

## **Reply to RC1: 'A review report', Anonymous Referee #1**

(review in italics, our responses in plain text).

*The paper presents purposes and strategy of DynVarMIP. The importance of the momentum and energy budget of the atmospheric circulation for decreasing uncertainty in projections of future climates including regional climate, precipitation and extreme events responding to natural and anthropogenic forcing is documented. The strategy for the diagnostics is also concretely described. This activity is relevant to WCRP grand challenges mainly on “Clouds, Circulation and Climate Sensitivity”, and additionally on “Climate Extremes” and on “Biospheric Forcing and Feedbacks”. The description is relatively concise and clear. I think that this paper has a value to be published in Geosci. Model Dev. However, I have minor comments which may make this paper clearer and more easily understood for general readers as well as modelling scientists. Thus, I recommend minor revision before being accepted for publication.*

We thank the review for this careful review, and believe that the manuscript has improved in response to these concerns and suggestions.

### **Comments**

*ll. 24-34: The authors mainly emphasized the importance of research on the mid-latitude storm tracks. However, it is also important to examine waves with various scales in various latitudes evenly because all these waves as well as convection and boundary layer processes are interacted with each other and affect the atmospheric circulation. This point should be discussed in more detail.*

The initial emphasis on storm tracks was done to link more closely with the Grand Challenge on Clouds, Circulation, and Sensitivity. But we certainly did not mean to limit our selves to this region alone. We've added a new sentence to this paragraph emphasizing the global nature of any regional circulation problem. The sentence reads:

“Wave coupling between the tropics and high latitudes (e.g. Li et al., 2015) make regional circulation change a global problem, requiring a careful assessment of dynamical processes across all latitudes.”

In addition, in response to the second reviewer, we've provided a very brief review of the importance of stratosphere-troposphere interactions in weather, which better emphasizes the global nature of the research interest of the DynVarMIP. The new paragraph reads:

“The stratosphere impacts tropospheric weather (e.g. though blocking events; Anstey et al., 2013; Shaw et al., 2014), and an improved representation of stratospheric processes can improve synoptic weather forecasts (e.g. Gerber et al., 2012; McTaggart-Cowan et al., 2011). Coupling between the stratospheric polar vortices and the tropospheric jet streams enhances subseasonal and seasonal predictability in the midlatitudes (e.g. Baldwin and Dunkerton, 2001; Roff et al., 2011; Sigmond et al., 2013), while in the tropics, the Quasi-Biennial Oscillation affects subseasonal variability and precipitation (e.g. Yoo and Son, 2016) and provides a source of enhanced interannual predictability (e.g. Boer and Hamilton, 2008). The stratosphere

has also been implicated in the ENSO teleconnections to the extratropics (e.g. Bell et al., 2009; Cagnazzo and Manzini 2009) and linked with decadal variability in the Atlantic (e.g. Reichler et al., 2012). Finally, the stratosphere plays an important role in climate change (e.g. Scaife et al. 2011), particularly through ozone loss and recovery over Antarctica (e.g. Gerber and Son, 2014; Min and Son, 2013; Thompson et al., 2011; Wilcox and Charlton-Perez, 2013) and through changes in stratospheric water vapor, which impact surface temperatures and climate sensitivity (e.g. Dessler et al., 2013; Solomon et al., 2010).”

*l. 40: Cumulous convection is also an important parameterized process. This process is related to generation of resolved waves particularly in the tropical region and hence indirectly contribute to the momentum budget of the middle atmosphere. This point should be discussed.*

We’ve included a reference to parameterized convective processes here, and discuss it in more detail in section 3.2. The reviewer is correct to note that there are additional parameterized processes that affect the momentum budget of the free troposphere, and the cumulative effect of these processes will be estimated as a residual in the momentum budget. The new paragraph in section 3.2 reads:

“Additional parameterized processes can impact momentum transport in the free atmosphere, including convective momentum transport, vertical diffusion, and sponge layers near the model top (often used to prevent artificial wave reflection). Numerical diffusion can also artificially impact the momentum transport. The impact of these processes will be diagnosed in aggregate, however, as a residual between the total momentum tendency by the resolved flow and gravity waves and the actual change in the resolved flow.”

*ll. 93-96: A reference is necessary, which describes details of DECK experiment, preindustrial control, abrupt 4x CO2 and 1pctCO2 etc.*

We’ve included a new section (‘4. Experiments’ in the revised paper) that discusses the experiments in more detail and includes all the necessary references.

*l. 291: What CMOR is an abbreviation for?*

Climate Model Output Rewriter – this is now stated in the manuscript.

*ll. 313-372: Equation numbers should be added.*

*ll. 374-385: Equation numbers should be referred to.*

*l. 518: It is better to add the formulae and/or equation numbers in the table. For example, “tendency of eastward wind due to TEM northward wind advection and the Coriolis term” may have some ambiguity (i.e or ).*

Done. We agree and we have added the equation numbers, and refer to them in the mapping (at lines 376-385 of the original manuscript).

*l. 209: Remove the second “.”*

*ll. 333A space is needed after “.”*

Done.