# Wave breaking analysis using stereo video system


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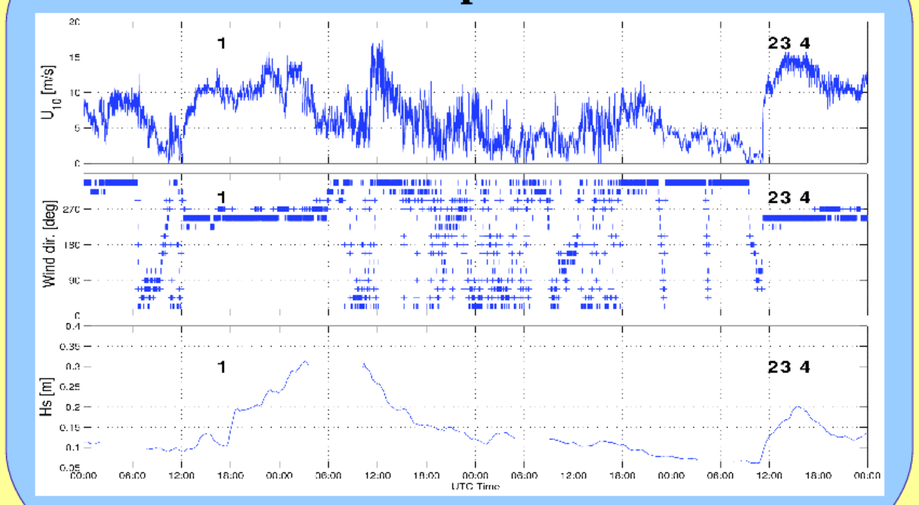
## Introduction :

Images of the ocean surface in the visible range of the electromagnetic spectrum provide quantitative information on a number of physical parameters. Recently, Mironov and Dulov (2008) used video records to analyze wave breaking. Their study provided statistics over a large range of breaking events. On the other hand, Benetazzo et al. (2008) proposed a method to reconstruct the elevation maps of the ocean waves from spatial-widespread and non-intrusive stereo video system. Here we combine these two approaches to provide a full 4-D analysis of breaking.

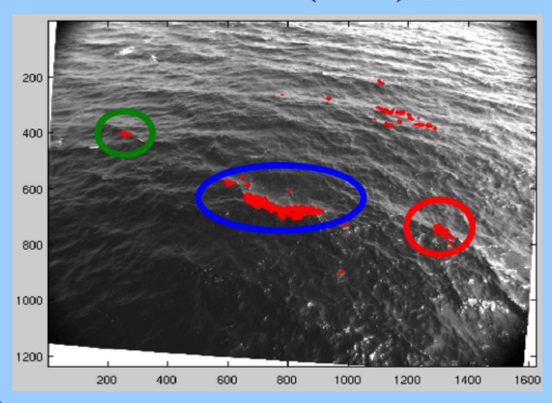
## High definition, high frequency stereo video acquisitions

## Wind and Wave experiment conditions




## Detection of breaking events

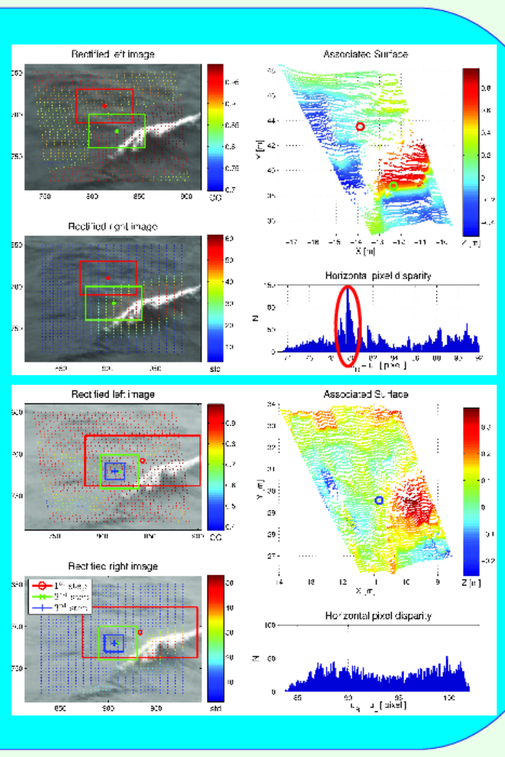
Detection of breaking events on images is done using method of *Mironov and Dulov (2008)* [3].



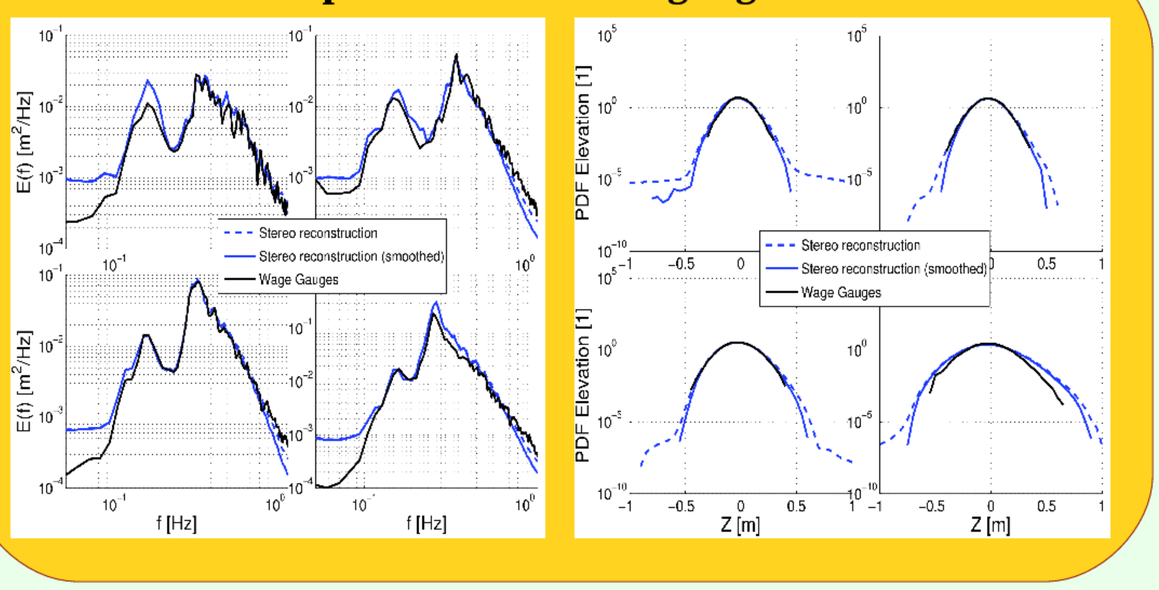
## Sea surface reconstruction by stereo triangulation

### Point matching improvements

Point matching processing used here is greatly inspired from work of *Benetazzo (2006)* [1]. Using cross-correlation, pairs of corresponding points are found, with sub-pixel matching algorithm proposed by *Benetazzo et al. (2012)* [2]. However, this methods fails to detect properly corresponding points around foam patches (upper figure). Method used here was improved to provide better matching (lower figure).



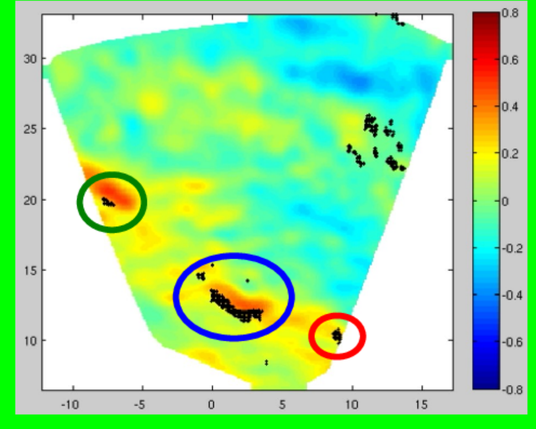

## Comparison with wave gauge data



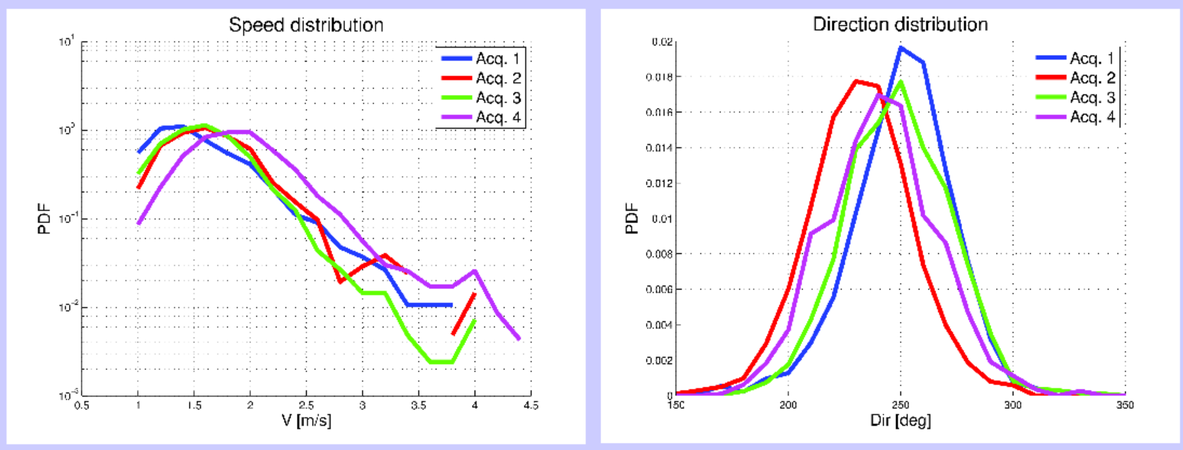

## Analyse of Breaking Events

The four sequences of elevation maps are used to investigate distribution of breaking over wave scales and directions. First, breaking events are detected on images. Reprojected on 3D sea surface, breaking speed and direction are computed.

## Projection on 3D surfaces



## Breaking speed and direction distributions




## Conclusion :

We improved the point matching point method of *Benetazzo (2006)* to reconstruct sea surface in presence of breaking waves. Reconstructed 3D sea surfaces were validated using wave gauges data. Nevertheless, we notice that small swell in first acquisition is badly reconstructed.
Four sequences of elevation maps are then used to investigate distribution of breaking over wave scales and directions. These distributions are in line with previous observations by *Mironov and Dulov (2008)*.

## Perspective :

Evolution of the breaking wave shape will be investigated, in particular the critical slope of the incipient breaking waves. Wave dissipation due to breaking should also be estimated.
Obtained sea surfaces will also be used to analyze directional shape of the wave-number spectrum.

## References


**[1] A. Benetazzo, Measurements of short water waves using stereo matched image sequences, Coastal Engineering, 2006, 53, 1013-1032**
**[2] Benetazzo, A., Fedele, F., Gallego, G., Shih, P. C., & Yezzi, A. (2012). Offshore stereo measurements of gravity waves. Coastal Engineering, 64, 127-138.**
**[3] A. Mironov and V. Dulov, Detection of wave breaking using sea surface video records, Measurement Science and Technology, 2008**