Reply to RC2: 'Review of "DynVarMIP: Assessing the Dynamics and Variability of the Stratosphere-Troposphere System" by Gerber and Manzini', Anonymous Referee #2
(review in italics, our responses in plain text)

The paper describes overall goals and scopes of the DynVarMIP, one of the diagnostic MIPs of the CMIP6. Objective and scientific questions of the project is concisely described. Proposed diagnostics are also reasonably well defined by listing specific variables of interest in the Appendix.

We thank the reviewer for this careful review, and believe that the manuscript has improved significantly as a result of our efforts to acknowledge these concerns.

1. Scientific questions
One of my concerns is that three key questions in section 2 are not well addressed. It would be helpful what the common biases of the current generation of the models, such as CMIP5 models, and why they are important. It is unclear to me what "the role of dynamics in shaping the climate response to anthropogenic forcings" means. Are there any climate responses that are independent of atmospheric dynamics? This question needs to be better justified. Lastly, it would be helpful to describe what stratospheric processes are important in varying time scales. Since not all readers are familiar with stratosphere-troposphere coupling, one or two paragraph long discussion would be useful. If possible, a simple schematic diagram could be useful here.

We've made several changes in response to this overall concern about the connection between the diagnostics and research questions.

First, we now explicit stated that climate models have a problem with the storm tracks, particularly in the austral hemisphere. In both CMIP3 and CMIP5 models, it is biased equatorward and too persistent. References are also provided. The new sentence reads:

"Accurate simulation of the storm track climatology and variability has long proved a challenge for climate prediction models, particularly in the austral hemisphere, where the storm track and associated midlatitude jet stream is generally located too far equatorward and is too persistent (e.g. Kidston and Gerber, 2010; Simpson and Polvani, 2016; Swart and Fyfe, 2012, Wenzel et al., 2016)."

Second, we've added a new section ('4. Experiments' in the revised document) that discusses the experiments for which the DynVar diagnostics are requested, and relates them to the three scientific questions. It includes references to papers that analyzed biases in the CMIP models, such as Wenzel et al. 2016 that documented the equatorward bias of the austral jet stream in CMIP5 models, and linked it to biases in future projections.

Third, we've expanded our introduction to include a brief summary of stratosphere-troposphere interactions, providing a number of references for the interested reader (see response to Reviewer 1). As recent review papers, such as Kidston et al. 2015,

have included schematic diagrams, we felt it might not be necessary for this paper which is focused more on the technical details of the DynVarMIP.

Lastly, we agree that our second question was written too vaguely – to the point of being vacuous – and have sharpened it: "What is the role of atmospheric heat and momentum transport in shaping the climate response to anthropogenic forcings", to emphasize the connection with our diagnostics.

2. Link between key questions and diagnostics
It would be useful to relate each diagnostics, briefly outlined in section 3, to three key questions in section 2. To me, all three diagnostics (i.e., variability, momentum, and heat) are focused on the model biases. It is unclear how they are related with questions 2 and 3.

As noted above, a new section has been added to the paper (4 in the revised paper), which discusses the experiments and their relation to the scientific questions in more detail. We've also provided a number of references to studies, which have linked dynamical mechanisms to CMIP5 models. For example, the initial response of atmosphere in the 4xCO2 experiment (as suggested by the reviewer below) is an excellent opportunity to focus on question 2.

3. Workshop result
It is stated that workshop will be held in June. But, as far as I know, the workshop is already held. It would be helpful what community is concerning about DynVarMIP and what the detailed projects, proposed by DynVar community, for DynVarMIp. These details would be useful for modeler to better understand the nature of the DynVarMIP.

This section has been fully rewritten in light of the results of the workshop. Three groups have been organized to focus on the three science questions of the MIP.

4. Data
Abrupt4*CO2: It is proposed to archive key data for the equilibrium state, year 111-150. But, it would be also interesting to see how circulation reaches equilibrium state by analyzing first 10 or 20 years. Is it possible?

This is a good suggestion, and was echoed by many at the DynVarMIP organization meeting in June. We've now requested the first 40 years of this simulation, in addition to the last 40 years, which provide an opportunity to understand the equilibrated response of the model.

TEM recipe: Please show the mathematical formulation of psitem "on log-p coordinate". I found that utendvtem and utendwtem are computed on pressure coordinate. Is there any reason not to use log-p coordinate?

We recommend pressure coordinates because most models are in p-coordinate and for models in geometric-z coordinate, prior to the diagnostic calculation it is necessary to transform the input variables to pressure coordinates (Hardiman et al. 2010) to avoid spurious differences. Climate models are usually not written in log-p coordinate.

utendvtem has the same formulation, in both coordinates.
utendwtem does not require a transformation.

We need to keep psitem in kg s-1, to keep it consistent with CMIP already existing conventions; hence we have not given the formulation of psitem in log-p.

5. Minor issues:
L100: Please define acronyms of each MIPs. Although this paper is a part of CMIP6 special issue, readers do not need to read all other papers to figure out the acronyms.

This is now done (and we provide the up-to-date references as well.)

L176: Table -> Tables
L181: Shepherd, in 2016 -> Shepherd, 2016 L183: models by in the -> models by the
L189: circulation are -> circulation is
L201: forcing -> forcings
L209: diagnostics.. -> diagnostics. (delete one dot)
L349: add "-" in front of w*

Done – thank you for spotting these mistakes.