Nonlinear Processes in Geophysics Discussions

Nonlin. Processes Geophys. Discuss., referee comment RC1
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Comment on npg-2020-49

Anonymous Referee #1

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-RC1, 2021

This short communication calculates (for some lower bounds) the residence timescale of an atmosphere for Venus, Earth, Mars, and Titan. The authors use the comparability of the residence timescale and the KH timescale to argue that both have the same meaning, i.e., both express the time needed to return to equilibrium after a thermal perturbation. This article can be considered for publication after addressing some concerns listed below.

Major comments

- I am Not sure I am convinced that the residence timescale is equivalent to the time needed to return to equilibrium after a thermal perturbation. This claim is from the comparability between the residence timescale and the KH timescale for the Sun. However, this can be a mere coincidence. By definition, the residence timescale is the time that takes, in this case, energy, from entering the system until it goes out. Although it can be, this is not necessary the time to return to equilibrium, other processes, such as radiative, transport, and turbulence, can act to make the equilibration either faster or slower.
- Lines 22-35: The transition to the Sun is unclear and not motivated. After reading Osacar et al. 2020, it became clear that it is for claiming the residence time as an equilibration timescale. You should give a motivating sentence before this discussion and emphasise the point you want to say.
- Line 71: "The longest of these scales corresponds to the residence time as computed in Section 3." - Is this statement correct? Can you show or reference this?
- The radiative timescale discussion is important but feels detached from the rest of the manuscript. You should give a connecting sentence at the beginning of the discussion and a summarising sentence at the end.
- The parameters you chose are motivated; however, they are not unique. First, the radiative timescale is manifested in our daily living. Consider Earth's seasonal cycle, there is a time-lag of about a month between solstice and the warmest day of the year, resulting from the radiative timescale. Also, Mitchell and Lora (2016) estimate 200 Earth years for the tropospheric radiative timescale of Titan. This radiative timescale is about five times longer than the residence timescale you have calculated. Also, note that there they consider the effect of the atmospheric opacity.

Minor comments

- Line 21: "Harte (1988) uses this concept to estimate the anomalous temperature in urban heat islands." - Adding this line is a bit confusing. Consider elaborating on this point or remove that line.
- Line 48: "It is important to remark that S is much bigger than the sum K + L. For example, for the Earth" - This is probably true, but on other planets, like Mars (or Pluto and Triton) where the atmosphere is thin, or Titan, where it is cold, but still has strong winds, these terms might be comparable. So maybe not be so decisive.
- Line 72: "The residence time of energy in a planetary atmosphere characterises the planet, and is computed in a model independent way." - This sentence is unclear. What do you mean by characterises the planet? In what form?