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Delft3D-FLOW on PRACE infrastructures for real life hydrodynamic applications.

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PRACE, the Partnership for Advanced Computing in Europe, offers access to the largest high-performance computing systems in Europe. PRACE invites and helps industry to increase their innovative potential through the use of the PRACE infrastructure. This poster describes different efforts to assist Deltares with porting the open-source simulation software Delft3D-FLOW to PRACE infrastructures. Analysis of the performance on these infrastructures has been done for real life flow applications.

Delft3D-FLOW is a 2D and 3D shallow water solver which calculates non-steady flow and transport phenomena resulting from tidal and meteorological forcing on a curvilinear, boundary fitted grid in Cartesian or spherical coordinates. It also includes a module which sediment transport (both suspended and bed total load) and morphological changes for an arbitrary number of cohesive and non-cohesive fractions. As Delft3D-FLOW has been developed over several decades, with a variety of functionality and over 350k lines of source code, porting to PRACE infrastructures needs some effort.

At the moment Delft3D-FLOW uses MPI with domain decomposition in one direction as its parallellisation approach. Because it is hard to identify scaling issues if one immediately starts with a complex case with many features enabled, different cases with increasing complexity have been used to investigate scaling of this parallellisation approach on several PRACE platforms.

As a base reference case we started with a schematic high-resolution 2D hydrodynamic model of the river Waal that turned out to be surprisingly well-suited to the highly-parallel PRACE machines. Although Delft3D-FLOW employs a sophisticated build system, several modifications were required to port it to most PRACE systems due to the use of specific, highly-tuned compilers and MPI-libraries. After this we moved to a 3D hydrodynamic model of Rotterdam harbour that includes sections of the rivers Rhine and Meuse and a part of the North Sea. This model is used in The Netherlands to study possible measures to prevent that freshwater intake points are affected by more saline water. This is quite important as due to sea level rise and other possible future developments in the Rhine-Meuse estuary, it is expected that salinity intrusion will increase in upstream direction.Delft3D-FLOW is able to simulate the relevant processes and measures to reduce salinity intrusion.This model with a complicated geometry requires a huge computational effortis large with a complicated geometry, which gives both a good reason and a challenge for porting Delft3D-FLOW to PRACE infrastructures. The performance profiles show that there is some room for improvement by optimizing the parallel decomposition and the communication pattern. A third case that we studied includes sediment transport and morphology processes.