Nutrient dynamics and biological consumption in a large continental shelf system under the influence of both a river plume and coastal upwelling

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ABSTRACT: We examined the dynamics of dissolved inorganic nitrogen (DIN, nitrate + nitrite), dissolved inorganic phosphorus (DIP), and silicate ($Si(OH)_4$) in the northern shelf of the South China Sea in summer, which is under a complex hydrodynamic scheme largely shaped by river plume and coastal upwelling, along with the enhanced biological consumption of nutrients therein. The Pearl River plume, with high nutrient concentrations (~ 0.1 – 14.2 μmol L^{-1} for DIN, ~ 0.02 – 0.10 μmol L^{-1} for DIP, and ~ 0.2 – 18.9 μmol L^{-1} for $Si(OH)_4$), occupied a large area of the middle shelf (salinity < 33.5). The nearshore area had high nutrient concentrations apparently sourced from subsurface nutrient-replete waters through wind-driven coastal upwelling. These nutrient levels were significantly elevated relative to those on the oligotrophic outer shelf where DIN, DIP, and $Si(OH)_4$ concentrations dropped to < 0.1 μmol L^{-1}, ~ 0.02 – 0.03 μmol L^{-1}, and ~ 2.0 μmol L^{-1}, respectively. A three end-member mixing model was constructed based on potential temperature and salinity conservation to assess biological consumption of inorganic nutrients, which was denoted by Δ and defined by the deviation from conservative mixing. In the coastal upwelling zone and deep chlorophyll maximum layer, the nutrient uptake ratio ΔDIN : ΔDIP was 16.7, which is the classic Redfield ratio. In contrast, in the river plume the uptake ratio was 61.3 ± 8.7. We believed that an alternative non-DIP source likely contributed to this higher DIN : DIP consumption ratio in the river plume regime. Meanwhile, $Si(OH)_4$ showed predominant consumption in the river plume and a combination of regeneration and consumption along the path of the coastal upwelling current.

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