

## ***Interactive comment on “Seismic imaging of a thermohaline staircase in the western tropical North Atlantic” by I. Fer et al.***

### **Anonymous Referee #1**

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I think this paper should be improved leading to publication in Ocean Science. The topic is as described in the title, and is interesting. The paper presents data and interpretation including parallel supporting analysis. However, the argument is somewhat by example: there is no real demonstration that all staircases have been detected, and the evidence that the identified feature is a staircase is rather circumstantial. I was left unsure whether a local lack of internal waves enabled the identified staircase, or if the existence of the staircase inhibited internal waves. (The introduction rather suggests the latter through cited literature).

In a final version I would like to see some care to make the English more readable in detail, and some of the punctuation is strange.

Quite a lot of detailed comments follow.

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Page 362 line 11. Delete “within”.

Page 364 line 15. It is not clear here where this 10 m horizontal resolution comes from (and I am not expert). Resolution is not the same as sampling interval and in the horizontal it is not  $\sim \lambda/4$  either. I am told it can be better than the Fresnel zone resolution  $(\lambda h/2)^{1/2}$  but that needs justification. [Here  $\lambda$  is a sound wavelength and  $h$  the depth of the reflector].

Page 364 line 24 – “temperature”. This is rather bold in view of the following sentence with a significant salinity influence, and Sallarès et al (2009) find up to 40% salinity contribution in places. However, I agree with the sentence in lines 27-29.

Page 367 line 8 – “time-migrated”. Please explain or cite. [This might be the justification for “10 m horizontal resolution”?]

Page 367 line 10. “. . (Ai) . .”?

Page 367 lines 16-18. Why not use the optimum from Fortin and Holbrook (2009)?

Page 367 lines 23-24. This implicitly assumes  $\lambda/4 \gg 4$  m.

Page 367 line 25. Scale is not the same as wavelength. 50 m is the wavelength for the dominant frequency 30 Hz, and high pass to retain scales  $< 50$  m seems reasonable, but the juxtaposition of “scale” and “(the wavelength)” is confusing.

Page 368 section 2.3. It is not made clear what “synthetic modelling” means. Acoustic model? 2D? Simulated air-gun source or believed resulting signal?

Page 368 line 19 expression for  $N$ . Better “ $\rho^{-1}$ ” than to use “ $1/\rho$ ” here.

Page 369 line 8. I don’t know “superjacent”. Also the figures really are not clear enough to see an increase from 19 m to 25 m.

Page 369 line 11. “. . not an artefact . .”. This is a strong statement! So it ought to be justified by evidence (e.g. nothing like it elsewhere in the image?). I think lines 11 to

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14 could be rearranged to make the logical argument stronger.

Page 369 line 21. “.. necessary for staircase ..” In the Introduction, first paragraph, it was implied that there could be a (convective) staircase with temperature and salinity increasing downwards.

Page 370 lines 1-3. There is a problem reconciling these locations and lengths with each other, or with Figure 2 and its caption. 11 is not 212 – 189 (and this is an east-west section). Certainly “the reflective horizons become less regular and have lower amplitudes at  $\sim 175$  km” but in the figure one could say the same at 185 km. This is crucial because of the specific identification that is the essence of the paper.

Page 370 lines 6-12. This is all OK for  $dT/dz$  and  $dS/dz$  positive (T and S increasing upwards). If  $dT/dz$  and  $dS/dz$  are negative then  $R > 1$  implies instability. So what about dive 124 near / just below 600 m ?

Page 371 line 3. “Fig. 3 of Schmitt et al., 1987” is also cited in section 2.1. Perhaps it should be reproduced in the paper.

Page 371 section 3.4. I don’t think this discussion of longevity is very good. Can the staircase be maintained by the salt-fingering process? It could be advected away. Persistence at any one place would seem to be chancy! In particular advection would seem to be likely to cause a lifetime  $< 3$  years at any one location. In the absence of maintenance by salt-fingering, one would expect a lifetime of order (depth scale)<sup>2</sup> / diffusivity, e.g.  $10^{12}/10^{-5}$  seconds  $\sim$  a few months.

Page 374 lines 17-18. This spectral behaviour should be related also to the true horizontal resolution – depending on the processing? – c.f. comment re page 364 line 15. Line 18. I don’t understand “before”; 125 m is where the spectrum flattens.

Page 375 lines 26-28. This sentence may be true but it first needs to be made clearer what character of reflection can be interpreted as a thermohaline staircase. [Especially with the confusion at the top of page 370 c.f. figure 2].

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Figure 3 caption, line 3, “less” not “lower”; lines 3 and 5 omit “between”.

Figure 9: I do not understand the scales. The last “trace” (does it mean hydrophone group?) is at 4.1 km but the “depth” of the direct arrival there  $\sim 1.4$  km: twice 1.4 is 2.8 not 4.1. Maybe sound speed comes in but not with these scale labels.

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