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Misconceptions of the marine biological carbon pump in a changing climate: Thinking outside the “export” box

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The marine biological carbon pump (BCP) stores carbon in the ocean interior, isolating it from exchange with the atmosphere and thereby coregulating atmospheric carbon dioxide (CO₂). As the BCP commonly is equated with the flux of organic material to the ocean interior, termed “export flux,” a change in export flux is perceived to directly impact atmospheric CO₂, and thus climate. Here, we recap how this perception contrasts with current understanding of the BCP, emphasizing the lack of a direct relationship between global export flux and atmospheric CO₂. We argue for the use of the storage of carbon of biological origin in the ocean interior as a diagnostic that directly relates to atmospheric CO₂, as a way forward to quantify the changes in the BCP in a changing climate. The diagnostic is conveniently applicable to both climate model data and increasingly available observational data. It can explain a seemingly paradoxical response under anthropogenic climate change: Despite a decrease in export flux, the BCP intensifies due to a longer reemergence time of biogenically stored carbon back to the ocean surface and thereby provides a negative feedback to increasing atmospheric CO₂. This feedback is notably small compared with anthropogenic CO₂ emissions and other carbon-climate feedbacks. A comprehensive view of the BCP’s impact on atmospheric CO₂, is a prerequisite for assessing the effectiveness of marine CO₂ removal approaches mediated by biology.