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Interactive comment on "A high-order conservative collocation scheme and its application to global shallow water equations" *by* C. Chen et al.

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Thank you for carefully reading the paper. Your constructive comments are extremely helpful for use to improve the manuscript. We have fully taken your comments into account and accordingly modified the paper. Below, please find our point-to-point responses to your comments.

This paper reports on a very interesting method for solving conservation laws, with an application to global ocean modelling. The method is in some senses a hybrid between Discontinous galerkin methods, Finite volume methods and Collocation methods. High order is obtained from the high order polynomial representation in the volumes, and robust high order approximation of the fluxes is obtained via an interesting combination of averaging the fluxes at the volume boundaries via (approx) Riemann solvers and interpolation in the interiors of the volumes. The numerical experiments and the linear analysis support the conclusion that the method produces a simple robust high order method.

The paper does need an edit to pick up slight problems in the language, for instance, there are a number of places where definite or indefinite articles are missing.

Thank you for your comments. We have made a thorough linguistic edit.

Some minor points or comments:

(1) As discussed on page 4255, the pointwise representation of the quantities and the fluxes are obtained via high order polynomial interpolation. a question: Is it always safe to do this, i.e. is it ever necessary to limit the interpolants or introduce some sort of artificial viscosity? Or does the use of the average fluxes at the boundaries stabilize the calculation of the derivative of the fluxes at the interior points?

At cell boundaries, we solve a Riemann problem to determine the values of the numerical fluxes. As a result, the proposed scheme is an upwind scheme with inherent numerical viscosity, which guarantees the computational stability as shown by the Fourier analysis of the semi-discrete system in the paper. However, in the presence of discontinuous solutions the non-physical oscillations might occur without effective limiters or artificial dissipations, which is a common issue of the high-order schemes. There are some existing works for this purpose.

(2) Equation (12). It would be good to remind the reader of the exactness of Gaussian Quadrature for polynomials of degree 5.

Thank you for suggesting this. We added some words in the revised manuscript.

(3) Page 4258. Comment on the choice of Runge-Kutta methods. Provide a reference.

Two types of explicit Runge-Kutta schemes have been adopted in present study. The third-order scheme has been widely used in the existing models. Third-order scheme is a good trade-off between numerical accuracy and computational cost. The fifth-order scheme was used here only for assuring the fifth-order accuracy in both time and spatial discretizations in numerical convergence tests. The reference for the Runge-Kutta method is added to the manuscript.

(4) Page 4260. Provide a very short overview of the methods DG3, MCV5 which you use for your numerical comparisons.

We conduct a comparison between DG3, MCV5 and the proposed scheme since these three schemes have fifth-order accuracy and can be derived by flux reconstruction framework using different constrained conditions for spatial reconstruction of flux functions. As detailed in Huynh(2007), the DG3 scheme uses the Radau polynomial as the correction functions to derive the flux reconstruction which assure the continuity of the numerical fluxes computed from Riemann solvers at the cell interfaces. MCV5 scheme can be derived by the general framework for flux reconstruction using multi moments proposed in Xiao et al. (2013). MCV5 uses constrained conditions on the point values, first- and second-order derivatives of flux functions at the cell interfaces where Riemann solvers in terms of derivatives of the flux function are required. We added a brief description in the revised manuscript as suggested.

(5) Page 4263. Provide the relationship between the covariant velocities u, v and the contravariant velocities ubar and vbar.

We added the relationship between covariant and contravariant velocity components in the revised manuscript as suggested.

(6) Can your method work with wet/dry interfaces?

The numerical techniques designed for the traditional finite volume schemes, as

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well as other high order schemes, like DG, can be straightforwardly applied to the present scheme without substantial barriers. The calculation of wet/dry front in shallow flows has been extensively studied under such numerical frameworks, and can be adopted in our model.

(7) Can your method reproduce a still lake (ocean) i.e. is well balanced for this stationary solution?

The stationary state can be exactly preserved by the proposed model since the topography source term is formulated in the way that satisfies the "exact C-property". The numerical procedure for this was described in details in Chen Xiao, JCP, 2008.

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