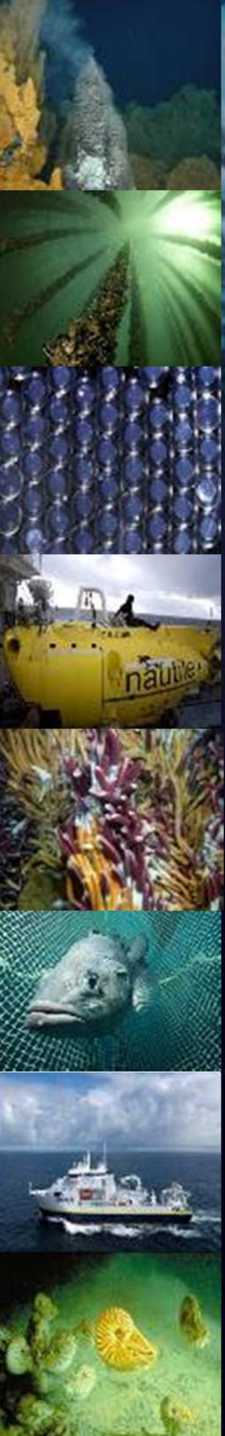


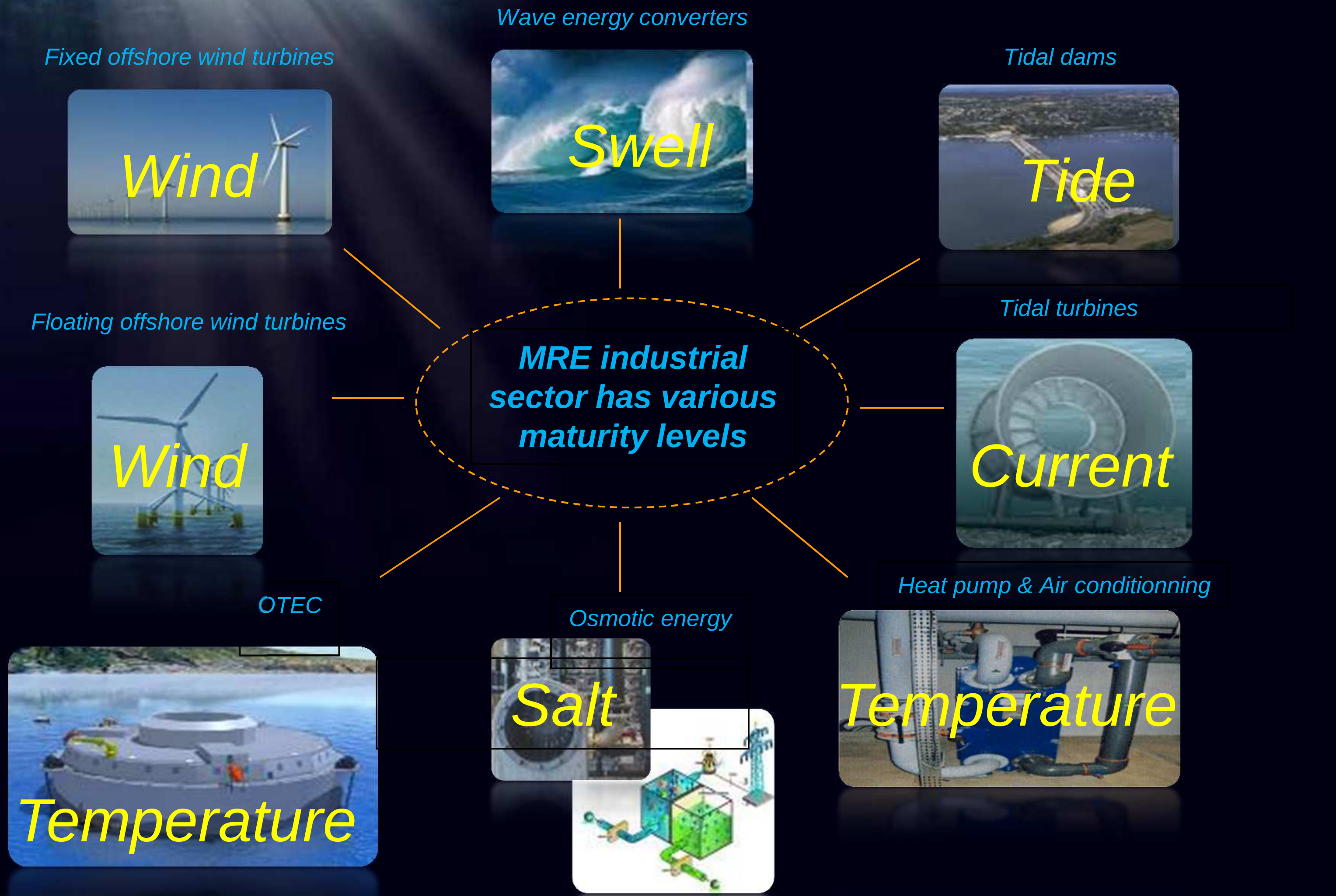
Current needs for currents for Marine Renewable Energies

Globcurrent –March 7th 2012

Yann-Hervé De Roeck - France Energies Marines Project Manager

Marine eneries

THE FULL SET OF OFFSHORE, MARINE AND OCEAN ENERGIES



Challenges and opportunities of the MRE development

AN IMPORTANT CONTRIBUTION TO THE FUTURE ENERGY MIX

Commitments to reduce CO_2 emissions

- European commitment (20/20/20)
- Grenelle de l'environnement (23% EnR, 3% MRE)

A very large energy potential worldwide

3 600 TWh/yr of technical potential by 2030

(France electrical energy generation: 600 TWh/yr)

National data	Fixed offshore wind	Floating offshore wind	Tidal	Wave	OTEC
2020 Objectives (inst'd capacity in GW)	6	1	0,5	0,2	0,2
Practical resource, TWh/an	50 ? 15 by 2020	200 ? 2,5 by 2020	15 1,5 by 2020	40 0,8 by 2020	20 000 ? 1,4 by 2020
Investment (excl. R&D costs) 2020, md€	10	3	1,5	1	1

Source : updated Ifremer foresigth study

Nothing specific, however needed

GENERAL NEEDS FOR ALL MRE

Surface currents

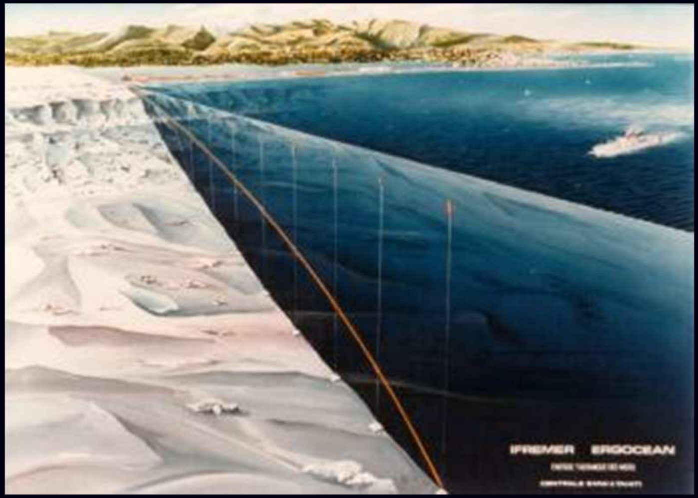
- Installation/ Access for maintenance
  - Local sea-state
  - Travel time optimization
- Storm surge
  - Tidal dam opt.
  - Onshore /nearshore systems

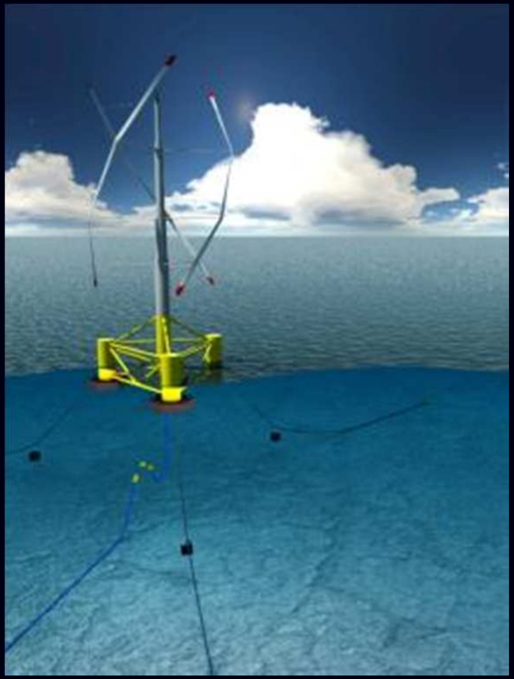
Water column shear currents

- Loads on lines
  - Anchored platforms (pendular, SPAR)
  - OTEC water pipes (ø 5 to 10m)

Bottom currents

- Piles or foundations of fixed structures
  - Erosion/accretion of sediments
- Vibrations on power cables
  - ageing/ acoustical impact





Floating Nenuphar Windturbine

First estimation for power take-off

W (kW) = (0,3 * ρ * S * V³) / 1000

ρ = 1kg/m³ (air) ; ρ = 1 030 kg/m³ (sea water)

V (m/s) fluid speed

S (m²): surface of the turbine

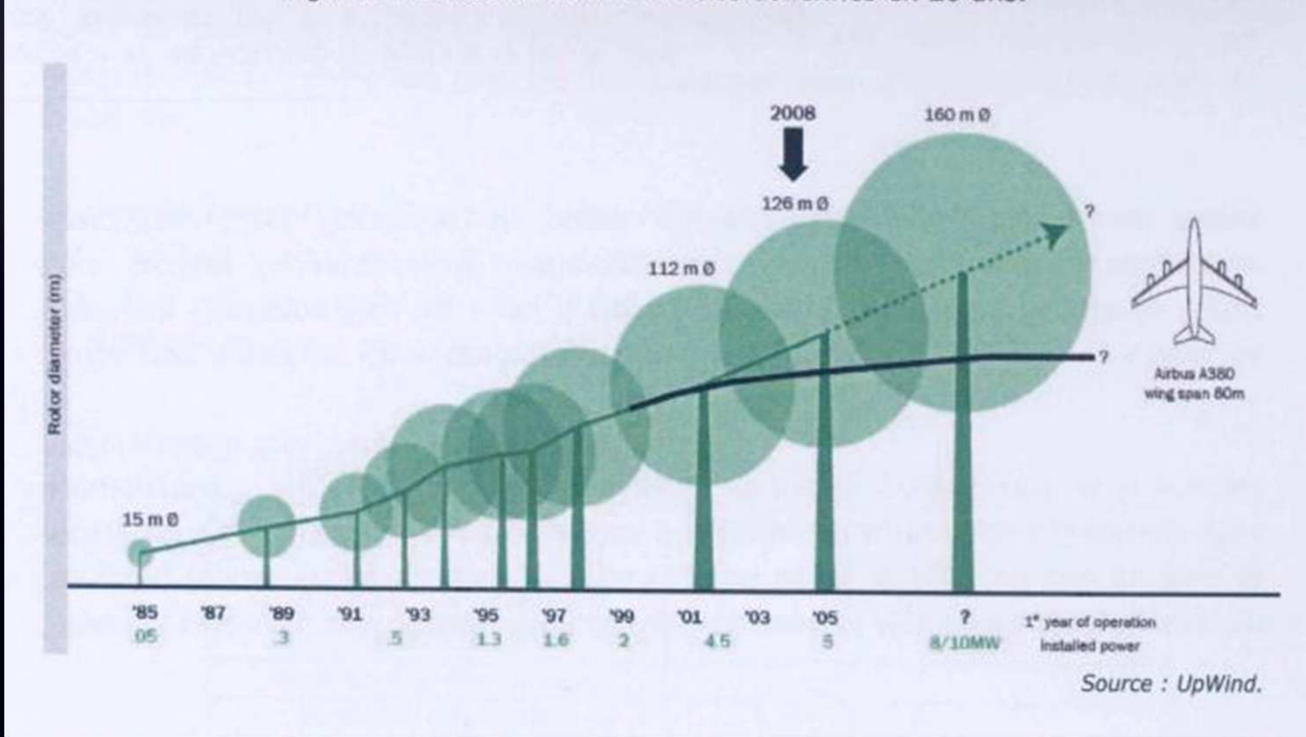


Figure 9. Evolution de la taille des éoliennes en 20 ans.

Source CSER Bretagne 2009

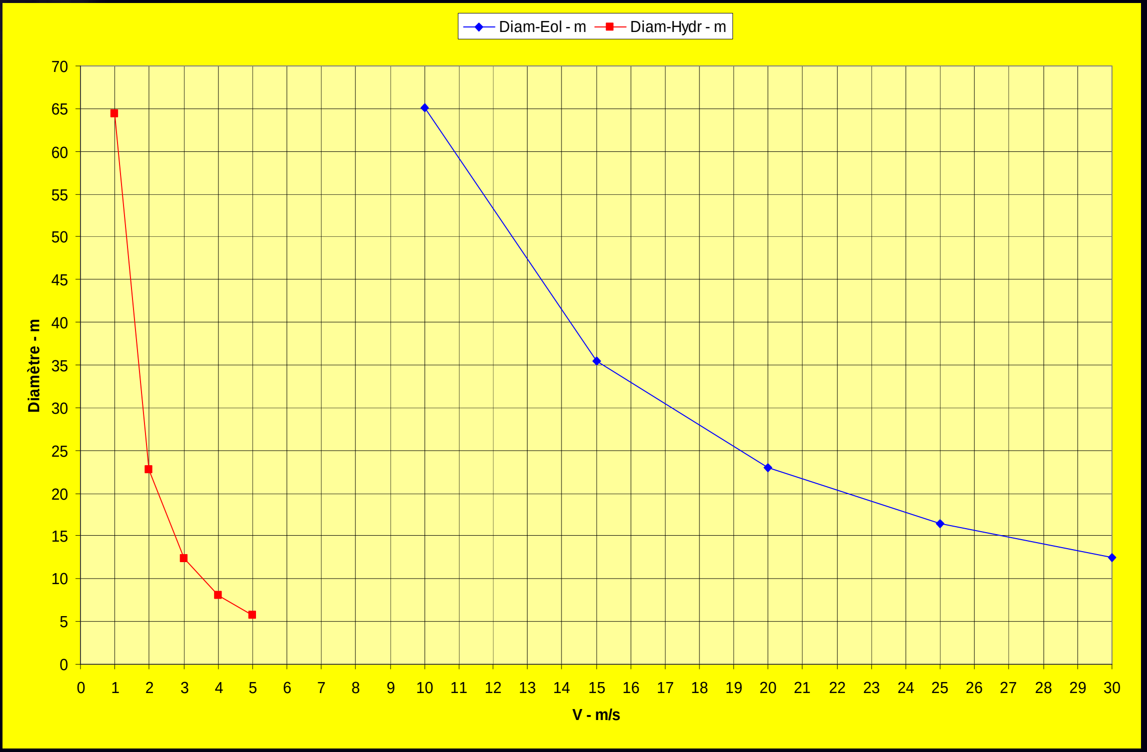
DIAMETRE EOLIENNE / HYDROLIENNE (minimum théorique)

W	RO-Air	RO-Eau
kW	kg/m3	kg/m3
1 000	1	1 025

v - km/h						36	54	72	90	108
V - nœuds	2	4	6	8	10					
V - m/s	**1**	**2**	**3**	**4**	**5**	**10**	**15**	**20**	**25**	**30**
Surf-Eol - m2						3 333	988	417	213	123
Surf-Hydr - m2	3 252	407	120	51	26					
V - m/s	**1**	**2**	**3**	**4**	**5**	**10**	**15**	**20**	**25**	**30**
Diam-Eol - m						**65**	**35**	**23**	**16**	**13**
Diam-Hydr - m	**64**	**23**	**12**	**8**	**6**					

Initial spin sometimes needed

minimal diameters wrt fluid speed



Source J. Marvaldi

Resource estimation

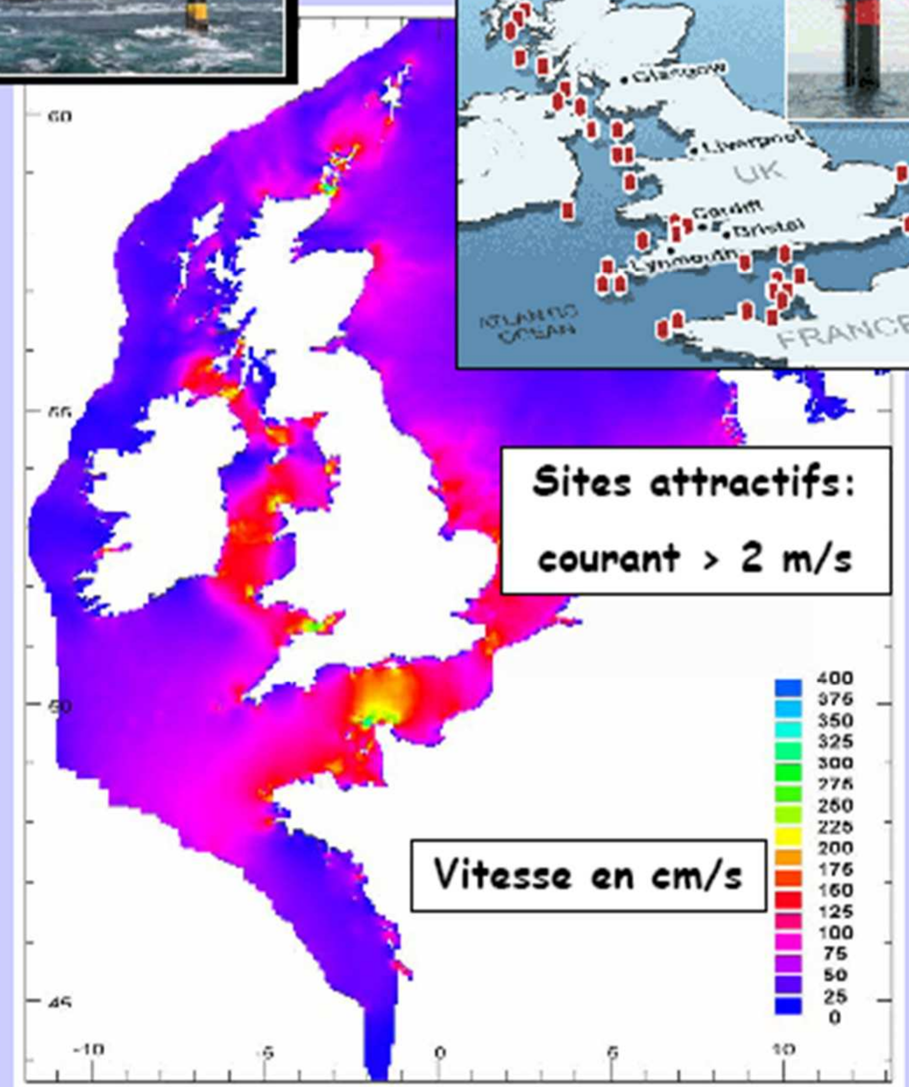
UP TO DATE TECHNOLOGY

Cinetic energy of tidal currents

France & UK share
the largest resource

Predictible
450 TWh/y (world)
10 TWh/y (France)
10 MW/km² max density ?

wt sea-state: overseas lagoons

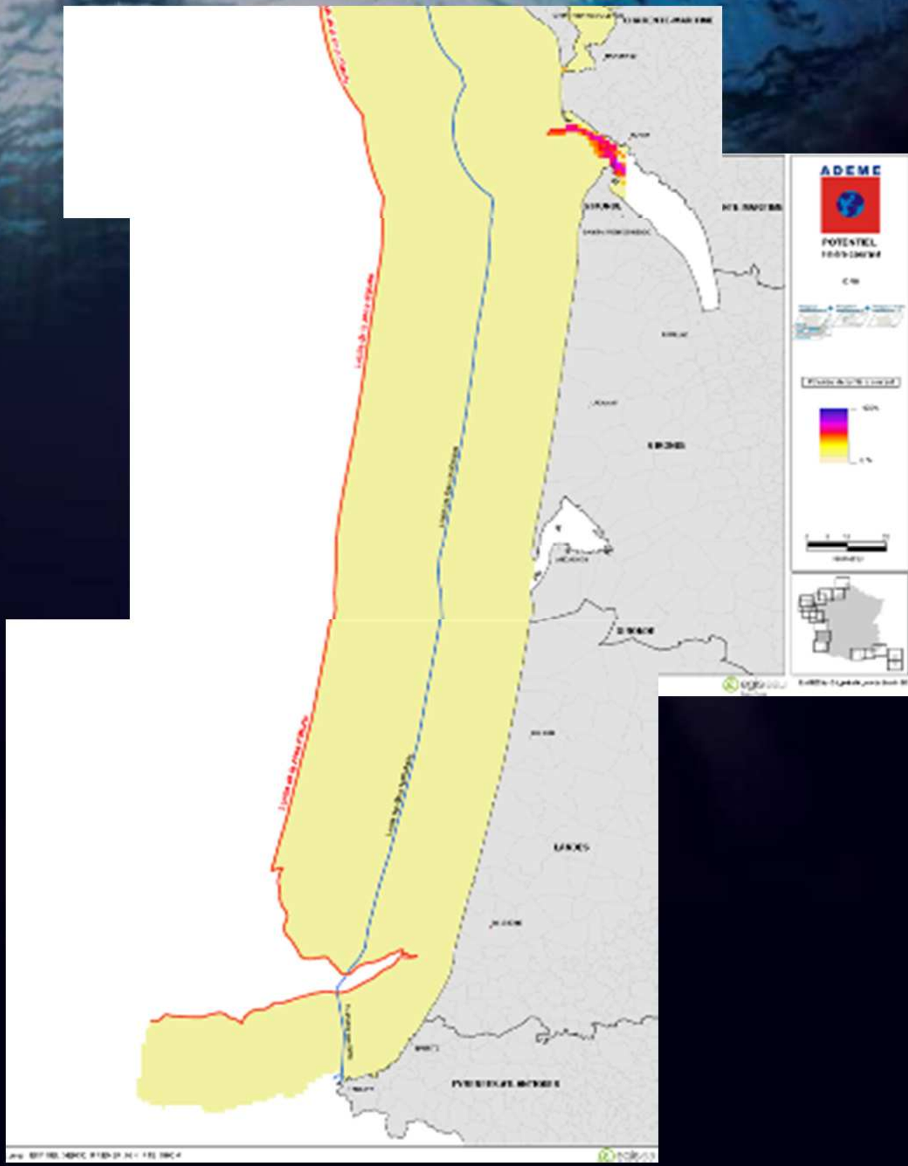


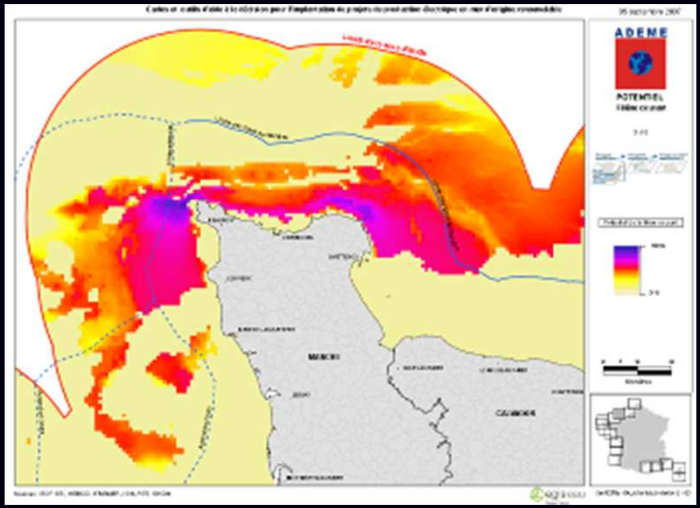
ifremer

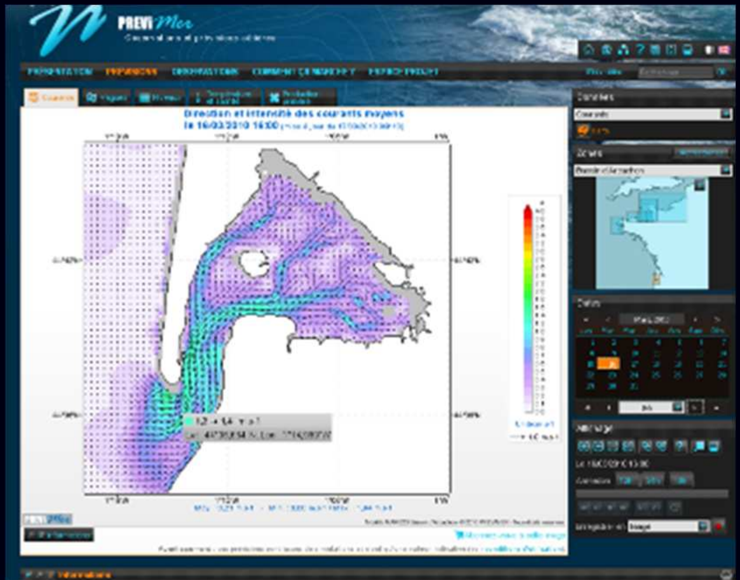
Source M. Paillard

Resource assesment

EXAMPLE AT VARIOUS SCALES







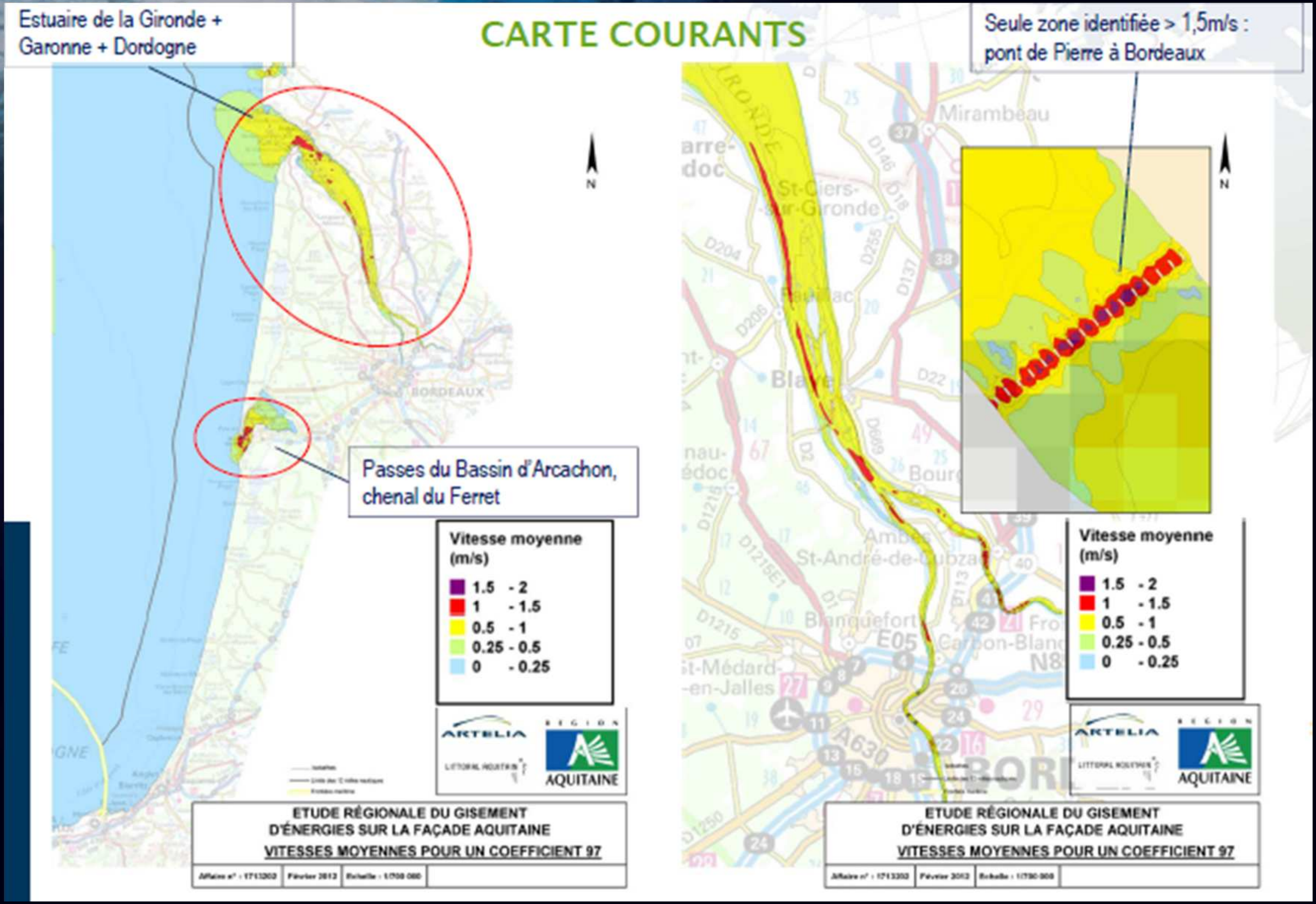
Resource assesment

EXAMPLE AT VARIOUS SCALES

Tidal Energy Tool by ASA on East Coast of USA

Resource assesment

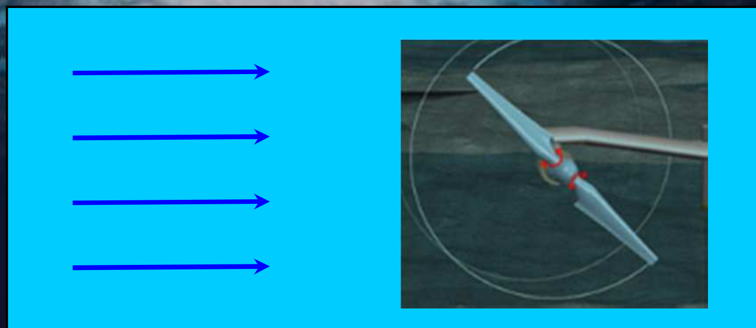
EXAMPLE AT VARIOUS SCALES



A high resolution study by Artelia

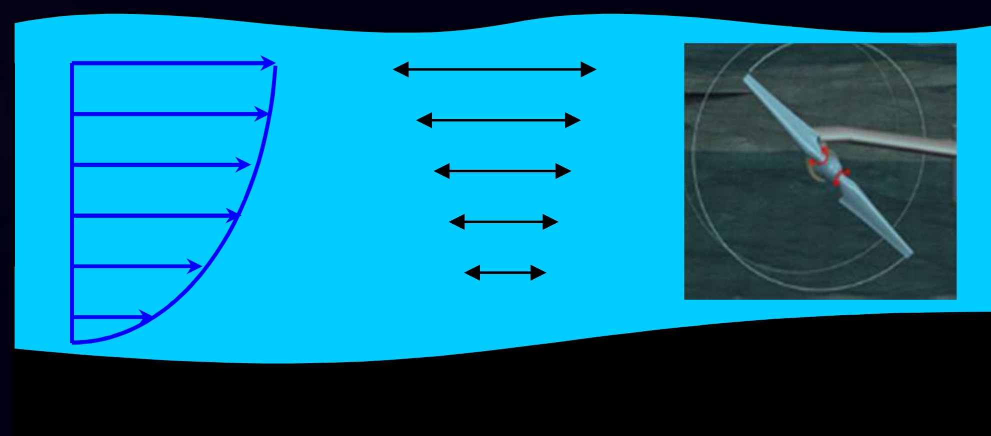
High resolution

CURRENTS FROM THE REAL LIFE



Ideal case:
uniform and stationary flow

Realistic marine conditions:
non-uniform flow induced by the bathymetry and unstationnary motions induced by waves and turbulence



ifremer

Real data

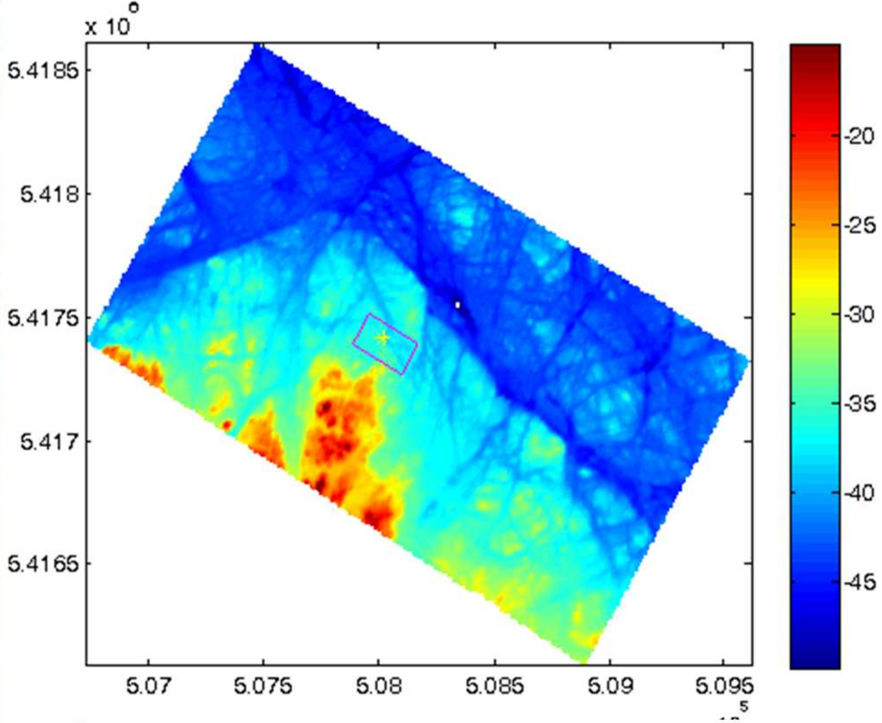
AT BREHAT SEA-TRIAL TEST-SITE

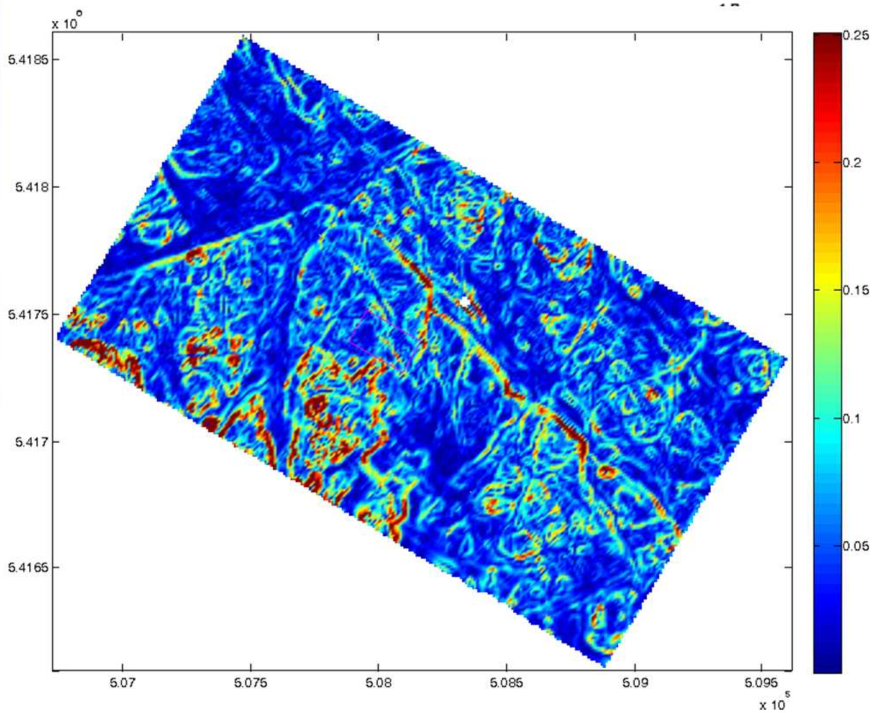
Location	Bréhat island
Instrument used	AWAC 1MHz
Ping rate	1Hz
Burst duration	10mn
Interval between burst	1hour
Deployment date	From 25/03/08 to 06/05/08
Water depth	30.3m (25m-35.5m)
Depth cell size	1.5m
Number of cells	18
First and last cell range	0.9m - 27.9m

Ifremer data

Real data

AT BREHAT SEA-TRIAL TEST-SITE





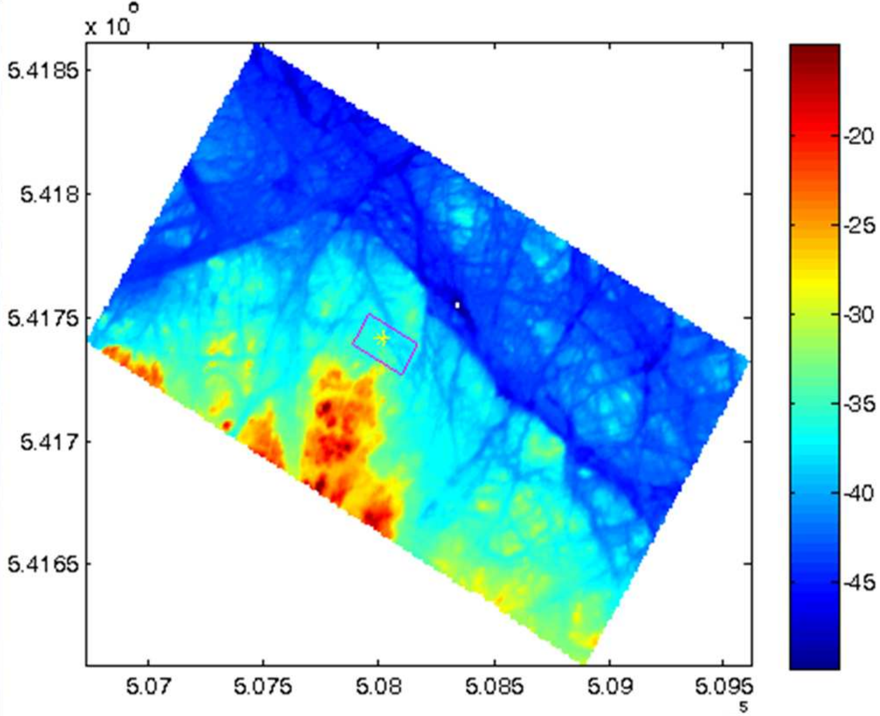
High resolution bathymetry

Gradient of bathymetry

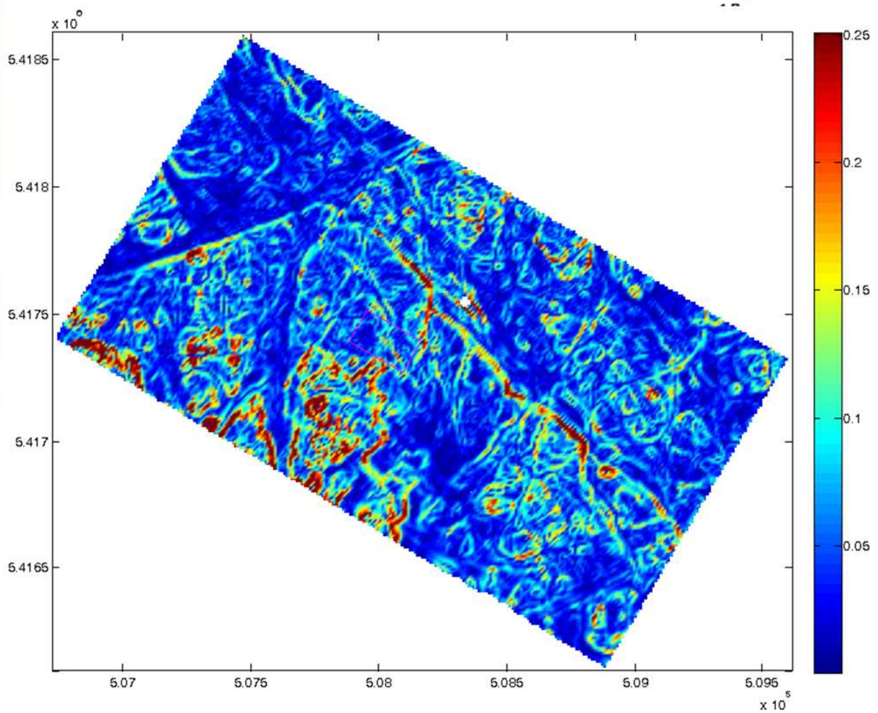
(NTM from EDF data)

Real data

AT BREHAT SEA-TRIAL TEST-SITE



High resolution bathymetry



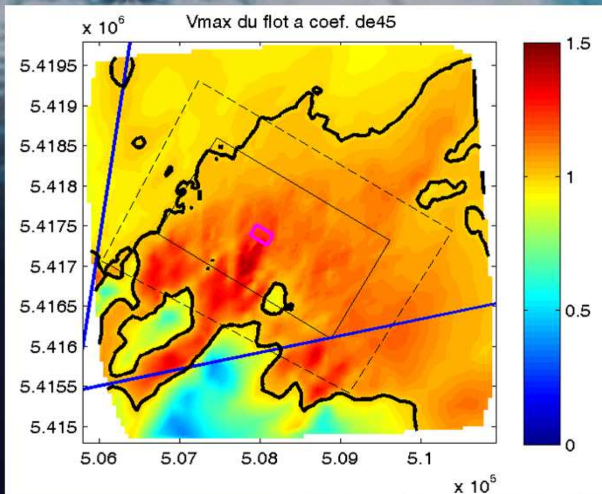
Gradient of bathymetry

(NTM from EDF data)

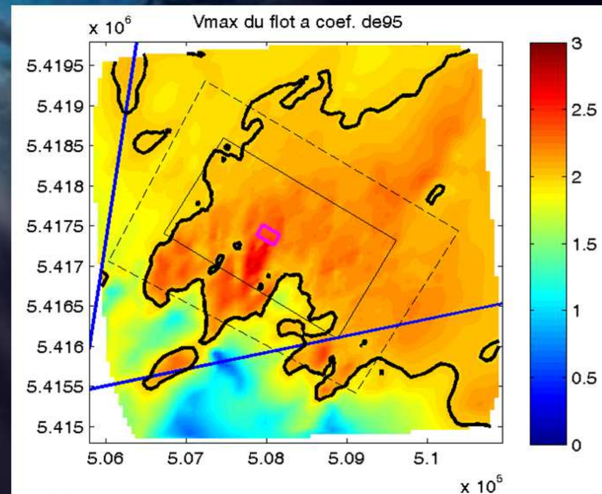
Real data

AT BREHAT SEA-TRIAL TEST-SITE

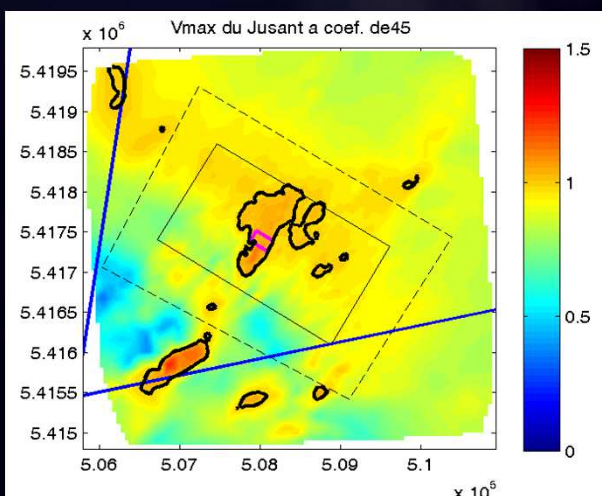
Neap tide, flow



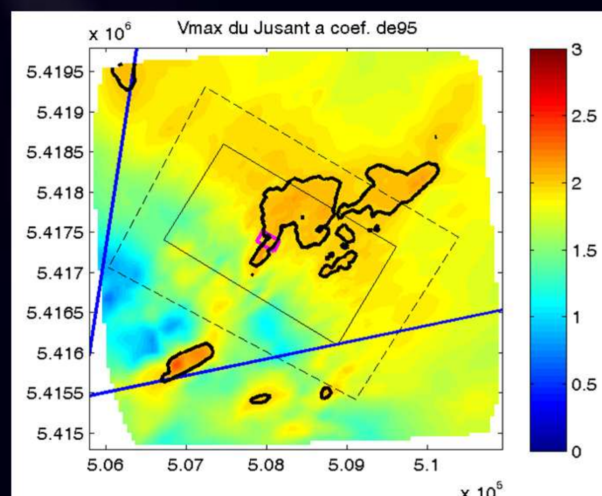
Spring tide, flow



2D model (Telemac)



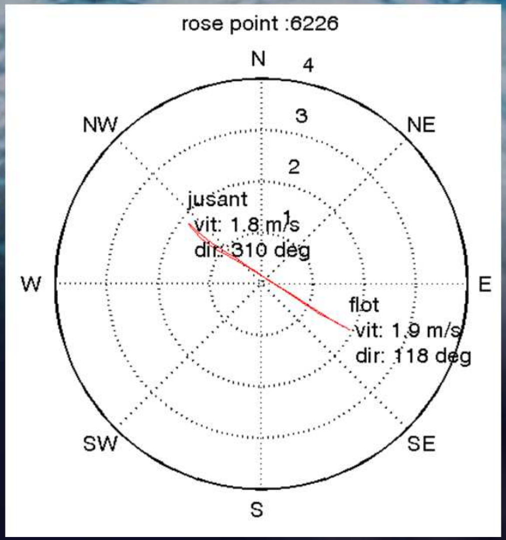
Neap tide, ebb



Spring tide, ebb

Real data

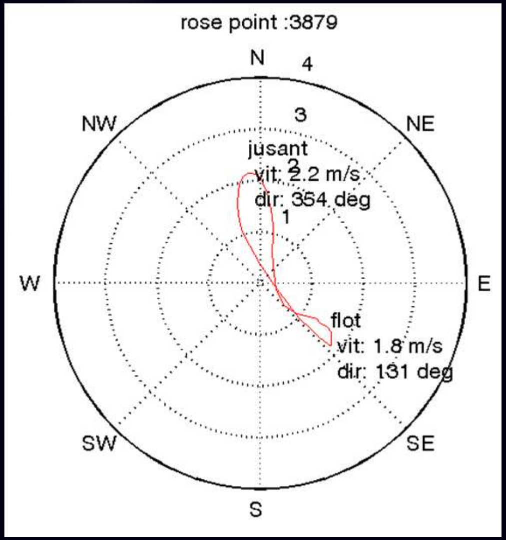
AT BREHAT SEA-TRIAL TEST-SITE



At the selected test site

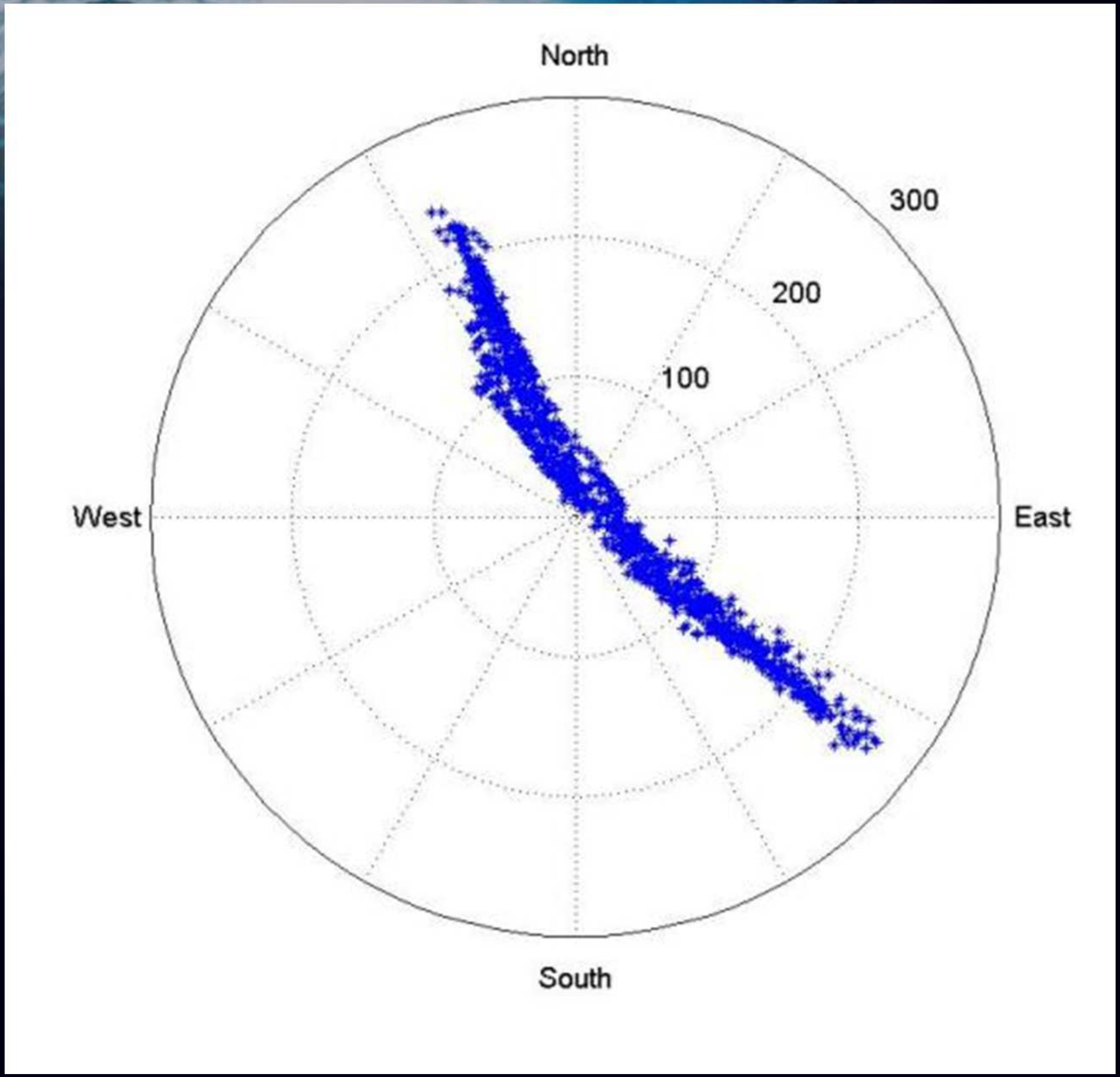
2D model (Telemac)
Direction roses

Nearby…



Real data

AT BREHAT SEA-TRIAL TEST-SITE



The current direction differs between bottom and top layers but always lower than 10° (except for lowest speeds)

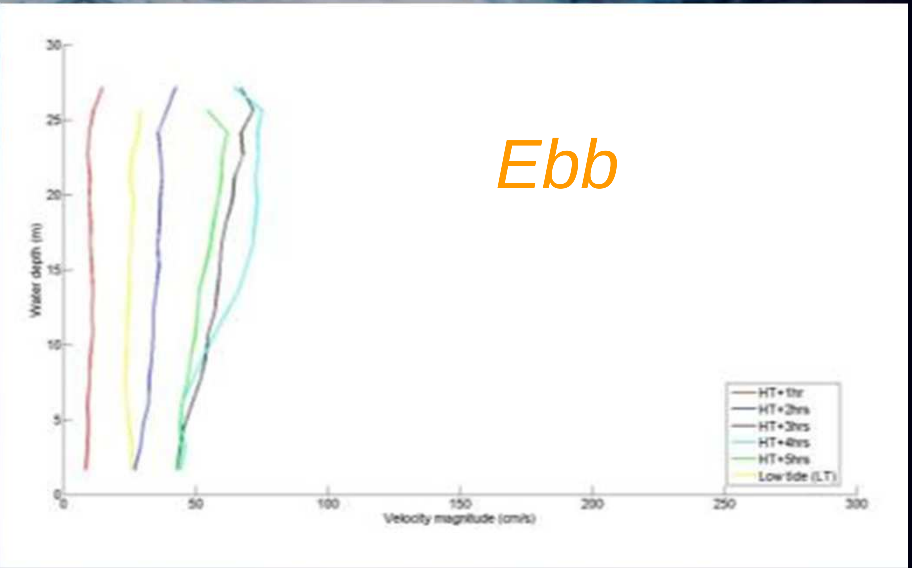
(Guinot, Le Bouluec, 2008)

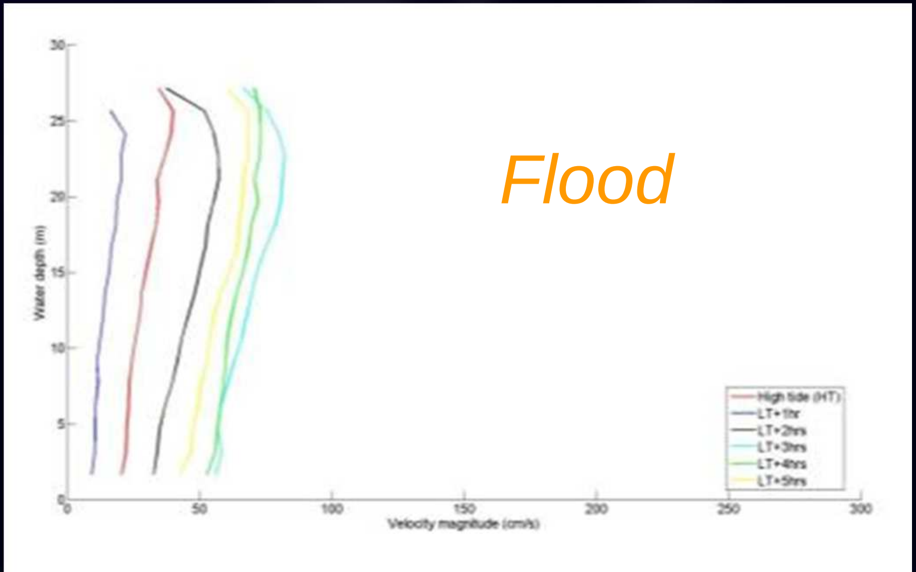
GlobCurrent 2012

Brest, 7 March 1012

Real data

AT BREHAT SEA-TRIAL TEST-SITE





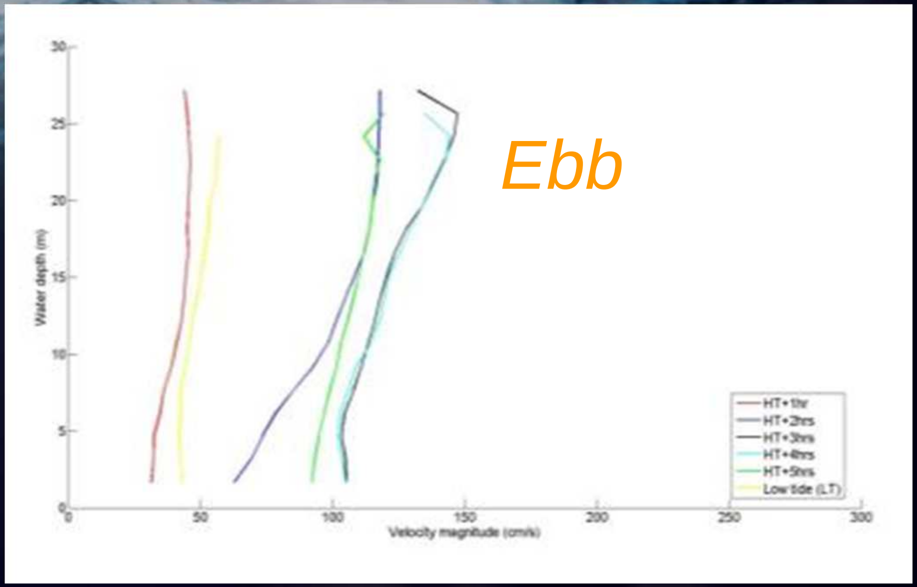
Neap tide

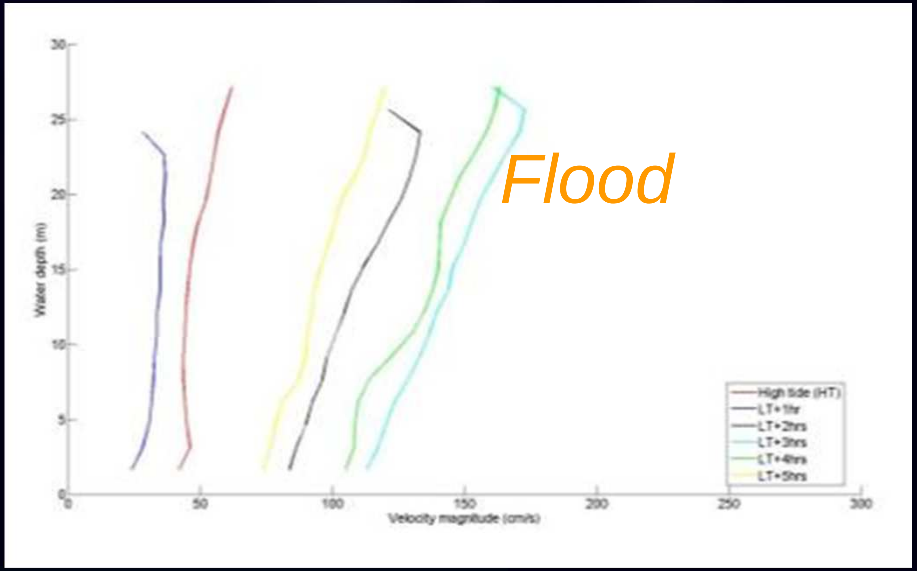
Shear occurs, especially at the surface layers

(Guinot, Le Bouluec, 2008)

Real data

AT BREHAT SEA-TRIAL TEST-SITE





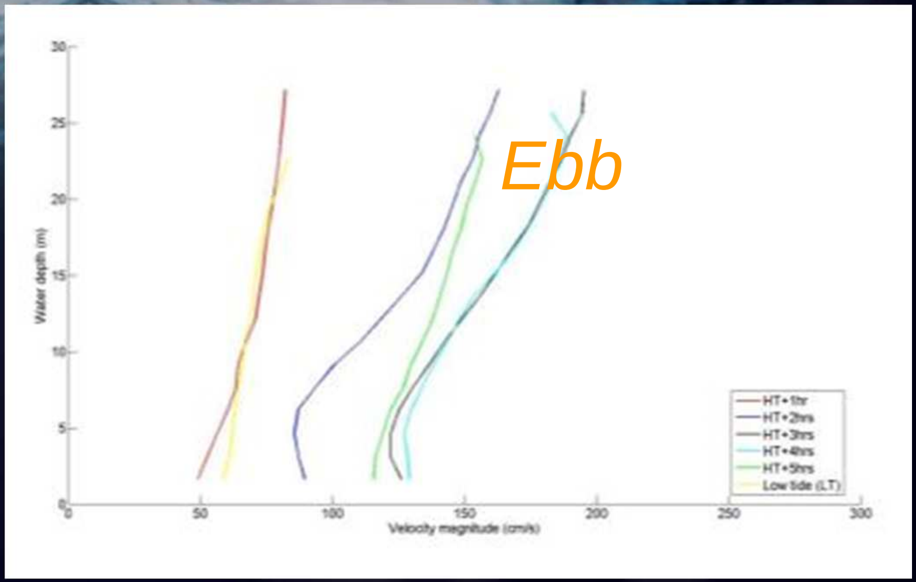
Normal tide

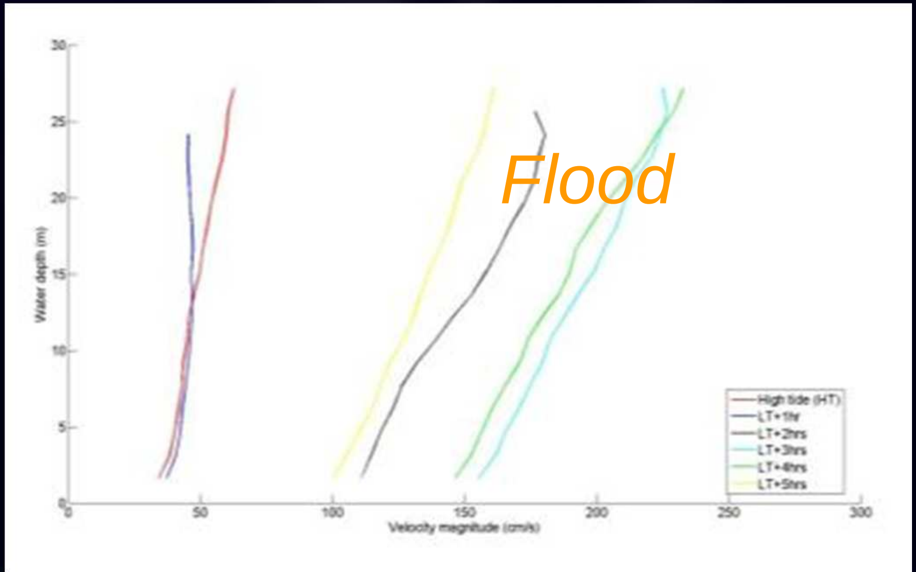
Linear shear occurs

(Guinot, Le Bouluec, 2008)

Real data

AT BREHAT SEA-TRIAL TEST-SITE





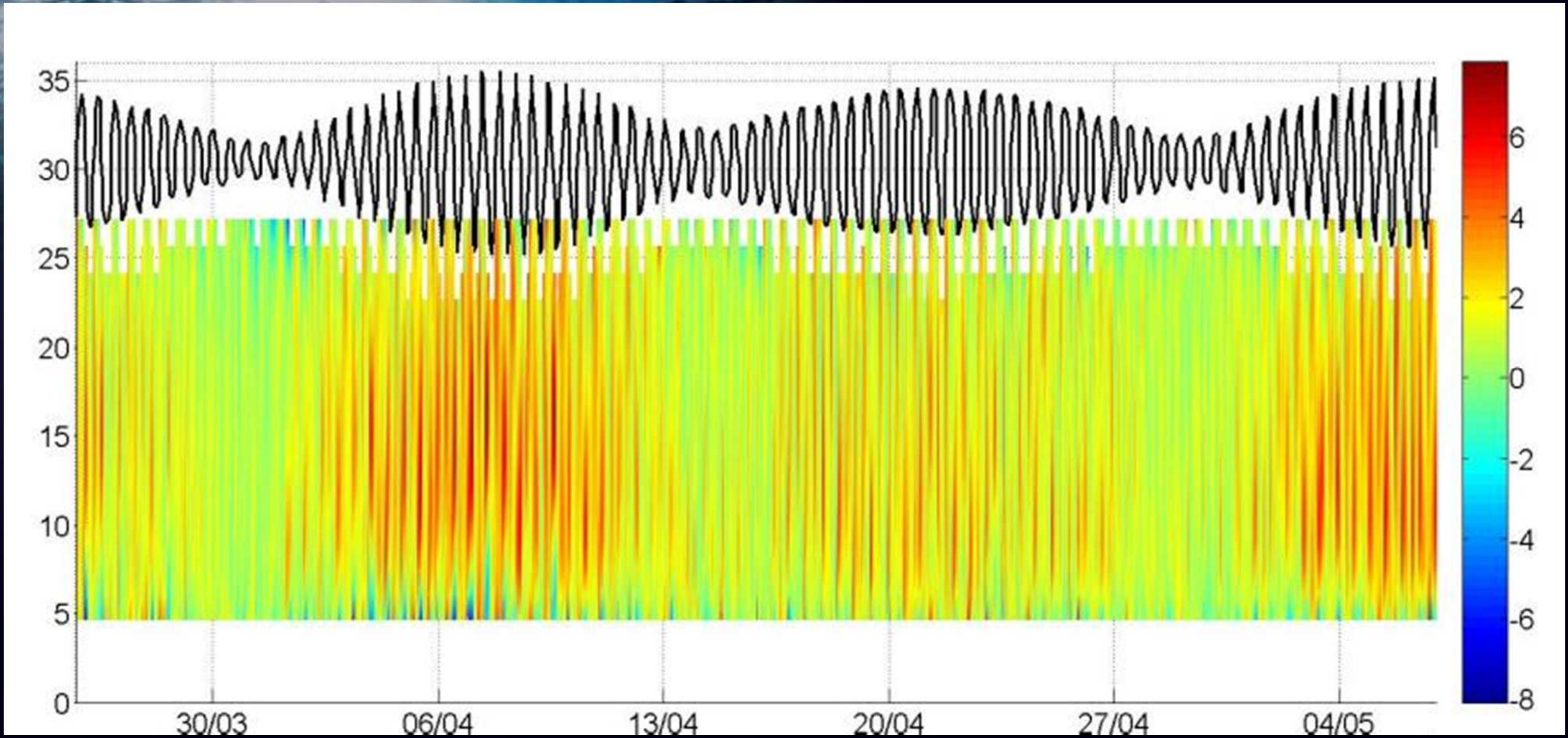
Spring tide

Over the linear shear, bottom layer effect at ebb occurs

(Guinot, Le Bouluec, 2008)

Real data

AT BREHAT SEA-TRIAL TEST-SITE

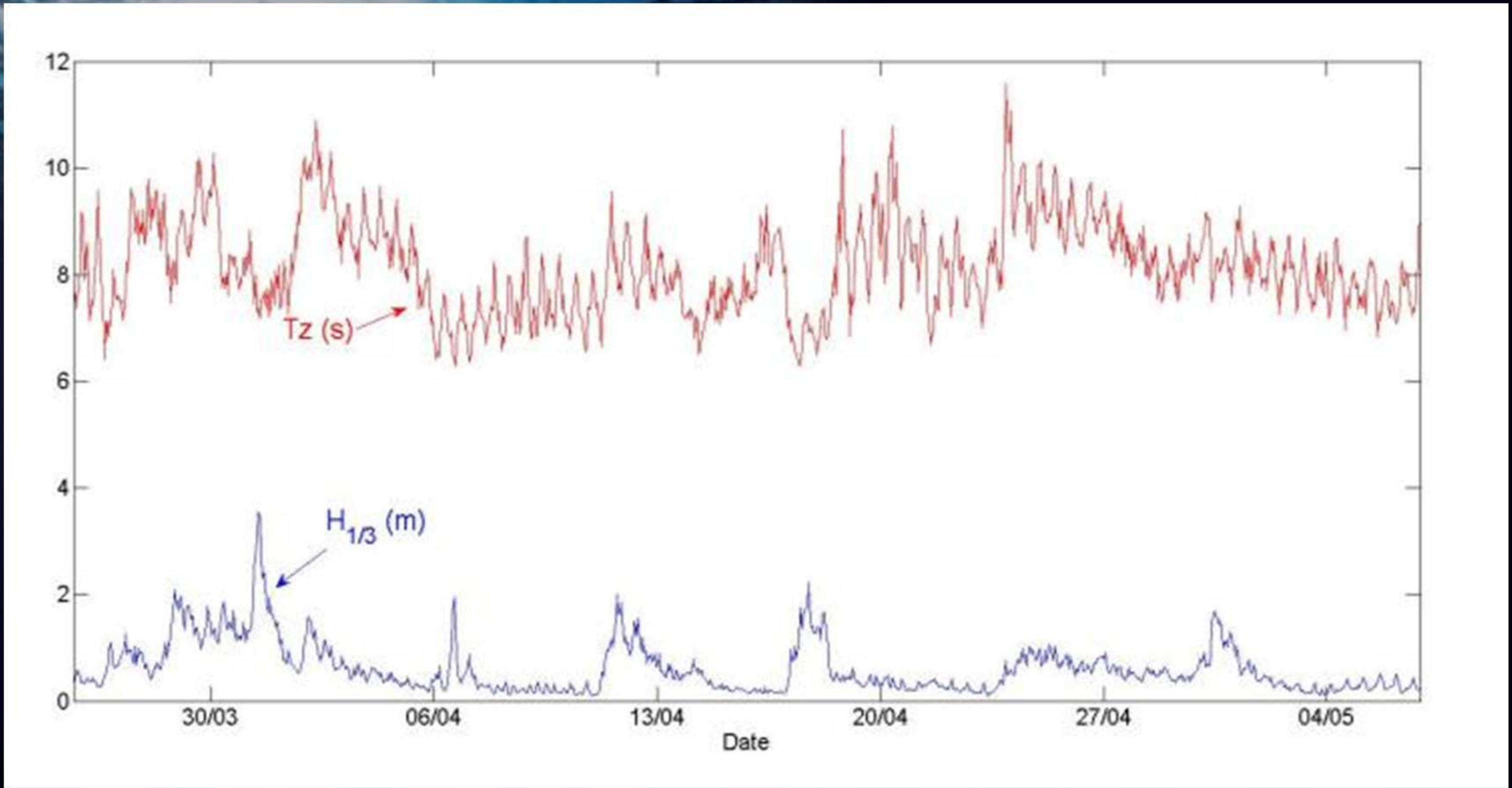


Vertical shear
(Guinot, Le Bouluec, 2008)

cm.s^{-1}/m

Real data

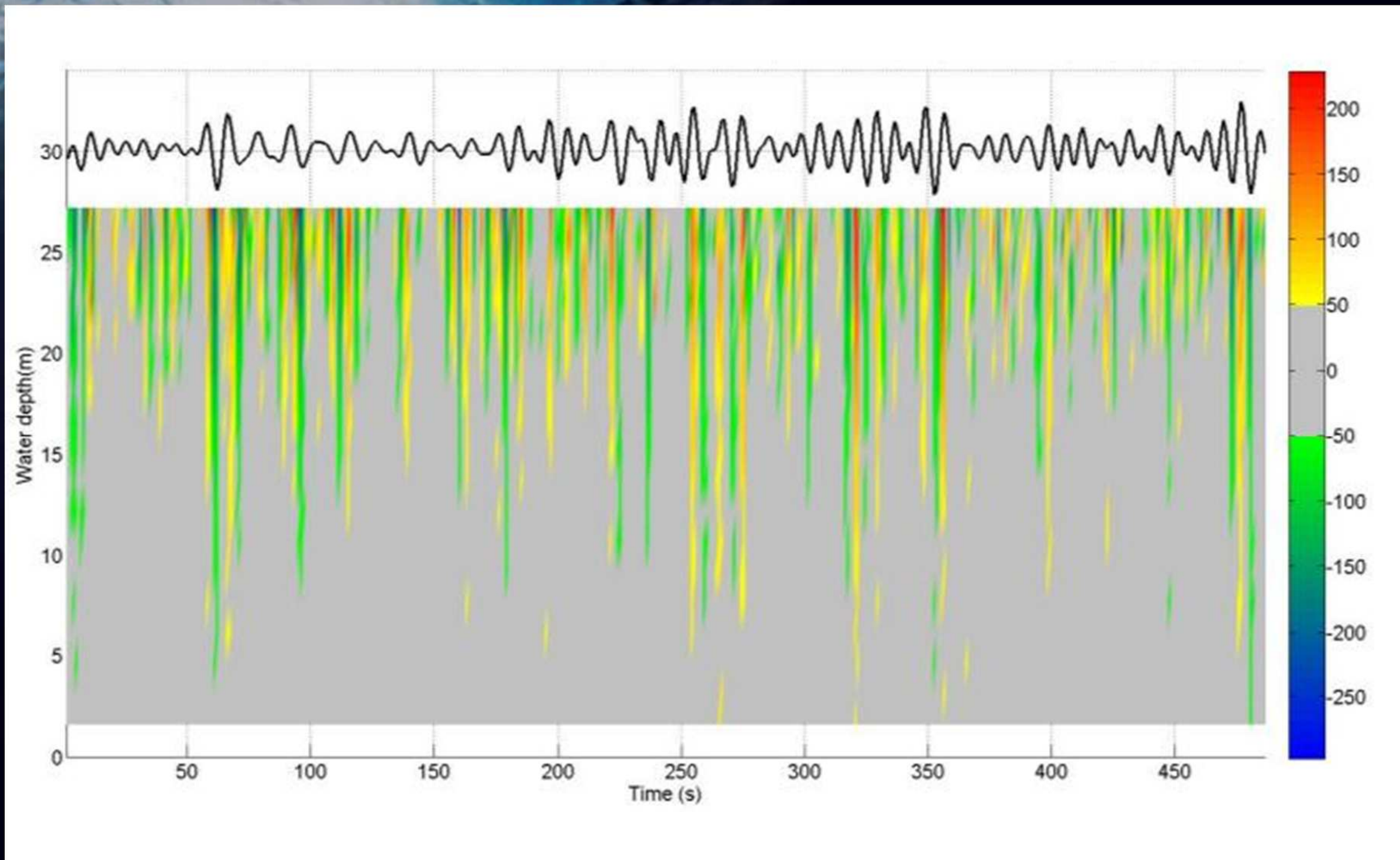
AT BREHAT SEA-TRIAL TEST-SITE



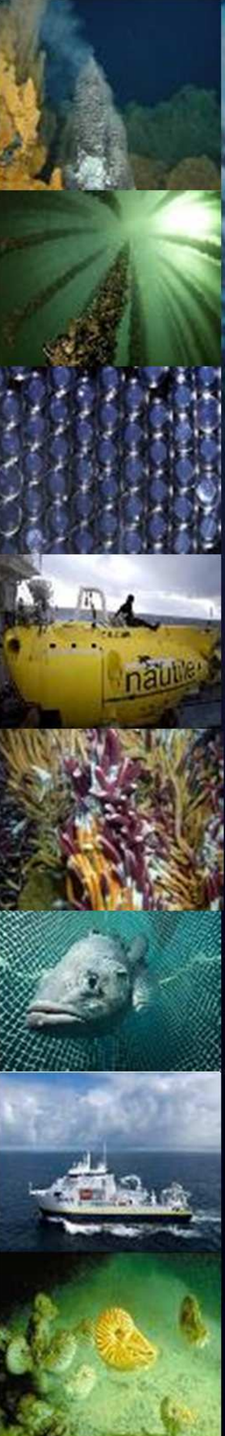
Unstationnary motions :
influence of the waves
(Guinot, Le Bouluec, 2008)

Real data

AT BREHAT SEA-TRIAL TEST-SITE



Unstationnary motions : horizontal wave-induced velocities (Uc=0.6m/s, H1/3=2.8m, T=8s) (Guinot, Le Bouluec, 2008)



Hence, many current needs for Marine Renewable Energies…

Globcurrent –March 7th 2012

Yann-Hervé De Roeck - France Energies Marines Project Manager