

Master 2 internship Offer - January 2023- June 2023

## Trait-based modeling of mesozooplankton feeding behaviors at the global-scale

Offre de Stage de Master 2 - Janvier 2023-Juin 2023

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Lieu de Stage : LOCEAN-Laboratoire d'Océanographie et du Climat: Expérimentations et Analyses Numériques, Campus Pierre et Marie Curie, 75005 Paris, France

**Context:** Marine zooplankton are small heterotrophic planktonic organisms that constitute a taxonomically and morphologically diverse group (Steinberg & Landry, 2017). Among these organisms, mesozooplankton (MZP) are a group of multicellular organisms whose size ranges from 200  $\mu\text{m}$  to 2 mm that feed on a wide diversity of prey (phytoplankton, detritus, bacteria, zooplankton, mesozooplankton). They play a pivotal role in marine ecosystems by controlling the amount of energy that is transferred from primary producers to higher trophic levels. They are also key players in marine biogeochemical cycles as they convert the organic matter they ingest into dissolved organic matter and nutrients that can be recycled on the one hand and into large fecal pellets that sink rapidly into the water column on the other hand.

Feeding behavior is an essential trait of mesozooplankton as it controls the amount of food the organism can obtain from its environment to cover its needs. Yet, feeding behavior has implications for other functions such as predation risk, energetic losses and mate finding. One may consider that the selection of a feeding behavior maximizes the individual fitness defined by one or several trade-offs between gains (food intake, reproductive success, ...) and costs (metabolic cost, predation risk, ...). Trait-based approaches (Martini et al. 2022) provide a theoretical and conceptual framework for deciphering the link between functional diversity and marine ecosystem functioning, which can be used to develop trait-based models.

**Objectives:** the general objective of this internship is to develop a trait-based approach to describe the diversity of mesozooplankton feeding behaviors. This approach will then be embedded into a global biogeochemical model (the PISCES model; Aumont et al. 2015) in order to assess the impacts of the diversity of feeding behaviors on mesozooplankton biomass, ecosystem dynamics and biogeochemical cycles.

Objective #1: Develop a trait-based modeling framework for mesozooplankton feeding behavior.

Objective #2: Embed this framework into the global biogeochemical model PISCES.

Objective #3: Evaluate the impacts of diversity in feeding behaviors on mesozooplankton biomass and biogeochemical cycles.

**Methods:** The master student will use the PISCES biogeochemical model (Aumont et al., 2015), which is an intermediate-complexity model of planktonic ecosystems and major marine biogeochemical cycles. The student will modify the current description of mesozooplankton (which is based on a single generic community with a single generic feeding behavior) and perform global scale simulations on supercomputers. The results of these simulations will then be analyzed and compared to available observations using multivariate statistics.

**Resources available:** This position will be based at the Laboratoire d'Océanographie et du Climat: Expérimentations et Approches Numériques (LOCEAN) in Paris. The candidate will be provided with a desktop using a linux environment. She/he will integrate the NEMO R&D research team, a multidisciplinary team of physical and biogeochemical modelers. There, she/he will be supervised by Dr. Olivier Aumont, a biogeochemical oceanographer who has a long expertise in modeling, and co-supervised by Dr. Sakina-Dorothee Ayata, marine ecologist at the LOCEAN in the PROTEO team. The candidate will also closely interact with Renaud Person, Engineer in the NEMO R&D team.

**Required skills:** We are looking for an enthusiastic candidate with at least an intermediate-level in programming (python and possibly FORTRAN) as model development and data analyses are essential aspects of this internship. Good writing and communication skills are also expected, including in English.

**Perspectives after the internship:** As part of the newly funded ANR project TRAITZOO (PI: SD Ayata), we have secured a PhD grant for 3 years at Sorbonne Université at the LOCEAN. This PhD will start in October 2023, and will be a continuity of this internship. Although it is not a mandatory criterion to apply to this internship, students aiming to pursue their Master with a PhD will be preferred. The TRAITZOO project also involved national and international collaborations, especially with Pr. Frédéric Maps at the Université Laval in Québec (Canada) whose team is developing Individual-Based Models (IBMs) of mesozooplankton.

### **How to apply?**

Interested candidates should send an email to Olivier Aumont (olivier.aumont@ird.fr) and Sakina-Dorothee Ayata (sakina-dorothee.ayata@locean.ipsl.fr) with the subject line: M2\_zoofeed, and include the following:

- Cover letter of 1 page presenting a brief summary of the candidate's academic experiences (both classes and internships) and explaining her/his motivation for this internship
- A detailed Curriculum vitae, including the list of the main classes followed for each academic year and academic skills. The names of the supervisors of any previous internship should also be indicated
- A copy of the grades obtained in first year of Master.

### **Cited references:**

Aumont, et al. (2015) PISCES-v2: an ocean biogeochemical model for carbon and ecosystem studies, *Geosci. Model Dev.*, 8, 2465–2513, <https://doi.org/10.5194/gmd-8-2465-2015>

Martini et al. (2021) Functional trait-based approaches as a common framework for aquatic ecologists, *Limnol. Oceanogr.* 66: 965-994. <https://doi.org/10.1002/lno.11655>

Steinberg & Landry (2017) Zooplankton and the Ocean Carbon Cycle, *Annu. Rev. Mar. Sci.*, 9:1, 413-444  
<https://doi.org/10.1146/annurev-marine-010814-015924>