Session block : CPP02
Coastal processees
Poster 3

Abstract n° 5392

Observation of non linear internal waves on the Bay of Biscay shelf

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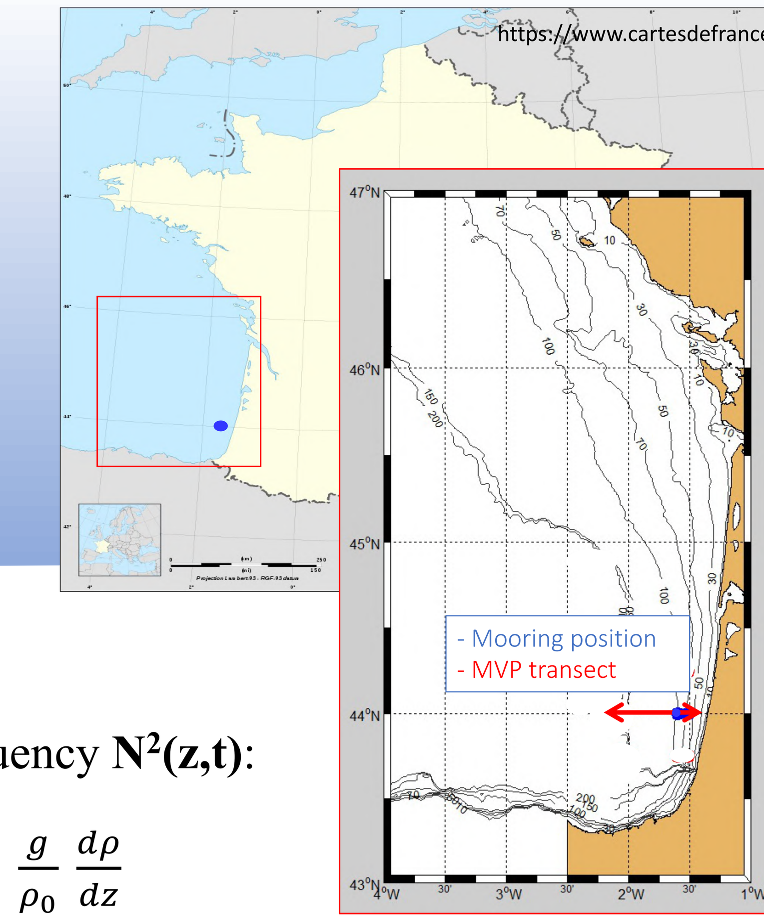

Abstract

Non linear internal waves (NLIWs) are responsible for mixing and transport over continental shelves. But NLIWs includes a wide range of hydrodynamical structures which modify their mixing and transport ability.

Here we present the first observation of NLIWs over the Bay of Biscay (Bob) shelf.

Questions : **What are the NLIWs hydrodynamical structure on the Bay of Biscay continental shelf? And how does suspended matter respond to them?**

Material and method

One month moorings

- **ADCP 300kHz** (2s sampling, 1m height resolution) :
  - *Eastern velocity* : **U(z,t);**
  - *Northern velocity* : **V(z,t);**
  - *Vertical velocity* : **W(z,t)**
  - *Backscatter* **B(z,t)** : proxy for suspended materials.
  - **6 probes MASTODON** (60s sampling) :
  - *Temperature* : **T(z,t)**
  - *Pressure* : **P(z,t)**

Moving Vessel Profiler 3 days HF measurements :

- *Salinity* : **S** (lat,z,t) ; *Density* : $\boldsymbol{\rho}$(lat,z,t); **T** (lat,z,t)

S ~ constant $\rho = f(T)$ $f : T \rightarrow aT + b$

Data analysis:

- Brunt-Väisälä frequency $\mathbf{N^2(z,t)}$:

$$N^2 = -\frac{g}{\rho_0}\frac{d\rho}{dz}$$

- *NLIW's amplitude* **A** : highest isotherm excursion
- *NLIW's horizontal length* $\boldsymbol{\lambda}$: length in the wave frame
- *NLIW's velocity* $\boldsymbol{c_{ph}}$ *and angle of propagation* $\boldsymbol{\theta}$:

Best fit to recover time lags between **B(z,t)** signals of ADCP beams [1]

- *Velocity in the wave direction of propagation* : $\boldsymbol{u_\theta}$**(z,t)**
- *Coordinate in wave frame :* $\xi = c_{ph}\,(t_0 - t)$
- *Stream function :* $\boldsymbol{\psi} = -\partial_\xi W$ $\boldsymbol{\psi} = \partial_z u_\theta$

Background condition

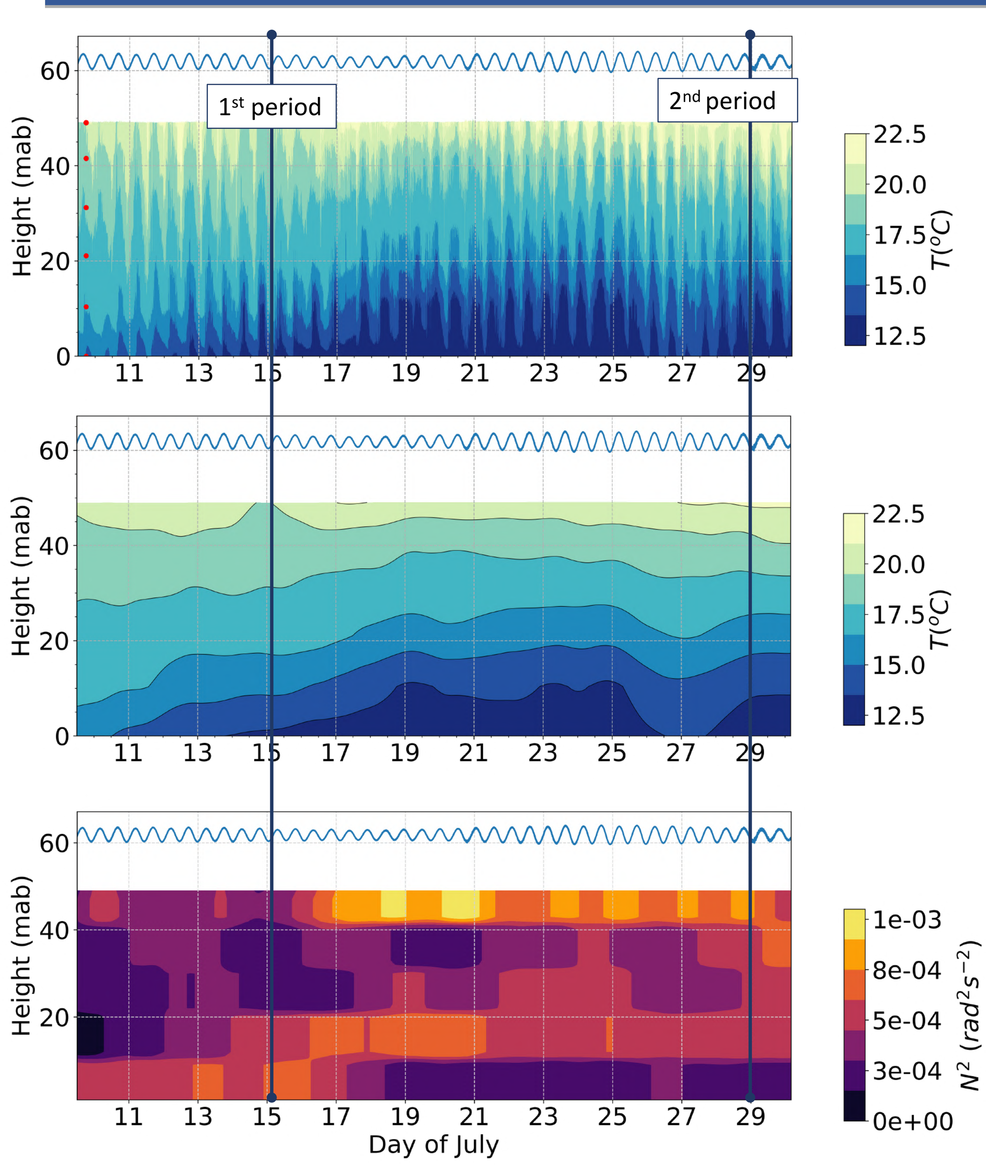

Figure 1 : Raw temperature signal T(z,t). Red dots are the mean heights of MASTODON sensors

Figure 2 : Low pass filtered T(z,t) Cutoff period = 36 hours

Figure 3 : N^2(z,t) computed with low pass filtered temperature.

Semi diurnal oscillations of the isotherm highlight the **internal tide** in Figure 1.

At depth cold water moves onto the shelf from the 11th to the 26th of July (see Figure 2). The **height of the maximum stratification background** changes during this period (*i.e* N^2) (see Figure 3). N^2 is maximum below 10mab for the 1st period, and around 50mab for the 2nd period.

1st period : 15/07

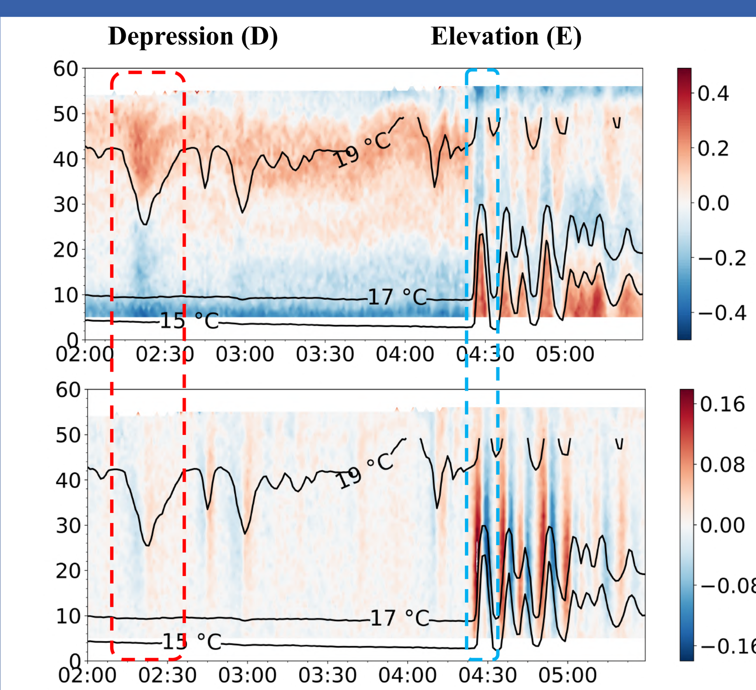

Figure 4 : (*Top*) baroclinic Eastern current (*i.e* U(z,t) – depth averaged(U)). (*Bottom*) W(z,t)

Both waves of depression and elevation were observed within a 3h period (see Figure 4). The **depression** wave around 2 AM is individual. At 04:30 AM a **train of elevation** waves is measured. W(z,t) is almost symmetrical for each waves. **This example is representative of the period with strong near bed N^2.**

The stratification structure outlines **two flow regions** (see Figure 6) :

(i) **Potential flow** : no rotation

(ii) A **rotating core** associated with small N^2 value.

High value of B(z,t) follow the streamlines in (i). Backscatter also show presence of matter in the region (ii).

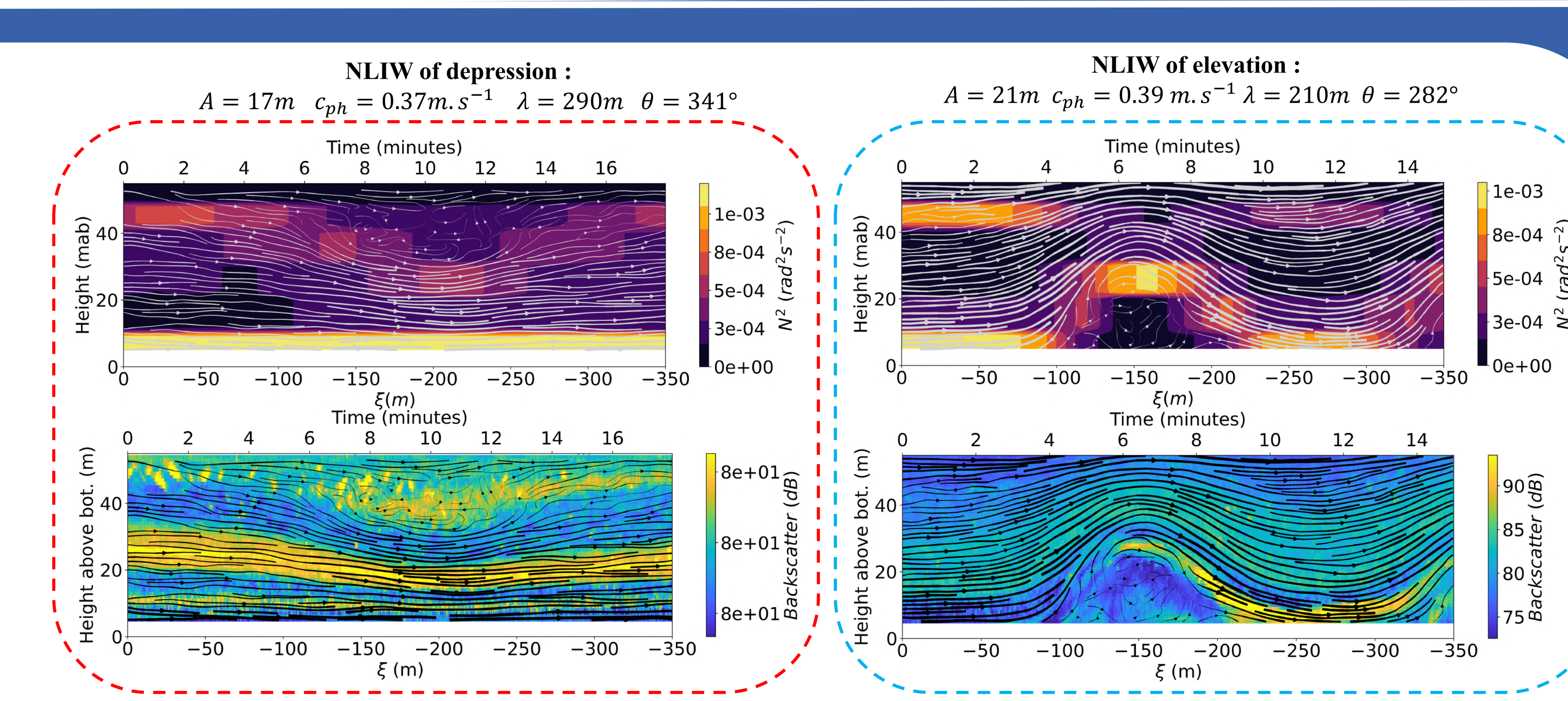

Figure 6 : (*Top*) Backscatter and ψ in the wave frame. (*Bottom*) N^2 and ψ in the wave frame.

2nd period : 28/07

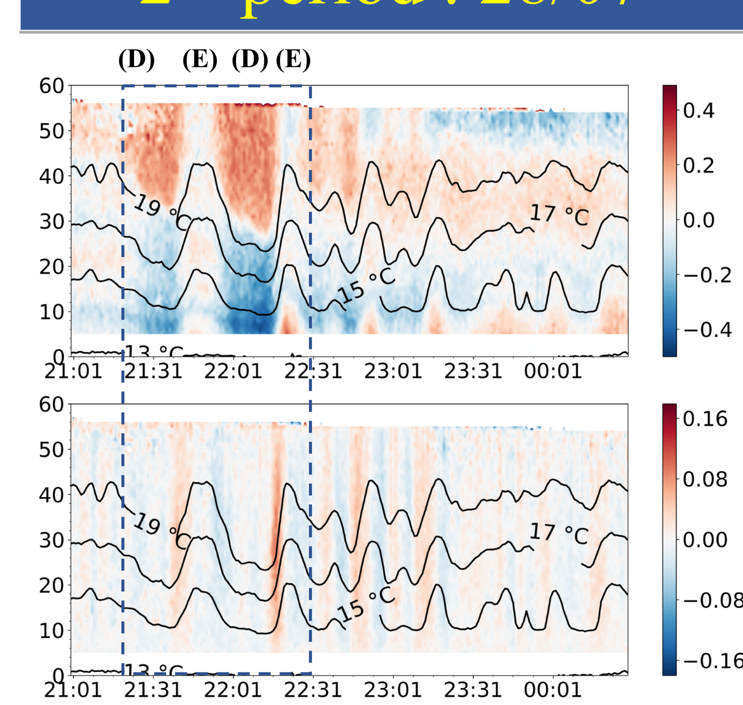

Figure 5: (*Top*) Baroclinic Eastern current (*i.e* U(z,t) – depth averaged(U)). (*Bottom*) W(z,t)

Isotherm oscillation of 10m coincide with vertical shear of horizontal baroclinic velocity (see Figure 5). Shear alternate sign from 21h15 to 22h31. **The oscillations with maximum shear and amplitude centered around 21h30 and 22h are depression NLIWs.** The waves are not as symmetrical as during the 1st period.

They are **immediately followed by elevation waves of elevation with upward current** (~0.10m/s) observed at 21h45 and 22h25.

We likely observed the transition of waves of depression to elevation as described in [2].

The stratification structures do not outline two flow regions as clearly as during the 1st period (see Figure 7 (*Top*)). A maximum of backscatter is measured at the surface, associated with reduced velocity (see Figure 7 (*Bottom*)).

The waves do not have a clearly defined rotating core.

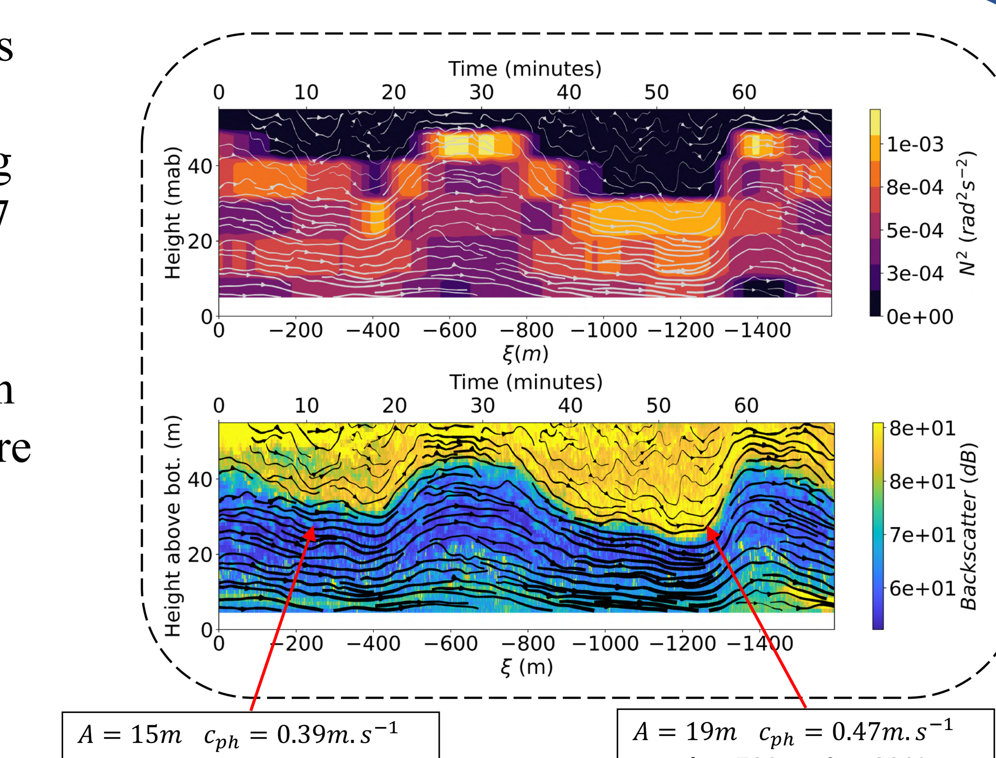

Figure 7 : (*Top*) Backscatter and ψ in the wave frame. (*Bottom*) N^2 and ψ in the wave frame.

Conclusion

We observe changes in the NLIWs response with the background stratification. Clear elevation and depression NLIWs exist when there was strong near bed stratification. Twenty days later, maximum stratification was in the middle of the water column and packets of mixed polarity waves were observed. NLIWs on Bob's middle shelf is rich and depends on the background stratification similarly to what was observed on the Californian inner shelf [3] .

[1] Scotti, *et al.*(2005). A Modified Beam-to-Earth Transformation to Measure Short-Wavelength Internal Waves with an Acoustic Doppler Current Profiler, *Journal of Atmospheric and Oceanic Technology*, *22*(5), 583-591. https://doi.org/10.1175/JTECH1731.1
[2] Shroyer *et al.* 2009: Observations of polarity reversal in shoaling nonlinear internal waves. *J. Phys. Oceanogr.*, **39**, 691–701, https://doi.org/10.1175/2008JPO3953.1
[3] McSweeney *et al.* (2020). Observations of Shoaling Nonlinear Internal Bores across the Central California Inner Shelf, *Journal of Physical Oceanography*, *50*(1), 111-132 https://doi.org/10.1175/JPO-D-19-0125.1

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