RolE of Mixing on phytoplankton bloom initiation, maintEnance and DIssipatiOn in the galician ríaS (REMEDIOS)

The fertilization of phytoplankton by the Iberian upwelling is responsible for the production of ~250,000 t year^{-1} of blue mussels in the Galician Rías. This amount represents 95% of the Spanish and 50% of the European production, respectively. This production is jeopardized every year by toxic phytoplankton blooms. Turbulent mixing is a key process as it controls water renewal time, which in turns determines the rate of exchange of nutrients, organisms and pollutants in the water column. Our current knowledge states that phytoplankton blooms occur when mixing provides the right levels of light and nutrients. However, due to methodological limitations, only very recently we have been able to quantify turbulence in the field. One of the most fascinating implications of this progress is the possibility to revisit classic models of phytoplankton ecology. In 1953 Sverdrup proposed a simple conservation mass model which used the depth of the mixed layer to predict the onset of the North Atlantic spring bloom. This model assumed a thoroughly mixed layer where turbulence was strong enough to distribute the phytoplankton cells evenly through the layer. Following trials, either to verify this hypothesis or to use its theoretical background, have generally forgotten this assumption and used the mixed layer, defined as a layer homogenous in density, as the equivalent of a turbulent or mixing layer. Despite evidence suggesting that vertical mixing controls the annual cycle of biomass and composition of the phytoplankton community in the Galician Rías, its importance has been inferred from hydrographic conditions. So far, a specific study relating mixing and phytoplankton bloom formation is lacking. For the first time we propose to use the theoretical framework of the Sverdrup hypothesis to investigate phytoplankton bloom initiation, maintenance and dissipation in NW Spain. Special attention will be devoted to blooms of species from the genera *Dinophysis* and *Pseudo-nitzschia,* responsible for lengthy shellfish harvesting closures due to accumulation of diarrhetic (DSP) and amnesic (ASP) shellfish poisoning toxins, respectively, above regulatory levels. Previous studies in this region and others in Europe indicate that these species frequently aggregate forming “thin layers”. Less than five meters thick and up to several km in horizontal extension, these layers have important implications for the management of molluscan shellfish safety. Despite this, the frequency of occurrence of thin phytoplankton layers in the Galician Rías, and the role of mixing conditions in their formation and persistence remains unknown. This proposal combines field observations in the Galician Rías, time series analysis, and empirical and numerical modeling with the aim of 1) describing the seasonal variability in the sources of turbulence and the magnitude of mixing, 2) investigating the role of mixing on resource availability and phytoplankton bloom initiation, maintenance and dissipation, 3) describing the frequency and spatial distribution of thin layers of phytoplankton (TLP), and 4) investigating the mechanisms responsible for the formation of TLP. The determination of the mechanisms responsible for phytoplankton bloom formation is fundamental to improve our capabilities to predict the toxic events, and contribute to the management and mitigation of their socio-economic impacts in the region.

Keywords: turbulence, mixing, plankton, harmful algae blooms, *Dinophysis, Pseudo-nitzschia,* Galician Rías