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Interactive comment on "The nonlinMIP intercomparison project: physical basis, experimental design and analysis principles" *by* P. Good et al.

Anonymous Referee #2

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General comments: "The nonlinMIP intercomparison project: physical basis, experimental design and analysis principles" by Good et al proposes a new model intercomparison project aimed at quantifying and understanding nonlinear climate-change responses, i.e. those that depend nonlinearly on the forcing. To assess the linearity in climate responses, the authors suggest that modelling centres perform a variety of simulations with abrupt changes in CO2 concentrations (in addition to the abrupt4xCO2 simulations that are standard in the community and are in the new CMIP6 deck). The motivations for doing these simulations are: (i) to identify new nonlinear responses, (ii) to quantify the nonlinearity and potentially understand the physical mechanisms behind such responses, and (iii) to apply knowledge gained about the nonlinear responses to

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give more realistic inputs to impact/energy balance models. A method is also outlined for determining the "traceability" of the abruptCO2 simulations, which is useful.

The authors provide numerous examples of climate responses that depend nonlinearly on the forcing. Indeed, given the complexity of the climate system and the fundamental nonlinearities associated with water and radiative transfer (among others), I wonder whether we should reasonably expect the response of any regional climate variable to be linear! Overall, I think this is a potentially interesting and beneficial MIP. However, I suggest that the authors be much clearer and much more explicit about what they envisage being the big scientific/practical advances that would come from this MIP. In particular, if a nonlinear response for a given impact-relevant variable is found to exist using the suggested simulations, how might this usefully be used to give more realistic impact assessments? Also, the authors say that these simulations will help to "understand" nonlinear responses, but how would this be done in practice if a nonlinear response is found? Can the authors give an illustrative example based on simple physical mechanisms? On a more practical note, how will internal variability be separated from the nonlinearity when attempting to quantify the latter? I believe modifying the paper to address the above questions more explicitly, and in general better highlighting and emphasising the potential/expected outputs from this MIP, will make this proposed endeavour much more compelling to the climate community.

Specific comments: Section 1: "...but this assumption may also be applied either explicitly or implicitly in understanding mechanisms." -> I don't understand this sentence, please be clearer about what is meant here Section 1 and throughout: "(Chadwick et al., 2013;Held et al., 2010;Williams et al., 2008;Manabe et al., 1990;Andrews and Ringer, 2014)" -> references are neither in chronological nor alphabetical order. Is there a good reason for this? It is typical to arrange references chronologically Section 2: "apriori" -> typo Section 3.2: "Both moisture content and atmospheric dynamics respond to CO2 forcing, so in general we might expect convective precipitation to have a nonlinear response to CO2 forcing." -> we would expect a nonlinear response from

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the moisture part alone, given the Clausius-Clapeyron, in the absence of any changes in dynamics

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