Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2020-114-AC2, 2021

Ocean Science
Discussions
Open Access

Interactive comment on "Laboratory experiments on the influence of stratification and a bottom sill on seiche damping" *by* Karim Medjdoub et al.

Karim Medjdoub et al.

mvincze@general.elte.hu

Received and published: 19 March 2021

We thank the referee for reading our manuscript and for making highly useful comments and suggestions even if recommending rejection. Below we reply to the raised issues point by point.

Comment:

1) The role of the obstable in the bottom layer is not clear and never studied. The flow around it should be measured and might explain its role in the interfacial waves generation.

Response:

The present paper intended to focus on the damping effect due to barotropic-baroclinic energy conversion in a setting that has already been thoroughly investigated from the wave generation point of view in our earlier work, Vincze and Bozóki (2017) (available for the reviewer at: http://karman3.elte.hu/mvincze/pub/13_exp_fluids_obstacle.pdf). There we extensively discussed the mechanism of internal wave generation above the obstacle and analyzed the velocity field using the technique of particle image velocimetry (PIV). However, in that study, we applied oscillatory forcing at the water surface, and therefore could not explore the dynamics of damping.

It was our unintentional mistake that when listing earlier work in the introduction, we forgot to mention this paper, which is a predecessor of the present study. In the updated version of the manuscript we will definitely summarize our earlier findings related to the wave generation mechanism in the system.

Comment:

2) The excitation by the wave maker is kind of obscure. Its motion should be qualified: what is its motion (amplitude, duration)? This could be done by video analysis.

Response:

This was indeed done during our experiments. The characteristics of the vertical motion of the wave maker is demonstrated in Fig. 1. attached to the present response letter. (Based on the referee's comment, we will also incorporate this plot to the manuscript.) The dotted horizontal line ($z = 0$) represents the unperturbed water surface and the orange curve shows the vertical displacement of the runner foam "bumper" as a function of time. The width of the line represents the error of reproducibility. The total duration of the $z < 0$ interval was found to be (0.8 +/- 0.06) s and the amplitude (maximum depth w.r.t. the unperturbed water surface) was (3.65 +/- 0.25) cm.

Comment:

3) Both interfaces motions should be analyzed through the space-time series recorded by the camera. The 2D FFT transform will thus show the experimental dispersion relations for each interface, to be compared with the classical surface wave theories.

Response:

Based on the referee's comment we have carried out these analyses, and some exemplary plots will be included in the updated version of the manuscript. Fig.2 attached to the present response letter shows some of the results (both for the surface and for the internal interface in the selected cases of m = 4 and m = 6 dominant surface modes) with the theoretical surface and internal interface dispersion relations shown with solid curves.

Comment:

4) The use of the transfer function, simply defined by the ratio of the Fourier spectra of the motions of each interface is misleading: for instance, if the interfacial wave gains its energy at a given frequency by an other effect than linear direct energy transfer from the free surface mode, then the division by zero will make T(f) to diverge. I will recommend the use of cross-spectra that will show the energy exchanges between the Fourier modes.

Response:

The referee is of course right when stating that the transfer spectrum method can produce non-physical artifacts in case of nonlinear coupling between the source signal (surface wave) and the response signal (interfacial wave). Yet, such transfer functions are widely used tools for studying linear source-filter interactions in various fields (e.g. acoustics) and in our particular case it turned out that all of the significant peaks of the transfer function T(f) actually correspond to frequencies that are associated with internal seiche eigenmodes, as calculated from the dispersion relation (eq. 3).

For pairs of quasi-stationary signals cross power spectral density (CPSD) would indeed be a more informative way to present such results. Unfortunately though, here, probably due to the decaying nature of the time series in question, we were not able to acquire useful information using that method.

However, the wavelet spectrograms of the time series obtained using the so-called Morlet wavelet (aka Gabor wavelet) yielded reassuring results, when comparing their patterns to the T(f) transfer spectra. Wavelet transforms are generally more suitable to handle time series with time-dependent spectral structure (as the ones in this case). Some of our findings are presented in the attachment (Fig. 3) of this response letter, showing an exemplary T(f) transfer spectra (analogous to those presented in Fig.4 of the submitted manuscript) and the corresponding Wavelet spectrograms for the surface and interface time series extracted from the vicinity of the left-hand sidewall of the tank. Time scale ("period") tau, shown along the vertical axis represents the width of the Morlet window, and it gives higher wavelet coefficient values (color coding) when it fits locally to the time series. Thus, we can see the damping of surface modes (upper spectrogram), and the appearance and disappearance of various modes at the internal interface (bottom spectrogram).

On the bottom spectrogram, the notation is the following. The horizontal black dashed line is always the fundamental surface mode from the simple surface dispersion relation of Eq. (2). Dotted black lines belong to the peaks (simply tau = 1/f) in the transfer function. It is visible that the peaks of the transfer function T(f) indeed coincide with actual detectable oscillations. (Which, as it turns out in our Fig. 6b also coincide with internal seiche modes.)

Comment:

5) The extraction of the energy damping coefficients is not explained but the results of major importance for the authors.

Response:

Indeed, our explanation under equation (1) was not explicit, we will formulate it in a clearer manner in the updated version of the manuscript.

Taking the surface vertical displacement time series at the lateral sidewall of the rectangular tank (where it is assured, due to the boundary condition that all standing wave modes have antinode), we fitted the formula with N = 2 as a limit. It turned out (when checking the standard deviations of the residuals) that this two-term sum was sufficient to account for > 90% of the observed variance in all cases. This is how the frequencies and the damping coefficients of the most dominant modes (shown in Figs. 5 and 7) were acquired.

Comment:

6) The authors claimed that the Fourier Transform of a damped sinusoïdal function possesses low frequency peaks. This is wrong in general. The Fourier Transform of exp(âAËŸTat) sin(w0t) is : w0/[-wËĘ2 + i w a + w0ËĘ2 + aËĘ2] and does not contain necessary low frequencies.

Response:

We are well aware of the Fourier transform of the damping exponential function. The statement in question (line 142) has been the following: “even if the surface seiche was a perfectly ‘monochromatic’, single frequency source signal, its exponential decay would still unavoidably introduce nonzero amplitudes into the low-frequency range of its spectrum (see, e.g. French (1971)), making it suitable for the excitation of slow internal oscillations.”

In the text did not intend to refer to “peaks” in the w < w0 range, merely stated that the spectral amplitudes are nonzero in this domain (as the spectral peak widens due to damping), which is true, also for the formula mentioned by the referee.

Also our statement in line 205 may very well have been misleading as it said: “the spectral structure of the decaying source signal includes low-frequency components that can resonate with certain internal standing wave modes whose wavelengths are such that they fulfil the geometrical boundary conditions, representing a 'band-pass filtering"'

Thus, we reformulated the text, exchanging "low-frequency components" to "non-zero amplitudes in the low-frequency range" for clarity.

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2020-114, 2020.

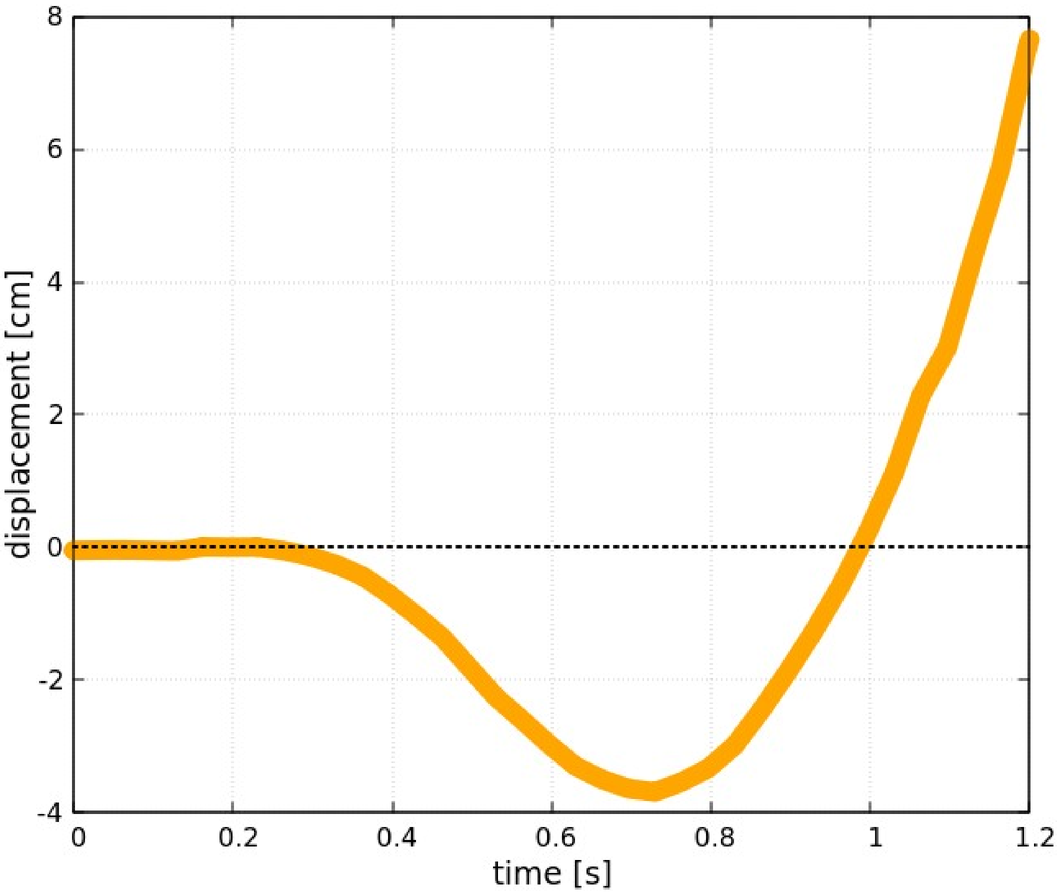

Fig. 1.

Printer-friendly version

Discussion paper

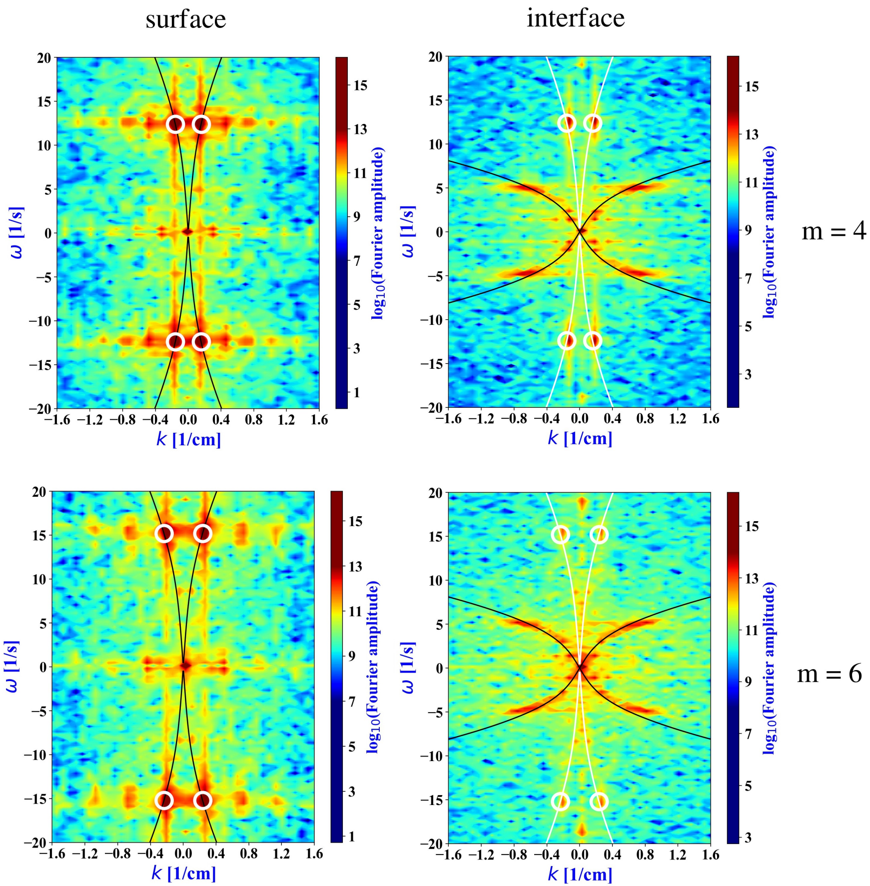

Fig. 2.

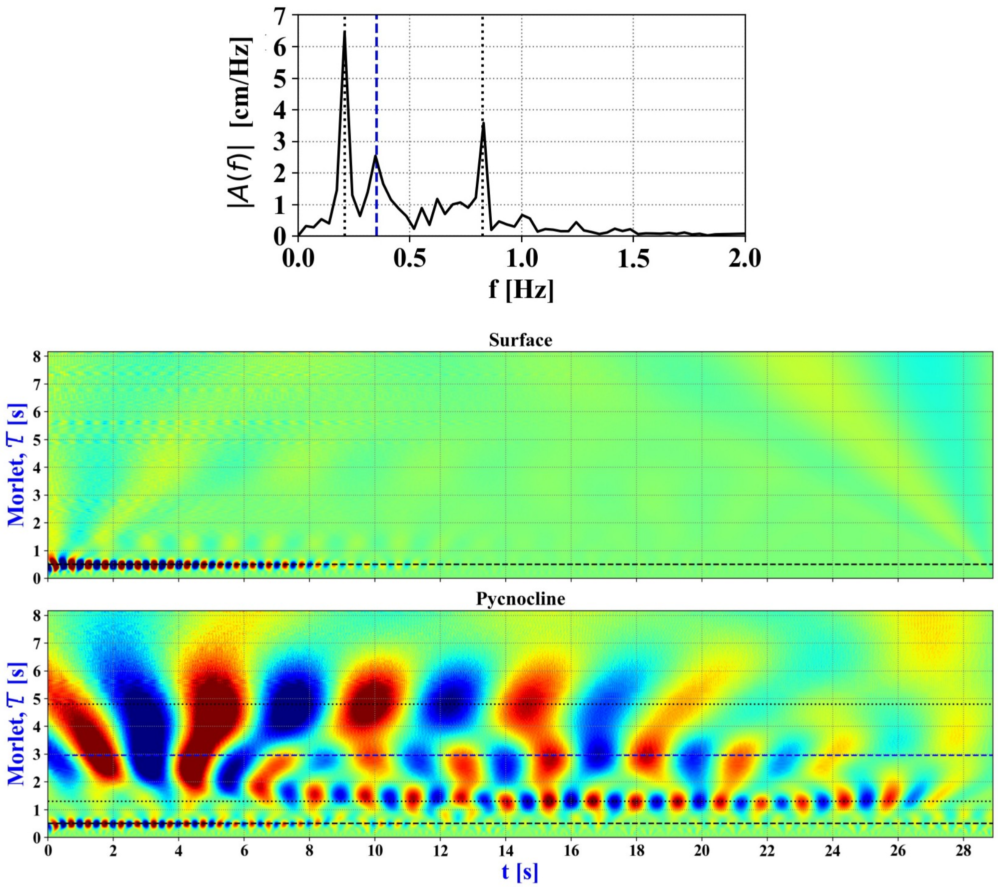

Fig. 3.