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Geoscientific Model Development Discussions

Interactive comment on "Development of a tangent linear model (version 1.0) for the high-order method modelling environment dynamical core" *by* S. Kim et al.

Anonymous Referee #1

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This manuscript deals with the development of a tangent linear model (TLM) for the HOMME (High-Order Method Modeling Environment) dynamical core. TLM is an essential ingredient to develop a complex 4D-Var system for data assimilation (DA). HOMME is relatively a new framework for developing element-based highly scalable atmospheric dynamical cores based on the spectral-element (SE) or discontinuous Galerkin (DG) method. Its novelty includes singularity-free spherical mesh based on cubed-sphere topology, and non-orthogonal curvilinear geometry. However, the resulting primitive equations are in tensorial form involving several metric terms. Developing a DA system based on 4D-Var method is not a trivial task, and authors' efforts in this regard are laudable. HOMME is now an operational dynamical core for the Commu-

nity Atmospheric Model (CAM), and which relies on a run-of-the-mill 3D assimilation system 'DART.' Development of a TLM for HOMME is very timely and the research is interesting, this may be a path toward an ambitious 4D-Var system development. I am happy to recommend this manuscript for acceptance if the following minor points are addressed.

(1) As far as I know HOMME has two basic formulations which are based on SE and DG methods, however, both rely on same grid system and parallel communications. But the treatment of flux at the element edges and numerical viscosity are based on different ideas. On page 1179, lines 10-15, authors mention that they employ DG formulation for developing a TLM. However, hyper-viscosity filter is based on SE method not the part of DG discretization. Please clarify how do you apply hyper-viscocity. Is your TLM formulation based on SE or DG?

(2) On page 1184, lines 10-15: There are several basic operators such as div, curl, grad etc. involved in RHS estimation and hyper-viscosity computations. It will be interesting provide an example about your "hands-on" linearization for one of theses operators at least, say "divergence_sphere", how does the liner version appear in terms of mathematical expressions? How do you handle the metric terms?

(3) Did you ever test the TLM formulation in a simplified framework such as the spherical SW system, which is available in HOMME? If so, please provide some computational examples with one of the SW test cases.

Minor Point: Abstract Line 5, "spectral element method"

Interactive comment on Geosci. Model Dev. Discuss., 7, 1175, 2014.