

From a regional wave hindcast database to characterization of coastal sediment cells

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FROM A REGIONAL WAVE HINDCAST DATABASE TO CHARACTERIZATION OF COASTAL SEDIMENT CELLS

The Guadeloupe island case study

Louisor. J, Idier. D, Moisan. M, Pedreros. R

CCI SEA STATES 2019
OCTOBER 8 & 9TH 2019

Géosciences pour une Terre durable

Solarcam dans le cadre du projet suivi d'échouage de sargasses, Saint-François, Guadeloupe.

Introduction

Our general approach at BRGM: coastal flooding

Historical events

Field Expertise

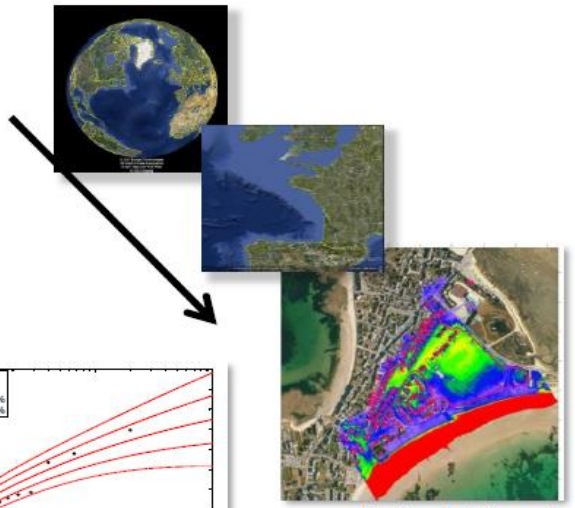
Modeling (waves, storm surges, tide, flooding)

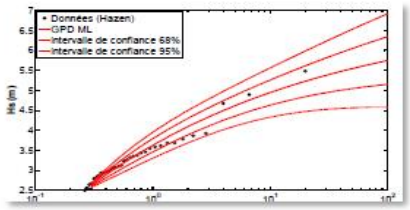
Meta-Modeling

Extremes statistics

Damages

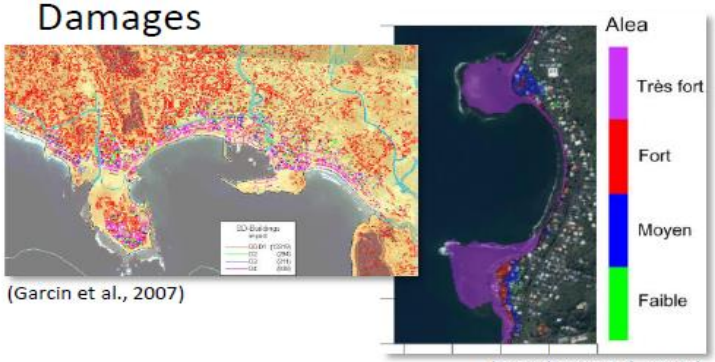
Prevention, Prevision, Crisis management, Adaptation





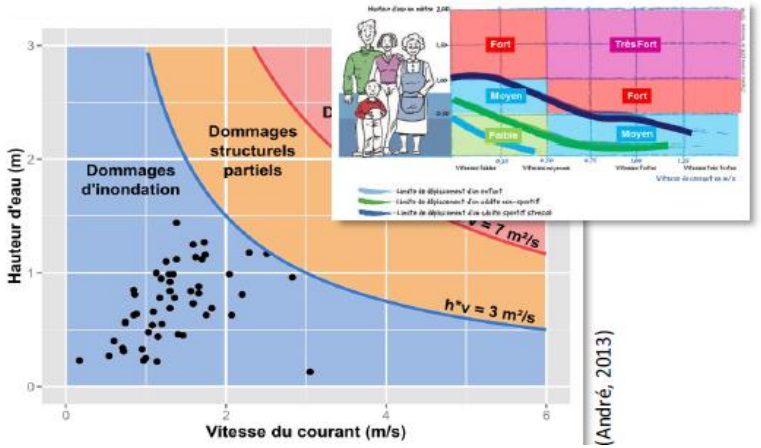
(Le Roy et al., in prep)

Damages



(Garcin et al., 2007)

(Lecacheux et al., 2013)



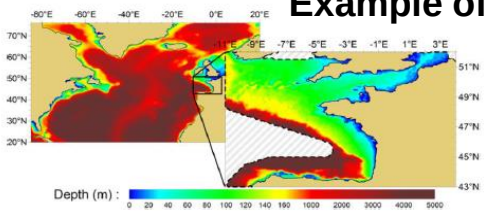
(André, 2013)

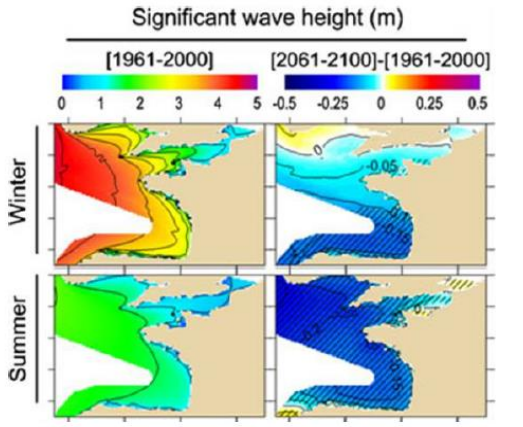
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Introduction

- Questionning
  - Present wave climate and trends?
  - CC effect on future wave climate?
  - Effect on longshore and cross-shore sediment transport?
- Approach
  - Dynamical downscaling (Ex: Bobwa database)
  - Reanalyses & projections (IPCC scenarios, extra-probabilist approach)
  - Statistical downscaling
  - Multivariate extreme value analysis to populate wave models (SWAN, SWASH)
  - Meta-modelling for early warning systems

Example of Bobwa



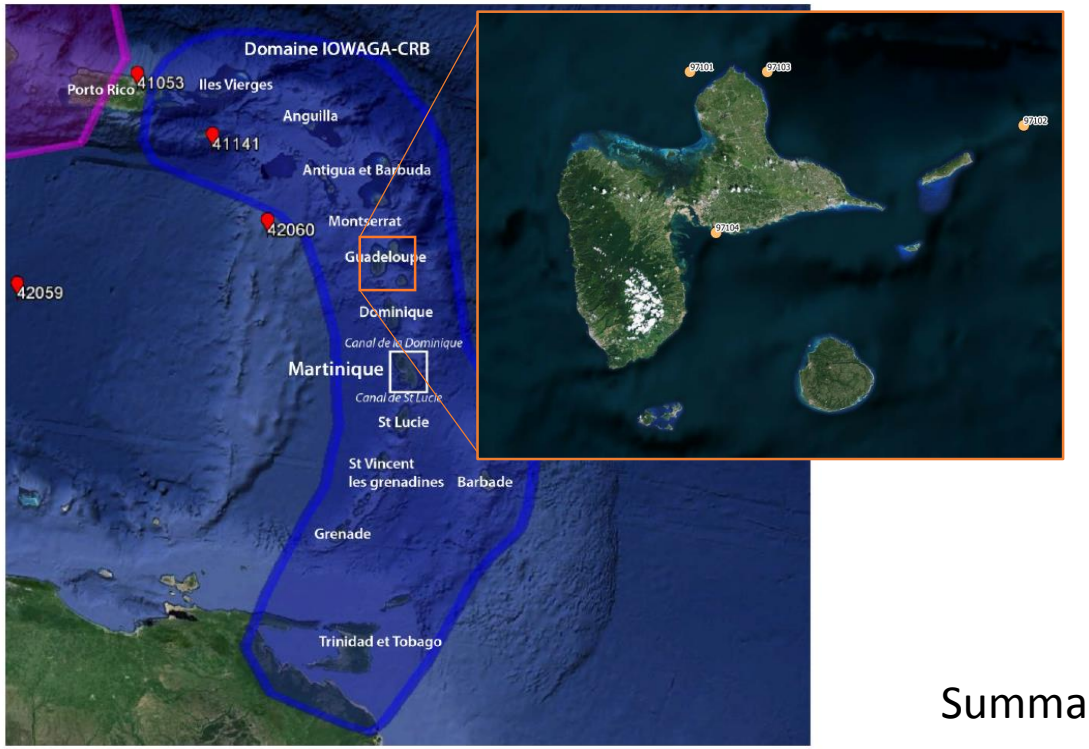


→ A public database (1958-2001) : http://bobwa.brgm.fr
→ Also with extreme value analysis

Outline

- Introduction: General approach at BRGM
- An example of a policy support study using sea state conditions
  - Study area and data overview
  - Methodology
  - Validation
  - Clustering
  - Offshore to nearshore
- Our needs regarding satellite based products providing wave conditions
- Conclusion

Study area and data overview



Summary of data sources

Variable	Product	Source	Resolutions
Regional Wave conditions (Hs, Tp, Dp)	IOWAGA-CRB	Ifremer/Lops	2min; 3h
Wind conditions (U, Du)	CFSR/ CFSv2	NCEP	0,312°/0,25°; 3h
Bathymetry	HOMONIM	Shom (France)	100 m
In-situ wave time-series	Buoy time-series	Candhis (France)	1h or 30 min

Methodology

i. **Validation** of the dataset in our zone of interest

ii. **Clustering** offshore representative conditions using statistical clustering methods;

   a. DBSCAN algorithm (density-based spatial clustering of applications with noise) to define the number of useful clusters and eliminate outliers (extreme waves coming from tropical storms and hurricanes)

   b. K-means++ algorithm used for a well defined number of clusters

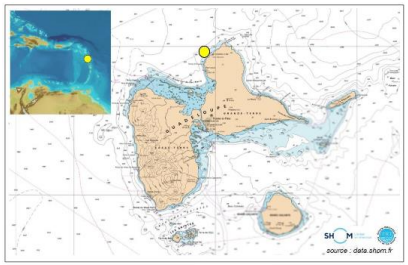
iii. Analysis of **associated winds** ;

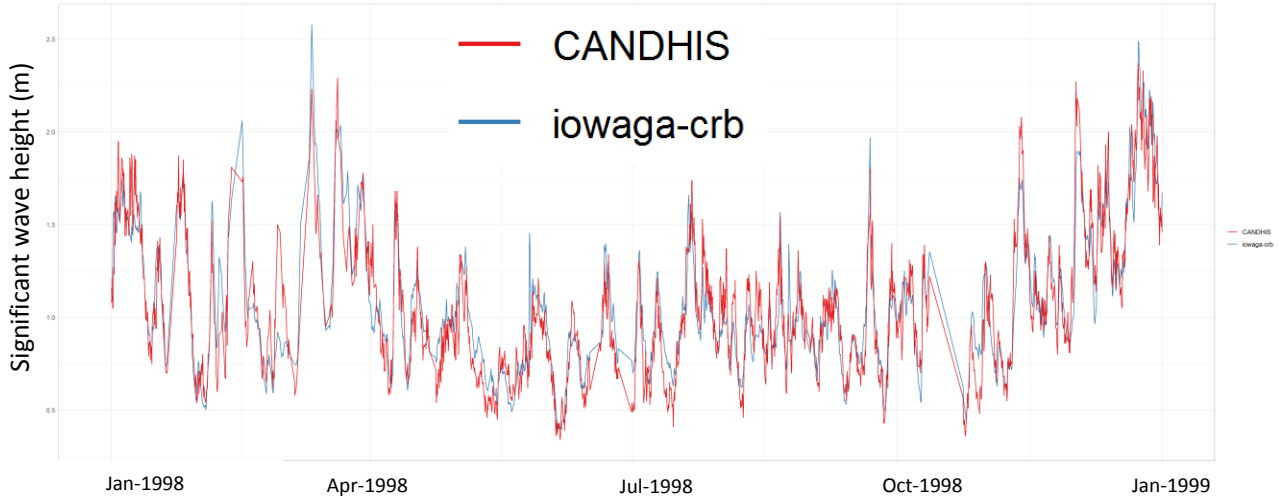
iv. **Offshore to nearshore modelling** using the the third generation wave model WAVEWATCH III© forced by all the clustered offshore conditions in order to obtain the sea states along the Guadeloupe coasts (100m resolution);

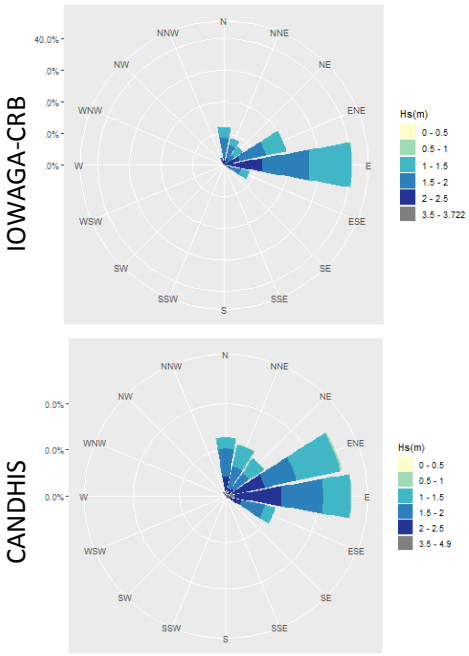
v. **Identifiy** the dominant direction of the sediment transfers and the homogeneous cells associated.

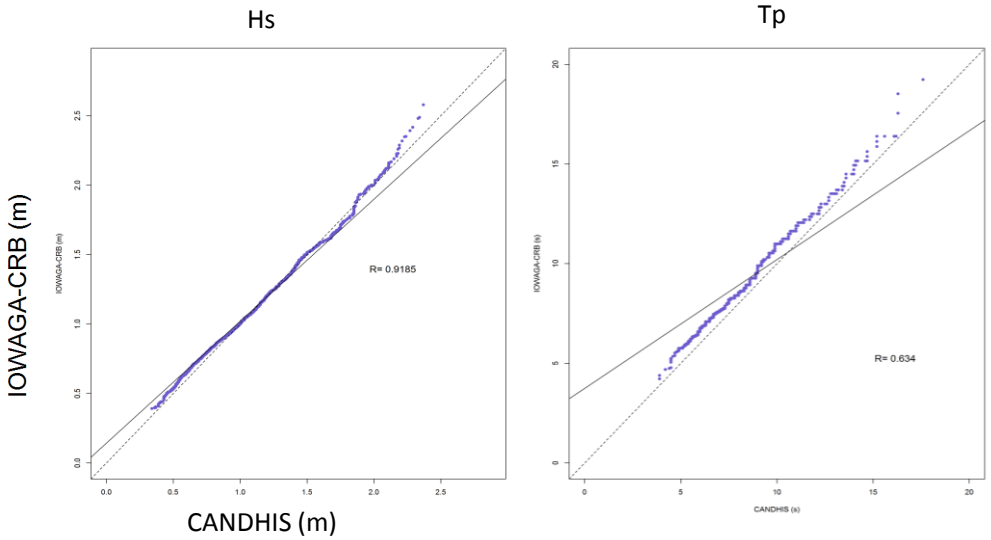
Validation

Example at Port-Louis (97101) in 1998







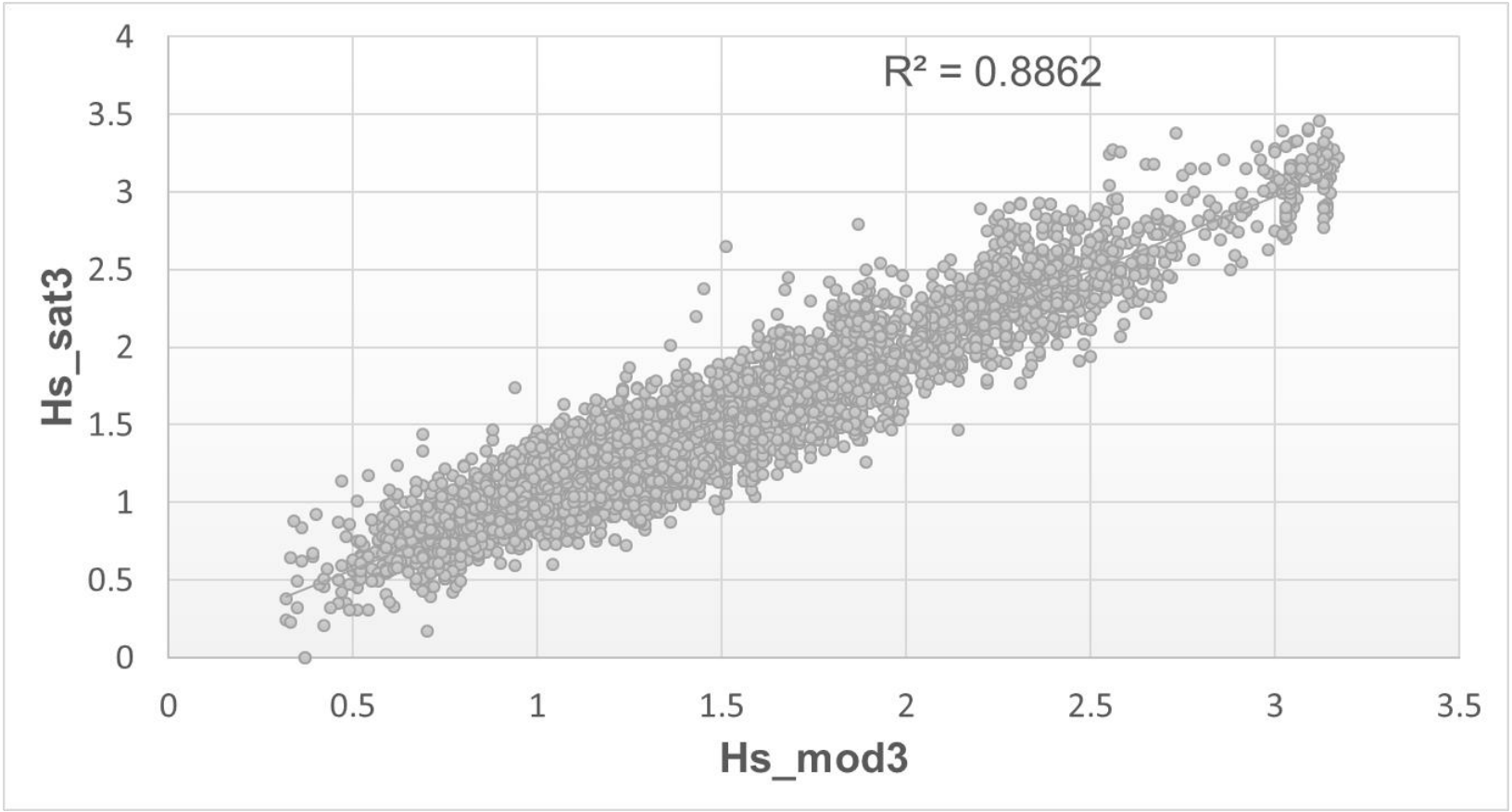


- Good reproduction of Hs by IOWAGA-CRB, overestimation for the highest values;
- The peak periods Tp are well reproduce in IOWAGA-CRB
- The main Dp (from E & ENE) are presents in IOWAGA-CRB

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Validation of H_s

Example along a sat track

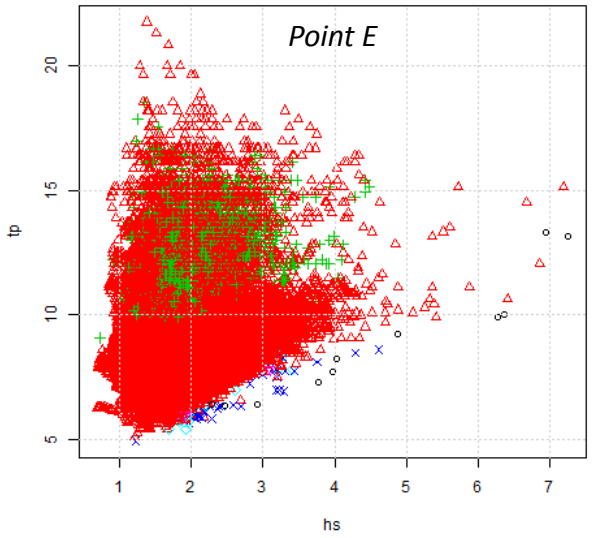


The model under−estimated the observations > to 2.5 m =>
Here IOWAGA is forced by ECMWF for 2008

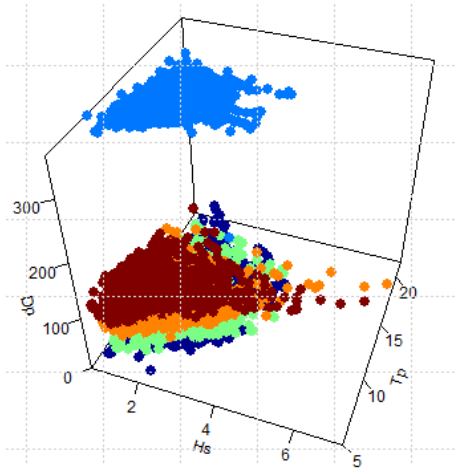
Clustering

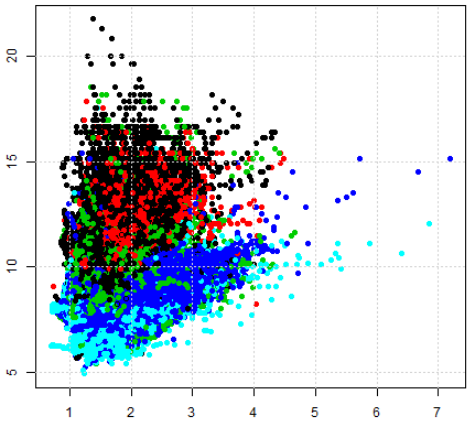
- Clustering algorithms applied on 5 offshore points around Guadeloupe island





- Kmeans++ applied using k=5 clusters





Point E

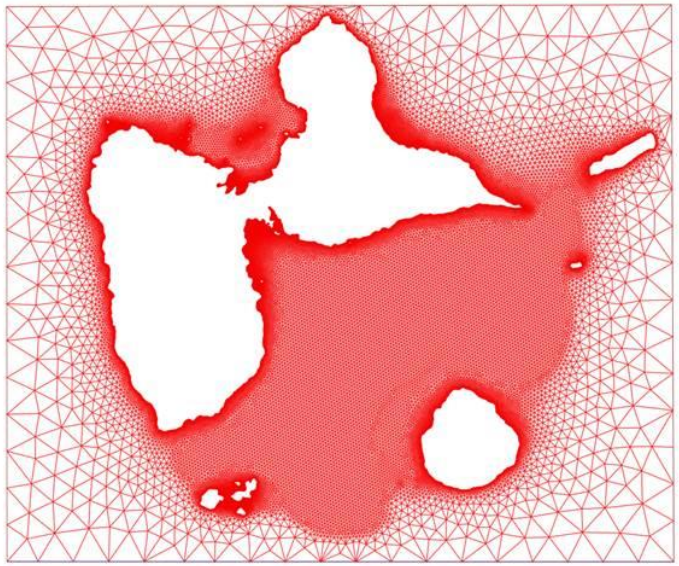
- DBSCAN algorithm used in order to have an idea of main clusters and eliminate the outliers. Here the optimum is k=5 clusters and 11 outliers.

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Offshore to nearshore

Boundary conditions

	Vagues Nord-Ouest (point 182)				Vagues Nord-Est (point 194)				Vagues Sud-Est (point 29)				Vents	
	Hs	Tp	Dp	Etal	Hs	Tp	Dp	Etal	Hs	Tp	Dp	Etal	Vit	D
Classe 1	1	7,9	69	27,8	1,4	8,4	81	40,5	1,4	8,4	82	40,5	6	8
Classe 2	1,5	8,2	68	31,4	1,9	8,1	89	36,8	1,9	8,1	87	36,8	6,4	8
Classe 3	1	10,4	33	34,4	1,6	10,1	37	34,4	1,6	10,1	41	34,4	7,9	8
Classe 4	1,4	13,5	26	25,9	1,8	13,1	15	37,8	1,8	13,1	19	37,8	5,9	9
Classe 5	2,1	9,2	60	30,4	2,5	9,1	74	42,4	2,5	9,1	73	42,4	8,9	8



Model setup

Bathymetry:

HOMONIM + Litto3D

unstructured grid:

coastal grid (5km to 100m)

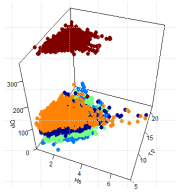
Spectral wave model WW3

Outputs: Sea states at the coast on a grid and at some points along the island (isobath 20 m)

- Step further:
  - Identify homogeneous cells knowing the dominant direction of the sediment transfers giving by the simulation for the wave contribution and mainly by expertise field for other contributions.

Our needs regarding satellite based products providing wave conditions

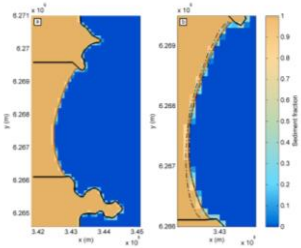
- For wave condition clustering



- To populate specific climate services (example of INSeaPTION)

- Working on uncertainties

- Have access to wave spectra for shoreline evolution in embayed beaches (LX-shore model)



- For flood induced by overtopping studies



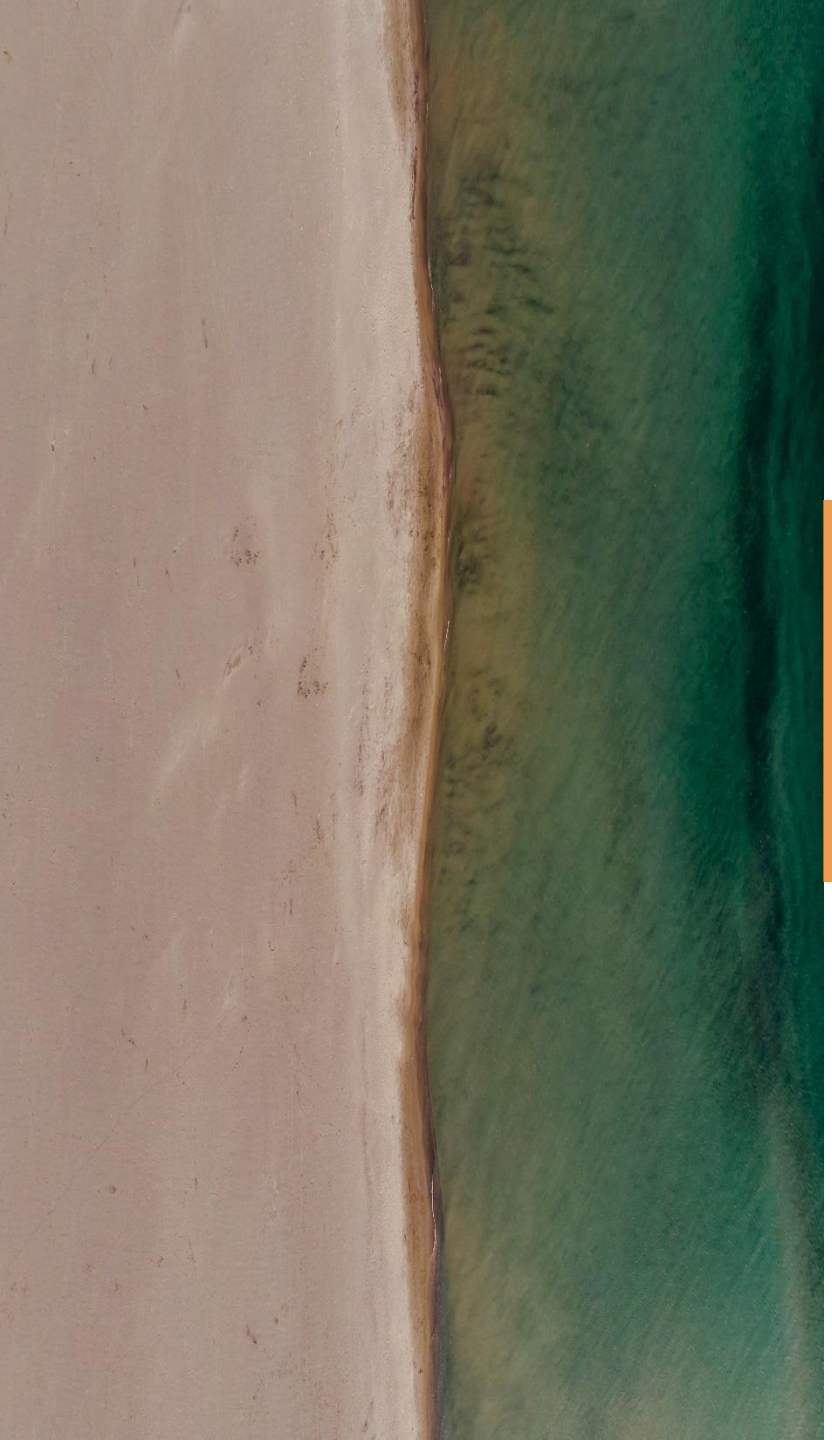
- Wave conditions offshore leewar coasts (example: west coast of Caribbean islands)

Summary

- An example of a policy support study using sea state conditions:
  - Use a clustering methodology to feed a wave model;
  - Offshore to nearshore simulation in order to obtain the sea states along the Guadeloupe coasts (100 m resolution);
  - Identifiy the dominant direction of the sediment transfers and the homogeneous cells associated.

  A possible alternative:
  - Use satellite data on the zone, in order to define the clusters using the DBSCAN algorithm. Indeed, DBSCAN was made especially for observations and to filter outliers. This way we can use directly the wave clustering. That could reduce sources of uncertainties?

- Interests and needs at BRGM for satellite based products:
  - For validation
  - Uncertainties reduction
  - As input for modelling
  - …

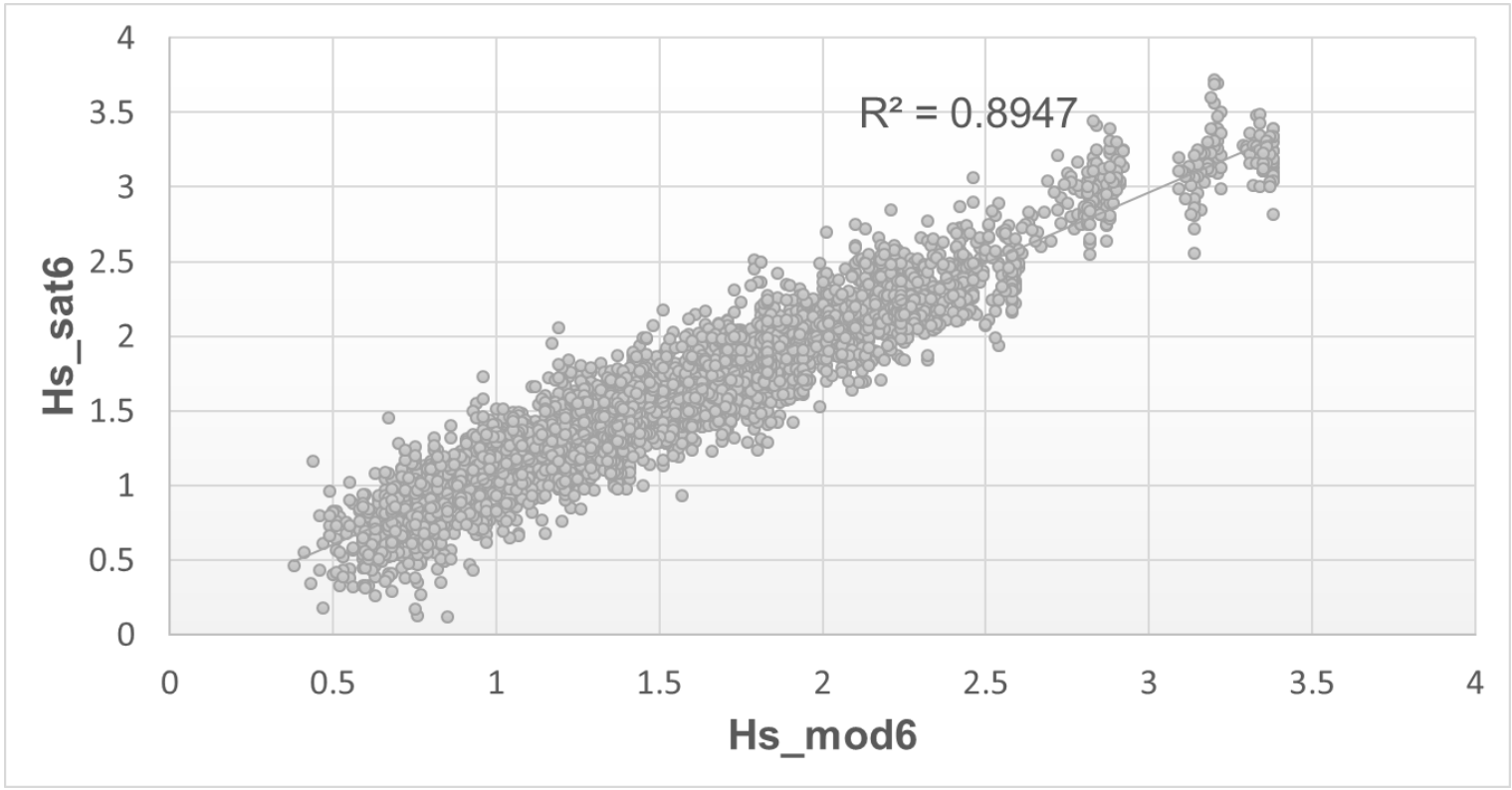


THANK YOU

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VALIDATION OF Hs

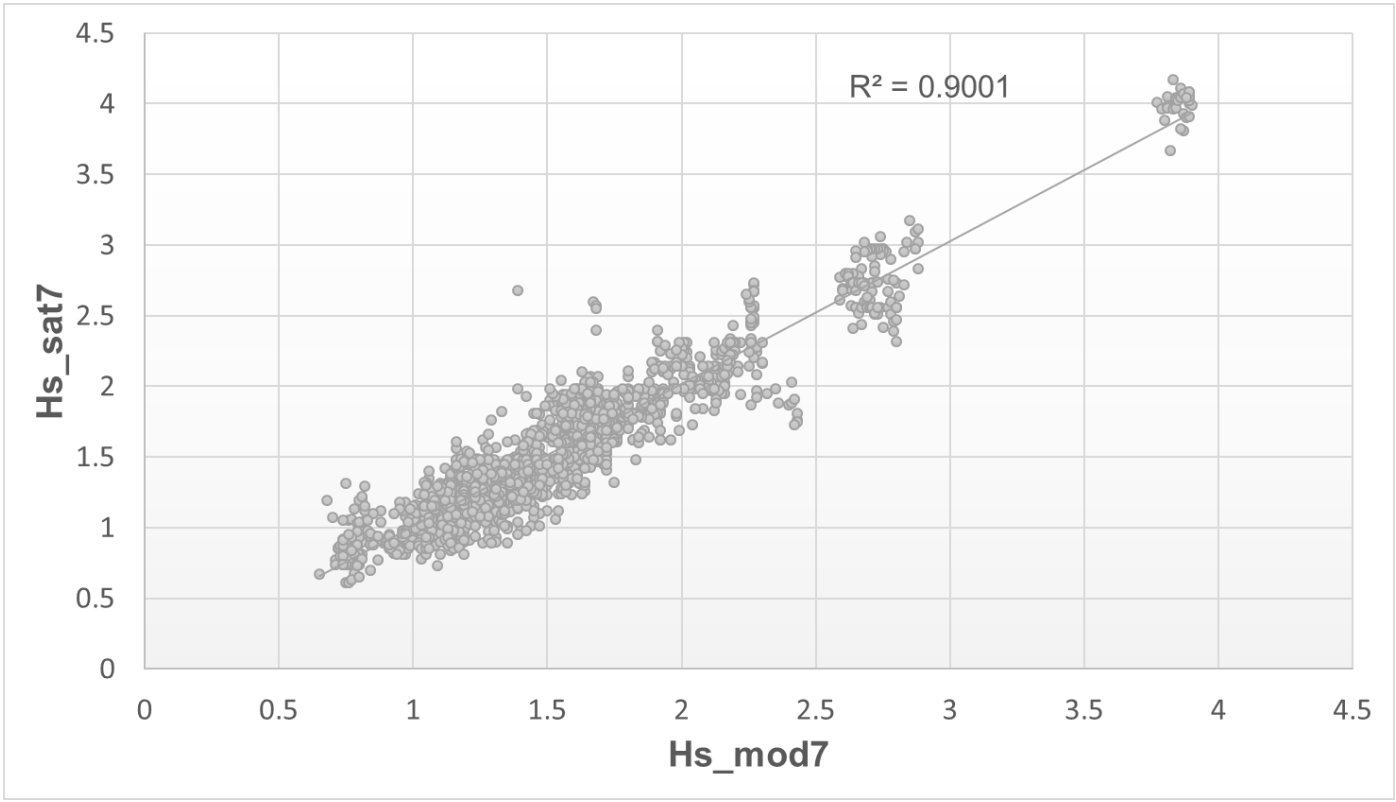
Example along the sat track 6



The model under−estimated the observations > to 2.5 m =>
Here IOWAGA is forced by ECMWF for the year 2008

VALIDATION OF Hs

Example along the sat track 7



The model under−estimated the observations > to 2.5 m =>
Here IOWAGA is forced by ECMWF for the year 2008

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