

Interactive comment on “Biological catalysis of the hydrological cycle: life’s thermodynamic function” by K. Michaelian

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I thank Anastassia Makarieva for her comment. Of course one has to take the solar radiation incident at the top of the atmosphere of the Earth and not the solar radiation at the surface of the Sun when calculating the entropy production of Earth. In the manuscript I wrote "...the radiation incident from the Sun, $I_{\text{in}}(\nu)$..." the word "incident" here referring implicitly to "incident on the Earth’s atmosphere". When one does this, one gets the correct value of $1.19 \times 10^{-4} \text{ J cm}^{-2} \text{ K}^{-1} \text{ s}^{-1}$.

My original response to Prof. Gorshkov was that the simple variable "albedo" is not sufficient to describe the effect of life on the entropy production of Earth. Albedo is usually defined as the ratio of reflected over incident radiation averaged over the visible region of the solar spectrum. There is usually no account for frequency transformations

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of the light (which is by far the greatest effect of life on light). If Dr. Makarieva were to suggest that Prof. Gorshkov's albedo is frequency dependent, then we would be in agreement, but it would be necessary to perform an integral over all frequencies, as in my Eq. (3) and not use the albedo as a simple variable as in Prof. Gorshkov's Eq. (1).

I stand by my original statement that Prof. Gorshkov's calculation of the Earth's entropy production is a worse approximation than mine, particularly when a more accurate calculation of the entropy production would not assume a black-body radiated spectrum for Earth. I also stand by my original assertion that life augments the entropy production of Earth in its solar environment, rather than reducing it as claimed by Prof. Gorshkov. This last statement appears to me to be the main point of discord between Prof. Gorshkov and I. I will address it further in a forthcoming more detailed reply including the consideration of the work of Zotin mentioned by Dr. Makarieva.

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