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Stable carbon isotopic composition of biomass burning emissions – implications for estimating the contribution of C3 and C4 plants

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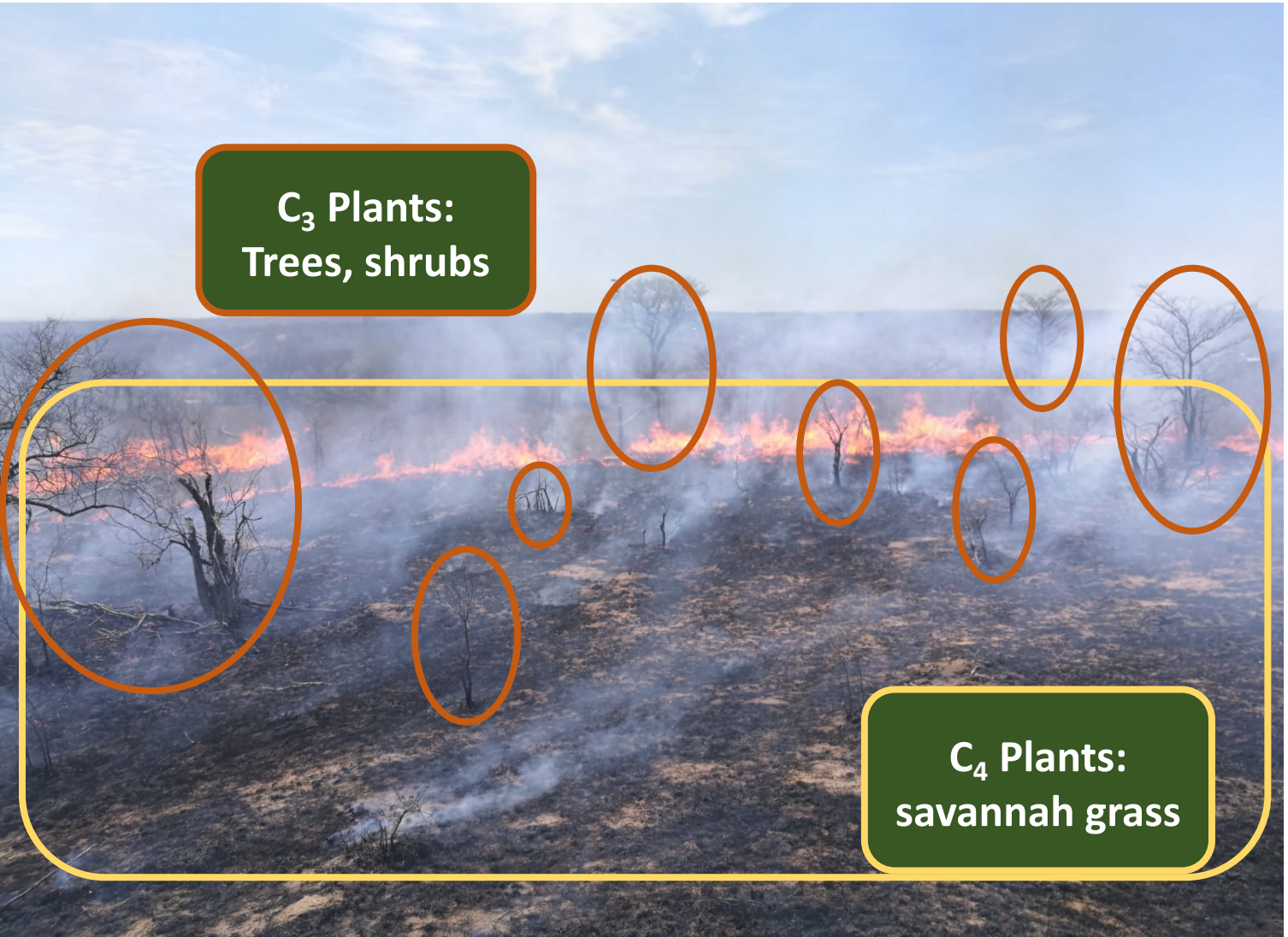
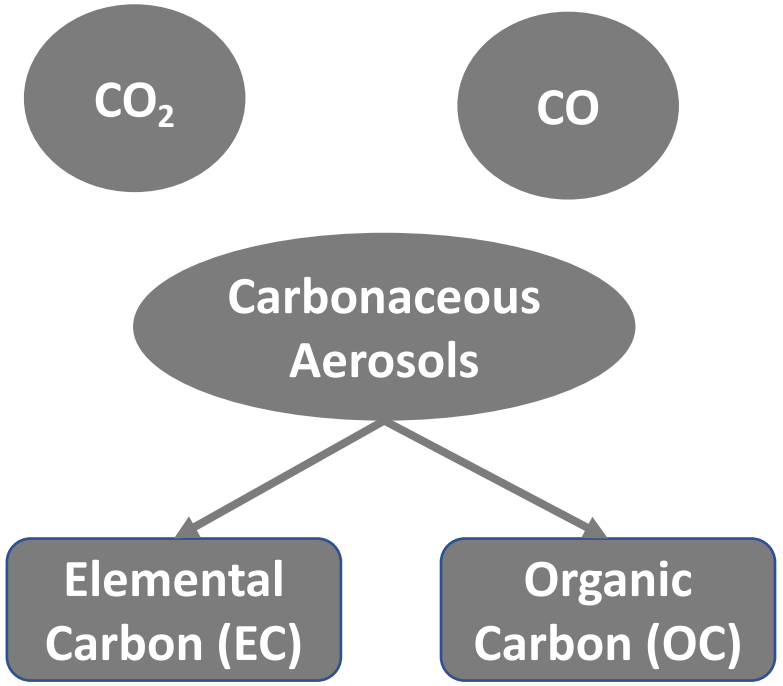
IMAU Institute for Marine and Atmospheric research Utrecht

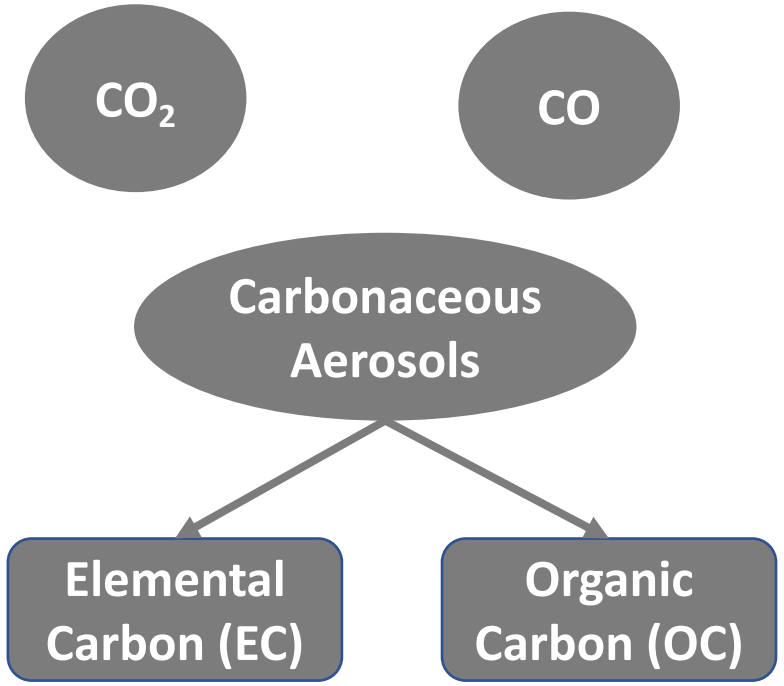
Savannah Fires in Africa





How much of the emissions stem from C3 vs C4 plants?

^{13}C for distinguishing C3 and C4 plants



How much of the emissions stem from C3 vs C4 plants?

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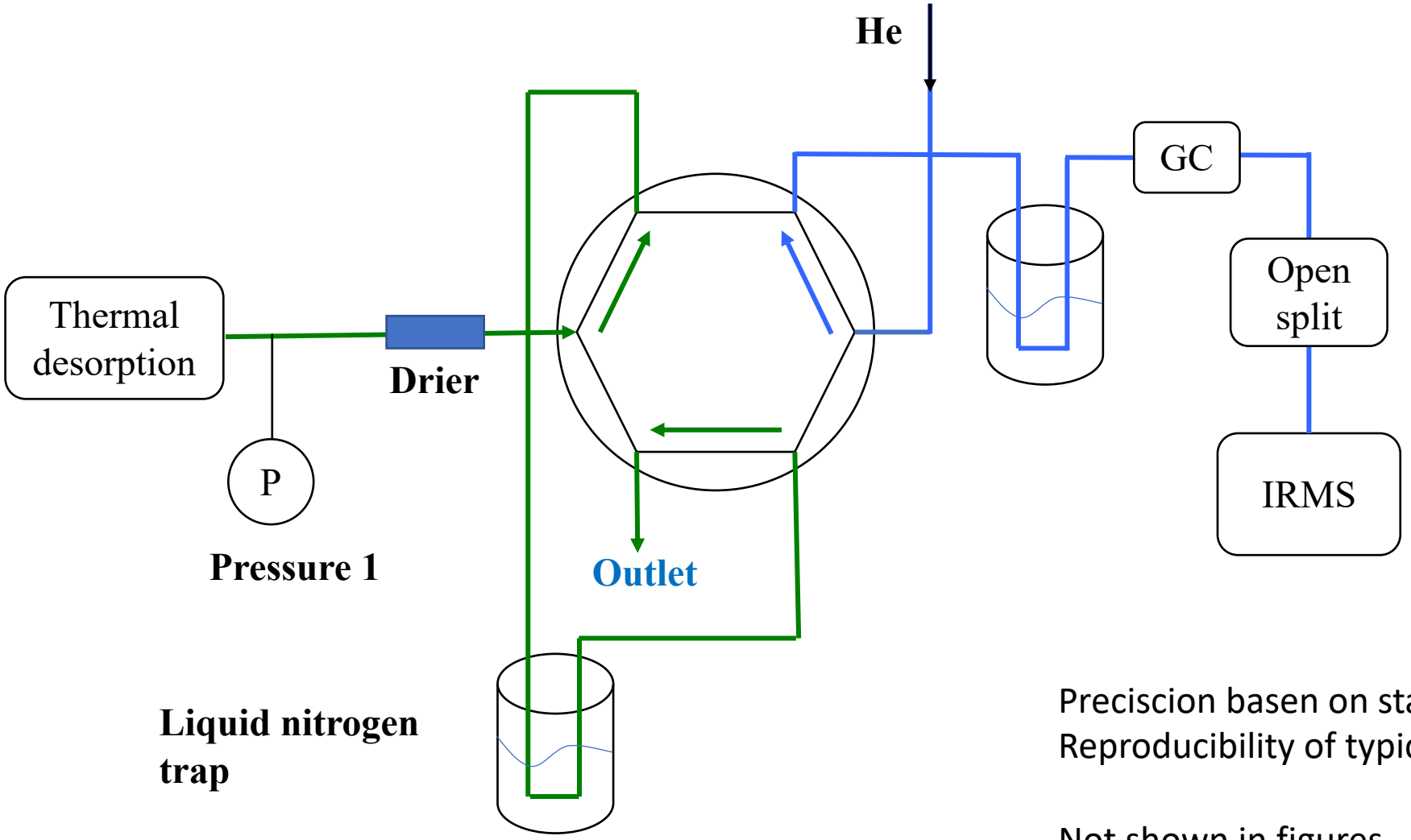
Experimental Setup: $\delta^{13}C$-thermogram system



Organic carbon is desorbed from Filter samples at 3 temperaure steps:

200, 350, 650 °C

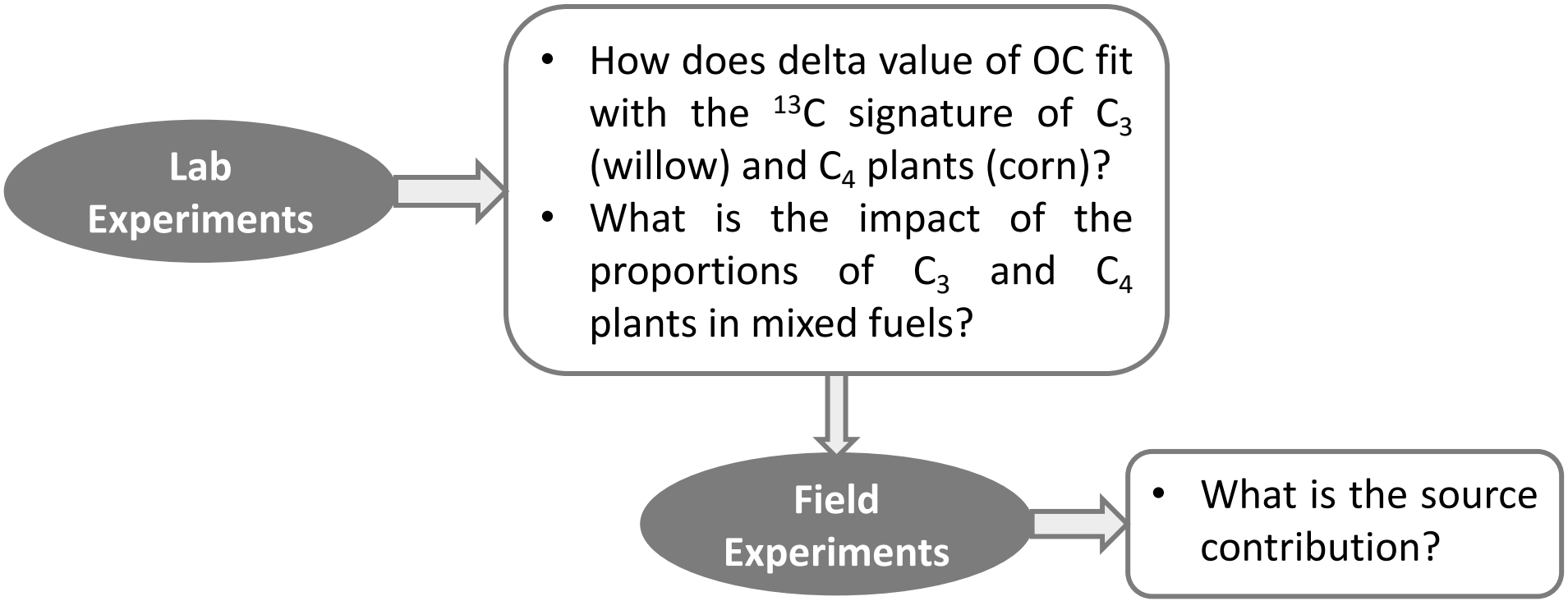
Catalytically converted to CO_2 and analysed for 13C

Preciscion basen on standards: ± 0.2 ‰
Reproducibility of typical samples < 0.3-0.4 ‰

Not shown in figures

Research Question

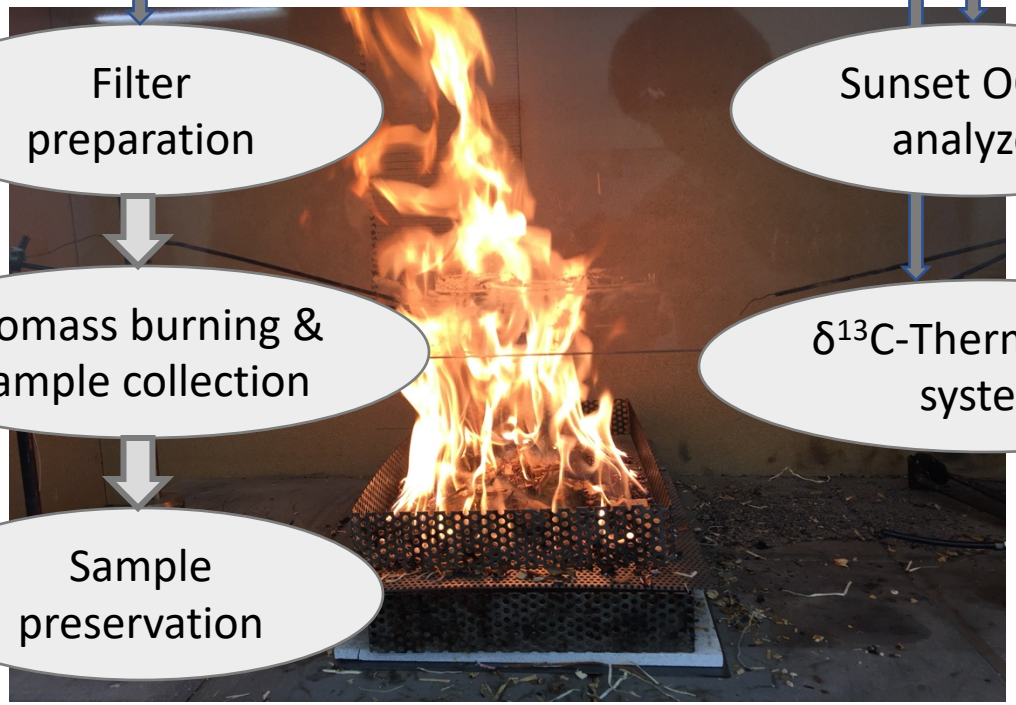
"How do C_3 and C_4 plants in the savannah fires contribute to the ORGANIC CARBON?



Methodology

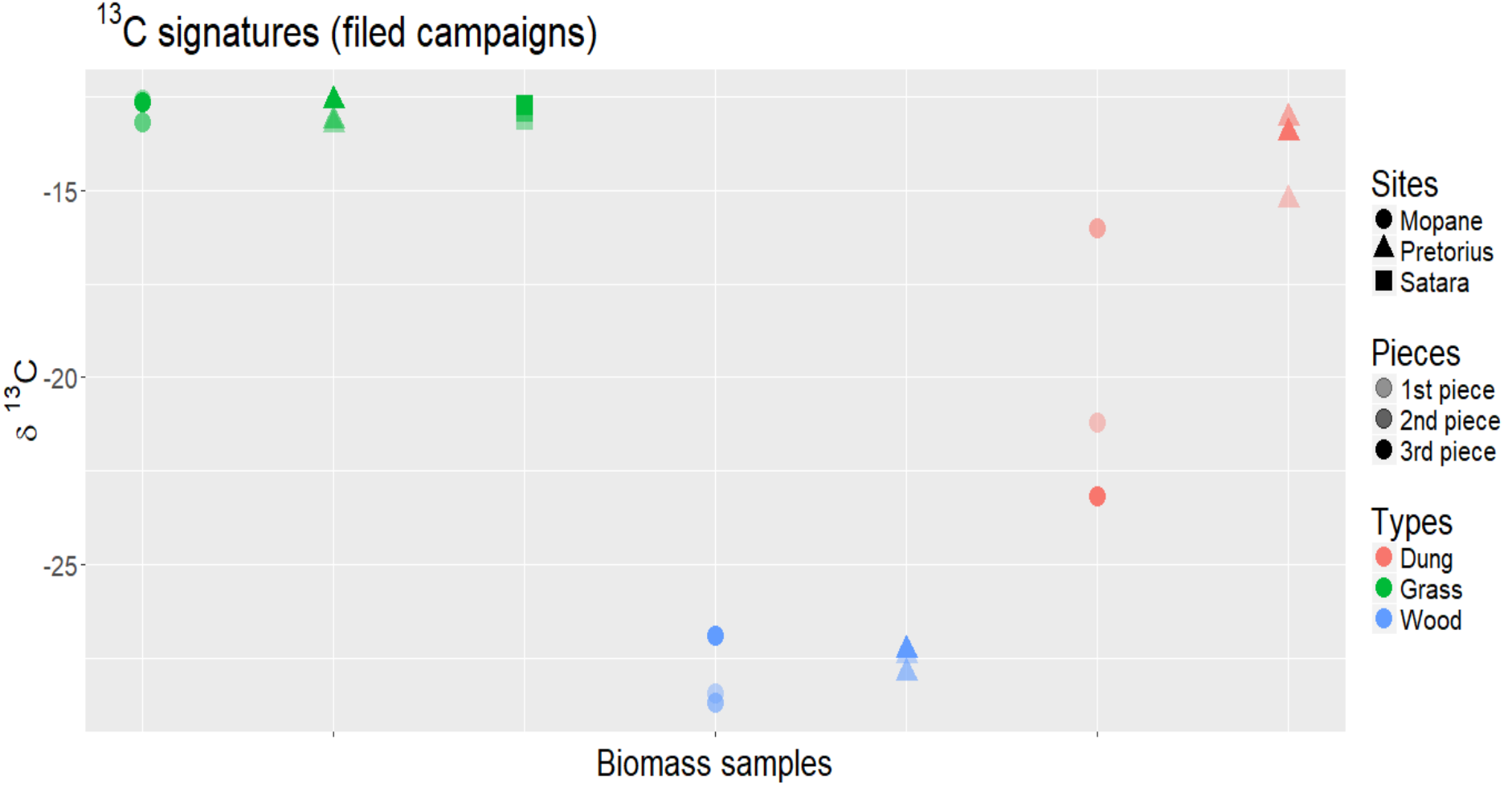
Aerosol sample Collection → **Aerosol sample Measurement** → **Data Calculation & Analysis**

- Filter preparation
- Biomass burning & sample collection
- Sample preservation

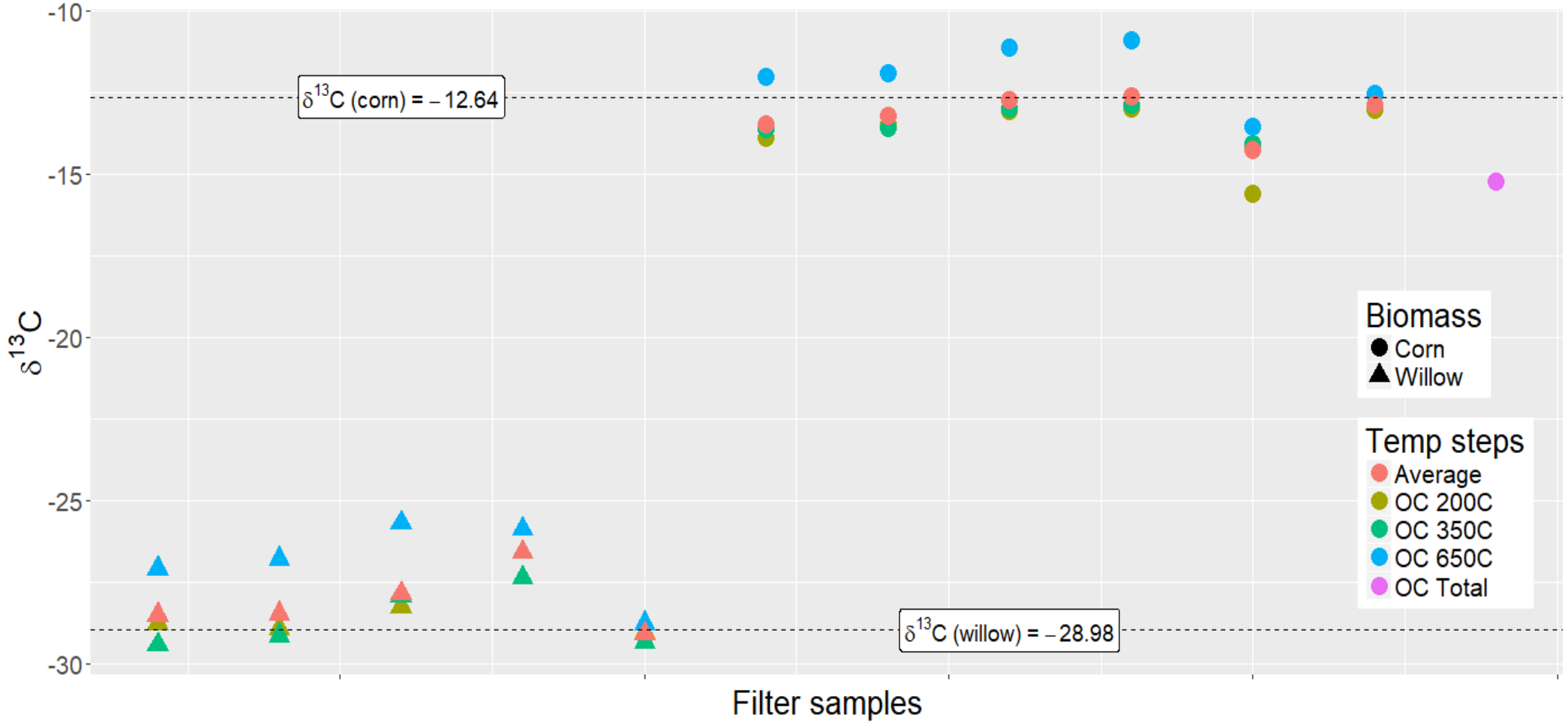


- Sunset OC/EC analyzer
- $\delta^{13}C$-Thermogram system

Overview of African biomass fuels

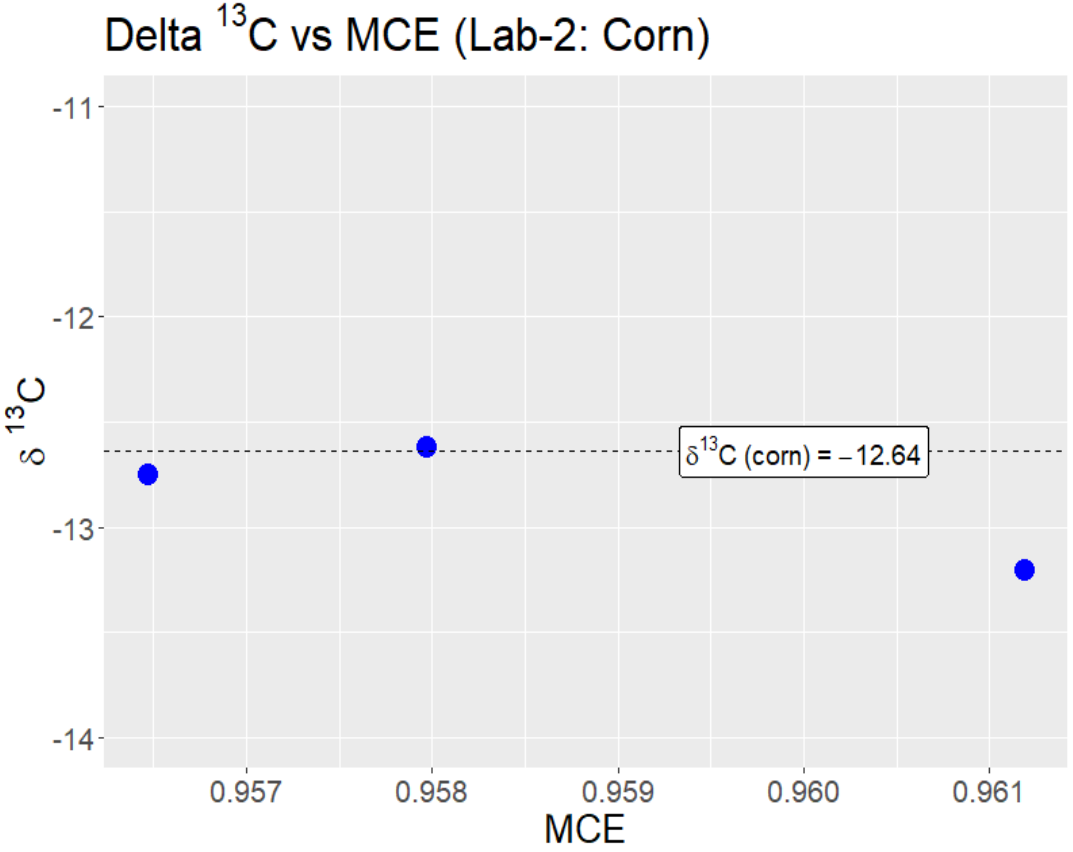


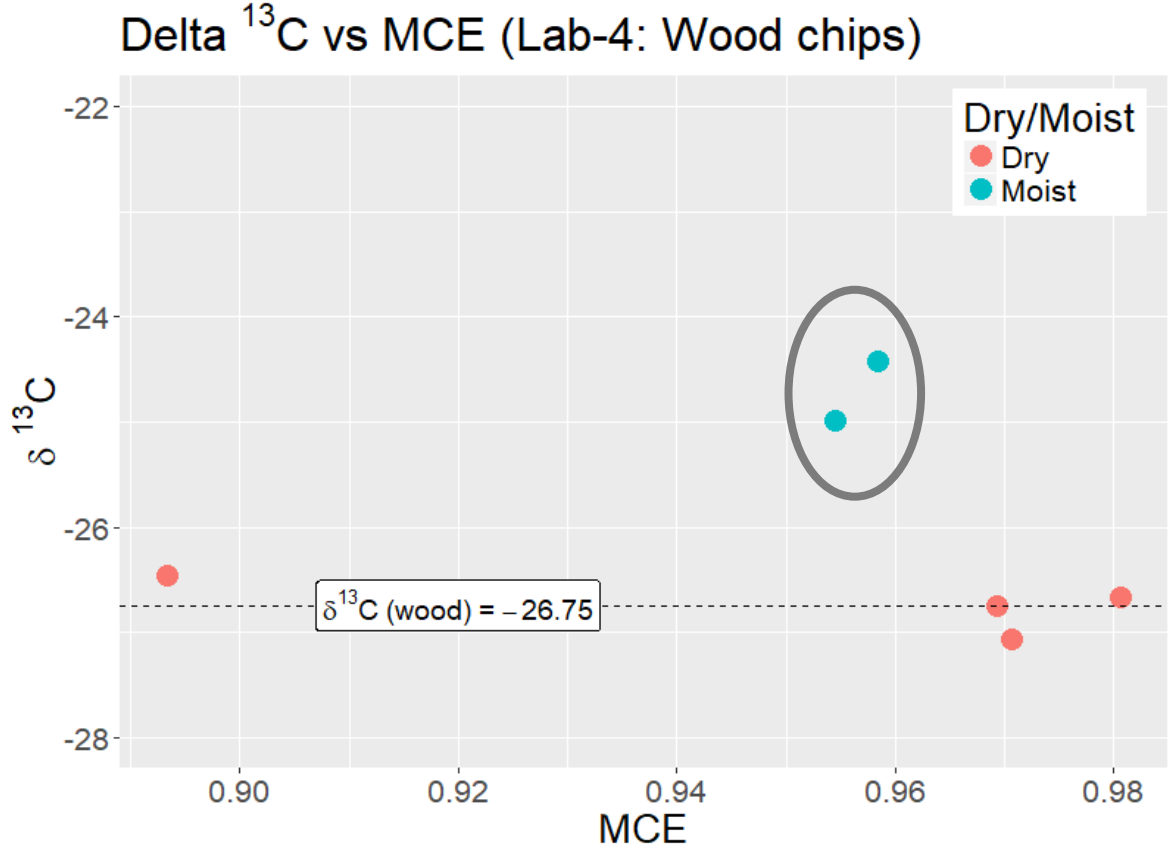
$\delta^{13}C_{OC}$ for willow and corn (Lab)



- Delta value of OC for willow is higher than ^{13}C signature of fuel
- Delta value of OC for corn is slightly lower than ^{13}C signature of fuel

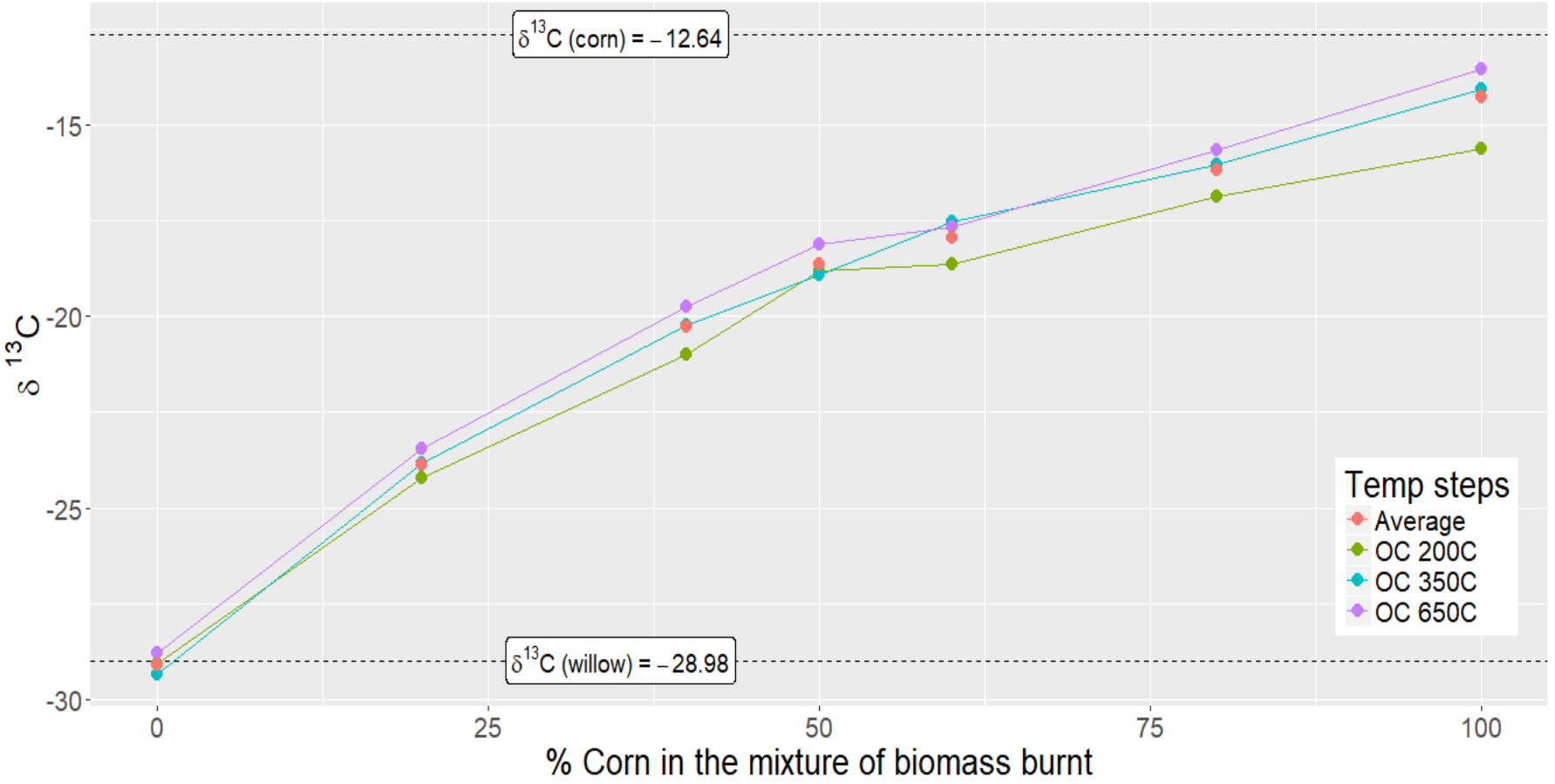
Impact of MCE and moisture on $\delta^{13}C_{OC}$





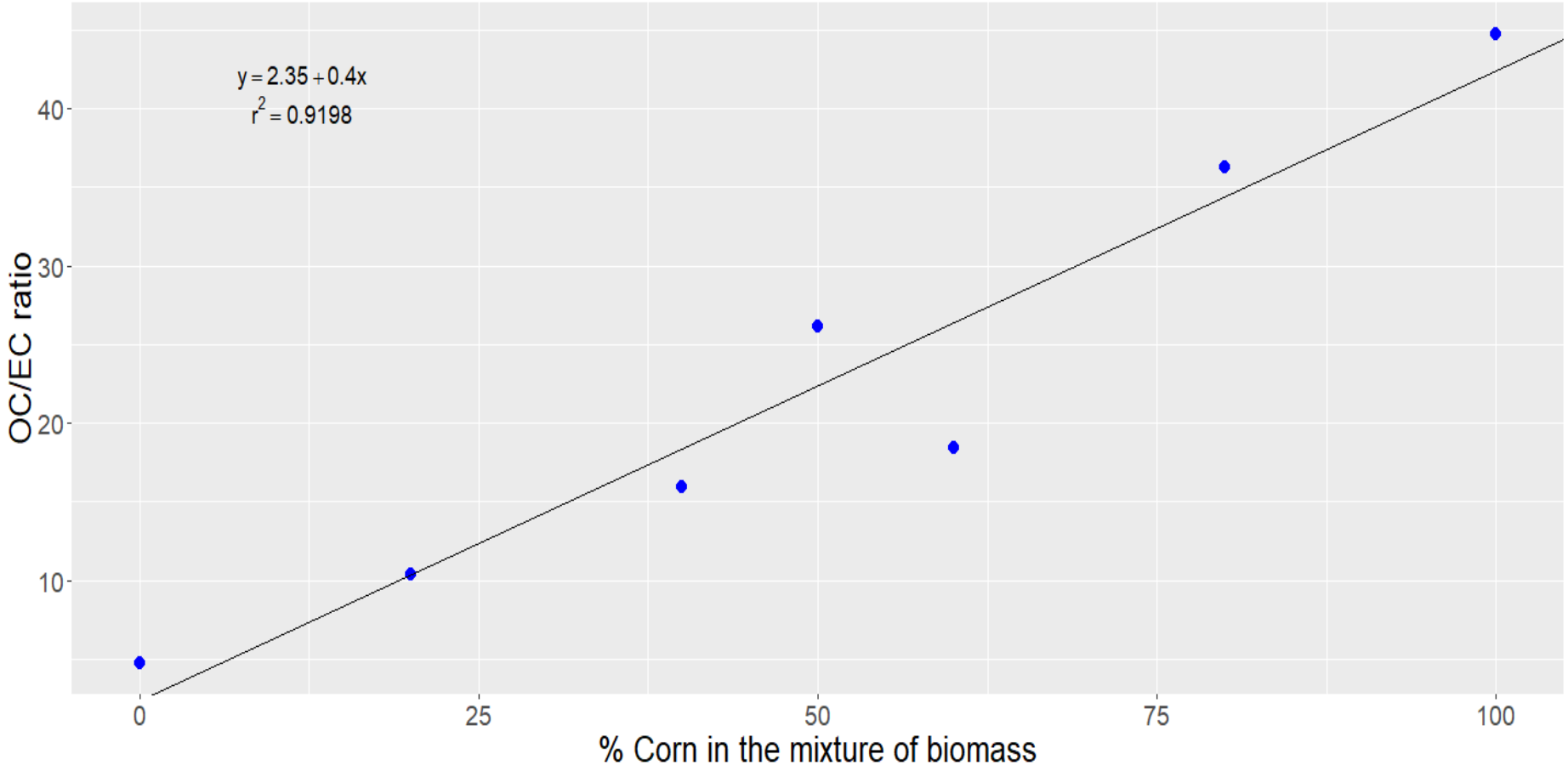
- Modified combustion efficiency, MCE = $\Delta CO_2 / (\Delta CO_2 + \Delta CO)$
- MCE seems to have no relation
- With moisture delta value increases

Results: Delta ^{13}C vs %Corn (Lab)



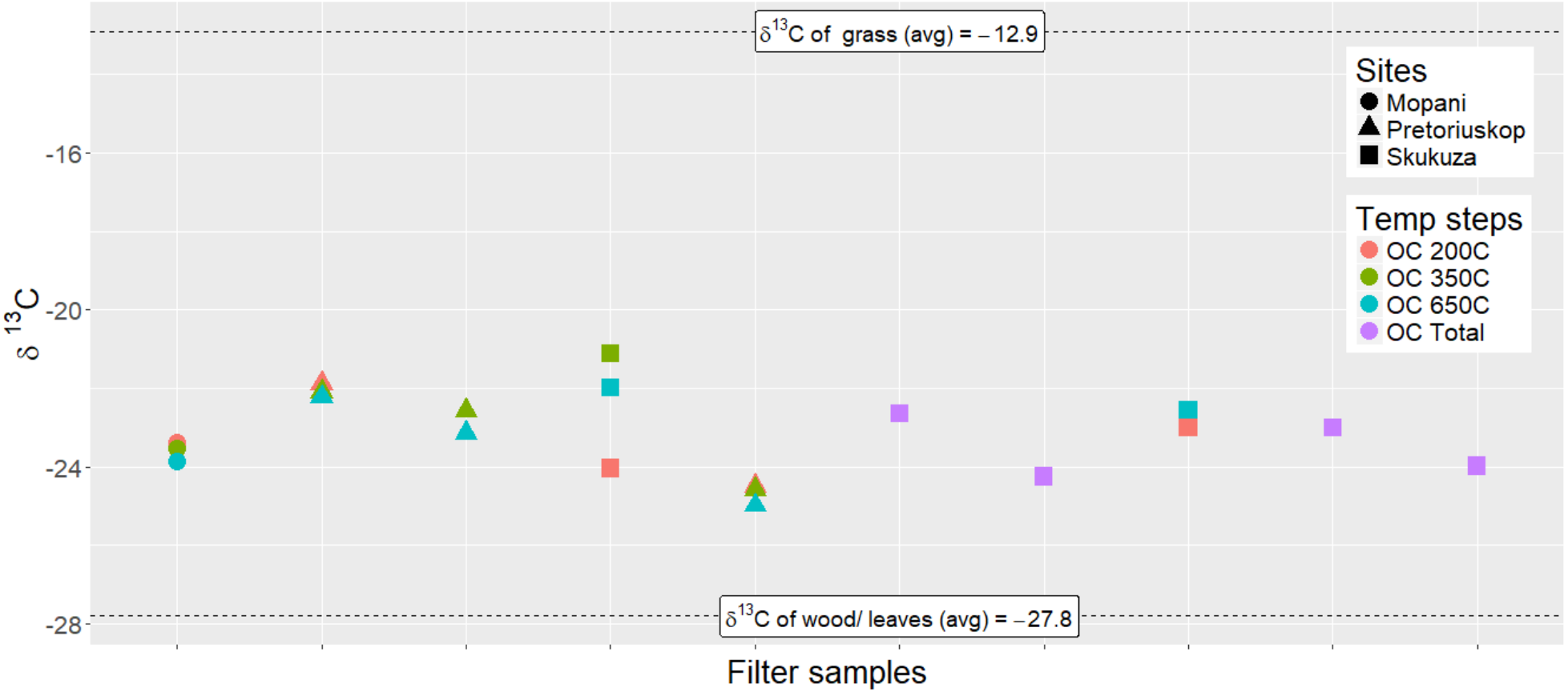
- Not linear: For a 50-50% mixture delta ^{13}C of OC is closer to ^{13}C signature of corn than that of willow.

Results: OC/EC Ratio vs %Corn (Lab)



- OC/EC ratio of Corn is higher than that of willow
- OC/EC ratio increases with increasing proportion of corn in the mixture.

Results: Delta ^{13}C (Field Campaign)



- $\delta^{13}C$: -25‰ to -22‰
- Delta value: close to ^{13}C signature of C_3 plants

Conclusion & Discussion

- LAB: $\delta^{13}C$ values of OC: close to ^{13}C signature of fuel
- Mixture of corn & willow: corn (C4) => higher contribution
- Field: $\delta^{13}C$ values of OC: close to ^{13}C signature of C_3 plants

- **C_3 plants => higher contribution in Savannah fire**
  - Mass of trees vs grasses
  - C_3 plants burn longer – C4 grasses burn faster
  - Aerosol collection
  - Impact of moisture
  - Impact of combustion efficiency

- **Further investigation: future research**

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