The comment of Nicholson addresses an important issue in application of oxygen triple isotope composition of dissolved O_2 as a tracer of gross O_2 production (GOP) by marine photosynthesis, the method developed by Luz and Barkan (2000; 2005; 2009). Specifically, Nicholson suggests a correction of the isotopic composition of photosynthetic O_2, $\delta^{17}Op$, recently derived by Kaiser (2011). Historically, the ^{17}O excess in photosynthetic O_2 has been defined through several, somewhat different from each other, mathematical formulations (for details, see Kaiser, 2011). These formulations were based on certain approximations, and while the deviation from the exact expression were small (PROKOPENKO et al., 2011), applying approximated formulations in the triple O isotopic mass balance of dissolved O_2 resulted in an error of the calculated values of GOP. Recently, Kaiser (2011) and Prokopenko et al. (2011) derived an exact formulation for quantifying the GOP. The new formulation was based on $\delta^{17}O$ and $\delta^{18}O$ rather than approximated expressions for the ^{17}O excess. However, the new formulation required a precise knowledge of $\delta^{17}Op$ and $\delta^{18}Op$ (p stands for photosynthetic O_2) composition of the photosynthetic end member, used in the mass balance calculations. The value of $\delta^{17}Op$ was not known precisely at the time when Kaiser (2011) has written his paper, thus it was derived by Kaiser (KAISER, 2011) from the previously published $\delta^{18}Op$ and definition of ^{17}O excess, $^{17}\Delta$ (ANGERT et al., 2003; LUZ and BARKAN, 2005):

$$^{17}\Delta*10^{-6} = [\ln(\delta^{17}Op/1000+1)- \lambda*\ln(\delta^{18}Op /1000+1)] \qquad (1)$$

where $^{17}\Delta=249$ is the ^{17}O excess in photosynthetic O_2 relative to atmospheric O_2 previously reported by Luz and Barkan (2000, 2005). The value of λ in equation (1) is the focus of the current comment by Nicholson. λr for respiration only, where $\lambda r = (1-\alpha^{17})/(1-\alpha^{18})=0.5179$, was determined experimentally by Angert et al. (2003) and Luz and Barkan (2005). On the other hand, Angert et al. (2003) and Luz and Barkan (2005) argued that since the atmospheric O_2 is in the steady state with O_2 produced by marine photosynthesis, when comparing atmospheric O_2 and photosynthetic O_2, a λst (λ for steady state) should be used, where $\lambda st = \ln(\alpha^{17})/\ln(\alpha^{18})=0.5154$ in equation (1). Applying $\lambda r=0.5179$ in equation (1) results in value of $\delta^{17}Op \sim 0.050$ ‰ lighter than $\delta^{17}Op$ calculated with $\lambda st=0.5154$. Nicholson (2011) showed that the ~0.050‰ lighter $\delta^{17}Op$, obtained with $\lambda r=0.5179$ results in a larger discrepancy between the exact and approximated formulations than $\delta^{17}Op$ obtained with $\lambda st = 0.5154$ and argued that λst should have been used instead.

Using an example, provided by the other Referees of the current comment, if $\delta^{18}Op = -20.003$ ‰ (for further details, see Eisenstadt et al., 2010, Luz and Barkan, 2011 and Barkan and Luz, 2011 and the Referee comments by Luz and Barkan on the current manuscript), then corresponding the $\delta^{17}Op = -10.112$ ‰ (instead of $\delta^{17}O = -10.164$ ‰, as would have been obtained if $\lambda r = 0.5179$ were used). If $\delta^{17}Op = - 10.112$ ‰ is used instead of $\delta^{17}Op = - 10.164$‰, it decreases the discrepancy between the exact and approximated formulations from ~ -35% to ~ + 5 to + 15%. Similar results were obtained in the example shown by Nicholson for $\delta^{18}Op= - 22.835$ ‰ and corresponding $\delta^{17}Op$ values of -11.646‰ and -11.588 ‰.

I agree with the logic of Nicholson, arguing for using the steady state λst value. However, I found one problem with using λst$\neq\lambda$r: subsequent respiration of the photosynthetic O_2 leads to changes in $^{17}\Delta$ values, if λst = 0.5154 is used in equation (1) applied to steady state, while λr = 0.5179 is used in defining $^{17}\Delta$ excess in dissolved O_2 (calculated using equation (1) and Rayleigh fractionation associated with respiration of ^{17}O and ^{18}O). In fact, I calculate that if the initial isotopic composition of $\delta^{18}O$ = -20.003 ‰, and $\delta^{17}O$ = -10.112‰ (as suggested by Luz and Barkan in the Referee comments) (or $\delta^{18}Op$ = -22.835‰ and $\delta^{17}Op$ = -11.588‰, example given by Nicholson), then respiration of this photosynthetic O_2 to the final atmospheric values of 0‰ would result in $^{17}\Delta$ = 0.299 ‰ ($\delta^{18}O$ = 0‰, $\delta^{17}O$ = 0.299 ‰) steadily increasing from 0.249‰ = 249 per meg (or 249 ppm as suggested by Kaiser (2011)), which is the currently accepted value, as $\delta^{18}O$ increases due to respiration. On the other hand, if $\delta^{17}O$ = -10.164 ‰ is used (as obtained from equation (1) with λr = 0.5179), the subsequent respiration of this photosynthetic O_2 does not result in changes of $^{17}\Delta$ value, as respiration progresses. In other words, using the λst for calculating the $\delta^{17}Op$ seems to result in a non-conservative behavior of $^{17}\Delta$ excess during subsequent respiration, while by definition, $^{17}\Delta$ should not affected by respiration (Luz and Barkan, 2000, Luz and Barkan, 2005).

I am really curious to see this issue addressed in the final published version of the Nicholson comment. I recommend this manuscript for publication, as it further improves and clarifies the application of the elegant and innovative method of oxygen triple isotopes for quantifying GOP.

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