

EGU24-11718, updated on 23 Jan 2025
<https://doi.org/10.5194/egusphere-egu24-11718>
EGU General Assembly 2024
© Author(s) 2025. This work is distributed under
the Creative Commons Attribution 4.0 License.



An ocean-atmosphere paradox, Phase 2

Brian Durham and Christian Pfrang

University of Birmingham, GEES, Oxford, United Kingdom of Great Britain – England, Scotland, Wales (brian@oxpot.co.uk)

Last year we posed the question: *Given Earth's ocean-atmosphere gas equilibrium, why do measured atmospheric carbon dioxide (CO₂) curves rise more steeply against solvent temperature than predicted by Henry's Law?* (https://presentations.copernicus.org/EGU23/EGU23-6069_presentation.pdf). We here develop our experimental procedure to simulate more closely the ocean-atmosphere gas exchange in the lab, seeking to better understand the relationship between atmospheric CO₂ and average sea surface temperatures, with implications for past and future climate variability in the Earth System.

To this end, we previously reported provisional trends when water and natural seawater samples are equilibrated with an atmospheric ratio of CO₂ in air. We also outlined a narrower interest in the published offset in annual CO₂ cycles between marine and terrestrial stations which record atmospheric CO₂ levels (Ye Yaun et al 2019).

Provisional results were compared with published values from seawater that had been 'killed' and acidified (Li and Tsui 1971 and Weiss (1974). Working at atmospheric partial pressures of CO₂ however, a definitive value for the respective Henry constant was complicated by the difficulty of predicting an equilibrium asymptote in either water or seawater determinations.

We therefore listed a number of modifications to be adopted in future campaigns to address this issue. One proposed modification was to investigate alternative catalysts. Sodium dodecyl sulphate (SDS) is therefore replaced with a natural enzyme complex, generically carbonic anhydrase (CA), described as efficient in the reversible hydration of CO₂ to bicarbonate. CA is seen as an enzyme family with several independent evolutions across the phylogenetic tree, abundant in plants, diatoms, eubacteria and archaea (Supuran, 2016). The metallo-proteins are described as including a reaction space that combines one half hydrophilic and the opposing half hydrophobic, 'allowing these enzymes to act as some of the most effective catalysts known in nature'.

In Phase 2 we therefore compare water samples with and without dosing with an infusion of terrestrial soil biota, while for seawater, being a living medium, we use a freshly-unfrozen sample of UK Atlantic coast water for each determination.