StEPhI
Statistics for Environmental Phenomena and their Interactions

FUTURO IN RICERCA

Observations of storms flooding along a natural sandy beach

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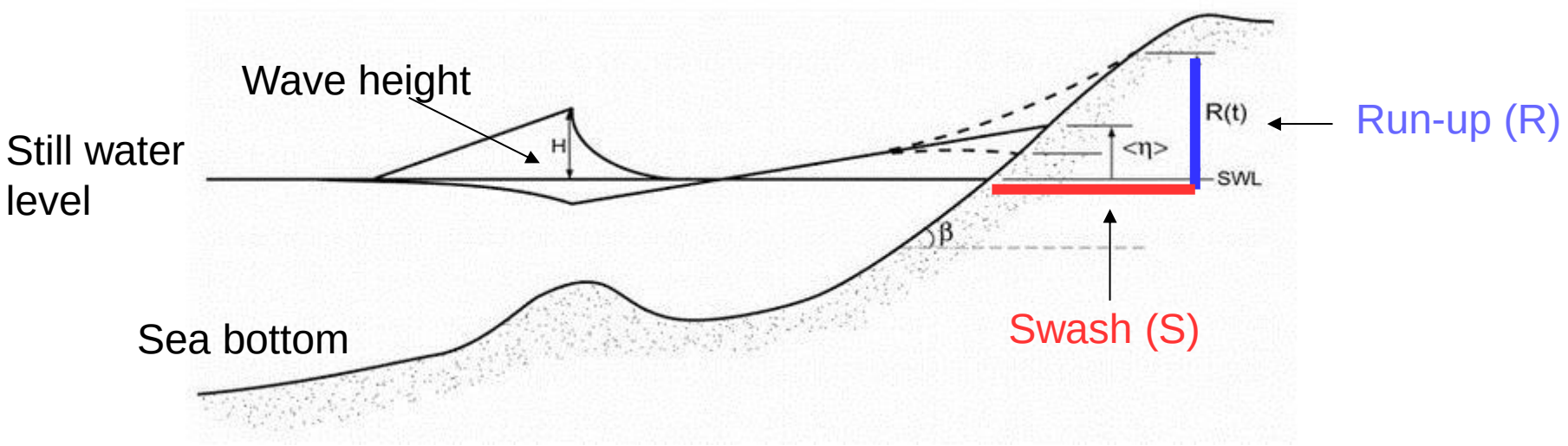
Wave run-up on the beach during storm events



The measurement of R and S is foundamental to plan every restoring or defence action on the beach

The relation between **R** and **S** is linear and it depends on beach sediments and mean beach slope (assumed as time-invariant)

In general, the measurment requires deployment of array of ottic, pressure-induced and electromagnetic sensors on the beach.

The measurement of R and S is complex:

- localized phenomenon
- spatial variability is larger than off-shore sea-states

Wave run-up on the beach during storm events

R and **S** are commonly *simulated* starting from the measurement of off-shore wave heigth (H). However, due to the feedbacks existing between incoming wave height and the sea bottom in the nearshore, the relationship requires calibration

Off-shore wave height : measured along the Italian Coast by 20 Sea Buoys of the National Sea Buoys Network of ISPRA. Radar-sat and other instruments might also be available

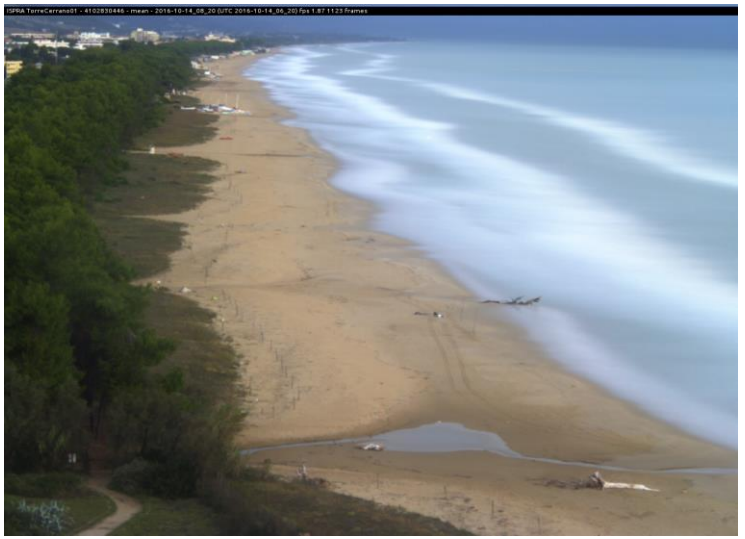
Aim of the present study: use video-monitoring of swash dynamics in order to calibrate numerical simulation of wave run-up on the monitored beach.

Swash zone video-monitoring

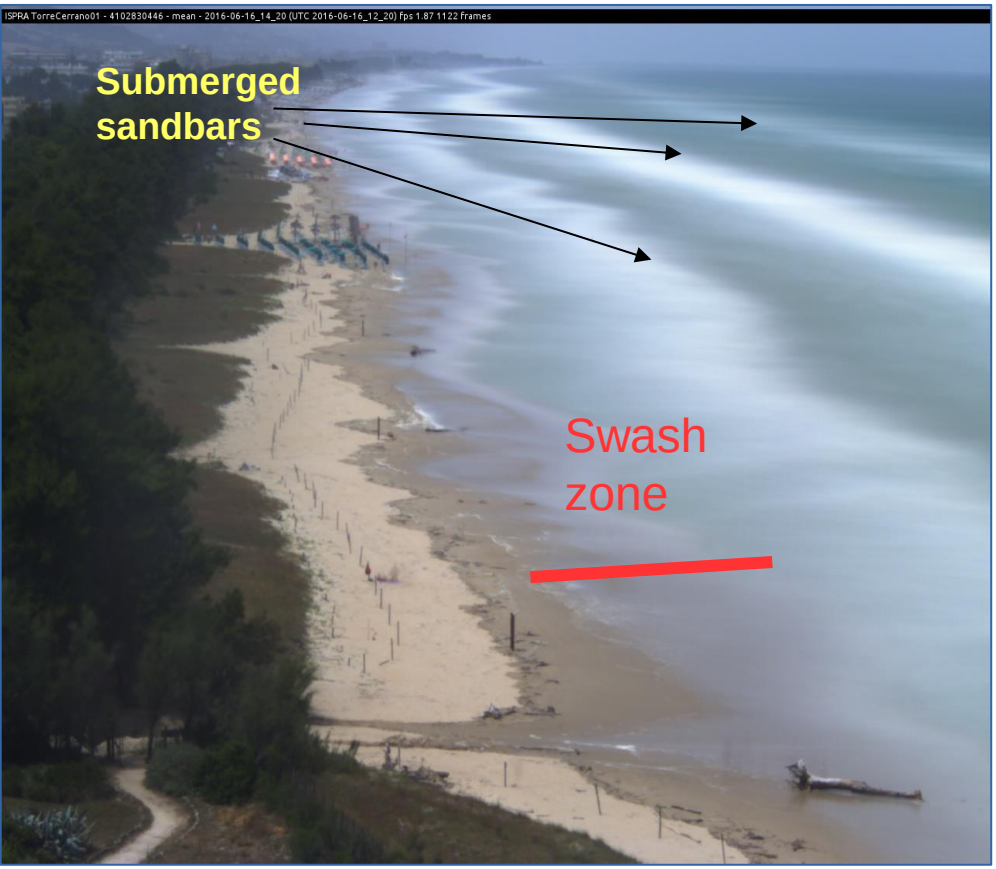
Video-monitoring system: made up by videocameras monitoring the beach and acquiring snapshots of the beach and sea every day-light hour.

Around 900 frames available in 10 minutes.

Intensity averaged image.



Wave run-up, swash and backwash



Wave energy dissipation complets in the **swash zone**, the zone extending from the limit of wave uprush down to the low-tide line and **commonly submerged during storm events**. As a consequence **the width of the swash zone is time variable** and related to the incoming wave field.

Wave run-up and **swash** are driven primarily by the momentum of the wave itself and are moderated by the beach slope and infiltration into the sediments.

The return flow of the backwash is driven primarily by gravitational forces and thus depends on the beach face slope and on the volume of water remaining.

The dynamics in the swash zone are critical to the exchange of sediment between the beach and the nearshore and to the evolution of the beach form in response to changing wave and water level conditions.

Swash zone video-monitoring

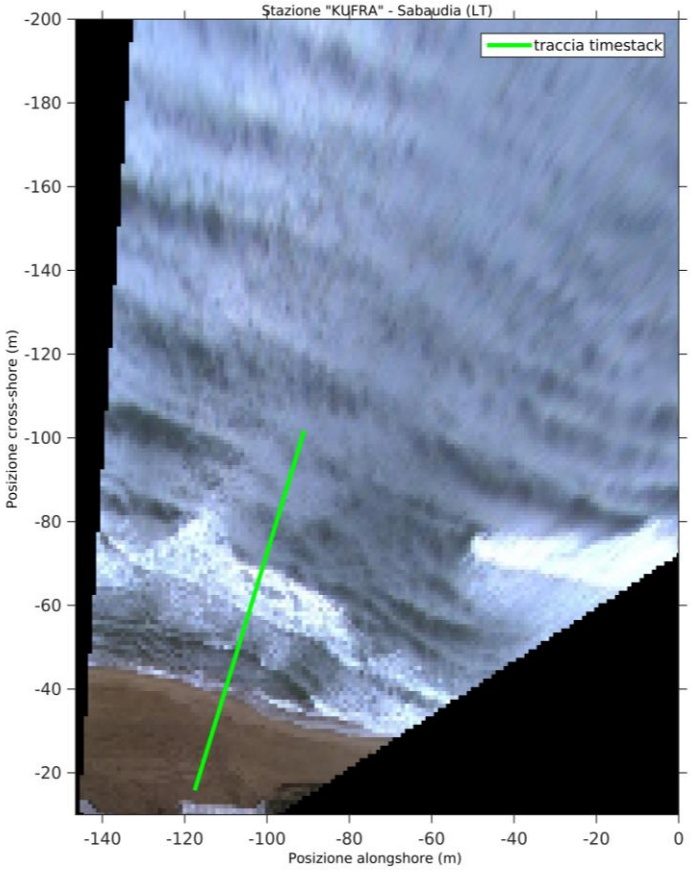


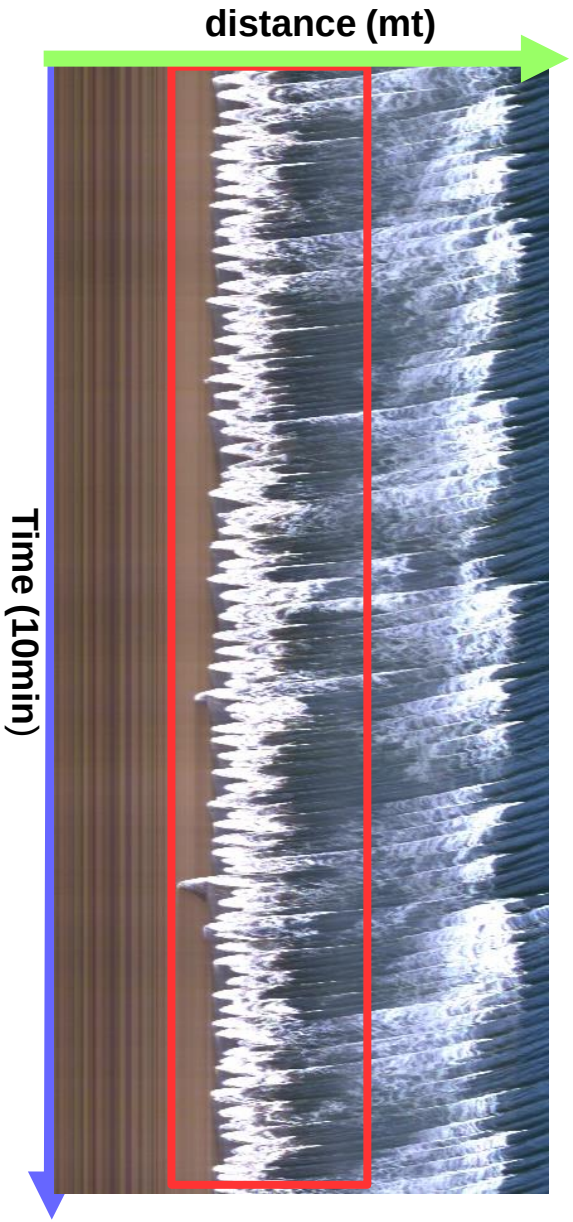
Image processing:

- Image registration (achieved by affine transformation);
- Image enhancement;
- Signal detection

Possible Image features associated with the incoming wave field:

- wave breaking on the beach as a proxy of shoreline position;
- wave breaking on the submerged sandbars as a proxy of nearshore morphology;
- the orientation and wave-length of the wave fronts as a proxy of the wave field in the breakers zone.
- **Timestack images** give further idrodinamical information

Swash zone video-monitoring: Timestack

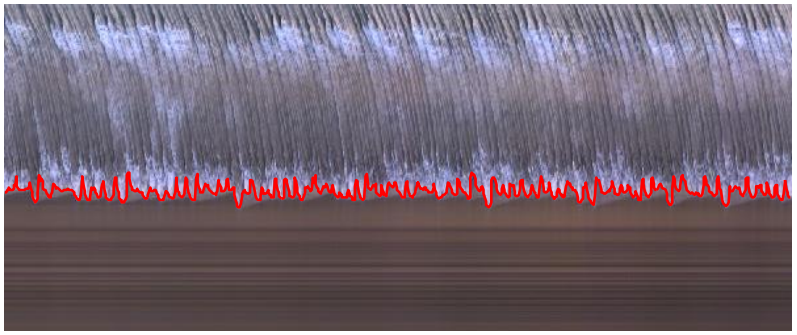


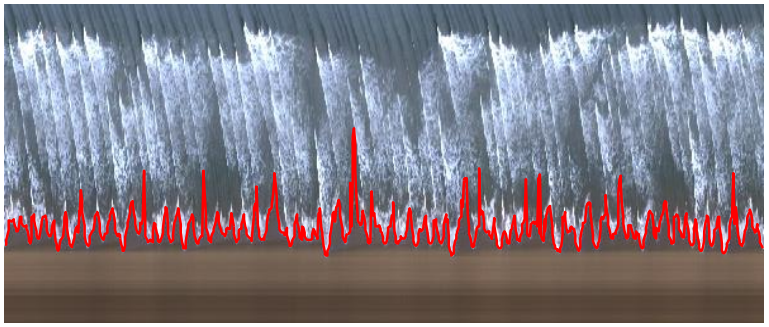
Video-monitoring calls for **high-dimensional data analysis and the management of big data**.

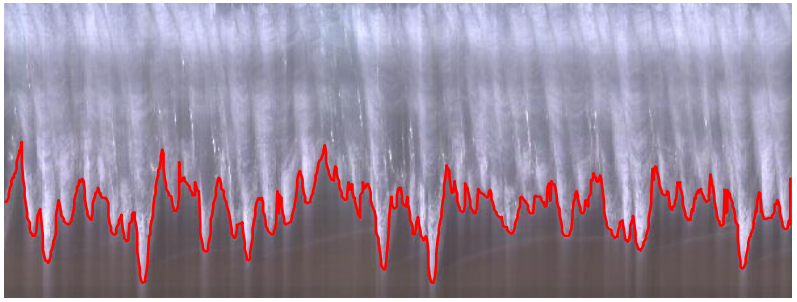
Problems associated with the analysis of such data include, for example:

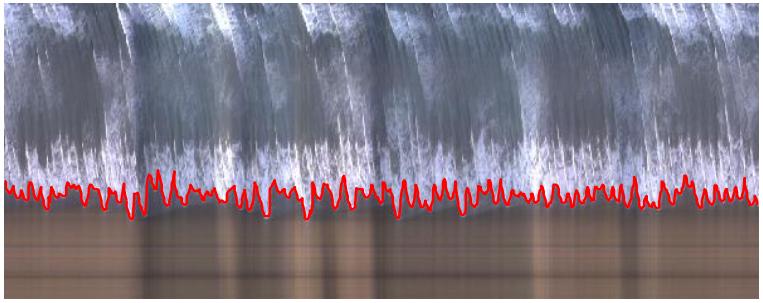
- collection
- Storage (massive sample size)
- search
- Sharing and integration of data from different sources
- visualization
- statistical analysis.

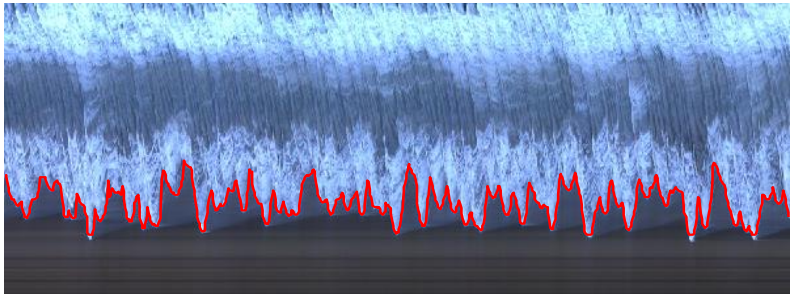
Timestack: time series

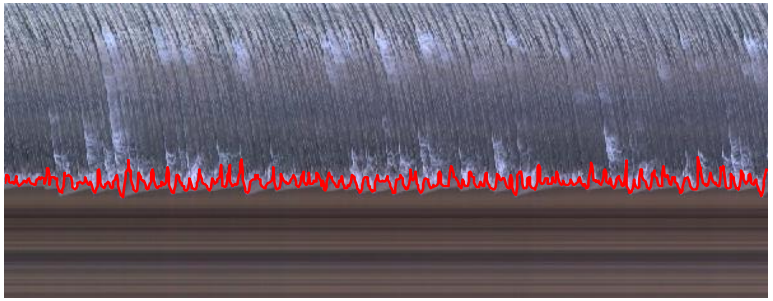




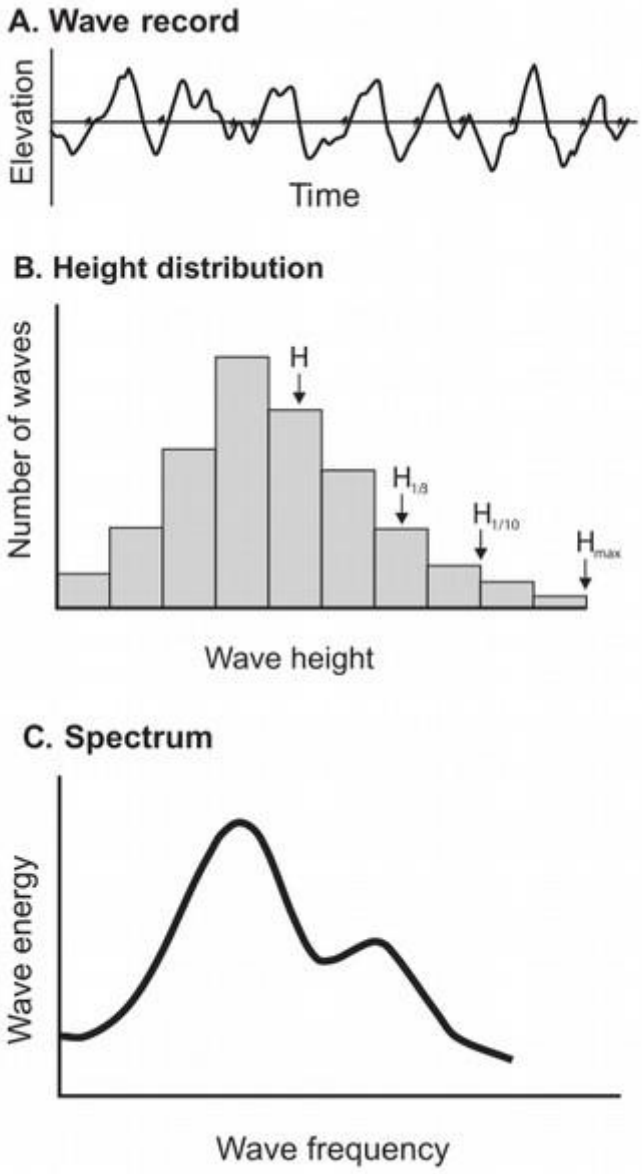


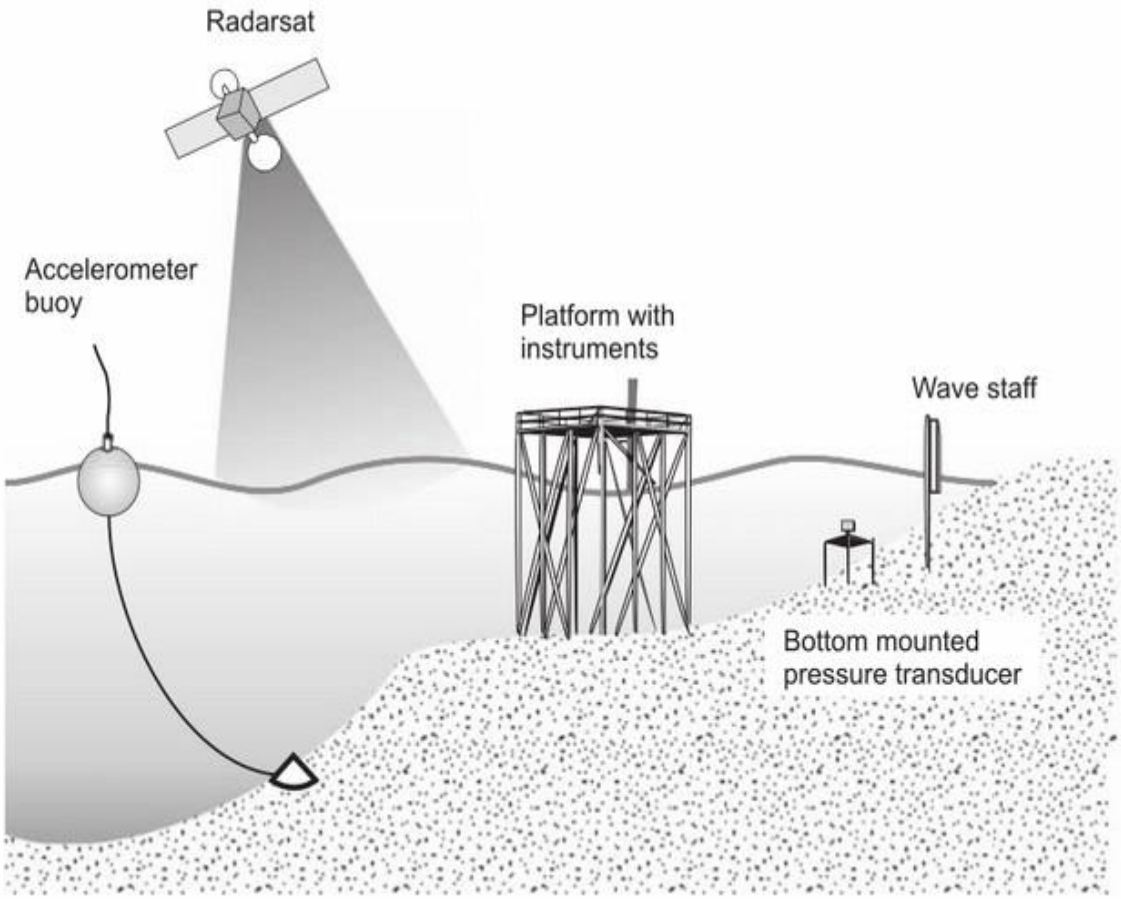






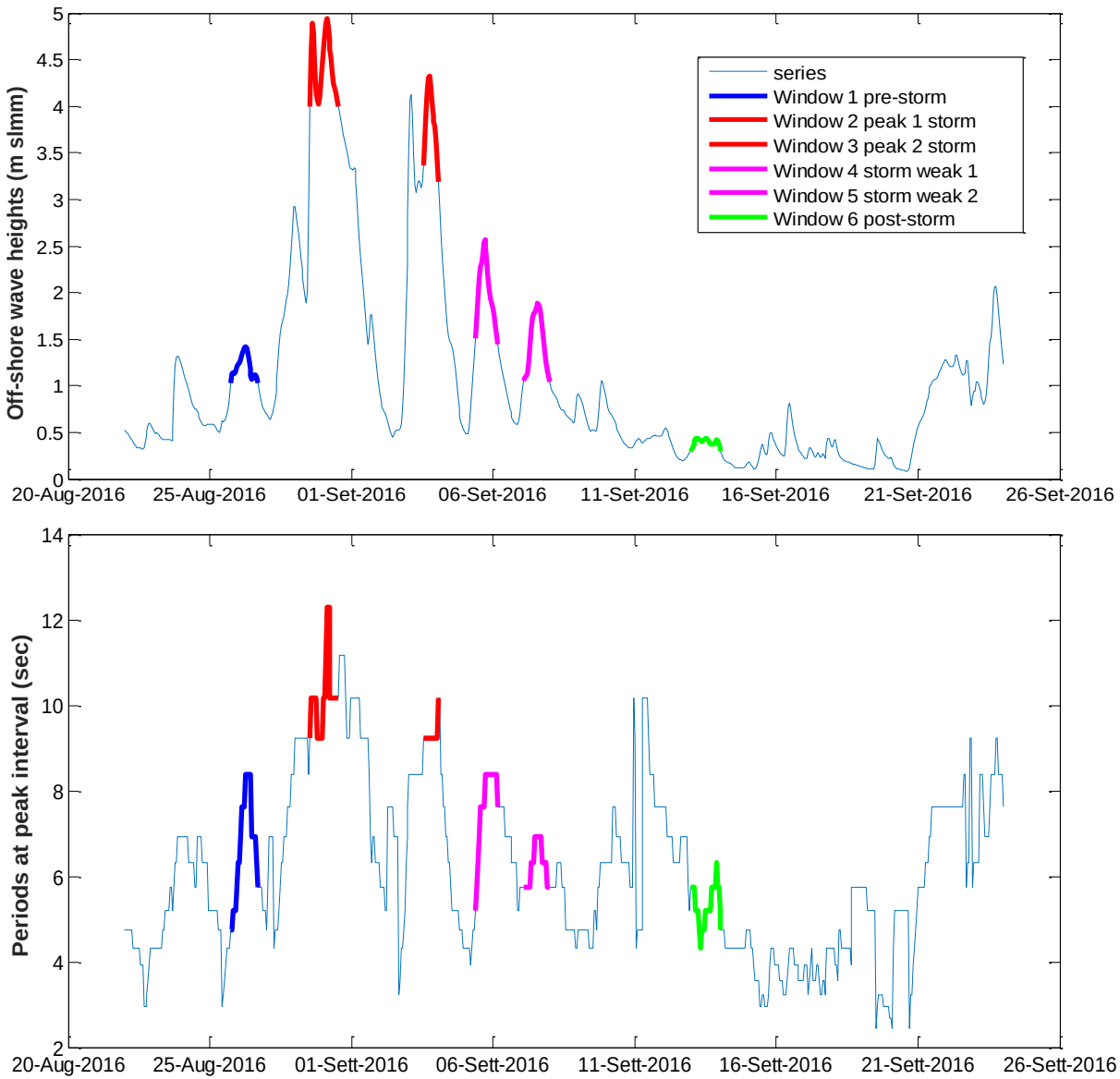
Wave measurements



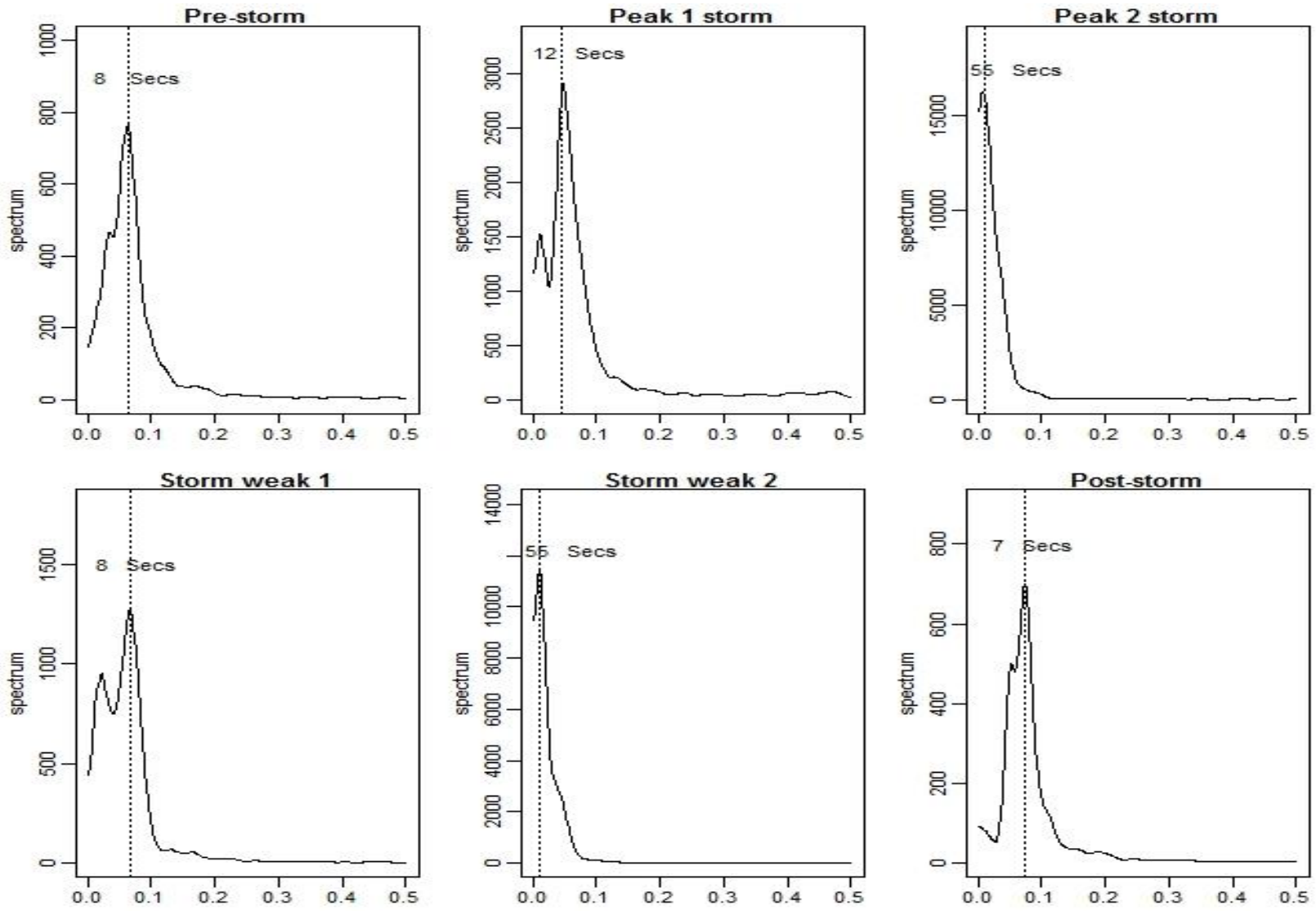


Wind effect: the total energy in the spectrum increases with increasing wind speed and the peak frequency is shifted toward the lower frequencies (i.e. waves with longer periods)

Wave time series: heights and periods



Timestack: frequency analysis



Timestack: dynamic frequency analysis