Geophysical Research Abstracts, Vol. 9, 04051, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04051

Penetration of spectral visible and ultraviolet radiations in the upper ocean for photobiological and photochemical applications in the Mediterranean Sea

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Recent years have brought a wealth of information on the interaction between the field of ultraviolet (UV) and visible radiation in the aquatic ecosystems and the various forms of life that inhabit it including phytoplankton, zooplankton, bacterioplankton or viruses. Moreover, the efficiency of shortwave radiation for photosensitizing dissolved organic matter opens the door to all sorts of photochemical processes leading to the formation of a variety of organic and inorganic compounds which are relevant for studying marine biogeochemical cycles. These photobiological and photochemical processes are often intertwined in complex ways, and therefore it appears important to consider these various effects in an integrated way. This work mainly deals with a model describing UV and visible radiation spectrum (280-700 nm) at the sea surface and its propagation throughout the water column. Importantly, these two spectral domains are treated within the model with a common optical framework using the same forcing, a common vertical structure for the optically significant water constituents, and a common bio-optical model for the light propagation through the water column. The atmospheric model takes into account dependences on clouds, aerosols and gases, particularly ozone. The ocean module, simple enough to perform computations at basin scale, considers up-to-date bio-optical parameterizations to represent the water optical properties, including the most recent UV and visible spectrum of pure seawater absorption (by Fry et al., 2006). The distribution of the other inherent optical properties (IOPs), i.e. the absorption by phytoplankton and the sum of absorption by chromophoric dissolved organic matter and non algal particles, are derived from satellite data (SeaWiFS/MODIS) using a semi-analytical bio-optical algorithm. This ocean-color dataset has been used to characterize spatio-temporal variations of

absorption and photon budgets in the Mediterranean Sea. The ratio of the CDOM and detrital absorption and total non-seawater absorption at 443 nm presents strong spatial variations with values ranging from 0.4 to 0.8 from the north-western to the south-eastern Mediterranean Sea. Interestingly, a seasonal cycle has been identified for this ratio with variations ranging from 0.65 at the end of summer to 0.80 in winter in the oligotrophic Southern Ionian Sea for example. These satellite-derived IOPs also serve as inputs to the basin-scale optical model used to assess spectral light penetration depths and to quantify the levels of photobiologically and photochemically usable radiations in the water column. Further, a first application of this model was to derive estimations of primary production and UV photochemical processes in the Mediterranean Sea and to appreciate the relative importance of these processes for the carbon fluxes in the basin.