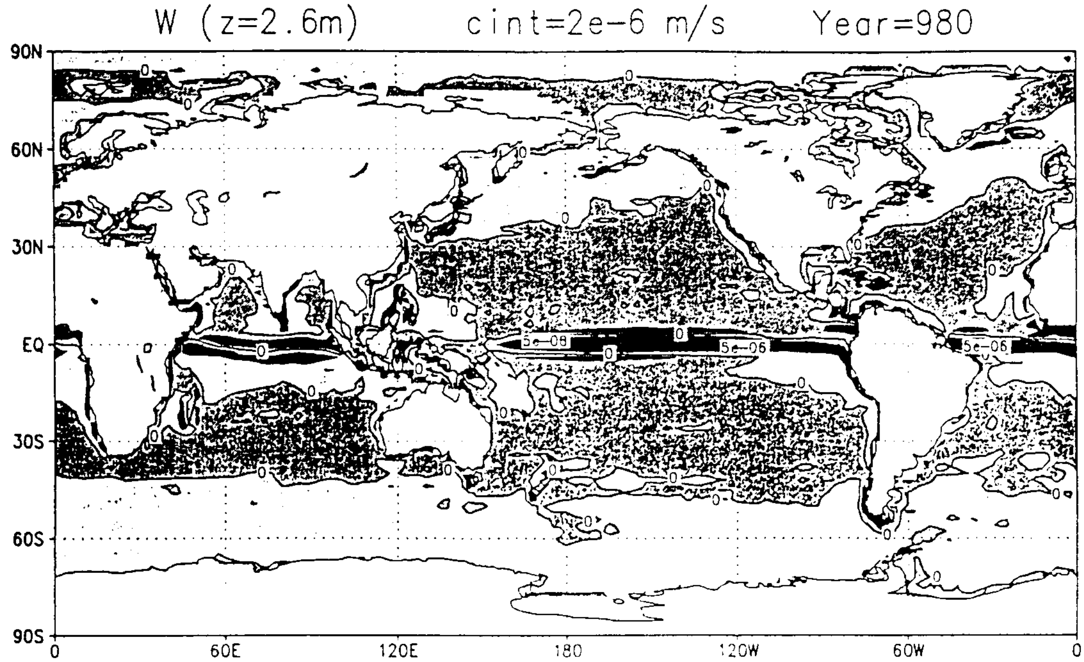

Fig.1 Upwelling (positive) distribution in the ocean surface with the annual mean wind stress. Contour interval is 2 x 10^{-6}m/s. Downwelling in the middle latitude and upwelling in the equatorial and high latitudinal areas are shown.

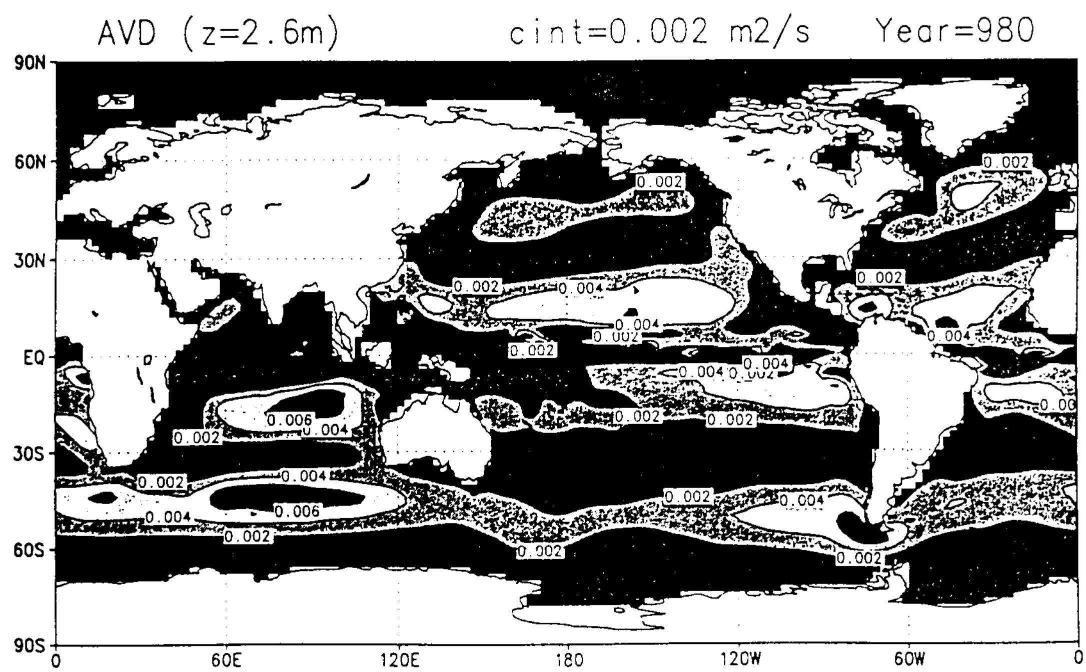

Fig.2 Vertical mixing coefficients in the ocean surface. Contour interval is $2 x 10^{-3}$ m^2/s. Large values are indicated in the latitudinal belts of strong easterlies and westerlies of wind.