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Methodology to assess of methane emission from a tropical hydro reservoir: case of Nam Theun 2, Laos

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The identification and quantification of sources and sinks of greenhouse gases (GHG) have become an important environmental, political and public issue. Some studies show that emission of CO2 and CH4 from inland aquatic ecosystems is in the same order of magnitude as emission from fossil fuel combustion, deforestation and carbon uptake by ocean. Hydroelectric reservoirs have been identified as significant carbon dioxide (CO2) and methane (CH4) contributors to the atmosphere, especially in the tropics. So far, studies on tropical hydroelectric reservoirs were only conducted in South America and no information was available from Asia, which is the place of around 68% of reported dams. Assessing these emissions and their underlying processes represent important challenges in our understanding of surface atmosphere interaction and climate surface feedbacks. In this context, our main objective is to quantify the annual net GHG (CO2, CH4 and N2O) budget (production, consumption, and emission) from the subtropical Nam Theun 2 Reservoir (NT2, Lao PDR).

The present abstract focuses more precisely on the methodology applied to determine CH4 budget in the reservoir. It presents a set of data obtained during a first field campaign after reservoir impoundment (May 2009). The sampling strategy included three different types of flux measurement techniques: floating chambers, submerged funnels, and a micrometeorological station allowing for flux determination based on the eddy covariance technique. A total of 7 different sites and 26 measurements with floating chambers were performed for diffusive fluxes. Set of ten submerged funnels were successively placed in 6 different sites, covering water depth from 0.5 to 10m, to capture bubbles. Eddy covariance system, composed by a 3D sonic anemometer coupled with a cavity ring-down spectroscopy (CRDS) analyser, was deployed in a large surface of open water corresponding to an homogeneous ecosystem (floodplain) before the impoundment. Eddy covariance techniques allows for the determination of fluxes for large areas, about 0.4 km^2 in our case (in relation with the measurement height above the water surface). It provides automatically half-hour mean fluxes, but those data need to be post-processed to take into account corrections, especially in terms of frequency. To knowledge, this is the first time that a CRDS analyzer is deployed to quantify CH4 emission above an hydro reservoir, nor any other kind of water body.

First results from the field campaign show diffusive fluxes measured by floating chambers in the order of 1.2 [U+F0B1] 1.35 mmol/m2/day. Bubbling fluxes of CH4 were found to be highly sporadic and water depth dependable (decreasing with water depth). Mean values of CH4 fluxes were 2.5 ± 2.7 mmol/m2/day, with bubbles made by up to 100% of CH4. A comparison of the three techniques, i.e. floating chambers, funnels and eddy covariance technique was performed. After frequency correction, which can represent up to 20% of the flux, eddy covariance technique gave a mean emission of 3.8 mmol m-2 day-1. This is very consistent with the sum of the two terms measured independently (1.2+2.5 = 3.7 mmol m-2 day-1), indicating that the eddy covariance system picks-up both diffusive and bubbling fluxes from the reservoir, which is a very new and encouraging result. Next step will be to deploy the eddy covariance technique for different levels of the water in the reservoir. This will allow to assess the effect of pressure dropping in the water column on total quantity (through bubbling or diffusion) of CH4 emitted at the water surface. Eddy covariance will also be used at the end of the next dry season (June 2011) to estimate the CH4 emission from the drawdown area which could represent up to 370km^2 at that time. From the seasonal and spatial variability of fluxes, the final step will be to assess the quantity of methane released annually by the reservoir. This will also include two more terms, that is methane degassed by the turbines, and methane diffused downstream, evaluated separately.