

Call for proposals OCÉAN Institute – 4 “Master’s Internship 2” scholarships funded and open to student applications for January-June 2025

Deadline : 16 décembre

AAP Stage AMU results:

MIO – Study of the antropogenic Carbon changes along thiuer pathways in the North Atlantic

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Since the beginning of the Industrial Revolution, human activities have emitted large amounts of carbon (CO₂) into the atmosphere. Through the ocean circulation, biological processes, and heat and freshwater fluxes, the ocean has taken up to $26 \pm 5\%$ of the total excess of carbon, referred to as anthropogenic carbon (Cant), slowing the accumulation of anthropogenic CO₂ in the atmosphere and reducing the pace of global warming (Friedlingstein et al., 2023). Understanding the processes causing this uptake and their susceptibility to change are therefore high-priority activities as the storing of Cant comes at a cost for the ocean's ecosystem (e.g. Doney et al., 2020) with drastic consequences.

Despite having only 15% of the global ocean surface, the North Atlantic (NA) Ocean has the largest Cant inventory per surface, storing up to 23-38 % of the total oceanic Cant (Sabine et al., 2004; Steinfeldt et al., 2009). In this region, this is due to a combination of (1) the northward advection of Cant by the North Atlantic Current (NAC, i.e. the upper limb of the Atlantic Meridional Circulation) from the subtropics (Brown et al., 2021) and (2) the downward mixing transferring Cant from surface waters to the deep ocean (Pérez et al., 2018). However, the projected weakening of both the AMOC strength (Jackson et al., 2022) and deep-water formation (e.g. Schweckendiek et al., 2005) in combination with the increasing atmospheric Cant could modify the Cant increasing trends and related Cant storage rates.

Cant in the ocean cannot be measured directly but has to be inferred by indirect techniques. To date, Cant estimates are mainly based on ship-based measurements of carbonate parameters (Sabine et al., 2004, Pérez et al., 2013) or transient tracers such as CFCs (e.g. Steinfeldt et al., 2024). Recently, Asselot et al (2024) broaden the way to investigate the Cant evolution in the ocean by demonstrating the possibility of inferring Cant concentration by combining Argo-O₂ data with neural networks (Bittig et al., 2018, Carter et al., 2021) and the back-calculation method (Pérez et al., 2008). Taking advantage of the noticeable spatial coverage over the entire NA basin (i.e. almost 580 Argo floats measuring oxygen were or are still active over the entire Atlantic Ocean), Argo-based Cant estimates represent a valuable opportunity to extend our understanding of the Cant estimates and changes in between ship-based measurements in the region as these tools are able to capture changes while rapid circulation events or submesoscale processes are occurring.

Particularly, the purpose of the study we would like to conduct focuses on the determination of the spatial and temporal evolution of the Cant inventory in the NA region, with a focus on what waters/floats are doing that start outside the region and move into the region and how their carbon signals change over time in response to physical processes (deep water formation, stratification, etc.). The Lagrangian aspect of the Argo data as well as the high temporal resolution associated with the Argo data make them a relevant tool to answer this question. Using Argo data (temperature, salinity, and oxygen), we will (i) derive the Cant concentrations using machine learning tools and create a new Cant Argo-O₂-based derived data product, trying to reduce the associated uncertainties, (ii) analyse the Cant-derived inventory and compare it against the literature, evaluating the potential differences with the previous indirect techniques and (iii) investigate the relationship between the ocean dynamics and Cant evolution over time and space. At a later stage, other data products such as GOBAI or MOBO-DIC could be also explored, while Argo- based Cant estimates will be used as a benchmark to identify smaller temporal changes via other datasets.

ESPACE – Projet IDUL - Interdisciplinary Study of Coastal Urban Identity - A.Schleyer-Lindenmann

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This internship application concerns research in the human and social sciences (geography/psychology) on the issue of coastal urban identity. The work envisaged is in line with the Institute's Challenge 1 (adapting to climate change) and Challenge 4 (alternative socio-economic development paths and blue growth).

Research question

In the context of climate change in the Mediterranean, coastal towns need to redefine their relationship with the sea and the maritime development options available. This redefinition must also take into account the attitudes of the inhabitants of the cities concerned. We are looking at three major coastal cities (Marseille, Toulon and Nice), where little is known at this stage about the attitudes and identification of the inhabitants with their coastal environment. Our research questions are therefore as follows: Does the coastline play a role in defining the personal relationship with the city?

If this coastal dimension is important for the perceived urban identity, does it result in a differentiated positioning with regard to the desired future of the city's maritime environment?

Study approach and research methodology

We propose to adapt to the specific case of coastal cities a methodology proposed by Belanche et al. (2017) around the issue of urban identity.

1. Characterisation of the three cities (Marseille, Nice, Toulon) in their historical, cultural, political, environmental, social and coastal dimensions. The methodology used will be based on territorial indicators and social representations as reflected in Instagram publications bearing the cities' official hashtags.
2. Three empirical surveys of residents to test two questions: To what extent do these different dimensions contribute to the perceived urban identity? In addition to the prescribed urban dimensions, we hypothesise that different variables such as age, social class, the area in which the respondents live or their use of the sea have an impact on their perceived identity, and will therefore be included in the survey. To what extent do these perceived urban identities influence attitudes to the future of the sea? In other words, what future for the sea (economic, ecological, etc.) do respondents consider desirable or undesirable? Here we can use the 'future of the sea' measure already tested in previous research (Robert et al., 2022).

Schedule

During the six-month internship, the intern will carry out the characterisation of the three cities, the empirical studies in Marseille and Toulon, and the data processing and analysis. We are actively seeking funding for a second internship, which will cover the empirical study and its processing in Nice. The interns will be jointly supervised by Carine Fournier (geography) and Alexandra Schleyer-Lindenmann (psychology).

CERIC/TELEMME – Marine Protected Areas and Climate Change (AMPCC); part of the PROTEUS programme funded by AMIDEX

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Marine protected areas (MPAs) have been widely studied and promoted as tools for mitigating the effects of climate change, while at the same time facilitating the adaptation of coastal populations. By acting as 'sentinel' sites, MPAs are seen as 'nature-based solutions'. However, the role of MPAs largely depends on their effectiveness in practice and their resilience. When MPAs fail to fulfil their conservation role, this potential 'solution' becomes an illusion. MPAs are themselves faced with the effects of climate change, such as rising sea levels and temperatures, changes in species distribution, acidification and invasive species. These factors can be addressed by the human and social sciences, in particular by asking how the uncertainty of the effects of climate change can be taken into account in decision-making related to MPAs and biodiversity conservation, at all scales.

The proposed internship will take a legal and/or geographical approach to studying the relationship between MPAs and climate change, with a particular focus on one case study: the Port Cros National Park. The trainee will attempt to answer various questions that will be progressively refined:

Are the effects of climate change taken into account in the regulations and governance of an MPA, and if so, how?
What practical tools can be used to integrate climate issues into the management of an MPA (in terms of mitigation, anticipation and adaptation)?
How is the uncertainty generated by climate change incorporated into conservation decision-making?

In order to provide answers to these questions, the trainee will first carry out a fairly general bibliographical analysis in order to establish an initial theoretical state of the art on these issues. He/she will then study all the regulatory and management documents for the Port Cros National Park. Finally, it will be necessary to question certain members of the management organisations of this MPA (agents of this Scientific Council) on the various points mentioned and also on their vision of the future, in relation to climate change. If time permits, the research could be extended to include a study of other MPAs such as the Pelagos sanctuary or the Calanques national park, in order to compare the way in which these different MPAs are dealing with these uncertainties and adapting to climate change.

LMA – ultrasound mapping of a coral microatoll

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The global rise in sea and ocean levels as a result of climate change poses numerous threats to the world's population, particularly in coastal regions. The accumulation of data on sea level is vital for a better assessment of climate disruption, but given the spatially heterogeneous variations, it is necessary to acquire data on a global scale. The study of the growth of coral microatolls (Figure 1), which act as natural tide gauges, meets this need by providing a unique insight into relative fluctuations in sea level with centimetre-level accuracy. However, in order to study a microatoll, it is necessary to sample it using a hydraulic saw, so as to obtain a slice on which it is possible to identify, in the laboratory, after fine cutting by a marble cutter and obtaining X-ray images from medical scanners (figure 2), growth anomalies, markers of relative sea level fluctuations. This method involves complex and time-consuming logistics, and above all generates stress for the coral colony and the flora and fauna living nearby. This also implies the death of the part of the colony removed. There is therefore a great interest today in proposing alternative examination techniques that are non-destructive, in situ, and that would keep sampling and cutting to a minimum. One of the methods being considered is ultrasound imaging, which involves viewing the inside of a microatoll in the same way as a medical ultrasound scan. Initial imaging tests (Figure 3) of the subsurface of a microatoll slice have been carried out using configurations at 500 kHz and 1 MHz, demonstrating the performance of the acoustic method but also its limitations, which need to be understood and corrected.

It is in this context that the project is proposed. The work is broken down into 2 complementary actions.

Stage 1: To understand the physical phenomena involved when an acoustic wave propagates in a coral microatoll, a numerical model has been developed¹ (2023-2024 internship) using ComsolTM multiphysics, which reproduces the signals observed. The development of this numerical simulation tool will be continued as part of this new internship, by adapting a new geometry of geometry and new acoustic parameters.

Stage 2: In parallel, and as for the first study², parallel experimental tests will be carried out on a microatoll slice at scale 1 using an ultrasound scanner (11 d.d.l.) and a³ X microtomograph. The aim is to produce B-mode ultrasound mappings of the microatoll and compare it with its reference X-ray image.

This work will be based on an initial detailed bibliographical study, the development of a numerical simulation tool and the implementation of ultrasound experiments. Depending on the results obtained, a paper will be presented at a conference and an article published in a peer-reviewed journal.