Consistency between 2D-3D Sediment Transport models

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Sediment transport models have been developed and applied by the engineering community to estimate transport rates and morphodynamic bed evolutions in river flows, coastal and estuarine conditions. Environmental modelling systems like the open-source Telemac modelling system include a hierarchy of models from 1D (Mascaret), 2D (Telemac-2D/Sisyphe) and 3D (Telemac-3D/Sedi-3D) and include a wide range of processes to represent sediment flow interactions under more and more complex situations (cohesive, non-cohesive and mixed sediment). Despite some tremendous progresses in the numerical techniques and computing resources, the quality/accuracy of model results mainly depend on the numerous choices and skills of the modeler.

In complex situations involving stratification effects, complex geometry, recirculating flows... 2D model assumptions are no longer valid. A full 3D turbulent flow model is then required in order to capture the vertical mixing processes and to represent accurately the coupled flow/sediment distribution. However a number of theoretical and numerical difficulties arise when dealing with sediment transport modelling in 3D which will be high-lighted :
(1) Dependency of model results to the vertical grid refinement and choice of boundary conditions and numerical scheme
(2) The choice of turbulence model determines also the sediment vertical distribution which is governed by a balance between the downward settling term and upward turbulent diffusion.
(3) The use of different numerical schemes for both hydrodynamics (mean and turbulent flow) and sediment transport modelling can lead to some inconsistency including a mismatch in the definition of numerical cells and definition of boundary conditions.

We discuss here those present issues and present some detailed comparison between 2D and 3D simulations on a set of validation test cases which are available in the Telemac 7.2 release using both cohesive and non-cohesive sediments.