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Effects of ocean biology on the penetrative radiation in a coupled climate model

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About half of the solar energy is within the spectral range of 350 to 700 nm, where pure sea water is highly transparent. Marine phytoplankton absorb light within this spectral range and thereby modulate the heat flux in the upper ocean. The influence this has on the seasonal cycle and the mean global climate is investigated in a fully coupled high resolution climate model (atmosphere: ECHAM5; ocean: MPI-OM; marine biology: HAMOCC5). The control experiment uses a fixed attenuation depth for shortwave radiation, while the attenuation depth in the experiment with biology is derived from phytoplankton concentrations simulated with the marine biology model. We find an amplification of the seasonal cycle, warming in upwelling regions such as the equatorial Pacific and the Arabian Sea and reduction in sea-ice cover in the high latitudes. In addition, positive feedbacks within the climate system cause a global shift of the seasonal cycle. The onset of spring is about 2 weeks earlier, which results in a more realistic representation of the seasons. Temperature changes also occur over land where they are sometimes even larger than over the ocean. The strength of interannual SST variability is reduced by about 10-15\% and phase locking to the annual cycle is improved. The ENSO spectral peak is broader than in the experiment without biology and the dominant ENSO period is increased to around 5˜years.