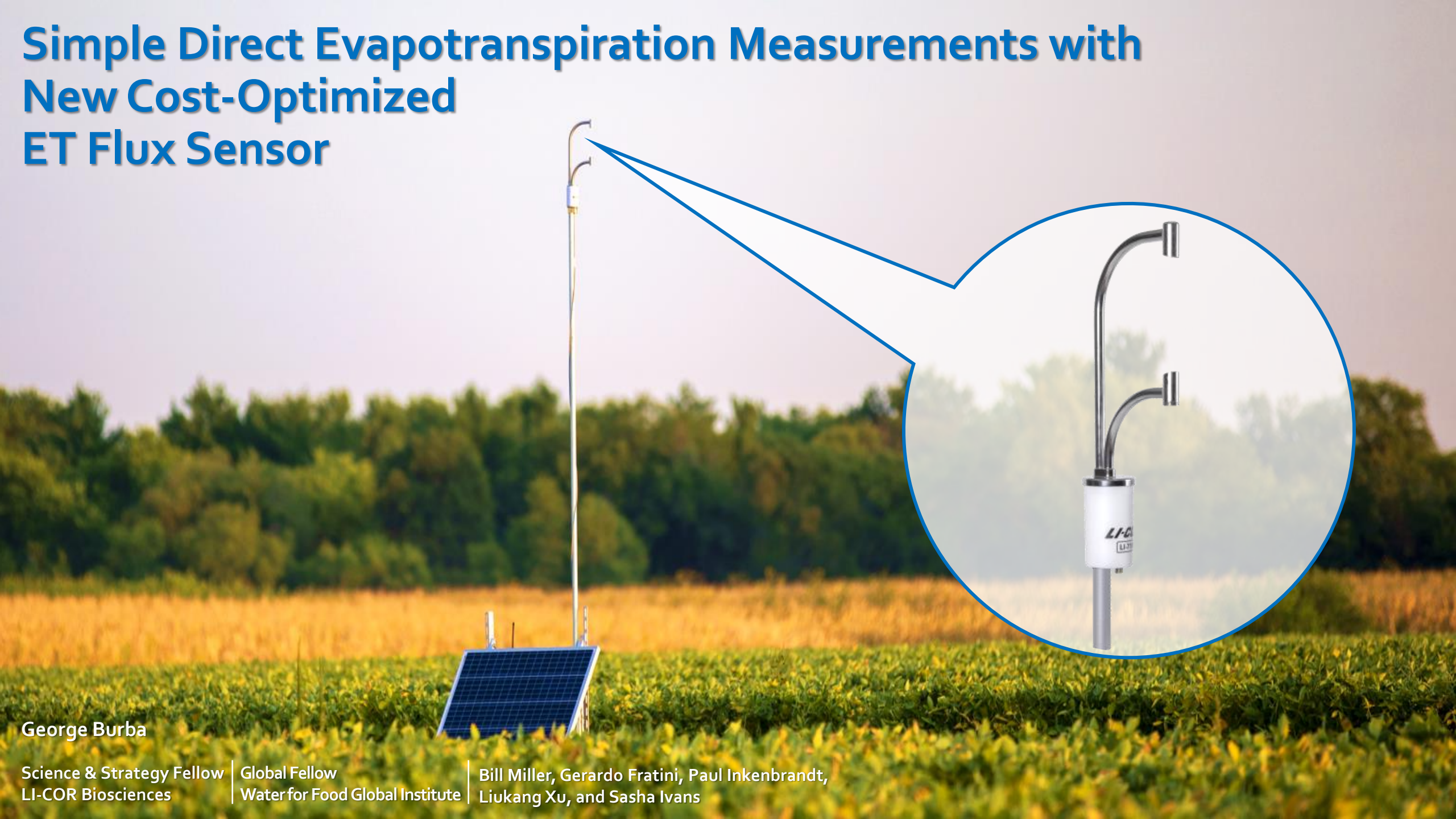
Simple Direct Evapotranspiration Measurements with New Cost-Optimized ET Flux Sensor



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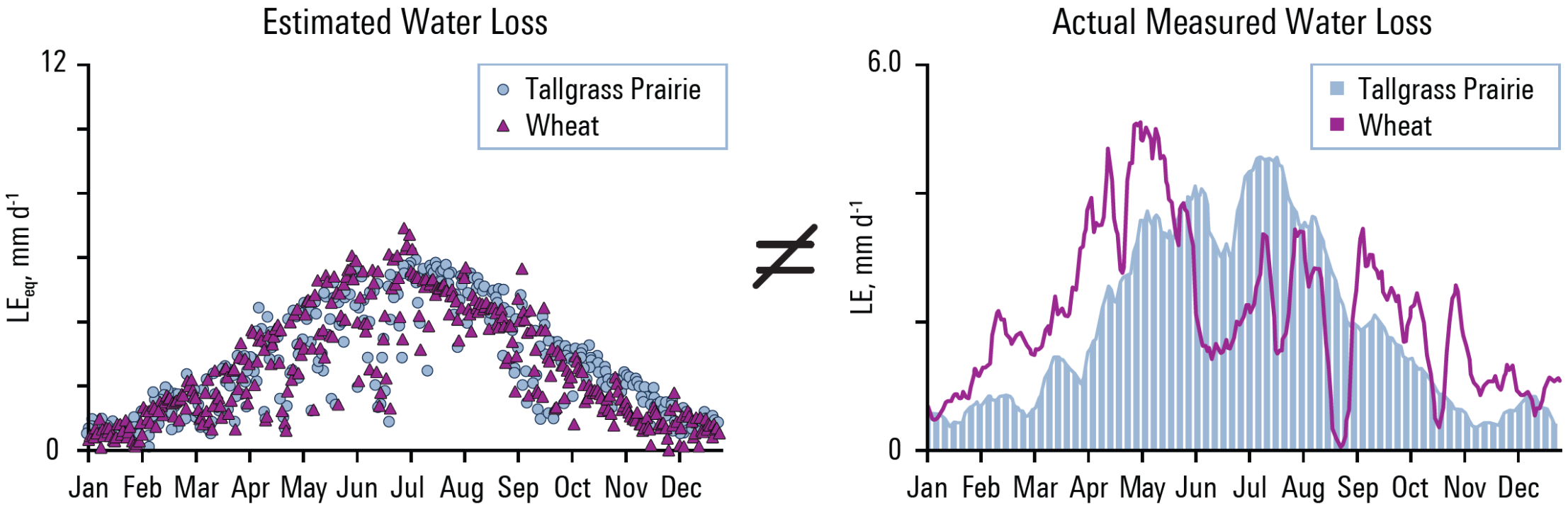
Why We Need Hi-Res ET

Overview

- Around 2B people face water scarcity now, with 3B more by 2050
- Global water demand of 5000 km^3yr^{-1} is a small fraction of 70,000 ET moves over land
- Saving 10% of ET in the soil, groundwater or freshwater bodies, cab solve global water shortage
- But in order to manage an area to save 10% of ET, one has to measure ET better than 10%
- Such resolution is not practically achievable with areal models (e.g., potential, reference, max, equilibrium, pan, etc.), but can be achieved using eddy covariance method, *only if* the current high cost and complexity are resolved

Direct Flux Measurements

Advantages over Models

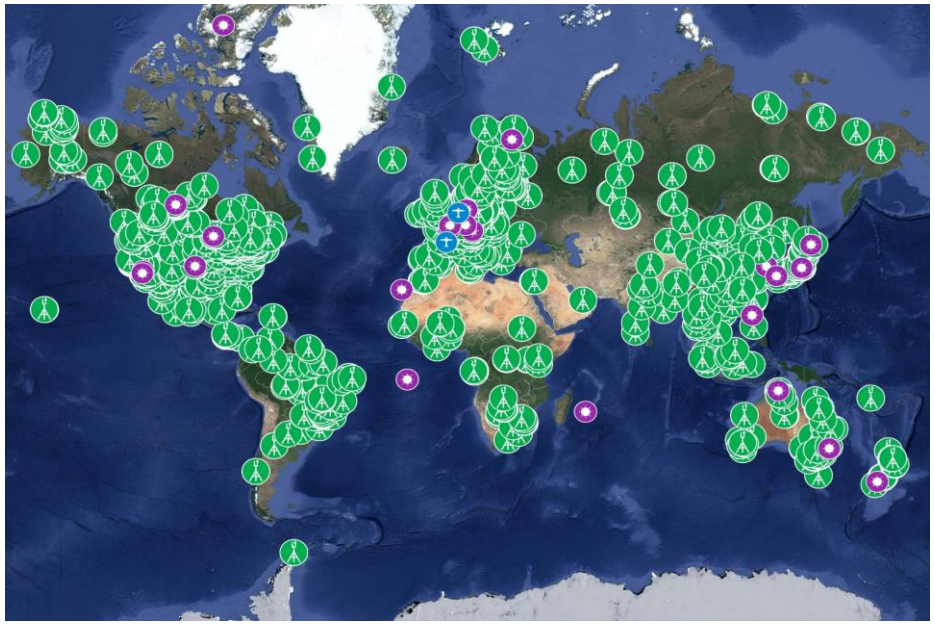


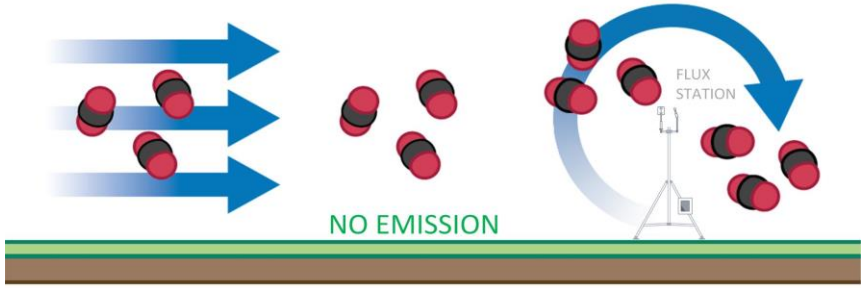
- Without specific crop coefficients etc., the ET models can be way off
- These are unknown for mixed communities, during diseases, stresses and for new varieties
- Few people outside academia use crop coefficients

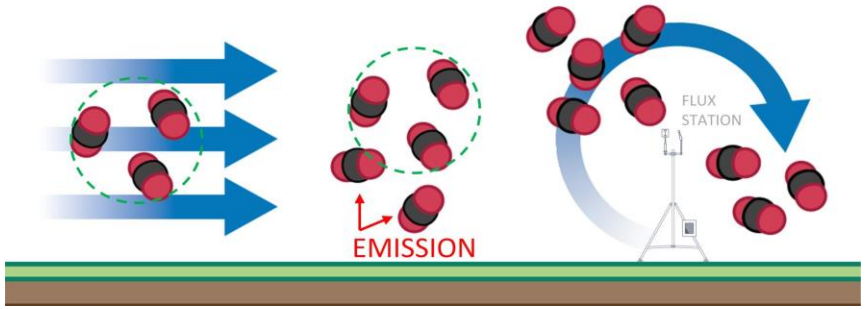
Eddy Covariance

Eddy Covariance Measurements

Overview

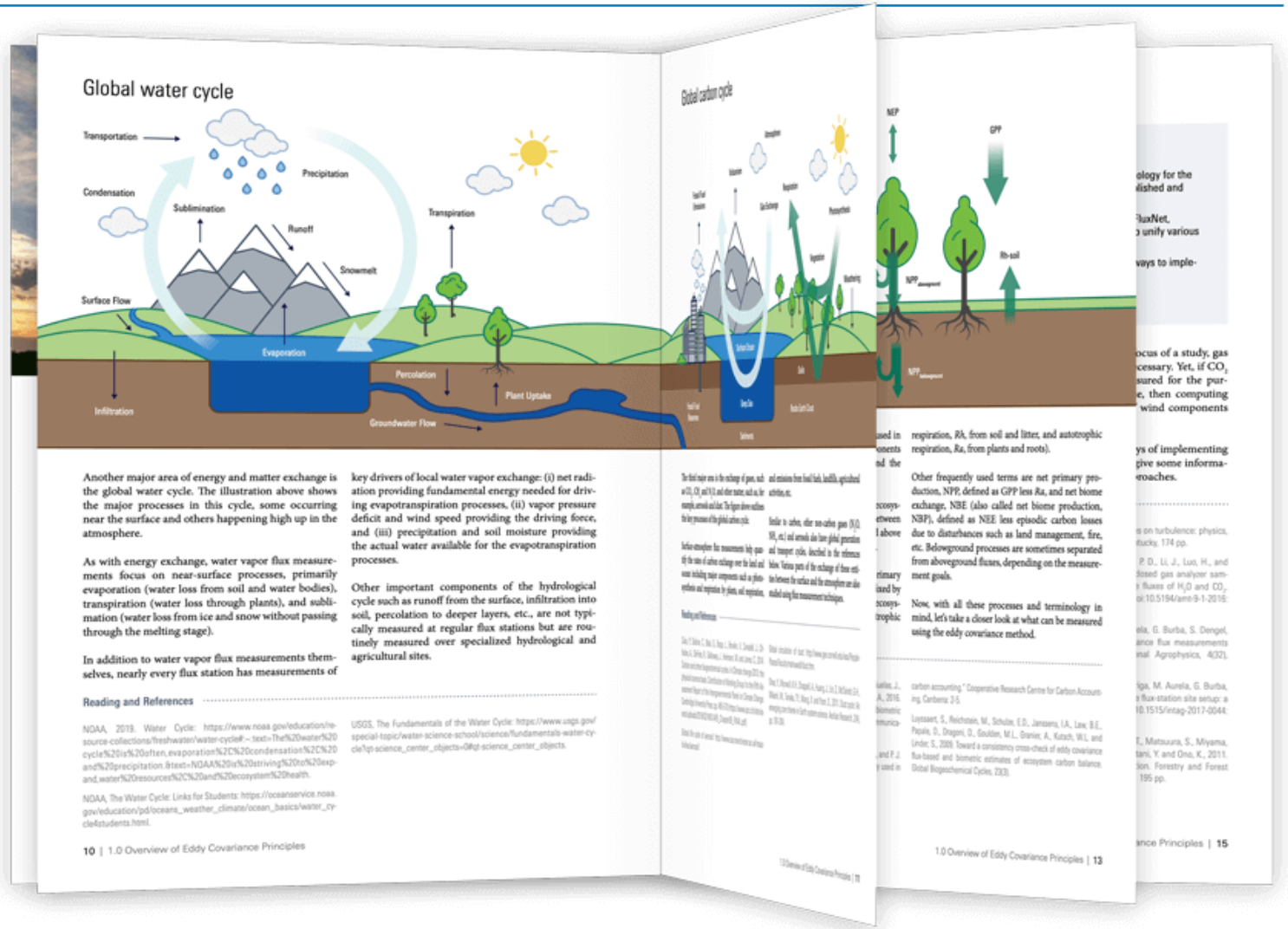






- Directly in and out of the air
- Continuous 10-20 times per sec
- 2150+ stations since the 1980s
- 1000+ stations active now

Latest EC Book



www.licor.com/ec-book

New Technology:
Reduced-Cost Eddy Covariance Sensor

New Technology: LI-710

Cost reduced 5-10 times below current EC technology

Power consumption reduced 3-15 times for solar/wind operation

Fully automated real-time calculations of all parameters

Extremely simple and fast installation: poll or stick

Designed for use by a novice and not an expert

Evapotranspiration
Water vapor flux
Latent heat flux

Sensible heat Flux: the heat going from surface into the air

Temperature: Ambient Air

Humidity: Absolute Relative

Ambient Atmospheric Pressure

Dewpoint, VPD, Saturated Vapor Pressure

SDI-12 compatible with most weather stations and loggers


Forests


Orchards


Wetlands


Grasslands


Bare fields


Crops

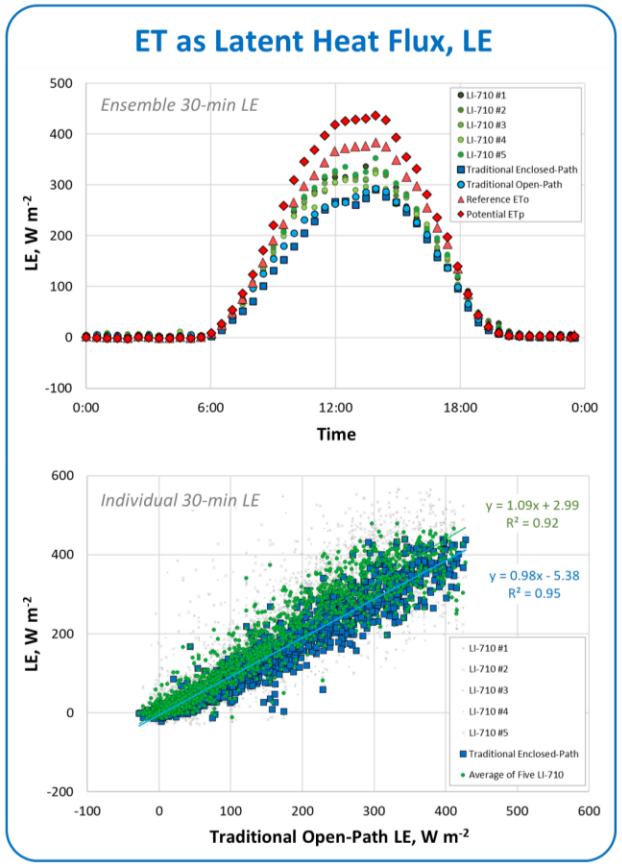
- Eddy covariance for ET
- Simple, direct, fully automated
- 1.5 W power
- Costs 5-10 times below traditional EC

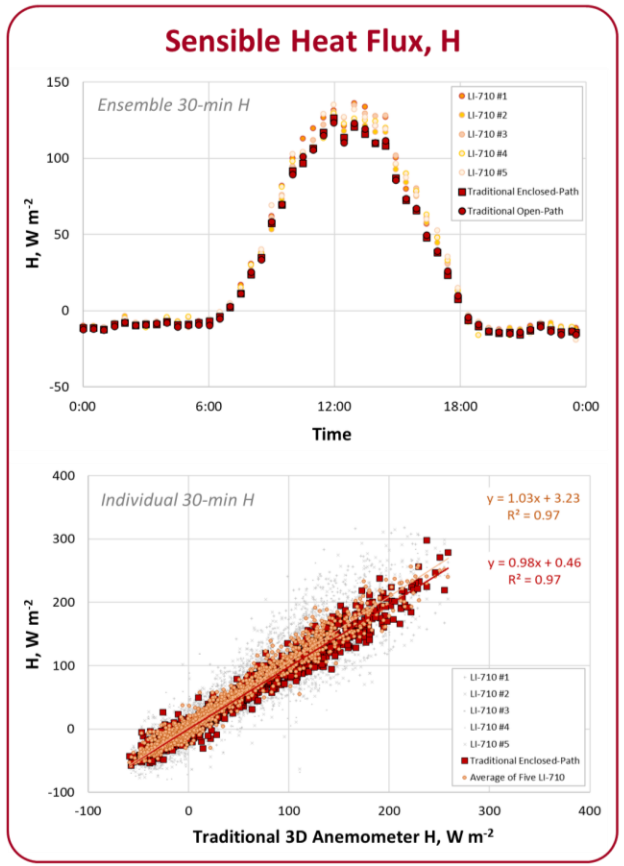
Enables the best available academic method for direct ET measurements to be used in non-academic practical applications

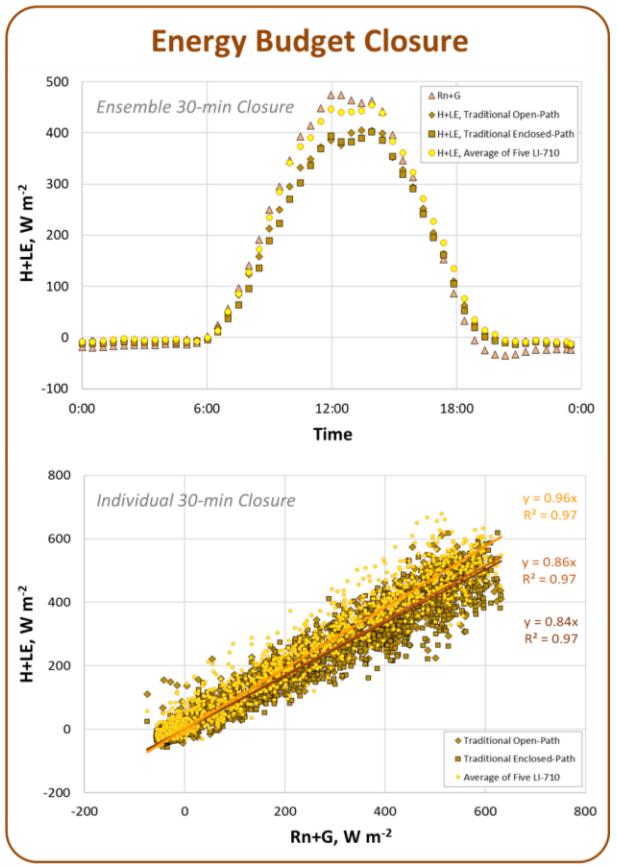
LI-COR

New Technology

Examples of Half-Hourly Performance



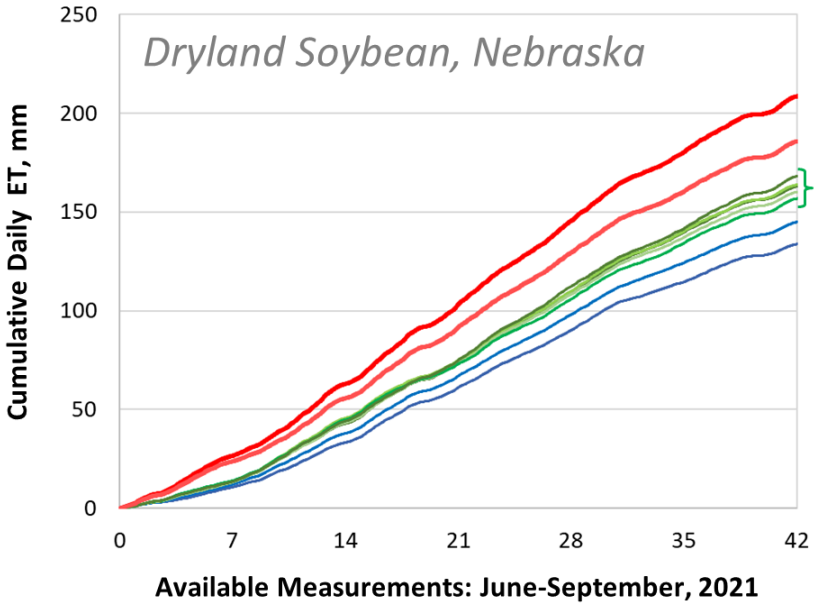




- Tested in over 30 contrasting locations, covering corn, soybean, almonds, pistachios, oranges, vineyards, alfalfa, wetlands, pastures, etc.

New Technology

Examples of Long-Term Performance



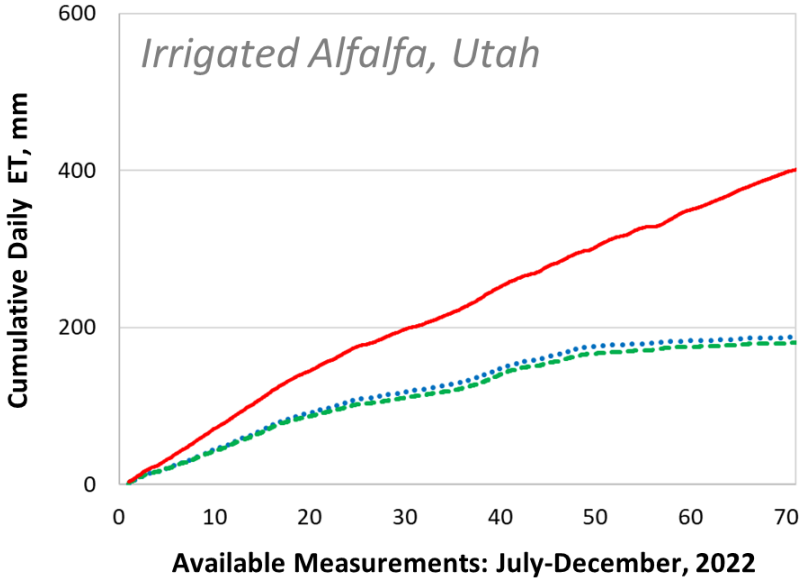
Potential ETp=208 mm

Reference ETo=185 mm

Actual ET, five LI-710= 163±4 mm

Actual ET, Traditional Open-Path =144 mm

Actual ET, Traditional Enclosed =133 mm



Max ETm=401 mm

Actual ET, Co-located Open-Path =187 mm

Actual ET, LI-710=180 mm

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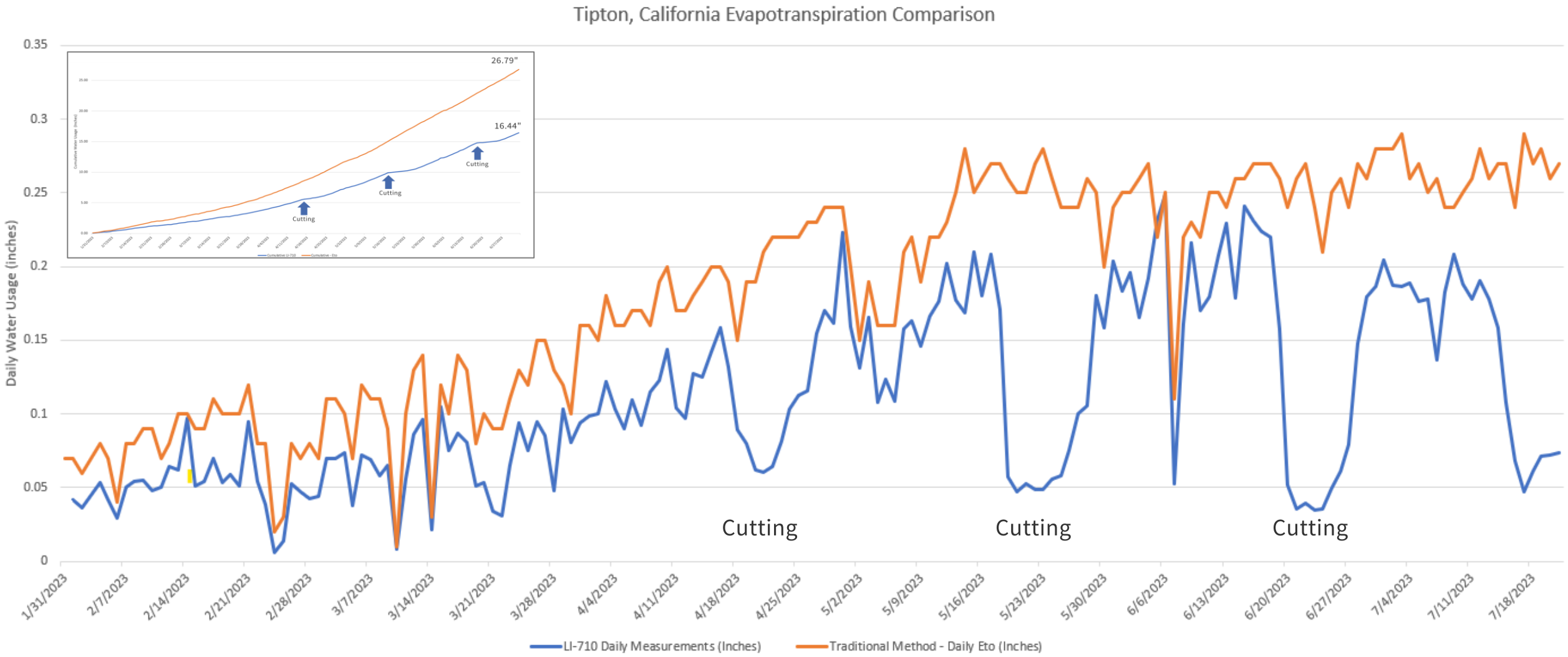
Immediate Societal Benefits

Immediate Societal Benefits

Significant Water Savings



Immediate Societal Benefits

Expansion of Existing Applications

"the eddy covariance (EC) micrometeorological measurement is often considered to be a 'golden' standard method for field ET determination…

Immediate Societal Benefits

New Applications

The new technology enables the use of direct ET in many new applications, both academic and commercial:

- Agricultural water management:
  - irrigation scheduling
  - improvement in crop coefficients
- Hydrological watershed management:
  - tuning of ET models
  - ground-truthing remotely sensed ET
- Water rights regulation:
  - water use verification
  - water regulation
- Academic applications:
  - distributed flux measurements
  - understory fluxes
  - etc.

Immediate Societal Benefits

Carbon Footprint Reduction

- A 25% reduction in water use is not just water use:
  - 25% reduction in fuel/energy consumption
  - 25% in equipment amortization
  - Major reduction in carbon footprint of ag operations
- In urban environments, a 10% reduction in water use:
  - 10% reduction in fuel/energy usage
  - 10% reduction in pump and delivery infrastructure amortization
  - Significant reduction in urban carbon footprint
- Effectively managing a natural watersheds to retain 5-10% more water:
  - Promotes recharge and green growth
  - Improved long-term stability and plant diversity
  - Significant improvement in the value of ecosystem services







THANK YOU!

ANY QUESTIONS?

FUTURE DEVELOPMENTS IN EC TECHNOLOGY

Technology Transfer Outside Academia

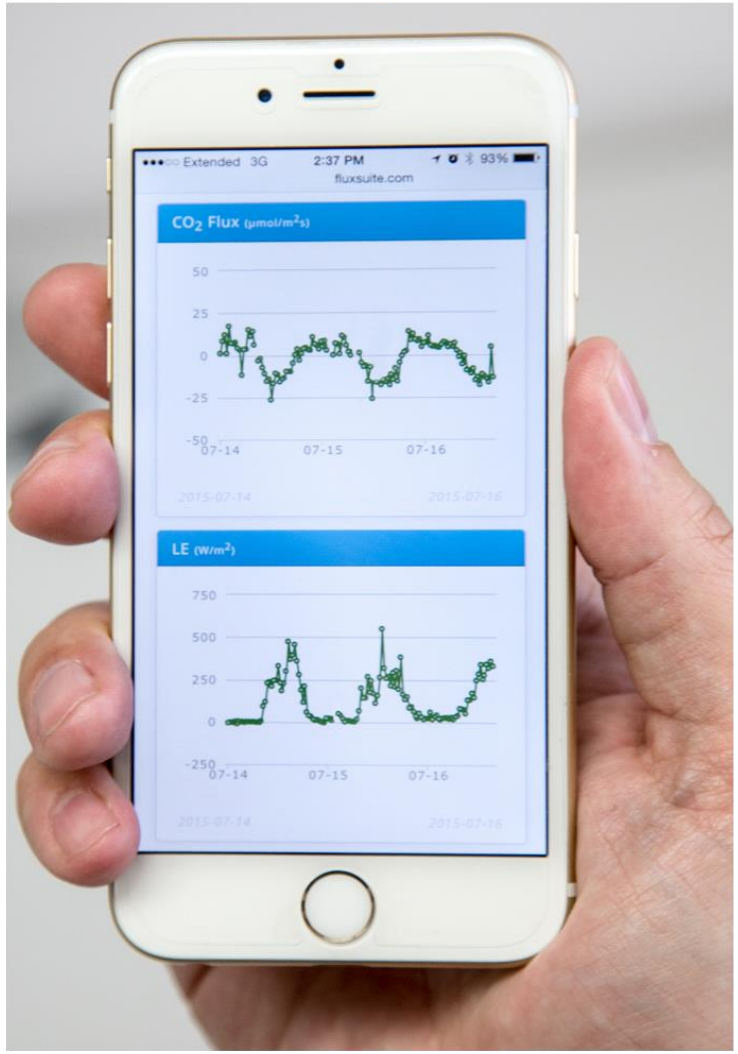
Further Simplification & Automation

- Academic tools are good but expensive and complex to use by a novice
- We just developed simple lower-cost tool for measuring water loss
- On the way to do the same for CO_2
- Such simple yet direct and accurate devices were not available for carbon markets until now
- The transfer of this direct measurements approach from academic science to practical use can now be utilized for many societal and commercial benefits, from water savings to carbon verification and trading

Existing Tools for Academia and High-end Practical Applications

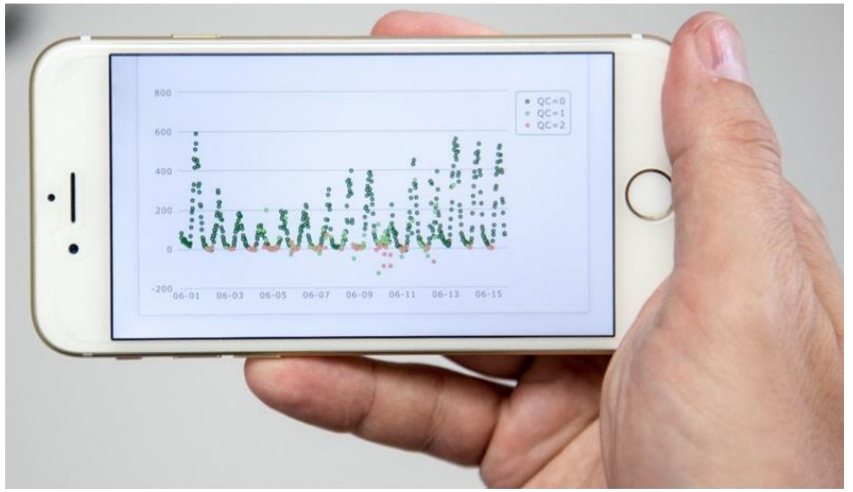
FluxSuite: Site Management

Station snapshot



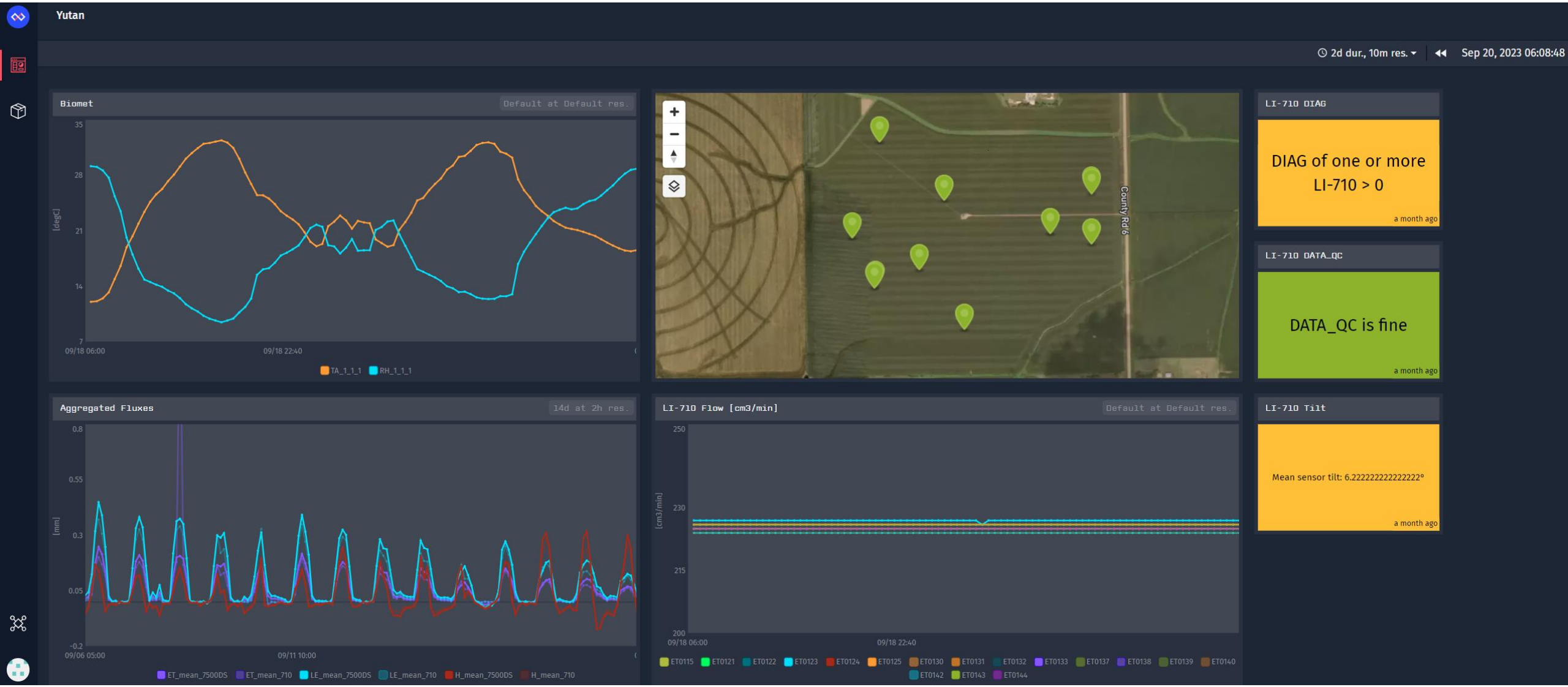
Flux details

Quality-controlled fluxes



Technology Transfer Outside Academia

Automated Flux Station Networks

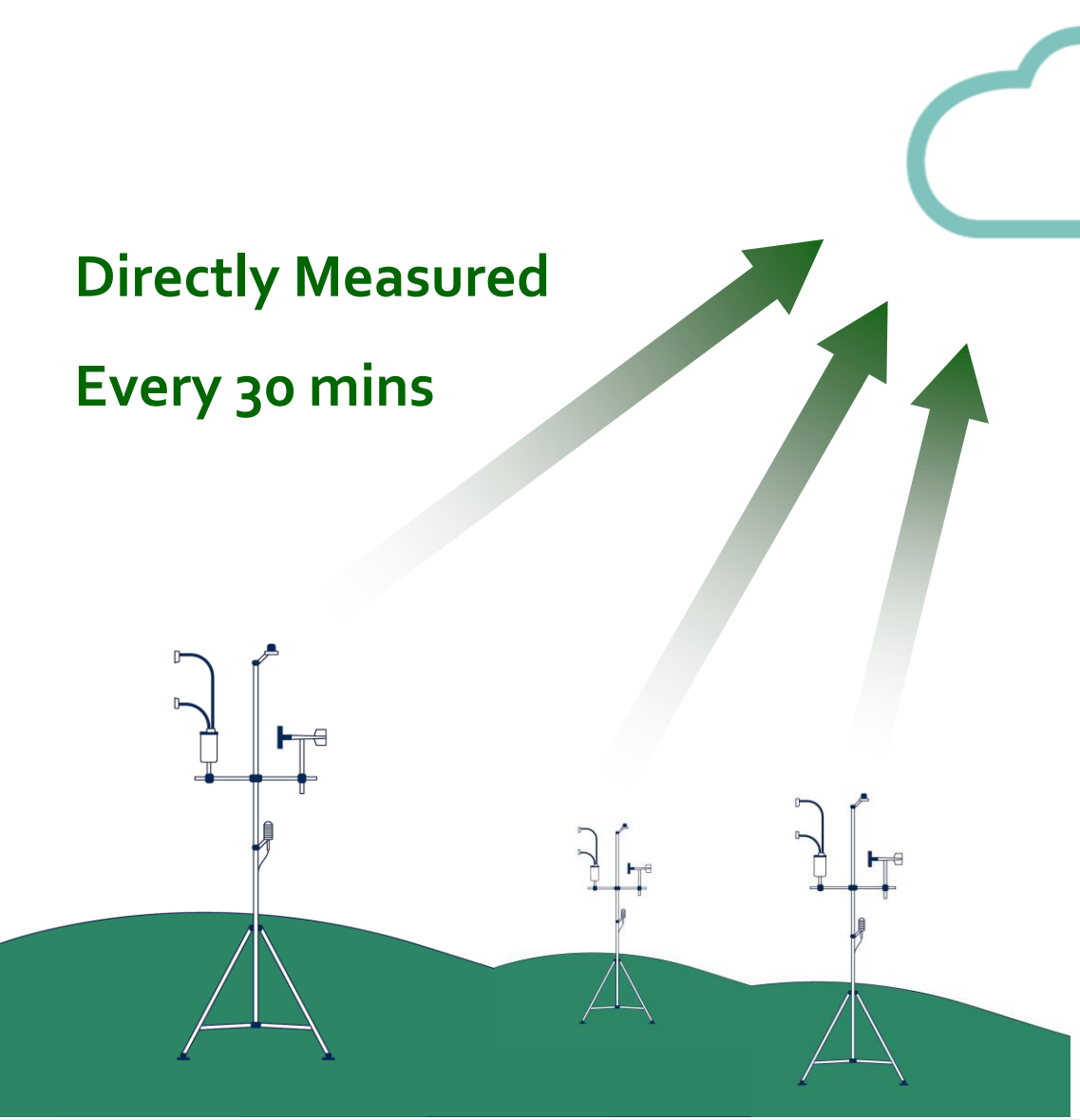


Future Vision for LI-COR

Continuous Delivery of Secure Results

Directly Measured

Every 30 mins



Quality-Controlled &

Summarized

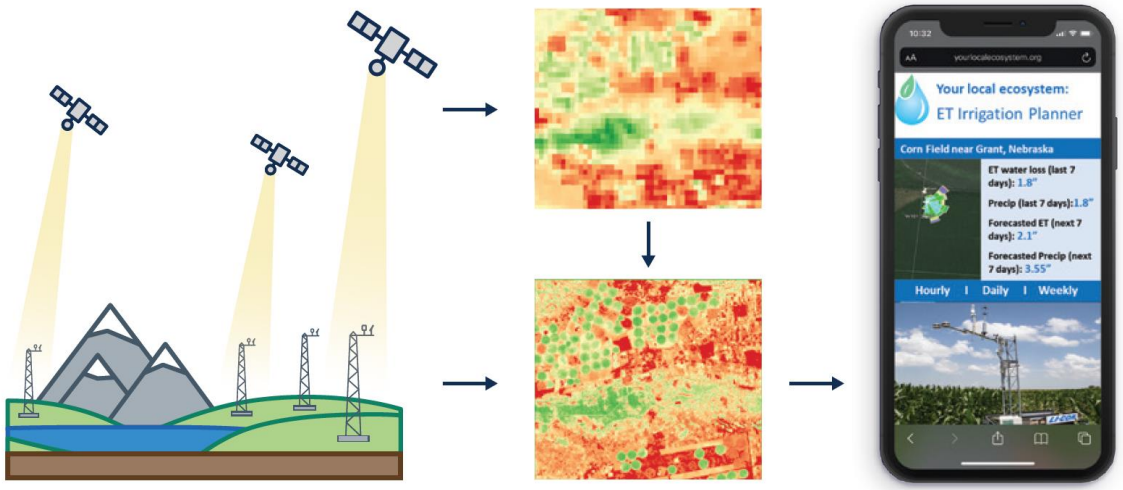
H

Water
Lost

Carbon
sequestered

EXPANSION OF EXISTING NETWORKS

Parallel 41
Flux Network
WaterforFood
DAUGHERTY GLOBAL INSTITUTE



- Real-time automated ET network based on SmartFlux and FluxSuite for irrigation water management: first station active since late-2018, major expansion in 2023
- ET estimates from the models anchored in real-time with the tower data to accurately expand the spatial estimates from the satellites
- Data streaming to an online tool to allow each investigator and a broader community of water managers and farmers to view and use the data