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Subtropical desert conundrums

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The oligotrophic subtropical gyres of the oceans have been the focus of controversy regarding the magnitude and even the direction of their biotic contribution to the airsea flux of carbon dioxide. Local measurements of primary production and respiration have yielded much lower (and even negative) biological carbon dioxide uptake than estimates of export production from large-scale and long-term integrals of respiration in subsurface waters. Using numerical models and data collected during two research cruises into the subtropical North Atlantic, we investigate a number of hypotheses put forward to explain this apparent discrepancy. While eddy- and salt-finger induced transports approximately double previous estimates of nutrient supply, high rates of nitrogen fixation and shallow export of carbon-rich dissolved organic matter are the dominant processes that explain the previously observed mismatch between organic-matter production and nitrate supply in the area. Accounting for these processes, we propose a consistent picture of the nitrogen and carbon cycles in the subtropical North Atlantic.