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First long term (~30 years) coral acclimatization to ocean acidification recorded in geochemical signatures: A case study of New Caledonia

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Calcifying organisms such as corals currently living on the thresholds of their optimal environment, and adapted to extreme conditions have become useful models to predict the future of coral reefs facing ocean acidification (OA) and holistically climate change. In New Caledonia, we discovered a rich and abundant coral reef thriving in a large semi-enclosed lagoon surrounded by mangroves (Bouraké), where the most ecologically relevant oceanic parameters in the context of climate change varied towards extreme future predictions: lower pH (<7.7) and oxygen (-20 to 30%), and warmer temperatures (+ 0.5 to 3°C). In March 2020, we have sampled two 30-cm long *Porites* sp. cores, one in Bouraké and one in an adjacent reference reef exhibiting environmental conditions close to actual open ocean values.

We performed geochemical analyses through the *Porites* sp. cores and reported 30 years of annually resolved $\delta^{18}O$, $\delta^{13}C$, $\delta^{11}B$ and B/Ca results. Here, we present evidence of striking trends of pH decline in the past 30 years in our reference site while a stable pH around 7.70 pH units was observed in Bouraké. Our study allowed us to compare an uninterrupted OA with a decreasing pH trend in the South Pacific over the last three decades to a naturally long-term acidified environment on multi-generational coral reefs evolution. In parallel, to assess the physiological traits of *Porites* sp. and help geochemical calibrations, we cultured small fragments of *Porites* sp. from our two sites. During 100-day, these fragments were maintained under four different pH_T conditions, three at constant value: 8.05±0.05 (Present-day); 7.70±0.07 (Future); 7.40±0.08 (Extreme); and one at variable pH: 7.4-8.0, which mimic the diurnal pH variation at Bouraké.

Physiological results from culture experiments showed an increased growth of Bouraké samples regardless of the pH treatment, while no differences regarding other physiological traits could be observed. This indicates a strong and specific calcification of Bouraké's corals acquired through many generations in an extreme environment. The comparison of our geochemical signatures on both cultured and sampled *Porites* cores showed significant differences between the two populations (Bouraké vs control) and are giving us some clues on coral responses to anthropogenic effects.