The ocean surface, a whole world in motion

July 4 2007

Technical advances over the past 50 years have allowed improved knowledge to be gained of the properties of sea water at great depths. Yet the first centimetres of the ocean remain its least well known part. They are difficult to sample and study owing to the mixing the oceanographic vessel provokes between this superficial layer and the deeper strata of water. Nevertheless, a whole ecosystem exists within this layer, carrying numerous living organisms like bacteria, zooplankton and larger animals such as flying fish, which feed and reproduce in it.

Research usually focuses rather on the whole of the sunlit part of the ocean (the first 30 to 120 metres) where the phytoplankton elaborates organic matter (in primary production) thanks to chlorophyll – its green pigment - during photosynthesis. Through this process, the ocean proves to be capable of trapping the carbon dioxide from the atmosphere by incorporating it with the organic matter produced and storing it by sedimentation down towards the deep waters. This downward movement of carbon-carrying particles is the focus of great attention among oceanographers.

In this theoretical context, IRD scientists (France) advanced the hypothesis that part of this carbon flux would rise up instead of descend, feeding the surface fauna. These living beings and the organic particles they absorb are still little known as a whole and are designated as “floating biogenic material”. A physical ocean circulation model, coupled with a model reproducing the behaviour of the ecosystems, was used in order to obtain more accurate notions of the distribution of these particles present at the ocean surface and of their relationships with the

food “hot spots”, first observed several years ago.

The simulation run showed that the distribution of the biogenic material does not follow that of the primary production that generates it. The surface-layer organisms with their associated organic matter are under the direct influence of the surface currents. These currents carry this floating material as far as the oceanic convergence zones, places where two water masses meet. These “fronts”, where the concentrations of biogenic material are up to 10 times higher than those of other marine regions, prove to be no richer in phytoplankton and chlorophyll than the surrounding waters. The surface layer of the convergence zones is a site of accumulation only for floating debris of marine life and the organisms that feed on it.

Such concentrations of floating biomass in the otherwise nutrient-poor ocean, with low productivity and little organic-matter, is like an oasis for fish in search of food. They help explain in particular why tuna fishing is carried out essentially near these fronts, a factor that had not hitherto been clearly elucidated.

Another finding was that the optical properties of this floating material were quite close to those of chlorophyll. Consequently, this biogenic material influences observation of the colour of the ocean in the same way as the green pigment. Its presence thus distorts calculation systems which use these satellite colour data to estimate the chlorophyll concentration and therefore that of the phytoplankton. The great quantities of chlorophyll apparently detected in the convergence zones could in reality correspond to the presence of floating debris. More accurate definition of the distribution of the chlorophyll and biogenic material that accumulate at the fronts could therefore lead to a better perception and use of ocean colour as an indicator of oceanic circulation and of the ecosystem’s biological and biogeochemical processes.

Further, the accumulation of microorganisms and floating debris might influence carbon dioxide (CO_2) absorption by the ocean. In fact, the life forms of the ecosystem in the first centimetres of the water breath and produce CO_2. The existence of an excess of carbon dioxide just under the surface could therefore call into question the assessment methods used for the quantifying the CO_2 absorbed by the ocean.

A surface sampling device is currently being developed. This kind of tool is a prerequisite for studying this theme, highly important for understanding climatic phenomena and atmospheric carbon concentration, a key parameter in global warming.

Source: IRD