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Interactive comment on "DynVarMIP: Assessing the Dynamics and Variability of the Stratosphere-Troposphere System" *by* Edwin P. Gerber and Elisa Manzini

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General comments

We welcome the range of diagnostic variables being requested as part of DynVarMIP especially the diabatic heating rates which will be useful alongside the Transformed Eulerian Mean (TEM) quantities. We believe the ability to study not only the momentum budget but also the mass and thermodynamic budgets will be extremely valuable for the DynVar community (and others). As a general principle, we think it is important that the data requested permit researchers to have a good chance at closing these budgets.

The requested data goes a long way in that direction, but we have a few suggestions for possible improvements.

Our specific comments and suggestions are as follows.

Specific comments

Line 95: It may be more valuable to have the first 40 years of the abrupt 4xCO2 runs instead of the final 40 years, if we are also requesting the final 40 years of the 1pctCO2 runs, since we would then have access to both a period of strong transient adjustment as well as a period with an established, strong response.

Line 123: As other comments have also pointed out, it may be useful to recommend what should be done on pressure level grid points which lie below the surface. We would argue that having extrapolated data would be more useful than missing values (following, for instance, the approach given in the NCAR technical note Isla Simpson has referred to), particularly for zonal mean fluxes. If modelling centres do not extrapolate data, representative zonal means for these isobars (e.g., an integral around latitude circles normalized by the fraction of the isobar which lies above the surface) are far better than missing values, but to interpret fluxes correctly one also would need the longitudinally-varying surface pressure (to work out how much of a given isobar lies above the surface at a given latitude and time).

Surface pressure (not sea level pressure) is also essential for the mass budget and for computing the mountain torque. It should be included in Table 1.

Lines 151-160: In addition to the flux and tendency terms in Table 2 and 5, we should request $\overline{u}$ and $\overline{T}$ on the 39-level grid. Having access to the finer scale structure will be essential for investigating dynamical mechanisms, especially near the tropopause. The temperature on a finer grid will be useful for a range of offline radiative calculations.

Moreover, while we appreciate and agree with the importance of the TEM framework, we think the following are good arguments for requesting the more fundamental fluxes of momentum and heat, $\overline{v'T'}$, $\overline{u'v'}$, $\overline{u'w'}$, rather than the more derived Eliassen-Palm (EP) fluxes.:

(1) Provided that $\overline{u}$ and $\overline{T}$ are available on the higher resolution set of pressure levels (plev39), the EP fluxes can be calculated from these fluxes, subject to computing some vertical and meridional derivatives, and losing some of the temporal covariances on time scales between less than a day (these could be retained in the raw fluxes, but covariances between the raw fluxes and the various derivatives of the mean state would be lost). Spot checks using ERA Interim data do show some errors associated with this interpolation, but they are generally less than 10%; whether this is important of course depends on what a given study has in mind.

(2) Given only the EP fluxes, the reverse is not possible; one cannot recover the raw momentum or heat fluxes. Since many tropospheric studies use an Eulerian framework, having $\overline{u'v'}$ itself will be very useful.

(3) Since they are less derived quantities, there is less risk of the different modeling groups making different decisions about how to compute them, and thus we are more likely to get apples-to-apples comparisons. This is perhaps also an argument for requesting $\overline{v'T'}$ rather than $\overline{v'\theta'}$.

(4) The decision of how to treat pressure levels is simpler for these fluxes – of course missing values are still an issue, but for EP fluxes there are also issues of how to compute vertical derivatives on levels next to those that intersect the surface. Providing the raw fluxes leaves the decision of how to deal with this up to the needs of the study.

(5) Having the heat-fluxes permits calculation of both the Eulerian and Transformed Eulerian Mean meridional circulation.

The main arguments for requesting the EP fluxes are that

(A) The vertical and meridional derivatives can potentially be computed more accurately, on a grid closer to the native model resolution.

(B) Some additional temporal covariances (between the fluxes and the mean state-derivatives) could be retained, if the modeling groups compute the EP fluxes at a higher temporal resolution, then average to daily output.

(C) There would be less work involved for studies interested in the EP fluxes themselves.

However, with the higher vertical resolution of the 39-level grid, it's not clear that (A) is as much of a concern as it is for the coarser 19-level grid, and while there are some issues with sub-daily scale covariances being important in the raw fluxes (e.g. mid-latitude momentum fluxes in the Southern Hemisphere troposphere), we are not aware of major sources of covariance between the fluxes and the mean-state derivatives on these timescales. We would argue that the importance of the Eulerian momentum budget for tropospheric studies and the simpler nature of the request outweighs the potential benefits of (A) and (B). If the vertical gradients are a significant concern, the vertical gradients of zonal wind and temperature could also be requested.

Moreover, if we accept the accuracy of derivatives computed on the 39-level grid and the loss of the temporal covariances on timescales less than a day, the advective tendencies utendvtem and utendwtem can be computed offline, and so do not need to be requested.

For numerical reasons, there can be a difference between the meridional streamfunction calculated from the meridional wind and that calculated from the vertical wind. Integrating the meridional wind seems likely to be the better option though we are not aware of a study demonstrating that fact explicitly. Nonetheless, given any one of the meridional wind, the stream function and the veritical wind, the other two can be computed (again subject to the accuracy of the integration and differentiation). The principle of requesting the simplest variable might therefore suggest that the most sensible course of action is to request $\overline{v}$ as a Priority 1 variable, followed perhaps by $\overline{\omega}$ as a Priority 2 variable. Again, if the heat fluxes and mean temperatures are available, one can then compute the TEM circulation offline, removing potential inconsistencies in how the heat flux and static stability is treated near the surface.

Finally, in order to close the budget, it would be very useful to have the net tendency of the zonal wind due to all parameterized processes (say, 'utendnet').

We therefore propose replacing the quantities (epfy, epfz, vtem, wtem, utendepfd, utendvtem, utendwtem, psitem) in Table 2 with the following: $\overline{u}$, $\overline{v}$, $\overline{T}$, $\overline{v'T'}$, $\overline{u'v'}$, $\overline{u'w'}$, and utendnet.

Line 200: Short wave and long wave heating tendencies have a broader applicability in determining circulation changes – they are relevant for determining the mean structure and seasonal cycle of lower stratospheric temperatures [Fueglistaler et al., 2009] , a region with significant biases as shown by Kim et al. (2013) in CMIP5 models and of central importance to stratospheric composition and therefore also to radiative forcing [Forster and Shine, 1997; Solomon et al., 2010; Nowack et al., 2014, Marsh et al., 2016]. They also play a role in determining the structure of the tropical upwelling [Ming et al. 2016a, 2016b].

Lines 203-205: Are these diabatic tendencies due to gravity wave dissipation more important than having a separation of the radiative tendencies into all sky and clear sky? The latter would also be very useful for understanding the diabatic heating budget near the TTL [Wright and Fueglistaler 2013], and could also be requested as Priority 2 fields.

Line 529: In Table 5, is zmtnt the net tendency of all parameterized diabatic processes? This is a bit ambiguous from the text as it stands, but would be the most useful for closing the thermodynamic budget. tntrl and tntrs should be clearly specified as all-sky heating rates.

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