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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Baroclinic and barotropic instabilities in planetary atmospheres - energetics, equilibration and adjustment" *by* Peter Read et al.

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Thank you for these comments and your detailed and careful reading of this manuscript. We will take these into account in producing a revised version of the paper, which we hope will then be acceptable. Our detailed responses follow.

The line numbers below are those of the version I have had access to, once printed. For some reason, the numbers seem to be shifted by one or two units from the ones on the version I visualize on my screen.

I have noticed this too! But I think most of your references are clear.

1. Eq. (1). An integral sign (from 0 to H I presume) is missing for the integral with respect to z on the left-hand side of the equation. And it might be useful to specify at

this stage that y is the latitudinal coordinate and z the vertical coordinate.

Well spotted! Yes, the integral sign should be added. We will also specify the coordinates here as suggested.

2. There seems to be an inconsistency as concerns the values of the thermal Rossby number Ro$_T$. The text (starting l. 388) says that the eddy meridional heat transport peaks at Ro$_T \sim 0.07$, while Fig. 11(a) shows a peak at Ro$_T \sim 0.3$ (see also Table 1, and ll. 724–730 and 748–751).

This looks like a straightforward error – it will be corrected to Ro$_T \sim 0.3$ for the peak.

3. Fig. 3(c). There are two curves on the figure. What is the difference between them ?

This is just a single curve that is double valued, and comes from plotting u vs dQ/dy point wise across the domain represented in the radial profiles in 3(a) and (b). u takes different values at different radii, despite have the same value of dQ/dy. This is presumably because the flow is not precisely at the inviscid marginally stable state.

4. Ll. 444-445, ... leads to a value of $\mathcal{T}_R$ which is much larger than O(1) but not hugely so .... Well, the value given in Table 2 is 1.3 x 10^5.

OK point taken. We will omit the "but not hugely so" phrase.

5. Ll. 710-711, ... to infer the existence of a unique reference frame on each planet ... A unique reference frame with which properties ?

This is the unique state at which the gravest Doppler-shifted Rossby wave trains are just able to propagate at the same phase speed and hence couple together and interact to grow via over-reflection. We will clarify in the text.

6. Ll. 461-462, ... the observed near suppression of baroclinic instability in Martian summers .... It would be better to give appropriate reference(s).

OK. A reference will be inserted here.

7. Fig. 6. What is the precise connection between the vertical coordinate (Stability parameter) and the thermal Rossby number ?

OK - they are the same in this diagram (a consequence of using a figure from another source). We will clarify this in the caption.

8. Fig. 8. Inset. It would be preferable to say explicitly that that Pe refers to heat transport by the axisymmetric flow, Pxs to transport by the eddies, and m to the number of longitudinal waves.

This will be clarified.

9. L. 100, ... for comparison, in Section 4, with the known properties ...

Well spotted! Reference to Section 4 will be added.

10. Eq. (15) Inconsistency of notation. θ or θ with overbar ?

OK, overbar is intended here and will be added.

11. Ll. 418-419, ... the values of Bu, Ro$_T$ and $\mathcal{T}_R$ [...], based on Eqs (12-14)

Noted.

12. Ll. 780-781. Contrary to what the text implies, Table 2 does not mention values for Saturn.

Reference to Saturn will be deleted.

13. Fig. 10, caption, and l. 382. What is PUMA-S with respect to PUMA, introduced earlier ?

This was used in Wang et al. (2018) to mean the Held-Suarez simplified version of the PUMA model. But this distinction is unnecessary in the present context so the "-S" suffix will be omitted.

14. It would be preferable to define the Burger number when it is first introduced (l. 241) rather than later on (Eq. 13).

OK, the definition of Bu will be moved to this point.

15. L. 125. Say that u and v* are perturbations with respect to zonal mean, and that the overbar denotes a longitudinal mean.*

These definitions will be added.

16. Table 1 does not seem to be referenced in the text. It could be on l. 363, after mention of the range of variation of Ω^*.

Noted - thanks for the suggestion.

17. L. 350, $\Delta\theta_{EP} \rightarrow \Delta\theta_E$P

Noted - to be corrected.

18. Caption of Table 2. Expand PDS (Planetary Data System)

Will do.

19. L. 64, ... quasi-geostrophic potential vorticity (QGPV), ...

We will add this.

20. L. 468, expand LMD (Laboratoire de Météorologie Dynamique)

Will do.

21. L. 451, ... tilt with altitude.

We propose to clarify this by "...pronounced latitudinal tilt with altitude".

22. L. 141, ... yet it is observed ...

OK – arguable but happy to change this.

23. L. 114, ... stability criterion (i) (parentheses, a similar correction is to be made in other places, please check).

Well spotted. Will check for other occurrences.

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