**Supplementary Methods.**

In order to determine if injecting the 15N2 tracer as a bubble or previously dissolved in filtered seawater had an impact of N2 fixation rates, we sampled 12 gallons of surface seawater at one occasion. Six of them were amended with 5 ml of 15N2 (98.9% Cambridge isotope) using a gas tight syringe, and six were amended with 5% vol : vol of 15N2-enriched seawater prepared as described in Berthelot et al., (2015). Briefly, lagoon seawater was first degassed through a degassing membrane (Membrana, Minimodule®, flow rate fixed at 450 mL min-1) connected to a vacuum pump (< 200 mbar absolute pressure) for at least 1 h. It was then tightly closed with no head space with a silicone septum cap and amended with 1 mL of 15N2 (98.9% Cambridge isotope) per 100 mL. The bottle was then shaken vigorously to promote 15N2 dissolution. Bottles were then incubated altogether in deck incubators as described in the Method section. In both cases, the 15N enrichment of the dissolved N2 pool was measured in the incubation bottles after incubation by membrane inlet mass spectrometry (MIMS) according to Kana et al., (1994).

**Results.**

Figure S1. Average N2 fixation rates (blue bars, nmol N L-1 d-1) and 15N enrichment (atom %) of the dissolved N2 pool in the incubation bottles (red dots) (n=6) in both methods (left: addition of 15N2 as a bubble (‘bubble’); right: addition of 15N2 as 15N2-enriched seawater ‘FSW’).

The 15N enrichment of the dissolved N2 pool measured in the first set of bottles (bubble method) was 4.41 ± 0.51 (n=6) atom%, while it was 2.63 ± 0.06 (n=6) atom% in the second set of bottles (15N2 enriched seawater). The 15N enrichment of particulate N in the first set of bottles was 0.382 ± 0.03 (n=6) atom%, and 0.372 ± 0.05 (n=6) atom% in the second set (data not shown). However, the resulting calculated N2 fixation rates were 4.0 ± 1.4 nmol N L-1 d-1 (n=6) in the first set (bubble method) and 3.8 ± 0.51 nmol N L-1 d-1 (n=6). Both distributions were not significantly different (p>0.05). This result is consistent with previous studies conducted in the WTSP (Bonnet et al., 2016) and another recent extensive meta-analysis (13 studies, 368 observations) between bubble and enriched amendment experiments to measure 15N2 rates reported that underestimation of N2 fixation is negligible in experiments that last 12–24 h (e.g., error is ~0.2%) (Wannicke et al., 2018). We thus considered that the use of two different methods did not affect the resulting rates in our time series.

Table S1. Supplementary data representing meteorological data (monthly average wind speed, monthly average wind direction and ENSO index) during the GOPS survey.



