

Soil Water Cation Chemistry Under Elevated

CO₂ Conditions at BIFoR FACE

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Background

Soil nutrient bioavailability is widely considered to limit the continued mitigation of anthropogenic CO₂ emissions by forests, however, is yet to be well constrained (Smith et al., 2016).

Nutrients are available for uptake by plant roots when dissolved within soil water. Concentration of nutrients within soil water develop from complex interactions, including cycling between input of dead organic matter, mineralisation by microbes and fungi, and uptake by plant roots.

This study aims to quantify the concentration of cations bioavailable in the soil water under eCO₂. However, traditional soil sampling methods do not independently quantify bioavailable nutrients in soil water. This study uses novel ion exchange membranes to analyse soil water chemistry without disturbing the soil.

Methodology

The BIFoR FACE experiment investigates the whole ecosystem response of a mature deciduous forest to elevated CO₂ concentrations at 550ppm.

In this study 8 sets of 3 Cation ion-exchange membranes are deployed each month into the top 10cm of the soil in each of the ambient and fumigated arrays at BIFoR FACE. These membranes sample bioavailable cations, i.e. those available for uptake by plant roots, throughout the duration of the month.

The ion-exchange membranes are collected and treated with 0.5M HCl to extract the cations and bulked into 1 extracted solution per array.

The extracted solution is analysed through ICP-OES to obtain abundance of cation in solution to come into contact with the membrane.

Preliminary Results

Analysis is ongoing, however, preliminary results suggest a difference in bioavailability of K, Mg, Ca, Mn, Fe, Zn, Pb, Ni and Co between ambient and fumigated plots, being depleted under elevated CO₂ conditions. This suggests additional nutrient demand under high CO₂ Conditions.

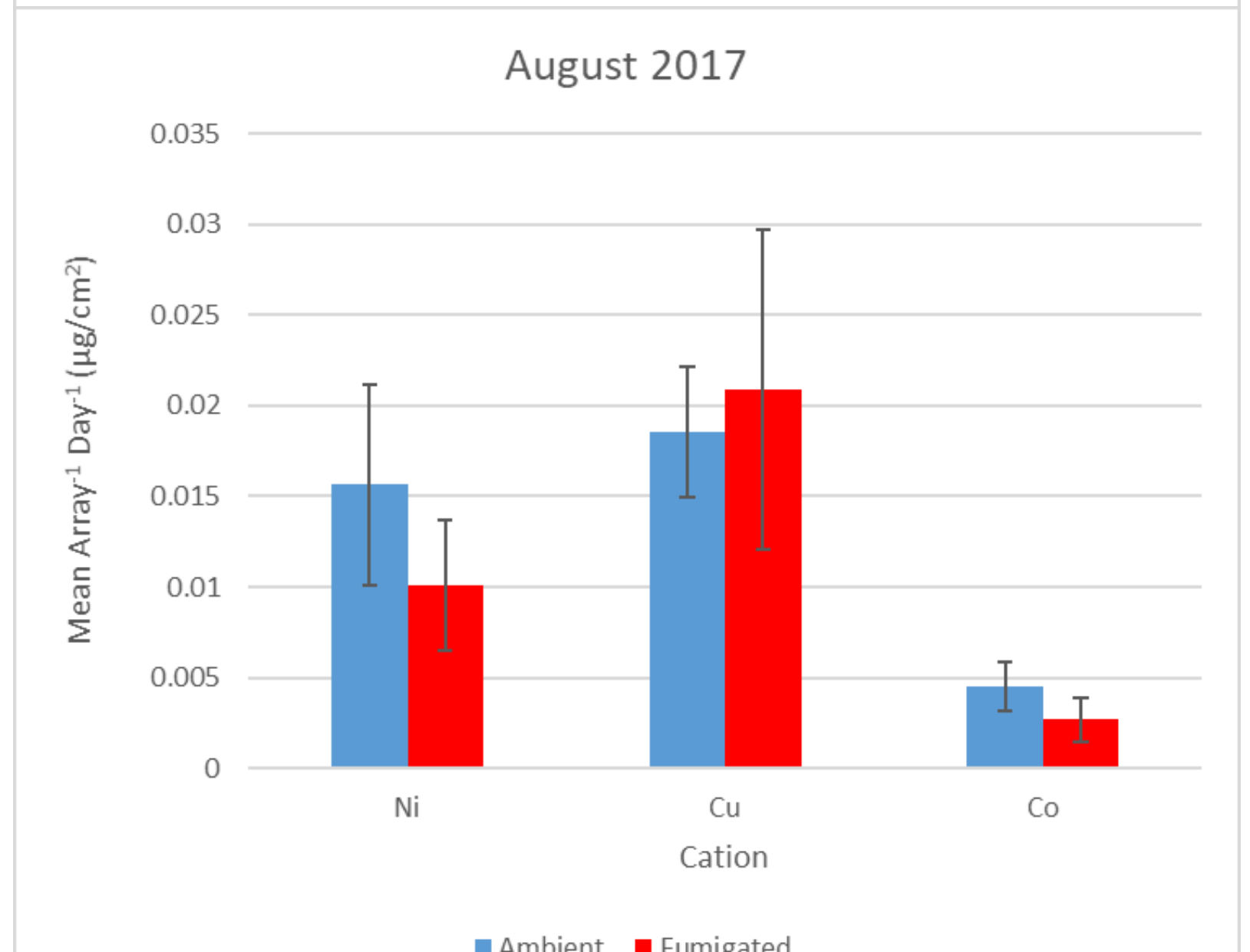
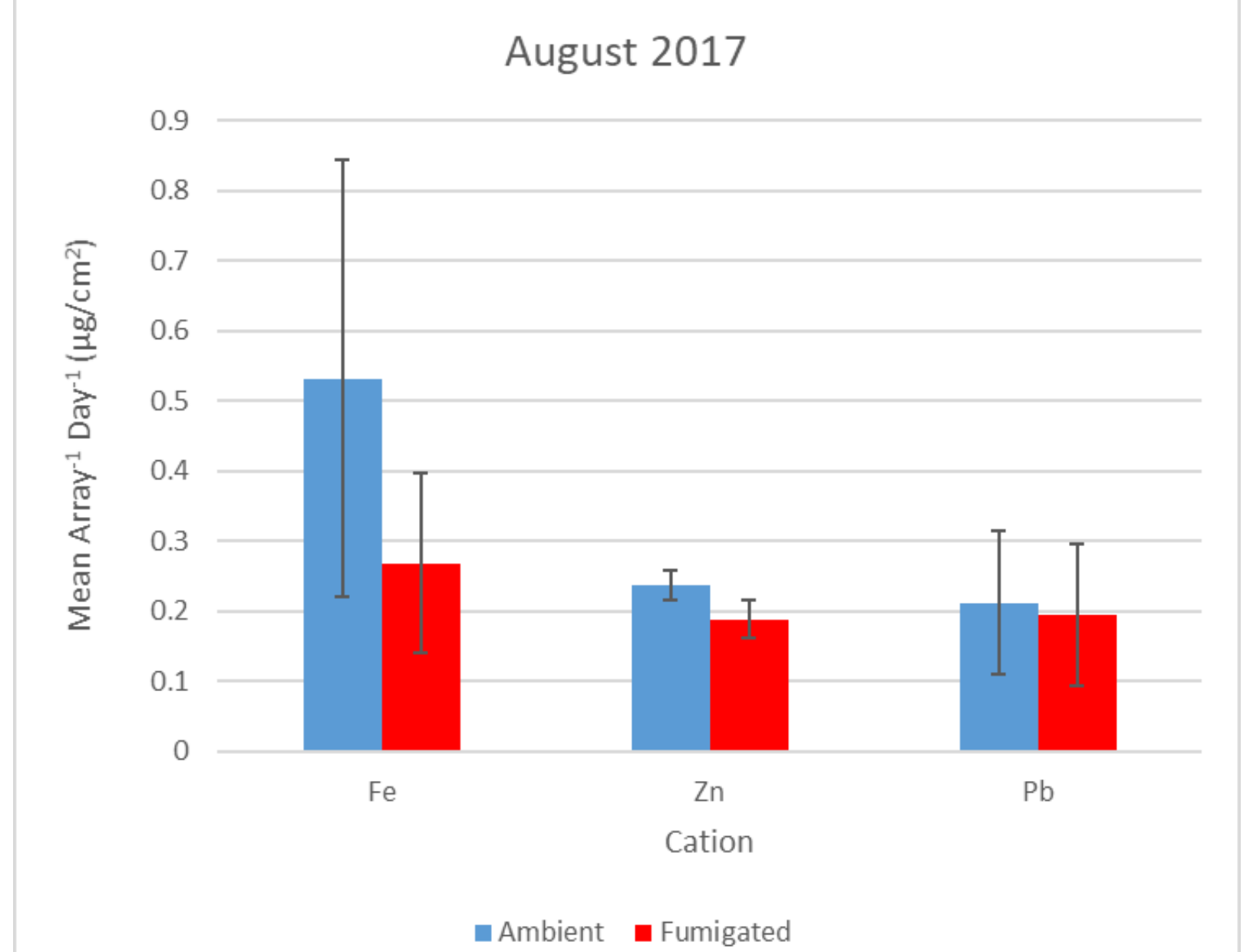
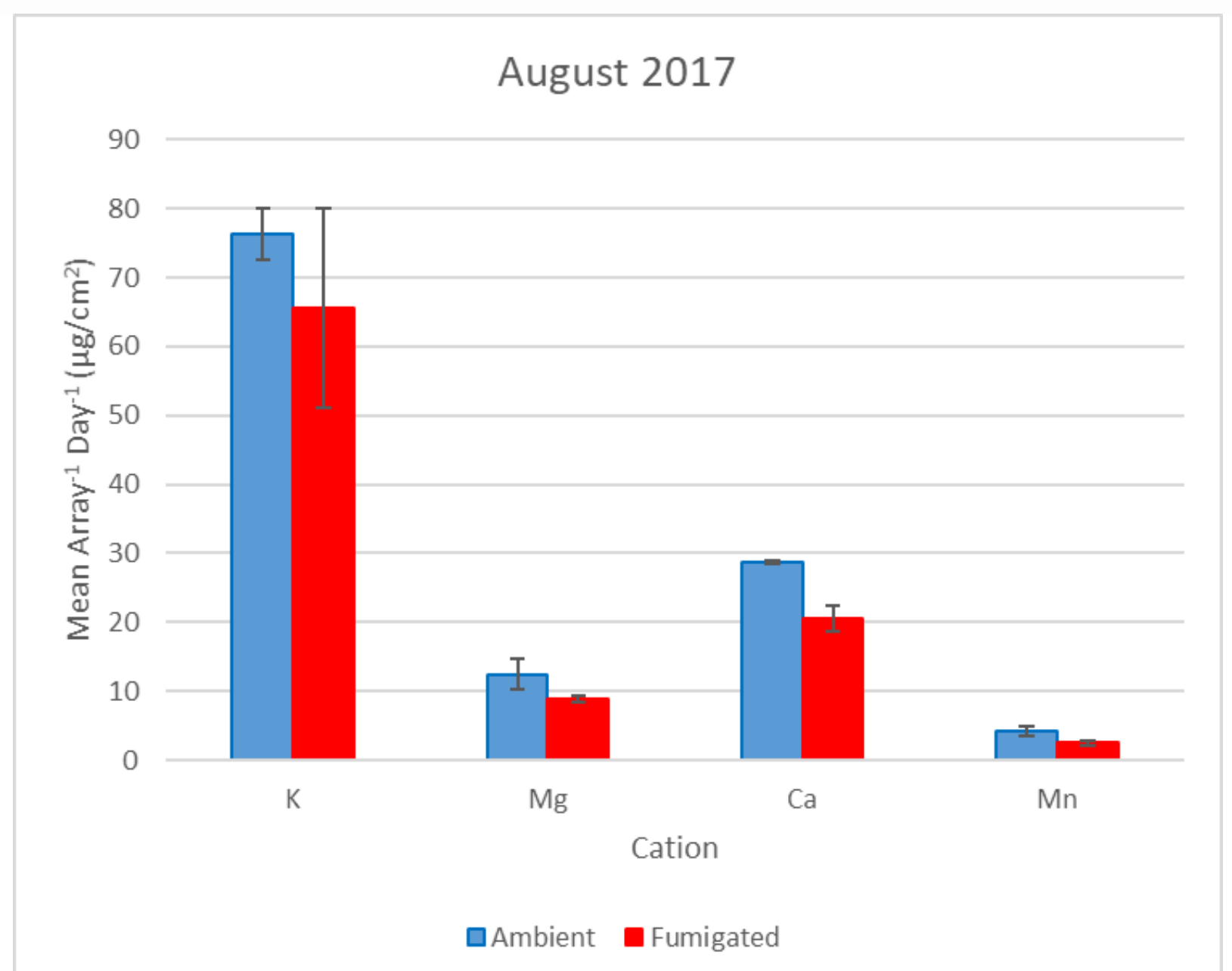
Na saturated the resolution of ICP-OES, whereas Mo concentration often fell below the ICP-OES detection limit.

Future Work

Further ICP-OES analysis of K, Mg, Ca, Mn, Fe, Al, Zn, Pb, Ni, and Co using over 2 years of diluted membranes extractions, consisting of 1 year pre-fumigation and 1 year post-fumigation.

Data will be compiled to examine the annual pattern of cation availability in the deciduous forest soil, perhaps different trends will prevail between Major, Minor and Micro nutrients.

Also, the use of statistics will be used to confirm whether the difference of cation bioavailability between ambient and elevated CO₂ conditions is significant or not.



References

Smith, W.K., Reed, S.C., Cleveland, C.C., Ballantyne, A.P., Anderegg, W.R., Wieder, W.R., Liu, Y.Y. and Running, S.W., 2016. Large divergence of satellite and Earth system model estimates of global terrestrial CO₂ fertilization. *Nature Climate Change*, 6(3), p.306.

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