Developing Synergies Between Observations by Ocean Remote Sensing and Bio-Optical Floats

Chapter 1.2 , IOCCG (2011). Bio-Optical Sensors on Argo Floats. Claustre, H. (ed.), Reports of the International Ocean-Colour Coordinating Group, No. 11, IOCCG, Dartmouth, Canada.

Remote sensing of the ocean surface covers spatial scales ranging from kilometers to the global scale and temporal scales ranging from days to the decadal scale (Figure 1.1). Profiling floats sample the water column between the surface and 2 km (up to 1 m resolution) covering horizontal spatial scales from ~1 km to ~1000 km, and temporal scales from a day to several years. Interestingly, the intersection between the spatio-temporal domains covered by both remote sensing and profiling floats (Figure 1.1) encompasses the mesoscale processes and the seasonal cycle of mixed layer dynamics and its impact on biomass cycles. Studying these is pivotal for improving our understanding of the impact of physical forcing on ocean biology and the biogeochemical cycle of elements, in particular of carbon. Although considered as essential, these processes have been poorly studied to date, because of the lack of appropriate observational strategies. Obviously, the design of observational strategies based on the combined use of both remote approaches would be essential for improving our knowledge of these fundamental oceanic processes.

The potential of combining Argo float technology with ocean colour observations can be demonstrated with "simple" TS floats. For example, in the most oligotrophic waters in the vicinity of Easter Island in the South Pacific Gyre, a seasonality in surface [Chla] is observed with winter values exceeding the summer minimal values (0.02 mg m^{-3}) by a factor of ~3 (Figure 1.2). The analysis of the TS data from an Argo float deployed in this area at the same period shows a cycle in mixed layer depth. One interpretation of this data is that winter mixing erodes the deep nutricline, allowing phytoplankton growth limitation to be alleviated resulting in the subsequent increase in biomass in these clear waters (Morel et al., 2010). Another interpretation, not necessarily contradictory with the first one, is that low average irradiance within the deepening mixed layer in winter induces phytoplankton photo adaptation, i.e. more Chlorophyll-a per cell (McClain et al., 2004 ; Morel et al., 2010). Thanks to two independent datasets (SeaWiFS and Argo) openly available in quasi real time, an analysis of the tight coupling between physical forcing and biological response is now possible (e.g. Figure 1.2). It illustrates the potential to develop the synergetic association of remote platforms (space borne and *in situ*). This synergy is essential in the investigation, at the appropriate scales, of the role of oceanic biological and biogeochemical processes in the context of the increase of anthropogenic CO2 and, more generally, of global change.

The calibration and validation of remotely-sensed satellite data is another area

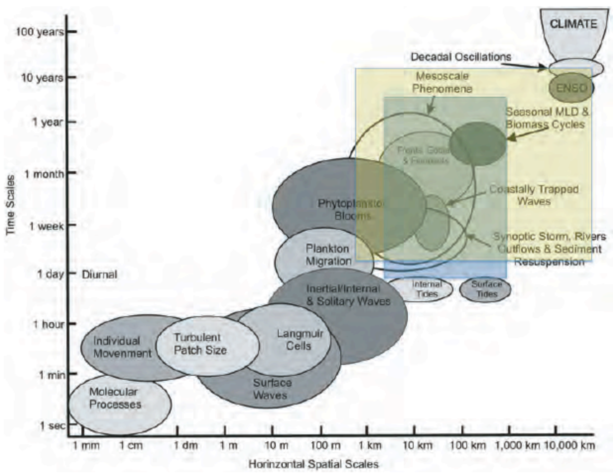

Figure 1.1 The spatio-temporal domain relevant to major physical and biological processes in the context of observations by remote sensing (shaded yellow) and profiling floats (shaded blue). The intersection between both spatiotemporal domains identifies the scales of oceanic processes that can be scrutinized using both remote (space and in situ) approaches. For the open ocean, it encompasses processes that are essential for our understanding of the impact of physical forcing on the biogeochemical cycle of carbon. Adapted from Dickey (2003).

that would benefit strongly from the development and deployment of bio-optical floats. On the one hand, this technology would permit measurements in remote oceanic areas that are not easily accessible by ship. On the other hand, dense and homogenous (with respect to data treatment) databases of surface oceanic properties measured by ocean colour satellite would be established.

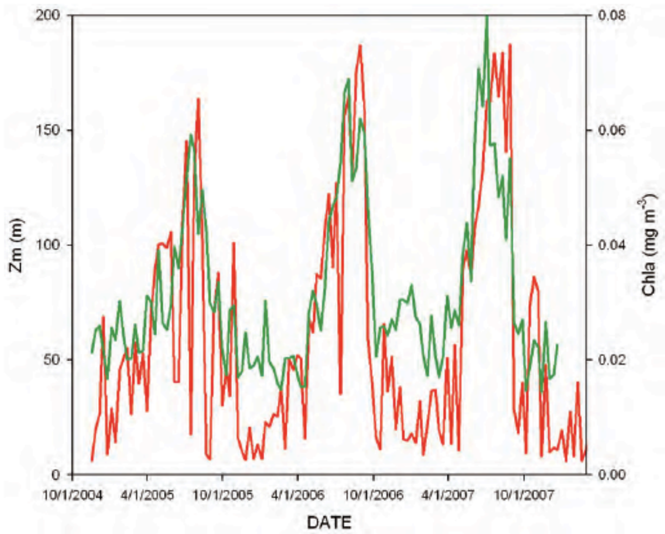

Figure 1.2 Dynamics of algal biomass as a function of physical forcing in the center of the South Pacific Gyre (vicinity of Easter Island). The surface Chlorophll-a concentration (green line), as quantified by SeaWiFS, is tightly linked to the thickness of the mixed layer (red line), Z_m, as recorded by a TS Argo float (WMO # 3000302). Adapted from Morel et al. (2010).