ECOR SmartFlux: Upgrading the ARM Eddy Correlation Flux Measurement Systems

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INTRODUCTION AND MOTIVATION

- ARM has been measuring near-surface turbulent fluxes since 1992 using the Energy Balance Bowen Ratio (EBBR) systems, and since 2003 using the Eddy Correlation Flux Measurement (ECOR) systems
- The Gill sonic anemometers and LI-COR H_2O/CO_2 gas analyzers used in the ECOR are no longer manufactured, can no longer be repaired, and ARM is running out of spares, necessitating upgrading of the system
- In addition to upgrading the anemometer and gas analyzer, the new ECOR systems will differ from the current ECOR systems in that they will use EddyPro processing software from within a SmartFlux box (containing a microcomputer) to produce both raw and fully corrected fluxes as outputs to be ingested into the ARM archive
- New data stream, ECORSF, will replace both ECOR and QCECOR datastreams

HARDWARE

- Newer Windmaster sonic anemometer from Gill with improvements to transducers and temperature calculations
- LI-7500DS open-path gas analyzer: reduced cost and power usage
  - Intercomparison of LI-7500DS and LI-7500RS models performed by LI-COR: regression slopes and R^2 for CO_2 and H_2O fluxes near unity
- SmartFlux microprocessor

PROCESSING AND CORRECTIONS

- Data processing and flux corrections computed in SmartFlux microprocessor
- LI-COR EddyPro processing software
- Raw data saved in ARM archive allowing custom reprocessing
- Coordinate rotation, time lag, WPL, and low/high frequency spectral corrections
- QC: steady state, developed turbulence
- Flags: spikes, amplitude resolution, drop-outs, absolute limits, skewness/kurtosis
- Replaces need for QCECOR VAP

COMPARISON TO CO-LOCATED AMERIFLUX SITE

- ECORSF collocated intercomparison with Fermi Prairie AmeriFlux site July-Aug 2018
- AmeriFlux system was designed and operated by the former instrument mentor (Cook), and has the same components and specifications as the current ECOR
- Fully corrected, high quality fluxes were considered (qc flags = 0)
- Flux R^2 between 89% and 95%: lowest agreement for CO_2 fluxes (Fc) and highest agreement for sensible heat fluxes (H), with momentum (τ) and latent heat fluxes (LE) agreement middling
- Mean Normalized Bias (MNB > 0 % indicates |ECORSF| > |AmeriFlux|) was only 1% for H, -6% for τ, -5% for Fc, and 11% for LE
- Magnitude of the daytime LE and Fc are larger from ECORSF than from AmeriFlux, potentially due to increased H_2O and CO_2 sensitivity of the newer LI-7500DS
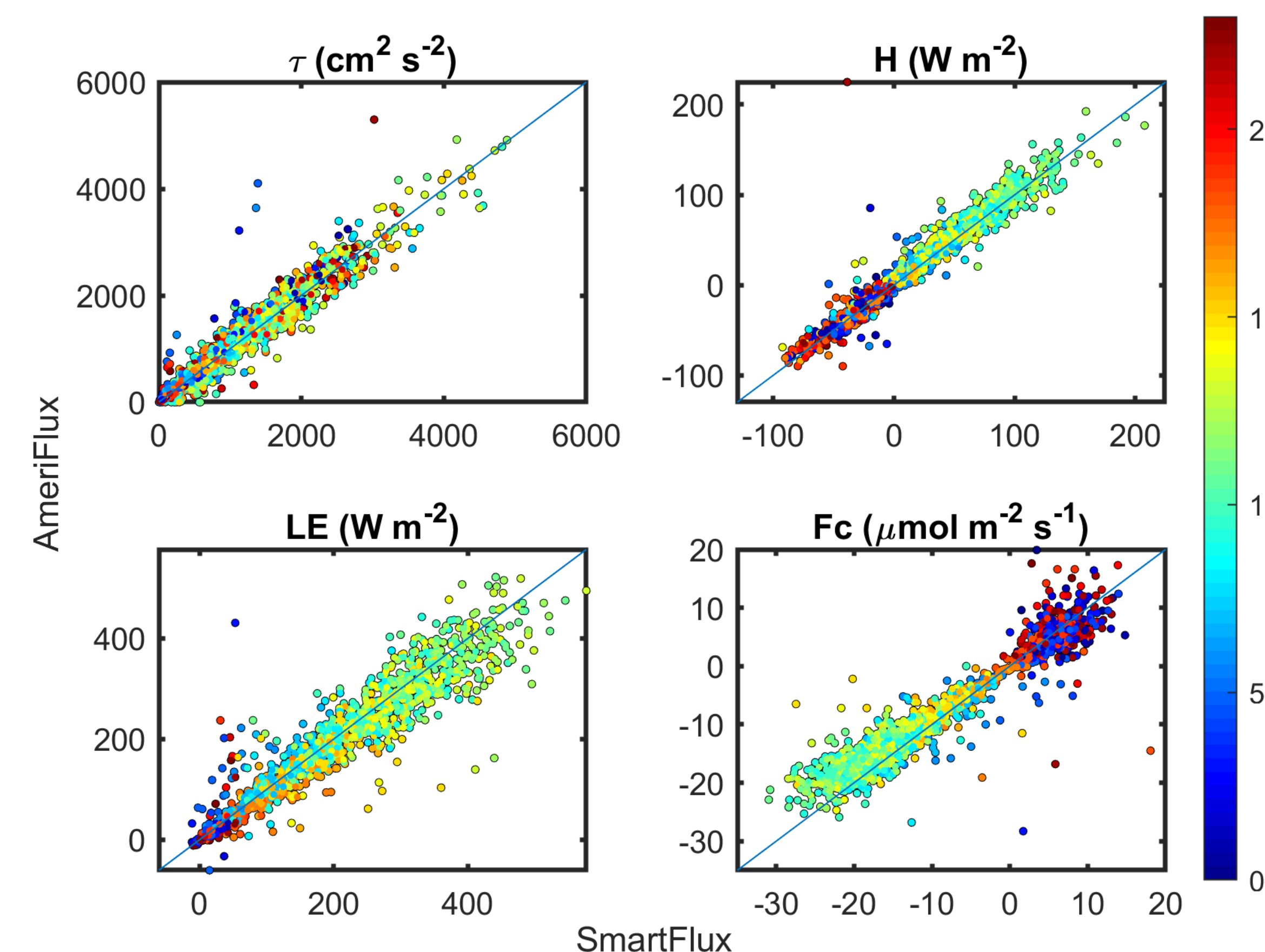
Comparison of collocated ECOR with SmartFlux and AmeriFlux system with identical design as current ARM ECOR. Color depicts hour of day in LST.

IMPACT OF CORRECTIONS ON FLUXES

- Flux corrections increased τ by 2%, decreased H by 2%, increased LE by 6%, and decreased Fc by 18%
- Flux corrections increased daytime τ by 1%, decreased H by 11%, increased LE by 11%, and decreased Fc by 25%
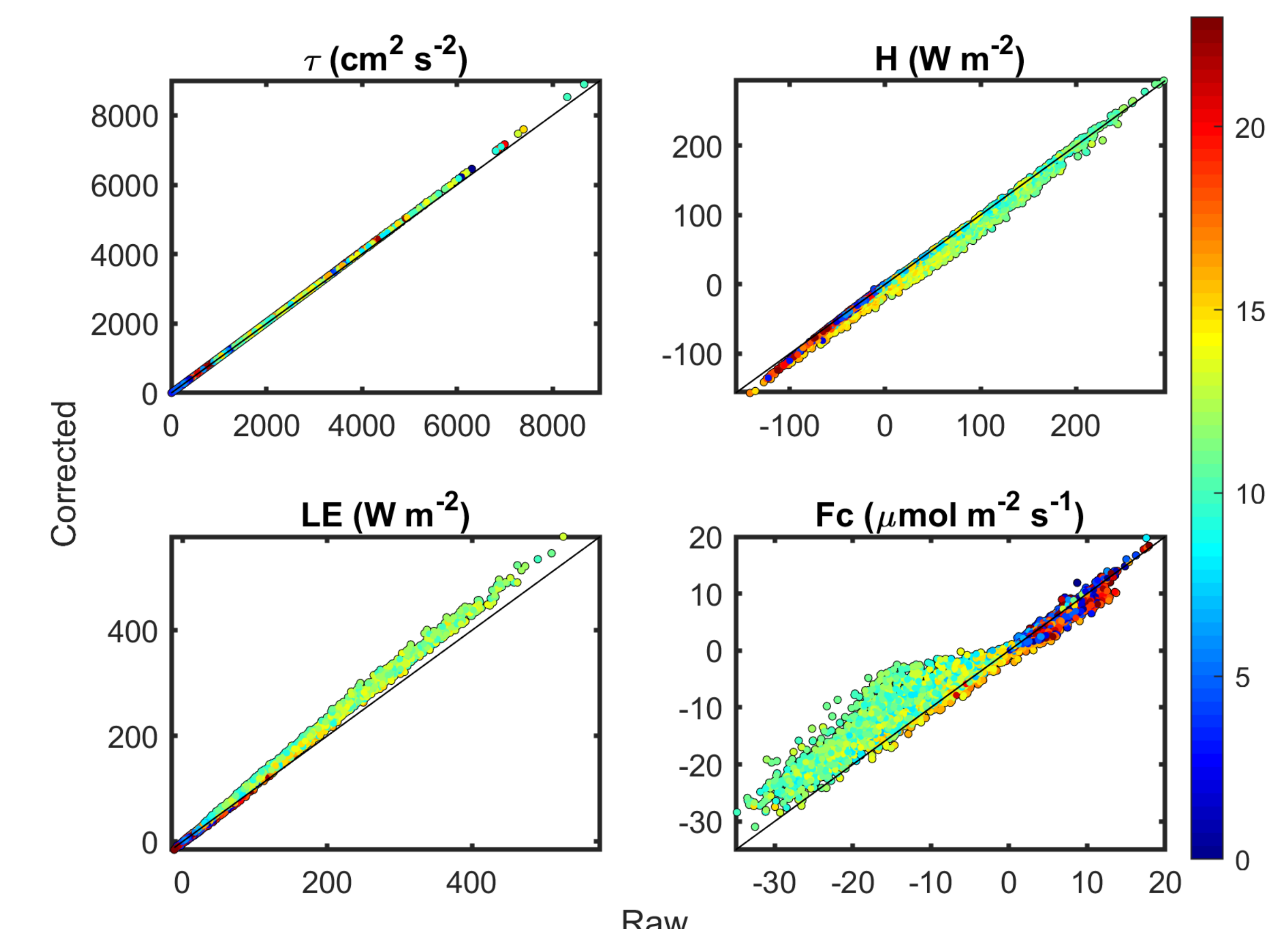
Comparison of fluxes before (raw) and after application of corrections comparable to the current ECOR VAP (July-Oct 2018). Color depicts hour of day in LST.

NEXT STEPS

- The replacement systems have been purchased, and will be built at ANL upon delivery
- Expected to replace all SGP ECOR systems summer/fall 2019
- Replacement of remaining systems at ENA, NSA, and AMF1/2/3 to follow

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