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A structure-preserving approximation of the discrete split rotating shallow water equations

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We introduce an efficient split finite element (FE) discretization of a y-independent (slice) model of the rotating shallow water equations. The study of this slice model provides insight towards developing schemes for the full 2D case. Using the split Hamiltonian FE framework [1,2], we result in structure-preserving discretizations that are split into topological prognostic and metric-dependent closure equations. This splitting also accounts for the schemes' properties: the Poisson bracket is responsible for conserving energy (Hamiltonian) as well as mass, potential vorticity and enstrophy (Casimirs), independently from the realizations of the metric closure equations. The latter, in turn, determine accuracy, stability, convergence and discrete dispersion properties. We exploit this splitting to introduce structure-preserving approximations of the mass matrices in the metric equations avoiding to solve linear systems. We obtain a fully structure-preserving scheme with increased efficiency by a factor of two.

References

[1] Bauer, W. and Behrens, J. [2018], A structure-preserving split finite element discretization of the split wave equations, *Applied Mathematics and Computation*, **325**, 375--400.

[2] Bauer, W., Behrens, J., Cotter, C.J. [2019], A structure-preserving split finite element discretization of the rotating shallow water equations in split Hamiltonian form, preprint: http://arxiv.org/abs/1912.10335.