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Realistic representation of light penetration in the upper ocean improves the representation of a structure coupled to the Atlantic Meridional Mode: the Guinea Dome

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A correct understanding of air sea interactions relies on an accurate representation of the ocean surface parameters and hence the processes occuring in the upper ocean, such as the heating by solar radiations. The vertical profile of light penetration in the water column depends directly of the water turbidity and the concentration of photosynthetic pigments. In waters characterized by high pigments concentration in the mixed layer, most of the solar energy is transfered into the ocean first meters. When compared to a case where pigment concentration is almost zero, one should then expect a warming of the surface ocean. This is however not the case everywhere. Impact of ocean dynamics and circulation is fundamental. Indeed, more energy absorbed in the upper part of the water column means less energy transferred at greater depth. In upwelling region, this cooled thermocline water is advected toward the surface. The net effect of the photosynthetic pigments on surface temperature could reach +/- 0.5 degrees and depends of the upwelling intensity. Situation becomes more complex in waters where pigment concentration is small in the mixed layer and high at thermocline level, which occurs in most of tropical ocean. When compared to a case where pigment concentration is almost zero everywhere, anomalous heating occurs both in the mixed layer and at thermocline level leading to a further stratification of the water column.
In this study, we assess the effect of photosynthetic pigments on sea surface temperature, mixed layer depth and ocean stratification. We focus more specifically on the Atlantic North East Tropical Upwelling System and particularly the Guinea Dome region. This structure is coupled to the Atlantic Meridional Mode, which is the dominant mode of large-scale ocean-atmosphere interaction in the tropical Atlantic.
Two experiments have been performed using the NEMO ocean general circulation model coupled to the biogeochemical PISCES model. Horizontal resolution is half degree in latitude/longitude. The models presents 15 levels in the upper 100m. In the experiment CHL0, optical properties of the ocean are the ones of oligotrophic regions, whereas in CHLZ the chlorophyll concentration used to compute the solar irradiance profile is determined by PISCES. In both cases, the atmospheric forcing used are provided by the CORE dataset (1958 - 2000).
In our region of interest heating by pigment is high, either in the mixed layer or at depth. This pigment heating effect contributes to the formation of the Guinea Dome, characterized by a very stratified thermocline. Cost functions analysis performed in the upper ocean show an improvement in CHLZ in the representation of the thermal structure in the region. Taking in account the impact of photosynthetic pigments in the solar radiation penetration should then improve the prediction skill of ocean atmosphere models.