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Review and rebuttal of the paper

The Delta Transport Processes Laboratory: a novel laboratory for surface wave-induced currents under rotation

Bayle et al.

Editor handling the paper: Miguel Esteban

The reviewers remain anonymous.

The author’s response to all reviewer comments is given below for each round of revision, where the original reviewers’ comments are given in black, our response in blue, and the modification made in the manuscript are highlighted in yellow.

ROUND 1

Reviewer A:

This report describes an experimental device that was constructed to contribute to elucidating the interactions and processes between Stokes drift and other Eulerian currents, such as the Coriolis force due to the rotation of the Earth. It is said that this device will enable experiments on free surface waves during rotation. It is equipped with a pumping system for creating any type of density stratification and an internal gravity wave generator for generating any type of internal wave in any type of density stratification. It is also equipped with a 3D Particle Tracking Velocity system and is capable of computing both the Lagrangian and Eulerian velocity. This is a pioneering and challenging experimental device, and it is expected to be used in many studies and accumulate data.

However, it is unfortunate that no results of performance confirmation tests or trial experiments are shown. These are necessary for the report on the device, and it is hoped that any data will be added.

We thanks the reviewer for pointing out the lack of technical results. For the first version of this manuscript, we could not perform technical tests because the construction of the laboratory was not fully completed. The construction has been completed since, and we have been able to perform all the technical tests necessary to assess the performance of the facility. The manuscript has been deeply changed, with the following new sections:

- Technical results: system performance. This includes tests on the turntable alignment and vibration; tests of the pumping system performance; tests on the 3D PTV system performance (the latter was already in the first version).
- Discussion on the parameter space and lab effects in the context of surface gravity waves under rotation. This includes a dimensional and dimensionless analysis of the key parameters used in surface wave under rotation experiments. The effects of the turntable vibrations and miss-alignment are also discussed.

The internal wave generator is now suggested for future development of the lab, as it is not possible to develop it now.

In addition to the point mentioned above, the English and grammar has been improved, the photos have been up-dated and the abstract and conclusion have been modified to reflect all the changes.

Reviewer B:

This study proposed a unique experimental facility (i.e. DTPLab) that aims to investigate the interaction between the Stokes drift and other Eulerian currents, such as those caused by the Coriolis force. The manuscript includes the design concept, the construction procedure, and the novelty of this facility (e.g. an internal wave generator). New insights are expected to be obtained using DTPLab, and readers will be interested. However, the current manuscript has a significant drawback; it lacks the results related to the research objective and relevant discussions. Although section 2.7 shows an initial result of measuring wave-induced current by a 3D Particle Tracking Velocity system, it is unclear whether the effects of the Coriolis force were considered. Even worse, the related discussion has not been written in the manuscript. These issues cannot be overlooked. Therefore, I recommend a 'Decline Submission' for the current manuscript, with encouraging the authors to resubmit the revised one after addressing these issues.

We thanks the reviewer for pointing out the lack of results and discussion. For the first version of this manuscript, we could not perform technical tests because the construction of the laboratory was not fully completed. The construction has been completed since, and we have been able to perform all the technical tests necessary to assess the performance of the facility. The manuscript has been deeply changed, with the following new sections:

- Technical results: system performance. This includes tests on the turntable alignment and vibration; tests of the pumping system performance; tests on the 3D PTV system performance (the latter was already in the first version).
- Discussion on the parameter space and lab effects in the context of surface gravity waves under rotation. This includes a dimensional and dimensionless analysis of the key parameters used in surface wave under rotation experiments. The effects of the turntable vibrations and miss-alignment are also discussed.

The research objectives that motivated the development of this lab are now discussed in the context of dimensional and dimensionless analysis. However, the actual tests and results associated with our on-going research on Stokes drift under rotation will be published in a separate paper, and in a more appropriate journal. Nonetheless, our recent tests of the 3D PTV system under rotation have shown very good results, demonstrating that the 3D PTV system can be used on the turntable during rotation, as stipulated in the manuscript.

The internal wave generator is now suggested for future development of the lab, as it is not possible to develop it now.

In addition to the point mentioned above, the English and grammar has been improved, the photos have been up-dated and the abstract and conclusion have been modified to reflect all the changes.

ROUND 2

Reviewer A:

This report describes an experimental device that was constructed to contribute to elucidating the interactions and processes between Stokes drift and other Eulerian currents, such as the Coriolis force due to the rotation of the Earth. It is said that this device will enable experiments on free surface waves during rotation. It is equipped with a pumping system for creating any type of density stratification and an internal gravity wave generator for generating any type of internal wave in any type of density stratification. It is also equipped with a 3D Particle Tracking Velocity system and is capable of computing both the Lagrangian and Eulerian velocity. This is a pioneering and challenging experimental device, and it is expected to be used in many studies and accumulate data. In addition, some performance tests and lab effects in the context of surface gravity waves under rotation ware discussed.

Recommendation: Accept Submission

Reviewer B:

The authors have revised the manuscript, and I acknowledge that this has improved its quality. The technical details and the characteristics of the experimental equipment in the DTP Lab are well described in Section 3, which may be useful to its potential users. Section 4 also presents its limitations, and Table 1 clearly summarizes the correspondence between the laboratory and the field for several important geophysical quantities. Although the significant differences in these due to the Coriolis parameter are described, this provides useful insights for users when designing their experiments.

However, despite the improvement in the current manuscript, I still wonder whether it meets the standard required for a research article in JCHS. In fact, the authors indicate that this paper comprises technical notes of the DTP Lab, and all the results relate to the laboratory's characteristics obtained under simple experimental conditions. Therefore, the scientific novelty of this paper appears to be unclear. Please refer to the following comments for further revision.

We would like to thank the reviewer for taking the time to review our manuscript.

This manuscript aims to present and describe a novel laboratory and its equipment to the scientific community, along with a focused discussion on experimental surface gravity waves under rotation. The first novelty lies in the DTP-Lab itself, which represents the integration of all components detailed in the manuscript. Additionally, this is the first laboratory where surface gravity waves under rotation can be experimentally studied – this constitutes the second major novelty. Accordingly, we aimed to outline the key limitations and parameters that must be considered when conducting such experiments, both from a technical and theoretical perspective.

However, we agree that the novelty is limited to presenting a new "methodology" (laboratory); we do not present novel scientific results herein. This manuscript is therefore intended to be published as a "Technical Note," which does not aim to present the first full experiment on surface gravity waves under rotation. This will be the focus of a future experimental campaign with a more targeted scientific objective.

Major:

1. In line 112: The damping rate of the absorption system indicates that the wave height of reflected waves can reach tens of percent of that in incident waves. I recommend adding a statement indicating the possible errors introduced by the absorption system.

In all flumes – except those equipped with two opposing wavemakers capable of fully absorbing the incoming wave signal – a portion of the incoming wave is reflected (typically around 10–15% off a gentle planar slope). We agree with the reviewer that such reflections are undesirable (in most cases) in and should therefore be explicitly mentioned.
We have added the following sentence, L. 112-115: "This level of absorption is common in flume experiments, and as a result, the wave field always contains a reflected wave component. This is realistic for nearshore experiments but not necessarily for those in deep water. As with all laboratory flumes, the presence of reflections must be taken into account by users and may be prevented further by optimising beach design."

2. In line 271: Please show the values of ρ_f and ρ_s used in the pumping system. Does the deviation in Fig. 13b occur near the value of ρ_s?

The value ρ_s will vary with each experiment. For the performance test presented in this manuscript, we have added the specific values used on L. 261-262: "For this test, the fresh-water density (ρ_f) and the salt-water density (ρ_s) are 998.9 kg/m³ and 1136.6 kg/m³, respectively."

The observed deviation in density occurs near the bottom, where the measured density is approximately 1040 kg/m³. We believe this additional salinity may be due to a minor inaccuracy in the flow rate delivered by the fresh-water pump. Another possible explanation is that, at pump start-up, the salt water may have been introduced slightly before the fresh water, thereby increasing the density of the initial (bottom) layer. This sentence was added L. 276-277.

3. In line 287: I agree that the content given in the "Discussion" section is valuable, but these points are more "notes for using the DTP Lab" than discussion. I recommend renaming this section accordingly.

We agree with the reviewer's comment. We have changed the title of section 4 to 'Guidance for DTP-Lab users: surface gravity wave under rotation'.

4. In line 294: Overall, the purpose of presenting the results in this chapter is unclear. For example, it is not evident what insights the relationship between each wave frequency and wavenumber shown in Figure 15a offers for conducting experiments.

As explained in the opening paragraph of Section 4, the aim of this section is twofold: first, to familiarise users with the key parameters that must be considered when studying surface gravity waves under rotation, and to illustrate the typical ranges of these parameters; second, to present laboratory-specific effects that are unique to this novel facility – particularly those related to rotation.

We understand the reviewer's comment regarding Figure 15, which prompted us to reconsider the organisation of the material discussed in this section. As a result, we have made the following changes:

- Figure 15 has been removed. This figure was originally intended to illustrate the wave steepness (*ka*) as a function of wave frequency and wave amplitude, with the intermediate step of obtaining the wavenumber by solving the dispersion relation for a given water depth and frequency. However, the relationships shown are relatively straightforward and do not add significant value to Section 4. Moreover, the relevant information is already included in Figure 7b. The associated explanatory paragraph has also been removed.
- Figure 16 and the accompanying paragraph – which discuss the centrifugal effect on the still-water level – have been moved to Section 4.2, as this phenomenon represents more of a laboratory limitation than a fundamental parameter of the wave experiments.
- We have added the following sentence to the first paragraph of Section 4, L. 297-299: "The aim of this section is to enable future users of the DTP-Lab, wishing to study aspects of surface waves under rotation, to determine which part of the real-world parameter space can be studied in the DTP-Lab (Section 4.1) and what experimental challenges may arise (Section 4.2)."

5. In lines 318–327: Related to comment #4, it would be clearer to present the limitations in a consolidated summary at the end of the chapter, after showing the various results and figures. For users, a summary of the operating conditions under which the DTP Lab should be used and the points to consider when configuring those conditions would be beneficial.

The paragraph referred to by the reviewer is intended to provide a comparison between the parameter values achievable in the laboratory and those typically observed in the field. Its purpose is to highlight the scale differences in the parameter space, rather than to suggest specific operating conditions. Since experiments on surface gravity waves under rotation may vary widely in their objectives, scope, and scale, we do not wish to prescribe fixed guidelines.

Moreover, while the laboratory provides a controlled environment for simulating field conditions, it also offers the possibility to conduct non-realistic (for a typical coastal environment, that is) experiments to explore theoretical boundary conditions or isolate specific processes. For example, in Figure 16, we present the conditions under which both the wave and current fields, or the current field alone, are influenced by rotation, but it is up to the user to determine the appropriate forcing conditions based on their experimental goals.

However, we agree that it would be useful to summarise the hard limitations of the laboratory setup. To address this, we have added the following sentence to the conclusion, L. 433-436: "The performance tests of the turntable and rotating flume showed that the turntable should preferably be operated in the negative (anti-clockwise) direction, particularly at rotation speeds between 0.4–0.8 rpm. Rotation speeds above ±7.0 rpm should be avoided, and speeds in the range of ±3.3–3.7 rpm are also discouraged due to the risk of increased vibrations."

6. In line 350: Even if this manuscript is written as the technical note of the DTP Lab, describing the effects of rotation on the generated waves is necessary. For example, when the tank is rotated, the water level differences can alter the wave propagation speed and affect bulk statistics such as significant wave height. Also, including the related figures may highlight the novelty of the DTP Lab as well.

The effect of rotation on the surface gravity wave field is expected to manifest itself as a deformation of the wave field. For sufficiently high rotation rates relative to the wave conditions (see Figure 16), wave propagation is expected to be deflected by the Coriolis force. As a result, waves reflect off multiple surfaces, including the sidewalls, and these reflected waves are also deflected by the Coriolis force. The expected outcome is a complex three-dimensional wave field. However, the exact structure of this wave field is unknown.

To properly investigate the wave field under rotation, a three-dimensional surface measurement method – such as the Schlieren method – would be required, along with a detailed analysis of the underlying physical processes. This represents a separate line of research, which is beyond the scope of the present paper. Nonetheless, the DTP-Lab is now fully operational and suitable for conducting such studies.

In summary, the exact structure of the wave field in a flume under rotation is currently unknown (so we do not want to speculate on this) and cannot be accurately captured using wave gauges alone (so we cannot produce a figure such as requested by the reviewer). What we do know is that the field will be deformed. We agree with the reviewer that this point was missing from the original manuscript, and we have now added the following explanation at L. 448-450: "The influence of rotation on the wave field is expected to deflect wave propagation and alter its direction, which is expected to result in a complex three-dimensional wave pattern. Experiments aiming to investigate such wave fields should employ a method capable of capturing the free surface in three dimensions, such as the Schlieren method."

Regarding the reviewer's comment on the effect of water level differences on wave propagation, our response is similar: we currently do not know the precise effect and can only speculate – something that does not align well with the scope of this manuscript. However, we agree that this potential influence should be acknowledged more clearly. We have therefore added the following sentence, L. 366-368: "Users should be aware that water-level differences along the flume may influence wave propagation – the greater the difference, the more significant the potential effect – but further research is needed to fully understand these interactions."

Minor:

1. In line 42: The word "section" is duplicated. Please revise.

Thanks for pointing this out.

2. In line 70: Please add the official names of Franke and SEW.

The name of the company Franke was already complete; but thanks for pointing out that SEW was incomplete. It has been changed to SEW-EURODRIVE.

3. In Fig. 15a: The x- and y-axes should be converted to match those in Fig. 15b.

This figure has been removed. See our answer to Major comment 4.

4. In Table 1: The table caption is too long. For example, the equations used to calculate the indicators employed for comparison and the conditions under which they were computed should be described in the main text. Also, please correct the expression "Figure ??" in the caption.

Thank you for pointing this out. We have made some changes which we believe improves the readability of this caption. The caption was reduced in length, and the equations used to calculate the parameters employed for comparison and the conditions under which they were computed are now explained in the main text, L. 301-319. Section 4.1 has been reorganised.

5. In Fig. 17: Which cases are shown as the minimum, maximum, and representative cases?

In Fig. 17 (now Figure 15), the dimensionless parameters are computed using the min, max and representative value of the primary parameters displayed in Table 1, as a function of the rotation speed. We acknowledge that it was not clear, so we have modified the following sentence in Figure 15 caption as: 'These dimensionless parameters are computed using the minimum (min), maximum (max) and representative value of the primary parameters presented in Table 1.'