NEW OPEN-PATH LOW-POWER STANDARDIZED AUTOMATED CO_2/H_2O FLUX MEASUREMENT SYSTEM

George Burba*[1,2], Israel Begashaw[1], and James Kathilankal[1]

[1]LI-COR Biosciences, Lincoln, Nebraska, United States; [2]School of Natural Resources, University of Nebraska-Lincoln, United States, *Corresponding author: george.burba@licor.com

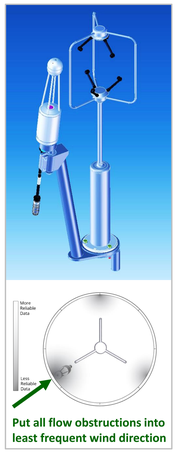
INTRODUCTION

- The latest 2017 model of CO_2/H_2O flux research system, LI-7500DS, is a streamlined, lower cost, lower power version of the 2015 model, LI-7500RS [1,2]
- Two 2015 flux research systems, open-path LI-7500RS and enclosed LI-7200RS, were in turn based on the original LI-7500/A and LI-7200 analyzers [3,4]
- Both RS and DS flux research systems include analyzers, but also have important additional functionality, significantly broader than just measuring gas concentrations:
  - increased stability under contamination and improved temperature controls
  - automation and standardization of final flux calculations in real-time
  - seamless integration with latest tools for flux tower networking, data sharing, and data analysis

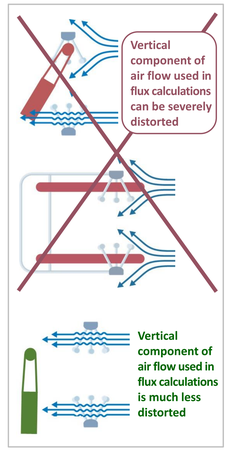
AUTOMATED SYSTEMS

- Automated flux systems output real-time fully processed fluxes of CO_2, H_2O, CH_4, H, τ, and auxiliary data [5]
- Low-power (1.5 W) weatherized field microcomputer, SmartFlux3, runs EddyPro same way as on desktop
- Fully configurable processing includes Fourier Transform, spectra, co-spectra, planar fit, progressive RH corrections, *etc.*
- Onsite clocks synchronized with PTP, clocks between stations are synchronized using GPS [6]
- Flux network tool, FluxSuite, shows status, fluxes, weather, flags etc., sends email alerts, and allows online data access and data sharing across the globe [see poster X1.59 on Thursday, April 12, for details]

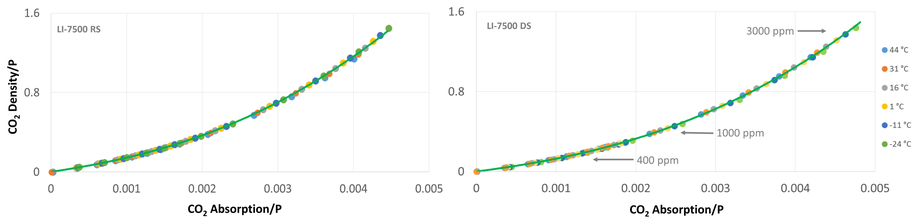
DS: POWER & SETUP



- Analyzer power consumption is reduced to 4W nominal to help cut overall site power
- LI-7550 box is eliminated to reduce cost, complexity and power demand
- The system includes SmartFlux3 microcomputer to fully compute fluxes, ogives, footprints *etc.*, and merge these with weather, soil and optical data
- Standard mount is provided to minimize the flow distortion in the anemometer and associated flux errors [7-15]



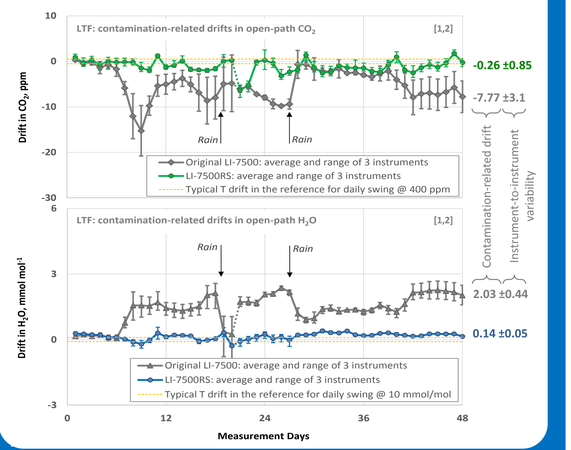
DS: TEMPERATURE CONTROL



- Temperature control of key electronics and optics is essential for reduction of temperature drifts in infrared gas analyzers [16, 17] and associated flux errors
- Examples above show typical calibration curves for LI-7500RS and LI-7500DS determined by using a full set of calibration gases at each specific temperature
- All the curves on each plot overlay each other well, showing that the calibration is consistent across the nearly 70 °C temperature range
- Such data are collected for each individual LI-COR IRGA as a part of routine factory calibration

RS: CONTAMINATION TESTS

Contamination-wise, DS has an identical design to RS



DS: COLD SEASON UPTAKES

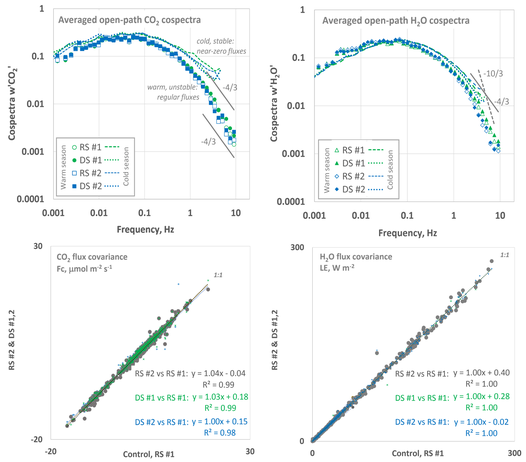
	Uptake events	Average uptake	Cumulative impact on winter CO_2 budget		Notes
			absolute	fraction	
	count	*μmol m⁻² s⁻¹*	*mmol m⁻²*	*%*	
Old LI-7500, *30 C*	174	1.62	507.4	**25.2%**	Typical, approx. from [18]
RS #1, *cold 5 C setting*	13	1.18	27.6	1.4%	Improvements in LI-7500RS vs. old LI-7500 are consistent with the switch from 5 C to 30 C settings for LI-7500A [19-21]
RS #2, *cold 5 C setting*	20	1.13	40.7	2.0%	
DS #1, *cold 5 C setting*	7	0.74	9.3	**0.5%**	Initial field results; experiments continue
DS #2, *cold 5 C setting*	8	0.59	8.5	**0.4%**	

- Cold season tests covered ambient temperatures range from -19 to 0 C; no uptakes were expected over a dormant and frozen ryegrass field
- Preliminary data suggest that LI-7500DS surface heating impact is 3-5 times smaller than that observed for LI-7500RS at cold settings, and 55-60 times smaller than that observed for the original LI-7500 model [4,18]

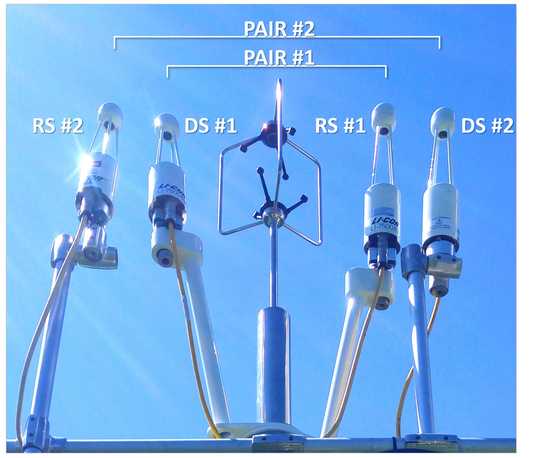
SUMMARY

- Field tests of RS systems were conducted over six periods 5-14 months long, at 6 diverse sites, using 26 gas analyzers [1,2]
- Instrument-to-instrument variability was reduced very significantly, 3-9 fold, in both open-path and enclosed RS models vs originals
- In terms of contamination-related drifts, the open-path LI-7500RS system performed significantly better than the original for both CO_2 and H_2O
- Improvements in CO_2 drifts in open-path RS were strong, with drifts few-to-tens of times less than the original
- Improvements in H_2O drifts were particularly significant, with RS drifts many tens of times less than the original
- Frequency response and hourly fluxes were substantially similar between the redesigned RS models and the original
- LI-7500DS system retained all the advantages of the RS models, but at much lower power consumption, and with reduced complexity and cost
- New models can significantly reduce site maintenance and improve flux data quality vs original models

DS: WARM AND COLD SEASON CO-SPECTRA & FLUXES



- Field tests at 3.5 m height covered ambient temperatures range from -19 to +36 C
- RS-DS Pair #1 was located 20 cm from the anemometer
- RS-DS Pair #2 was located 42 cm from the anemometer
- DS models performed similar or a bit better (nss) than RS models in terms of frequency response
- DS models performed similar (nss) to RS in terms of fluxes



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