Join the Institute for Energy Transition
dedicated to research and innovation for offshore wind

Master's/Engineering Internship - Climate change and ocean extremes: what projections for offshore wind and aquaculture? (F/M/X)

Are you looking for an internship in a human-sized structure, where innovation, benevolence and team spirit are at the heart of the projects? France Energies Marines offers you the opportunity to contribute to applied research, recognized by the sector's players and directly related to the challenges of the energy transition. Join us to actively participate in the development of a booming industrial sector... and build the world of tomorrow together!

The France Energies Marines Institute

France Energies Marines is a research and innovation centre for offshore wind power with an industrial, economic and societal impact recognised in France and internationally.

Its mission? To remove the obstacles facing the offshore wind sector. Supported by the State, supported by a multidisciplinary team of more than 90 employees, a network of international experts and unique infrastructures, the Institute conducts multi-partner research projects guided by excellence.

The resulting results are transferred to the industry in the form of research and expertise, operating licences, transfer of know-how, as well as participation in expert committees and networks.

These activities are structured around four complementary departments: Wind and Ocean Dynamics, Systems and Performance, Biodiversity and Interactions, Ecosystem and Society. Cross-functional services support these activities.

Background

Offshore wind farms are designed to operate for several decades but are generally sized based on the ocean conditions observed in the past. However, climate change is changing the ocean: sea level rise, warming of waters and reinforcement of stratification, evolution of circulation and currents (Fox-Kemper *et al.*, 2021). These parameters are involved in the design and operation of wind farms: waves and currents for hydrodynamic loads and scour, temperature and salinity for corrosion, biological colonization of structures or heating of cables. In addition, coastal areas, where other uses such as aquaculture are concentrated, are increasingly exposed to extreme events such as marine heat waves, which correspond to prolonged episodes of abnormally high ocean temperatures (Hobday *et al.*, 2016, Oliver *et al.*, 2018). These extremes can have a strong impact on aquaculture sites and production (Smith *et al.*, 2021).

In order to adapt these coastal socio-economic sectors vulnerable to climate change, it is necessary to anticipate these changes and to characterize not only the average trends, but also the evolution of extreme events at spatial scales adapted to the sites studied. Climate projections, in particular those from the CMIP6 exercise (Coupled Model Intercomparison Project Phase 6, Eyring *et al.*, 2016) used in IPCC reports, are an essential source of information on future climate change. However, their low spatial resolution and simplified representation of some sub-grid ocean processes limit their ability to accurately describe local conditions, especially in coastal areas (Holt et *al.*, 2017). Higher-resolution regional simulations, obtained by dynamic downscaling, allow these climate projections to be refined at a local scale, but they have a high numerical cost and are therefore only available for a limited number of configurations that do not allow for the systematic quantification of all sources of uncertainty. Statistical downscaling, which relies on statistical learning of the relationship between the large and local scales from different simulation datasets, including reanalyses and observations, is a much less expensive alternative (Hobeichi *et al.*, 2023), but whose performance has so far been relatively poorly evaluated for oceanic variables and their extremes. The respective merits of these two approaches to describe oceanic extremes in littoral zones therefore remain to be established.

In this context, this internship will aim to answer two scientific questions:

- How will temperature, salinity, and current conditions evolve on a local scale on the French coast in a context of climate change? With what uncertainties?
- To what extent do statistical methods improve ocean climate projections at the coastal scale, and how do they compare to dynamic approaches to representing future trends and extreme events?

Supported by France Energies Marines, the internship offered is part of two research projects:

- 2C MORE, led by France Energies Marines, which aims to assess the impacts of climate change on offshore wind power;
- ExTempCO, led by the CNRS at the Laboratory of Physical and Space Oceanography as part of the France 2030 Climate – TRACCS programme, is dedicated to the study of marine heatwaves in coastal areas with an application to aquaculture.

The internship will focus on the analysis and improvement of ocean climate projections at the local scale for the adaptation of the coastal socio-economic sectors concerned. The study variables will focus on temperature, currents and salinity. The work will be based on existing Python processing chains, developed within the teams and their partners, which the intern will take over, adapt and complete.

Description of the internship

The internship will take place in two parts. **The first part**, which is mainly applicative, will consist of analysing the available climate projections and characterising future changes in ocean variables. It will include the following steps:

- **Explore climate datasets** with Python: CMIP6 projections, Copernicus products (C3S: Copernicus Climate Change Service, CMEMS: Copernicus Marine Service), high-resolution simulations from related projects: SEACLIM, MEDIATION, RiOMar.
- **Analyze future changes** in temperature, currents and salinity at sites of interest (wind farms, aquaculture sites), for several climate scenarios and time horizons, and identify trends and sources of uncertainty.
- **Interpret and promote the results** within the two projects: production of maps and indicators characterizing ocean conditions and their evolution (percentiles, threshold exceedances, frequency and duration of extreme events, etc.), writing of a summary for a scientific and technical audience and preparation of presentation materials. Depending on the results obtained, this work may contribute to a scientific publication.

The second part, more exploratory, will consist of studying the contribution of statistical methods to the climate projection of oceanic variables and their extremes at the local scale and will be based on the following steps:

- **Implement statistical downscaling methods**, based on existing algorithms. To do this, different statistical methods will be formulated as supervised learning problems, ranging from simple linear univariate methods to more complex, multivariate or non-linear methods, notably based on artificial neural networks (Bürger *et al.*, 2012 ; Legasa *et al.*, 2023).
- **Evaluate the performance of these methods** by comparing them to dynamic downscaling simulations, including their ability to correctly represent nearshore extremes, in order to establish the inputs, limitations, and cost of each approach.
- **Interpret and promote the results** with the experts of the two projects: writing a summary for a scientific and technical audience, presentation materials, possible contribution to a publication.

Quality scientific supervision will be offered in close collaboration between France Energies Marines and the Laboratoire d'Océanographie Physique et Spatiale (CNRS). Collaborations are also planned with the Laboratoire des Sciences du Climat et de l'Environnement (CNRS) on the second part of the internship. The intern will work in two consortia and will have the opportunity to contribute to scientific publications or communications. This internship will develop skills in climate and ocean data analysis, scientific programming, statistical methods, assessment of climate uncertainties, and production of decision support indicators for marine renewable energies and aquaculture.

Profile and skills

Initial training

Final year of engineering school or Master's 2, with a specialization in oceanography, meteorology, climate, applied mathematics, statistics, machine learning or equivalent

Specific knowledge

- Physical Oceanography and Climate
- Scientific Programming (Python)
- Processing large datasets

The +:

Knowledge of statistics, machine learning, downscaling or bias correction, experience with Pandas, Xarray and Dask libraries, as well as an interest in marine renewable energies and coastal ecosystems would be a plus

Professional qualities

- Scientific rigour and organization
- Analytical and synthesis skills
- Autonomy
- Scientific curiosity
- Communication skills
- Collaborative spirit

Practical information

Type of contract	Internship
Duration	6 months
Internship allowance	€960 gross monthly (Bac +5 level)
Place of work	Headquarters of France Energies Marines - Plouzané (29)
Start date	01/02/2027 (flexible)
Application Deadline	20/11/2026

In accordance with the regulations, with equal skills, priority will be given to people with disabilities.

Application procedure

- Applications must consist of a **CV** and a **cover letter.**
- To apply, go to the France Energies Marines website in the **Join us section**.

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