Nonlinear Processes in Geophysics Discussions

Nonlin. Processes Geophys. Discuss., referee comment RC2
https://doi.org/10.5194/npg-2020-49-RC2, 2021

Comment on npg-2020-49

Anonymous Referee #2

Referee comment on "Brief communication: Lower-bound estimates for residence time of energy in the atmospheres of Venus, Mars and Titan" by Javier Pelegrina et al., Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2020-49-RC2, 2021

This short paper presents some simple estimates for what is described as the residence timescale for energy in a planetary atmosphere, as applied to the atmospheres of Venus, Mars and Titan. The calculations are relatively crude, "back of the envelope" estimates based on data derived from the published literature with insufficient detailed explanation or discussion/critique of how accurate or appropriate these are for the purpose described. The motivation for the calculations is also not well developed and the authors seem unaware of the considerable literature on energy storage and transfer in planetary atmospheres.

Although this is mentioned in Section 4, how does the proposed timescale differ from the well known radiative relaxation timescale in atmospheric physics (e.g. see J. T. Houghton "The Physics of Atmospheres" Chapter 2 - which is similar to the timescale in Wells 2012)? Such timescales have been computed for many years for all three planets in question as well as for the Earth - e.g. see P Gierasch & R Goody, A study of the thermal and dynamical structure of the Martian lower atmosphere, Plan. Space Sci., 16, 615-646 (1968) for Mars; Pollack JB, Young RE (1975) Calculations of the radiative and dynamical state of the Venus atmosphere. J Atmos Sci 32:1025–1037 for Venus; F. M. Flasar, R. E. Samuelson & B. J. Conrath Titan's atmosphere: temperature and dynamics, Nature, 292, 693-698 (1981) for Titan. For Earth's climate, energetic adjustment timescales have been computed using more sophisticated models - e.g. see T. W. Cronin & K. A. Emanuel, The climate time scale in the approach to radiativeâ□□convective equilibrium, JAMES, 5, 843-849 (2013), which takes into account the adjustment timescale for the surface as well as the atmosphere - which seems more appropriate when comparing with the Kelvin-Helmholtz timescale for the Sun. These may not be computing quite the same quantities as what the authors have in mind here, but why not compare them quantitatively with the residence timescale computed here?

Without a clearer motivation for what is the purpose and significance of the residence timescale it is completely unclear how useful these new estimates are likely to be. I also mention some more detailed comments below. But without a significant clarification of the purpose of the calculations and a proper discussion of the novelty and significance of the new timescale with respect to the considerable existing literature, I cannot recommend publication in its present form.

Detailed comments:
P.2 Eq (7) - This assumes a simple integration with height, but atmospheres also vary in structure horizontally. Won't this make a difference?

Section 2 - By focusing on E or S as the main measures of energy you focus on essentially the dry static energy, which is dominated by internal energy. But much of this energy will be unchanged by internal dynamical adjustments and would be unlikely to vary unless the global thermal perturbation was to be fairly cataclysmic. Why is this the most significant quantity to calculate?

Table 2 - It is mentioned that most of these figures for fluxes originate from the Trenberth diagrams published by Read et al. (2016). But the fluxes quoted appear to represent either the upward or downward IR fluxes between the atmosphere and surface. Would it not be more meaningful to compute the net flux entering or leaving the atmosphere? For Venus this would look more like 22 W/m^2 at the surface. The corresponding figure for Mars would be nearer 26 W/m^2 and 0.26 W/m^2 for Titan, based on the information in Read et al. (2016). These figures definitely need more explanation and justification.