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Dynamic biogeochemical controls on river pCO_2 under increasing impoundment: an example of the Yangtze River

Shaoda Liu and Xi Xi Lu

Department of Geography, National University of Singapore, Singapore (lsdeel@gmail.com)

We highlight two aspects of the dynamic biogeochemical controls of riverine pCO_2 in an increasingly impounded large subtropical river (the Yangtze River): the terrestrial dominance through internal respiration of terrestrially derived organic carbon and the influence of increased autotrophic activity in impounded areas on river pCO_2. River pCO_2 and total organic carbon (TOC) increase downstream on the mainstem (pCO_2: 528–1703 μatm; TOC: 137–263 μmol/L) and vary significantly among tributaries (464–3300 μatm; TOC: 109–340 μmol/L). pCO_2 displays larger spatial variability than temporal variability and is spatially correlated with river organic carbon across the river ($p < 0.05$–0.0001) (seasonal independent). pCO_2 is also negatively correlated with dissolved oxygen ($r2 = 0.46$, $p < 0.0001$). Heterotrophic respiration of river organic carbon is concluded as an essential source of CO_2 supersaturation and river heterotrophy. However, preliminary budgeting indicates that water column respiration alone cannot explain the magnitude of CO_2 emission from the river, and significant benthic respiration and/or direct soil CO_2 transport (e.g., via groundwater) ($\sim 80\%$) must exist to account for the discrepancy. The temporal and spatial distribution of POC compositional characteristics and chlorophyll a indicate the dominant control of terrestrial processes (e.g., organic matter transport and soil erosion) on the river pCO_2 biogeochemistry, especially in warm seasons. Increased autotrophy and significant pCO_2 decrease ($> 60\%$) do occur in impounded areas (especially in nutrient-rich rivers), but the decrease is mostly temporal and regional ($\sim 8\%$ of the data points are significant influenced, all from the upper reach and/or major tributaries). The paper concludes that terrestrial influence still dominate the pCO_2 biogeochemistry in this increasingly intercepted and regulated river system. However, the effect of continuing river impounding and increased nutrients input is to be watched.