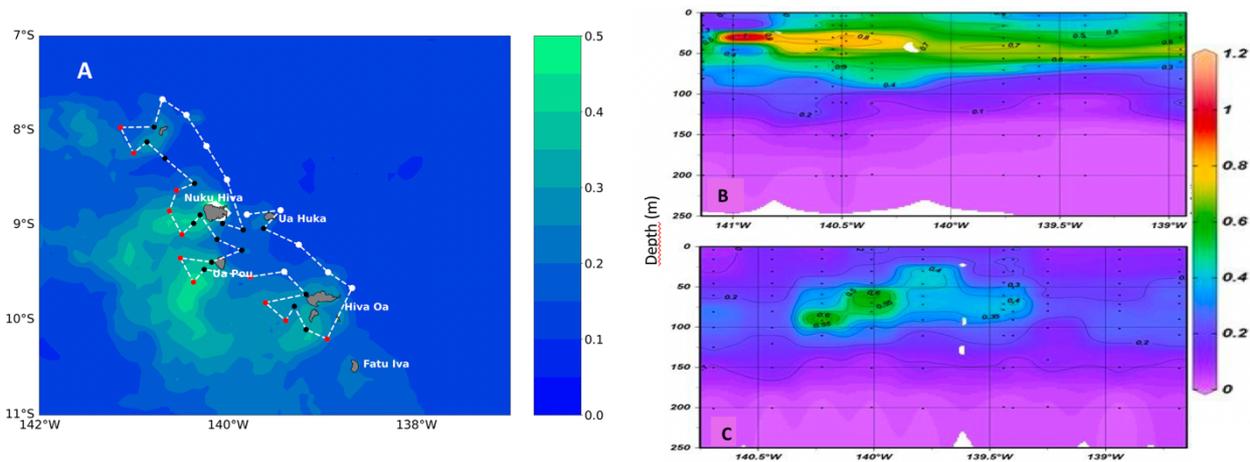


## FINAL REPORT PROGRAM LEFE

Program LEFE/ CYBER and GMMC	MOANA MATY "the Marquesas biOlogicAl eNhAnceMent within the pAcific ocean: from the processes to the decadal variabiliTY"  (MOANA-MATIE signifie "océan vert" en polynésien)	Years 2018 – 2019
PI: Elodie Martinez, LOPS ( <a href="mailto:elodie.martinez@ird.fr">elodie.martinez@ird.fr</a> ) Participating Laboratories: French: MIO, LOPS, EIO, LEGOS, IMAGO, LEMAR, LOV International: Moss Landing Marine Lab, NOAA	Contribution to international programs : <ul style="list-style-type: none"> <li>• US_GEOTRACES</li> <li>• Global Drifter Program</li> <li>• Argo and biogeochemical-Argo Program</li> </ul> Other funding sources: <ul style="list-style-type: none"> <li>• Délégation à la Recherche de Polynésie française 2015-2018 &amp; 2018-2020</li> <li>• IRD &amp; CNFC</li> <li>• Agence française pour la biodiversité</li> </ul>	
<p><i>Context:</i> The Marquesas Islands (central South Pacific) are characterized by a strong phytoplanktonic enhancement (island mass effect-IME, Figure 1-left) and rich marine biodiversity. However, the pelagic oceanic environment of this archipelago has been poorly studied and mechanisms at the origin of this IME remain unknown.</p> <p><i>Objectives / scientific questions:</i> The objectives of the MOANA-MATY project are: 1) to understand the physical and biogeochemical processes at the origin of the Marquesas IME, 2) to characterize the seasonal and interannual variability of phytoplankton and the physical and biogeochemical processes involved.</p> <p>This interdisciplinary project combines physical, biogeochemical and biological approaches. It has been developed through 3 methodological aspects: numerical modeling and satellite observations (2015-2018), and <i>in situ</i> observations from 2 oceanographic cruises (funded by the LEFE program over 2018-2019).</p> <p><i>Main results:</i> The Marquesas archipelago is located in a high-nutrient low-Chlorophyll (HNLC) area, which is likely iron-limited. Several hypotheses have been investigated to explain iron input in the upper-sunlit layer allowing phytoplankton growth:</p> <ul style="list-style-type: none"> <li>- Numerical modeling in the framework of H. Raapoto's PhD thesis showed an eddy activity induced by the presence of the islands. However, no conclusion could have been drawn on a nutrient uplift by eddies to explain the IME (Raapoto et al., 2018). The role of a wind-driven upwelling to uplift nutrient along the coasts wasn't conclusive neither. Finally, an input from the island sediment to fertilize waters before being advected in the wake of the islands is more probable (Raapoto et al., 2019). However, the clear origin of iron (for instance from the bathymetry or induced by land drainage) and mechanisms involved remain under investigation.</li> <li>- Satellite observations support the hypothesis of an iron contribution from the island themselves before advection of the phytoplankton or/and nutrient plumes leeward the islands (Cassianides et al., 2020). They have also allowed to investigate a potential iron advection from the equatorial upwelling toward the archipelago through tropical instability waves during La Nina events. This mechanism may have been at play during the 1998 and 2010 La Nina events (Martinez et al., 2018).</li> <li>- The LEFE funding supported the biogeochemical analyses of the two Moana-Maty cruises which took place in the archipelago during the dry (19 Sept - 16 Oct. 2018, austral winter) and wet seasons (11 Feb. - 12 Mar 2019, austral summer, Figure 1A). The aim was to document the nature of the planktonic compartments in the Marquesas, as well as the physical and biogeochemical environment (especially the role of dissolved and particulate iron) to help understanding processes involved in this IME in two contrasting seasons. Attention has been paid in the cruise itinerary (the same for the 2 cruises, Figure 1A) to characterize the coastal-offshore gradient and northern-southern archipelago differences, as well as the contrast between the enriched area downstream the islands vs. the upstream unenriched area.</li> </ul>		



**Figure 1:** A) Chlorophyll-a concentration (Chl) from satellite observations average from 11 Feb to 12 Mar 2019 (i.e., the 2nd cruise in austral summer). The dashed line shows the 2 cruises trajectories and dots the stations. *In situ* Chl are plotted for stations (B) upstream (white dots in A) and (C) downstream (red dots in A) the islands also during the second cruise (austral summer).

Preliminary analyses of the 2 cruises show contrasting results between the 2 seasons. In austral winter, an intense dynamical mesoscale activity makes it difficult to distinguish upstream/downstream contrasts in the biological and biogeochemical observations (not shown here). On the other hand, in austral summer, the surface current towards the west/southwest is well established and the upstream/downstream contrast on chlorophyll-a concentration can be observed both from satellite (Figure 1A) and in situ observations (Figure 1B,C) with a poorer area upstream vs. a richer one downstream. This pattern has also been observed on zooplankton distribution.

#### Future of the project:

- Due to the Covid-19 health crisis, iron analyses were not carried out as the American laboratory in charge of them was closed in 2020-beginning 2021. These iron measurements remain to be put in connection with the planktonic and biogeochemical observations from the cruises, as well as with metagenomic and transcriptomic observations from the phytoplankton compartment.
- Observations from 4 physical-biogeochemical Argo released in the area during the 2 cruises will be investigated. These observations, associated to satellite observations, will provide a spatial context within the archipelago and a temporal one to in situ measurements from the 2 cruises. Research for funding's for a Phd grant on this topic is ongoing.
- The post cruises meeting planned in Brest in 2020 is postponed to 2021 because of the sanitary conditions related to Covid-19. Valorization of the 2 cruises results through per-reviewed articles.

#### Nombre de publications, de communications et de theses (within the framework of the Moana Maty project and specifically from the cruises in purple and \*)

- Data archiving in the SISMER database.
- 4+1\* Peer-reviewed articles + 1 book chapter and 2 presentations in international congress.
- 1 PhD thesis (H. Raapoto, 2015-2018) and 6+4\* student internships from bachelor to Master 2 level.

\*Cassianides, A., E. Martinez, C. Maes, X. Carton, T. Gorgues (2020). Monitoring the Influence of the Mesoscale Ocean Dynamics on Phytoplanktonic Plumes around the Marquesas Islands Using Multi-Satellite Missions. *Remote Sensing*, 12(16), 2520.

Martinez, E., M. Rodier, M. Pagano, R. Sauzède (2020). Plankton spatial variability within the Marquesas archipelago, South Pacific. *Journal of Marine Systems*, 212, 103432.

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Raapoto, H., E. Martinez, A. Petrenko, A. Doglioli, C Maes (2018). Modeling the wake of the Marquesas archipelago. *Journal of Geophysical Research: Oceans*, 123. [https://doi.org/ 10.1002/2017JC013285](https://doi.org/10.1002/2017JC013285)