31ST INTERNATIONAL WORKSHOP ON WATER WAVES AND FLOATING BODIES

Discussion of Presented Papers

Title of Paper: Three-dimensional steep wave impact onto vehicle plate of finite width

Author: Chatjigeorgiou, I. K., Korobkin, A.A., and Cooker, M.J.

Question: The problem is dynamic – yet the fluid is described with linear boundary conditions. Can you clarify how the time scale of your impact calculations relate to the time scale of change of fluid shape during impact?

Questioner: Bredmore, H.

Answer: Indeed the problem is dynamic and small scale approximations are taken allowing the linearization of the boundary value problem. However, the approach taken provides the solution at the instant of the impact, which accordingly allows the computation of the pressure impulse as well. The time evolution of the phenomenon is approached using 2D Wagner's model. That means that the wetted area in the cylinder case, which is increased as the time is increased, is approximated as a plate, which accordingly is assimilated as a degenerate elliptical cylinder. Overall, the fluid shape is assumed by the Wagner model. In the cylinder impact case, what it is not taken into account is the vertical variation of the impacted region.

Title of Paper: Time domain hybrid TEBEM for 3D hydrodynamics of forward ship with large flare

Author: Chen, J.K., Duan, W.Y. and Ma, Q.W.

Question: Have you done any comparison between TEBEM with HOBEM for a curved body with the same number of unknowns? What is the advantage of TEBEM over HOBEM?

Asked by: Terry, B.

Answer: Response from author not received

Title of Paper: Numerical investigation of unsteady hydrodynamic loads on a vertical cylinder in waves and sheared currents

Author: Chen, L.F., Zang, J. Taylor, P.H., Stagonas, D., Buldakov, E. and Simons, R.

Question 1: Would you please comment on how you deal with breaking effects at the wave surface-body intersection, when experiments show severe run-up, breaking and bubble formation, or are you below this parameter range

Asked by: Grue, J.

Answer 1: In our case, we didn't observe wave breaking.

Question 2: Why does your wave-focusing method require iteration? How many interactions are typically needed?

Asked by: Maki, K.

Answer 2: We would like to give a violent wave-structure iteration with and without currents. Thus the interation procedure was applied to make sure that groups with the same time history and with the same spectrum and phases occurred at the focus. It depends. Generally, with the 3 iteration we would get desired results.

Question 3: How was the sheared current produced?

Asked by: Doctors, L.J.

Answer 3: The current was injected from a recirculating zone beneath the tank. Just upwave of this the waves were driven by a paddle. The current was injected through an array of chicken wire with variable density, the resulting flow down the channel is strongly sheared and stable down the channel.

Question 4: The wave group time histories are identical for different current values – then due to the Doppler shift the wave numbers must be different. Now, as the forces are very similar, does this imply only weak dependence to wavelength?

Asked by: Bredmose, H.

Answer 4: The force time histories are similar with each other because of the applied iteration method. Groups with the same time history impacting on the cylinder resulting in similar wave-structure interaction.

Title of Paper: Mathematical modelling of the WITT wave energy converter

Author: Crowley, S. and Porter, R.

Question 1: When modeling the SEAREV device which is essentially the same principle as our device, we found 2 peaks. Capture width curves corresponding to the 2 resonant degrees of freedom heave and pendulum rotation. Can you explain your 4 peak curves, especially the very sharp peak of fig. 3 of your abstract? What is the physical meaning of this peak?

Questioner: Clemént, A.H.

Answer 1: It's hard to assign particular responses to each of the individual peaks, but we know that:

i) The moorings are critical for the multiple resonant peaks.

(ii) with the full degrees of freedom (heave, surge, pitch and pendulum) we see these four peaks, but if you reduce the degrees of freedom you reduce the number of peaks seen in the plot of the optimum capture width.

(iii) Typically the very sharp peak is associated with the resonance period of the pendulum. [This is the one resonance that is straightforward to identify as you can calculate the pendulum resonant frequency when you consider it in isolation].

Question 2: Have you considered the cost of constructing the device?

Asked by: Beck, R.

Answer 2: Our project partners have been developing levelled cost of energy for the device. Taking cost into consideration, the cylindrical hull would now be favorable over the spherical device despite being predicted to absorb a similar amount of power given the much lower construction cost.

Question 3: I understand that the hull geometry of a floating body is a sphere, for which the wave exciting moment in pitch is generally small, which is not good to excite the rotational motion of the internal pendulum. Why didn't you use a square-like floating body?

Asked by: Kashiwagi, M.

Answer 3: The spherical hull was chosen to be looked at initially as the geometry was appropriate given the internal pendulum. Indeed, under linear assumptions there are no wave forces in pitch for a floating sphere and we also wondered if changing the geometry of the hull to one which would induce wave forces would be beneficial to the mean power absorbed by the device. We have since considered a floating, vertical cylindrical hull, but when optimized we have not seen any significant increase in the mean power when compared to a spherical device of the same diameter. We did see however, reduced device excursions (presumably due to the larger surface area of the cylinder in comparison to a sphere).

Title of Paper: The raked-wedge hull: A severe test of linear wave-making theory

Author: Doctors, L.J.

Question: For your shifting LCG experiment, did you change the trim, or alter the LCB location?

Asked by: Beck, R.

Answer: The change of LCG was effected by shifting weights from the stern of the model to the bow. This means that the displacement of the model was fixed for all four positions of the LCG and the trim for each LCG was determined by still water observations of static equilibrium. The consequential changing immersed geometry was full accounted for in the theoretical analysis.

Title of Paper: Computation of the diffraction transfer matrix and the radiation characteristics in the open source aero-order BEM code NEMOH

Author: Fabregas, F., McNatt, C., Rongère, R., Babarit, A. and Clément, A.H.

Question 1: What are advantages & disadvantages of McNatts method in your opinion?

Asked by: Meylan, M.

Answer 1: With McNatt's method there is no need to dispose of a custom BEM to compute the elements of the Diffraction Transfer Matrix. However, only progressive terms can be taken into account and the method is less straightforward than the one proposed by Goo & Yoshida (1990).

Question 2: Presumably you could not use your method in the form presented for infinite water depth. Have you investigated how the convergence of your method depends on the water depth?

Asked by: Eatock-Taylor, R.

Answer 2: When used with the finite-depth Green's function as written in Goo & Yoshida (1990), the finite –depth interaction theory only converges up to a certain depth. However, this limitation can be circumvented by rewriting the finite-depth Green's function using the dispersion relation.

Question 3: Have you studied the optimal layout and number of wave energy converters in typical sea states with regard to the maximization of the wave energy capture? There have been studies suggesting that no more than ten converters are necessary.

Asked by: Sclavounos, P.

Answer 3: This will be the next step of our research once the numerical tool to do so has been implemented and validated.

Title of Paper: Coupled motion equations for two interconnected floating bodies in an auxiliary function approach

Author: Feng, X., and Bai, W.

Question: 1. What kind of scheme did you use to pursue correctly the movement of the cross point between the body and free surfaces? 2. Did you check numerically satisfaction of Green's identity to ensure the accuracy of the scheme?

Asked by: Kashiwagi, M.

Answer: 1. We use the quadratic higher-order boundary element method to solve the boundary value problem. Double (triple) nodes are distributed on the intersection line between body and free surface to avoid the singularity. A small iteration procedure is introduced to trace the intersection line which we found is effective. 2. We will check the satisfaction of Green's identity to find out how large the error will be in the near future. This will be a useful way for checking the accuracy of the scheme.

Question 2: For two freely floating bodies, the results from the paper presented good agreement with that of Hydro Star. However, they are all based on potential flow. If you validate against experimental results, the potential flow results will overestimate the roll motion due to the damping. Consequently, the other degrees of motion will be mis-estimated. How can you deal with roll motion?

Asked by: Yuan, Z.-M.

Answer 2: We agree on the comment that the potential flow will sometimes over-estimate the results as no viscosity of the fluid is considered. However, this piece of work focuses on the development of the coupled dynamic model and wave resonance is not the main concern here. We will certainly continue our work to see how we could incorporate viscous effects into the potential flow model in the future.

Title of Paper: Upstream waves at ship moving at low subcritical speed

Author: Grue, J.

Question 1: Although the profile of the upstream long wave is different from a soliton, it seems that it is enhanced in the interaction with the side wall. Does it elongate with time? Is there any similarity as the Mach reflection when solitary waves impinge onto the side wall with a small oblique incident angle?

Asked by: Meng, Q.

Answer 1: This wave phenomenon is basically linear and the wave speed follows the linear dispersion relation where for the very long waves, this is only weakly dispersive. The reflection at the walls is maybe a variant of Mach-reflection, with the reservation that no nonlinearity is acting. An observation is that the upstream waves eventually became long crested, stretching across the channel. Only small variations are observed of the amplitude, as a function of the lateral coordinate.

Question 2: Thank you for a very interesting talk and novel topics. Your calculations are convincing but you have not suggested a qualitative explanation. Is the following correct? When the ship crosses a depth change there is an impulsive transient, which, like a time-domain singularity, sends out waves of all wavelengths including long waves moving at $\sqrt{gh}$. The sign will depend on the sign of the depth change.

Asked by: Newman, J.N.

Answer 2: Yes, a relatively abrupt ramp-up of the ship motion generates an upstream elevation wave and a downstream depression wave. The similar situation happens when the ship encounters the bottom change. These impulsively generated waves can be obtained analytically by integrating the equations (1-3) presented in the abstract (not shown here). It is possible to express the elevation in closed form and thereby obtain the far field wave train. I will include the derivations when the final paper is published.

Title of Paper: Improvement of immersed boundary method for simulation of fluid-structure interaction

Author: Hu, C. & Liu, C.

Question:

1. Is it possible to compute for much higher Reynolds number problems?

2. Could you summarize the reason for the pressure oscillation shown in computed results?

Asked by: Kashiwagi, M.

Answer:

1. Present validation results are for low Reynolds number problems. For higher Reynolds flow simulation with the Cartesian grid method, AMR or overset grid technique is necessary to resolve the boundary layer which we are developing now.

2. The pressure oscillation phenomena for moving bodies is due to mainly the following two reasons:
-Velocity derivative calculation uses a grid point inside the solid phase.

-The role of grid point (forcing point, solid point, and fluid point) changes during the motion of the body.

Question 3: We have seen that in some immersed boundary methods, the vortex structures are not well captured with time (example A turbulent jet) We have seen that a smaller grid size is needed to avoid dissipating vortices sooner. Can you comment how you take into account this problem, to correctly capture how vortices evolve?

Asked by: Urbina, R.

Answer 3: Yes, sufficient grid resolution is required to resolve vortex structures. By the present Cartesian grid approach, the turbulent jet can be simulated if the grid is fine enough.

Title of Paper: On nonlinear wave-structure interaction using an immersed boundary method in 2D

Author(s): Kontos, K., Bingham, H.B., Lindberg, O. and Engsig-Karup, A.P.

Question 1: In comparison with the experiment of Yamashita (1977), you have chosen the case of A=0.2R, although Yamashita did the experiment with larger amplitudes. Are there some difficulties in your computations for larger amplitude cases?

Asked by: Kashiwagi, M.

Answer 1: I haven't attempted to simulate higher amplitude cases yet. I have tried computing lower amplitude cases A=R and the comparison was good.

Question 2: There are no computed results for lower frequencies in the comparison with the experiment of Yamashita. Are there some reasons for that?

Asked by: Kashiwagi, M.

Answer 2: I didn't manage to try simulating for more frequencies before the submission deadline. However, I don't expect facing any problems with these test-cases.

Question 3: You appear to also be solving an interior flow problem. Do you have any trouble with irregular frequencies?

Asked by: Beck, R.

Answer 3: Thank you very much for your question. In the immersed Boundary Method there is no internal flow. There are two types of points in the interior of the body, the ghost points and the 'dummy' points. The ghost points are used to satisfy the body boundary condition. The dummy points are not used at all. Their potential is set to zero and they don't interact with the external flow.

Title of Paper: Deformations of an elastic clamped plated in uniform flow due to jet impact

Author: Korobkin, A.A., Khabakhpasheva, T.I., and Malencia, S.

Question: Waves often have a somewhat softer shape than a vertical profile. Do you believe the vertical profile used in this presentation is a good approximation of a worst case impact?

Asked by: Skene, D.

Answer: We cannot prove that the case with the vertical wave profile is the worst case in terms of the bending stresses in the plate caused by impact. However, we believe that this is the case. The impacts with non-vertical fronts are 'softs'. In a sense the time of leading is an important factor of the interaction.

Title of Paper: Wave energy absorption by a floating air-filled bag

Author: Kurniawan, A., Chaplin, J., Greaves, D., Hann, M. and Farley, F.

Question: Flexibility of the bag is certainly an important parameter, difficult to vary in experiments but easy in numerical simulations. Did you investigate the influence of this parameter? 2. In this system, the air is worked in closed loop, and you will have elevation of temperature which could be the origin of power loses. Did you consider this question?

Asked by: Clemént, A.H.

Answer: The bag material is inextensible, both in the model and in the concept for the prototype. It is free to fold out between the tendons which extend over the height of the bag, carrying all tension. 2. Checks have shown that this effect is insignificant at model scale but may be important at full scale.

Title of Paper: Dispersion relations of waves generated by a traveling oscillating disturbance on a shear current

Author: Li, Y., and Ellingsen, S. Å.

Question 1: Different from a singularity, at the resonance frequency, a geometry of finite extent will not have or pose a similar singularity; it will simply become a poor wave maker at the resonance frequency.

Asked by: Grue, J.

Answer 1: Just a comment.

Question 2: Will your approach work when S<O as is typical of wind driven shear?

Asked by: Thiagarajan, K.

Answer 2: Yes, we assume $S \geq O$ in our work as it's better for analyses by varying other parameters. In principle, our work has taken the situations where S<O into consideration. When the terms which involve S or H_s/F_n observed, one may find that these terms appear in combinations with cos γ or cos θ. That is to

say, by simply choosing the coordinate system in a clever way, we can always change a case where S<O to the case S≥O.

Title of Paper: Impact of hydrodynamic interactions of the performance of a three-float multi-mode wave energy converter M4 in regular waves

Author: Liang, S., Zang, J., Standsby, P., Carpintero Moreno, E., Taylor, P.H. and Eatock Taylor, R.

Question 1: For regular waves, we can optimize the performance in some ways, but in irregular waves the absorption efficiency tends to decrease. Although there are some ideas to enhance the performance in irregular waves in the past references, what is the idea to enhance the efficiency for irregular waves for the present device?

Asked by: Kashiwagi, M.

Answer 1: Optimization of the linear response and average produced power in a given sea-state of specified spectral shape (JONSWAP, say) is straightforward. Then we can perhaps adjust the PTO value as a function of the wave period corresponding to the spectral peak, Tp say. Optimization of the (? fixed) machine geometry would require knowledge of the longterm wave climate at a particular location.

Question 2: In the 1970's the "Cockerell raft" was proposed, with two simple barges connected by a hinge. Your concept is basically the same. Can you comment on the comparison between these two devices?

Asked by: Newman, J. N.

Answer 2: We thank Prof. Newman for his historical perspective with 3 floats and the beams above the water, the M4 machine has many more adjustable parameters so much more optimization is possible, particularly with modern computational techniques. But of course the basic idea behind M4 is similar to the "Cockerell raft".

Question 3: Have you considered how the device will perform in non-head seas?

Asked by: Beck, R.

Answer 3: Brief reference to this was made in the presentation. Two papers to be published by Sun et al in J. Ocean Eng. Mar. Energy include the effect of angle of incidence in regular waves, and the effect of directional spreading.

Title of Paper: Eigenvalue approach for statistical analyses of the second-order hydrodynamics responses

Author: Lim, D.-H., Kim, T., and Kim, Y.

Question: It is perhaps worth commenting here that in the early days of TLP design one of the major concerns was fatigue damage due to springing. This led to a number of studies of the statistics of second order responses. The methods you have described here may very easily be applied to the assessment of the fatigue life of TLP tendons.

Asked by: Eatock Taylor, R.

Answer: You are absolutely correct that springing of TLP is related to fatigue. Most of the past studies were for fatigue analysis. We focused on extreme loads in the study and this can be easily extended/used for fatigue analysis.

Title of Paper: Added mass and damping of a column with heave plate oscillating in waves

Author: Moreno, J.

Question: Could you please comment on scale effects and side wall effects in the tank experiment?

Asked by: Beck, R.

Answer: We did comparisons with a model from Madrid which was 3 times larger than ours. Also, CFD of a 1:80 full scale showed good assessment. This was summarized in a recent paper by Moreno et al. in ISOPE Conference 2015. The tank side wall effects were partially mitigated by adding deflectors along the sides. That helped with reducing the higher harmonics as shown in the presentation.

Title of Paper: Channel wall effects in radiation-diffraction analysis

Author: Newman, J.N.

Question 1: Do you think there is a connection with Rayleigh-Bloch waves (which seem universal) and the trapped mode you see? Is symmetry essential to the trapped mode problem?

Asked by: Meylan, M.

Answer 1: There certainly is a connection between Rayleigh-Bloch waves and the trapping modes I showed for the elliptical cylinder. See for example, the abstract by Porter and Evans at the last workshop in Michigan (1999). See also their paper in J.F.M. 386, 233-258. The latter paper also addresses the issue of symmetry.

Question 2: Your interesting finding of zero radiation damping of the vessel in the tank has an analogy with results presented by Wolgamot et al at last year's workshop (subsequently published in Journal of Fluid Mechanics). This concerned an array of 8 vertical truncated cylinders oscillating in heave. In that case the geometry of the array was chosen such that the heave resonant frequency was equal to that at which the damping was zero, leading to a motion-trapped mode. Presumably the geometry you considered could be adapted to achieve something similar.

Asked by: Eatock Taylor, R.

Answer 2: It seems likely that there are geometries similar to the barge and ellipsed where both the damping is equal to zero and the sum of the inertial and restoring forces is also zero at the same wave number. In that case these would be examples of "motion trapping".

Question 3: The side wall effects can be estimated by different numerical methods. However, in the model tests in towing tanks, how can we reduce or eliminate the side wall effect, in order to get some reliable results as those in open sea?

Asked by: Yuan, Z.

Answer 3: The only possibility I can think of is very complicated: install active wave absorbers on the tank walls which are controlled so as to absorb most or all of the radiated/scattered waves, without affecting the incident waves.

Question 4: We are not sure if you might be aware of, or not, there was a semi-analytical solution for a vertical cylinder heaving in a channel that Prof. Sphaier & I published in J. Engrg. Math, 1989, v.23, pp95-11. In this work, the slowly convergent series was summed in an efficient way. Previous to summing that series or images exactly, the damping could be negative! The work was motivated by a paper of Thomas in the Bristol Workshop (2IWWWFB)!

Asked by: Yeung, R. W.

Answer 4: There are several papers from that era dealing with vertical cylinders in channels, which evaluate the slowly-convergent series. Most of these use the asymptotic expansion of the Hankel function; then the slowly-convergent series involve exponential functions and the remainder is algebraically small. My approach uses the expansions given by Linton (1998), which are exact (do not depend on the asymptotic expansions), and the remaining series converges exponentially in finite depth. Unfortunately the bibliographic details for Linton's paper in my abstract, Reference 7, are mistakenly replaced by the corresponding details for your paper with Sphaier in the same journal. The correct reference is Journal of Engineering Mathematics 33, 377-402 (1998). That paper contains an extensive list of references, including your paper.

Title of Paper: Hydrodynamic investigation of a fixed OWC Wave Energy Converter

Author: Ning, D.-Z., Wang, R.-Q., Teng, B., Zang, J. and Chen, L.-F.

Question 1: We can see that you generate waves in the numerical wave tank by internal sources. I just want to let you be aware of my paper at IWWWFB 1999, here in Michigan, where I introduce a numerical tool, called the spinning dipole, if you use it instead of sources, you are able to generate waves in one direction only, left to right say, and no waves in the other direction. This trick would be useful in your case.

Asked by: Clemént, A.H.

Answer 1: Thanks for the kind suggestion. I can try this wave generation method as Prof Clement suggested.

Question 2: In your experiments and calculations of the OWC, how do you benefit from existing analyses over the past 30 years or more, to improve the performance? E.g. this kind of device was built in Norway in the 1980's, Secondly, how do you improve the fundamental energy conversion to electricity?

Asked by: Grue, J.

Answer 2: The existing analyses provide the points for pushing the further improvements of the hydrodynamic performance of an OWC. The present study was based on the optimal geometry derived from the previous works.

The balance between efficiency and survivability of an OWC is a difficult problem. The present study shows that large waves may not result in high efficiency which could be a way to overcome the problem. In addition, decreasing viscosity and avoiding seiching phenomenon can also increase fundamental efficiency which were related to the geometry design.

Title of Paper: Some aspects of high kinematics in breaking waves due to sloshing

Author: Scolan, Y.-M., Hay, A. and Brosset, L.

Question: Very exciting work. It reminds me of the flip-through impact which occur at a vertical wall. Here due to rotational forcing the symmetry is no longer complete – so “competing” jet may not shoot up along the wall but somewhere out in the fluid. 1. This suggestion can perhaps be confirmed by running with horizontal forcing only. 2. Could also be related to amplification of a short-wave mode of the initial condition. Suggestion: perturb initial condition with a short wave disturbance and see what happens.

Asked by: Bredmose, H.

Answer: Thank you for the comment and your suggestion. The appearance of the secondary jet is still unclear. That will be studied in future works

Title: Deep water wave-breaking in a high-order spectral model

Authors: Seiffert, B.R. and Ducrozet, G.

Question 1: This work is very relevant for the use of fast potential flow wave models in the context of large-amplitude waves. Do you think the breaking criterion is also applicable in intermediate and shallow water? How is the strength of the eddy viscosity term determined?

Questioner: Bredmose, H.

Answer 1: Thanks you for your comments. I believe the strategy for implementing wave breaking in intermediate and shallow water will be similar to that of deep water. However, it will have to be carefully determined whether differences in the calculation of breaking onset as well as energy dissipation occur when calculating depth-limited breaking instead of steepness-limited breaking.

The strength of the eddy viscosity term is determined following the empirically determined equations presented in [2], for example. These equations relate pre-breaking wave geometry to the falling crest height, breaking length and time scales, which are then use to determine the strength of the eddy viscosity.

Reference: [2] Zhigang Tian, Marc Perlin, and Wooyoung Choi. An eddy viscosity model for two-dimensional breaking waves and its validation with laboratory experiments. *Physics of Fluids*, 24(3):036601, 2012. ISSN 10706631. Doi: 10.1063/1/3687508

Question 2: Thank you for presenting a very thorough work. Regarding wave breaking threshold, we have, for irregular waves, in long crested conditions, in a wave tank, systematic wave breaking for $\partial\phi/_{\partial x}\ /C_X > .9$ (your condition). We have also observed backward breaking for a very low-amplitude wave. Reference: J. Grue & A Jensen (JGR, 2012)

Questioner: Grue, J.

Answer 2: Thank you for your comments. It is an interesting observation to have backward breaking events. I believe the difference in observation of wave breaking for the value $\partial\phi/_{\partial x}\ /C_X$ may have to do with the calculation of *k*. In the present paper, instantaneous *k* is calculated using the Hilbert transform which is different than in [1] which uses a trough-to-trough period and local wave slope.

Reference: [1] John Grue and Atle Jensen. Orbital velocity and breaking in steep random gravity waves. *Journal of Geophysical Research: Oceans*, 117(7):1-16, 2012.

Title of Paper: Large wave groups-their probability, profiles, and mean offsets

Authors: Seyffert, H. and Troesch, A.

Question 1: Will you be able to obtain wave group information (as shown) by doing a evaluate transform of the measured time series history?

Asked by: Thiagarajan, K.

Answer 1: The use of a wavelet transform in this context is an interesting possibility, especially given the shown structure of the wave groups, which resembles in some cases the shape of the real part of harmonic wavelets. Presently, however, wavelet transforms haven't been considered by the authors.

Question 2: How would your method apply to wave groups in shallow water? Do you expect a different behavior in shallow water?

Asked by: Hayatdavoodi, M.

Answer 2: As of now, we have only looked at times series which come from a deep-water area. However, we make no deep-water assumptions in our analysis. In shallow water, the wave elevation may not be considered Gaussian, which would violate the assumption in our analysis of a Gaussian seaway. However, we would be interested in testing our method in time series which come from shallow waters. Empirically, it has been shown that a non-Gaussian signal will become more Gaussian as it passes through a linear filter. Since our method employs a linear filter, it is possible that we would still see interesting results with the non-gaussian shallow water time series.

Question 3: In the slide comparing mean offset, why are the mean peak/trough values different between the CDIP buoy and your mathematical approximation?

Asked by: Beck, R.

Answer 3: The time series shown from the CDIP buoy data is larger than the mathematical representation for two reasons. First, the specific time series has the largest value of the derived process for eight waves in all the of the seventy 30-minute time series which are considered in the paper (which we can consider as having a probability of non-exceedance of 0.98). As well, this specific time series also has a significantly larger variance than the ensemble wave group average. These both contribute to a higher mean amplitude than found in the ensemble wave group. The mathematical wave group formulation is based on the ensemble spectrum. We can account for the differences and show that the realized maximum derived process value for the singular time series is bounded by theoretical bounds.

Table 1: Nondimensional scale factors based on theory (TH) (i.e. Eq. 4 and 5) and empirical time series (TS) for $k = 8$. Separation period $\tau = T_{modal} = 14.88$s. Comparing Time Series January 20, 2010 15:09:00 and Ensemble Wave Group

Wave Group ($k = 8$)	$(\sqrt{m_{z_{ko}}}/k)_{TS}$	$(\hat{z}_k/\sqrt{m_{z_{ko}}})_{TH}$	$(\hat{z}_k/\sqrt{m_{z_{ko}}})_{TS}$	$\frac{(\hat{z}_k/\sqrt{m_{z_{ko}}})_{TH}}{(\hat{z}_k/\sqrt{m_{z_{ko}}})_{TS}}$
January 20, 2010 15:09:00	1.135	4.297	3.715	1.156
Ensemble Average	0.847	3.156	3.060	1.032

Table 2: Comparison of (absolute value) Mean Peak and Trough Values for January 20, 2010 15:09:00, Autocorrelation Function Wave Group ($k = 8$) from January 20, 2010 15:09:00, and Ensemble Average of 70 Samples. Fig. 1, $200s \leq t \leq 309.8s$.

	Mean Peak Value [m]	Mean Trough Value [m]	Peak-Trough Ratio	Mean Amplitude [m]	Mean Offset [m]
January 20, 2010 15:09:00	4.714	3.758	1.254	4.23	0.478
Eq. 3, 4, 5	2.708	2.171	1.248	4.23*	0.466*
Stokes Wave	-	-	-	4.23	0.164

*Note, the mean amplitude and offset, based on Eq. 3, 4, and 5, and ensemble average of the seventy records are scaled up to match the mean amplitude of the January 20, 2010 15:09:00 record.

The most probable extreme maxima, $\hat{z}_k$, for a given exposure time, T, in seconds, is given as:

$$\hat{z}_k = \sqrt{m_{z_{k_o}}}\ \left[2\,ln\left(\frac{T}{2\pi}\sqrt{m_{z_{k_2}}/m_{z_{k_o}}}\right)\right]^{\frac{1}{2}} \quad (1)$$

We consider the rareness of the group by estimating the number of cycles we would expect to see before encountering the examined wave group. We can calculate this expected number of cycles for the single time series, and the ensemble wave group, for both the theoretical and empirical cases.

Now we scale up the mean peak value of the wave group predicted from Eq. 3, 4, and 5 (2.708m). We consider the rareness of the event by the ratio of standard deviation of the individual time series considered is a much rarer event than the ensemble group. We can also consider the rareness of the group by finding the number of cycles we would expect to see before encountering the examined wave group (1.36). We can also find this ratio for the empirical value (1.21). When we scale up the mean peak value predicted from Eq. 3, 4, and 5 in the paper (2,708m), we find an upper and lower bound of the realized value of the mean peak value of the singular time series (4,714m). This explains why the predicted value from Eq. 3, 4, and 5 is lower than what is seen for a singular time series, and also why it is reasonable to scale up this value for comparison.

$$\left(\frac{1.135}{0.847}\right) \times 1.36 \times 2.708 = 4.94 \text{ (Theoretical values)} \quad (2)$$

$$\left(\frac{1.135}{0.847}\right) \times 1.21 \times 2.708 = 4.41 \text{ (Empirical values)} \quad (3)$$

Title of Paper: Instability of axially-symmetric propagating waves by a vertically-oscillating sphere

Author: Shen, M. and Liu, Y.

Question: Your analysis neglects the effects of viscosity. It may not be important, but it would be worth checking out the effects of steady streaming* generated by non-linear features of the non-uniform oscillatory boundary layer on the sphere. See paper by N. Riley at UEA in the UK.

*also known as acoustic streaming

Asked by: Chaplin, J.

Answer: Response from author not received

Title of Paper: Comparison of mathematical and CFD models of overwash of a step

Author: Skene, D., Bennetts, L., Meylan, M., Wrights, M. and Maki, K.

Question 1: Regarding the thin film behavior, there is a rich literature on colloidal research originating from the 1960's and 1970's, see Benney (1966), Gijevik (1970, Phys. Fluids). See also literature in a bio of Bjorn Gjevik by John Grue published in Ocean Dynamics on (2010).

Asked by: Grue, J.

Answer: I will certainly look at these as soon as I can. Thank you for your comment.

Question 2: What have you done to consider surface tension in both your numerical models and your experiment?

Asked by: Beck, R.

Answer 2: We have only done a scale analysis of surface tension on the mathematical model. I believe that its effect is proportional to the third height derivate and will therefore have a flattening effect on the bores, however, it does not appear to be strong enough to account for the flattening show in the CFD. We will certainly be trying to incorporate it into the models in the near future.

Title of Paper: Coupling of normal and hyper-singular integral equations in wave-structure interaction problems

Author: Teng, B. and Gao, S.

Question: When working with second order derivatives of the Green function, one may use the Laplace equation to rewrite the kernel, and then obtain derivatives in the tangential directions instead, for subsequent rewriting of the intergral in consideration, and then avoiding the hypersingularity. Another possibility is to use numerical differentiation on the integrating surface. Of course, a high accuracy should be aimed at.

Asked by: Grue, J.

Answer: Thanks for the suggestion. This will be considered in our later work.

Title of Paper: PIV measurement and CFD computation for sloshing impact flows

Author: Yang, K.-K., Kim, J. and Kim, Y.

Comment: Please look at paper by Marc Perlin & Z. Tian from Michigan. They have a lot of papers on visualizing breaking waves.

Question 1: Your pressure peak values are smaller than typical impact pressures. Will your $P\text{-}V^2$ equation work for higher impacts.

Asked by: Thiaparajan, K.

Answer 1: As pointed, the absolute value of the pressure is not high. We used a small tank for the test, therefore the pressure value is not very large. The main objective of this study was not to measure high pressure but to observe the relation between velocity and pressure during impact occurrence,
The single impact test was not supposed to measure very large impact, and it was intended to measure the velocity and pressure before the generation of fully mixed flow of liquid and air bubble. We could capture clean shots of liquid flow just before impact occurrence and the resultant impact pressure by exciting the tank in a short time. Generally higher pressures occur in fully developed sloshing flows, then it is really hard to measure particle velocity using PIV. Therefore, we could not handle very large magnitude of pressure impact, particularly in this small-size tank.

More important parameter to be observed, rather than the absolute pressure value, is the time-history and pattern of pressure. A positive result of this test is that the observed pressure patterns show the typical impulse types of sloshing flows. That is, although the magnitude is small, the present test generated typical impact process. Therefore, we think that the observation and conclusions are not much related to the absolute magnitude of pressure.

Question 2: By using boundary value method, what kind of gas statement equation did you adopt in considering gas bubble effects?

Asked by: Ni, B. Y.

Answer 2: I'm not fully understanding how the results were derived, but it is in the textbook "sloshing" by Faltinsen & Timokha

Title of Paper: Wave interference effects on two advancing ships

Author: Yuan, Z.-M.

Question 1: Since both ships are oscillating, have you considered the effects of phasing between the two ships?

Asked by: Beck, R.

Answer 1: It is not necessary to consider the phase. Since two vessels are with the same geometry and speed, in the head sea condition, they will oscillate with the same phase if there is no other external force to violate this stable status. However, if the two ships have difference sizes, the effects of phase have to be taken into consideration.

Question 2: In the comparisons with experiments by Kashiwagi (1991), for a single ship with side walls, I could see clear difference between two computed results by the superposition method and the other method for a single ship with side walls, particularly at high frequencies. I think theoretically both results must be the same. What do you think the reason of this difference?

Asked by: Kashiwagi, M.

Answer 2: The reasons for the difference between the two numerical methods can be attributed to the numerical dispersion and damping (Kim et al., Numerical dispersion and damping on steady waves with forward speed, Applied Ocean Research 27, Issue 2, May 2005, Pages 107-125). Even through this paper mainly discussed the steady waves, the wave length in my study is very small at high frequencies and can be treated like the steady wave problem. Then, the numerical dispersion and damping becomes evident, since I use the constant panel method. The numerical dispersion and damping becomes even more evident in the ship-to-ship problem, because the free surface is larger than that in narrow tank. The waves produced by Ship_a have to propagate a long distance until they strike Ship_b, and during this propagation, the numerical dispersion and damping occurs. However, in single ship with two side walls problem, the free surface is smaller. The reflected waves from the wall only travel a short distance, then they can strike the ship model. Therefore, the numerical dispersion and damping are not as obvious as that in ship to ship problem. The numerical dispersion modifies the wave length during the propagation and it is the main reason for the difference between two numerical methods.

Title of Paper: On hydrodynamic behavior of a cylindrical moonpool with an entrapped two-layer fluid

Author: Zhang. X. and Yeung, R.W.

Question: I don't understand the internal wave contribution to the piston mode – the internal wave should imply a shear. For lateral modes the situation is different, and internal wave sloshing may be important.

Asked by: Grue, J.

Answer: We are focusing in the study on the effect of density stratification inside the 3D moonpool of finite size. It is found that the pistion-mode resonance due to forced heave motion can be impacted by density stratification. In addition, the higher-order resonances in the low frequency region are caused by the internal wave mode. We have not studied lateral modes yet. The internal wave mode may be more important in that case. Your comment related to shear may be related to an unbounded domain.

Title of Paper: Fully nonlinear solitary wave interaction with a freely floating vertical cylinder

Author: Zhou, B.Z., Wu, G.X. and Meng, Q.C.

Question: On Fig. 2 a, one can see the floating body drifting at constant velocity after the solitary wave has passed. One expects there is a return to a steady position for the body. Can you explain the behavior?

Asked by: Clemént, A.H.

Answer: We agree that the slope of Fig.2a implies a constant speed. However, we may notice that the average slope over the period $20<\tau<60$ is about 1/40 which is much smaller than the figure itself suggests, due to its scale. Physically, constant forward speed is unsustainable after the wave has past the body, because there is nothing to overcome the wave-making resistance. The body is expected to become stationary eventually. However, similar to the rolling motion, its decay is rather slow. A much longer simulation with larger domain would be needed to show the entire process until all the motions of the body have stopped. This became excessive for the power of the personal computer we used. This is the something we will try to achieve on some more powerful computers with an improved code.