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Diel and seasonal variation of methane and carbon dioxide fluxes from the Three Gorges Reservoir

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In order to investigate the CH4 and CO_2 fluxes across the water-gas interface of the Three Gorges Reservoirs and identify their controlling factors, four diel field campaigns and one monthly sampling campaign during June 2010∼May 2011 were carried out at two site. Site Guojiaba was located at the mainstream of the Yangtze River and near the Three Gorges Dam, and Site XX06 was located at the middle of the Xiangxi Bay, which was a tributary of the Yangtze River before impounding. Hydrodynamic situation of the two sites was completely different, and the current velocity was big at Site Guojiaba and very low at Site XX06 at all times. CH4 fluxes at the sites were much lower than those from most other reservoirs or natural lakes. One of the most important reasons may be due to the oxidation of CH4 in water column owing to the huge water depth and high DO in water in the TGR.
At XX06, the diel CH4 flux varied greatly during April 27-28, 2011 and October 4-5, 2010, and changed less during August 23-24, 2010. The average CH4 flux during October 4-5, 2010 is ∼0.081 mg m- h-1, which is approximate to that of August 23-24 and much less than that during April 27-28, 2011. The diel average of flux observed during April 27-28, 2011 was ∼3.6 and ∼3.8 times of that during August 23-24, 2010 and October 4-5, 2010 respectively. Eutrophication of the bay occurred frequently as a consequence of large influxes of nutrients in most time of the observation year. The four highest Chl-a occurred in the time of low water level and warm season. The CH4 fluxes during the observation year ranged from -0.120 to 31.008 mg m-2 h-1 with an average of 3.288 mg m-2 d-1, which was much less than that reported from reservoirs in tropic and temperate regions. The maximum flux, which occurred in June 2010, was corresponding to the lowest water level. Water temperature, sediment temperature, and TOC did not have significant correlation with the monthly CH4 fluxes. Continuously decreasing hydrostatic pressure and the low water level resulted in more CH4 emission at the sediment-water during the discharging period, and thus increases the CH4 effluxes because the diffusion time through a thin water column is shorter and less CH4 may be oxidized compared with that in a long water column.
At Guojiaba, the diel average CH4 fluxes in spring, summer, autumn and winter were 0.07, 0.06, 0.04 and 0.02 mg/m2/h respectively. No significant correlation between either the diel CH4 fluxes or the diel CO_2 fluxes and environmental parameters is observed. The averaged monthly CH4 during the observation year was 0.05 mg/m2/h. The CO_2 flux showed a positive correlation with DOC to some extent, although not significantly, which indicated allochthonous organic C was a major source of CO_2 and biogeochemical processes in this reservoir were C-limited. Only a significant correlation was observed between the seasonal CH4 diffusive fluxes and the water pH, and all other correlations between the CH4 fluxes and independent variables tested were weak. The significant positive correlation between the reservoir outflow and the seasonal gas flux indicate the disturbing condition of water body dominated the seasonal gas emission.