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Numerical Solution for Sparse Linear Systems that occur from the discretization of Boussinesq-type equations

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Abstract

This work investigates preconditioned iterative techniques for the solution for sparse linear systems that occurs from the discretization of Boussinesq-type (BT) models using a finite volume scheme on unstructured meshes. The past few years enhanced Boussinesq-type (BT) models and their numerical solutions have evolved as predictive tools in the modeling of wave propagation and transformations. Recently, a novel high-order FV scheme on unstructured meshes for the extended 2D BT equations of Nwogu was developed. The equations of Nwogu are recasted in the form of a system of balance laws and are then numerically solved using a novel high-order well-balanced FV numerical method in unstructured meshes. In each time step the solution of a large sparse linear system (with a mesh depended matrix, **M** that occurs from the discretization of the dispersion terms) is mandatory to recover the velocity field. Matrix **M** is sparse, un-symmetric and often ill-conditioned. The properties of the matrix also vary on the physical situation of the problem examined. Various preconditioned and reordering strategies are investigated, including the ILU factorization the ILUT factorization and the CMK and RCM reordering techniques. Two iterative methods, BicGstab and GMRES, are tested for the solution process. A detailed comparison of the methods is given and their strengths and limitations of each are discussed. Furthermore, the performance of the various strategies is tested versus the most important parameters of the problem examined.

Key words: sparse matrix, finite volumes, Boussinesq-type equations.