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 #2

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This paper describes the development of a tangent linear version of the HOMME dynamical core. While there is no novelty in the concept or execution (line-by-line linearization), the development of such linearizations is complex and important, and deserves thorough documentation and verification.

Some comments:

* In section 2.1: does "advanced time stepping" mean "adaptive time stepping"? You also mention that HOMME uses adaptive mesh refinement. Can you discuss the impact of these techniques on the accuracy of the linearization? Did you try running the TLM of an adaptive simulation? I don't think adaptivity was used in combination with

the TLM, but I think this should be explicitly clarified.

* Figure 2 is confusing: annotating the input and output variables with (I) and (O) isn't sensible fortran. (For example, gfortran errors with "Unexpected junk in formal argument list".) Fortran has a built-in mechanism for indicating intent, with the intent(in), intent(out) and intent(inout) attributes. I suggest that figure 2 be changed to use these instead, and to drop the unnecessarily novel (I)/(O) notation.

* Section 2.4: "the high computational cost is extremely burdensome". This paper would be greatly improved with timing results — computational efficiency is crucial in 4DVAR applications of TLMs. Given that HOMME is explicit, the cost of (TLM + NLM) should be approximately twice that of the NLM, without any tricks (changing timesteps, or interpolating the original trajectory in time). Furthermore, the value of the tricks should be quantified by relating the error in the Taylor remainder (does the value of the LHS of equation (2) stay close to 1) against the computational savings (in seconds).

* The section on TAPENADE (note the misspelling in the manuscript) is quite strange. It's simply wrong that TAPENADE doesn't handle branches (see, e.g., figure 7 of 10.1145/2450153.2450158 for an example of TAPENADE applied to code with a branch). I strongly suggest that you consult with the developers of TAPENADE and make a fair comparison with AD tools (in particular in terms of computational efficiency). I expect that the hand-coded TLM will be quite a bit more efficient; quantifying this would improve the scientific value of the manuscript greatly, as it would give future developers of TLMs of other models in this area an idea of the tradeoffs.

* The English used in the manuscript could be improved (for example, many articles are missing). I suggest having a native anglophone editor review the text and correct the minor grammatical errors.

* The GMD manuscript types state that 'All papers must include a section at the end of the paper entitled "Code availability".' The code availability is discussed, but it's not in its own section as the journal requires. I suggest you review the discussion of the

manuscript types and reformat appropriately.

* Will the linearized version (and presumably, the future adjoint version) of HOMME be distributed with HOMME? I didn't see this mentioned in the text.

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