# Constraining Global Ocean Productivity Using Triple Oxygen Isotopes

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Since the first use of the triple oxygen isotope approach to constrain oceanic productivity 15 years ago, the method has been applied from pole to pole in nearly every ocean regime. Various studies have yielded estimates of gross photosynthetic $O_2$ production at basin scales and have allowed identifiaction of productivity fronts that were previously uncharacterized. Repeat measurements made at fixed locations have offered insights into relationships with traditional, incubation-based productivity rates, and have helped to identify potential biases in the triple oxygen isotope as well as incubation-based approaches. Laboratory experiments and newly reformulated equations for calculating gross $O_2$ production from oxygen isotope measurements have eliminated some of the sensitivities to choice of mass dependent fractionation slope, and $\delta^{17}O$ and $\delta^{18}O$ of photosynthetically produced $O_2$. Emerging from this body of work, several challenges remain: 1) adequate characterization of physical biases; 2) adequate characterization of non steady-state processes; 3) evaluation of the plasticity of gross photosynthetic $O_2$ production to net primary production ratio. Improvements in the above areas will significantly reduce some of the largest remaining uncertainties in the application of the triple oxygen isotope apporach, and will allow more robust use of the data for calibration of satellite productivity algorithms, and hence, constraint of global ocean productivity.