Satellite-based Lagrangian identification of fine-scale physical features of ecological importance in the Amsterdam/Crozet/Kerguelen open ocean region

In the recent years, multisatellite data analysis has shown that altimetry is a powerful tool for understanding how the ocean currents structure the upper layer of the marine environment. Maps of Lagrangian diagnostics compared to ocean color (Lehahn et al. 2007; d'Ovidio et al. 2010) have shown that the ocean mesoscale transport modulates the interface between water masses with different content and allow to identify the presence of predominantly stagnant or mixing regions (d'Ovidio et al. 2013). Inhomogeneities due to large-scale gradients, tracers like nutrients and contaminants, are segregated, transported, filamented, and eventually mixed together by these features.

Lagrangian features have been shown to affect not only drifting tracers (like phytoplankton) but to have an effect over the entire trophic chain. Tew-Kai et al. (2010) showed for the first time that transport barriers identified by altimetry-derived Lyapunov exponents are tracked by frigatebirds. Several other studies have followed, looking at predators belonging to different guilds and to possible mechanisms affecting their behavior, like possible stirring of the prey field (Cotté et al. 2015) or even interaction with the predator swimming ability (Della Penna et al. 2015). This year, we have integrated these Lagrangian tools in the analysis of the ecological hotspots present inside Kerguelen Exclusive Economic Zone (Koubbi et al. 2016a,b). This work is now being extended to the high seas in the framework of CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources). In order to achieve this, we are consolidating a large database of trajectories of marine predators which will have to be integrated with mesoscale and smaller physical features that we plan to extract from multisatellite data. The work of the Master student will consist in analyzing remote sensing observations with Lagrangian diagnostics developed at LOCEAN and already applied to several other biophysical applications (e.g., Della Penna et al. 2015). The expected outcome is a description of the surface of the ocean in terms of maps of eddies' cores, filaments, and other (sub)mesoscale features which are expected to structure the habitat of marine organisms. These maps will be compared to the biologging trajectories and will serve as a first building block for identifying important ecological areas in the high seas around French TAAF.

The student will have access to computational resources, to a training period for using the Lagrangian code developed by F. d'Ovidio for multisatellite data analysis and to desk space at LOCEAN.

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References:

Cotté C, d'Ovidio F, Dragon AC, Guinet C, Lévy M Flexible preference of southern elephant seals for distinct mesoscale features within the antarctic circumpolar current. Progress in Oceanography 131:46-58, 2015

Della Penna A, De Monte S, Kestenare E, Guinet C, d'Ovidio F Quasi-planktonic behavior of foraging top marine predators. Scientific Reports, 2015

F. d'Ovidio, De Monte S, Penna AD, Cotté C, Guinet C Ecological implications of eddy retention in the open ocean: A lagrangian approach. Journal of Physics A: Mathematical and Theoretical 46, 2013

P. Koubbi et al., Ecoregionalisation of the Kerguelen and Crozet islands oceanic zone. Part I: Introduction and Kerguelen oceanic zone, WG-EMM-16/43, 2016a

P. Koubbi et al., Ecoregionalisation of the Kerguelen and Crozet islands oceanic zone. Part II: The Crozet oceanic zoneWG-EMM-16-54, 2016b

Y. Lehahn, F. d'Ovidio, M. Levy, E. Heifetz, “Stirring of the Northeast Atlantic spring bloom: a Lagrangian analysis based on multi-satellite data”, J. Geophys. Res., 112, C08005 (2007).

E. Tew Kai, V. Rossi, J. Sudre, H. Weimerskirch, C. Lopez, et al.. Top marine predators track Lagrangian coherent structures.. *Proceedings of the National Academy of Sciences of the United States of America*, National Academy of Sciences, 106 (20), pp.8245-50, 2009.