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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Residence Time of Energy in the Atmosphere" *by* Carlos Osácar et al.

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In our opinion, the concept of residence time can be introduced without starting with the continuity differential equation.

E / F = τ (1)

Let assume that there is a system with two elements: a box and a conserved substance. In (1), E is the stock of substance in the box, and the inflow, Fi, and the outflow, Fo, are equal, Fi=Fo=F; then E and F are constant, the system is in a stationary state and τ is the residence time of that substance in the box.

As you say, in a second interpretation, τ can be considered as the time to deplete the box in a value E if the rate of depletion is F. This comment will be added in the new version.

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Discussion paper

It is worth to remember that the Kelvin-Helmholtz (K-H) time scale, which is a relation of type (1), with a value of 10**7 yr, was originally proposed as an estimation of the life time of the sun. This second interpretation of (1) – depletion time – was incorrect because 10**7 yr is not the life time of the Sun. The correct interpretation is the first one i.e. τ is the residence time of energy in the Sun, and therefore, after a global thermal perturbation to the Sun, the K-H time scale is the scale for a new equilibrium. See, for example, H. Spruit, Space Science Reviews, 94, 113-126 (2000).

We do not consider a demerit that Eq. (1), which is traditionally used in atmospheric chemistry and in many other fields, can be applied for the first time to the energy in the atmosphere. We have written this paper because we think that its content is original and correct.

With respect to the other comments,

1) Yes, we agree. We are using data of actual times. Some sentences in this respect will be included in the new version.

2) and 3) Sincere thanks for your English corrections.

4) Yes, for the type of stars you mention, ||E|| should be modified.

5) In the interior of the Sun, the material is also a turbulent fluid and in a numerical experiment carried out by Stich (2002; see the complete reference in the paper) using a stellar evolution code, he produced a sudden perturbation in the centre of the Sun. This perturbation consisted in a 2% increase of the cross section of the p+p reaction. The time for the adjustement to a new thermal equilibrium was roughly 10**7 yr, illustrating the interpretation that the K-H time scale is the time scale for a new equilibrium after a global thermal perturbation.

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