labex MER

axis 7

"Sea motions and interactions with marine structures"

SCIENTIFIC CONTEXT

Surface gravity waves generally dominate in oceanic motions of scales under 1 kilometer. These are the scales of man-made or natural structures, from ships and platforms to windmills, coastal structures, or ice floes. Driven by high economical and societal stakes, our research partnership focuses on the understanding of interactions between waves and natural systems or artificial structures. We build on several fields of expertise (fluid and solid mechanics, statistics, physical oceanography, meteorology) in order to produce new understanding on physical processes, and reliable numerical methods and simulations for air-sea-structure interactions, at scales ranging from few centimeters to hundreds of kilometers.

Keywords

- Sea states
- Waves
- Hydrodynamics
- Marine renewable energies
- Geophysics

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ROADMAP

The future investigations envisioned for LabexMER Phase 2 build upon the three main themes of Phase 1, and four new emerging themes identified as areas of opportunities with great potential impacts.

- Wave dissipation rates

These rates are a key parameter for the proper estimation of wave growth and decay in various stages of their life, from swell dissipation across oceanic basins and across the marginal ice zone, to the determination of dissipation rates associated to whitecapping.

- Pressure waves related to sea states

More and more long time series of acoustic power are acquired at the bottom of the ocean for solid Earth studies. These contain wave-induced signals at 0.1 to 3Hz that are uniquely related to the poorly known high frequency part of the wave spectrum and the associated energy balance.

- Generation, evolution and climatology of infra-gravity waves

The work conducted during phase one of the LabexMER on the processes related to the infragravity (IG) part of the water surface displacement has emphasized the unforeseen intensity of the signal at oceanic scales and its consequences on various geophysical signals (e.g. pressure, seismic data). There are clear opportunities for further improvement in our understanding of the IG energy balance and development of applications for coastal hazards, and impact on marine structures.

- Atmospheric flows and their coupling with sea states

The proper description of general properties of the atmospheric boundary layer over the oceanic surface is a central concern for geophysical and engineering applications. From air-sea fluxes parameterizations to the complex loading of floating wind turbines and available wind energy, there are many potential geophysical and engineering applications of improved understanding, measurement techniques and numerical methods.

- Sea states and interactions with floating clusters

Floating clusters of natural or artificial structures raise some novel questions about the proper treatment of the hydrodynamic problem. This concerns for instance wave dissipation and transmission in marginal ice zones or wave interactions in arrays of marine renewable energy converters and their impact on the wave climate at regional scale.

- 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/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 characterization of the physics involved is then one of the challenges of this theme.

- 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 research projects are envisioned under this theme from the data processing from appropriate sensors to the real time propagation of an upstream-wave data to a target area.

EXPECTED RESULTS

Our research roadmap will push the frontiers of the state of the art in numerical modeling, observation techniques and related analysis tools for waves and their interactions with man-made or natural structures. These results will be used by our teams and the worldwide research and engineering communities for the hindcast, forecast, design or prediction of the dynamics for the environment and systems. We will particularly encourage applications for marine renewable energy (estimation of resources and support to operations at sea), the understanding of atmosphere-wave-ocean interactions (in partnership with axis 1), and coastal hazards (in partnership with axis 5).