This is a second review of the mauscript entitled "Dynamically-optimal models of atmospheric motion" by A. G. Voronovich.

I appreciate the attempts by the author to adddress the previous comments. And, again, I believe the maunscript has merit due to the significant potential advantages of the new scheme, and the–in my experience–novel use of the discretized action for deriving the equations of motion that will be solved numerically, such that these equations obey by construction the conservation properties reflected in the symmetries of the Lagrangian.

That said, in the end, the development provided is of a numerical scheme that solves the conservation laws for geophysical fluids, Over many years, the atmospheric "modeling" community has advanced several types of tests that are regarded as "standard" test cases in regional contexts that validate new numerical schemes. Several are provided below, and include 2d **and** 3d tests. The single 2d test that the author has provided, while reflecting a nontrivial case, does not adequately validate the scheme to the level the community demands, I'm afraid.

Indeed, since the scheme must be implemented on a computer, it is strongly desirable to at least pay hommage to potential performance benefits of the formulation, since good performance must be exhibited if the scheme is to be adopted. In my opinion, this need not be exhaustive at this point, mainly because of the novelty of the scheme, and because this is not the focus of the manuscript at this point in the development. But the author possesses a lot of material to use in offering such a tribute, as mentioned in my previous comments!

Finally, I still have concerns about the Lagrangian remapping ("reassignment"; see below) that is a key aspect of advancing the solution at each vertex or grid point that is a common problem with Lagrangian-Eulerian formulations: how do you ensure uniqueness or non-degeneracy of the solution due to converging flow-lines that might want to cross at a point?

I hope the author will make these changes and resubmit, as I feel that the author's treatment can offer potentially significant value to the geophysical modeling community. I want to thank the author for the kind invitation to join as a co-author, but I must respectfully decline due mainly to conflicts of interest in my capacity as a reviewer. I am, however, willing to offer constructive advice as best I can, as I would like to see this manuscript published if the issues identified can be addressed adequately!

Regarding 'technical issues' below, if one of these derives from my previous list, I'll include the number from that list in parentheses just after the new enumeration. I do not guarantee that the list of editorial comments is as comprehensive this time, but please note these below. The author made a lot of changes that have certainly improved the readability of the manuscript.

1 Technical considerations

1. Eq. (17) and Eq. (21): add a dot symbol between $\vec{p}$ and $\partial_t \vec{xi}$

2. (item (8) in previous comments) $\partial_t \vec{p}$ equation just below Eq (16): I certainly see that this equation follows from Eq. (8), but the boundary term is missing entirely here even though it's in Eq. (8)! In addition, as I showed in the previous comment item (8), it should also appear in this equation from straight-forward computation of the variational derivative acting on the pressure gradient term. Also, the lack of this term in this equation makes me wonder if you retained it in your test problem, and, if not, why not? Note that one of the test problems suggested below (the density current test) will likely highlight the inclusion of this term.

3. (items 16-17 of previous comments) Eq. (27) Given that this is not a barycentric approximation, I still don't fully understand where this ordering comes from. Can you please elaborate?

4. (items 16-18 of the previous comments) Around line 228: 'the condition in Eq. (27) selects the appropriate tetrahedron...': But is the selection of the originating tetrahedron unique? What is it about Eq. (27) that guarantees uniqueness? It doesn't appear that anything prohibits two or more particles from having paths that intersect at a vertex simultaneously, so isn't the solution for the upstream properties inherently degenerate? This should be discussed in the manuscript.

5. (relates to item (20) of the previous comments) Before Sec. 4: As noted above, it would helpful to identify either exiting or potential opportunities for performance optimization. The vectorization opportunities mentioned before is one, and the potential to optimize cache utilization is another. Given the manner in which you replace the sums over tetrahedra in Eq. (21) with the sums over unique vertices in Eq (23) suggests to me, perhaps naively, increased utilization of data stored in cache for floating point operations, which would increase so-called "computational intensity". All these things can be measured, and are referred to as "on-node" performance measures. You might consult a couple of recent papers that have considered these issues: Bertagna, et al. 2019 Geosci. Model Dev., 12:1423–1441, and Rosenberg et al. 2023 MWR 151:2521-2540. I don't think you need to measure these things in your test problems, though some reviewers may disagree. But it is important to cite these things as areas of future work to demonstrate that you're considering them even at this early stage.

   Geophysical flows, as you know, are often very high Reynolds number flows, and, therefore, require a lot of grid points to resolve the scale interactions accurately. Thus, it will also likely be important to touch on coarse-grain parallelization achieved by domain-decomposing the grid into subdomains and using the Message Passing Interface (MPI). This will require a little thought, as you should say something on how you will exchange data between subdomains so that you can have each MPI task or process continue to integrate your equations, and whether anything in your formulation will prohibit this (I do not believe that anything prohibits this, and I believe the domain decomposition of subdomains comprising tetrahedra is well understood). Again, I don't think you need to implement these things at this stage, but to sort of outline the considerations required to achieve good strong scaling, in order for your method to useful as a dynamical core. A few relevant papers on this include the Bertagna et al. reference, as well as Kelly and Giraldo,2012 J. Comput. Phys., 231:7988–8008, and Dennis et al. 2012 J. High Perform. Comput. Appl., 26:74–89.

6. (relates to item (21) of the previous comments) While you have provided a nice *potential* test problem, it cannot be used for validation purposes here because you have not provided a basis for comparison of the results of your scheme. Hence, I believe the editor will require that you provide some community-accepted test problems. You do not need to run a companion dynamical core, since many others have run these problems, so you only need to reproduce these results adequately with your scheme. Since you have formulated your scheme in 3d, it will seem oddly incomplete not to validate in 3d as well, so this should be done, in my opinion. Unfortunately, this will likely require at least coarse-grain parallelization in order to achieve. The above references contain many of the more popular ones, but I will distill them with references here:

   (a) 3D mountain wave:
      - Lock et al. 2012 MWR 140:411-424
      - Melvin et al. 2019 Quart. J. Roy. Meteor. Soc., 145:2835–2853

   (b) 2d density current, testing critical boundary effects, and multi-scale interaction:
      - Straka, et al. 1993 Int. J. Numer. Methods Fluids, 17:1–22

   (c) Linear gravity waves:
      - Baldauf, M., and S. Brdar 2013 J. Roy. Meteor. Soc., 139:1977–1989
      - Rosenberg et al. 2023 MWR 151:2521-2540

   (d) 3D rising thermal, testing basic coherent buoyancy within a 3d volume:
      - Shapiro, A., and K. M. Kanak 2002 J. Atmos. Sci., 59:2253–2269;
      - There are many versions of this type of test in the other references above.

2 Editorial considerations

Below, the angle brackets, ⟨XXX⟩, indicate that the text 'XXX' should be added. The strikeout, ~~XXX~~ means that the 'XXX' should be removed. The arrow, →, suggests an emendation.

1. line 22: 'The approaches ~~which~~ ⟨that⟩ start'

2. line 23: 'equations of motion and ⟨are⟩ pursued'
3. line 36: 'by modifying ⟨the⟩ corresponding'
4. line 41: 'one calculates approximately ⟨the⟩ action density'
5. line 43: 'From its standpoint' $\rightarrow$'From this standpoint'
6. line 48: 'ODE' $\rightarrow$'ODEs'
7. line 138: 'and ~~excluding~~ ⟨inserting⟩ from the result'
8. line 171: Reference to Eq. (29) should be to Eq. (19), right?