A Residual Distribution method for the Shallow Water equations in ALE framework on the sphere
Luca Arpaia, Mario Ricchiuto

To cite this version:

HAL Id: hal-01736137
https://hal-brgm.archives-ouvertes.fr/hal-01736137
Submitted on 16 Mar 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
A Residual Distribution method for the Shallow Water equations in ALE framework on the sphere

L. Arpaia¹, M. Ricchiuto²

¹ BRGM, R3C, 3 Av. C. Guillermin 45060 Orlans Cedex 2, l.arpaia@brgm.fr
² INRIA Team Cardamom, mario.ricchiuto@inria.fr

Keywords: Shallow Water Equations, Arbitrary Lagrangian Eulerian framework, PDEs on the sphere, Residual Distribution method

We consider the numerical approximation of the Shallow Water Equations (SWEs) in covariant curvilinear coordinates, in view of application to large scale hydrostatic wave phenomena, such as the propagation of tsunami waves. To provide enhanced resolution of the propagating fronts we consider adaptive discrete approximations on moving triangulations of the sphere. To this end, we re-state all Arbitrary Lagrangian Eulerian (ALE) transport formulas, as well as the volume transformation laws, in generalized curvilinear coordinates. Using these results, the SWEs can be written in a framework in which points move arbitrarily in a curvilinear reference frame. We then discuss the implementation of a multidimensional upwind scheme known as Residual Distribution (RD) in order to discretize the resulting ALE Shallow Water equations on the sphere. At the discrete level one must consider the preservation of time accuracy, non-linear stability but also the preservation of important physical steady states on moving meshes. A naif extension of fixed grid methods may lead to spoil the above properties and to the rise of numerical instabilities. For this reason classical properties as the Discrete Geometric Conservation Law and the C-property are reformulated in the more general context of moving curvilinear coordinates. The proposed RD method is tested on standard benchmarks for the SWEs on the sphere and it is compared to a classical Finite Volume method, both in the fixed grid case and in the ALE moving mesh case.

REFERENCES

