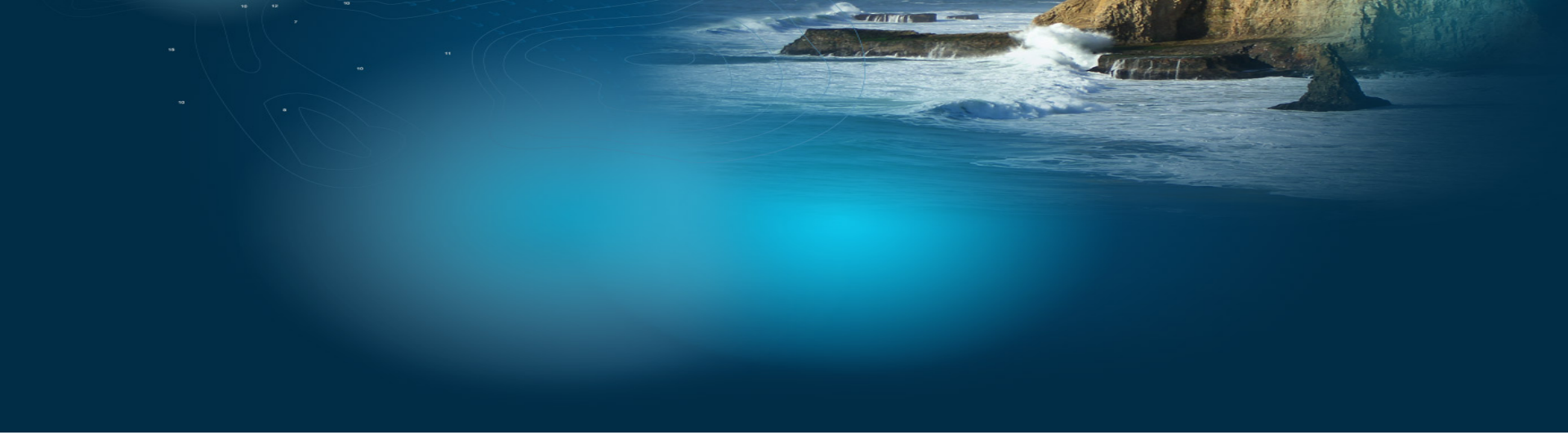


Extreme set-up and run-up on steep cliffs (Banneg Island, France)

Fabrice Ardhuin[(1)], Bernard Fichaut[(2)], David Corman[(3)], Serge Suanez[(2)], Jean-François Filipot[(3)]

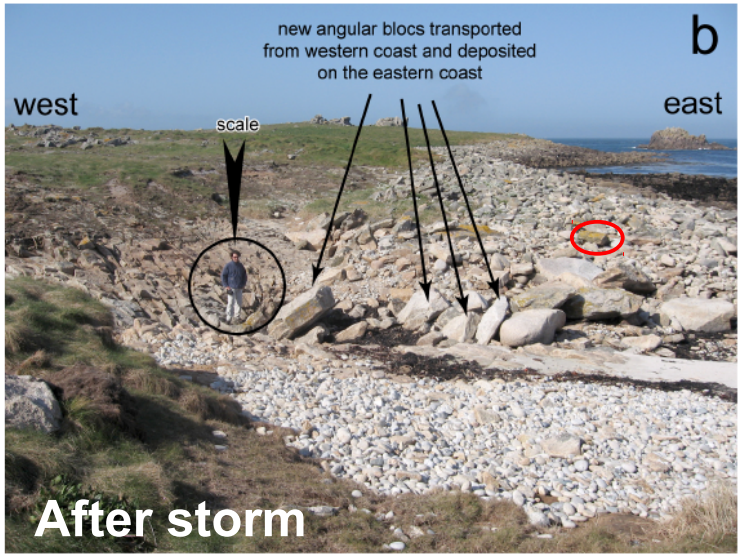
[(1)]Laboratoire d'Océanographie Spatiale, Ifremer, Plouzané, France

[(2)]LETG-Géomer-Brest,IUEM, Plouzané, France

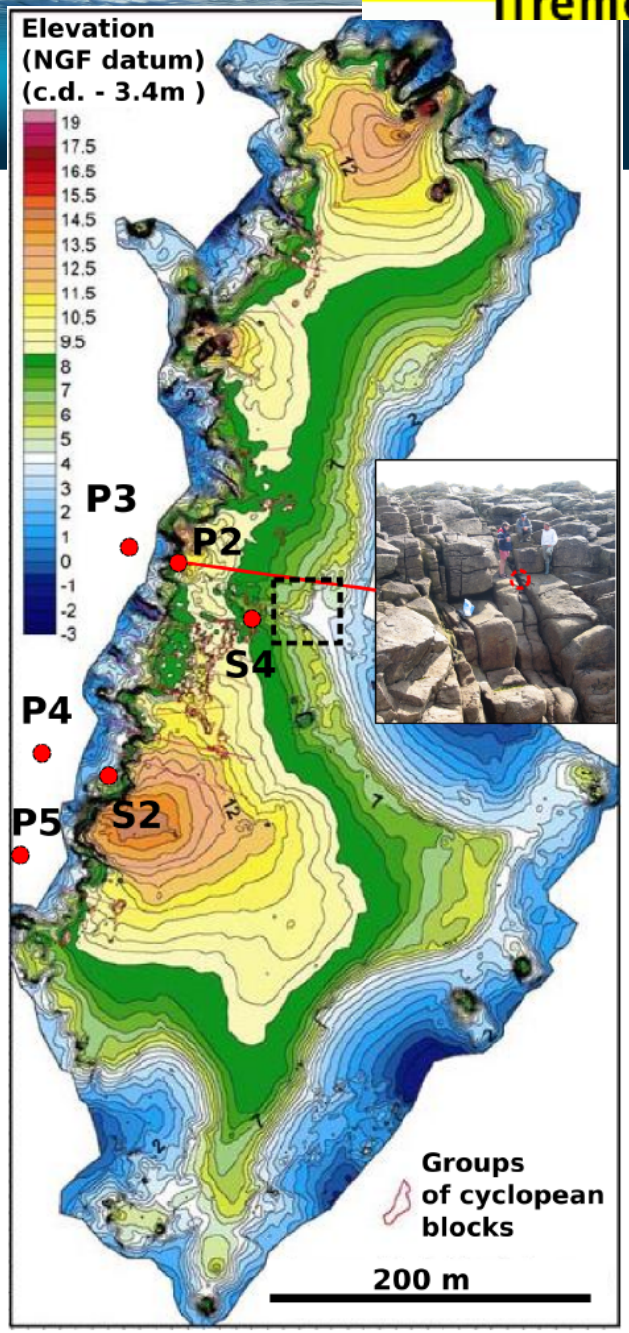
[(3)]Service Hydrographique et Océanographique de la Marine, Brest, France

http://wwz.ifremer.fr/iowaga

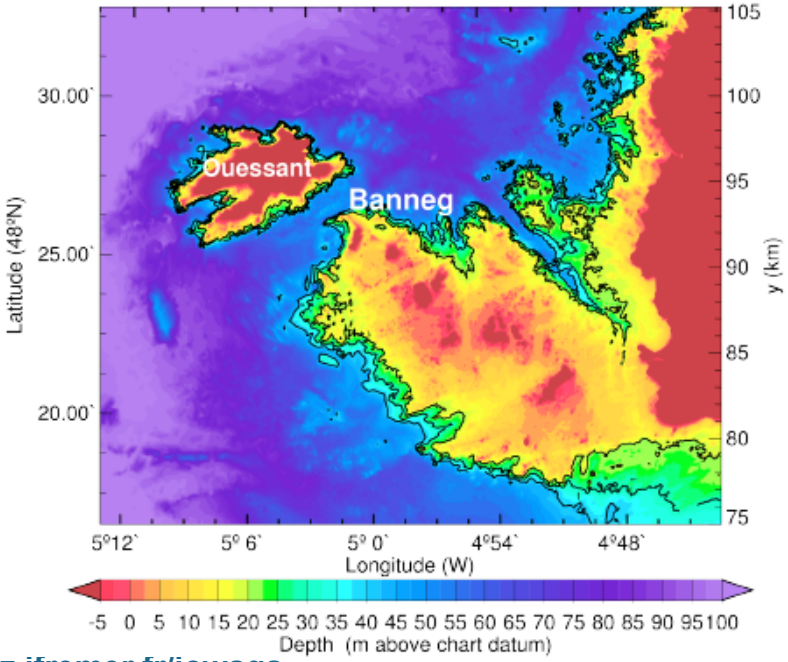
1. Motivations : flying stones …

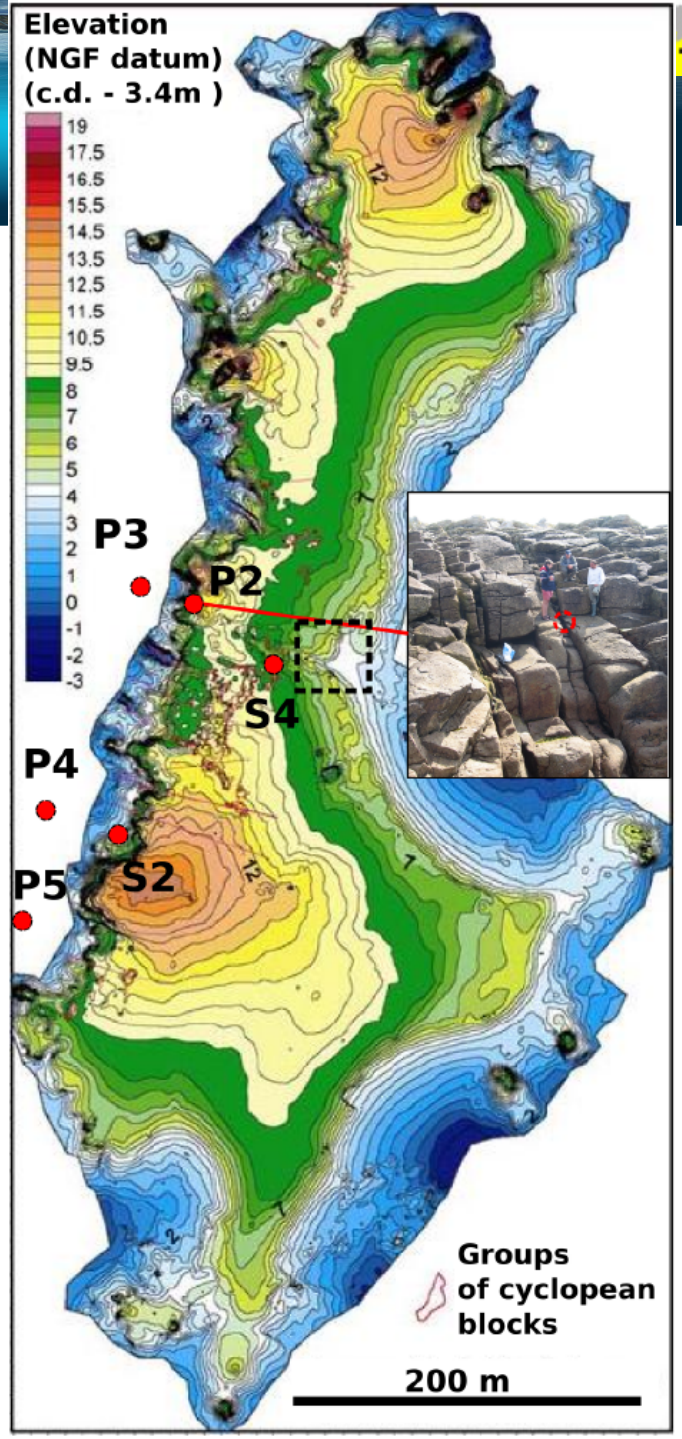


How did this happen ?



2. Where is Banneg ?





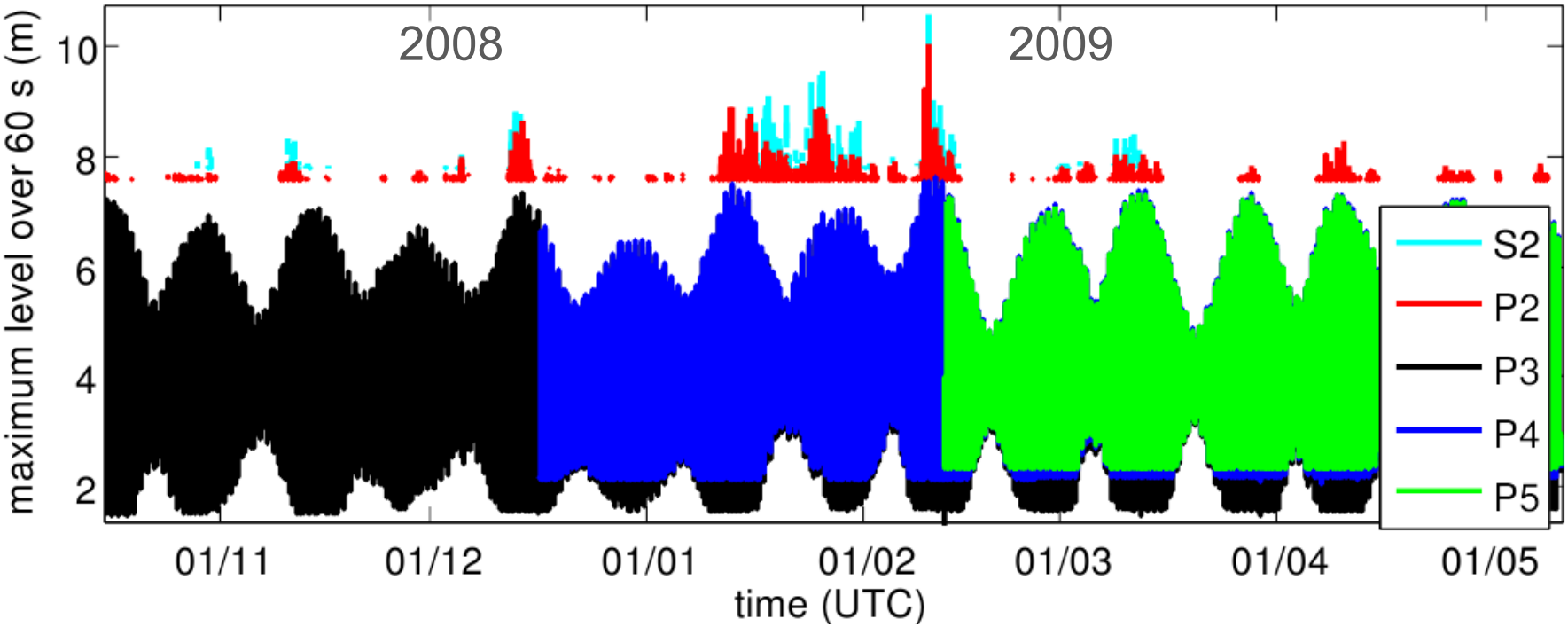
fremer

wwz.ifremer.fr/iowaga

3. Methods

pressure measurement and wave hindcast

Field experiment after the big storm of March 2008 : October 2008 to May 2009

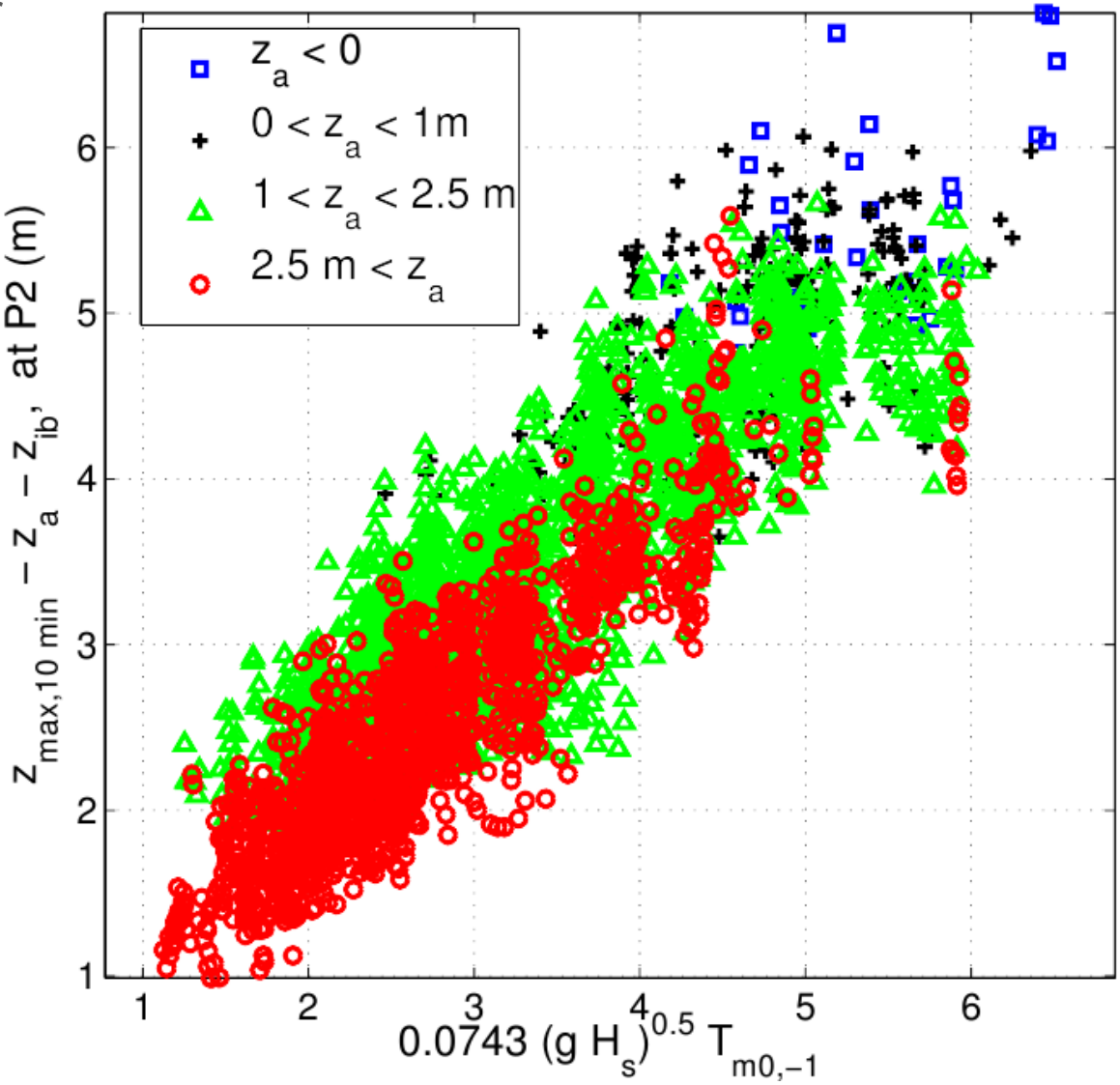


Wave hindcast 2002-2011 : 12000-node unstructured grid using WAVEWATCH III, forced by CFSR & ECMWF winds

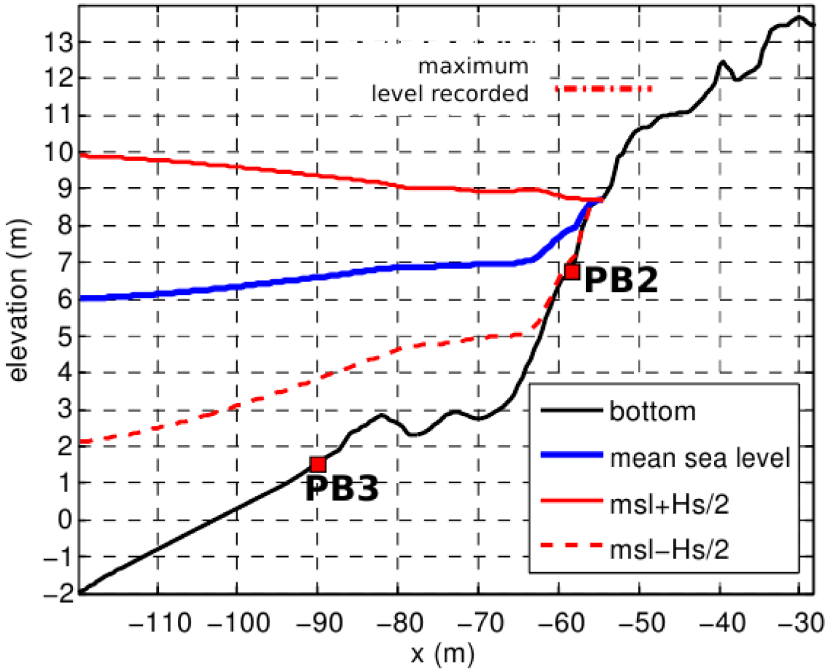
4. Main result : max water level is well predictable

The 10-minute maximum water level at sensor P2 is well predicted by :

$$z_{\max} = z_a + z_{\mathrm{ib}} + 0.0743 T_{m0,-1} \sqrt{g H_s}$$



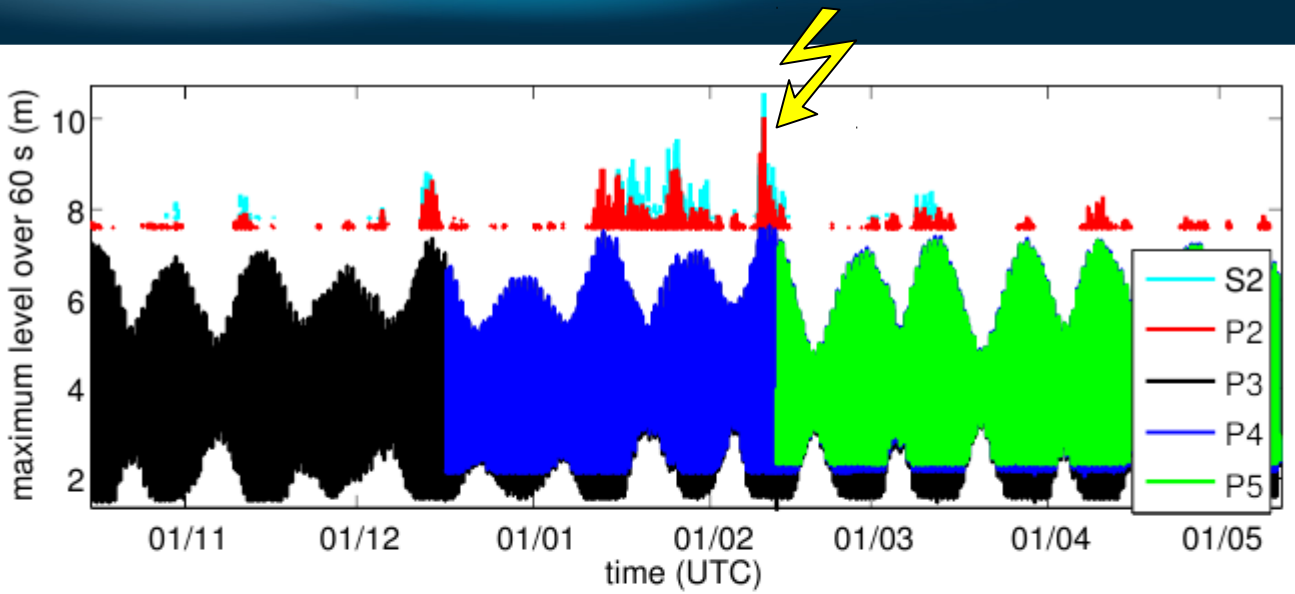
The cliff is rather steep …

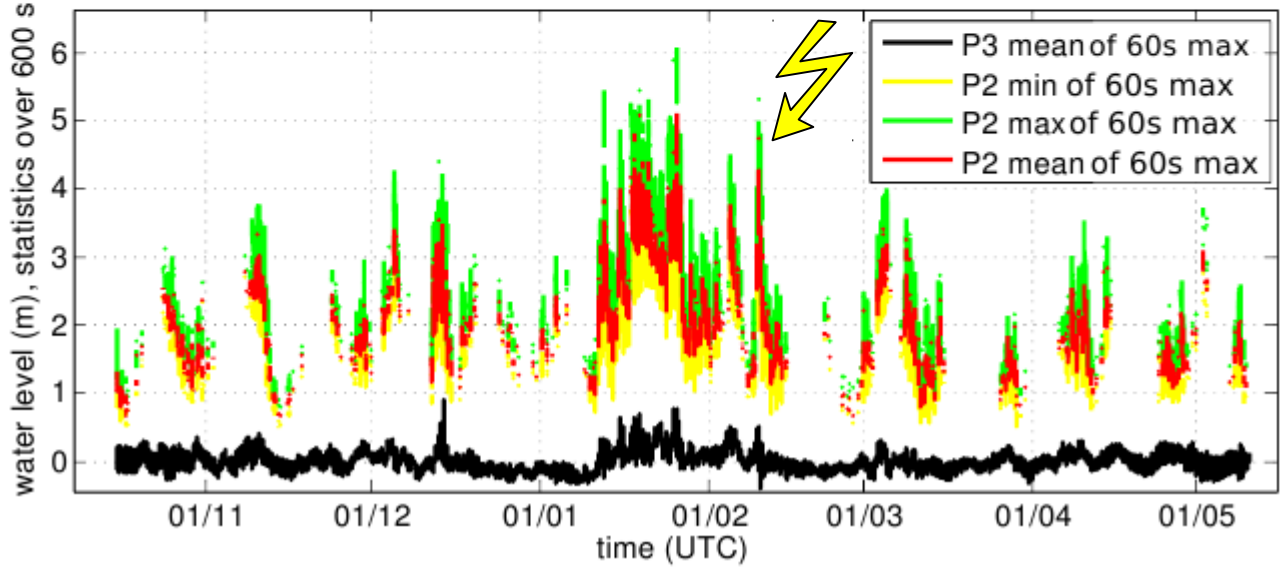


4. Observed water levels

We will now focus on **February 10**

The highest water level.

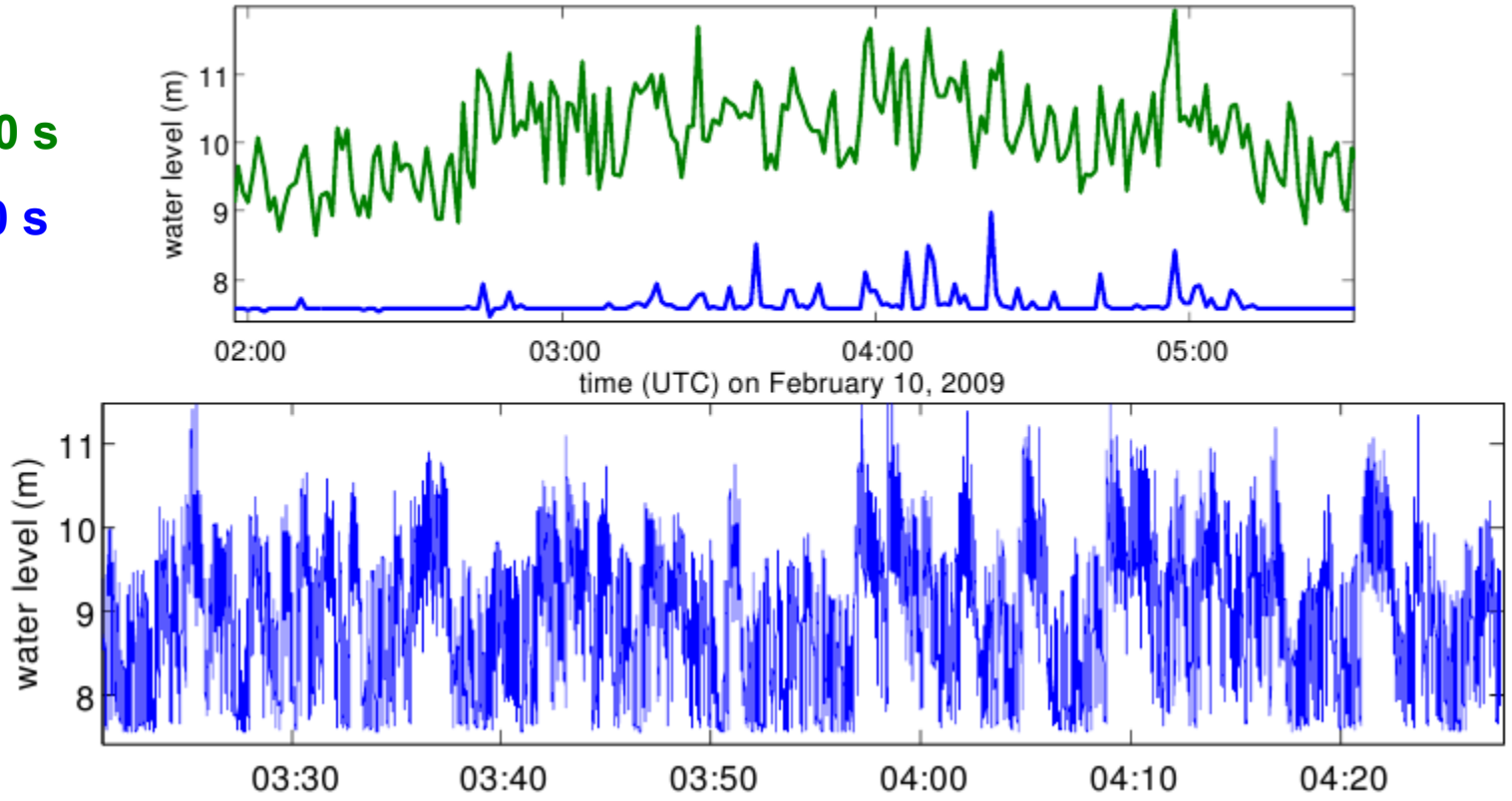




4. Observed water levels

Max over 60 s

Min over 60 s

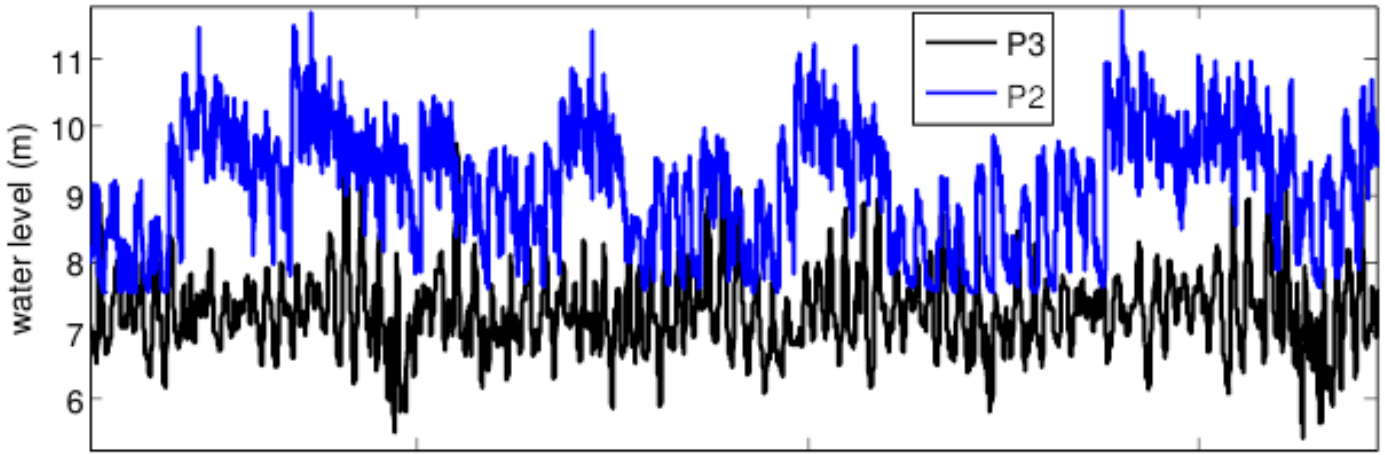


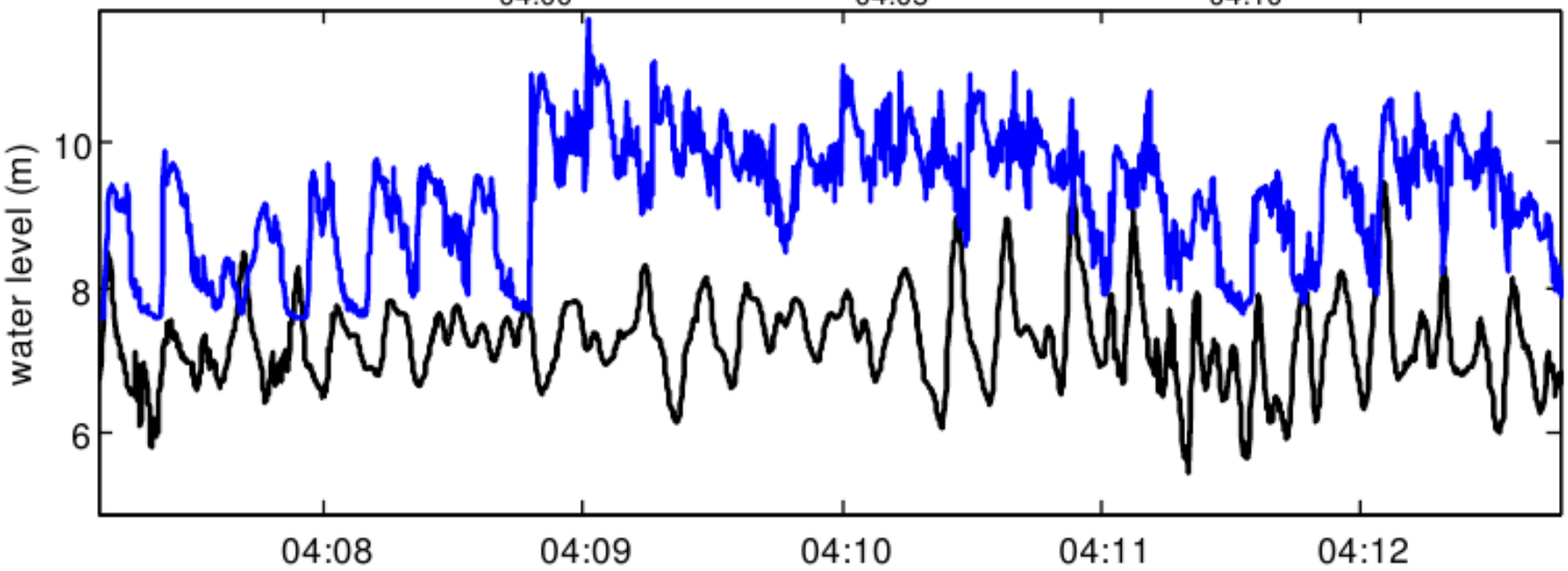
Full time series, 5 Hz.

4. Observed water levels

P2

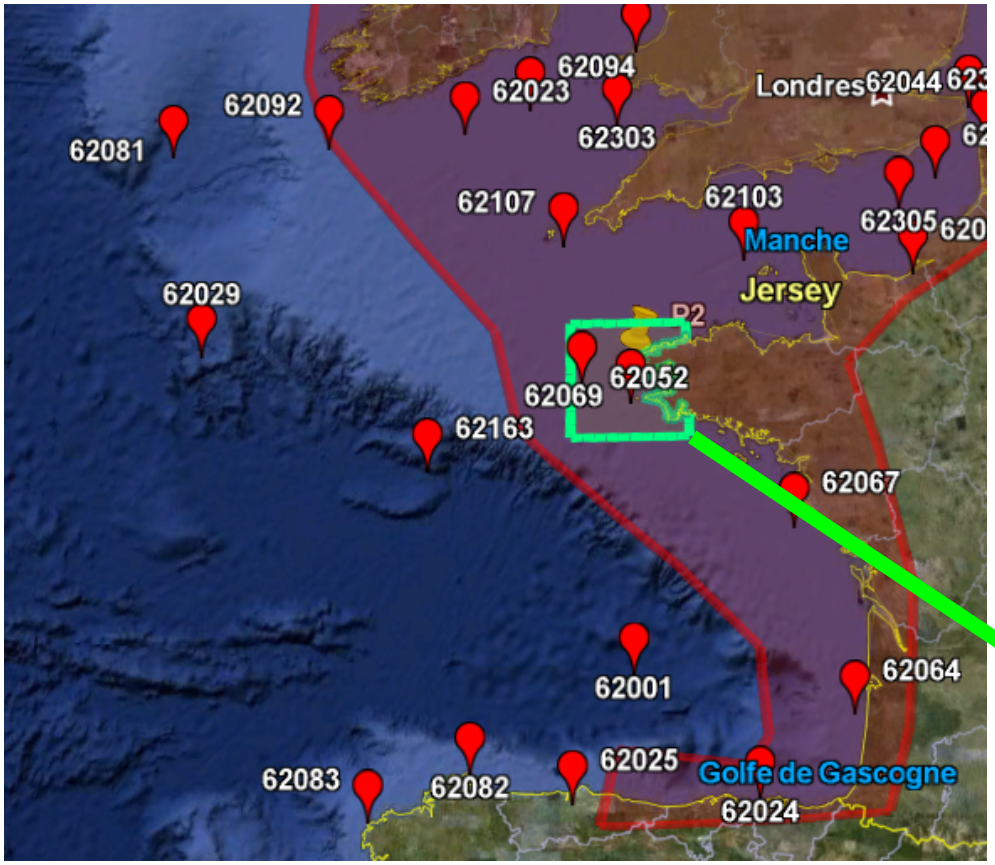
P3

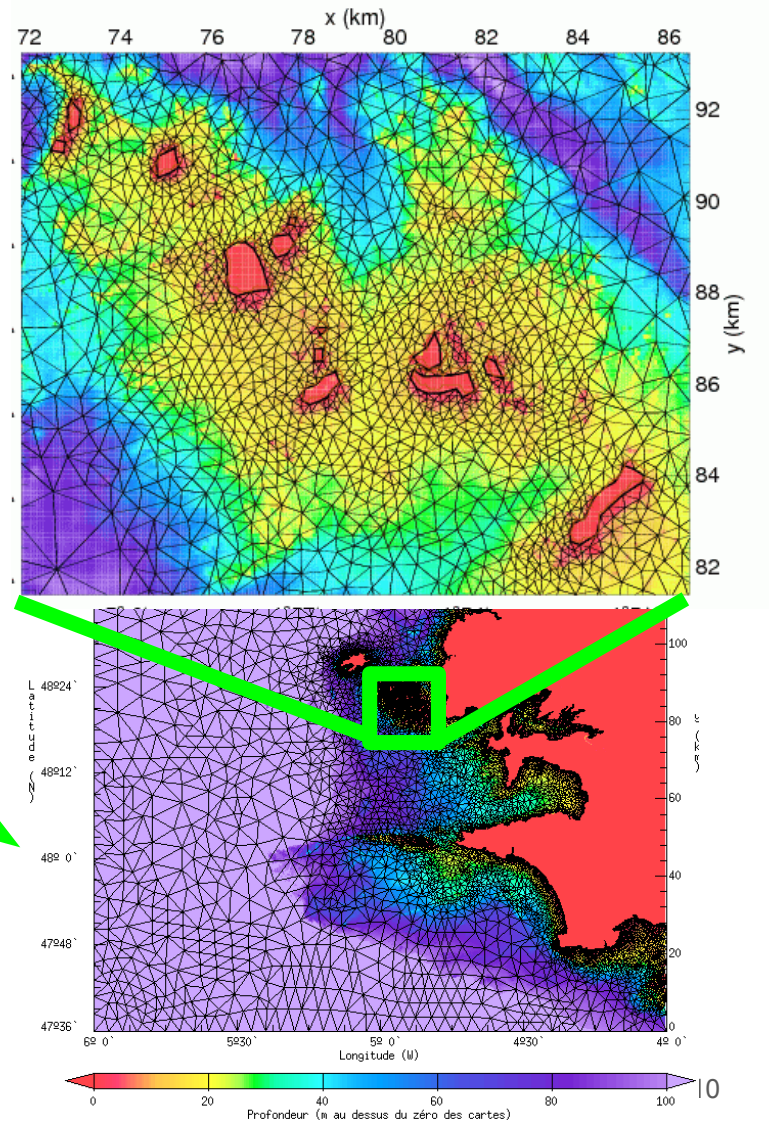




5. Numerical modelling

Triangle-based mesh (12000 nodes) nested in multigrid
(global 0.5° + Biscay 1/30°)



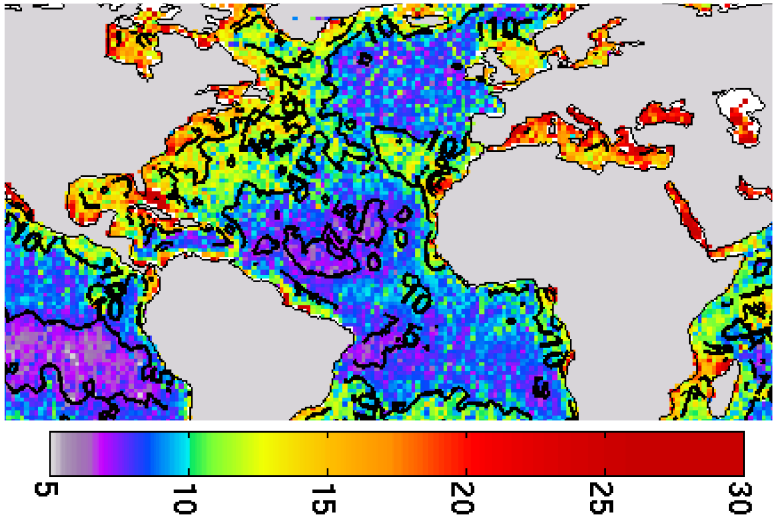


All models use the Ardhuin et al. (2010, TEST441b) parameterizations (input / diss.)

Forced by

- ECMWF wind analyses
- Previmer water levels and currents (www.previmer.org verified by MUSIC-processed 16-antenna WERA radar system : Gurgel et al. 1999, Sentchev et al., JMS 2011).

Verfication of offshore wave conditions :



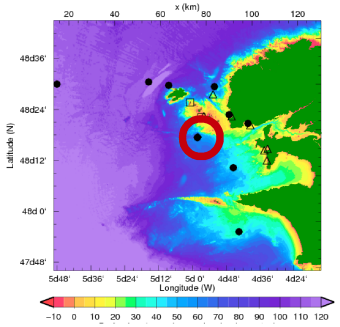
Normalized RMS error for Hs (%)

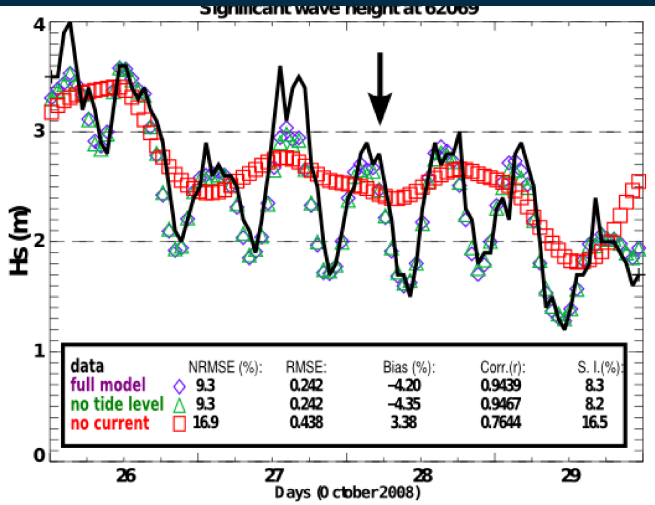
Errors at offshore buoy 62163 :

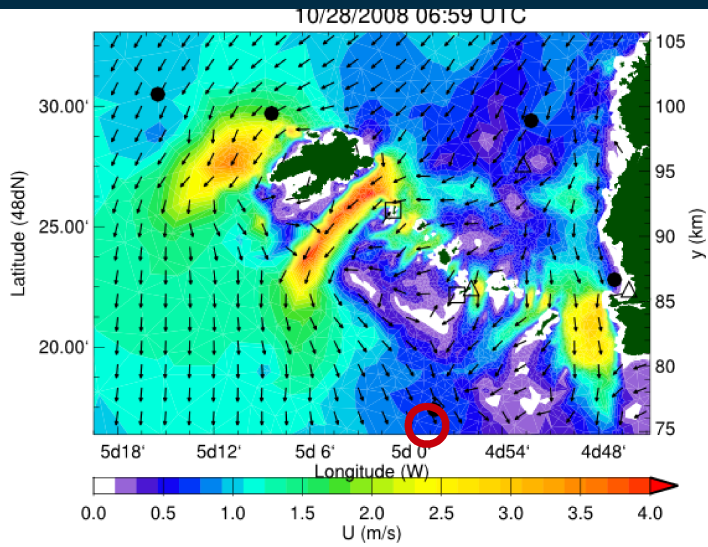
Hs : 9% rms error

Tmo2 : 7% rms error

Coastal validation :

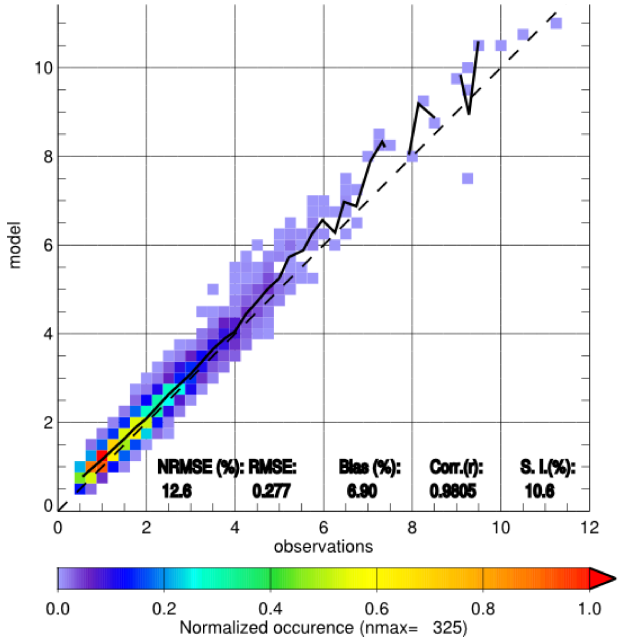






Case with steady offshore waves (Tp=10 s, Hs = 3 m) from the North-West

.... but ver unsteady coastal waves due to spring tides!



5. Numerical modelling

The 10-minute maximum water level at sensor P2 is well predicted by :

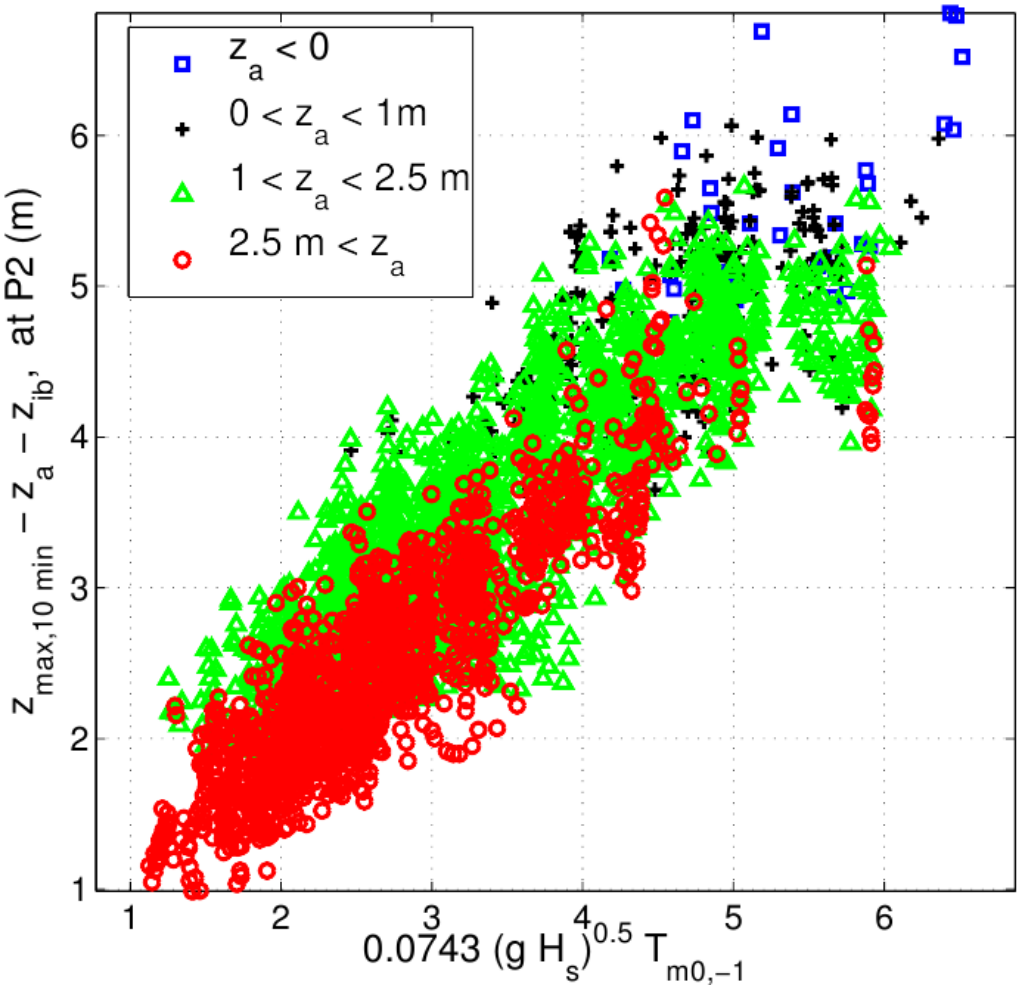
$$z_{\max} = z_a + z_{\mathrm{ib}} + 0.0743 T_{m0,-1} \sqrt{g H_s}$$

The 0.0743 coefficient would correspond to a shoreface slope of 8% using the Stockdon et al. (2006) run-up formula

(NB : probably Tp in Stockdon, not $T_{m0,-1}$)

Or 2% with Mase (1989)

The real slope is rather 15 to 40%
and our « run-up » is not the « full run-up »



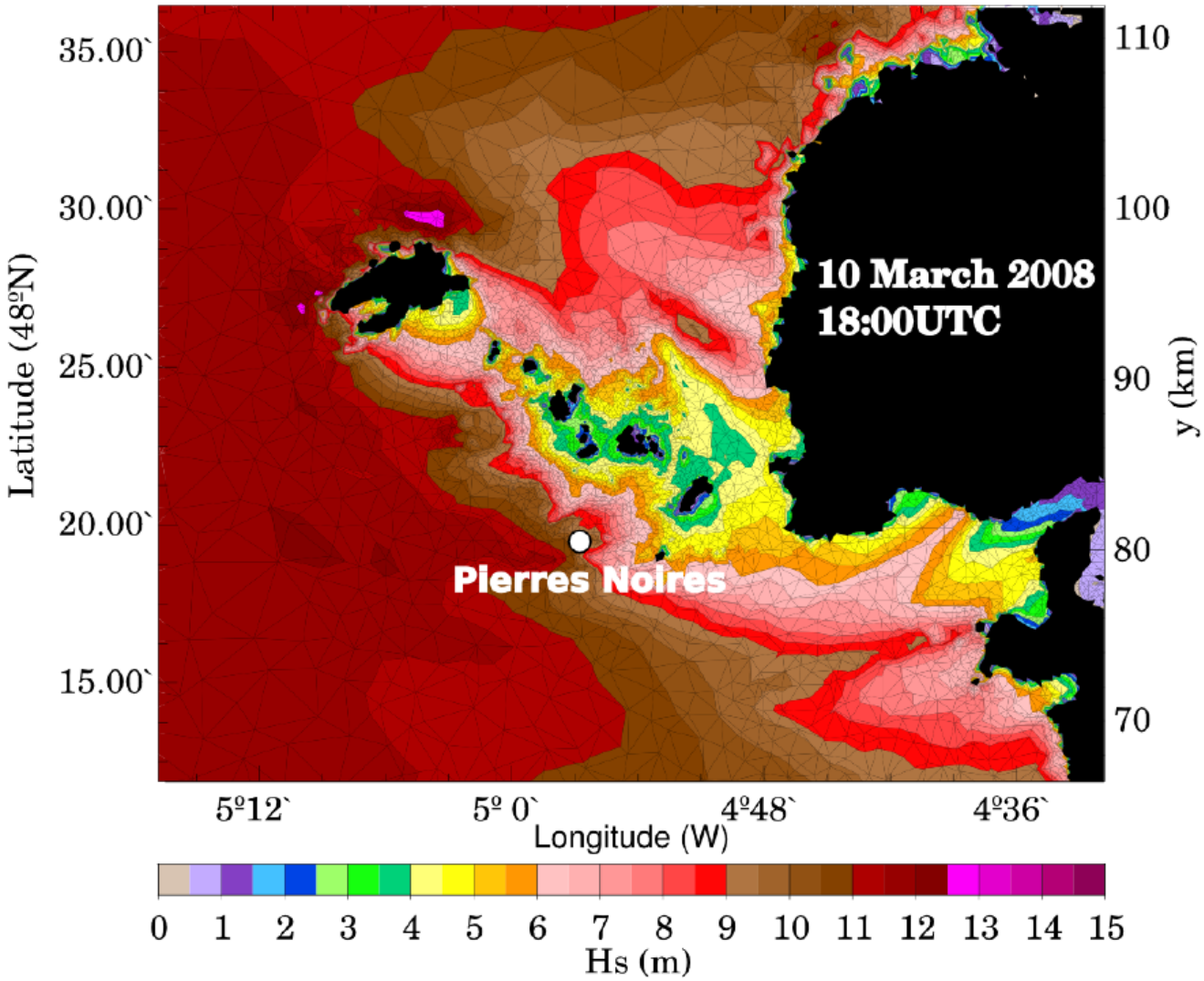
5. March 2008 Storm

We now extrapolate to March 2008 :
2009/2/10 → 2008/3/10

Hs
4.5 m → 6.7 m

$T_{m0,-1}$
9.0 s → 13.2 s

« Run-up »
4.4 m → 8.0 m
… easily going over the cliff … but how ??

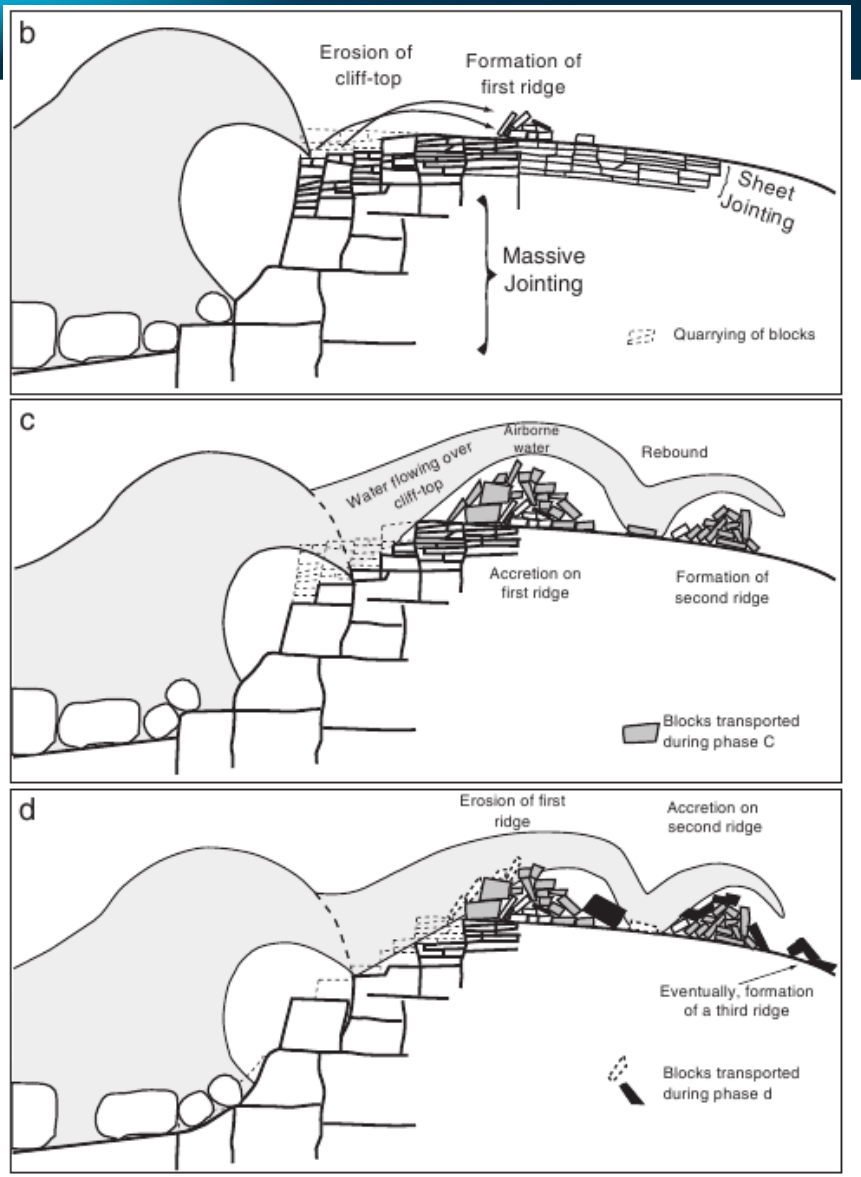


6. More questions

So that explains observations after the storm...

but during the storm, what did it look and feel like ?

not sure I want to be there …



Fichaut and Suanez (Marine Geology 2010)