

Air-water CO₂ flux in a subtropical mangrove-seagrass-coral continuum: A comparative study

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The threat of increasing CO₂ concentration on the global climate has triggered several research works which focused on understanding the carbon dynamics of as well as sink inventories of various natural ecosystems of the world. Amongst the terrestrial biosphere, the vegetated coastal ecosystems are known to have huge potential to store and sequester carbon for a long period of time. Ecosystems like mangroves, seagrasses, and salt marshes (collectively referred to as 'blue carbon ecosystems') and corals are the chief ecosystems in this regard. At present it has become imperative to study and analyze the CO₂ exchanges within these ecosystems with the atmosphere to quantify their mitigation potential to the ongoing climate change.

The present study has been carried out off the Iriomote Islands, Japan where mangroves, seagrasses and coral reefs coexist in close vicinity to each other. The variation in the partial pressure of CO₂ [pCO₂ (water)] in the aquatic bodies lying adjacent to these three ecosystems along with the air-water CO₂ fluxes were estimated for two 24-h cycles (during July, 2017) respectively in the mangrove, seagrass and coral waters. Other carbonate chemistry parameters like pH, total alkalinity (TALK) and dissolved inorganic carbon (DIC) were also monitored.

Though these three distinct types of ecosystems were located within 1 km distance from each other, stark differences in the mean pCO₂ (water) was observed during the study. The mean pCO₂(water) was found highest in the mangrove waters (906 ± 572 μ atm) followed by the seagrass waters (480 ± 88 μ atm) (which lies intermediate between the mangroves in the coastal periphery and the corals towards the shelf) and the least was observed in the coral waters (416 ± 82 μ atm). It can be seen that the difference between the seagrass waters and the coral waters was much less compared to that observed with the mangroves. The air-water CO₂ fluxes also mirrored the variability of pCO₂(water). Considering the average of the entire diurnal dataset, all the waters acted as a source of CO₂, however, the magnitude was highest in the mangroves (405 ± 464 μ mol m⁻² h⁻¹) followed by seagrasses (57 ± 71 μ mol m⁻² h⁻¹) and corals (5 ± 66 μ mol m⁻² h⁻¹). It is worth mentioning that the mangrove surrounding waters scarcely showed negative flux values (i.e. acted as a sink for CO₂) during the entire diurnal cycle, whereas, the seagrass waters acted as sinks for a substantial time period (maximum sink magnitude: -183 μ mol m⁻² h⁻¹). Coral waters acted as a sink for CO₂ for much more time than the seagrass waters and the maximum sink magnitude was also much higher than the seagrass waters (-206 μ mol m⁻² h⁻¹). Apart from pCO₂(water), TALK and DIC also showed a similar trend. The highest mean values for both the parameters were observed in the mangroves (TALK: 2291 μ mol kg⁻¹; DIC: 2074 μ mol kg⁻¹), followed by seagrass (TALK: 2219 μ mol kg⁻¹; DIC: 1933 μ mol kg⁻¹) and corals (TALK: 2211 μ mol kg⁻¹; DIC: 1878 μ mol kg⁻¹). It can be seen that the decrease in DIC from mangroves to corals was much more prominent than the decrease in TALK.

On the whole, it increased from the mangrove towards the coral site. Analyzing all the observations it can be concluded that, mangrove waters usually act as source of CO₂ towards the atmosphere, and it has shown nothing contrary in this study site. Corals are mostly reported to exhibit near neutral character in terms of source/sink of CO₂ which is exhibited here too. However, seagrass waters which mostly act as sink for CO₂ has been also found to act as source of CO₂ in his region which might be attributed to the influence of mangrove derived pCO₂ rich water lying in close vicinity to the seagrass bed.

Keywords: air-water CO₂ flux, partial pressure of CO₂, mangrove, seagrass, coral, Iriomote Islands