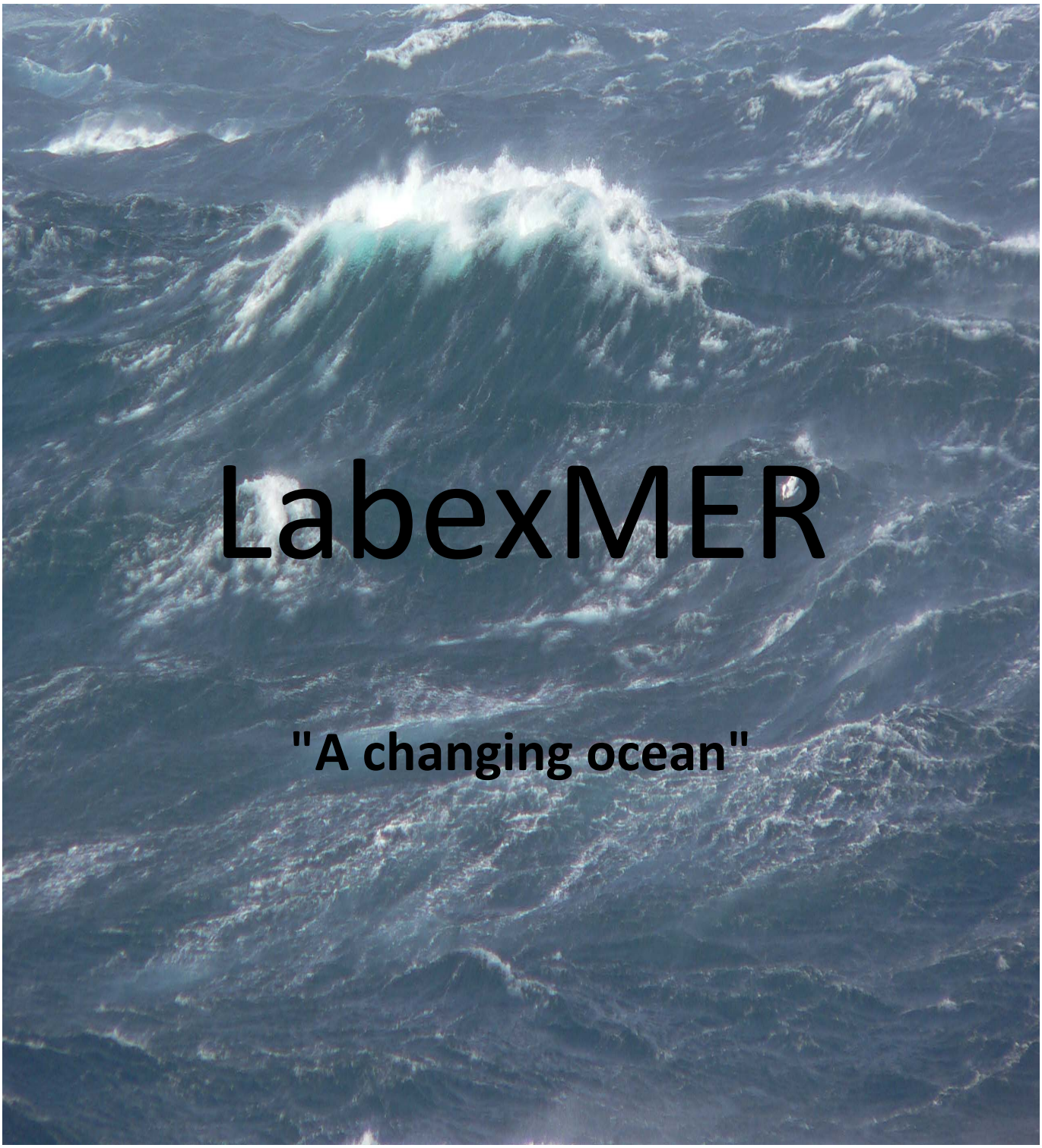

LabexMER

"A changing ocean"

LabexMER - Axis 7	**Research project 2012-2014**	**16/02/2012**

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1. AXIS 7 : SEA MOTIONS AND INTERACTIONS WITH MARINE STRUCTURES

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List of participating laboratories:

- Laboratoire de recherche en Hydrodynamique, Energétique et Environnement Atmosphérique, Ecole Centrale de Nantes
- Laboratoire d'Océanographie Spatiale, Ifremer, Brest

Associated laboratory:

- Unité Recherches et Developpements Technologiques - Hydrodynamique Océanique, Ifremer, Brest

1.1. SCIENTIFIC CONTEXT, QUESTIONS, AND 10-YEARS VISION

At small scales typically less than a kilometer, the motion of the oceans is mainly accounted by sea states. Their interactions are predominant with any natural system or artificial structure such as vessels, platforms, marine renewable energy converters, dams or piers, etc. The high stakes at play in term of economic and human impact imply to properly assess and understand the role of processes from small hydrodynamical to geophysical scales.
Long sought goals refer to the ability to produce reliable numerical simulations for air, sea and solid interactions, for typical length 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 now, research fellows in the axis 7 have emphasized five innovative themes at the crossing of their respective domains of competences and interests. All five are directly related to the understanding, measurement and forecast of sea states. Those themes are listed below:

1. dissipation rates
2. pressure waves related to wave breaking
3. generation, evolution and climatology of infra-gravity waves
4. breaking probabilities
5. short term deterministic prediction

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

Research partners have then chosen to specifically focus their efforts on the first three themes, seen as major themes for the next three years.

1.2. OBJECTIVES FOR THE NEXT THREE YEARS AND SPECIFIC ACTIONS

1.2.1. THEME N°1: DISSIPATION

A better knowledge and understanding of the dissipation rates of energy in various phases of evolution for water waves seems to currently remain a fundamental challenge. Two main distinct questions are raised into this theme:

- *Dissipation rates in a breaking wave, and its spectral signature*

Latest findings in the field of hydrodynamic simulations by Smoothed Particles Hydrodynamics (SPH hereinafter) methods seem to enable to capture properly some of the main processes at stake during strong wave breaking events. This new capabilities could be useful for the specific purpose of

evaluating partial dissipation of energy for white-capping breakers. Such findings have remained unaccessible to this date, and the new SPH modeling approach could prove itself a valuable tool together with other deterministic simulations of pre-breaking waves. Coupling between High Order Spectral potential method and SPH simulations seems able to provide a promising basis for the upcoming researches on this question. Numerical as well as experimental (indoor wave pool and offshore site) facilities from the research partners will be valuable to address this question.

- *Dissipation rates at the air-sea interface, accounted by viscous shear and turbulence*

The shear and/or atmospheric turbulence due to swell propagating in no to low wind conditions seem to remain some of the key processes not properly quantified to this day. Those locally weak processes could still be responsible for the decay of swells propagating across oceanic basins. Small scales Navier-Stokes simulations with proper accounting of the turbulent closure could provide efficient tools for the characterization of the momentum transfers from ocean to atmospheric boundary layer. This theme is at the meeting point of various capabilities in the teams of axis 7, from spaceborn observation of the ocean to accurate modeling of the hydrodynamic, including large scale simulations of the evolution of wave fields. Experimental facilities will as well be shown useful for this question.

1.2.2. THEME N°2: WAVE BREAKING AND PRESSURE WAVES

Underwater acoustics offer unique monitoring capabilities. Noise at ultra-low frequencies (below 50 Hz) have been linked to the sea surface roughness properties via the double-frequency effect demonstrated by Longuet-Higgins (1950). The possible contribution of breaking waves to this signal may be the source of important errors in the interpretation of bottom pressure signals in terms of directional wave properties (e.g. Farrell and Munk 2009). Compressible CFD capabilities with the simulation of breaking waves will be used to help in the interpretation of these signals.

1.2.3. THEME N°3: INFRAGRAVITY WAVES

Waves with periods between 25 s and 10 minutes have poorly known properties that limit the design of platforms at sea and also the design of the next generation of satellite altimeters. Key issues are the coastal amplification of these waves and their reflection to the open ocean, but also the mechanical response of moored systems to these low-frequency excitations.

The planned work will involve the development of numerical modelling capabilities for the generation of a global (IG) climatology, providing frequency-directional IG spectra. In parallel, theoretical and application work will be performed to be able to use such modeled or observed spectra to specify the response of moored systems.

1.3. DETAILED IMPLEMENTATION PLAN AND RESOURCES

The allocated resources are planned to finance one post-doc per year plus additional expense. The post doc will directly be attributed among the three major theme of interest, as stated above and in accordance with the scientific partners of the axis. Travel, consumables and small equipments funding are taken into account for this part.

In addition, Ecole Centrale de Nantes has already engaged one post-doc funding for 2012 for the theme n°1 “Dissipation”. This should be continued in 2013. Such a post-doctoral support for the theme 3 (infra-gravity waves) is expected for 2014.