

Corrigendum

Production of interstellar hydrogen peroxide (H₂O₂) on the surface of dust grains

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In Sect. 2 of Du et al. (2012) we misrepresented the results of Cuppen et al. (2010) by claiming that the grain surface reaction $\text{H} + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{OH}$ is barrierless. It does have a barrier, since its rate was found by Cuppen et al. to be 20 times slower than $\text{H} + \text{O}_2\text{H} \rightarrow \text{H}_2\text{O}_2$, with the latter being probably barrierless. We thank Herma Cuppen for pointing this out to us, and apologize to Cuppen et al. and the readers for this misrepresentation.

Considering the reaction $\text{H} + \text{O}_2\text{H}$ has another product channel, $\text{H} + \text{O}_2\text{H} \rightarrow 2\text{OH}$, with a branching ratio 1.6 times that of $\text{H} + \text{O}_2\text{H} \rightarrow \text{H}_2\text{O}_2$, the reaction probability of $\text{H} + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{OH}$ is then ~ 0.02 , assuming $\text{H} + \text{O}_2\text{H}$ is barrierless.

In our previous work we assumed quantum tunneling for reactions with a barrier. We calculated the reaction probability p using the formula from Hasegawa et al. (1992):

$$p = \exp\left[-\frac{2a}{\hbar}(2\mu E_a)^{1/2}\right], \quad (1)$$

where a is the barrier width, μ is the tunneling mass, and E_a is the barrier height. We assumed a barrier width of 1 Å for all reactions.

Using the reaction probability of 0.02 and taking μ as the proton mass, the above formula gives a low barrier height of ~ 92 K for the reaction $\text{H} + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{OH}$. Hence the energy barrier of the eighth reaction in Table B.1 of Du et al. (2012) should be modified to 92 K. However, since its barrier width is not well-known, this value is not necessarily the real height of the barrier, which cannot be obtained without further knowledge of the reaction. For our purpose, what really matters is the product $a(E_a)^{1/2}$.

We reran our model with a barrier width of 1 Å and a barrier height of 92 K, and found that the gas phase abundance of H₂O₂

is not affected noticeably. This is because it is formed from the surface reaction $\text{H} + \text{O}_2\text{H} \rightarrow \text{H}_2\text{O}_2$, followed by desorption due to the heat released in this reaction. Accordingly, a change in the rate of a reaction consuming surface H₂O₂ does not affect the abundance of gas phase H₂O₂. Other gas phase species are not affected either.

The abundance of surface H₂O₂ (denoted “gH₂O₂” in the figures) is affected, which becomes about one order of magnitude higher than before. A few other species are also slightly affected. A corrected version for the right-hand panel of Fig. 1 in Du et al. (2012) is shown in Fig. 1. Other figures containing surface H₂O₂ also need correction, including Figs. 2, and A.1 in Appendix A. Figure A.2 is also affected by a slight leftward shift ($\sim 3 \times 10^3$ yr) in time, owing to the slightly higher surface abundance of H caused by a lower consumption rate of it by suppressing the $\text{H} + \text{H}_2\text{O}_2$ reaction rate. The corrected versions are shown in Figs. 2–4.

The leading sentence in the last but one paragraph on page 4 of Du et al. (2012) is inaccurate. It should be changed into “as a precursor of H₂O₂, O₂H mainly forms from the reaction between O and OH (which does not have a barrier according to Hasegawa et al. 1992) on the grain at an early stage ($< 5 \times 10^4$ yr), and through reaction $\text{H} + \text{O}_2$ at a later stage”.

None of the main conclusions of our paper are affected.

References

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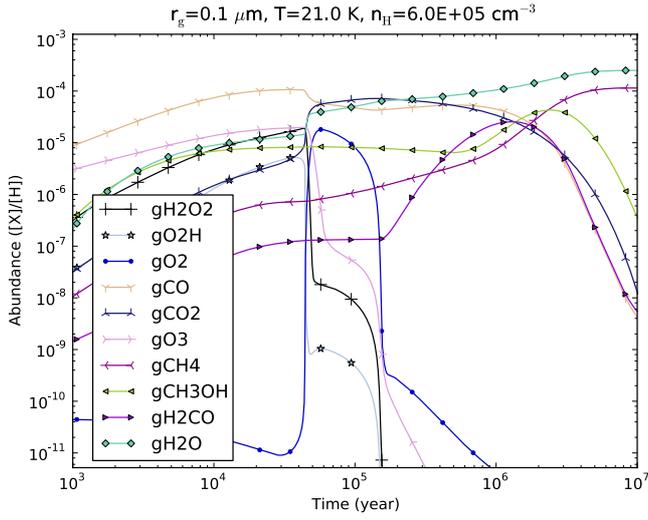


Fig. 1. Corrected version of the right-hand panel of Fig. 1 in Du et al. (2012) for the abundances of a selection of surface species relative to H nuclei as a function of time.

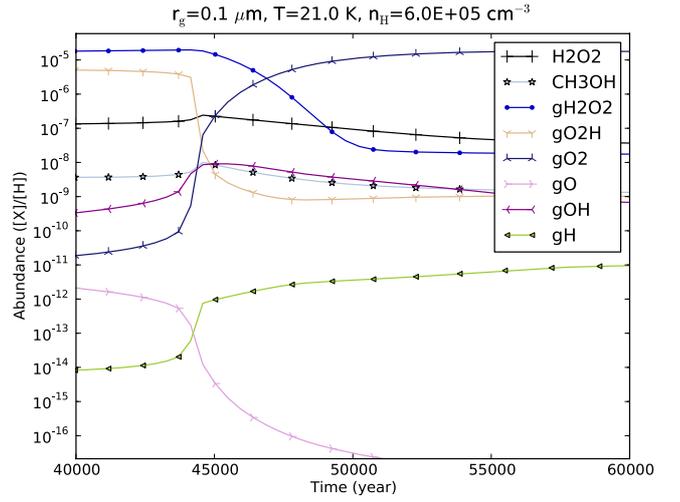


Fig. 3. Corrected version of Fig. A.1 in Du et al. (2012). This is just a zoom-in plot for Fig. 1 (with several species removed and several added) to show the details of the spike-like or jump-like features in the evolution curves.

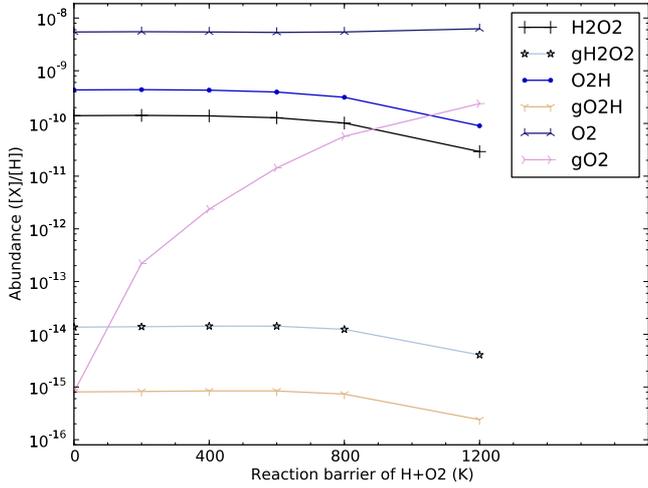


Fig. 2. Corrected version of Fig. 2 in Du et al. (2012). The abundances of gas phase and surface H_2O_2 , O_2H , and O_2 (at $t = 6 \times 10^5$ yr) as a function of the reaction barrier of the reaction $\text{H} + \text{O}_2 \rightarrow \text{O}_2\text{H}$. A prefix “g” means a surface species.

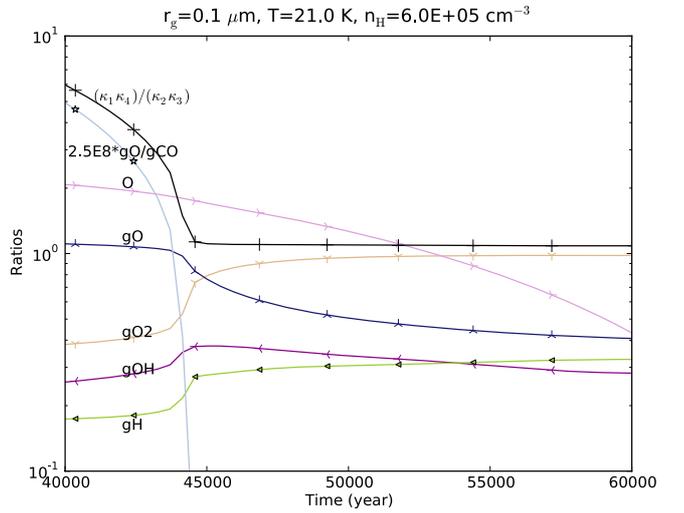


Fig. 4. Corrected version of Fig. A.2 in Du et al. (2012). The ratios $(\kappa_1 \kappa_4)/(\kappa_2 \kappa_3)$ and 2.5×10^8 gO/gCO are used in the text to explain the appearance of the spike-like feature in the evolution curves, where 2.5×10^8 is the ratio between two related reaction rates. The abundances of a few other species are plotted for reference (not to scale).