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Application of the Finite Window Method to a Time-Dependent Convection-Diffusion Equation

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Abstract : The FWM (Finite Window Method) is a new numerical meshfree technique for solving problems defined either in terms of PDEs (Partial Differential Equation) or by a set of conservation/equilibrium laws. The principle behind the FWM is that in such problem each element of the concerned domain is interacting with its neighbors and will always try to adapt to keep in equilibrium with respect to those neighbors. This leads to a very simple and robust problem solving scheme, well suited for transfer problems. In this work, we have applied the FWM to an unsteady scalar convection-diffusion equation. Despite its simplicity, it is well known that convection-diffusion problems can be challenging to be solved numerically, especially when convection is highly dominant. This has led researchers to set the scalar convection-diffusion equation as a benchmark one used to analyze and derive the required conditions or artifacts needed to numerically solve problems where convection and diffusion occur simultaneously. We have shown here that the standard FWM can be used to solve convection-diffusion equations in a robust manner as no adjustments (Upwinding or Artificial Diffusion addition) were required to obtain good results even for high Peclet numbers and coarse space and time steps. A comparison was performed between the FWM scheme and both a first order implicit Finite Volume Scheme (Upwind scheme) and a third order implicit Finite Volume Scheme (QUICK Scheme). The results of the comparison was that for equal space and time grid spacing, the FWM yields a much better precision than the used Finite Volume schemes, all having similar computational cost and conditioning number.

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