1 Schematic Frisian Inlet

Purpose

The purpose of this validation case is to check the online coupling between D-Flow FM and WAVE and to discuss the definition of the bed level.

Linked claims

Claims that are related to the test case are:

- The mechanics of the online coupling between FLOW and WAVE works correctly, i.e. the WAVE simulation can be controlled by FLOW;
- The user should be aware of large curvatures in the grid, when migrating to D-Flow FM

Approach

The schematic Frisian inlet was converted from the original Delft3D case to a D-Flow FM case with the dflowfm-converter in the Open Earth Tools.

This simple schematic test will only be used to (i) confirm that the mechanics of the online coupling between D-Flow FM and WAVE works and (ii) present results that show the effect of large curvatures in a computational grid.

Model description

The model was of a schematic tidal inlet with very curved grid lines. The computational grid consisted of 223 computational cells and the bathymetry is shown in Figure 1. A constant wave field was enforced on the offshore (Northern) boundary along with a tidal signal. The magnitudes of these are unimportant for the present comparison.

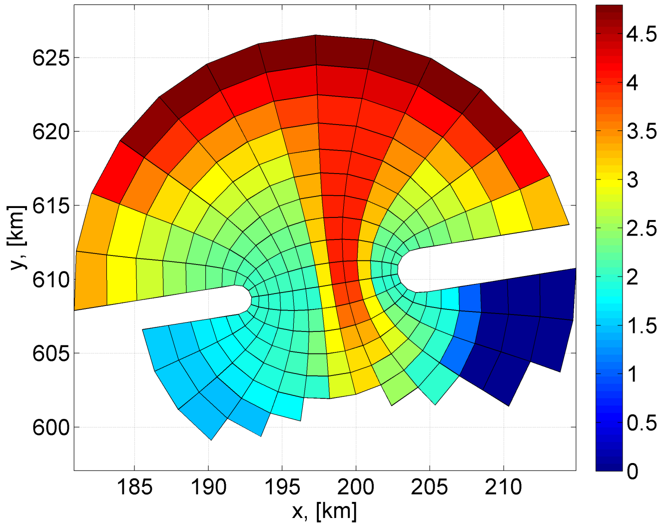

Figure 1: The bathymetry in metres below mean sea level. Based on results from Delft3D.

The bed level in the Delft3D model was described using `#MEAN#` for the velocity points and `#MAX#` for the ζ-point. As discussed in e100-f02 **[S.R.]** this translates into the use of the flags `bedLevType = 3`, `bedLevMode = 2` and `Conveyance2D = -1` for D-Flow FM. The effect of adopting `bedLevMode = 1` instead is presented below.

A simulation without any hydrodynamic properties passed to WAVE will first be conducted to evaluate the online coupling (external control). When FLOW and WAVE are coupled, the wave force and wave-induced mass flux is always passed from WAVE to FLOW. Secondly, a simulation with only the bed level passed to WAVE will be conducted, so the effect of the curvature in the computational mesh on the resulting interpolation of the bed level from FLOW to WAVE can be quantified, see Figure 1.

Results

No passed hydrodynamic properties:

The computed wave properties for Delft3D and D-Flow FM were identical and so were the logfiles from SWAN, when no hydrodynamic properties were passed from FLOW to WAVE. This means that the mechanics of the online coupling (the external control) of WAVE from D-Flow FM works correctly. Hereby, it is meant that the control of the wave simulations from FLOW is correctly performed.

Effect of curvature in the mesh

In Figure 2 the interpolation of the bed level from FLOW to WAVE is presented as a difference of the results obtained with Delft3D and D-Flow FM. The best match in the bed level treatment was obtained with `bedLevMode = 2` as expected. The results for `bedLevMode = 1`, on the other hand, gave considerable differences in the interpolated bed level (effectively changing the water depth by more than 10 %). This emphasizes the importance of an as close as possible representation of the bathymetry in Delft3D and D-Flow FM, when a direct intercomparison is performed

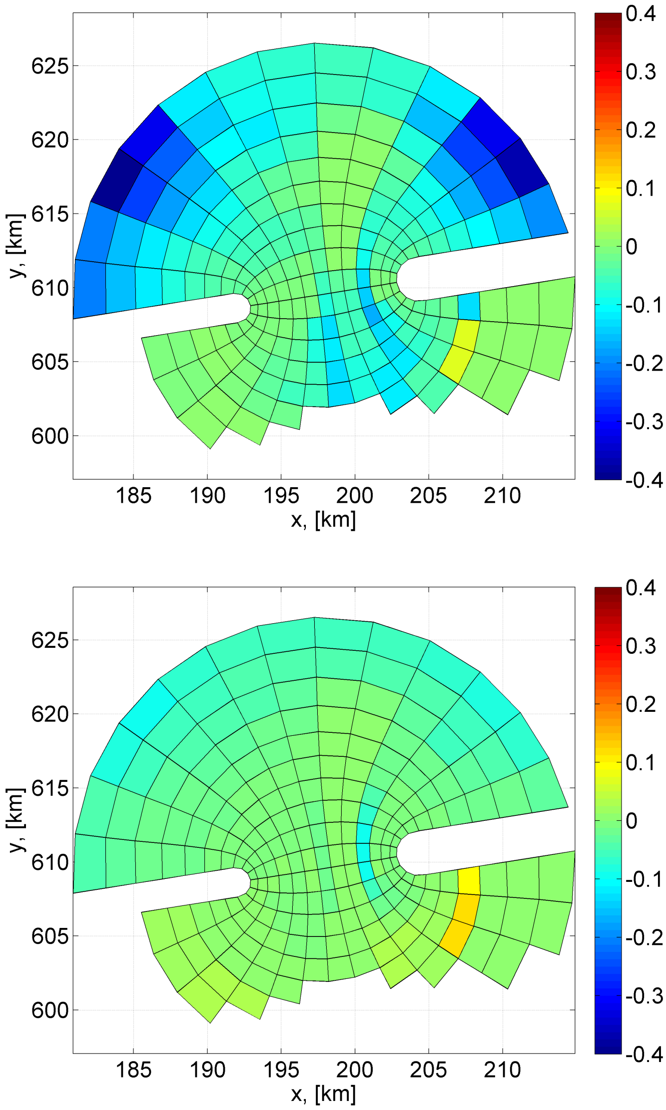

Figure 2: A comparison of the bed level difference between Delft3D and D-Flow FM. Top: `bedLevMode = 1`*. Bottom:* `bedLevMode = 2`*.*

There are still some differences in the interpolated bed level of up to ± 0.1 m for `bedLevMode = 2`. These differences are located in areas with large gradients in the water depth and large curvature in the computational grid. Consequently, the differences are ascribed to the fact that the water depth on the FLOW side is not defined in the same location in Delft3D and D-Flow FM. The cell center is defined as the algebraic mean of the four cell nodes in Delft3D, whereas the circumcentre of the computational cell is used in D-Flow FM. On strongly curved grids these locations differ and as a consequence hereof also the interpolation weights between the FLOW and WAVE sides. It is assumed that these differences will decrease as the computational grid is refined, though it has not been tested for this computational grid.

The difference between D-Flow FM and Delft3D is vanishing on for instance a computational mesh with square cells, see case e100-f02-c06 **[S.R.]**. A convergence study on the interpolation of the bed level from FLOW to WAVE is reported in case e100-f02-c07 **[S.R.]**.

Conclusion

The following conclusions were drawn:

- The mechanics of the online coupling between D-Flow FM and WAVE is working, i.e. the execution of WAVE can be controlled by FLOW;
- It is important to consider the representation of the bathymetry for a one-to-one comparison between Delft3D and D-Flow FM, because the difference of 10 % in the water depth, which was observed in this case for `bedLevMode = 1`, will have cascading effects on wave properties, hydrodynamics, and back to the wave properties;
- The curvature of the computational grid can have an effect on the comparison, and it is not possible to circumvent this, because it is an inherent difference in the evaluation of the grid properties between Delft3D and D-Flow FM.

Version

This test has been carried out with the following versions:

- 6.01.16.5169 of Delft3D
- fm-trunk-40852_ossbranch5250 of D-Flow FM.