Constraining the role of the surface microlayer in tropical riverine headwaters of Amazonia

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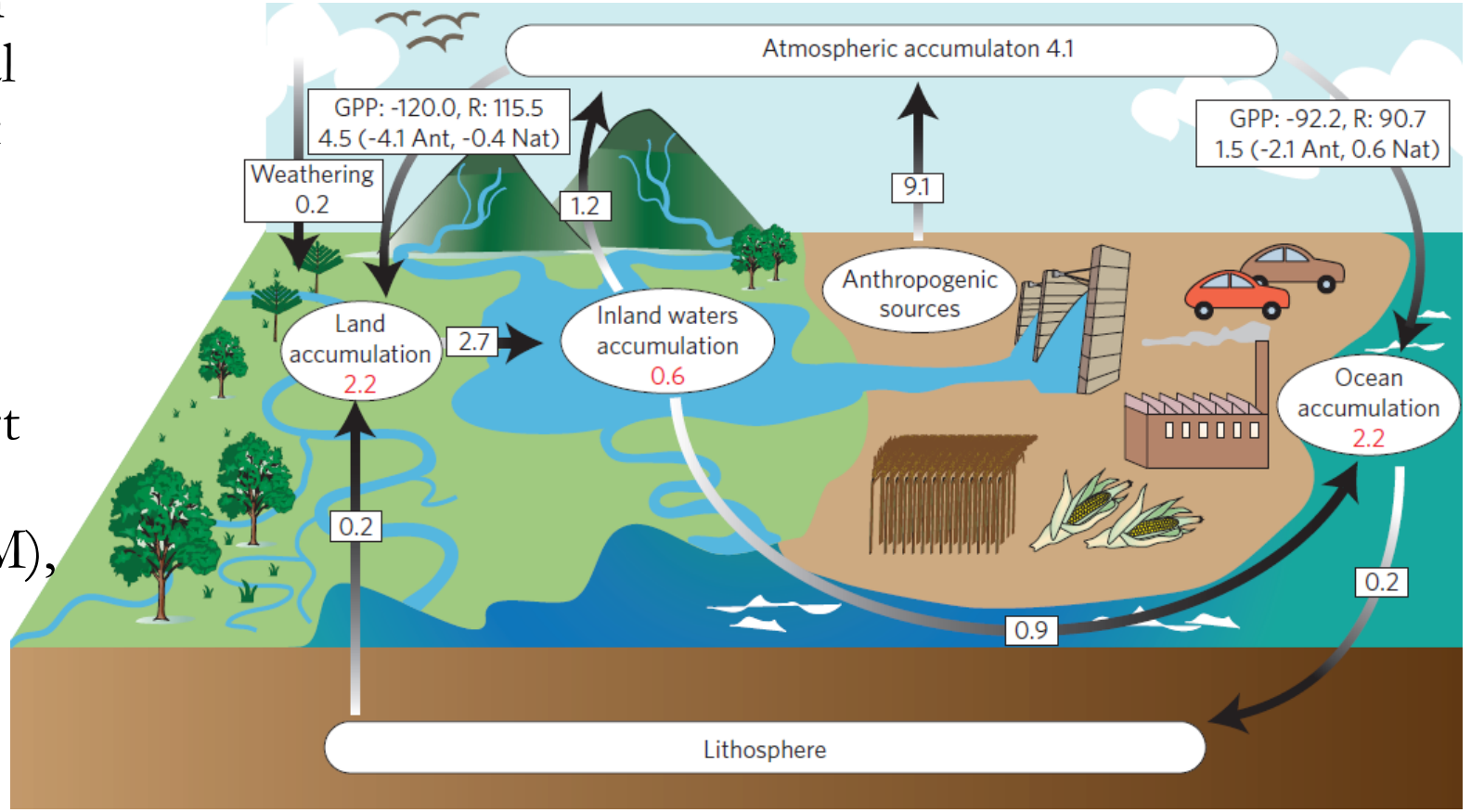
Introduction

- The exchange of CO_2 between atmosphere and water is critical for predicting its global budget and effect on climate change

- Tropical river systems transport and recycle large amounts of dissolved organic matter (DOM), major source of CO_2 to the atmosphere



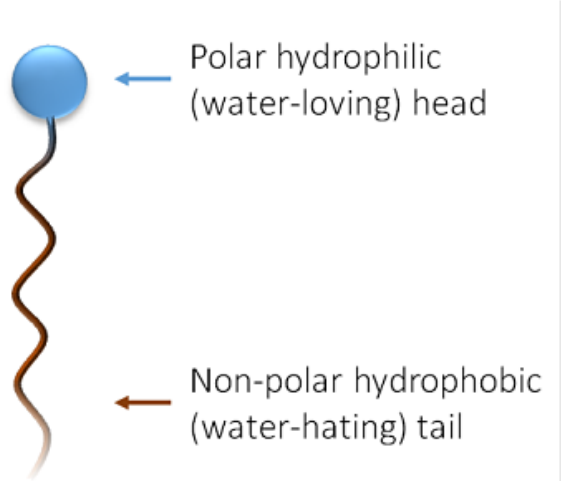
(Battin et al. 2009)

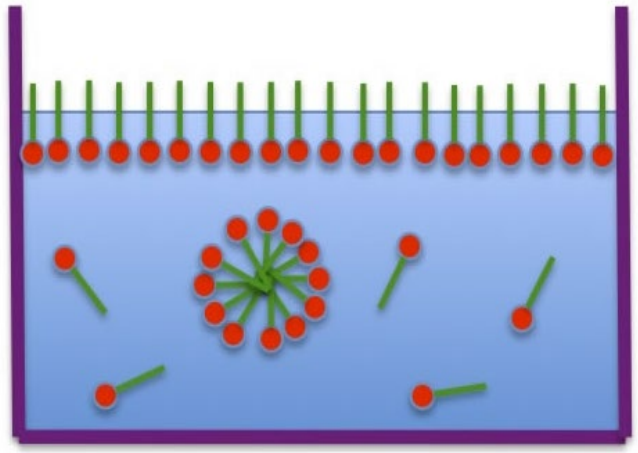
Introduction

- A large fraction of DOM can be surface-active (surfactant)

- Surfactants can effectively suppress gas transfer velocity (k) over a wide environmental range *(Salter et al., 2011; Pereira et al., 2016)*

- There is a lack of empirical evidence on gas transfer rate between water and atmosphere in tropical headwaters *(Raymond et al., 2013)*



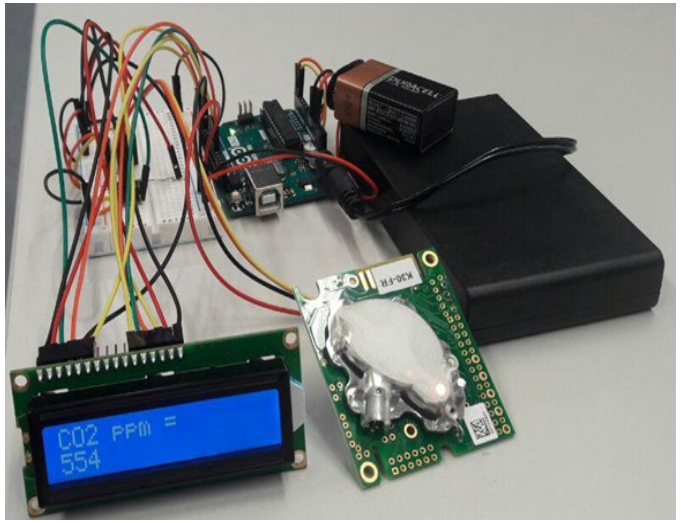


Iwokrama Rainforest, Guyana, South America

- Essequibo River is one of the largest rivers in the South America
- Blackwater Creek, a second-order headwater of the Essequibo River

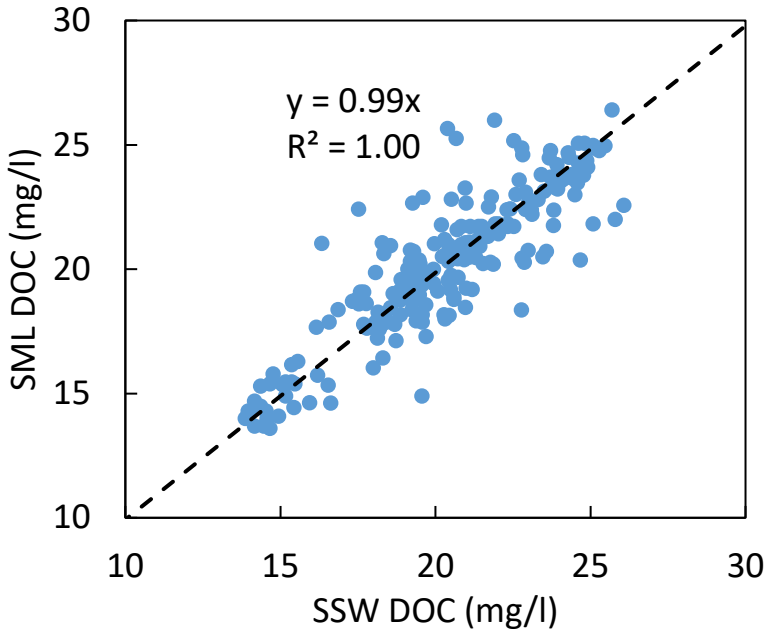
Methodology

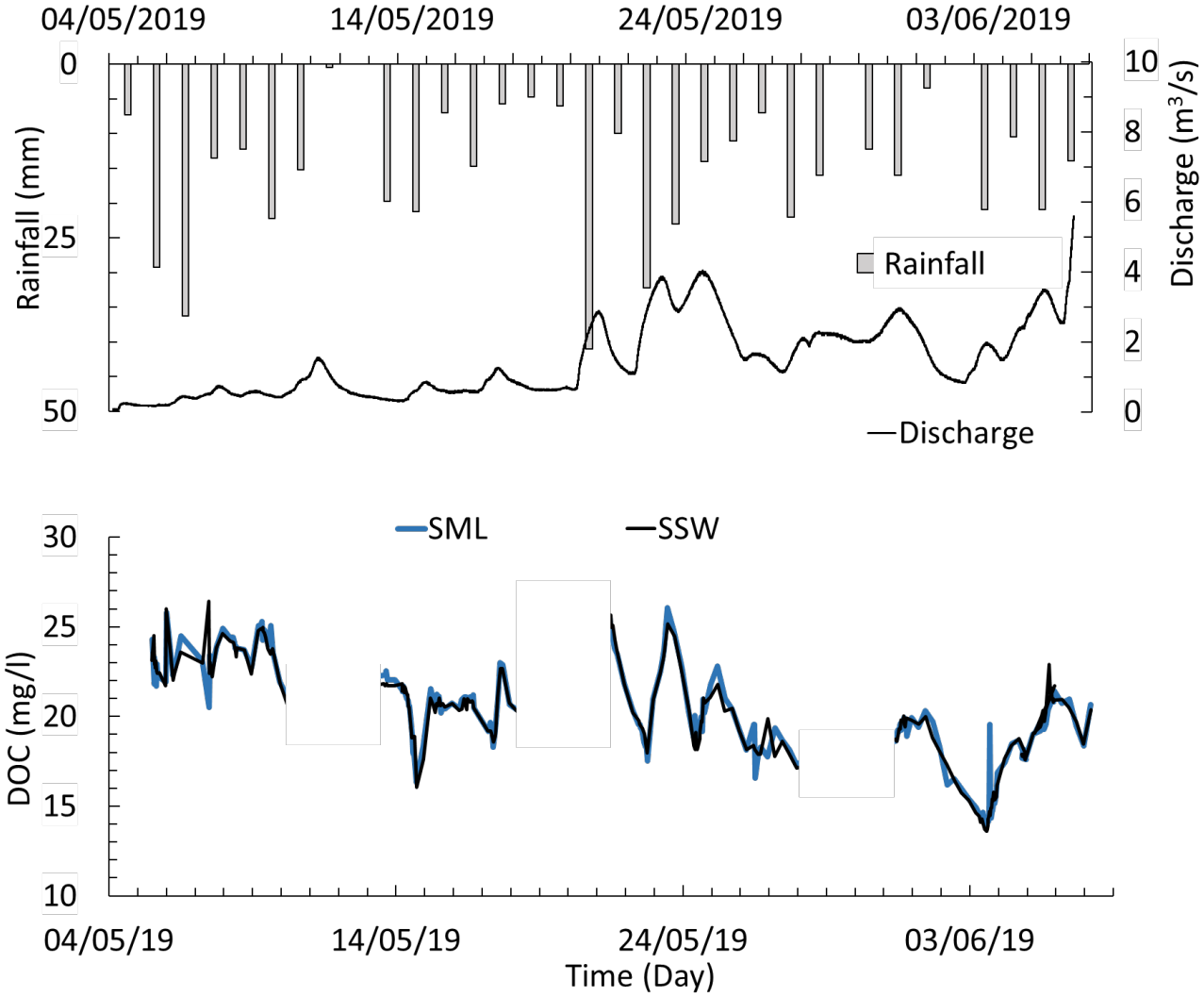
- In situ water quality measurements at least every 6 hours
- Surface microlayer (SML) and subsurface water (SSW) sampling
- Relative CO_2 concentration measurements in water and atmosphere in the field
- Dissolved Organic Carbon (DOC) and UV-absorbance spectrophotometry (Coloured DOM (CDOM)) analysis



Temporal variability of river DOC concentration

- Hydrological changes during the transition from dry to wet season
- Rain events drive short term fluctuation
- SML of the Blackwater Creek is not enriched in DOC

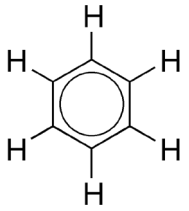




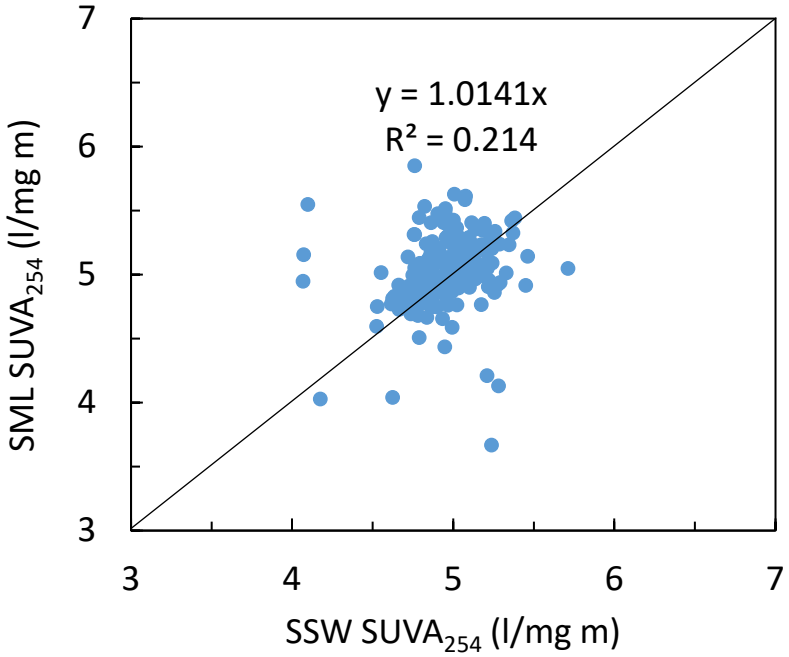
SML and SSW compositional similarities and differences

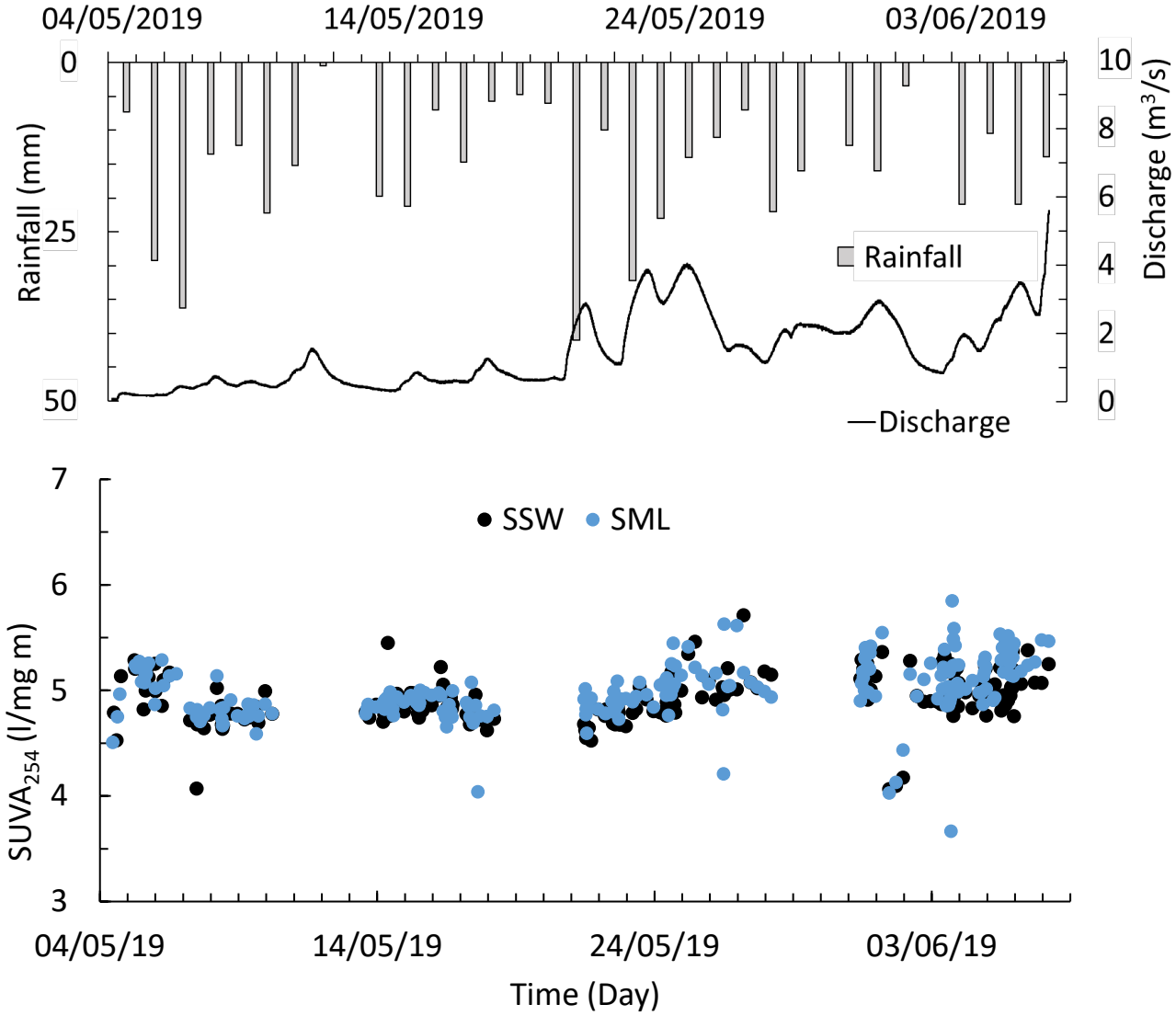
- Specific UV absorbance:

$$SUVA_{254} = \frac{A_{254}}{DOC}$$



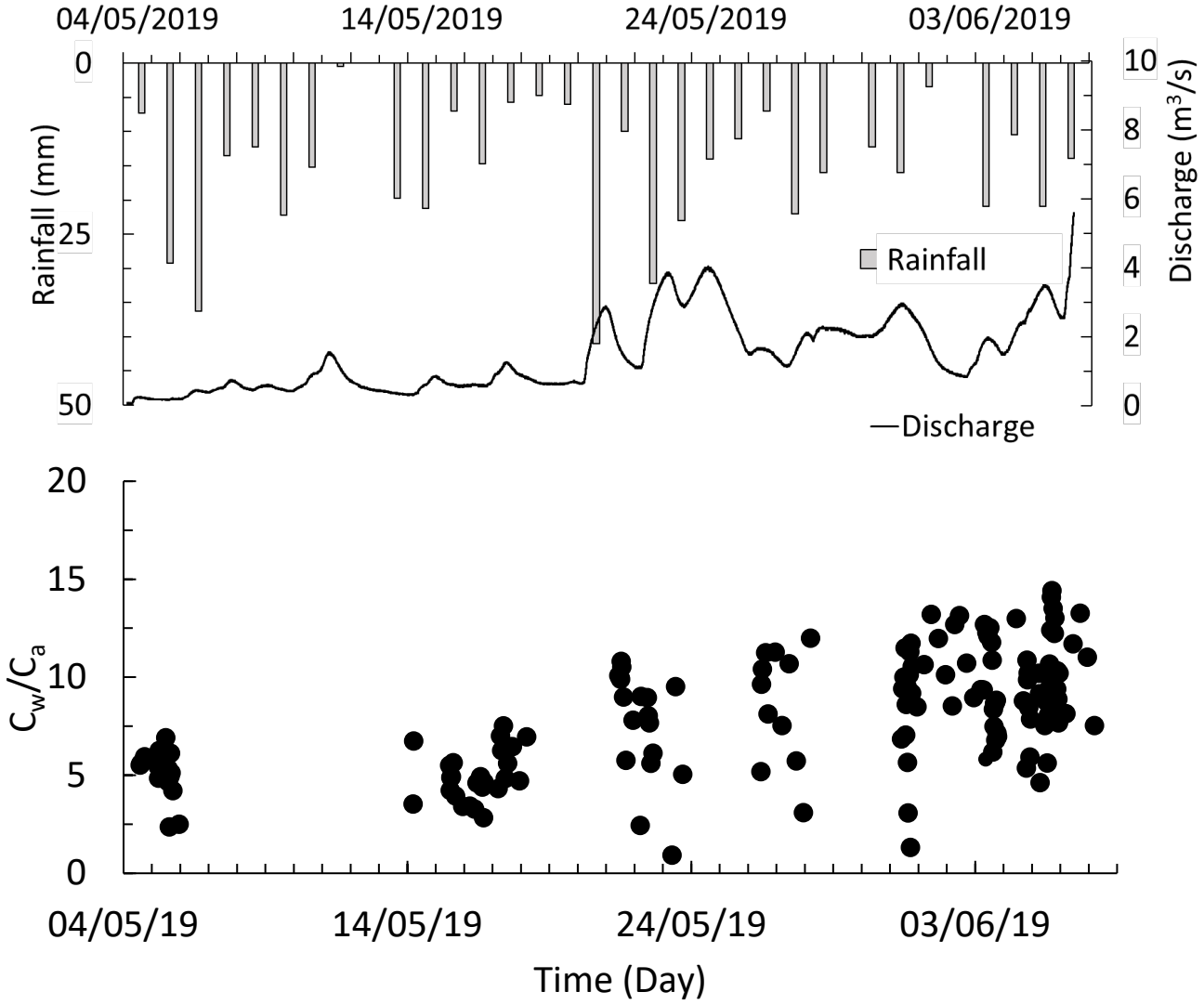
- The aromaticity of the DOC in SML and SSW is different





CO_2 concentration in river and atmosphere

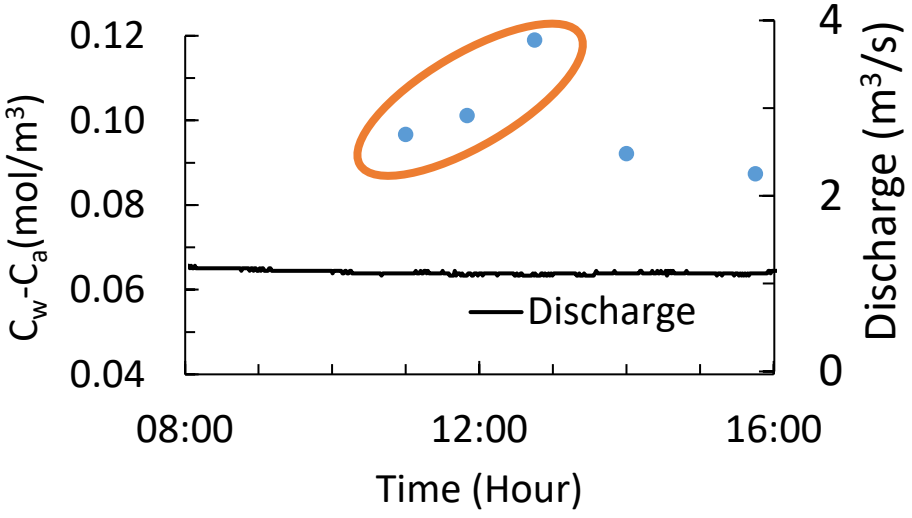
- The CO_2 concentration is higher in river water than the atmosphere
- On average, the CO_2 concentration in water is **8** times of the CO_2 concentration in atmosphere
- The CO_2 concentration in water to air ratio increases in the transition from dry to wet season



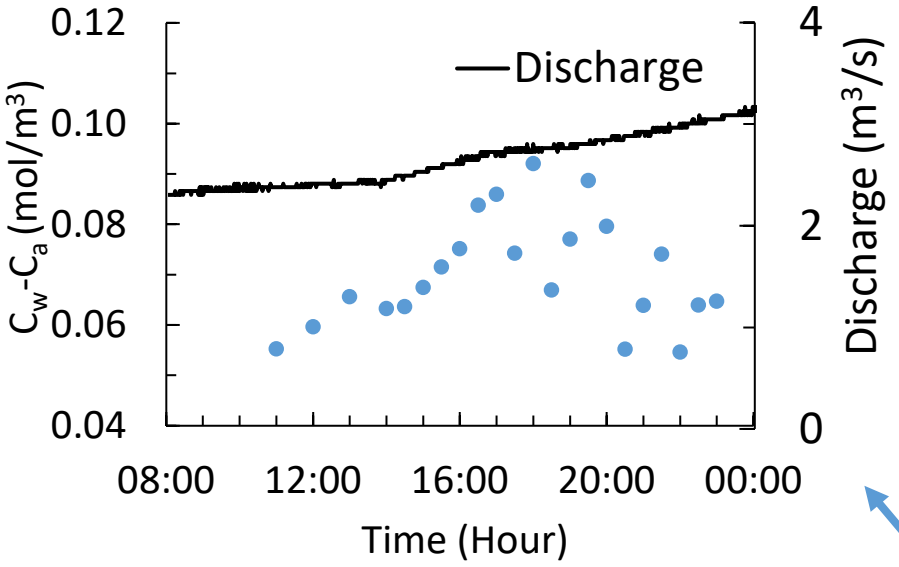
Signal and noise in CO_2 concentration difference

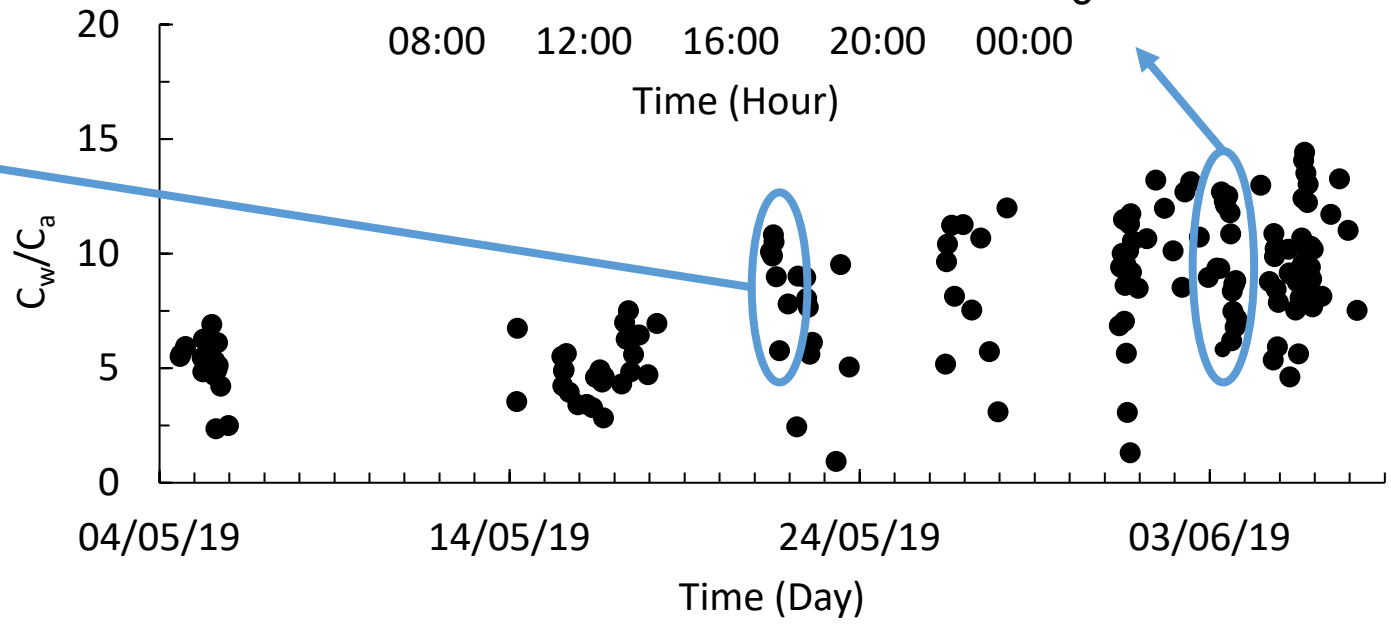
- The variability of the water and atmosphere CO_2 concentration is not because of the noise in the system

Rain impact



Diurnal cycle impact



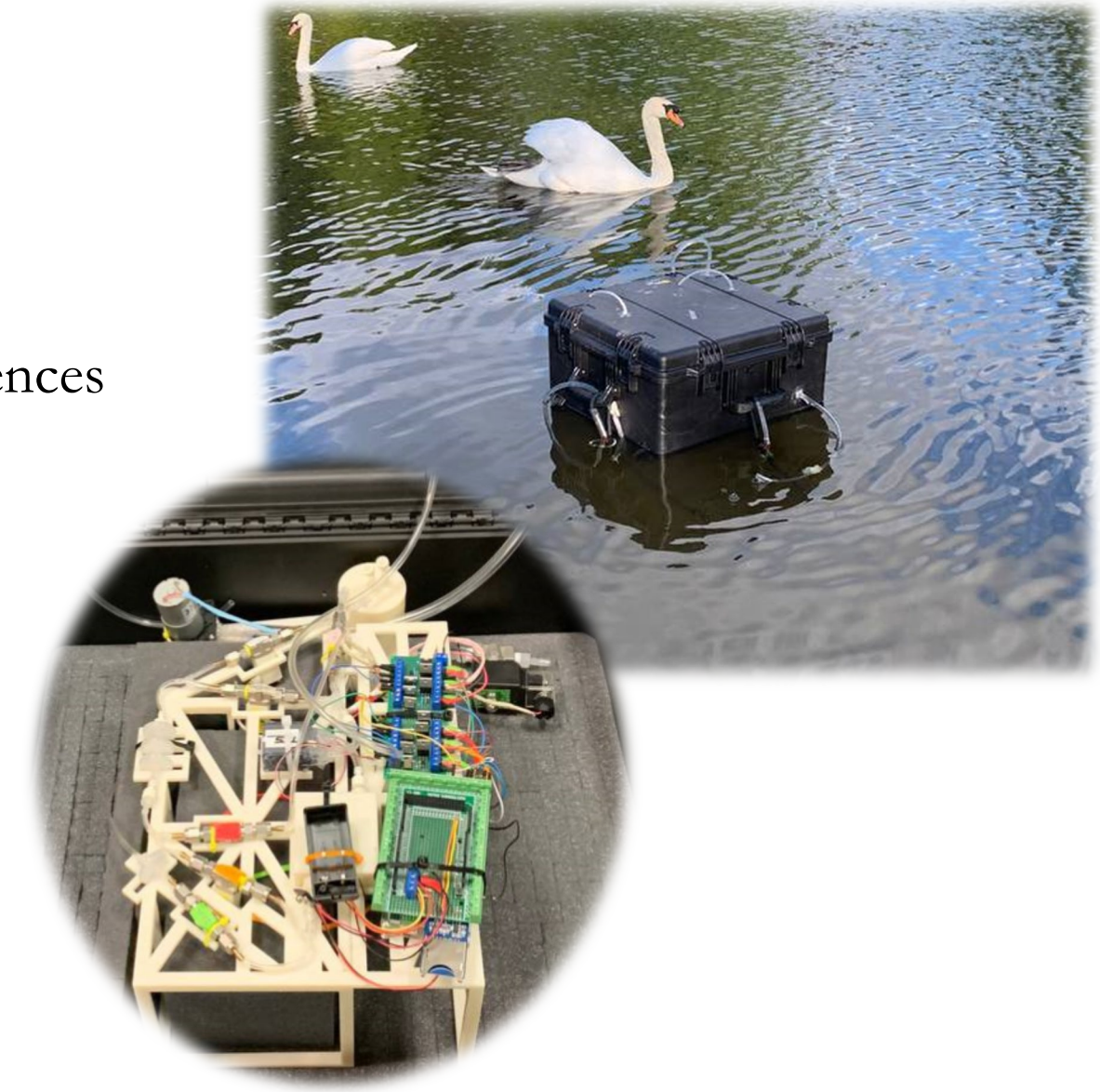


Implications

- The SML is generally enriched in aromatic compounds while DOC concentration appears uniformly distributed
- We show headwaters have great potential for outgassing CO_2 with up to 13 times more CO_2 in the water than atmosphere and this is variable in response to diurnal cycles and rain events
- The CO_2 concentration ratio in water to atmosphere is similar to previous estimates in larger Amazonian rivers *(Borges et al 2015; Alin et al 2011)*

Next steps

- The impact of presence of aromatic components on *k*
- Greater temporal resolution is required to assess the impact of compositional differences in SSW and SML on *k*
- As a result we have developed automated sensor platforms for CO_2 concentration measurement in water and atmosphere



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