Interactive comment on "A Multiphase CMAQ Version 5.0 Adjoint" *by* Shunliu Zhao et al.

Anonymous Referee #1

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The authors present a description and evaluation of the implementation of an adjoint methodology into CMAQ version 5.0. This method is compatible with all the major components of the CMAQ model, which is a step forward from previously published implementations in recent versions of CMAQ that only included the implementation of the adjoint approach for inert aerosol species. The authors evaluate the adjoint implementation in each of the major modules of CMAQ which allows for better confidence in the approach and also provides useful information about which modules are best suited to an adjoint. This could guide future decisions about which particular model components (such as inorganic thermodynamics) to include as part of the core model. Components better suited for sensitivity analysis might be a higher priority in situations where multiple choices exist and perform similarly in terms of speed and skill.

The manuscript is generally well organized and written. The use of brute-force sensitivity and finite difference as an evaluation approach is novel. One concern is the

illustrative example at the end. It is very helpful to have an illustrative example of the type of information the adjoint provides, but the Figures (Figure 14) related to the illustrative example are confusing to interpret. The Figure caption suggests annual monetized health benefits normalized by emissions are presented. However, it is not clear whether the monetized benefits are normalized by national emissions or emissions from that same grid cell. Further, it is confusing to think about monetized health effects in places where no people reside (over the ocean for instance) and also where there are little to no emissions (northern Ontario near Hudson Bay). Perhaps there is a alternative illustration of the type of information the adjoint provides which would be simpler to interpretâĂŤsuch as looking at concentrations relative to some source/region and not even get into converting the concentrations to health effects.