Interannual variations of biological net and gross production in the Atlantic subtropical gyres inferred from oxygen-to-argon ratios and oxygen triple isotopes

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Geochemical tracers and particle fluxes suggest unequivocally that the metabolic balance of the Atlantic subtropical gyres is governed by net autotrophy. In contrast, bottle incubations indicate net heterotrophy throughout large areas.

We have used continuous measurements of surface oxygen-to-argon ratios by membrane-inlet mass spectrometry, in combination with wind-speed based gas exchange rate parameterisations, to derive the mixed-layer metabolic balance during five AMT cruises between 2005 and 2013. The data reveal a consistent picture of net biological oxygen fluxes directed out of the subtropical gyres during both spring and autumn, corresponding to net autotrophy.

This suggests that bottle incubations are unsuitable to determine net biological production rates, either due to aliasing of the underlying environmental temporal or spatial variability, due to of enclosure biases or both.

Additional discrete samples have been used to derive gross oxygen production rates from oxygen triple isotope measurements. The resulting rates are surprisingly high compared to other methods, again pointing to systematic measurement errors or indicating a possible larger than expected role of non-carbon fixing, water splitting reactions in photosynthesis.