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Interactive comment on "The riverine source of tropospheric CH_4 and N_2O from the Republic of Congo, Western Congo Basin" *by* Robert C. Upstill-Goddard et al.

Anonymous Referee #1

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General comment

Upstill-Goddard and colleagues report a valuable data-set of CH4 and N2O in the Congo basin in the Republic of Congo (ROC).

Major comment

I suggest that the authors make their data-set public as a supplement of the paper. Considering the enormous range of (spatial and temporal) variability of CH4 (and to a lesser extent of N2O) in freshwaters, there is a need to compile and aggregate available data-sets to revise and update CH4 fluxes from inland waters. This is only possible if an open data access attitude is adopted by the community.

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Specific comments

L 47 : Alternative explanations have been proposed, such as related to agriculture (Schaefer et al. 2016) or fossil fuel (Rice et al. 2016), that differ from the explanation from Bousquet et al.

L 59 : This is not correct any more in the light of the paper by Stanley et al. 2016.

L 60 : It could be useful to mention that there's a discrepancy in bottom-up and top-down estimates of CH4 fluxes (Saunois et al. 2016), hence the comparison of Bastvinken et al. estimates with those of Kirschke et al. might be biased by the fact that they were derived by different and possibly incompatible methods.

L 171 : This explanation for the seasonal variations of DIN is surprising given these are near pristine watersheds due to the low population density in ROC and the absence of intensive agricultural practise (based on artificial fertilizer) and major industrial activities. Seasonal variations of DIN are likely due to surface run-off in the wet season and groundwater flow in deeper soil horizons in the dry season.

L 240-264: The existence, in rivers and wetlands, of high levels of CH4 in oxygenated waters is not "enigmatic" nor "counterintuitive" as stated. This has been shown and explained for decades for instance in the Amazon (Richey et al. 1988), and is related to methane production in the anoxic sediments of river-beds and floodplains that diffuses into aerated river water. In shallow and low turbulent "swampy" waters such as those sampled, the diffusion of CH4 from river sediments is stronger than loss terms in the water by oxidation or evasion to the atmosphere, leading to an accumulation of CH4 in the water (even in the presence of more or less large quantities of O2). This is fairly straightforward and intuitive, in rivers with a probable depth between 1 and 5 m, hence, in close contact with organic rich sediments. There is no need to use exotic hypothesis related to DMS(P) cycling (Dam) or methylphosphanate (Karl) that were developed for the ocean, where the occurrence of CH4 in oxygenated waters located hundredths to thousands of meters away from the seabed is indeed "enigmatic", hence, the so called

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"oceanic CH4 paradox". Further, most of these hypothesis rely on a more or less direct production of CH4 linked to phytoplankton (e.g. Grossart). However, phytoplankton is nearly absent in tributaries and wetlands of the Congo (Descy et al. 2016).

L 276: Please use the term "Pool Malebo", the term "Stanley Pool" has been abandoned since colonial times.

L 289-308 : Seasonal variations of CH4 in floodplains has been relatively well described in the Amazon varzeas (Devol et al. 1990).

L348-349: Rates of nitrification can exceed denitrification in NH4 enriched temperate rivers such as the Mississippi studied by Richardson et al., however this does not necessarily apply in DIN poor tropical rivers where as stated NO3 dominates the DIN pool.

L 357 : If the authors envisage all possible CH4 sources in marine and freshwater environments then CH4 has more diverse sources that N2O. However, the only documented CH4 sources in tropical rivers are methanogenesis in riverbed and floodplain sediments.

L 363-365 : The cited range of CH4 and N2O fluxes correspond to the basin average values and not the full range of individual CH4 and N2O flux estimates for each of the 12 river basins.

The range of CH4 fluxes for all individual estimates across the 12 rivers studied by Borges et al. (2015) is 0 to 274,600 μmol/m2/d for Aufdenkampe K estimate and 0 to 461,967 μmol/m2/d for Raymond K estimate. This range in fact corresponds to the one of the Congo that encompasses the data from all other African rivers.

The range of N2O fluxes for all individual estimates across the 12 rivers studied by Borges et al. (2015) is -30 to 299 μmol/m2/d for Aufdenkampe K estimate and -37 to 377 μmol/m2/d for Raymond K estimate. This range in fact corresponds to the one of the Congo that encompasses the data from all other African rivers.

L 375 : Hence, statement that the range of CH4 and N2O fluxes from rivers ROC is wider than previously reported for African rives is incorrect and is based on the comparison of individual estimates in ROC to the basin averaged values reported by Borges et al. (2015).

L 382 : I suggest to limit this comparison to rivers that are more turbulent than lakes, hence, diffusion is likely to dominate over ebullition (unlike lakes) due to higher gas transfer velocities and lower settling of organic matter in sediment compared to lakes. In rivers, CH4 diffusion:ebullition data from Congo and Zambezi (Borges et al. 2015) converge with data in the Amazon (Sawakuchi et al. 2014).

L 370 : Is there a point to the comparison with Canadian boreal rivers ?

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