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Recent trends in air-sea CO_2 fluxes and ocean acidification in the Arabian Sea

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Recent observations and modeling evidence indicate that the Arabian Sea (AS) is a net source of carbon to the atmosphere. Yet, the interannual variability modulating the air-sea CO_2 fluxes in the region, as well as their long-term trends, remain poorly known. Furthermore, while the rising atmospheric concentration of CO_2 is causing surface ocean pH to drop globally, little is known about local and regional acidification trends in the AS, a region hosting a major coastal upwelling system naturally prone to relatively low surface pH. Here, we simulate the evolution of air-sea CO_2 fluxes and reconstruct the progression of ocean acidification in the AS from 1982 through 2019 using an eddy-resolving ocean biogeochemical model covering the full Indian Ocean and forced with observation-based winds and heat and freshwater fluxes. Additionally, using a set of sensitivity simulations that vary in terms of atmospheric CO_2 levels and physical forcing we quantify the variability of fluxes associated with both natural and anthropogenic CO_2 and disentangle the contributions of climate variability and that of atmospheric CO_2 concentrations to the long-term trends in air-sea CO_2 fluxes and acidification. Our analysis reveals a strong variability in the air-sea CO_2 fluxes and pH on a multitude of timescales ranging from the intra-seasonal to the decadal. Furthermore, a strong progression of ocean acidification with an important penetration into the thermocline is simulated locally near the upwelling regions. Our analysis also indicates that in addition to the increasing anthropogenic CO_2 concentrations in the atmosphere, recent warming and monsoon wind changes have substantially modulated these trends regionally.