Observation of extreme wave breaking from X-band radar data

Context:
Extreme waves are a major concern of most of the application at sea, from ship security to MRE system design. In this context, the DiMe research project aims at better characterizing the extreme sea states and their breaking properties in the aim of providing the most accurate information for the engineers designing MRE systems such floating wind turbines of wave converters for instance. DiMe is a multi-partners project funded by ANR and France Energies Marines members and partners. Part of the project is focusing on the observations of sea states and their inherent wave breaking properties during storms conditions. To achieve this, a field experiment has been planned between December 2017 and March 2018 on La Jument Lighthouse, located West of Ushant Island in an position extremely exposed to extreme waves as illustrated by the enclosed figure. France Energies Marines will be leading the experiment in collaboration with Cerema, Ifremer, SHOM and the Helmholtz-Zentrum Geesthacht research center. The experiment will feature:
- a stereo-video system deployed at the top of the lighthouse, that will allow for a high fidelity reconstruction of the 3D geometry of the waves and its evolution in time. The area covered represents a few 100m²,
- an X-band radar also deployed from the top of the lighthouse capturing the wave field on a surface of several km², including the measurement area of the stereo-video system,
- a datawell buoy deployed at the outer edge of the X-band radar domain,
- an ADCP in the stereo-video field on view,
- accelerometers in the lighthouse to capture the tower displacements induced by waves.

Internship objective:
The internship will aim at investigating the capabilities of the X-band radar to provide relevant information regarding wave breaking statistics in addition to the stereo-video. Because of the intense sea spray generated by the wave impact on the lighthouse, the stereo-video system will not be operative during the most extreme conditions because of sea spray (see top figure). Therefore we expect that the intern's work will allow the use of the radar backscatter information to explore the wave breaking statistics of the most extreme sea states encounters during the experiment. The intern will start with the reproduction of the analysis conducted by Phillips (JPO 2001) of X-Band radar observations based collected in Kauai. The comparison with the very accurate measurements provided by the stereo-video system provide a unique opportunity to explore Phillips method validity and ideally to come up with improved solutions to capture the breaking statistics. The intern will then collaborate with the DiMe's team to investigate different aspects of the wave breaking process. Especially attention will be drawn on comparing the measured wave breaking statistics to those reported in the literature. Also, the intern will be involved in the validation of the existing
wave breaking statistics and the development of improved formulation, adapted to extreme conditions.

The result of this work is to provide an observation tool and appropriate methodology to observe the wave breaking statistics based only on X-Band radar observations. This will be later employed in the frame of the HYD2M project that fund the current internship. HYD2M is a research project dealing with wave currents interactions modeling in Raz Blanchard for the assessment of the tidal energy resource. In this context wave breaking observations are needed to improve wave model results through the development of wave breaking source terms valid in situations with strong current gradients.

Figure: the X-band radar sensor (left) and an illustration of the sea clutter observed from this instrument (right).

References:

Internship supervision:
The internship will be supervised by J.-F. Filipot (PhD), Scientific Director and in charge of the site characterization research at France Energies Marines. JF Filipot in specialized in sea states modeling and observation with a focus on their wave breaking properties. J. Horstmann and J. Boedewadt from HZG expert in the deployment and exploitation X-band radar data for wave purposes.

Duration and localization:
The internship duration will be 4 to 6 months, with a starting date between early February and early March 2017, depending the candidate availability.
The intern will be hosted at France Energies Marines, located:
15 rue Johannes Kepler
Site du Vernis
Technopôle Brest-Iroise
29200 Brest

Contact:
Jean-François Filipot: jean.francois.filipot@france-energies-marines.org