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High spatial variability of carbon dioxide and methane emission in three tropical reservoirs

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In the tropics, many new large hydropower dams are being built, in order to produce renewable energy for economic growth. Most inland waters, such as rivers, lakes and reservoirs, emit greenhouse gases to the atmosphere, and especially tropical reservoirs have been pointed out as strong sources of methane. However, present estimates of greenhouse gas emission from reservoirs are limited by the amount of available data. In particular, the spatial variability of greenhouse gas emission from reservoirs is insufficiently understood. In order to test the hypothesis that the diffusive emission of carbon dioxide (CO_2) and methane (CH4) from tropical reservoirs is characterized by strong spatial variability and incorrectly represented by measurements at one site only, we studied three reservoirs situated in different tropical climates, during the dry period. We conducted spatially resolved measurements of surface water concentrations of dissolved carbon dioxide and methane using an on-line equilibration system, as well as of the gas exchange velocity using floating chambers. We found pronounced spatial variability of diffusive CO_2 and CH4 emission in all three reservoirs. River inflow areas were more likely to have high concentrations of particularly CH4, but also CO_2, than other areas in the reservoirs. Close to the dam, CH4 concentrations were comparatively low in each reservoir. The variability of CH4 concentration was linked to geographical position, which we ascribe to hot spots of methanogenesis at sites of high sediment deposition, such as river inflow areas. The variability of CO_2 concentration seemed instead rather to be linked to in-situ metabolism. Also the gas exchange velocity varied pronouncedly in each reservoir, but without any detectable systematic patterns, calling for further studies. We conclude that accurate upscaling of reservoir greenhouse gas emissions requires accounting for within-reservoir spatial variability, and that the anthropogenic increase of sediment flux from catchments to downstream reservoirs may be linked to increased reservoir CH4 emission.