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Interactive comment on "On determining the Point of no Return in Climate Change" *by* Brenda C. van Zalinge et al.

Anonymous Referee #1

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This manuscript describes a method to determine the time at which greenhouse gas emissions must be reduced in order to avoid crossing a temperature threshold with a given probability. The concepts of the method are articulated and it is tested in an energy balance model. The method is then employed in a GCM with some further simplifying assumptions. Finally, a so called 'optimum mitigation scenario' is described based on further simplified cost assumptions.

The work is mostly novel and is partly well described and explained. However, some of the key simplifying assumptions are not recognized or explained, and these seriously undermine the potential utility of the method. These limitations should be acknowledged, along with their implications for use of the method to define a point of no return. Some of these limitations are described below.

1. Climate system not well behaved

The major limitation of the method is that it assumes that the climate is mostly well behaved without tipping points. The method assumes that once the state vector Xt is 'not viable', then greenhouse control measures can be introduced to render Xt viable again at a future point in time. That assumes that everything is reversible and that there are no tipping points crossed or critical impacts incurred during the period when Xt is not viable. For example, tipping points may exist in the oceans or cryosphere where circulation or melt processes persist even when the control measure is taken. Alternatively, critical impacts may occur which one would wish to prevent, but which won't be prevented by the control measure.

The effect of these nonlinearities and impacts is that the actual point of return may be much earlier than the one calculated here where the climate is well behaved and just has to be returned below the threshold global mean temperature change value. The failure to recognize and acknowledge this limitation is critical for the method, since it means that the method is somewhat reckless in ignoring the potential for abrupt, irreversible and/or persistent changes, and would furnish policy makers with a false sense of security about the alleged point of no return. The point of return calculated for this method is for a planet with no irreversible or very persistent changes, which is almost certainly violated for the actual planet. The authors propose their method for use in policy, which is an over-reach given the critical, unacknowledged limitations of the method.

2. GMST normally distributed

The extension of the method here to GCMs assumes that GMST is normally distributed. That may be the case for some GCMs and it may be the case when the climate is not undergoing a transition. However, departures from Gaussianity will occur when the climate state is undergoing transition, which is an example of the kind of nonlinear response noted in point 1 above that is not captured by the method here. The introduc-

tion of the normal distribution assumption here further predicates the method on a well behaved climate system. By using GCMs and assuming that the response is always Gaussian the method underestimates the potential for changes in the climate system that violate the assumptions of the method.

3. Optimal mitigation scenario

The approach followed to determine the optimal mitigation scenario takes a very narrow view of only some costs and only economic costs. This results in potentially misleading estimates of what is 'optimal' and what isn't. To do justice to this issue would require much more serious analysis and exploration of uncertainty than is carried out in this paper. As it stands, this section of the paper is so flawed and dependent on the precise set of assumptions used that it would need to be removed from the paper.

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