Identifying Spatialized Fluxes at Field Scale Through a Distributed Deployment of Next-Generation Flux Sensors (LI-710 and LI-720)

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Introduction

- Field-scale estimation of CO_2 and H_2O flux is vital for understanding ecosystem performance and resource use.
- Traditional point-based eddy covariance systems lack spatial resolution.
- The new distributed LI-710 and LI-720 sensors—connected through cloud-based data pipelines—enable scalable, near-real-time mapping of spatial flux patterns, providing insights for precision agriculture and sustainable management.

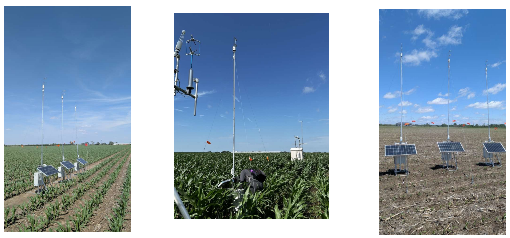

Figure 1: Field deployment of LI-710/720 sensors for spatial flux measurement

Objectives

1. Demonstrate distributed LI-710/720 deployment for field-scale flux sensing.
2. Quantify spatial variation in CO_2 and H_2O flux across an Enhanced Rock Weathering (ERW) treatment.
3. Apply machine learning to interpolate and visualize spatial fluxes from multiple distributed measurements.

Methods

- At the Mead, NE field site, several LI-710 (CO_2/H_2O) and LI-720 (energy) sensors were positioned across ERW and control zones.
- Each device transmitted data via cloud-connected Water and Carbon IoE modules. Collected time-series fluxes were aggregated and processed using a supervised machine-learning model to predict spatial patterns from discrete sensor points.

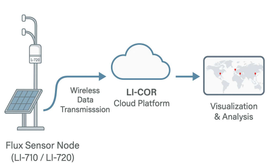

Figure 2: Workflow of distributed LI-710/LI-720 sensor network and cloud integration

Figure 3: Aerial view of the Mead, NE field

Results

- The distributed network of LI-720 (Carbon Nodes) captured consistent seasonal and diurnal trends in CO_2 and H_2O fluxes across the four field locations.
- Distinct spatial differences in flux magnitude were observed, particularly during the peak summer period, reflecting heterogeneity in canopy activity and local microclimate.
- Temporal patterns show the expected progression of ecosystem development — from low spring fluxes to pronounced summer photosynthetic uptake and evapotranspiration, followed by a decline in fall.
- These measurements demonstrate the ability of distributed, cloud-connected flux nodes to continuously monitor spatial flux variability across the field, providing a foundation for future scaling and network analyses.

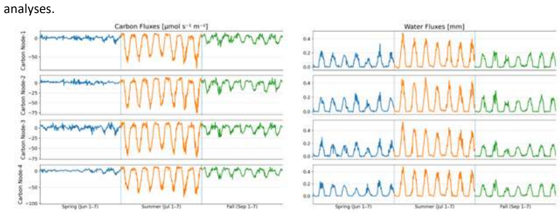

Figure 4: Seasonal CO_2 (left) and H_2O (right) fluxes from four LI-720 Carbon Nodes showing spatial variation across the field.

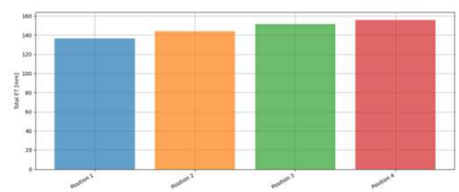

Figure 5: Total ET measured by distributed LI-710/720 systems across four field positions. Differences indicate spatial variability in field water fluxes.

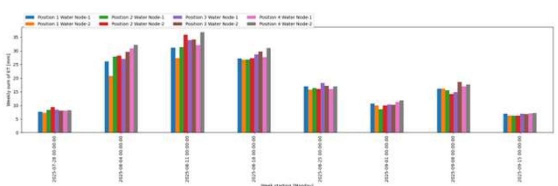

Figure 6: Weekly ET totals from distributed LI-710/720 sensors showing consistent temporal dynamics and spatial variation across field locations during the growing season

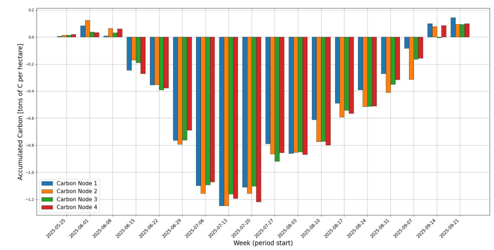

Figure 7:Cumulative CO_2 fluxes from four LI-720 Carbon Nodes showing consistent seasonal carbon uptake across positions.

- Each deployment set included two LI-710 (Water Nodes) and one LI-720 (Carbon Node), which were rotated biweekly among the four field positions.
- This rotation allowed all systems to experience comparable environmental and canopy conditions over the growing season.
- During the rotation, all node systems were periodically collocated at Position 4 with three eddy covariance systems (two LI-7500DS open-path and one LI-7200 closed-path).
- Collocation results showed strong agreement in CO_2 and H_2O fluxes between the distributed nodes and eddy covariance systems, confirming the accuracy and consistency of measurements across the network.

Discussion

- The distributed LI-710 and LI-720 systems captured consistent temporal and spatial variation in CO_2 and H_2O fluxes across the field.
- Biweekly instrument rotation ensured comparable sampling conditions, while periodic collocation with three eddy covariance systems verified accuracy and stability.
- The strong agreement among all systems demonstrates the reliability of the network and supports the scalability of distributed, cloud-connected flux sensing for field-scale carbon and water exchange monitoring.

Conclusions

- The distributed LI-710 and LI-720 flux sensor network provides reliable, spatially resolved measurements of CO_2 and H_2O exchange under real field conditions.
- Consistent performance, validated against eddy covariance systems, demonstrates the accuracy and robustness of the platform.
- These results establish a strong foundation for scaling distributed flux sensing and integrating cloud-connected networks into broader carbon and water cycle research.

Acknowledgements

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