Lessons Learned From AmeriFlux Site Visits

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Chad Hanson, Dave Billesbach
and
the AmeriFlux Community

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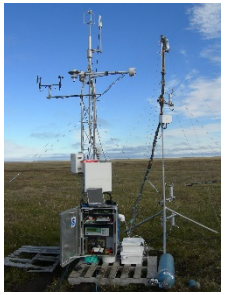
Berkeley CA

The AmeriFlux network

- Coalition of the willing



Barrow, AK

Everglades, FL

Bartlett, NH

Rosemount, MN

Chimney Park, WY

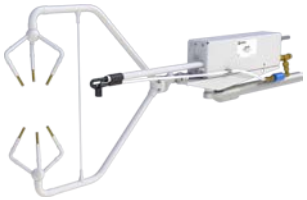
Audubon, AZ

Really, Trumpville

Valles Caldera, NM

- No Instrument / Data Processing Standardization

  => “know thy site”



Purpose and objectives

Assess and enhance data quality reported to the network

- Tech Team works closely with site staff;
- Site visits are short term (~2 weeks), side-by-side comparisons using an independent reference system called the portable eddy covariance system (PECS);
- Identify differences in systems whether due to instrumental bias, instrumental error, or data processing.

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Make AmeriFlux Great Again!

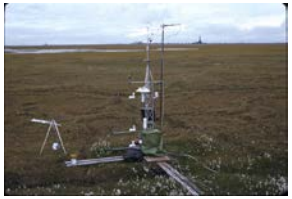
Sherman Island, CA

AmeriFlux Tech Team (then)

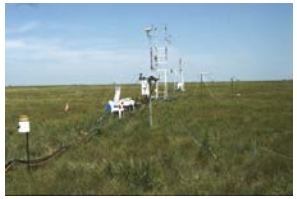
- PI: David Hollinger (1997-2001)
- Tech team: David Hollinger and Bob Evans
- First site visits in May 1997 at Howland
- PECS: LI-6252/CSAT

Howland

Walker Branch



UPAD

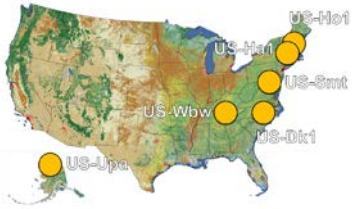


Schidler

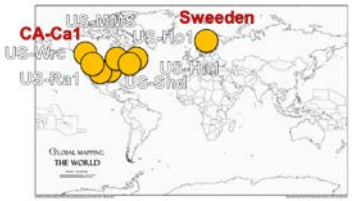
Lethbridge

Austin Cary

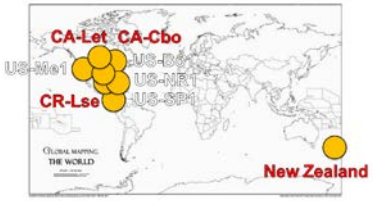
1997



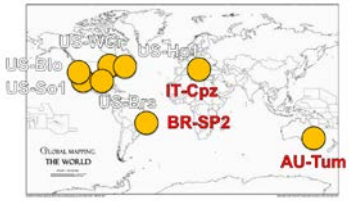
1998



1999

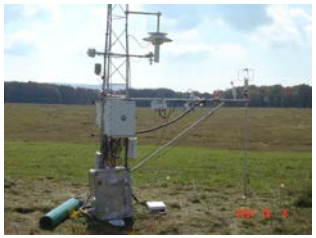


2000

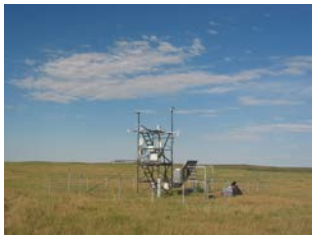


AmeriFlux Tech Team (OSU)

- PI: Bev Law (2001-2012);
- Tech Team: Uli Falk, Hank Loescher, Troy Ocheltree, Hongyan Luo, James Kathilankal, Andres Schmidt, Chad Hanson, and Stephen Chan;
- PECS: LI-7000 / CSAT;
- # site visits: 5-20 per year!



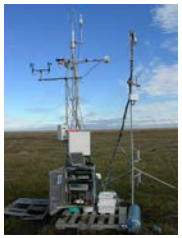
Canaan Valley



Cottonwood

Sevilleta

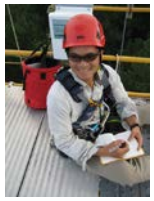
Fermi Lab



Ivotuk

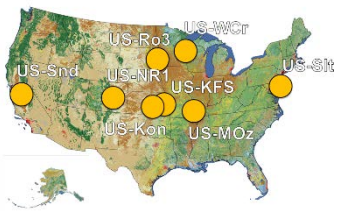
Sierran Mixed Conifer

AmeriFlux Tech Team (now)

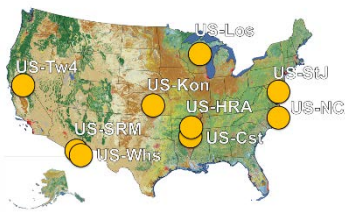


- 2012-present
- Tech Team: Sebastien Biraud, Stephen Chan, Sigrid Dengel, Chad Hanson, and Dave Billesbach
- PECS: LI-7200 / LI-7500A / Gill R3-50

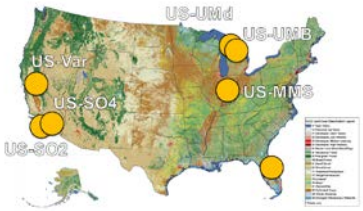
2013



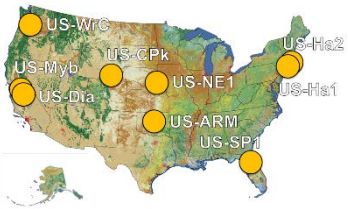
2015



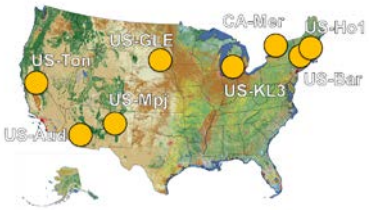
2017



2014



2016



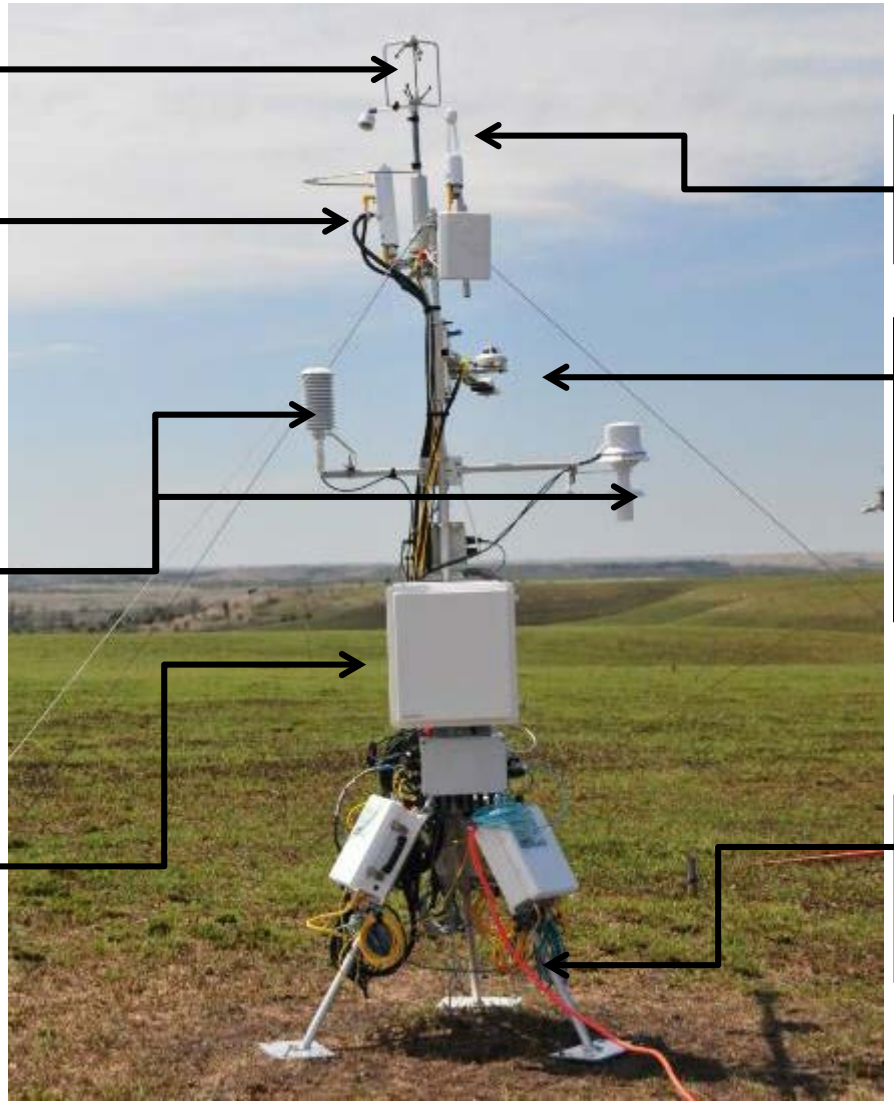
Portable Eddy Covariance System (PECS)

Sonic anemometer
(Gill, R3-50)

Gas analyzer 1
- Closed path IRGA (LI-COR, 7200)
- Short inlet (<1 m), fast flow (15 LPM), insulated

Met. Sensors
- Aspirated Platinum RTD (R.M. Young, 41342)
- T_{air} and RH (Vaisala, HMP155)

Acquisition system
- CPU
- Datalogger (Campbell, CR1000)
- Networking (Cellular modem)
- Barometer (Vaisala, PTB110)



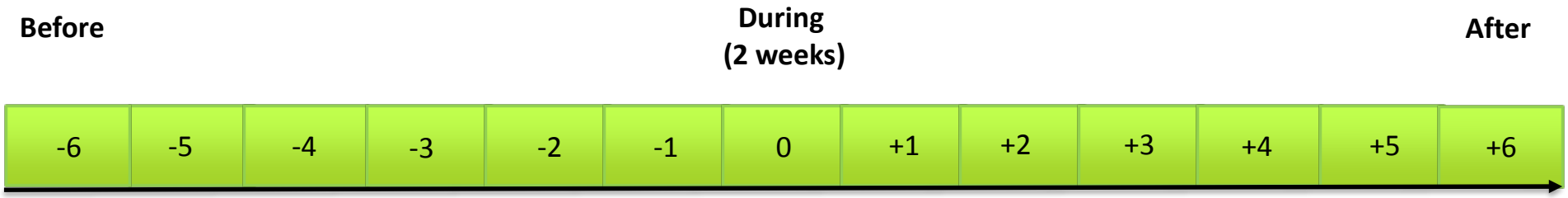
Gas analyzer 3
- Open-path IRGA (LI-COR, 7700) -> not shown

Gas analyzer 2
- Open-path IRGA (LI-COR, 7500A)

Radiation sensors
- 4-component radiometer (Kipp & Zonen, CNR4)
- Sunshine pyranometer (Delta-T, SPN1)
- Up- and down-welling PAR (Kipp & Zonen, PQS)

Power (options)
- Line power;
- Gas generator
- Solar panels / batteries

Site visits Description



Sites assessment
Sites pre-selection (15)

Initial response from PIs
Scheduling (10)
Observations review

Logistics

Setup
Mid-campaign comparison
Take-down

Tech Team & site PI interaction

High frequency processed data
Final report

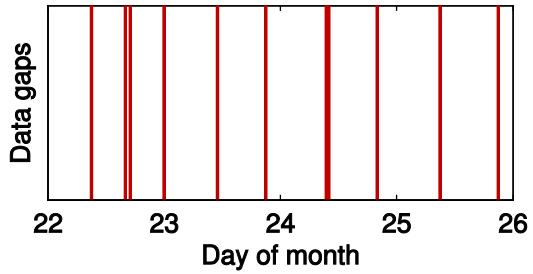
http://ameriflux.lbl.gov/tech/site-visits

Highlights from the last 20 years

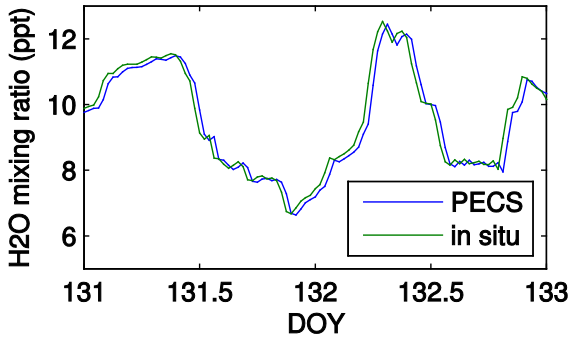
- PECS used as platform to evaluate new eddy covariance instrumentation (Novick et al. 2013; Burba et al., 2011);
- Empirical assessment of uncertainties in the AmeriFlux network from 2002-2012 (Schmidt et al., 2012);
- Vertical wind velocity errors associated with sonic anemometer geometry first identified following PECS visit (Frank et al., 2013);
- W-boost error in Gill anemometers. Missing calibration factor (16.6% and 28.9% for vertical wind) identified through site visit synthesis (see Gill WindMaster manual, issue 10).

Site visits Results: initial QA/QC

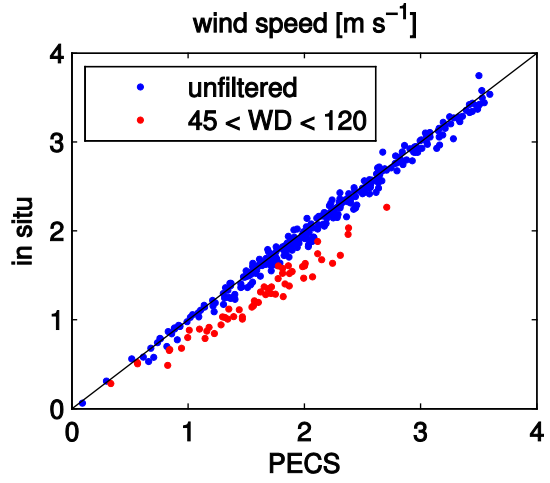
- Gaps in high frequency data due to inadequate logging systems:



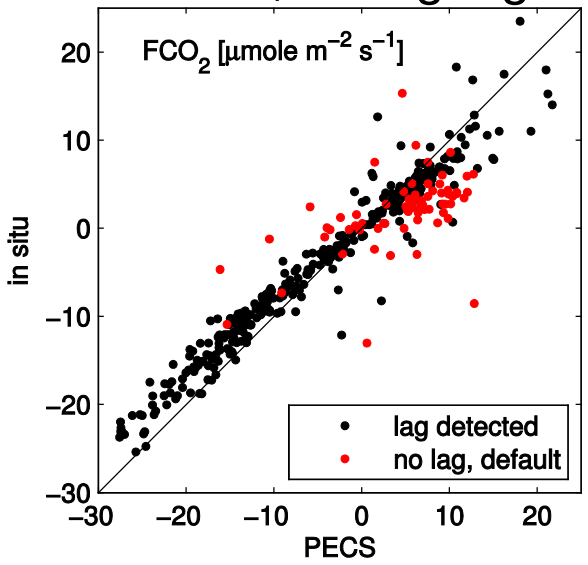
- Temporal shifts in time series data (hysteresis on scatterplot):



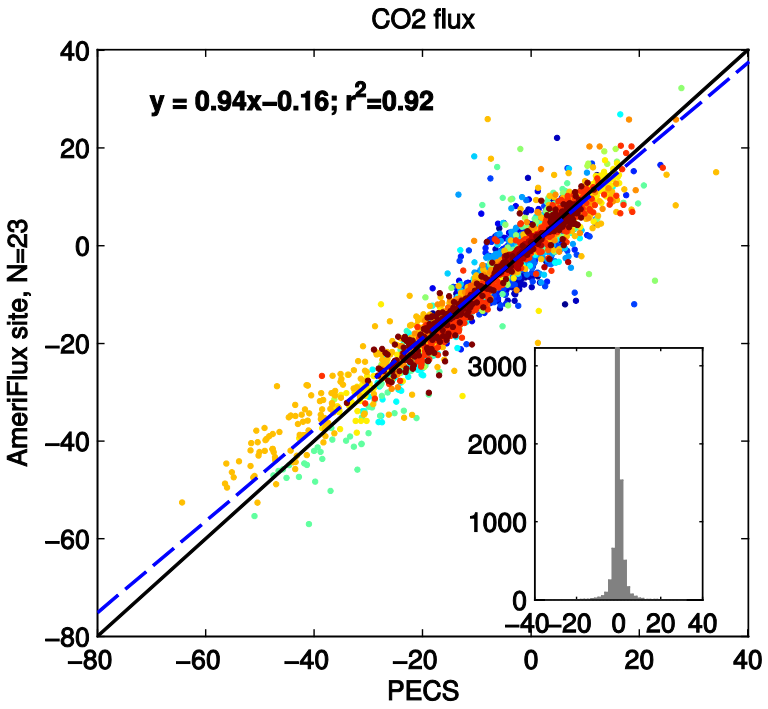
- Filtering for environmental conditions:

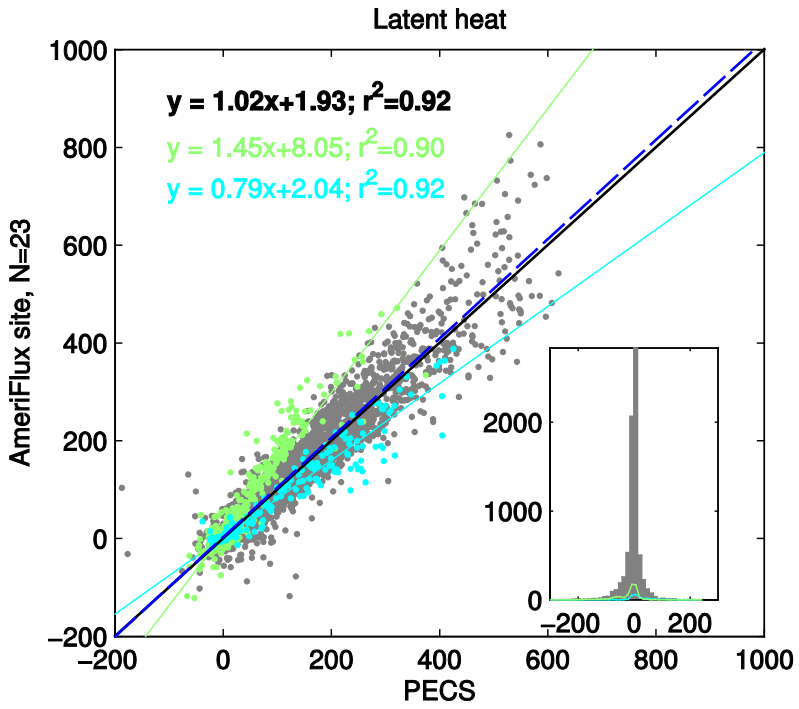


- Data processing errors (missing corrections, wrong lags used):



Site visits Results: CO2 and Latent Heat Fluxes

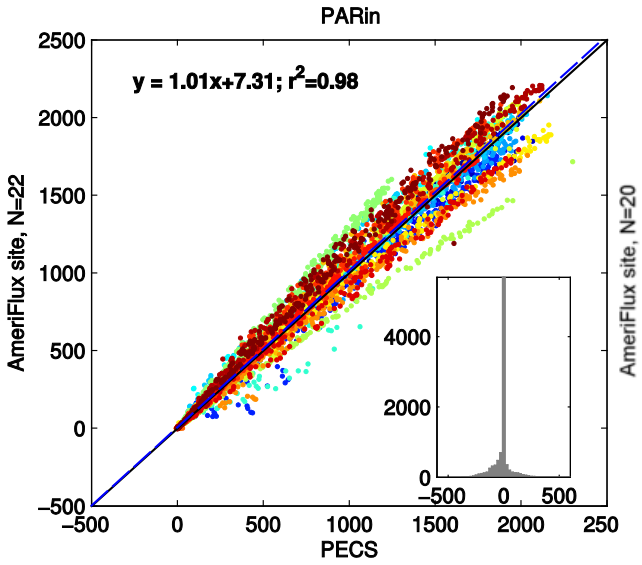


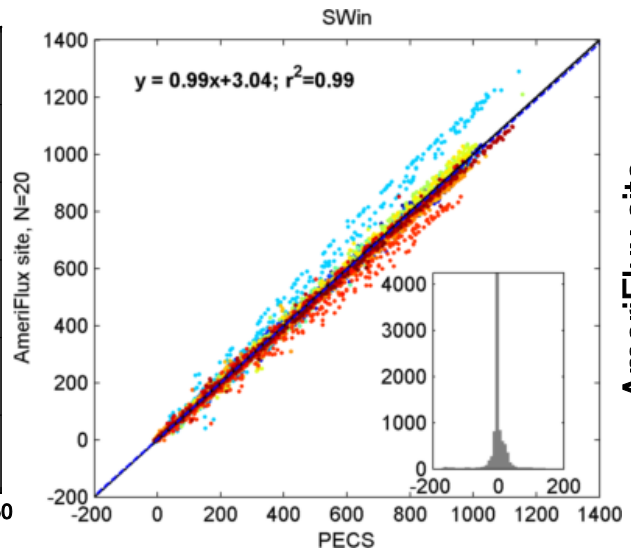


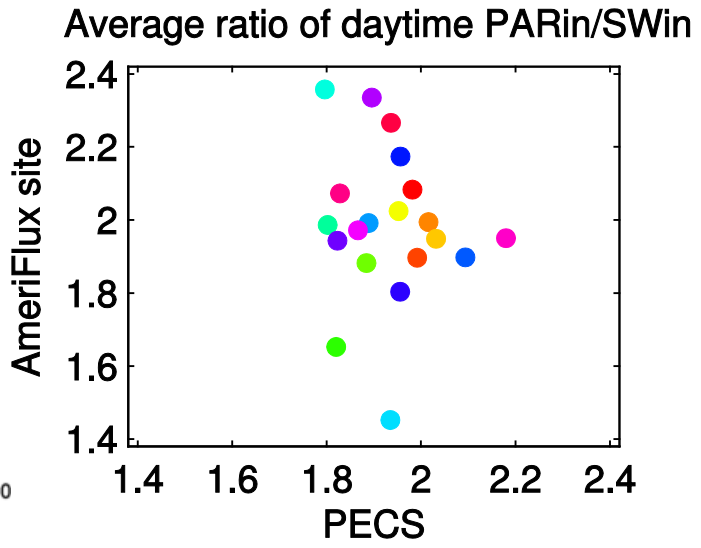
- No systematic bias!
- But
  - Sites with fluxes ~0 => large (negative) w'c' covariances + large (positive) density terms
  - Larger differences in LE are due to sensor drifts and challenges in calibration of H_2O.

Site visits Results: PAR

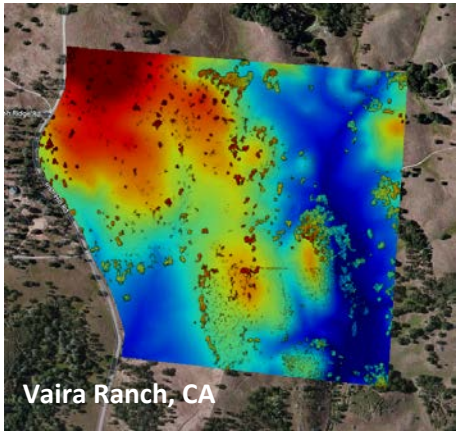
- Individual regression slopes ranged from 0.77 to 1.27;
- Sensor degradation, infrequent calibration, lack of uniform calibration standards, incorrect or out of date coefficients;
- Strong effort to improve PAR observations, not really working….
- Next step?

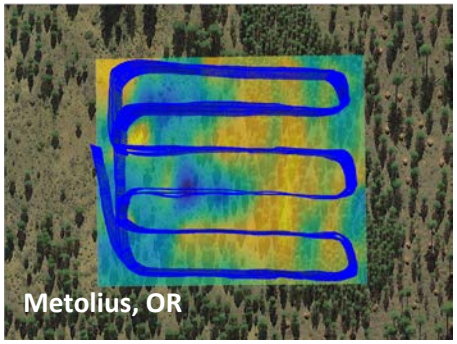






Site visits Results: New Capabilities





- Map horizontal and vertical concentrations of CO_2, CH_4, and H_2O;
- Determine mixing heights within tower footprint and sources and sinks-hotspot mapping;
- Surface Fluxes can be derived from UAS-based GHG measurements:
  - Data/model fusion and scaling approaches (XU et al., 2016).
  - GeoStatistical inversion approaches (Tadic et al., 2017).

Site visits Summary

- Synthesis of independent observations using a portable eddy covariance system across the AmeriFlux network finds no systematic biases but highlights variables with largest differences;
- Errors in latent heat fluxes were highly correlated to out-of-calibration or poorly calibrated gas analyzers (for open-path analyzers);
- PAR measurements across the network showed considerable range compared to the PECS whereas SW_{in} did not. SW_{in} may serve as a proxy for PAR;
- Challenges: Current approach is not scalable but critical;
- New ideas:
  - “Ecologist in a Box” concept (biometric collection, BADM, …)
  - UAS