Nutrient dynamics in the northern South China Sea Shelf under the influence of both a river plume and coastal upwelling

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South China Sea is the largest marginal sea of the West Pacific ocean. In wet season, the shelf region of the northern South China Sea (NSCS) is dominant by a large river plume that may extend to a few hundred kilometers away from the mouth of the Pearl River Estuary. Also featured is a well-defined coastal upwelling near shore. Both the river plume and the coastal upwelling have fundamental impact on the nutrient distribution and thereby the biological productivity in the NSCS. This study sought to examine the distribution and dynamics of nutrients in such a unique system in the NSCS based upon a field campaign in the summer of 2008.

There appeared significant spatio-temporal variations of both nitrate+nitrite (N+N), phosphate (P) and silicate in the upper mixed layer during and after a pulse of the river plume in the near shore. Nutrients concentration were enhanced by river plume following a flood upstream the Pearl River with N+N and P rising to 3.0-7.0 and 0.04-0.10 μM, respectively, which were remarkable compared to the outer shelf oligotrophic water. Another featured zone with high nutrients concentration (N+N 2.9-3.5 μM, P ~0.25 μM) was observed around Shantou, a nearshore area influenced by upwelling. Within a short period of time after the flood period, the river plume significantly diminished and the concentration of nutrients in the river plume also significantly decreased, with N+N concentration down to ~1.0-2.0 μM and with P concentration down to ~0.03 μM. At the same time, the upwelling-influenced zone near Shantou along with the area near Shanwei where cross-shelf transport being intensified by unique widened shelf topography had an elevated concentration level (N+N ~ 4.0-6.0 μM and P ~ 0.3-0.4 μM). Such a change in apparent nutrients

distribution and pattern suggests that there existed dynamic interactions between the river plume and the upwelling. The above nutrient pattern and its response to the river flood suggest that the nutrients distribution in NSCS shelf is jointly controlled by the river discharge, coastal upwelling and offshore oceanic surface water.

On top of the mixing between different water sources, nutrients in the study area have also shown to be consumed by biological productivity. During the flood period, the uptake rate both in the river plume and coastal upwelling zone were estimated by a two end-member mixing method. The maximum biological uptake concentration of P and NO_3 were 0.35 and 13.83 μM in river plume, and 0.19 and 2.75 μM in coastal upwelling zones, respectively. The fact that the removal ratio of NO_3/P in the river plume was higher than the Redfield Ratio may be attributable to the faster regeneration rate and turnover time of P. It is interesting that the removal ratio of NO_3/P in the upwelling zones was estimated to be ~14.47, close to the Redfield Ratio. As a first order estimation, the primary production was ca. 0.148 gC m^{-2} d^{-1} in the river plume and ca. 0.418 gC m^{-2} d^{-1} in the upwelling zone.

Keywords: nutrient dynamics, river plume, upwelling, biological production, continental shelf