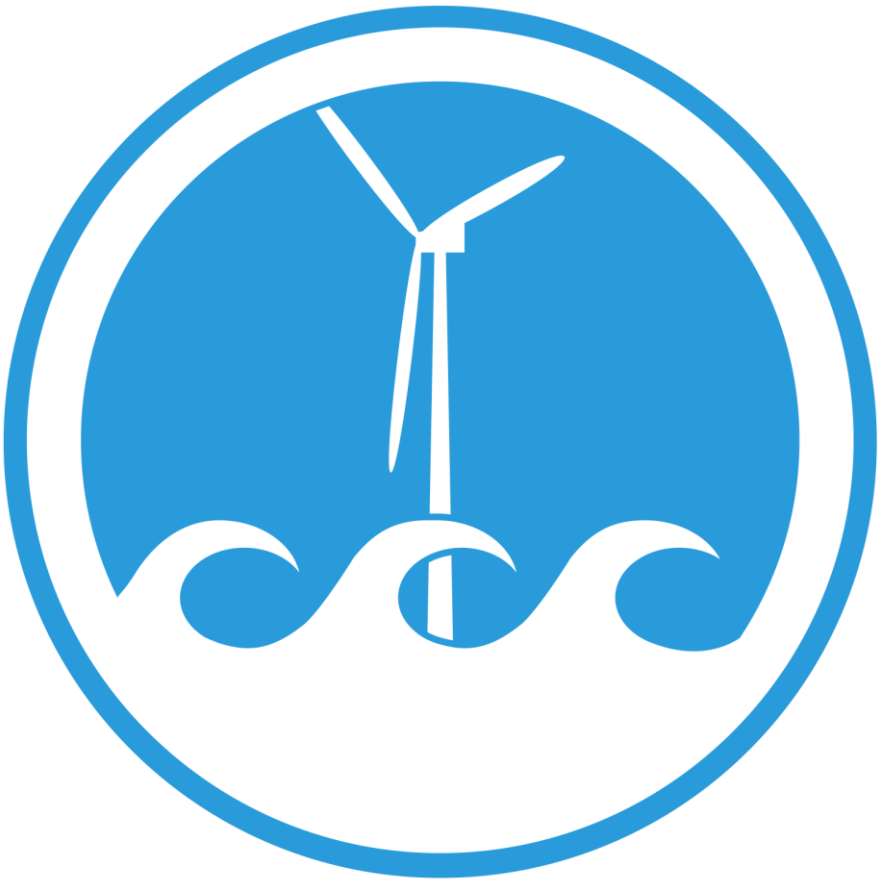

axis 7

Sea motions and interactions with marine structures

LabexMER Research project	**2016-2019 axis 7 roadmap**	**January 2016**

Sea motions and interactions with marine structures

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List of participating laboratories:

- LHEEA (Laboratoire de recherche en Hydrodynamique, Énergétique et Environnement Atmosphérique), Ecole Centrale Nantes
- LOPS - UMR 6523 (Laboratoire d'Océanographie Physique et Spatiale), Ifremer, UBO, CNRS/INSU, IRD
- LCSM (Laboratoire Comportement des Structures en Mer), RDT, Ifremer

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1. Scientific context, scientific questions

At small scales typically less than a kilometer, the motions of the oceans are mainly driven by sea states. Given the high economical and societal stakes at sea, it is essential to understand their interactions with natural systems or artificial structures such as vessels, platforms, marine renewable energy converters, dams, cliffs, etc as well as their evolution and properties from small wave/structure interactions scales to large geophysical scales.

Long sought goals refer to the ability to produce reliable numerical simulations for air, sea and structure interactions, for typical lengths of processes ranging from few centimeters to kilometers. Efforts will be pushed toward the transfer from those small-scale simulations to large scale modeling, including oceanic circulation and meteo-oceanic prospects.

For the second phase of LabexMER, research fellows in the axis 7 will pursue the efforts engaged during phase one on its three main themes and completed for phase two by four themes at the interface of the fields of interest for research teams in the axis. All seven themes are directly related to the understanding, measurement and forecast of sea states and/or of their interactions with structures.

Those themes are listed below:

1. dissipation rates
2. pressure waves related to sea states
3. generation, evolution and climatology of infra-gravity waves
4. atmospheric flows and their coupling with conditions at free surface
5. sea states and interactions with floating clusters
6. hydrodynamic conditions for Marine Energy Devices
7. deterministic prediction of sea states

Each theme of interest will benefit from the convergence of competences and capabilities in the context of axis 7.

2. OBJECTIVES FOR THE NEXT FOUR YEARS AND SPECIFIC ACTIONS

2.1. SCIENTIFIC OBJECTIVES

Phase 1 of LabexMER has paved the way for new investigations of ground topics and scientific bottlenecks by novel joint efforts and from different points of view. This axis provides the meeting point of several fields of expertise: from global scales approaches and measurements to the local wave mechanics.

Those future investigations envisioned for LabexMER phase two fall within the three former main themes now strengthened, and four new emerging themes:

1. Dissipation rates

   Following latest developments on the estimation of swell dissipation across oceanic basins, the same approach is envisioned for an application to swell travelling underneath ice fields. The determination of dissipation rates associated to white capping is an ongoing task between partners (co-funded PhD thesis of Pedro Veras-Guimaraes). The application of stereovideo data set to the time evolution and associated energy budget and spectral signature for whitecapping waves, coupled to appropriate numerical modeling is foreseen to provide insight in the underlying physics.

2. Pressure waves related to sea states

   The use of long time series of acoustic power records in the band 0.2 to 3Hz at large depth in the oceans would be able to provide a great substitute to more usual wave records for the high frequency part of the spectrum and the energy balance associated in the tail of the wave spectrum. Those new types of measurements combined with surface acoustic-gravity waves could provide a direct link of the directional wave spectrum to the associated acoustic power.

3. Generation, evolution and climatology of infra-gravity waves

   The work conducted during phase one of the LabexMER on the processes related to the infra gravity part of the water surface displacement has emphasized the unforeseen intensity of the signal to oceanic scales and its consequences on various geophysical signals (e.g. pressure, seismic data). During phase two, the work in this theme is due to be strengthened in all stages of evolution for IG waves, their exploitation in various records, and the knowledge inferred about sea states. Influence of IG waves on the response of marine structures or in the domain of coastal engineering will also be investigated.

4. Atmospheric flows and their coupling with conditions at free surface

   the proper description of the properties in the atmospheric boundary layer over the oceanic surface is a central concern from geophysical to engineering applications. From the proper description of the flux at free surface for meteo-oceanic concerns to the appropriate knowledge of the potential of energy to be harvested in off-shore wind farms, the effects of waves, currents or heat transfer over oceanic domains is planned to be investigated.

5. Sea states and interactions with floating clusters

Floating cluster of natural or artificial structures raise some novel questions about the proper treatment of the hydrodynamic problem, for instance in terms of wave dissipation and transmission in marginal ice zones, wave interactions in arrays of marine renewable energy (MRE) converters and their impact on the wave climate at regional scale. The processes, methods, tools and parameterizations of the physics for large-scale applications are the key concerns in this theme.

6. Hydrodynamic conditions for Marine Energy Devices

   Harvesting energy from marine energy sources brings structures, devices or vessels in novel operating conditions. This raises some new questions related to the operability at sea and its forecast or the appropriate description of the environment from which energy is to be extracted. Downscaling the description of the hydrodynamic forcing conditions from the geophysical scales to the scale of a structure, refining the characterisation of the physics involved is then one of the challenges of this theme.

7. Deterministic prediction of sea states

   Short term deterministic prediction of the sea surface, interacting with an energy converter or an operating vessel is seen as a key new capability able to enhance power production or to reduce the cost for marine operations. Several actions are envisioned under this theme from the data processing from appropriate sensors to the propagation of an up-wave data to a target area.

2.2. INTERDISCIPLINARITY AND SYNERGIES BETWEEN TEAMS

This axis addresses the multi-scale processes related to the physics of sea states and the induced interaction with structures at sea. Thus, spanning from geophysical to structural scales, it strongly bounds research teams from earth sciences to engineering sciences. Within this context, Axis 7 is for instance involved with Axis 5 on a joint project for the description of morphodynamics and hydrodynamics of rocky cliffs under strong stormy conditions.
Moreover, the scientific questions to be harvested are listed as bottlenecks; this is meant to enhance the visibility of the work scheduled.

2.3. INTERNATIONAL VISIBILITY

Axis 7 is in line with Labex's general purpose: "investigate new and ambitious research projects". Axis 7 carries investigations of ground topics and scientific bottlenecks by novel joint efforts and from different points of view, at the meeting point of several fields of expertise: from global scales approaches and measurements to the local wave mechanics.

Its international recognition is achieved through:

- High level publications in the field,
- High level workshops and short courses on topics and tools undertaken,
- International mobility (talks, short stays, etc.).

2.4. LEVERAGING EFFECT

The 3 three original main themes developed in phase one and the four additional ones for phase 2 are all integrated in the prospective of each laboratory involved in axis 7.

The themes are then linked to ongoing, as well as submitted and to-be-submitted projects:

- National ANR projects (PREDEMONAV, THYMOTE, …), regional calls from (Region Bretagne, Region Pays de la Loire),
- Investment for the future initiatives (IRT Jules Verne, France Energies Marines, SEMREV,…)
- International projects (FP7 SWARP, FP7 FLOATGEN, ONR,…)

2.5. GOVERNANCE

Over the first phase of LabexMER, the axis 7 has been easily structured around a small number of permanent research scientists from LHEEA (ECN-CNRS) and LOS and LPO (IFREMER-CNRS), both represented to date by A. Babarit and F. Ardhuin, for Nantes and Brest sites respectively. On daily basis, the help of a research engineer (Y. Pérignon, supported by LabexMER and ECN) has proven to be highly valuable. With the association of LCSM (IFREMER) during first phase, axis 7 has been able to delegate governance when necessary.

With the initial small and now increasing number of permanent scientist implied in the Axis 7 efforts, it has been decided to maintain a structuration as soft as possible, with regular workshops for the axis and open and collegiate discussions on the need and goals to be achieved. Projects can be proposed on the flow, which has been preferred to fixed terms calls for projects. The only requirement is that the projects must address a topic at the frontier between the labs involved in axis 7.

3. ANSWERS TO CSI RECOMMANDATIONS

The International Scientific Council advised our axis to follow the path that was proposed. Thus, the axis will carry on with the proposed work plan.

4. IMPLEMENTATION PLAN AND RESOURCES

The general strategy of the axis 7 is to provide mainly human resource for research actions from the LabexMER yearly grant.