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# *Interactive comment on* "The Habitable Zone of Inhabited Planets" *by* J. I. Zuluaga Callejas et al.

**Anonymous Referee #2**

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The manuscript gives a new definition of the Habitable Zone, based on the fact that life alters the planetary environment. The authors develop three theoretical arguments and two illustrative examples. The paper consists mainly in a review of papers illustrating the well-known theory that life has an impact on the planet habitability. This was discussed by Lovelock in the 1970s, and also illustrated in detail by the simulations of e.g. Franck et al. ten years ago. The (only) new element of this paper is the use of these concepts to define the Habitable Zone for Inhabited Planets, which is different from the classical Habitable Zone of Kasting and others.

While the arguments are well developed, the illustrative examples - even though they are based on previous works (Selsis 2007 and the Daisyworld model) already discussing the extension of the HZ - are not persuasive and should be revised. Moreover, the original contribution of the paper should also be clarified, and enhanced. For instance, the paper could show comparisons of the classical HZ and the InHZ when



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considering impacts of life not already discussed in the literature. Therefore, a major revision of the paper is suggested.

Major points:

- Section 3: In this work, the InHZ is always considered as a possibly larger habitable zone than the classical HZ of Kasting et al., since it is based on the original view of Lovelock. When defining the "Habitable zone of Inhabited planet", the possibility (or not) that the InHZ could be more restrictive than the classical HZ should also be discussed. Does life always act in favor of habitability? The concept of negative feedback is shortly introduced p. 8456. Do the authors have concrete examples?

- "... what would happen if the habitable state of an inhabited planet is a limit cycle instead of a fixed point?" p. 8460. I do not understand the implications of these two behaviors on the definition of the InHZ. Why is it related to the InHZ and not to the HZ in general? Limit cycles are just the result of a more complex modeling, right?

- Exemple 4.1: The example is not clear and quite unrealistic. The non-tidally-locked rotating planet is covered by water clouds in the sunlit hemisphere only, and uncovered in the dark hemisphere. What about the origin of the clouds, are they linked to life? Where is life on the planet? How can the clouds stay on the sunlit hemisphere only? Why low altitude clouds only? ...

Furthermore, the connection between the biota and the clouds is the cornerstone of this example and is not described at all. So far, the example only reproduces the results of Selsis et al. (2007): clouds (due to the carbonate-silicate cycle) can significantly increase the planetary albedo and reduce the greenhouse warming. Selsis et al. also enlarges the classical Habitable Zone as a function of the cloud covering.

- Exemple 4.2: The example corresponds to a previous work of the authors (Salazar and Poveda 2009). It is a variant of the Daisyworld model. In the original work, the benefit from life in the extension of the InHZ is obvious. But in the variant of the authors,



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it is more difficult to see the effect of life. How does life impact on the clouds? And clouds on the life? Eq. (1) seems rather simple to mimic the whole carbonate-silicate / clouds cycle. Is the extension of the HZ really due to life or to the cloud coverage?

Minor points:

- The relation between RHZ and AHZ should be clarified (see for instance p. 8449). Are they both necessary?

- The name "abiotic habitable zone" can be confusing, and another name should be more appropriate. The classical HZ is based on the carbon-silicate cycle depending on the biota, thus the planet is not considered without life in the work of Kasting et al.

- p. 8468, line 20: Do the authors really mean that discovering an ocean without life is impossible?

- Figure 1: all the notations should be described (T_eq, T, S, t)

- Figure 4: the legends 'wet neutral', 'dry dead' and 'wet inhabited' should be explained. Also the qualifying adjective 'dead' is not well suited, 'without life' would be more appropriate.

- Figure 5 is quite confusing, since the model is a parable and not a real computation of the InHZ. Maybe it would be better to keep Table 1 and remove Figure 5.

- Typos, grammatical errors: p. 8445, line 8: assessing, instead of assesing / p. 8445, line 25: definition of / p. 8446, line 8: estimation of / p. 8447, line 7: through conceptual / p. 8447, line 22: opposed to / p. 8447, line 23: to the AHZ / p. 8451, line 18: forests exert / p. 8452, line 26: balls represent / p. 8453, line 18: occurs / p. 8455, line 11: assessing / p. 8455, line 12: exert a non negligible / p. 8456, line 10: two kinds / p. 8456, line 25: higher than the / p. 8457, line 1: according to / p. 8457, line 2: maintenance / p. 8457, line 28: maintains / p. 8458, line 7: it has become / p. 8458, line 25: assess / p. 8459, line 17: exception / p. 8460, line 26: stretched / p. 8460, line 26: summarizes / p. 8461, line 14: show / p. 8464, line 4: clouds influence / p.



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8464, line 19: these clouds resemble / p. 8464, line 20: conclusions / p. 8466, line 19: established / p. 8466, line 21: assessment / p. 8466, line 23: of the many aspects / p. 8467, line 27: exists / p. 8468, line 12: increase / p. 8469, line 18: has / p. 8469, line 21: through

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