Supplement: 1-D coupled physical-biogeochemical model and results

A 1-dimensional coupled physical-biogeochemical model was used to simulate how upper water column structure might influence responses of phytoplankton growth to wind forcing (Wang, 2007). It is based on Mellor and Yamada's (1982) level 2.5 turbulent closure scheme. The vertical domain is from the surface to 500 m depth with a resolution of 1m, except for the surface four layers with thicknesses of 0.25, 0.5, 0.5 and 0.75 m, respectively. The time step of the model run is 60 s. The bottom boundary conditions are fixed at the initial conditions.

The biogeochemical model was previously established for the SCS (Liu et al., 2002; 2007). It has five biogeochemical variables, namely, dissolved inorganic nitrogen (DIN), phytoplankton, zooplankton, detritus and chlorophyll. The biogeochemical variables are all based on nitrogen except chlorophyll, which has a variable quotient with respect to phytoplankton biomass. The growth of chlorophyll is based on the quotient adjusted according to availability of light and DIN, reflecting photo-acclimation of phytoplankton.

Numerical experiments of Chl responses

Numerical experiments were conducted to investigate how deepened thermocline might have affected the Chl level in the surface water by using the 1-diensional coupled physical-biogeochemical model. Because the purpose of the modeling exercise was to explore the sea surface chlorophyll *a* response to wind forcing in winter, the model was driven by 6-hourly wind stress data taken from the National Centers for Environmental Prediction (NCEP) reanalysis data. The modeled photosynthesis uses the 6-hourly short-wave radiation data from NCEP. The model was initiated with data of temperature, salinity, DIN and chlorophyll observed on a cruise (OR3-600) on board Ocean Researcher III in January 2000 at the SEATS station and run from 1 January 2000 to the end of March 2000.

The modeled Chl data are presented for the period from 1 January to 15 March 2000. The modeled Chl data fit the observations reasonably well (Fig. S1). In order to test how thermocline position affect sea surface Chl-*a* the model was run with the thermocline shifted vertically between the range of -20 m to +40 m, while the original wind data were used. In order to test the effect of wind variation the model was run with the thermocline position fixed but with the wind stress varied within the range from -20% to +20%. The effects are expressed as follows:

$$[Chl]/[Chl]_o = 0.911\ (Wind/Wind_o) + 0.089 \qquad R^2 = 0.9999 \qquad \text{(S1)}$$

and

$$[Chl]/[Chl]_o = 0.0090\ \Delta Z + 1.00 \qquad R^2 = 0.989 \qquad \text{(S2)}$$

where [Chl] represents the model predicted average Chl during the period from 20 January to 26 February from different models and $[Chl]_o$ represents that under original conditions; “Wind” represents wind stress; ΔZ (m) represents the uplift of the thermocline position. The results are shown in Figures S2 and S3.

References

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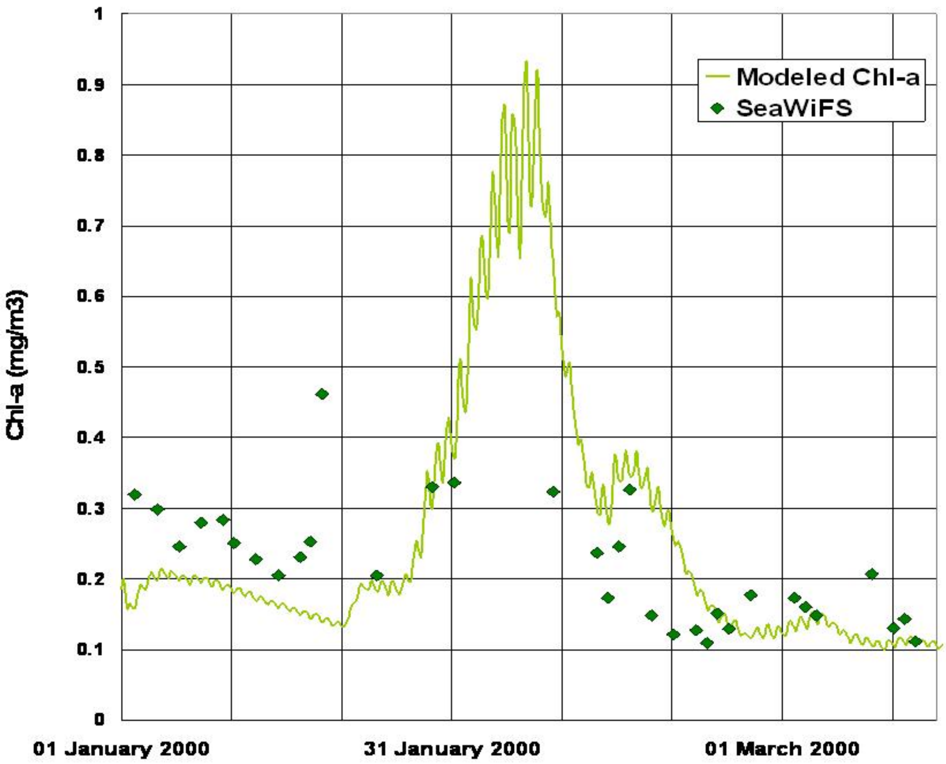

Fig. S1. Sea surface chlorophyll predicted by the 1D model for the period from 1 January 2000 to mid March 2000 as compared to the SeaWiFS data.

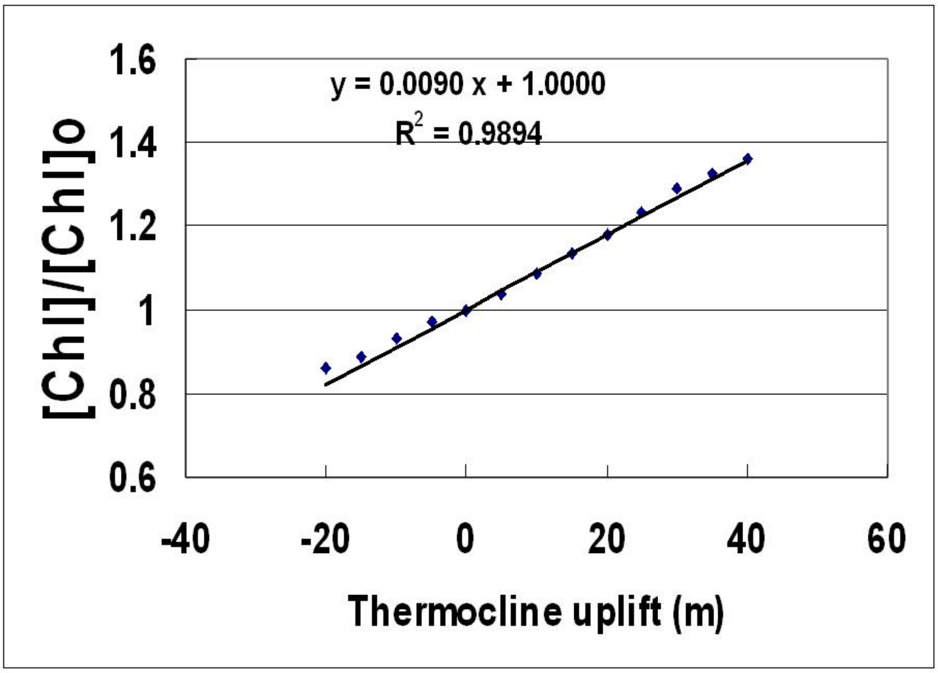

Fig. S2. Effect of the uplift of the thermocline position on sea surface chlorophyll revealed by the 1D model for the period from 20 January 2000 to 26 February 2000.

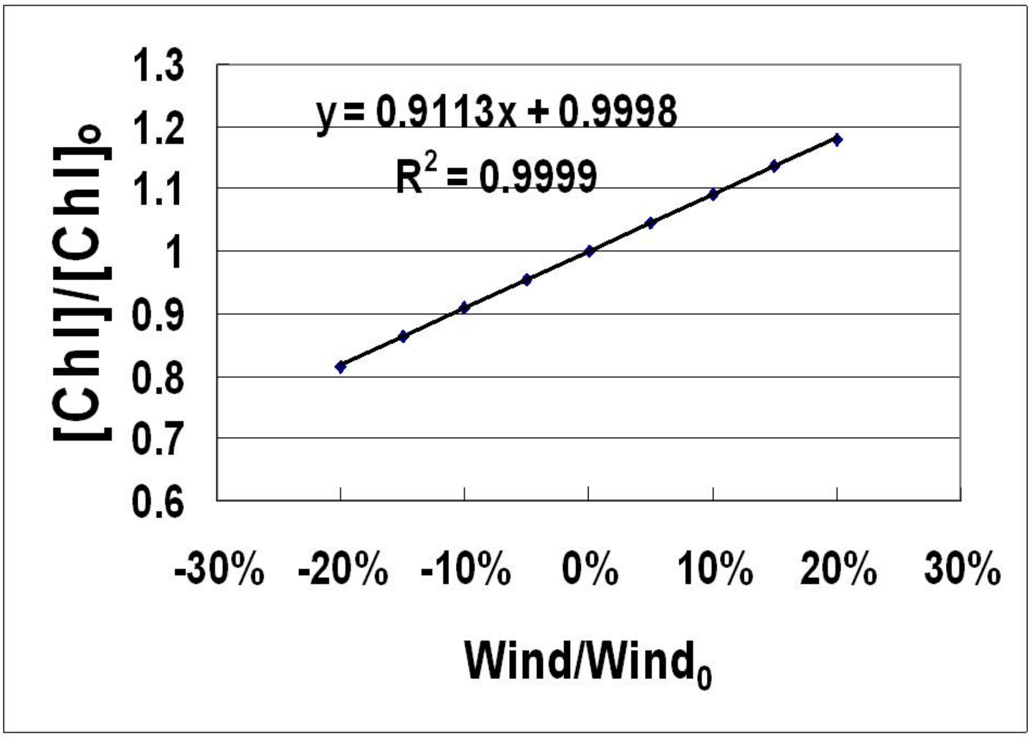

Fig. S3. The same as Fig. S2 except for variation of wind stress.