Carbon dynamics and greenhouse gas exchange in Papyrus (*Cyperus papyrus L.*) dominated wetlands in the Lake Victoria region (Kenya)

Contributors:

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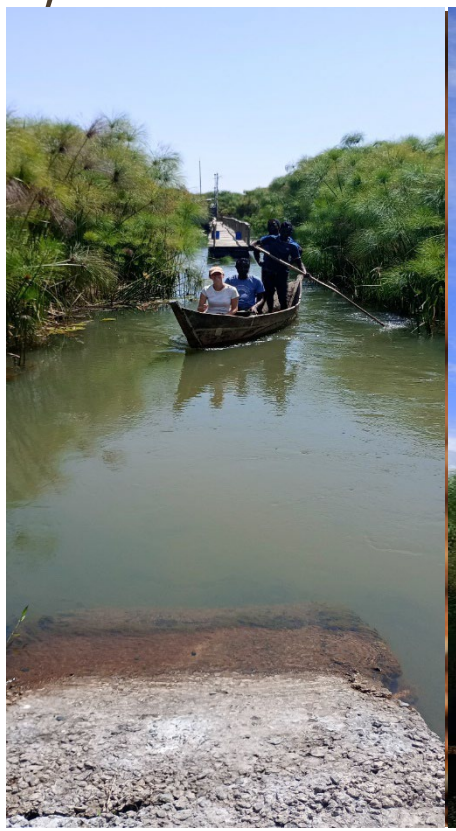
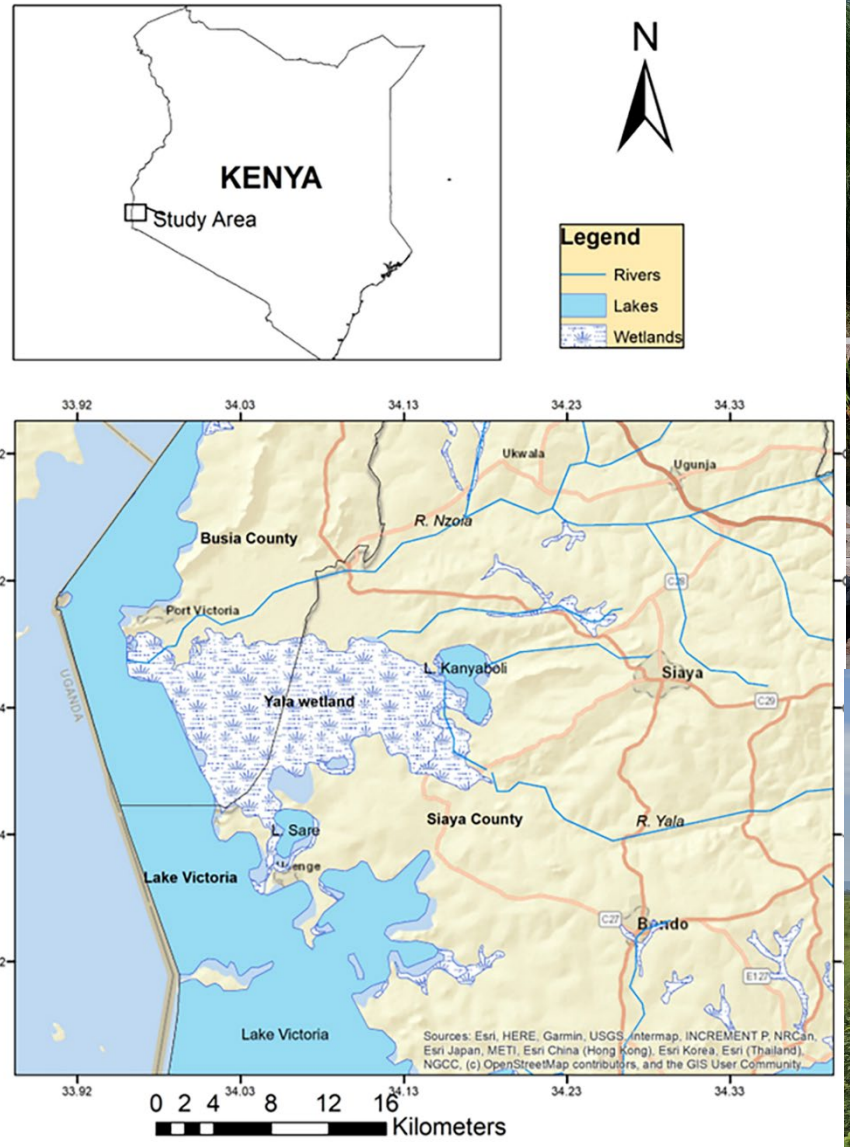


Study area: Yala swamp lake Victoria



Source: Githiora *et al.*, 2023

- **Largest freshwater wetland within Kenya**
  - Area coverage of the wetland **175 km²**
  - Floating papyrus mats
  - Papyrus rooted in the sediment
- **Threats to the wetland ecosystem**

Objectives

- **Quantify net ecosystem carbon dioxide (CO_2) fluxes** within Yala wetland ecosystem

- **Quantify methane (CH_4) fluxes** arising from sediment ebullition, water-air interface diffusion and plant mediated pathways

- **Estimate carbon stocks in vegetation and sediments,** constrain carbon sources to aquatic and sediment C pools

Seasonal variations of Temperature, photosynthetic photon flux density (PPFD), Precipitation and Net Ecosystem Exchange (NEE)

Period March to August NEE:

Positive:

Mean=23.92 µmol CO_2 m^{-2} s^{-1}

Range [0.05 to 82.10] µmol CO_2 m^{-2} s^{-1}

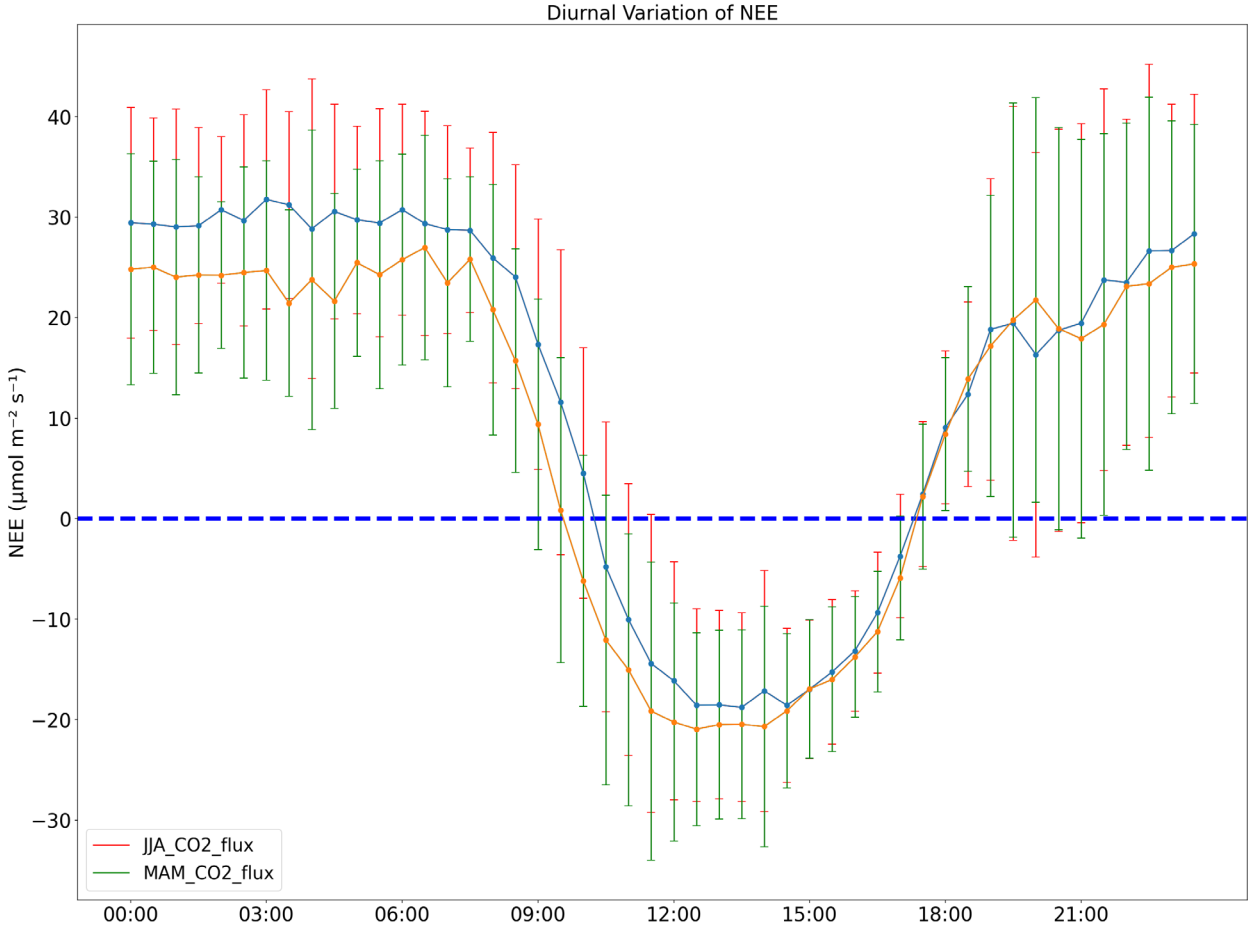
Negative:

Mean= -16.02 µmol CO_2 m^{-2} s^{-1}

Range [-62.78 to -0.01] µmol CO_2 m^{-2} s^{-1}

Period under consideration, NEE is positive

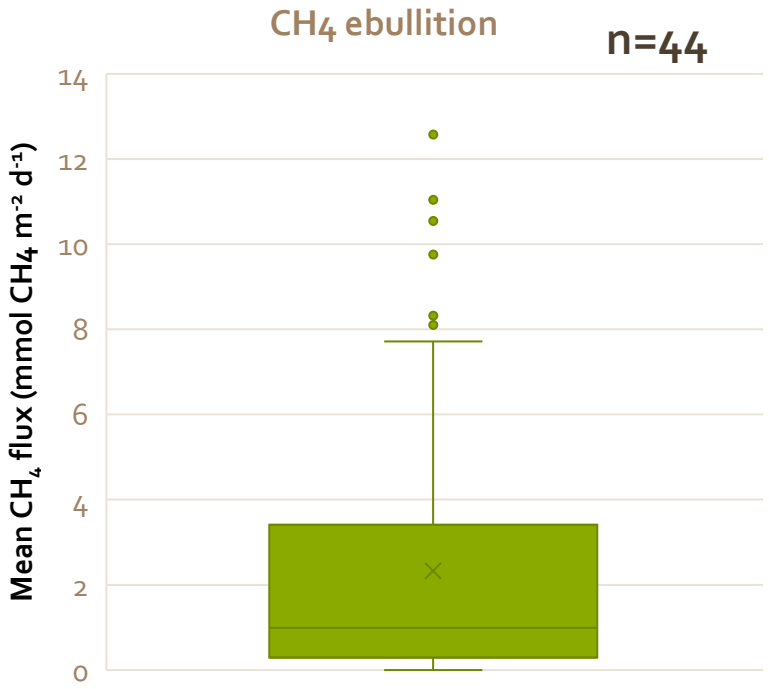
Diurnal Net Ecosystem Exchange

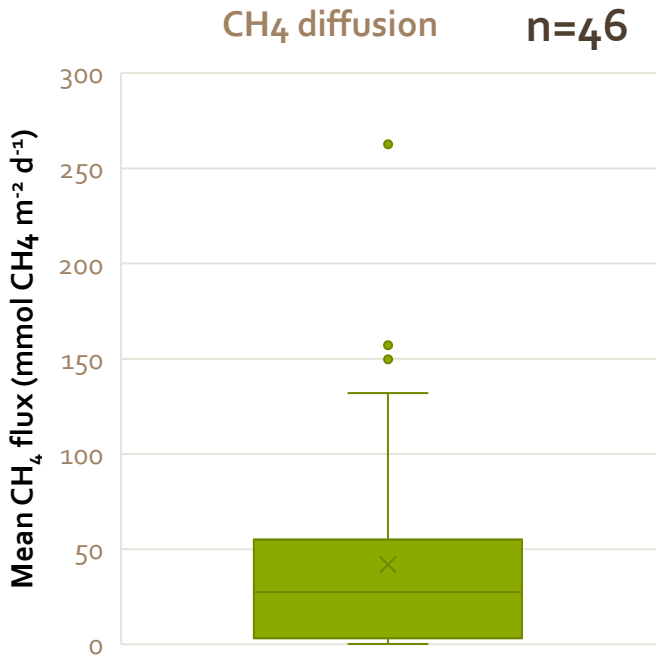


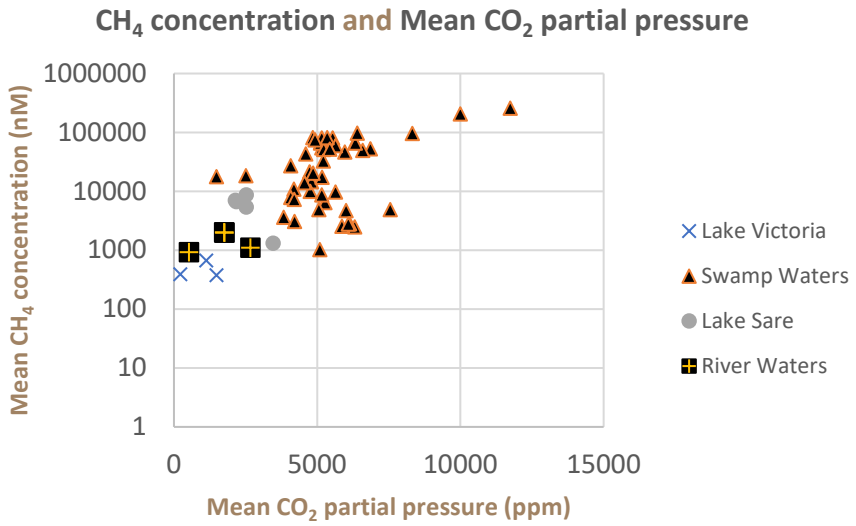
March to August 2025

- Preliminary deduction:
  - During daytime, the swamp acts as a sink for CO2 and at night source
  - Loiselle et al. (2006): Kirinya Uganda (Papyrus dominated): During nighttime 10–15 µmol CO_2 m^{-2} s^{-1} & daytime uptake 35–37 µmol CO_2 m^{-2} s^{-1} (one week data in September)
  - Saunders et al. (2007): Jinja Uganda Peak, midday rates of NEE approximately 40 µmol CO2 m–2 s–1, while night time losses 10 - 20 µmol CO2 m–2 s–1 hence net sink
  - Kariuki (2012): Naivasha Midday CO2 uptake was 24 - 28 µmol CO_2 m^{-2} s^{-1} (Conclusion NEE for the papyrus swamp was positive indicating a carbon source)

Ebullition and Diffusion of Methane

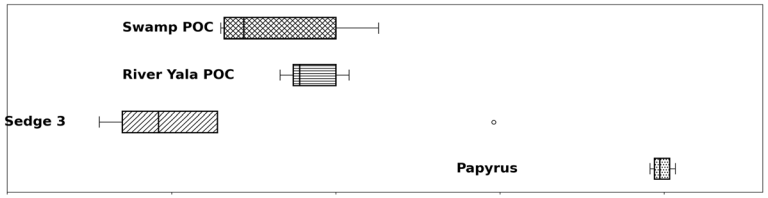


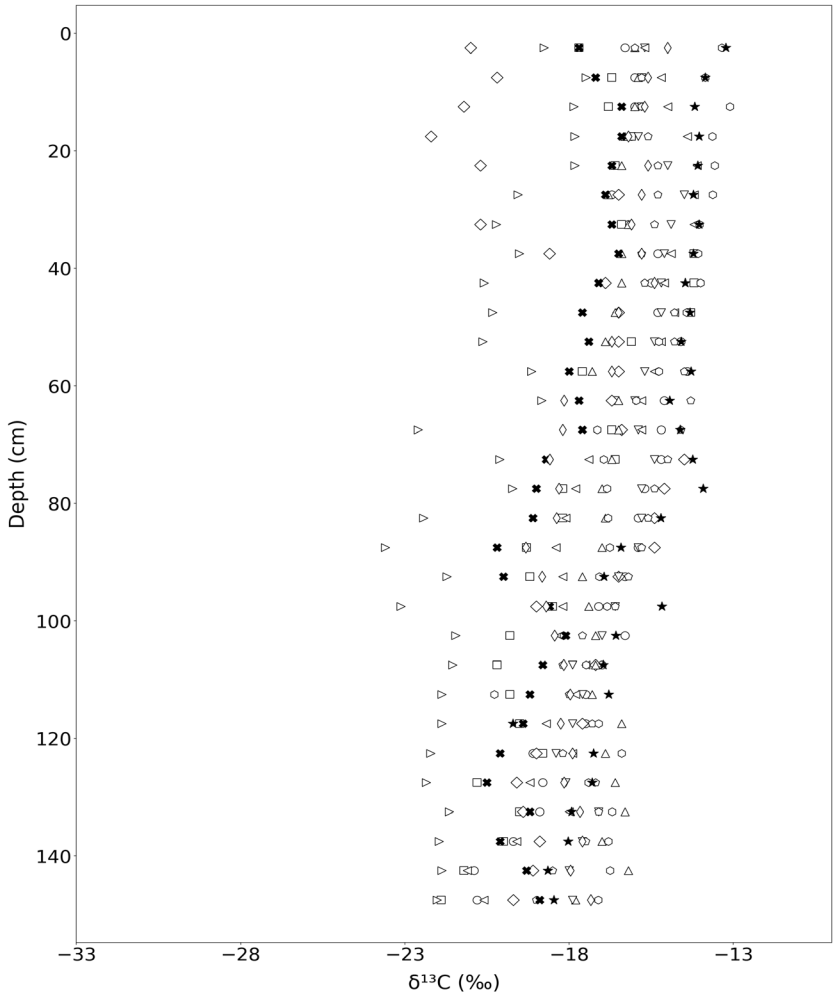




- Median CH_4 ebullition (Sep-Oct) and diffusion fluxes 0.99 and 27.9 mmol m^{-2} d^{-1} respectively
- Gas fluxes dominated by diffusion as compared to ebullition
- Low mean CH_4 concentration in river while swamp waters have highest concentrations

Spatial variation $\delta^{13}C$ in the sediment





○ d13C_Core4 △ d13C_Core7 ▷ d13C_Core10 ○ d13C_Core12 ✖ d13C_Core14
□ d13C_Core5 ▽ d13C_Core8 ⬠ d13C_Core11 ★ d13C_Core13 ◊ d13C_Core15
◇ d13C_Core6 ◁ d13C_Core9

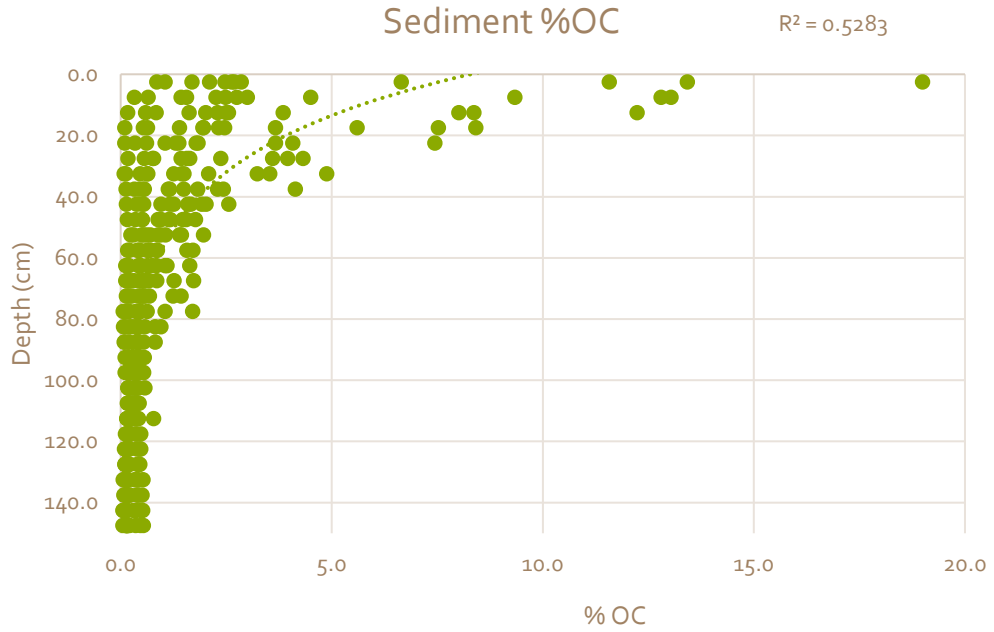
Ranges for C4 within wetland lies -15 to -10‰ while C3 up to -26‰

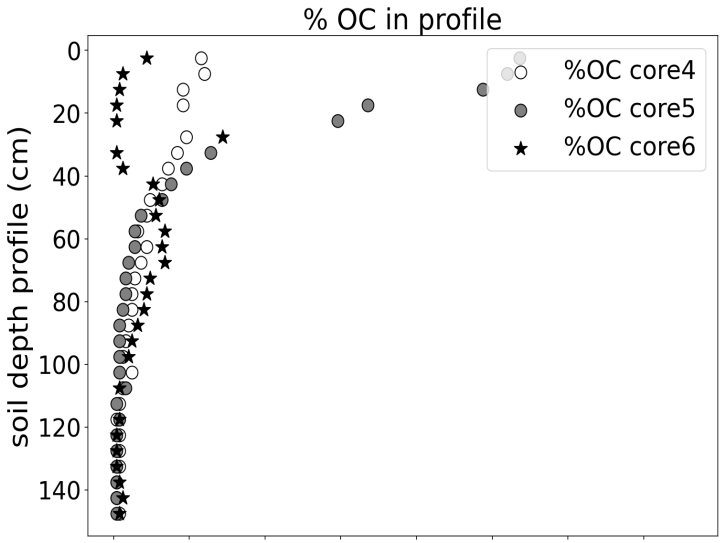
C3 includes Typha and Phragmites while C4 is predominantly Papyrus and Vossia

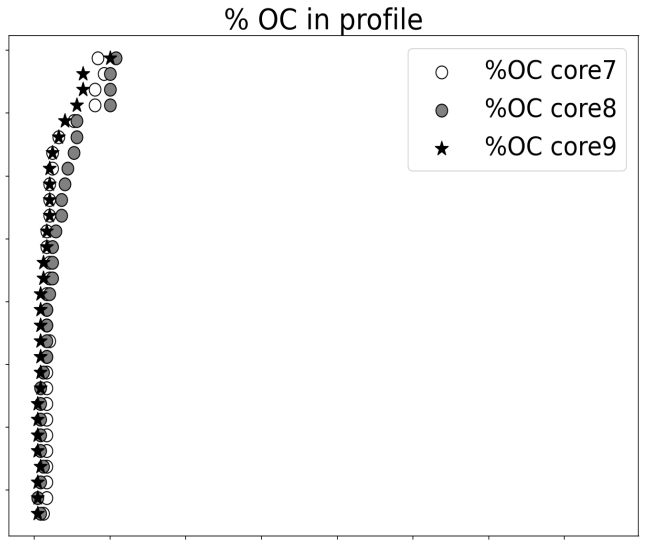
Footprints of C4 predominate in the upper layers (≃40cm) as indicated by $\delta^{13}C$

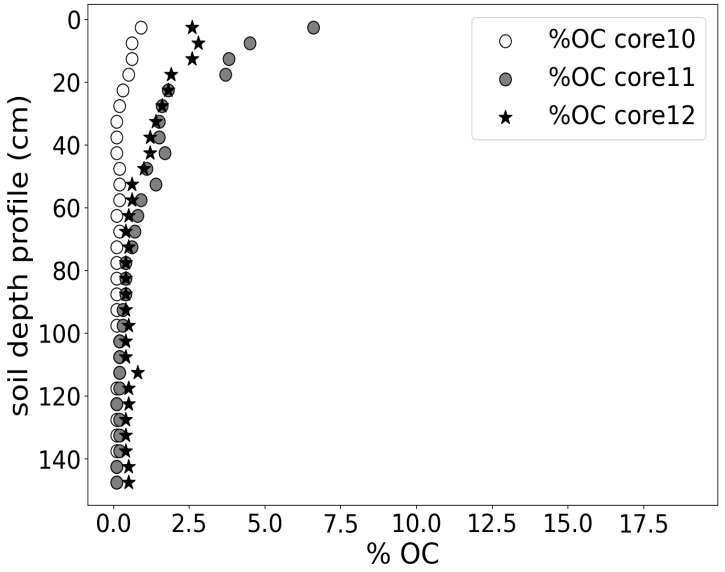
Percent organic carbon in sediment

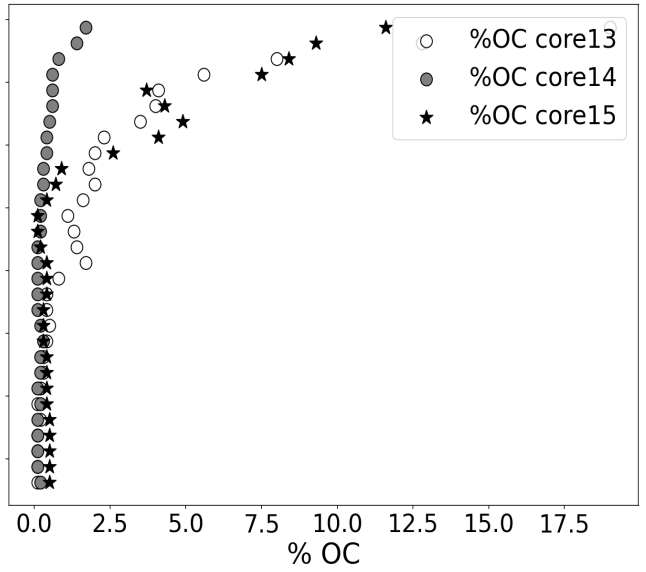
- Up to approximately 40cm is richer OC
- **Vegetation detritus & deposition from overlying water column**
- **R^2 = 0.5283**, about **52 % of the variance** in OC is due to depth











Summary and conclusion

Diurnal shift: swamp is a sink of CO_2 by day, source by night and for the entire period under consideration it's a source as indicated by NEE

CH_4 fluxes dominated by ebullition with the exclusion of plant mediated transfer

C_4 (Papyrus, Vossia) dominate OC inputs, particularly near the surface; deeper layers sedimentary sources dominate OC inputs

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Comments and Questions

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THANK YOU