Instrument-to-Instrument Variability in Next-Generation Flux Sensors (LI-710 and LI-720) from a Paired-Instrument Field Experiment

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Introduction

- The LI-710 Evapotranspiration Sensor and LI-720 Carbon Flux Sensor represent a new generation of integrated eddy covariance instruments.
- By combining sensors, data acquisition, and processing into a single compact unit, they simplify deployment and improve reliability.
- Their low infrastructure requirements make them ideal for both research and operational applications, from biogeochemical studies to irrigation management and carbon MRV systems.
- This integrated approach also enables dense sensor networks for high-resolution flux monitoring across landscapes.

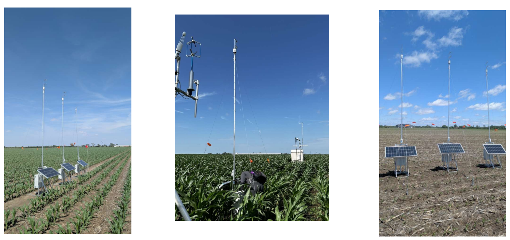

Figure 1: LI-710 and LI-720 sensors in the filed.

Objective

To characterize instrument-to-instrument variability and assess agreement between paired LI-710 and LI-720 sensors under field conditions.

Methods

- A paired-instrument field experiment was conducted in a homogeneous agricultural field in Mead, Nebraska.
- Eight LI-710 and four LI-720 sensors were deployed across four sites—three with paired LI-710/LI-720 units and one reference site equipped with LI-7500DS and LI-7200RS systems.
- Instrument pairs were rotated biweekly between sites to assess spatial and temporal variability. Standard eddy covariance processing was applied, and comparisons were based on correlation, bias, RMSD, and coefficient of variation.

Figure 2: Experimental field in Mead, NE

Results

- The LI-710 sensors showed excellent internal consistency. Across multiple field positions, the slopes of regression between individual LI-710 sensors and ensemble EC references ranged from 1.07–1.18, with negligible offset. (Figure 3)
- When comparing LI-710 (Water Node) and LI-720 (Carbon Node) fluxes across all field sites, the regression yielded $y = 1.025x + 0.008$ ($R^2 = 0.88$) — indicating excellent agreement between ET fluxes derived from both systems. (Figure 4)

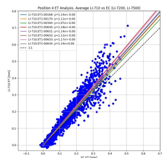

Figure 3: ET measured by multiple LI-710s against the ensemble EC reference

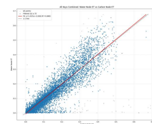

Figure 4: ET measured by multiple LI-710s against LI-720 references.

- Weekly evapotranspiration (ET) fluxes derived from all Water Nodes (LI-710) showed consistent patterns across positions and rotations throughout the field campaign. Weekly sums tracked expected seasonal declines from late July to mid-September, with minimal divergence among sites, indicating strong inter-instrument consistency.
- When combined with Carbon Node (LI-720) data, these results further confirm stable, coherent flux behavior across both sensor types over time.

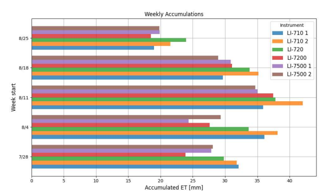

Figure 5: Weekly ET from LI-710 Water Nodes and LI-720 Carbon Nodes at Position 4. Consistent patterns show temporal stability and low instrument variability

- Diurnal latent energy (LE) patterns remained closely aligned among Water Nodes, Carbon Nodes, and the EC reference, confirming stable temporal response and consistent flux behavior across instruments.

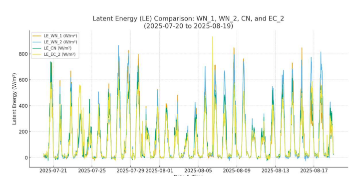

Figure 6: Time series of LE from two LI-710s and one LI-720 compared with the EC reference, showing stable temporal performance and strong cross-system agreement

Discussion

- The low instrument-to-instrument variability and strong cross-model consistency demonstrate that the LI-710 and LI-720 sensors are reliable tools for both research-grade and operational flux monitoring.
- Quantitative comparisons (Table 1) confirm the high agreement between instruments, with mean biases below 0.03 mm and R^2 values above 0.9 across all pairings.

Comparison	Mean Bias	RMSD	R^2	N	Comment
LI-710 vs LI-710	+0.02 mm	0.05	0.94	4500	High consistency
LI-710 vs LI-720	+0.01 mm	0.06	0.88	3200	Excellent agreement
LI-720 vs LI-7500	+0.03 mm	0.07	0.91	2800	Strong reference correlation

Table 1: Summary of inter-instrument and cross-model comparison statistics.

- This level of agreement supports:
  - Distributed network applications (e.g., high-spatial-resolution ET mapping).
  - Operational MRV systems in agricultural and carbon offset programs.
  - Simplified calibration workflows for multi-sensor deployments.

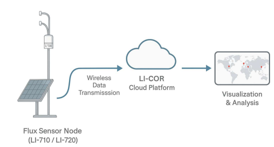

Figure 7: Cloud-integrated LI-710/LI-720 system architecture

Conclusions

- LI-710 and LI-720 sensors exhibit minimal variability and strong cross-system agreement.
- Their integrated, low-complexity architecture makes them ideal for scalable, distributed flux monitoring.
- These findings demonstrate readiness for network-level carbon and water flux observations supporting MRV and research applications.

Acknowledgements

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