AI FOR HYDROCLIMATIC EXTREMES
Challenges in geosciences

Abel HENRIOT, a.henriot@brgm.fr
Cécile Gracianne, c.gracianne@brgm.fr, Jérémy Rohmer j.rohmer@brgm.fr
& many, many other

7th of mars 2023

Abel HENRIOT
Hydrogeologist & Datascientist
10+ yrs of experience

Understand GroundWater Ressource evolution over time and space

Quantity & Quality aspects
Modeling & prediction

BRGM

French Geological Survey
60+ yrs of experience

Deliver science based knowledge to support decision maker in the field of geosciences

Geologoy, Geophysics, Mineral Resources, Natural Hazards, Groundwater
Monitoring, mapping and Data Providing

Fondamental Research, Public Policy support, Transfert to Economic World

www.brgm.fr

BRGM's Journey to face geoscientific challenges using AI in 3 chapters

GROUNDWATER

RISK MANAGEMENT
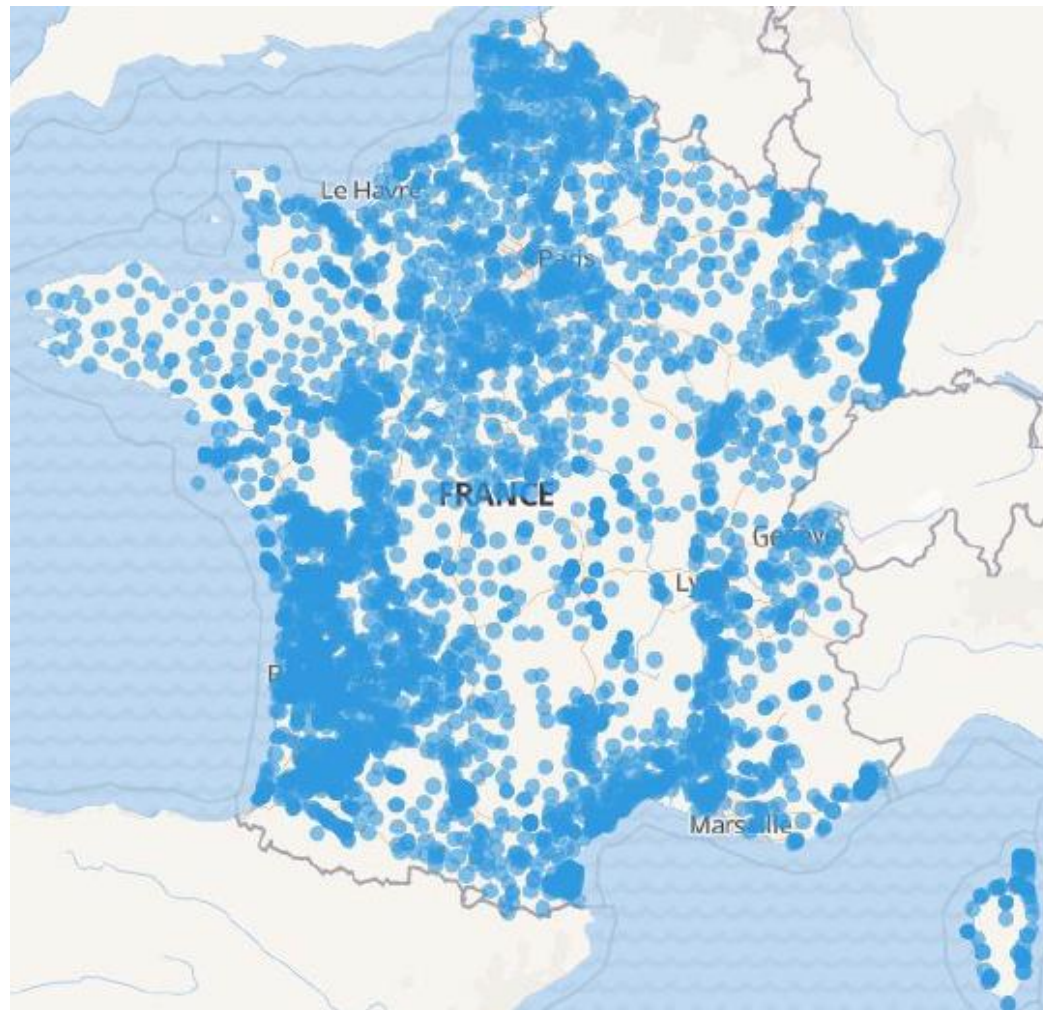
COASTAL HAZARDS

GROUNDWATER

Problem set up

535 851
wells

3679
Wells with
> 1000 GWL
records

118 M
chemical
analyses

2861
chemical
components
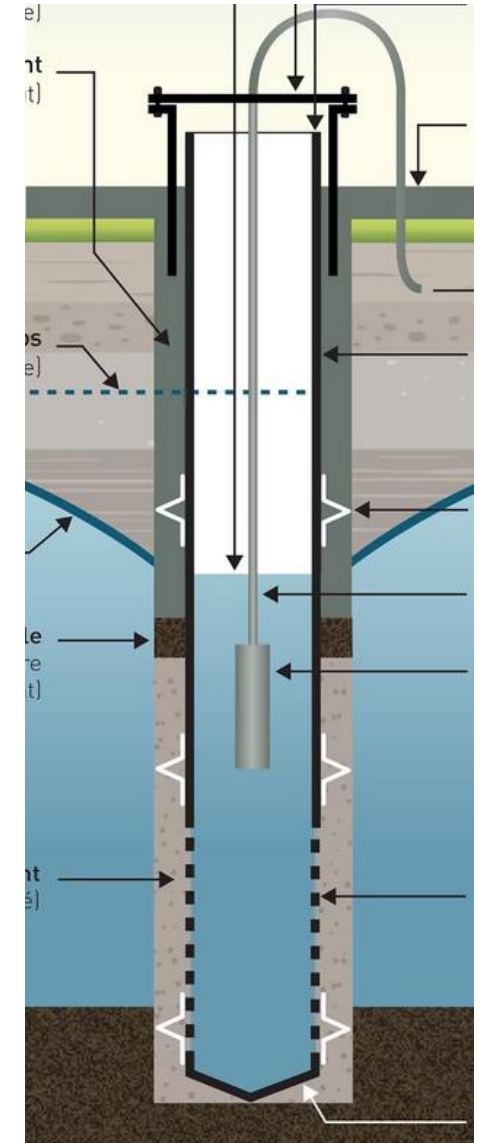
GROUNDWATER

Challenge

- **Need for GWL prediction at scale of France**
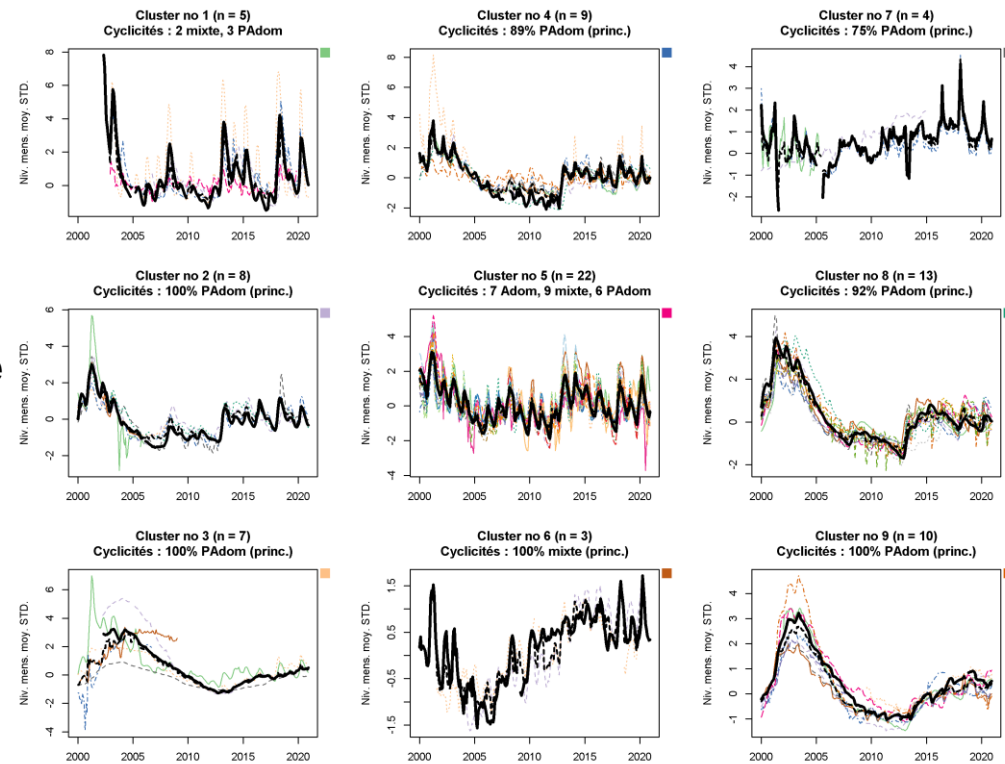
- **Fast reliable, trustable, explainable**

GROUNDWATER

Challenge

Deals with:

- **Inertia**

- **Effect of Climate Change**
- **Effect of Pumping**

- **Corrupted data**

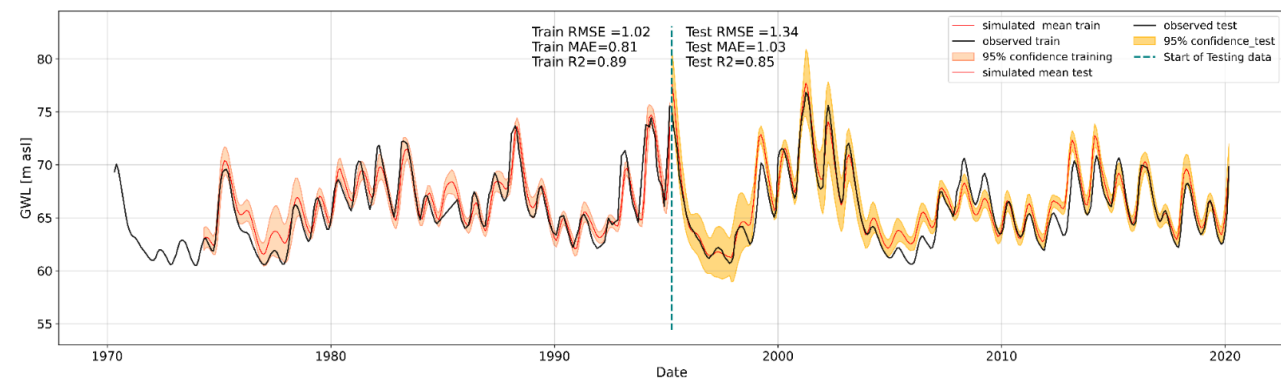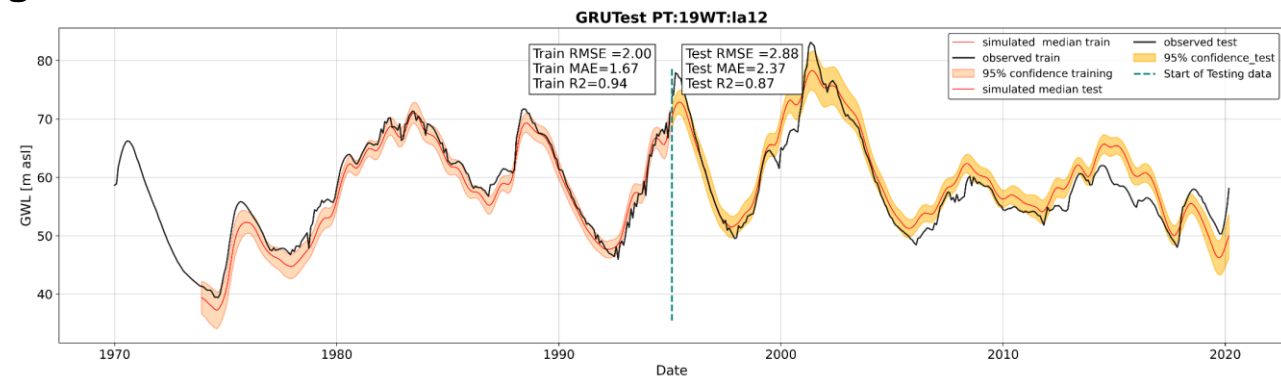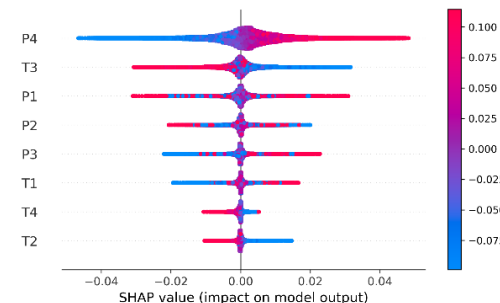- **Learn the evolution of GWL in time and space ?**

GROUNDWATER

Achievement

- **Hybrid architecture :**
  - **Wavelet decomposition + GRU/LSTM/BILSTM**
  - **Point scale**
  - **Regionnal scale**

NATURAL RISK MANAGEMENT

Problem set up

- **Rapid assessment of crisis situation appears 'slow' with existing sensors networks (accelerometers, raingauges,…)**

- **Humans could acts as sensors**
- **They commincate through social network**

7M people
Affected in 2022

500 M tweets
Every day
21 M tweets
Ian hurican – 12 days

RISK MANAGEMENT

Challenges : Early warning system

- **Process unstructured and heterogenous data**

- **Analysing text, extract geolocalisation**
  - **Irony, slang, abreviation**
  - **W/Wo geoloc.**
- **Real time**

- **High accuracy**

- **Deliver usable information for 'makers' on the field (firefighter, rescuers,…)**

alxousou
@alxousou

Je rêve ou il y a un tremblement de terre la ?
21:27 - 7 avr. 2014
♡ 3   Voir les autres Tweets de alxousou

vio ✏️
@vio_Official

🚨Tremblement de terre à St Raphaël à l'instant.
Pas très fort mais un mouvement de tangage
impressionnant tout de même!
21:28 - 7 avr. 2014
♡   Voir les autres Tweets de vio ✏️

Or Elya
@OrelyaB

Oh punaise!!! LA TERRE TREMBLE méchamment en ce
moment à #Nice06 !! Cc @GregLeclerc
21:28 - 7 avr. 2014
♡   Voir les autres Tweets de Or Elya

Ced Ced
@CedCannes

Tremblement de terre ressenti au Cannet !
21:28 - 7 avr. 2014
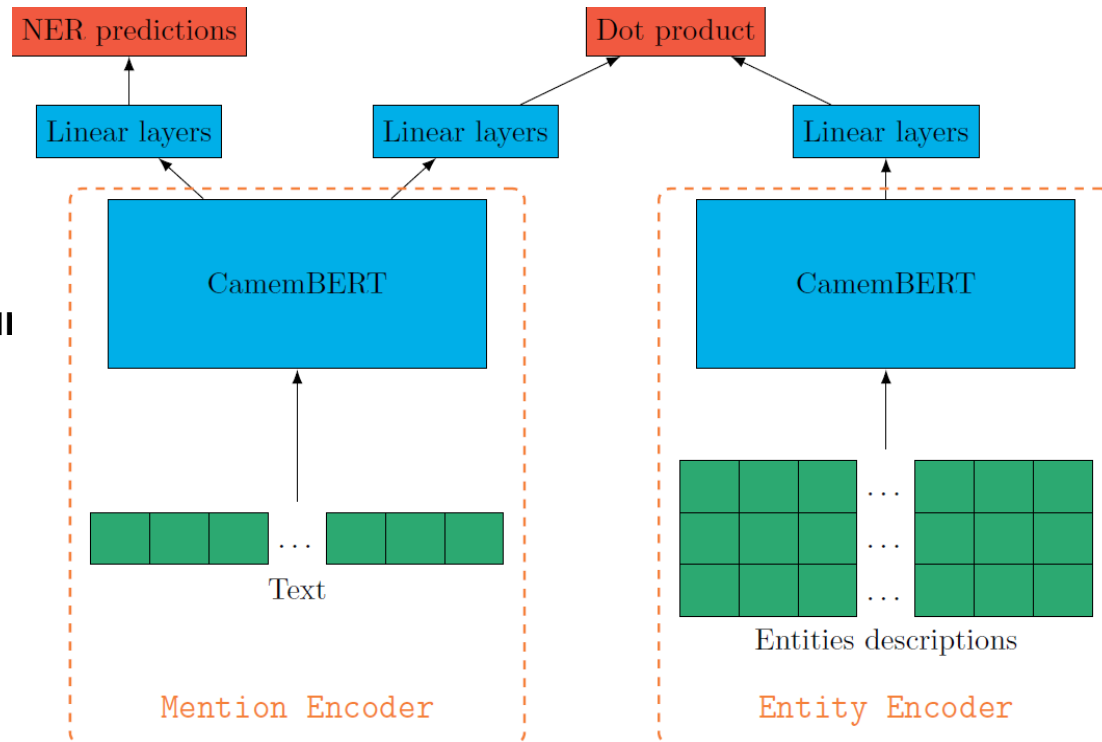♡   Voir les autres Tweets de Ced Ced

NATURAL RISK MANAGEMENT

Achievments

- **NLP**

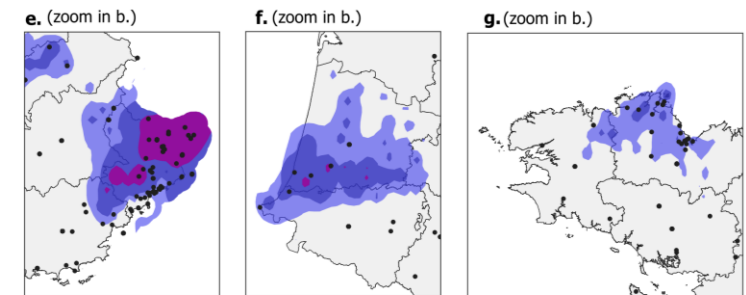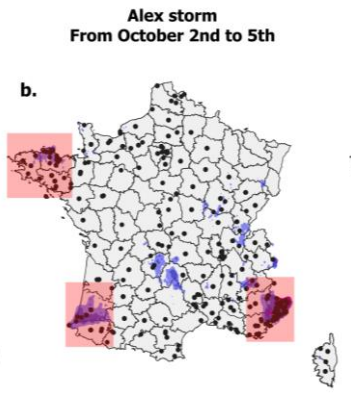- **Bi encoder architectu**

- **BERT**

NATURAL RISK MANAGEMENT

Achievments

- **Perception area :
  10 min**
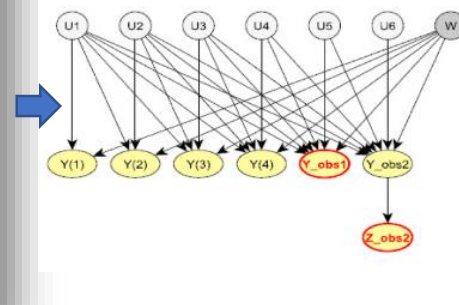- **vs Hours with in place monitoring**

Alex storm
From October 2nd to 5th

b.
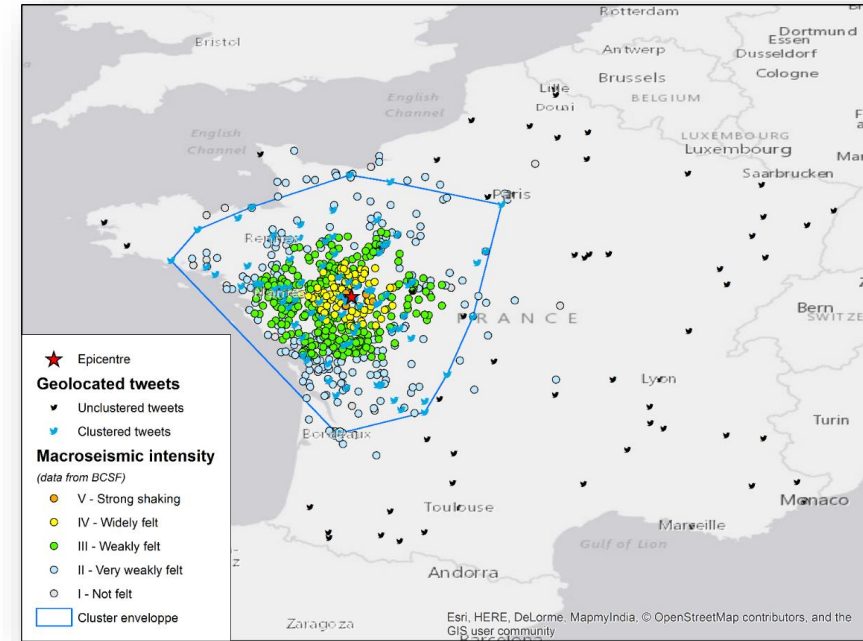
Significant flood events in the period:
- Alex storm, South-East / North-West / South-West of France

13

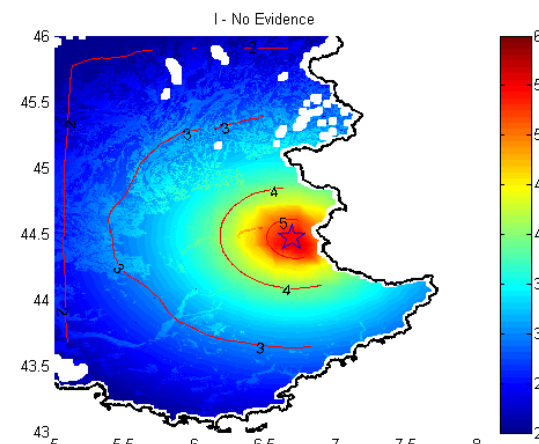G. Caillaut, S. Auclair, C. Gracianne, G. Touya, N. Abadie

NATURAL RISK MANAGEMENT

Achievments

- **Treated as complementary data source**
- **Gain in definition**

Soil motion intensity-sensors

Building intensity maps from Twitter and seismic data after an earthquake
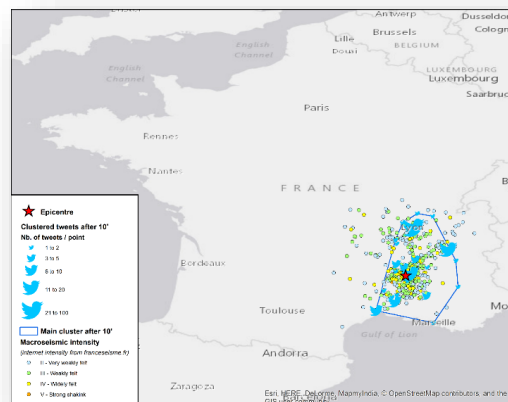
Soil motion intensity: sensors + Twitter

14

Fayjaloun et al. 2021

NATURAL RISK MANAGEMENT

Achievments

Webportal: www.suricatenat.fr

COASTAL HAZARDS

Problem set up: marine flooding

2.5B €
Total cost Xynthia

700 m€
**Marine
Flooding**

53 deads
Xynthia Storm- 2010

COSTAL HAZARDS

Challenge: learn the extrems ?

Deals with :
- **Extrems**
- **Too short time series**
- **Outliers / corrupted data**
- **...**
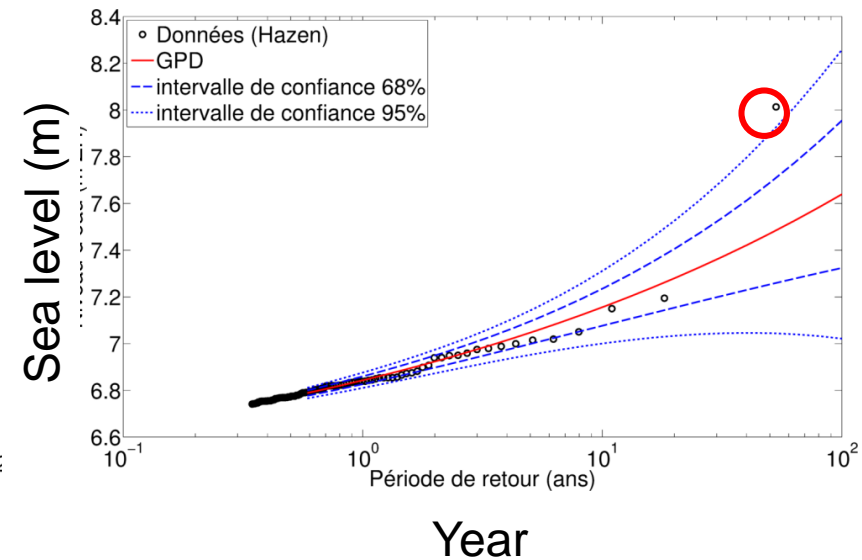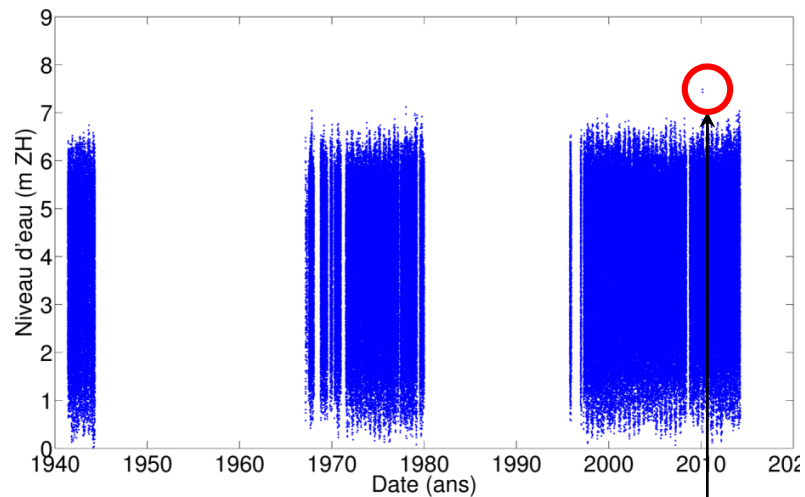
Sea level at La Rochelle (France)

28/02/2010

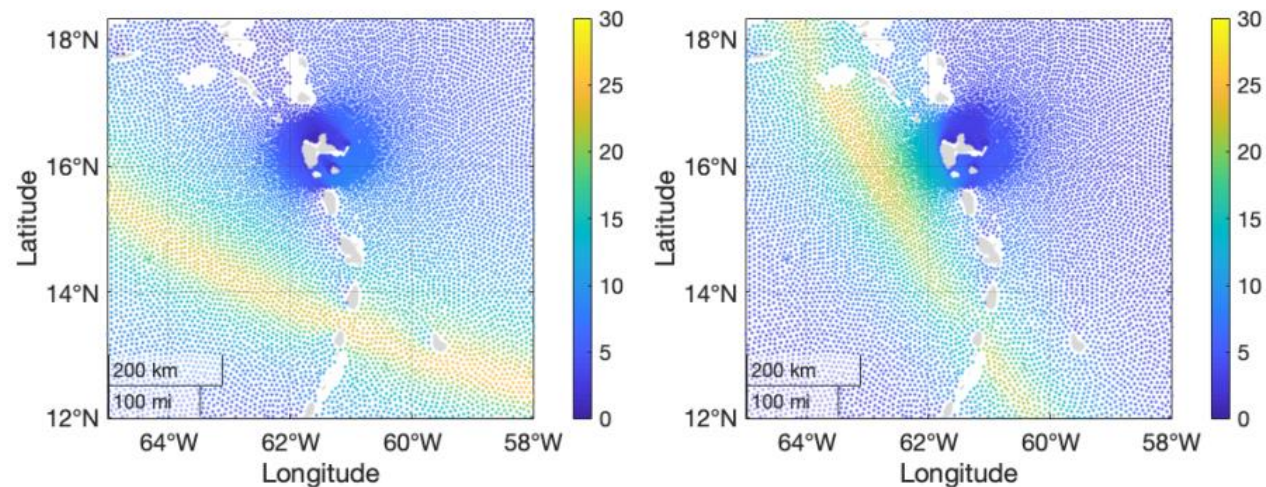Year

17

COSTAL HAZARDS

Challenge: learn the extrems ?

Deals with :
- **Extrems**
- **Too short time series**
- **Outliers / corrupted data**

Non stationarity of extrems
- **Effect of CC ?**

Spatial distribution of maximum wave height during two different cyclones at Guadeloupe (French West Indies)
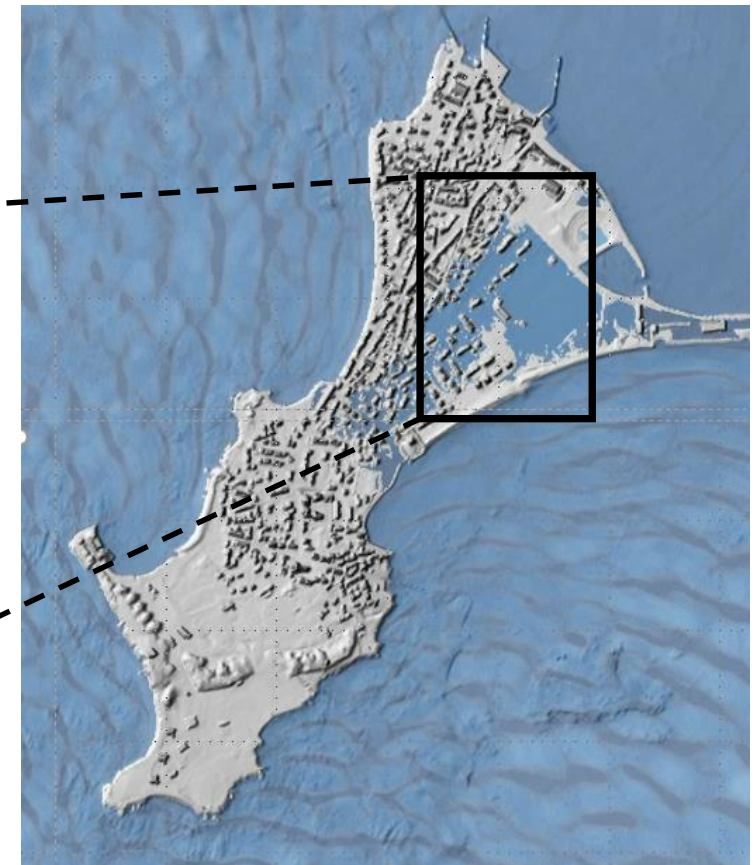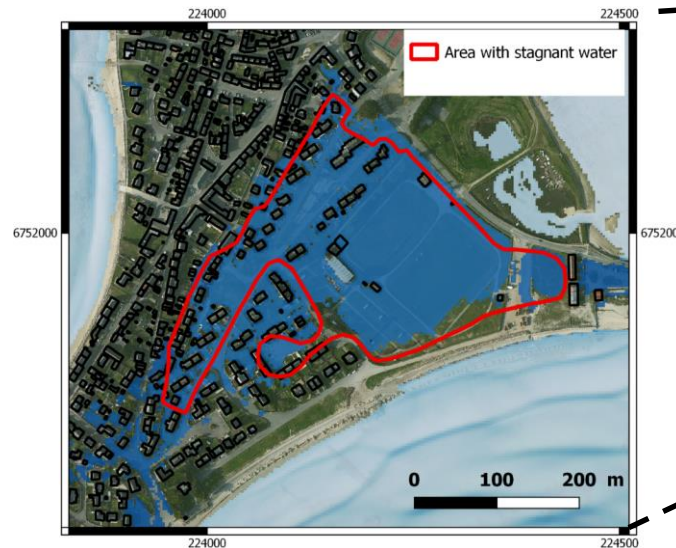
18

COSTAL HAZARDS

Achievments : Early warning system

- **Surrogate model**

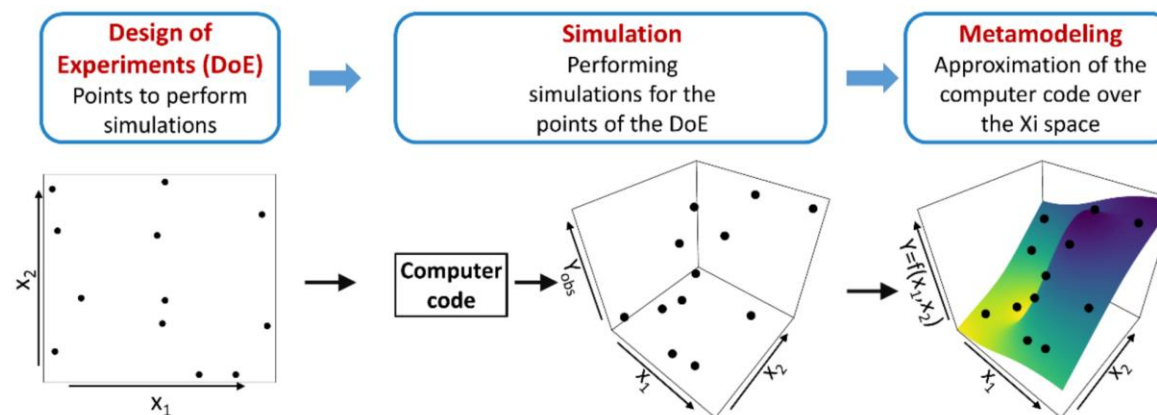Comparison with observations – RISCOPE project
[Idier et al., Nat. Haz., 2020]

COSTAL HAZARDS

Achievments : Early warning system

Surrogate model
- **Kernel methods**

- **200 runs of deterministic model (2 days comput time each)**
- **Once trained: prediction <u>in minutes</u>**
- **Site specific: Gavres, Boucholeurs, Reunion Island**

[Idier et al., JMSE, 2021],[Rohmer et al., ENVSOFT, 2018], [Lecacheux et al., Nat. Hazard, 2021]

GROUNDWATER

S. CHIDEPUDI, BRGM, MC2 ROUEN
N. MASSEÏ, M2C ROUEN
A. JARDANI, M2C ROUEN
B. HENRIOT, BRGM

a.henriot@brgm.fr

RISK MANAGEMENT

C. GRACIANNE,
S. AUCLAIR,
G. CAILLAUT,
F. BOULAHYA,
E. LECAUDE

c.gracianne @brgm.fr

COSTAL HAZARDS

J. ROHMER,
D. IDIER,
S. LECACHEUX,
R. PEDREROS,
G. LE COZANNET,
R. THIÉBLEMONT

j.rohmer@brgm.fr

LESSONS LEARNED

DATA is (still) often a weakness in geosciences
- good data
- Sufficient scale in space and time
- Especially when dealing with low frequency, extremes values
- Monitoring networks as patrimonial good

AI methods are not straight forward
- Data pipeline
- Combinaison of methods
- Combination of scientific expertises
- From site specifif models to generalist models

Pluridisciplinary teams is the key

Many fields remains unexplored !
- BRGM is open to collaborate

Thank you !
a.henriot@brgm.fr