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WAVE ATTENUATION SERVICE OF SALTMARSHES AND SHELLY CHENIERS: A SPATIO-TEMPORAL STUDY IN MONT-SAINT-MICHEL BAY, FRANCE.



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Introduction

A consequence of **Global Change** might be an increase of **coastal risks**. Indeed, sea-level rise conjugated with spring tides, can lead to hazardous sea-levels, in worldwide coastal areas subject to unprecedented demographic exposure, thus risks. Coastal ecogeosystems have the potential to alleviate hazards by **reducing wave energy** due to their topographic complexity (drag coefficient). This **attenuation service** is nonlinear, it evolves with time and depends on environment component, meteorological and environmental factors. (Koch and al., 2007)

(1) To estimate this non-linearity of this natural coastal protection and,
 (2) to rank the environmental components according to their efficiency in the reduction of hazards are the objectives of this work. This study focusses on the variability of the **Wave Attenuation Service (WAS)** provided by **shelly cheniers** (site a) and **saltmarshes** (site b), both major ecogeomorphic features of the **Mont-Saint-Michel Bay (France)**.

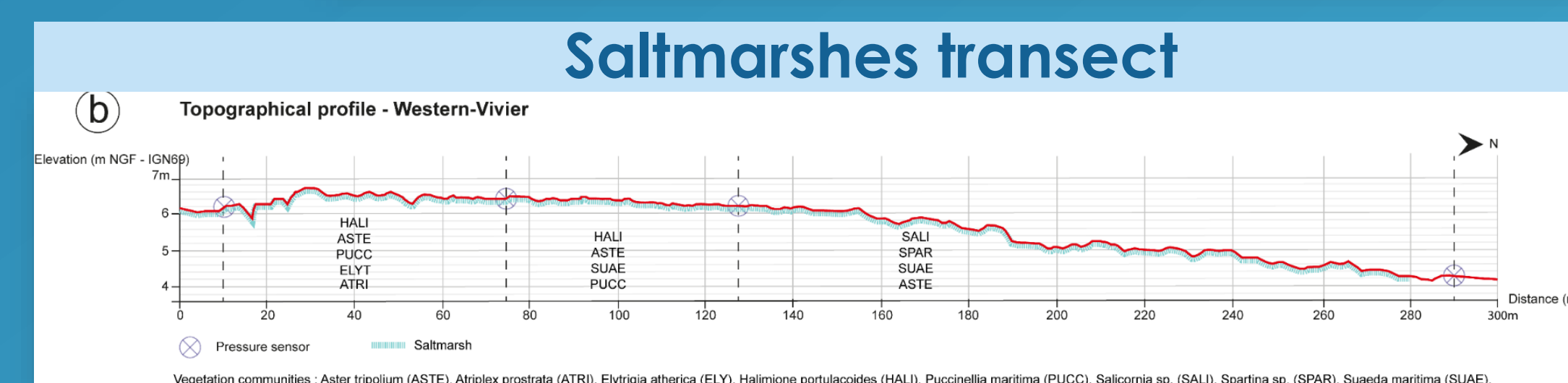
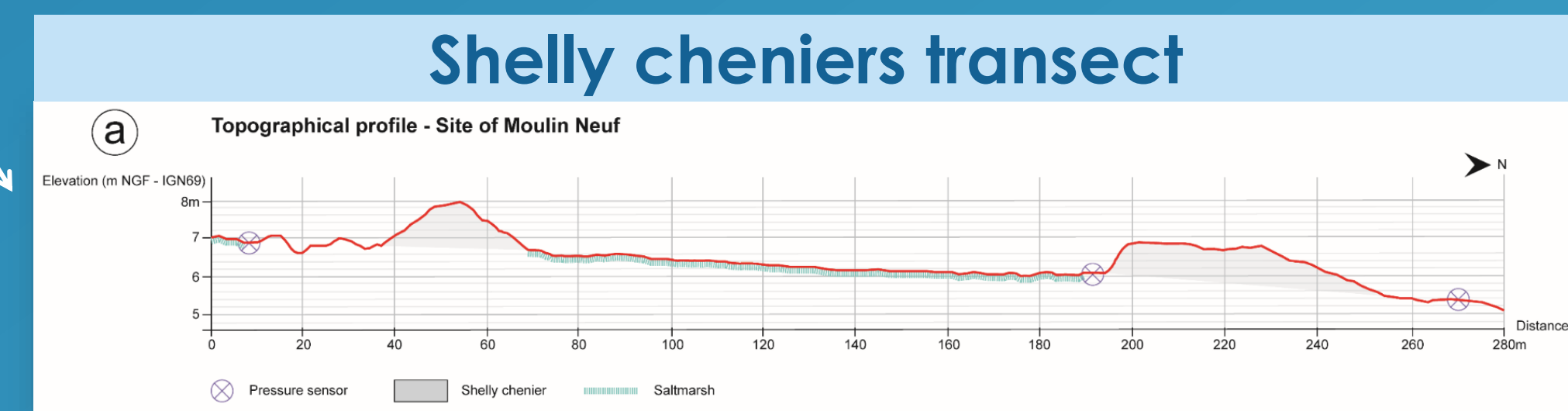
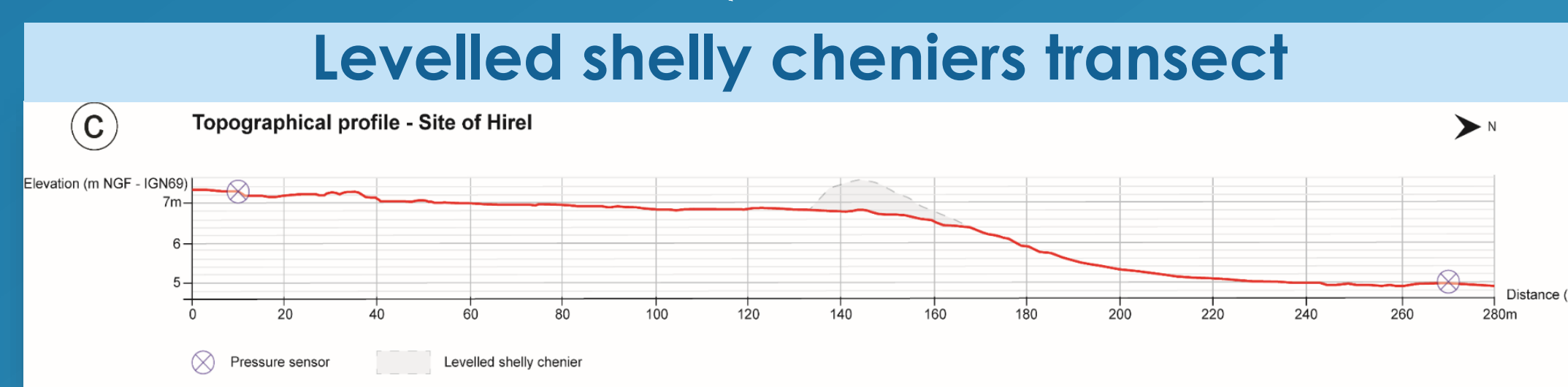


Figure 1. Location of the study area in the megatidal bay of Mont-Saint-Michel (France) and associated topographical profiles of the three study transects : a) Shelly ridges transect in Cherruix, b) Saltmarshes transect in Le-Vivier-sur-Mer and c) Levelled shelly cheniers transect in Hirel.

Materials and Methods

1. Deployment of **pressure sensors** (NKE SP2T10) along cross-shore transects selected according to ecogeosystem diversity, for three various events.
2. Pressure data acquired at a frequency of 2 Hz are corrected and converted into water heights, from which the wave signal is extracted for the determination of **significant wave heights (Hs)**.
3. WAS is determined from the average of significant wave height calculated over two hours of high tide during four consecutive tides, then turn into **attenuation per unity of distance (%/100m)** to be easily compared between study sites.

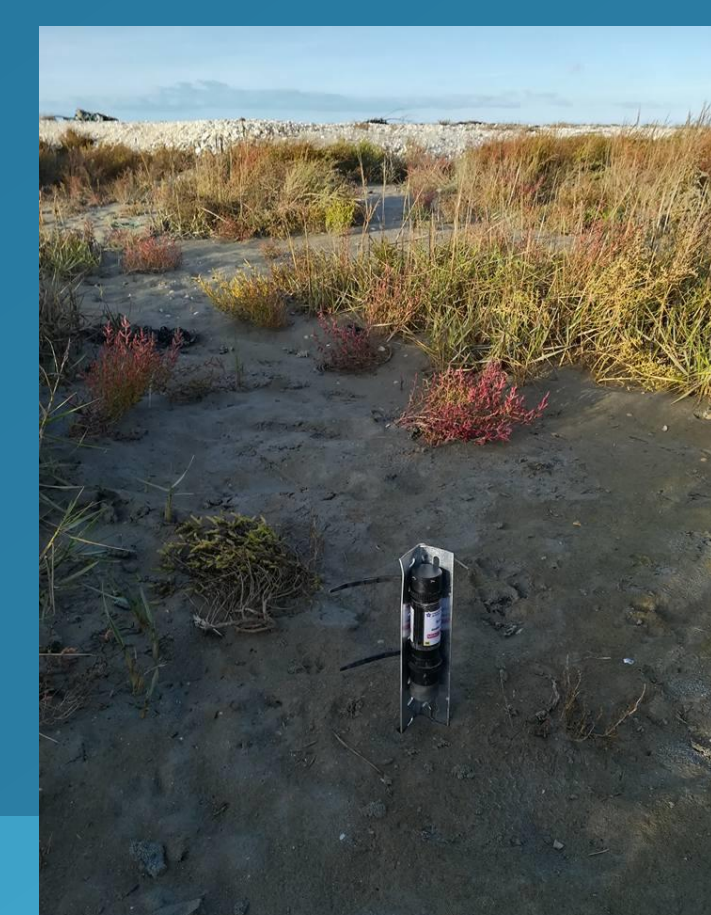


Figure 2. NKE pressure sensor SP2T10 fixed on an iron rod driven into the intertidal substrate

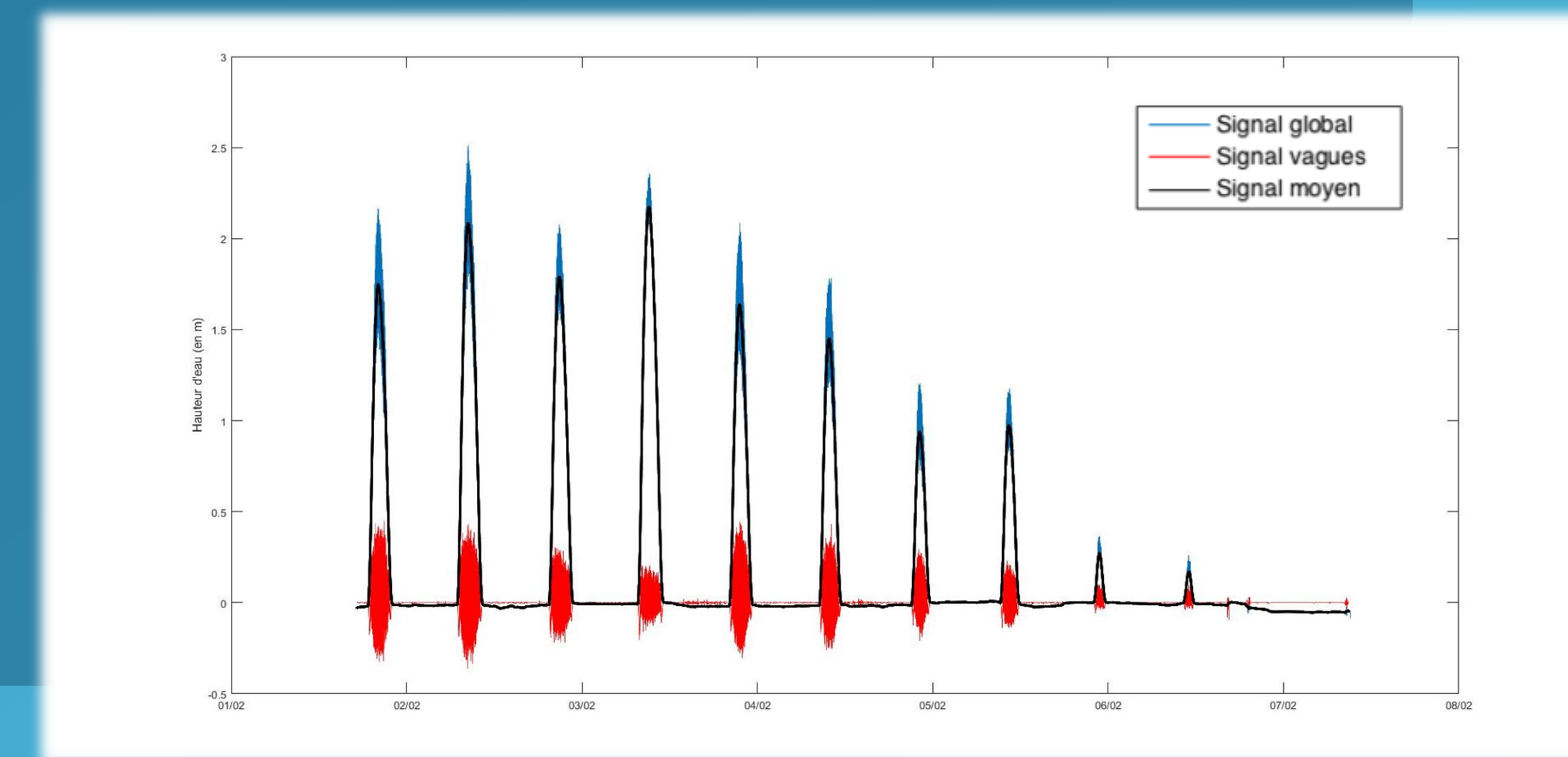


Figure 3. Representation of the global signal (after atmospheric pressure correction) (blue), average of recorded water height (black) and wave signal (red).

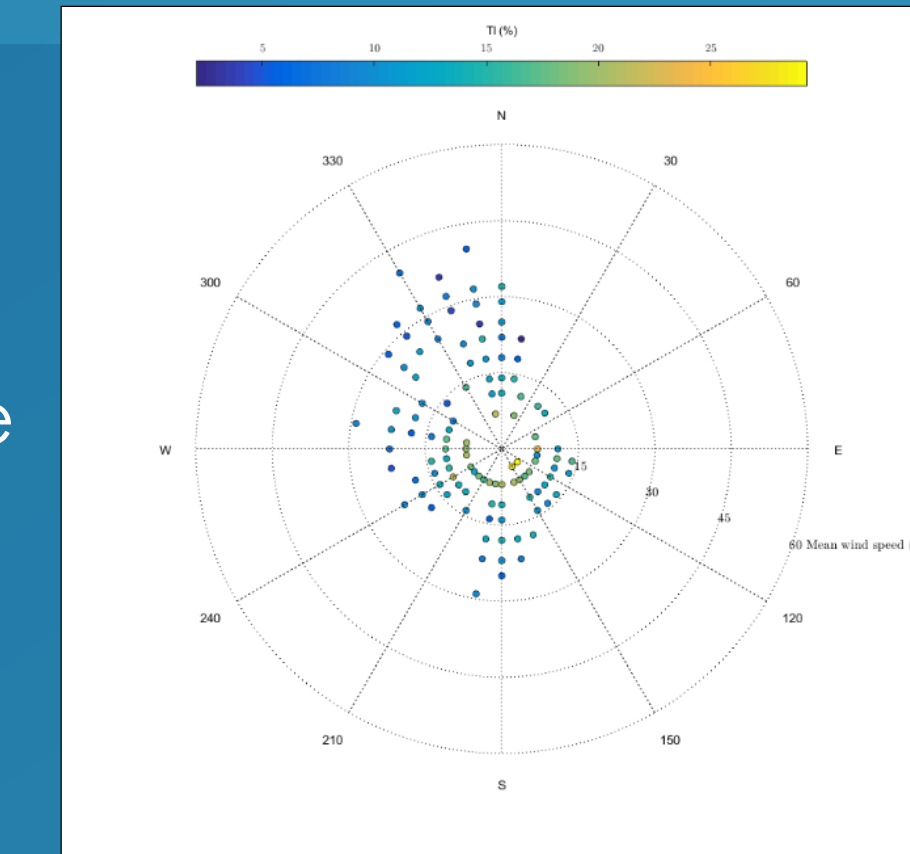
Results

Event #1

November 2017
 (2017/11/02 – 2017/11/09)

Atmospheric pressure
 Min. : 1006 hPa
 Mean : 1018,6 hPa
 Max. : 1027 hPa

Wind conditions
 Mean : 20,3 km/h
 Max. wind gust : 72 km/h.

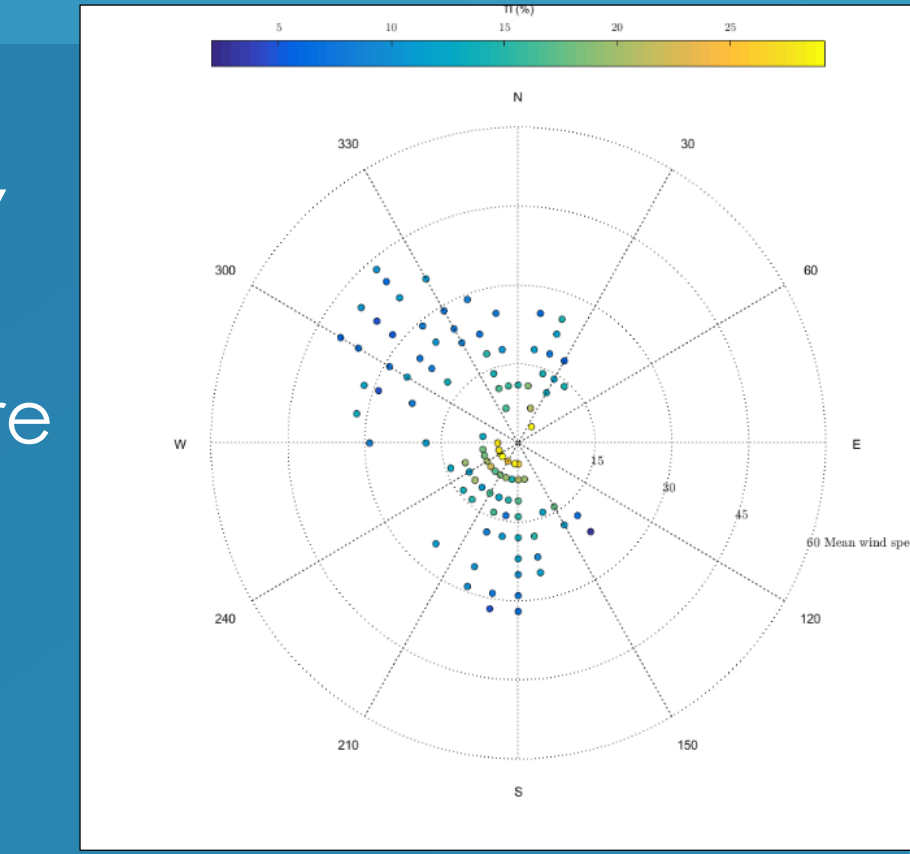


Event #2

December 2017
 (2017/12/02 – 2017/12/09)

Atmospheric pressure
 Min. : 1003,8 hPa
 Mean : 1027,5 hPa
 Max. : 1038,9 hPa

Wind conditions
 Mean : 16,1 km/h
 Max. wind gust : 82,8 km/h.

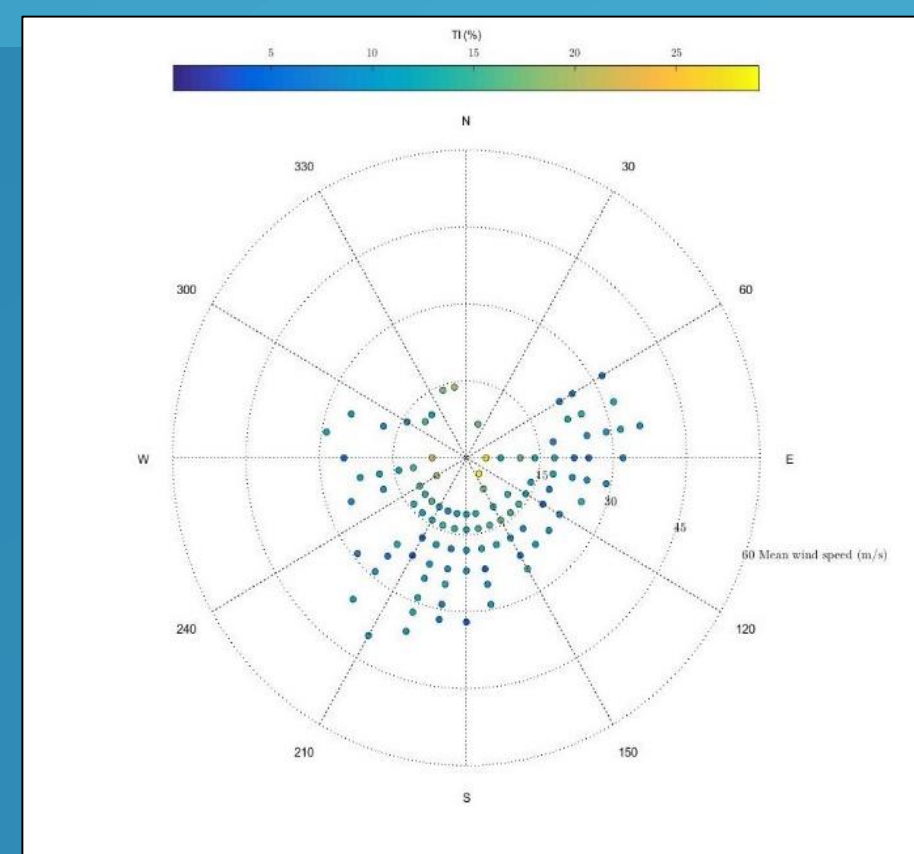


Event #3

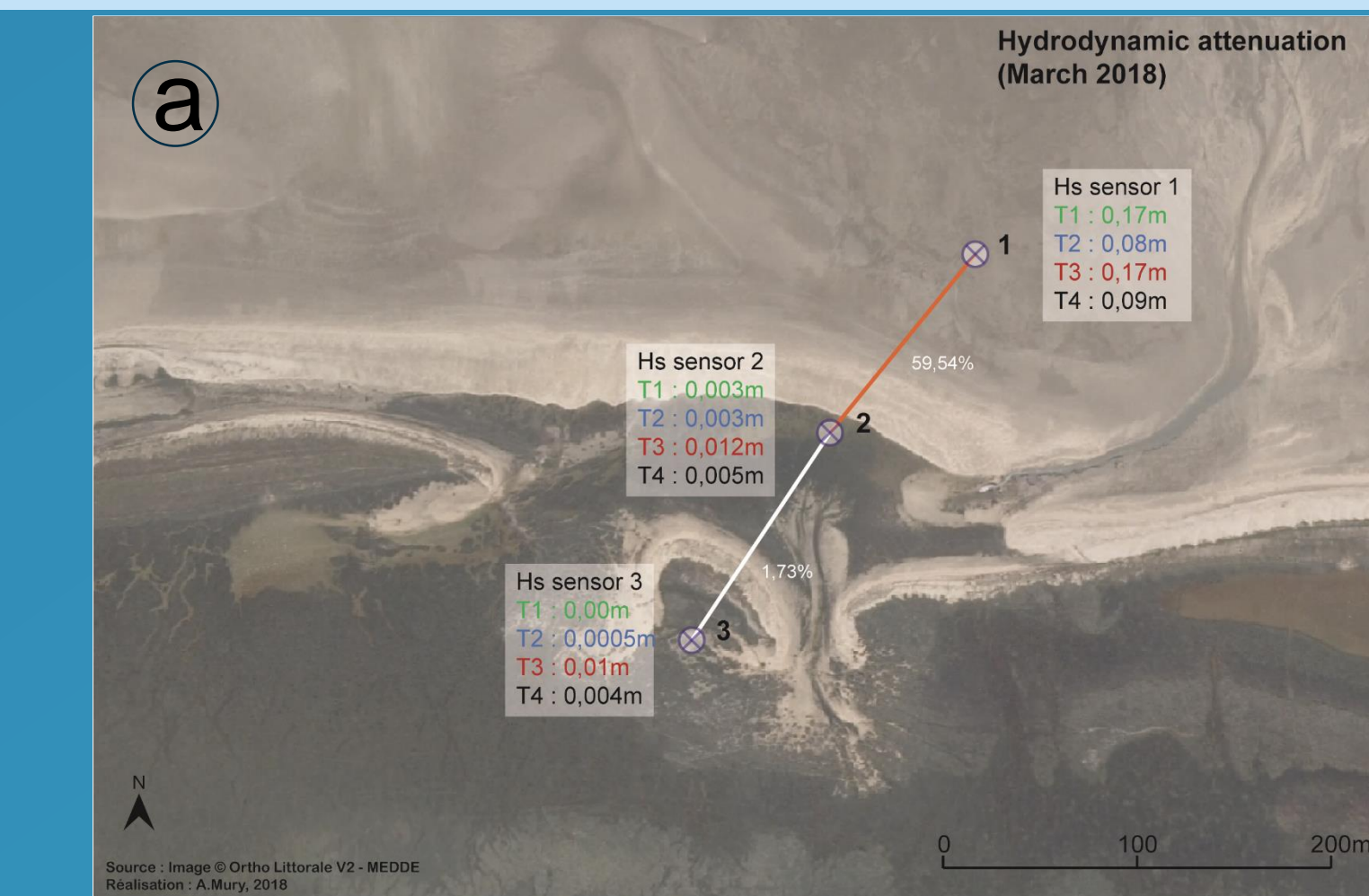
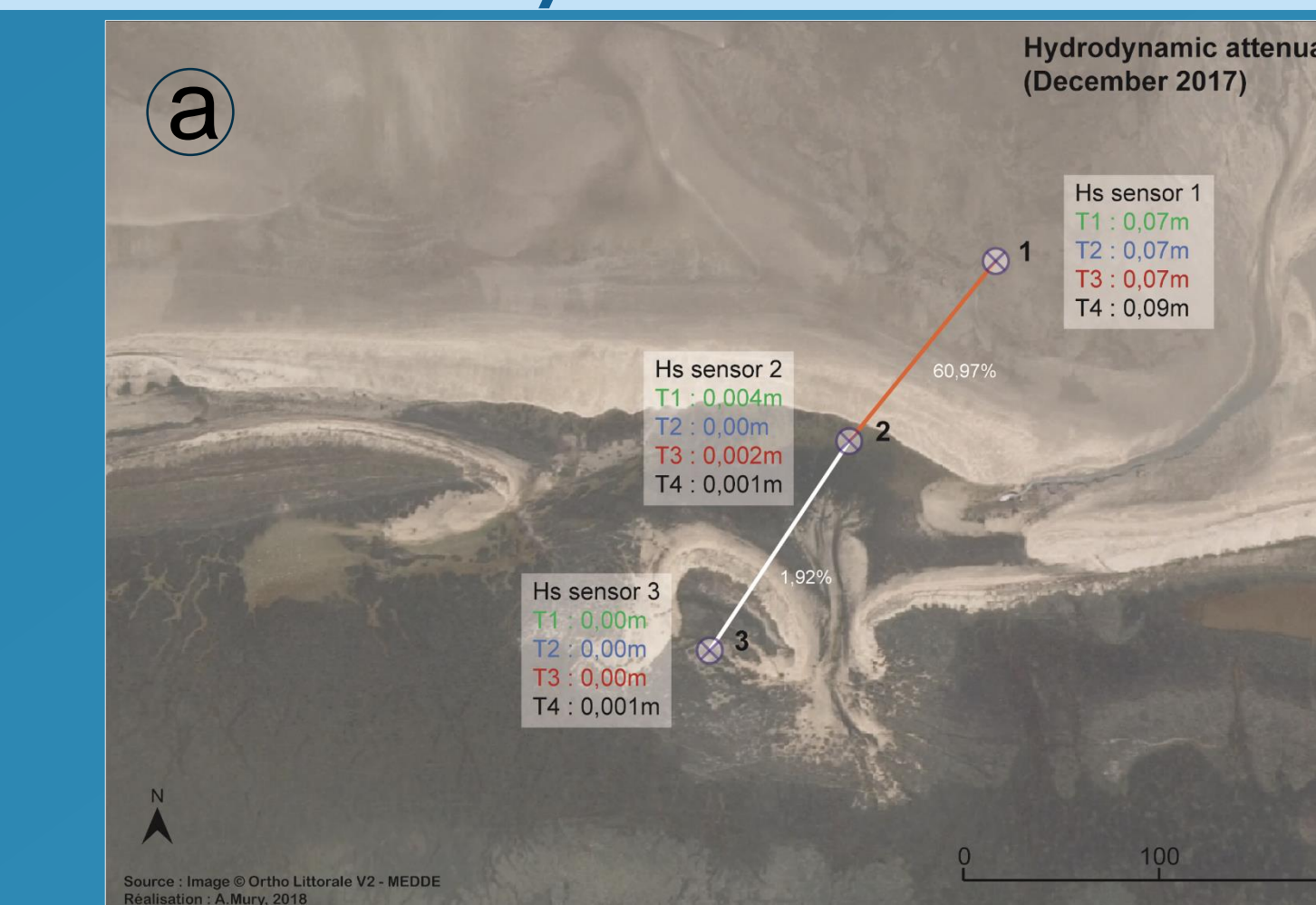
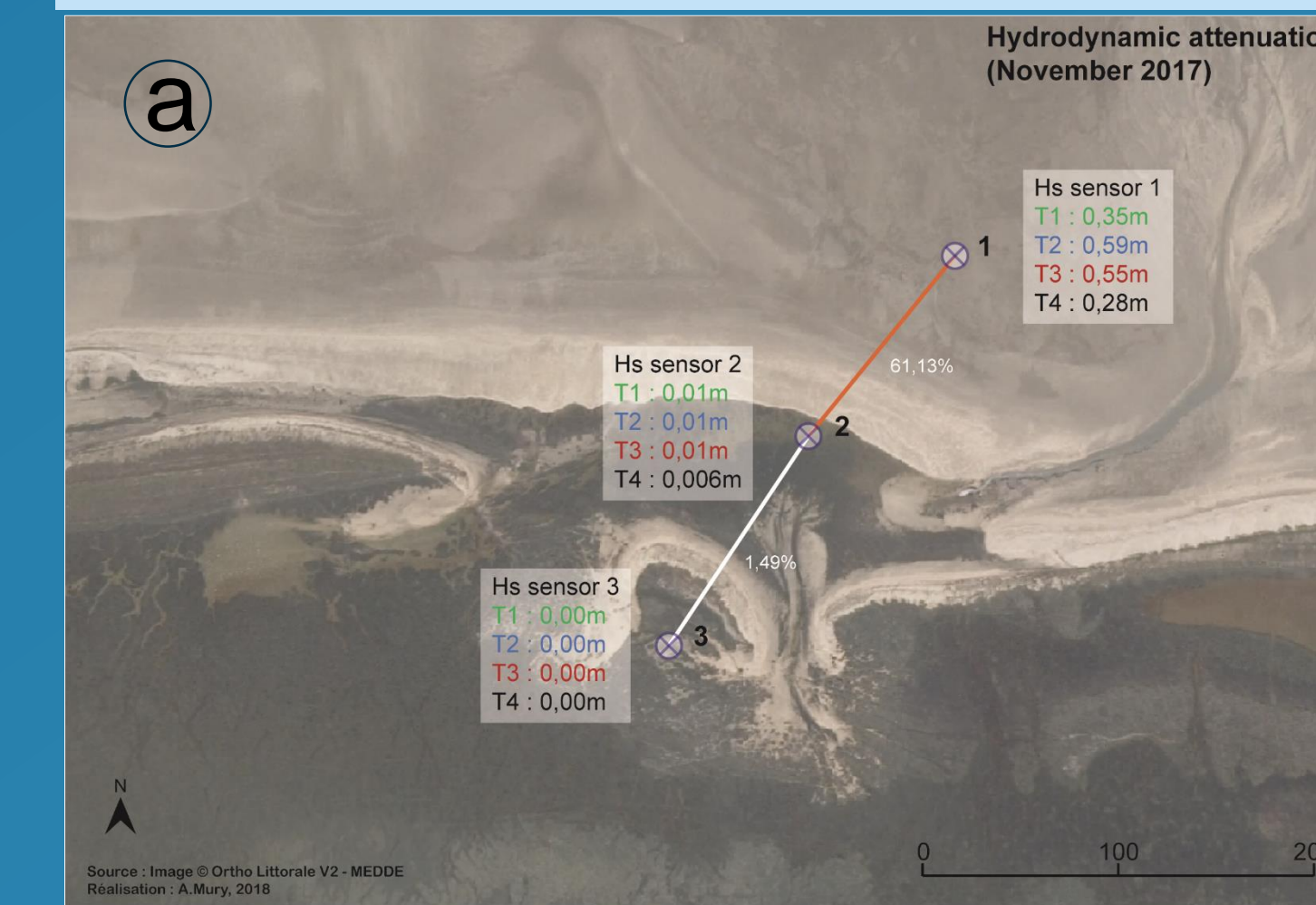
March 2018
 (2018/02/28 – 2018/03/07)

Atmospheric pressure
 Min. : 979 hPa
 Mean : 992,5 hPa
 Max. : 1016,9 hPa

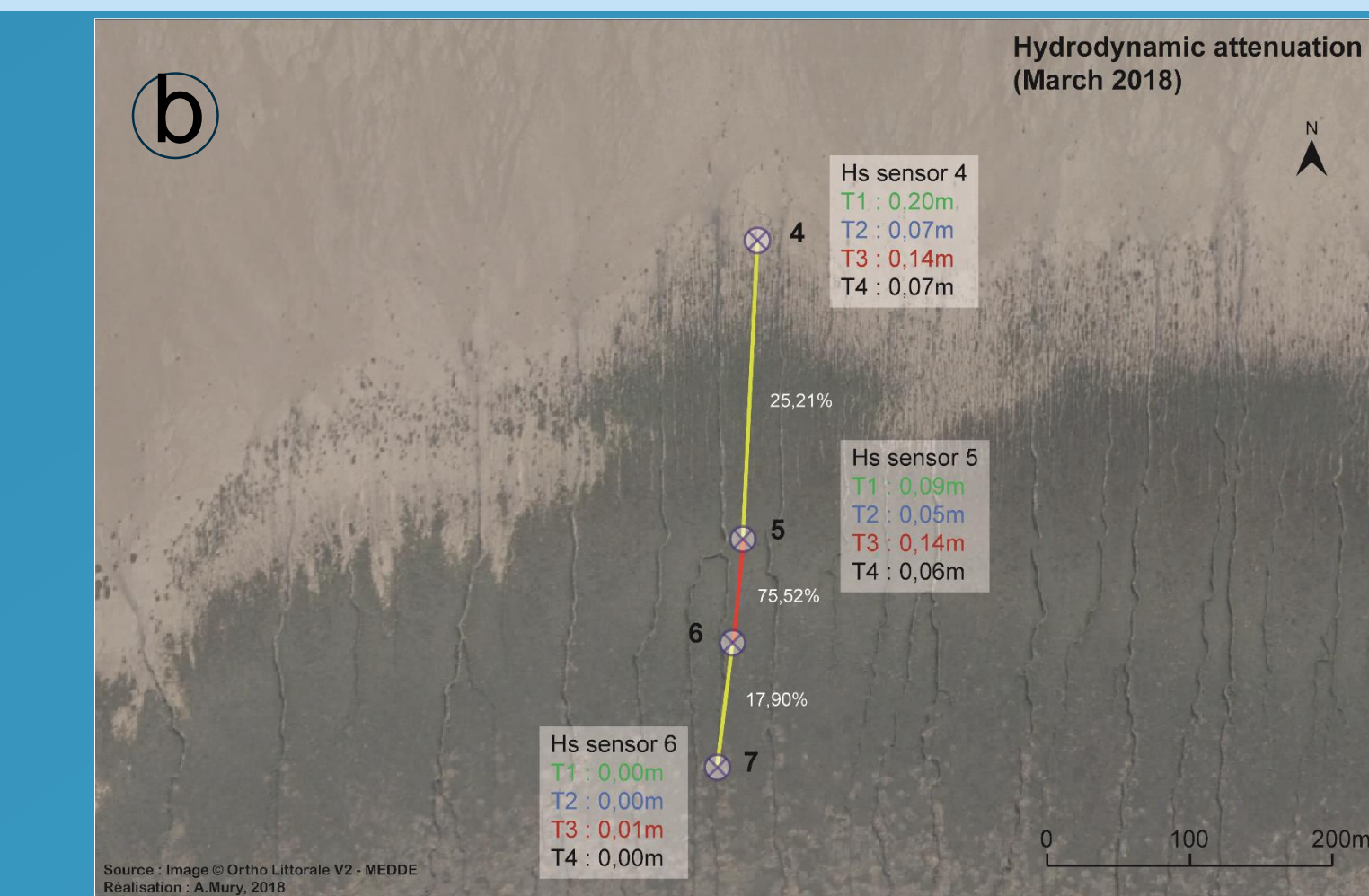
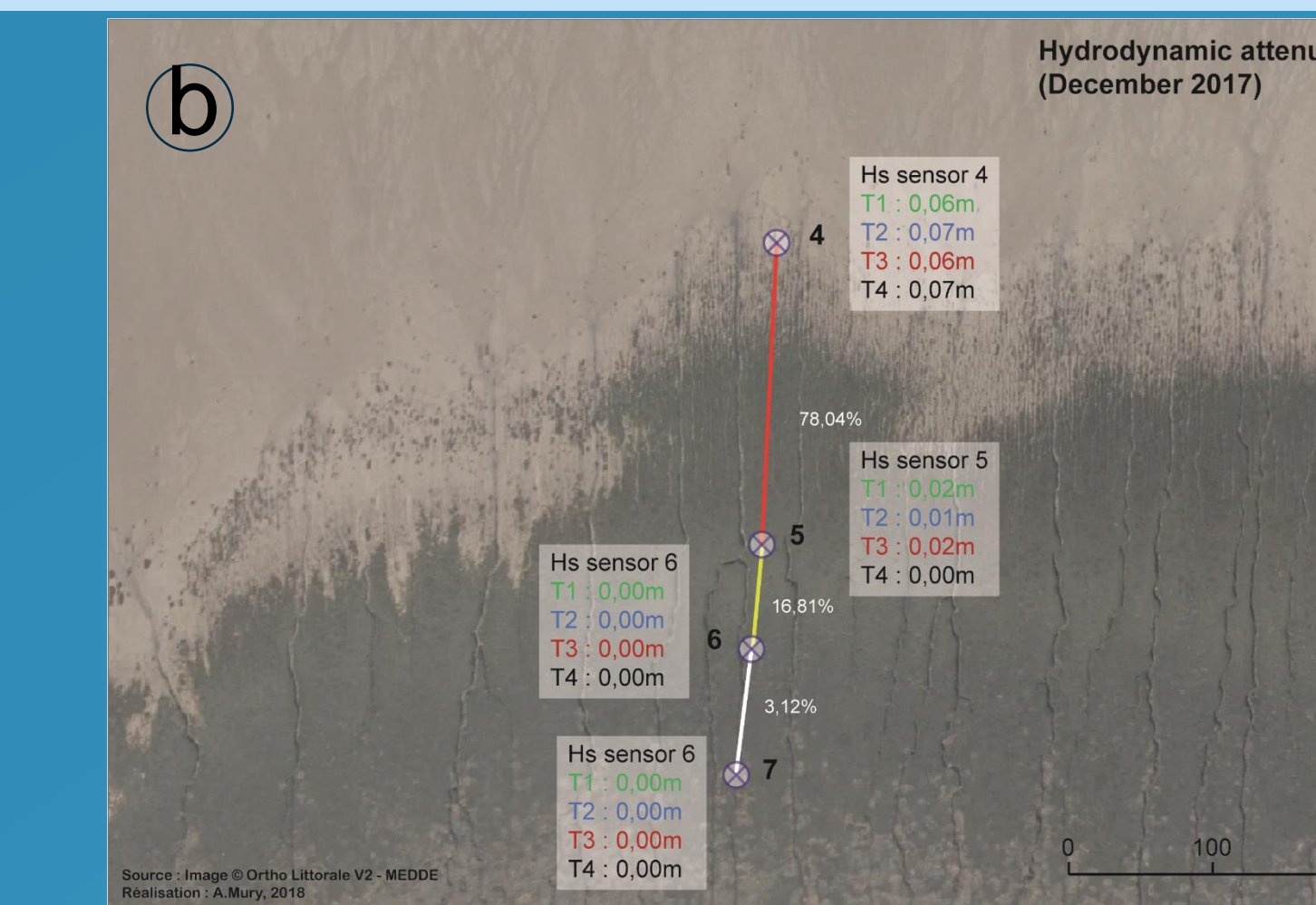
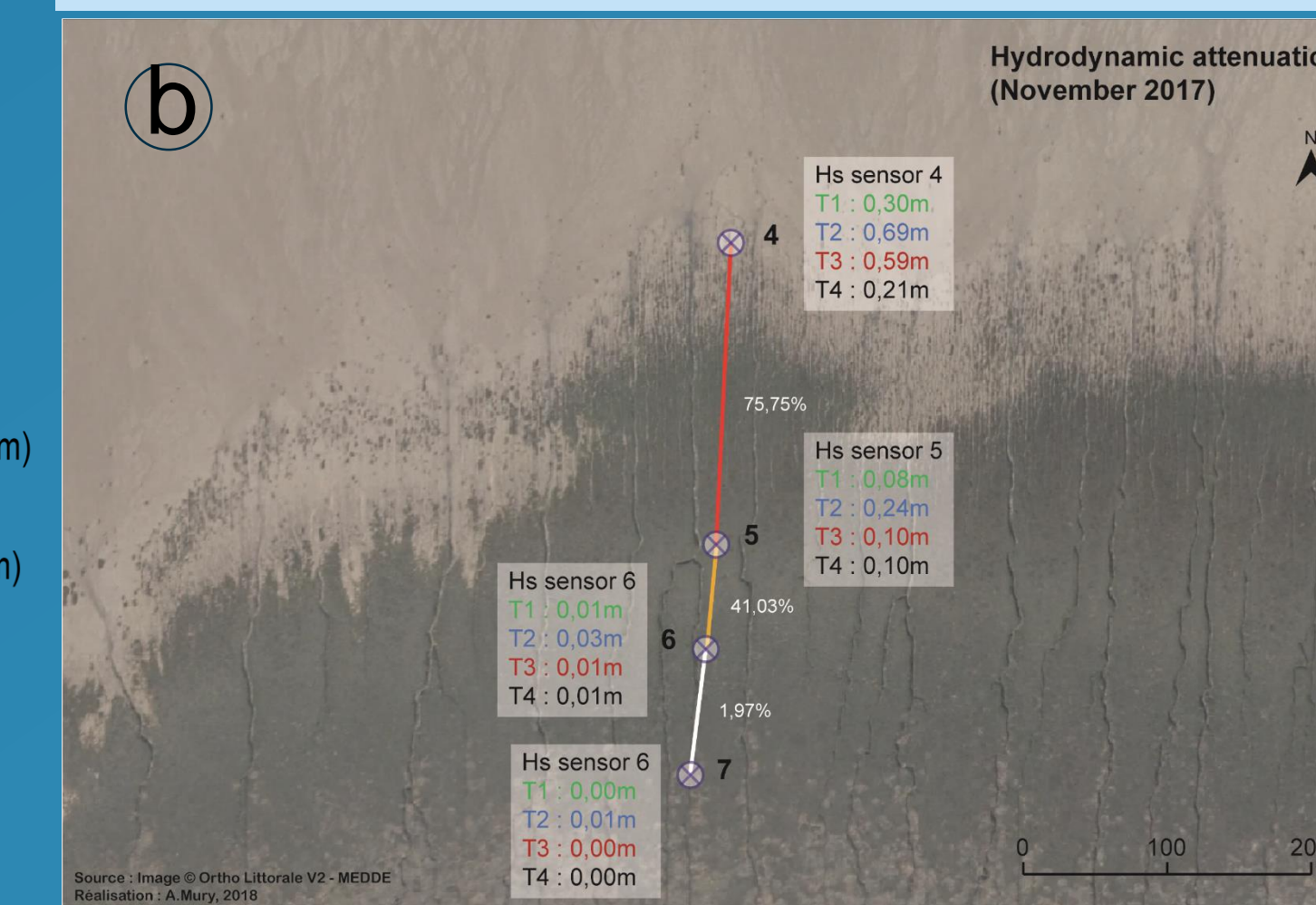
Wind conditions
 Mean : 20,3 km/h
 Max. wind gust : 64,8 km/h.



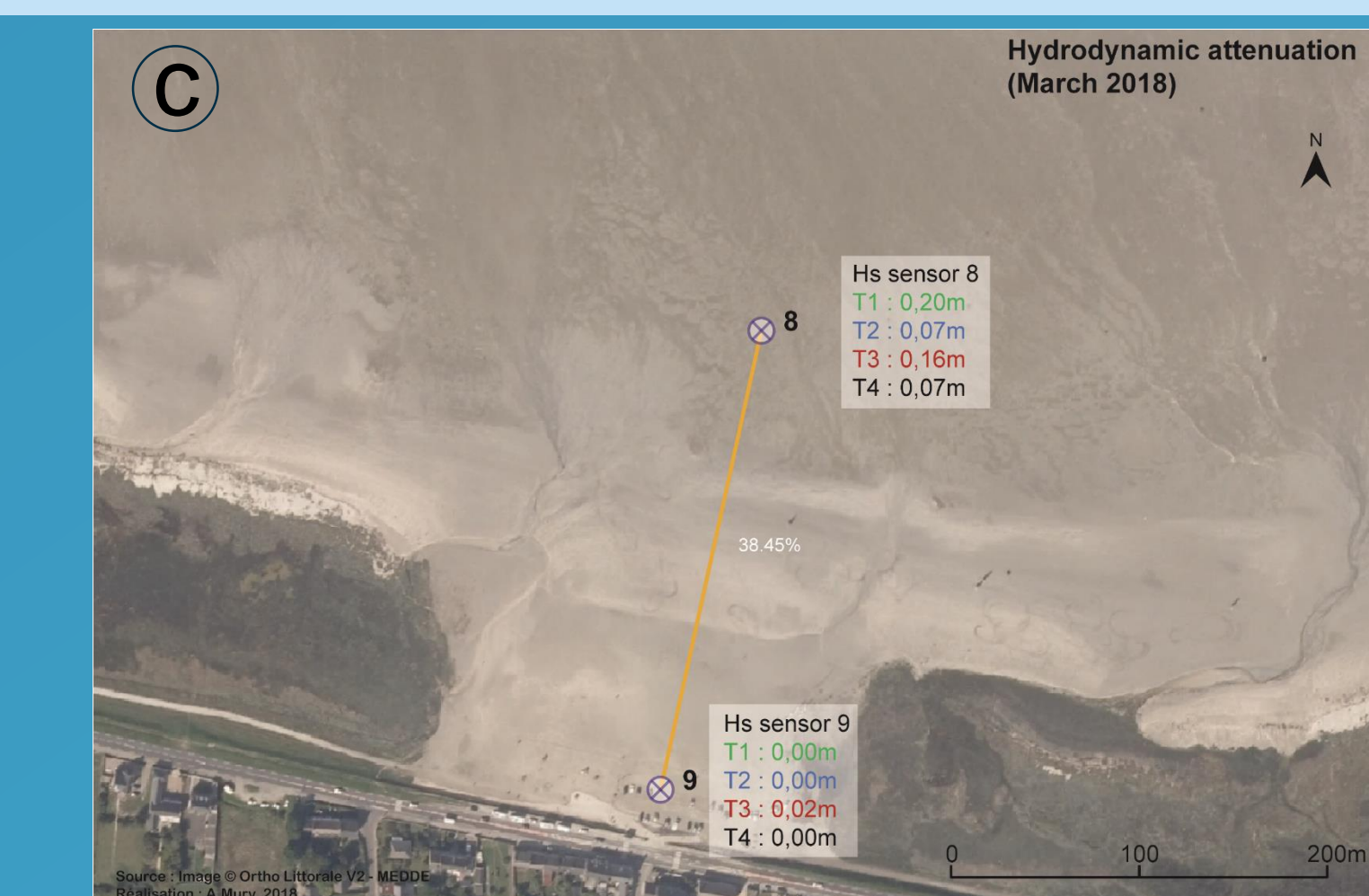
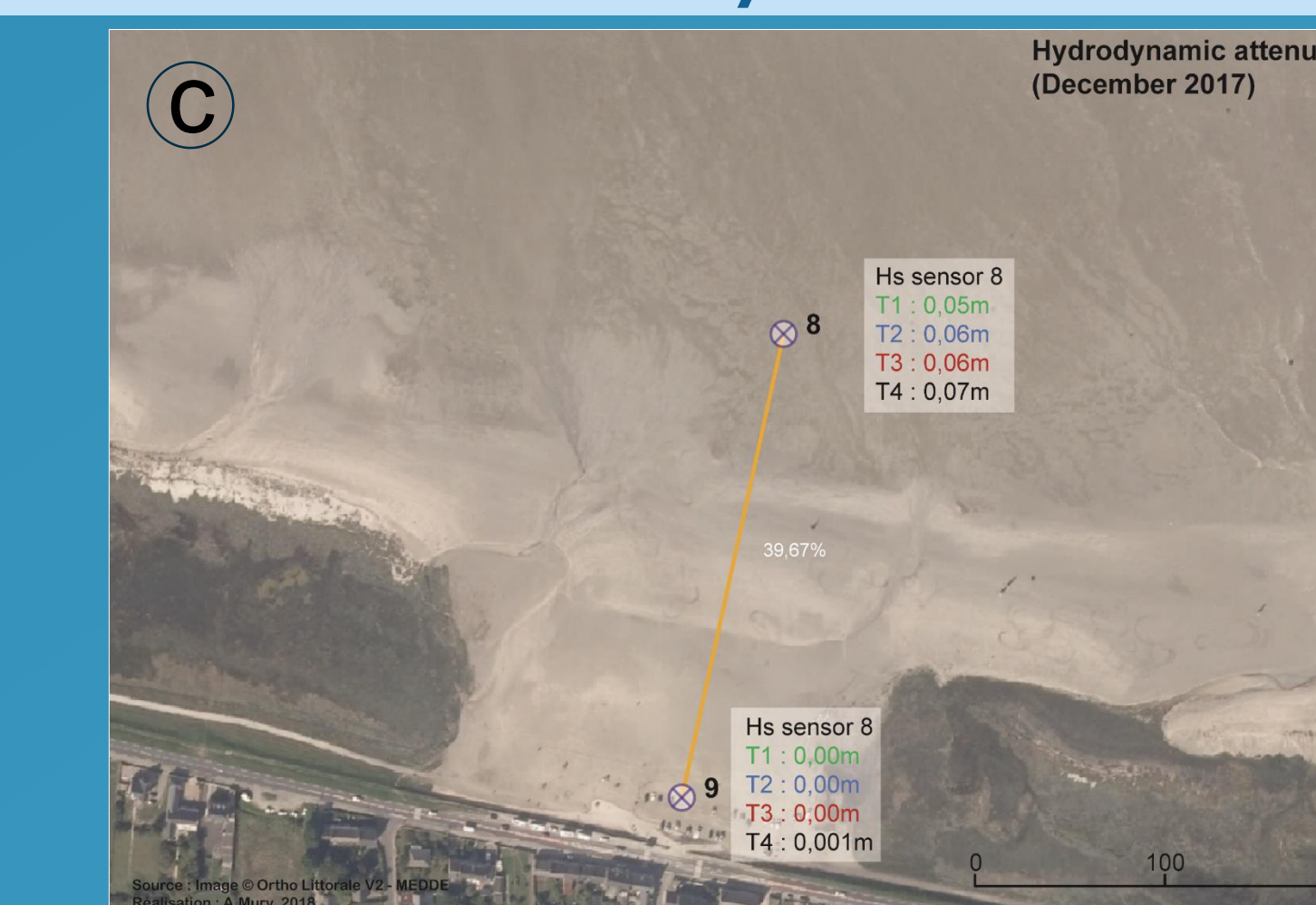
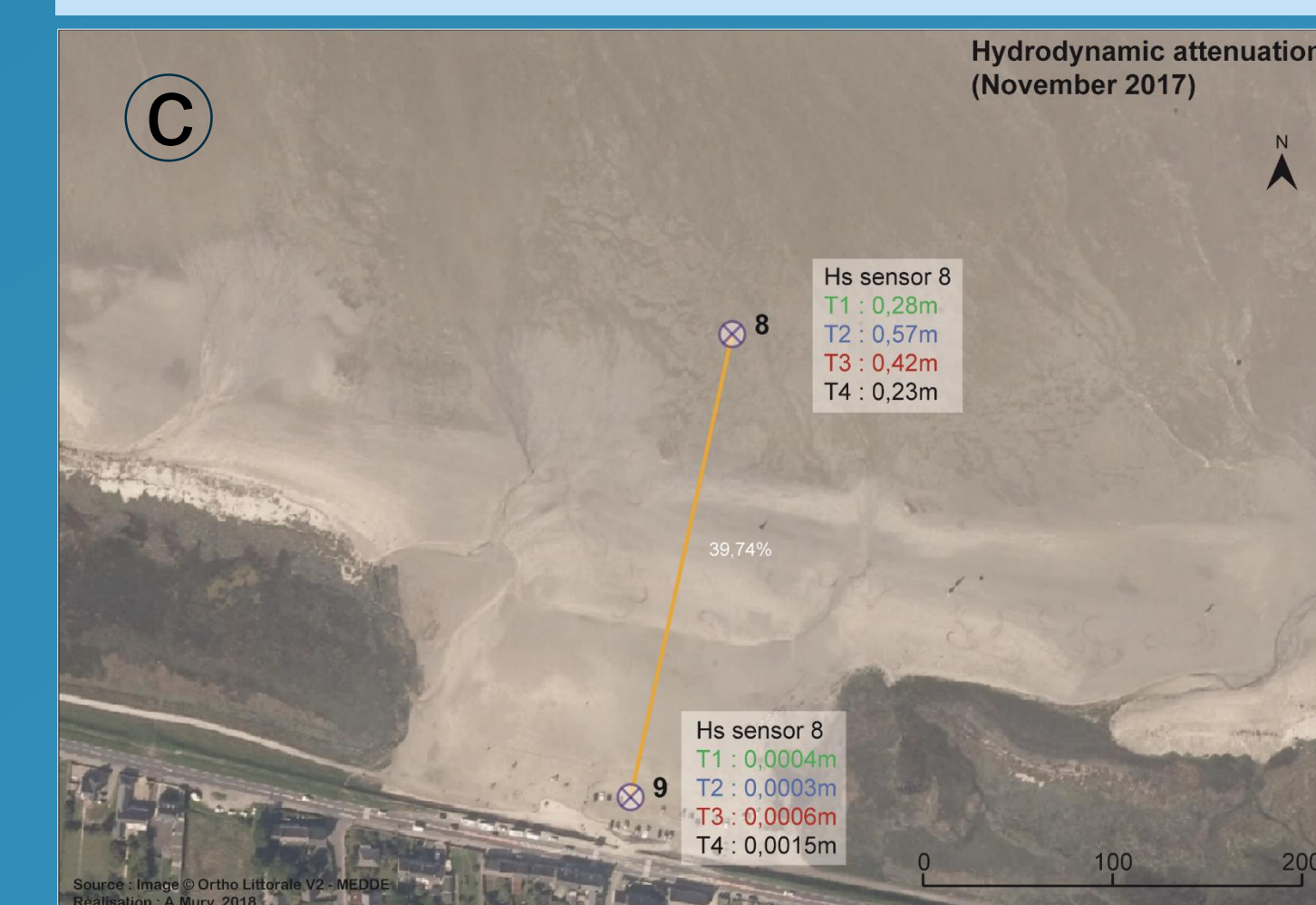
Shelly cheniers transect



Saltmarshes transect



Levelled shelly cheniers transect



Sensor position
 Hydrodynamic attenuation
 Very high (>70% / 100m)
 High (50.1 - 70% / 100m)
 Medium (30.1 - 50% / 100m)
 Low (15.1 - 30% / 100m)
 Very low (0.1 - 15% / 100m)
 Null (0%)
 Mean attenuation % / 100m
 T: Tide

Discussion

Preliminary results of this study confirm the ability of coastal ecogeosystems to **mitigate the wave height up to 78%/100m** and, therefore reduce the flood risks on human and material assets.

During the three campaigns, no storm conditions were recorded. Nevertheless, we can observe the variability of the WAS depending on weather and wave conditions, especially the atmospheric pressure variabilities that can provide sea surges (positive or negative) and, therefore increase locally the water depth and making the fringing marsh WAS less efficient (event#3 – site b).

Statistically, **saltmarshes appear to be the most efficient ecogeosystem in low energy (up to 78%/100m)**. However, shelly ridges WAS is very important too (**up to 61,1%/100m**) and at the contrary of saltmarshes we can make the hypothesis **the shelly chenier WAS is not dependent on seasonality**, as it is the case for saltmarshes WAS (**standard deviation : 29,9 [saltmarshes] vs. 0,9 [shelly cheniers]**) and it will not vary significantly with the succession of the wintry storms, because of its **morphological adaptativity and flexibility**.

Based on the third study site (i.e., **levelled shelly cheniers** for recreational activities), exhibiting **the lowest WAS (39,3%/100m)** irrespective of the meteorological conditions, we can point out upfront that the coastal management (conservation) is a crucial point to be accounted in the coastal risks.

References

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- Jeanson, M., Etienne, S., and Collin, A., 2016. Wave attenuation and coastal protection by shelly ridges: Mont-Saint-Michel Bay, France. *Journal of Coastal Research, Special Issue, No. 75*, pp. 398-402