

Newsletter Shallow Water

Knowledge Centre Manoeuvring in
Shallow and Confined Water



February 2023

This is the 53rd newsletter of the Knowledge Centre Manoeuvring in Shallow and Confined Water, which aims to consolidate, extend and disseminate knowledge on the behaviour of ships in shallow and confined water. In this newsletter, we present the implementation of waves and seakeeping in the ship simulators of Flanders Hydraulics.

Since the end of 2022 the [simulators](#) at Flanders Hydraulics have been able to represent waves and the motions of seagoing vessels much more realistically. Waves at sea are irregular in nature and as a consequence the motion of a ship in reaction to the waves is also irregular. The waves are not random, however, and spectral analysis gives information on the characteristics of waves. When you combine a wave spectrum with a so-called RAO of a ship, which basically tells you how a ship will move in response to regular waves of different frequencies, response spectra of the different motions of the ship can be derived. In addition, RAO's for second order drift forces are defined in the simulator. These horizontal forces and moment contribute to the mathematical manoeuvring model of the simulator.



Spectral waves and RAO based ship responses were recently added to the [simulators](#) of Flanders Hydraulics. Together with the Maritime Technology Division at Ghent University, a state-of-the-art code library was developed in the CUDA programming language to perform all the wave calculations on Graphic Processing Units (GPU). Spectral wave calculations are particularly suitable to benefit from the massively parallel architecture of GPUs. The newly developed library achieves very high performance, leading to the synthesis of realistic sea states in real time, which is of course very important for [ship manoeuvring simulators](#). The new library uses a multi-band Fast Fourier Transform approach to synthesize ocean waves in both deep and shallow water. A Discrete Fourier Transform is applied to the response spectra to calculate ship responses in the time domain. The code can deal with regular waves, theoretical wave spectra (e.g. a JONSWAP spectrum which is typical for the North Sea) and custom wave spectra like the ones obtained from wave measuring buoys.



The code can represent time and space varying wave conditions. The definition of multi-band wavenumber spectra is flexible, and it allows to increase the size or the number of bands when more computational power becomes available. At the moment, the library is being used in real time with three 512x512 wavenumber spectra, leading to a total of ~800 000 elementary harmonic

waves being represented. The library calculates the sea surface elevation, the sea surface normal direction and the Jacobian of the sea surface which is used to calculate a foam factor. For each of the above quantities, the new CUDA library can fill in a texture that can be used to visualize a realistic ocean surface by an OpenGL 3D application. Moreover, the new library uses the choppy sea approach to stretch the harmonic waves in space and visualize more realistic looking trochoid waves. The choppiness parameter, which is usually estimated empirically as a global constant, is instead calculated based on the physical properties of each elementary wave.

Not only does it look fabulous, the new implementation of waves and seakeeping also ensures that the ship motions and wave visualisation are perfectly synchronized. The improved representation of the waves and motions of ships allows to simulate manoeuvres at sea as realistically as possible. This is important, for example, to evaluate the navigability of different ship types in the fairways at the Belgian coast.

An example of the stunning realism that is obtained can be found on our [YouTube channel](#).

Researchers associated with the Knowledge centre recently published:

Mansuy, M.; Candries, M.; Eloot, K.; Page, S. (2023). [Simulation study to assess the maximum dimensions of inland ships on the river Seine in Paris](#), in: Li, Y. et al. [Proceedings of PIANC Smart Rivers 2022: Green Waterways and Sustainable Navigations](#). Lecture Notes in Civil Engineering, 264Page, S.; Mansuy, M.; Eloot, K.; Candries, M., Adams, R. (2023). [Benchmark of turning basin options for the large-gauge navigable network of Nord-Pas-de-Calais \(France\)](#), in: Li, Y. et al. [Proceedings of PIANC Smart Rivers 2022: Green Waterways and Sustainable Navigations](#). Lecture Notes in Civil Engineering, 264

Knowledge Centre Manoeuvring in Shallow and Confined Water

Berchemlei 115
2140 Antwerp
Belgium
T. +32 3 224 60 35



Although this newsletter is written with care, neither Flanders Hydraulics Research, nor Ghent University are responsible for typos or errors in the content.
You are receiving this email because you are subscribed to the Knowledge Centre newsletter. We care for your privacy, this newsletter is sent to you without displaying your email details

[Update your profile](#) - [Unsubscribe](#)

