Water residence time: A regulatory factor of the DOM to POM transfer efficiency

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ABSTRACT: The pools of dissolved (DOM) and particulate organic matter (POM) and of transparent exopolymeric particles (TEP) were studied along two sampling gradients in the lagoon of New Caledonia in relation to the residence time of the water masses. The efficiency of the transfer of material from the dissolved to the particulate phase via TEP formation, indicating the physicochemical reactivity of organic matter, was investigated. DOM, POM, and TEP concentration increased along the sampling gradients, but their relative proportions varied. The contribution of the TEP pool to POM increased from 20% to 60%, from the most oligotrophic stations to the more anthropogenically affected bays. According to the low density of TEP and to the observed variations of the proportion of TEP compared with more conventional and solid particles, the aggregates formed inside the bays would be either neutrally or positively buoyant, whereas in the vicinity of the coral barrier, they would be negatively buoyant. As a result, the downward export of organic matter inside the bays might be greatly reduced, thereby prolonging the residence time of organic matter in the water column. The efficiency of the DOM/TEP transformation and the TEP turnover rate dropped drastically when the residence time increased from 0 to 50 d, suggesting that the reactivity of organic matter is reduced as it ages. The very high residence time of the water mass inside the bays, constrained by the hydrodynamic circulation inside the lagoon, favors the installation of a feedback system in which organic matter is not exported and is continuously degraded, leading to the formation of refractory DOM with a low physicochemical reactivity. In contrast, organic matter produced in areas in which water mass has a low residence time (i.e., near the coral barrier) is rapidly exported because of its high physicochemical reactivity.