The GHG impacts of AWD and other rice production practices: eddy covariance studies in Arkansas

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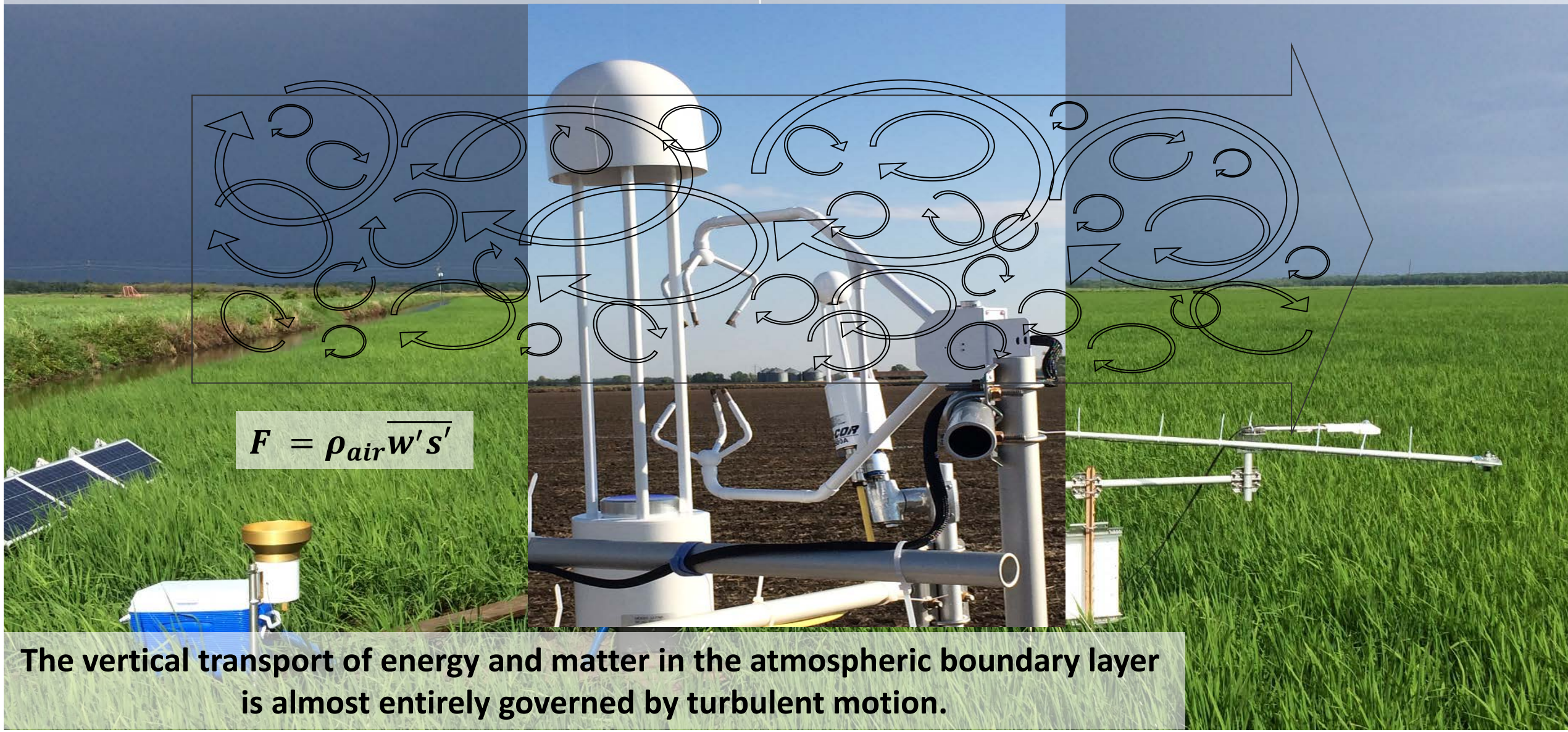
Outline

- Eddy covariance
- Experiment with AWD
- Multi-farm measurements
- Ongoing / upcoming work:
  - Rice husk amendments
  - Ratoon rice production
  - Fish in the fields

Photo: Dawson Oakley, summer 2021

Rice field in Arkansas: flat, homogeneous landscape



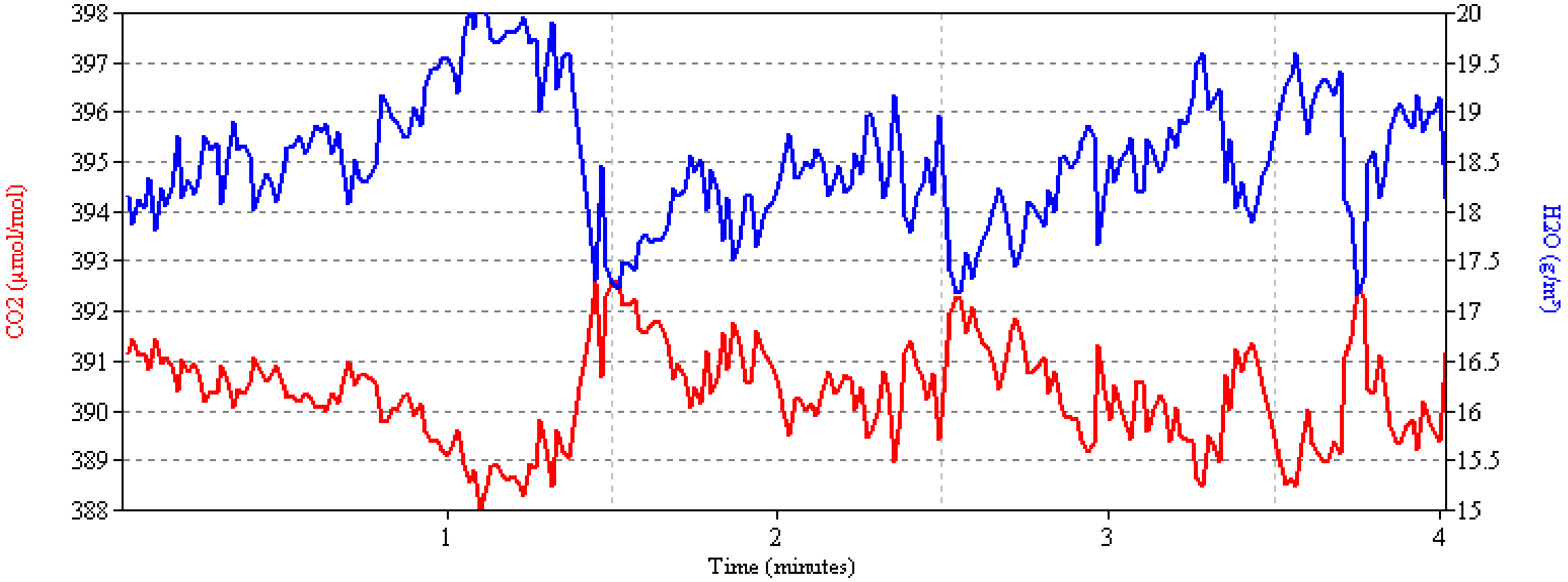
$$F = \rho_{air}\overline{w's'}$$

The vertical transport of energy and matter in the atmospheric boundary layer is almost entirely governed by turbulent motion.

Figure modified after LI-COR, Inc.

w' = vertical wind fluctuations, s' = scalar concentration fluctuations

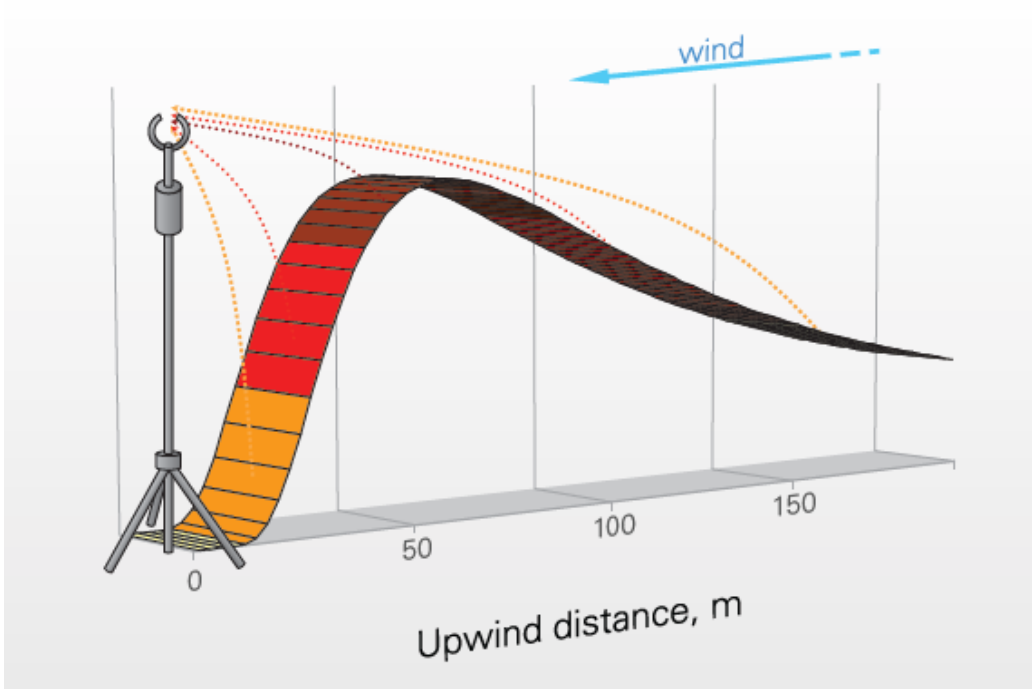
CO_2 and H_2O concentrations & transport on a May afternoon



Just 4 minutes!

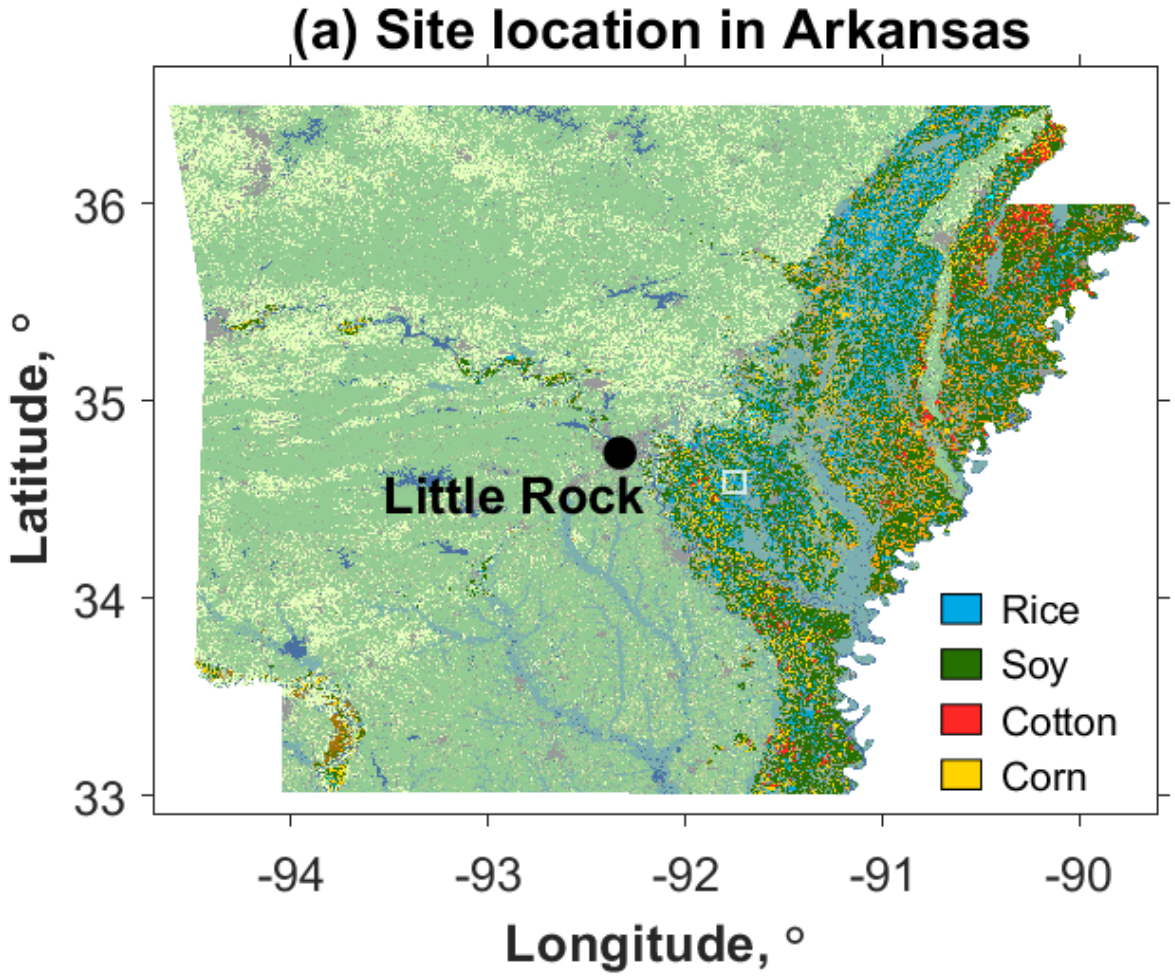
Eddy covariance “footprint” ~100-200m

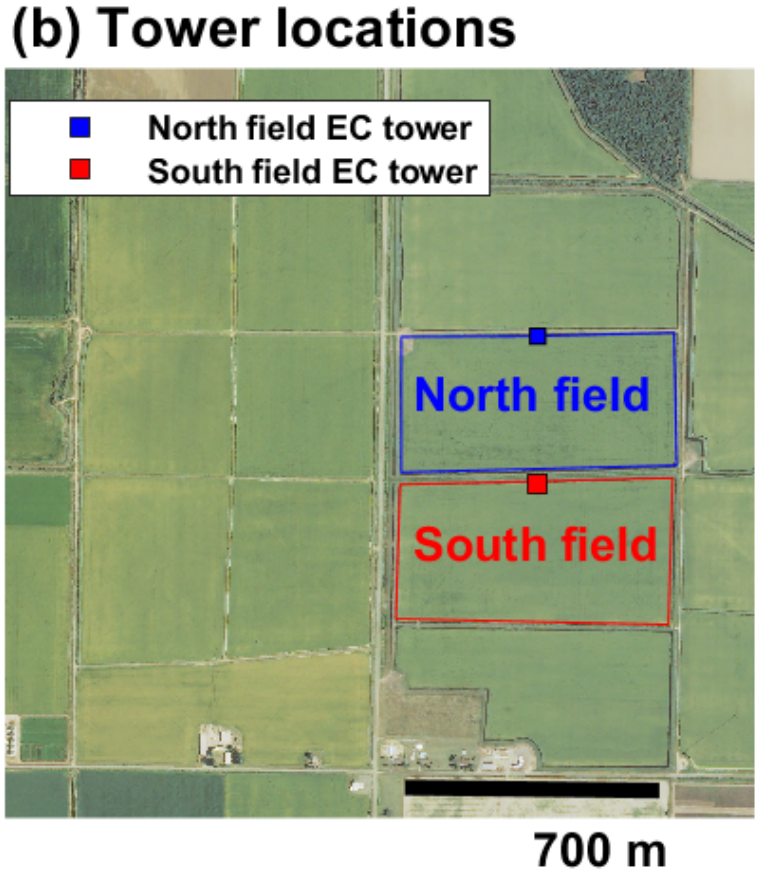
- Ideal for landscape or field scale
- Provides surface energy, H_2O, CO_2, CH_4, N_2O** fluxes
- Challenging for multiple treatments
- Good for paired-field experiments of a treatment vs. control



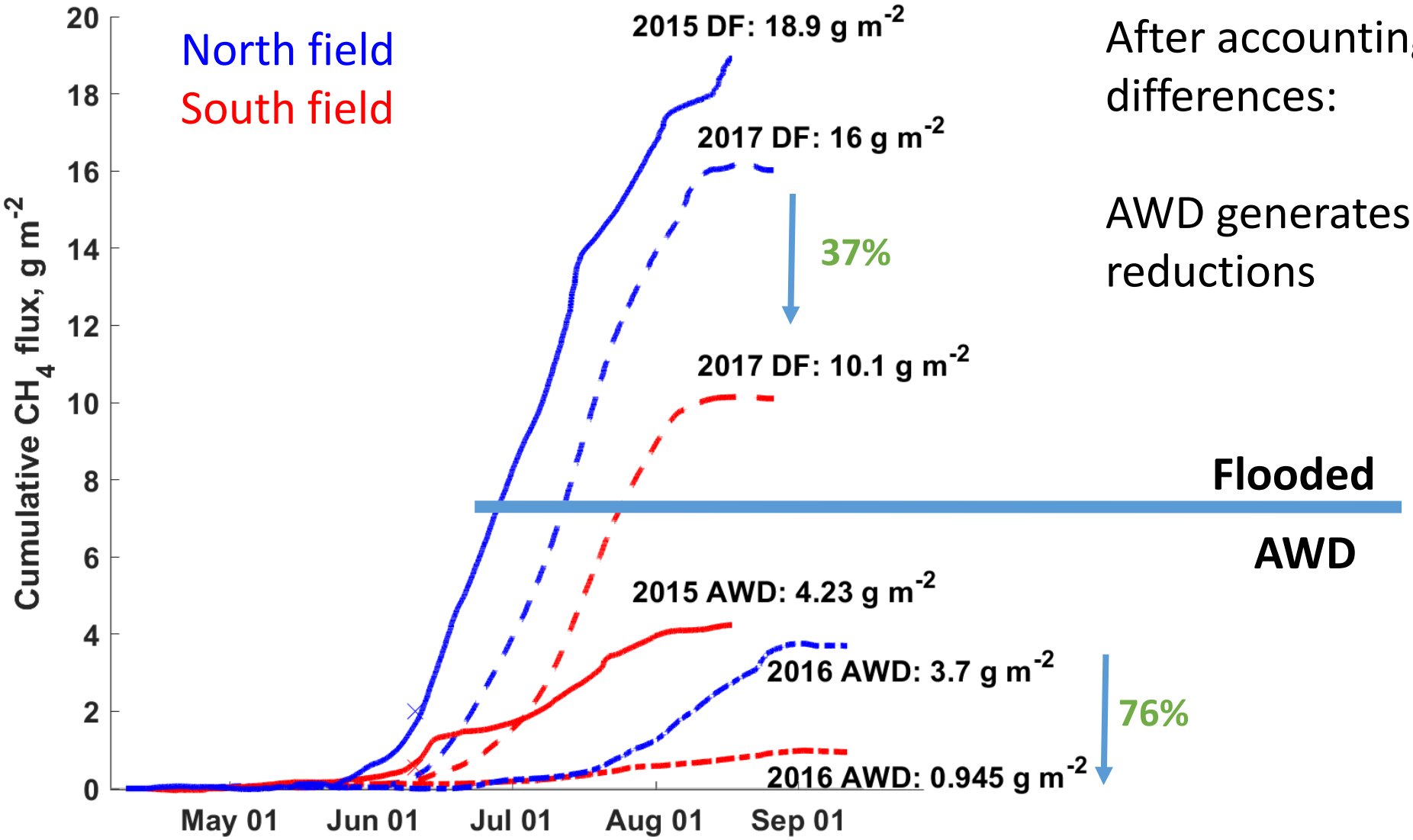
Burba 2013

Experiment 1: Comparing rice irrigation strategies on adjacent 70-acre fields in central AR





Three years of data: robust evidence to support AWD

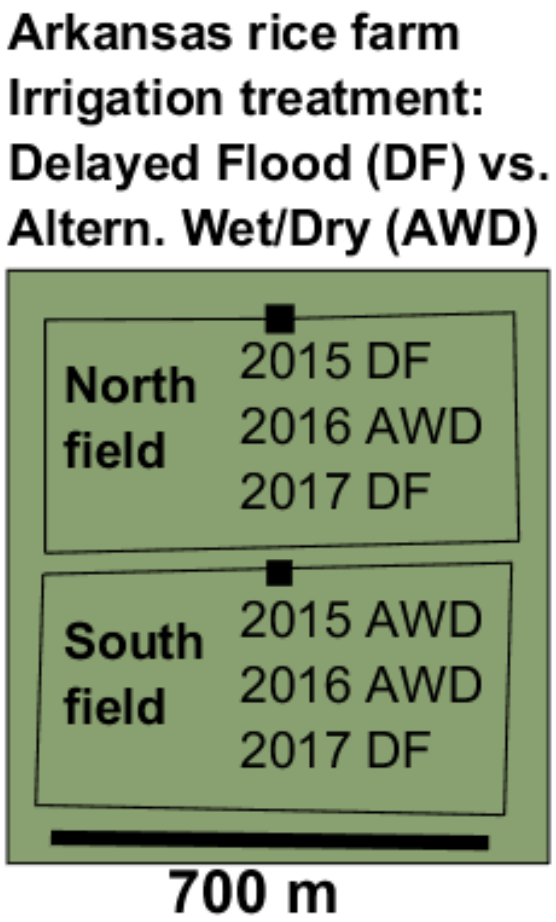


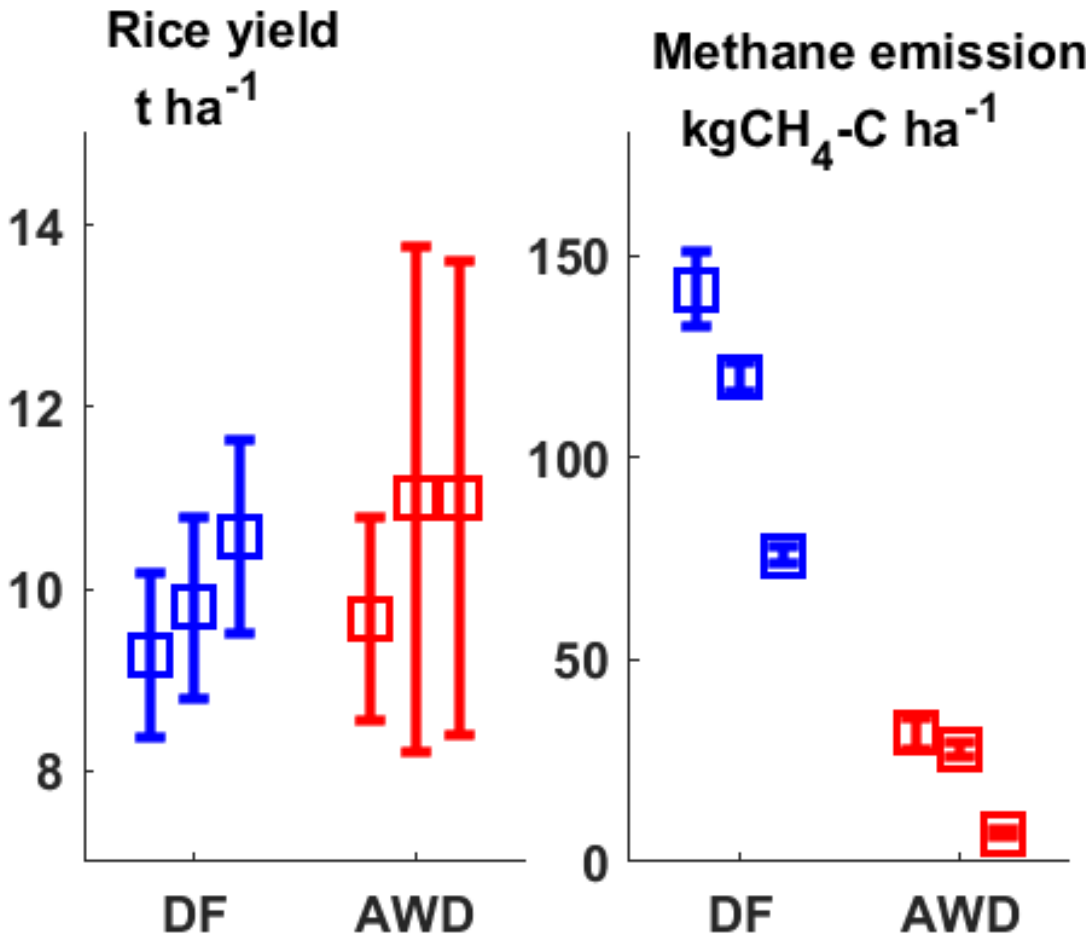
After accounting for field-to-field differences:

AWD generates 64.5% CH_4 emissions reductions

Runkle et al, 2019, ES&T

- No differences in yield
- AWD reduces CH_4 emissions by 64.5%

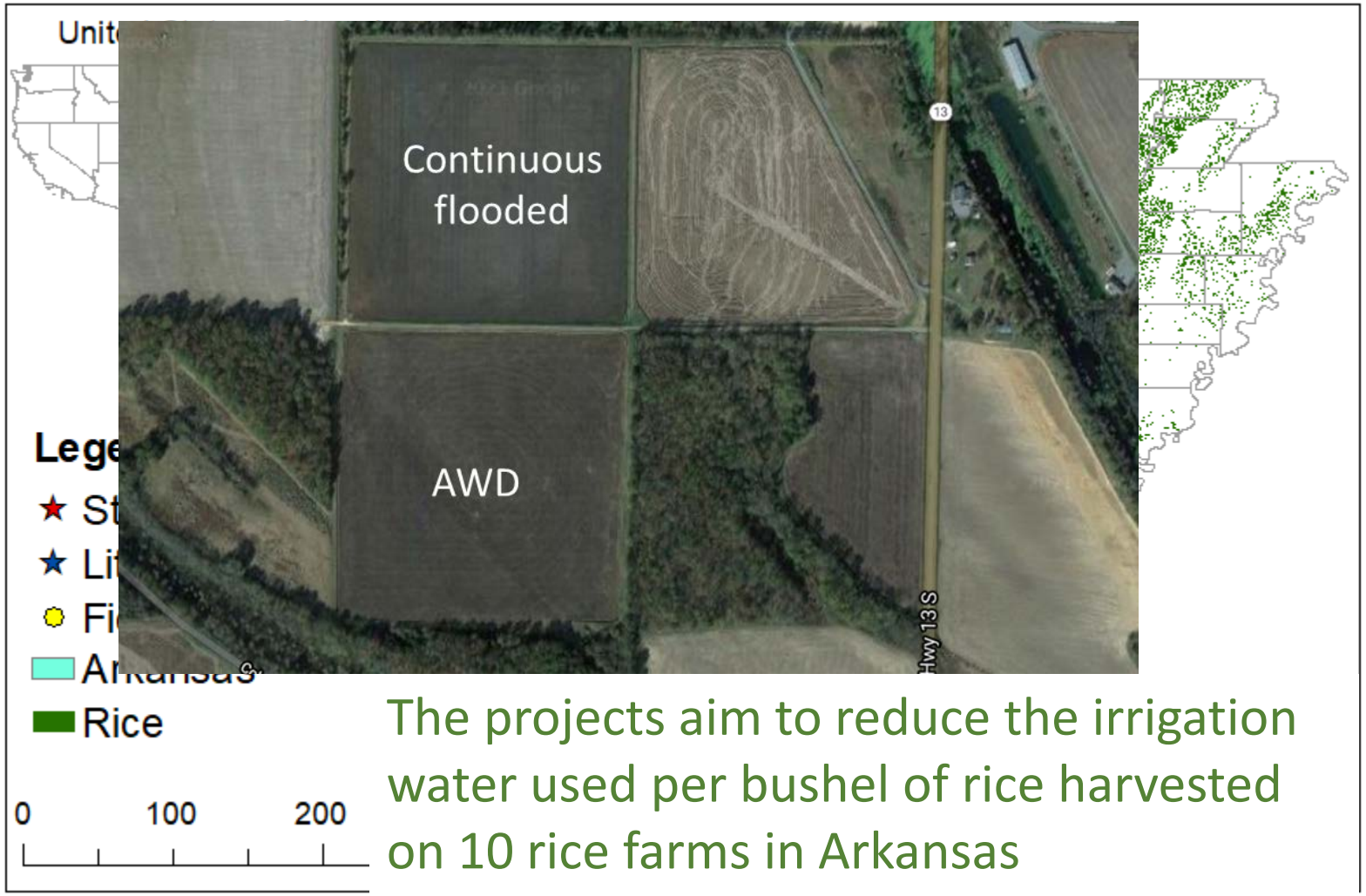




Runkle et al, 2019, ES&T

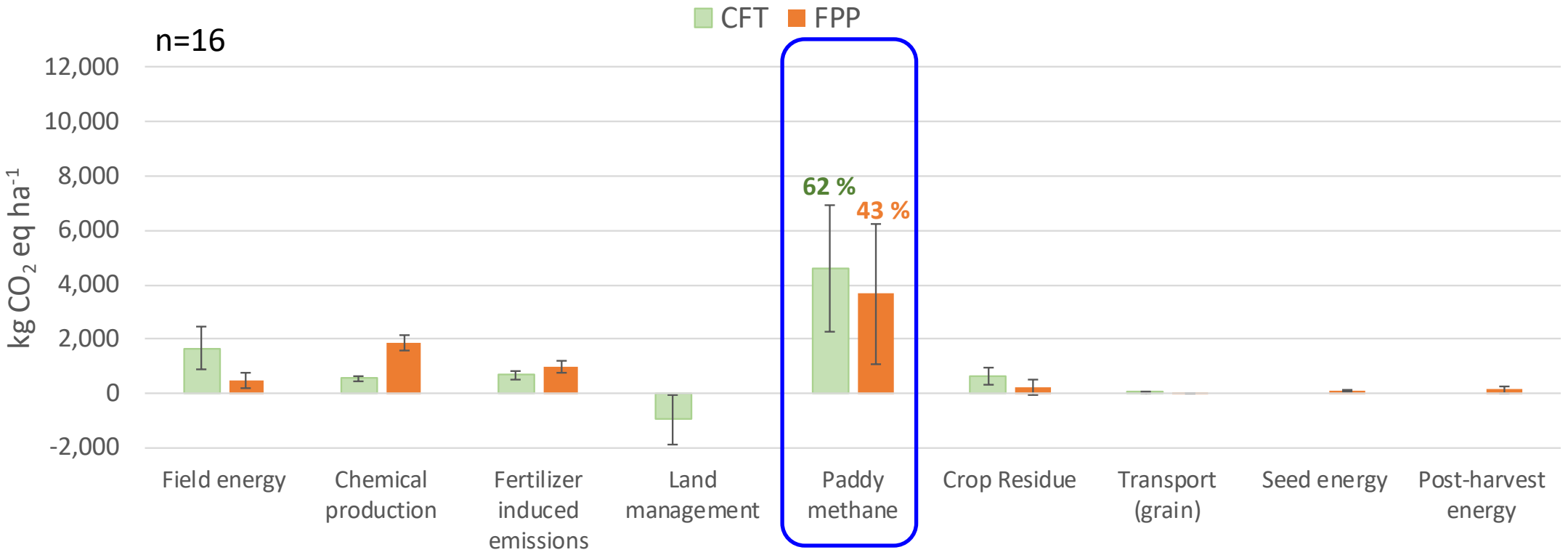
Experiment 2: "Water sustainability in Arkansas rice fields"

- 10 farms in Central-Eastern Arkansas, years 2018 & 2019, 2021-2022.



The projects aim to reduce the irrigation water used per bushel of rice harvested on 10 rice farms in Arkansas

We combined results across ~20 fields (2018-2019)
The GHG metric shows predominance of CH_4

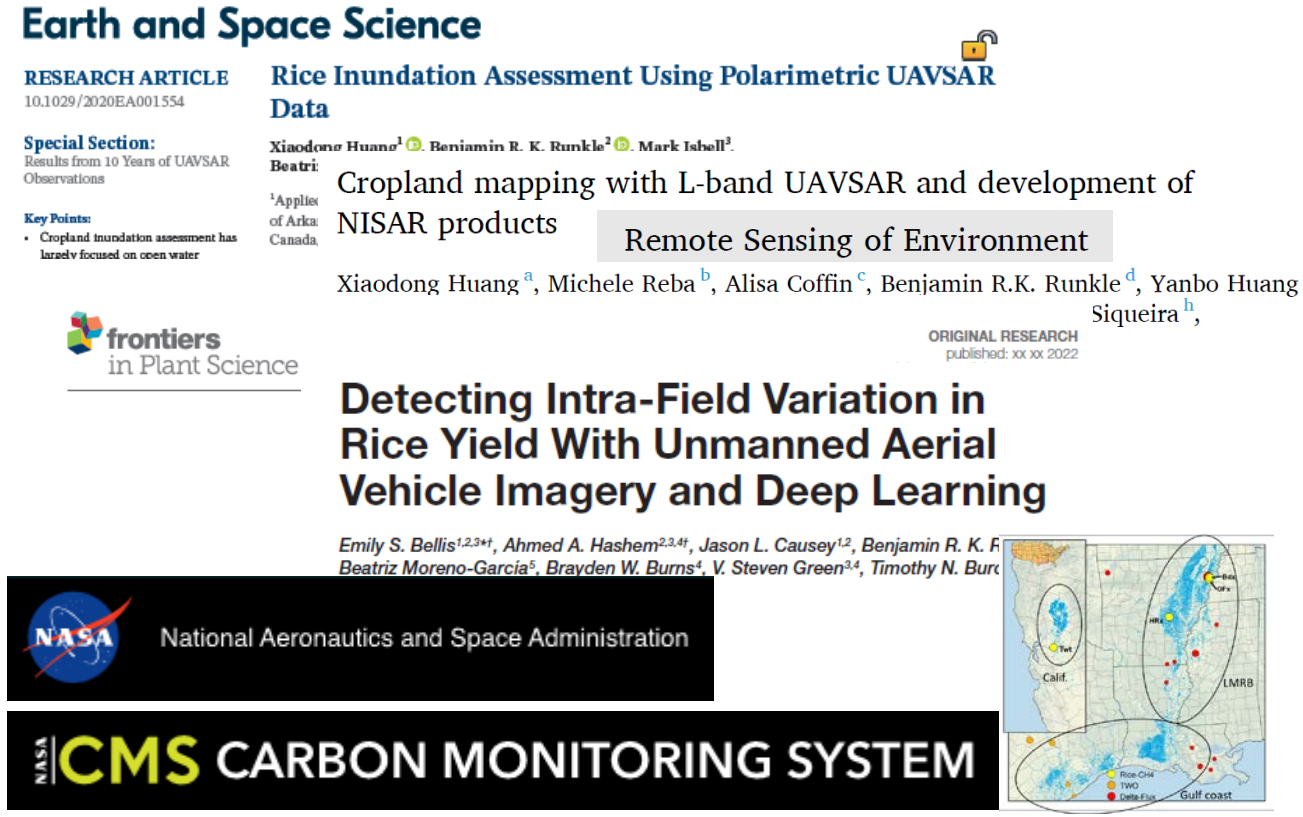


- Paddy methane is the component that most contributes to total GHG emissions
- Multiple aeration practices (AWD or furrow-irrigation) are critical

Moreno-Garcia et al. 2021, *J Cleaner Production*

Experiment results and scaling

- Farmer engagement
- More data as a basis for extrapolation



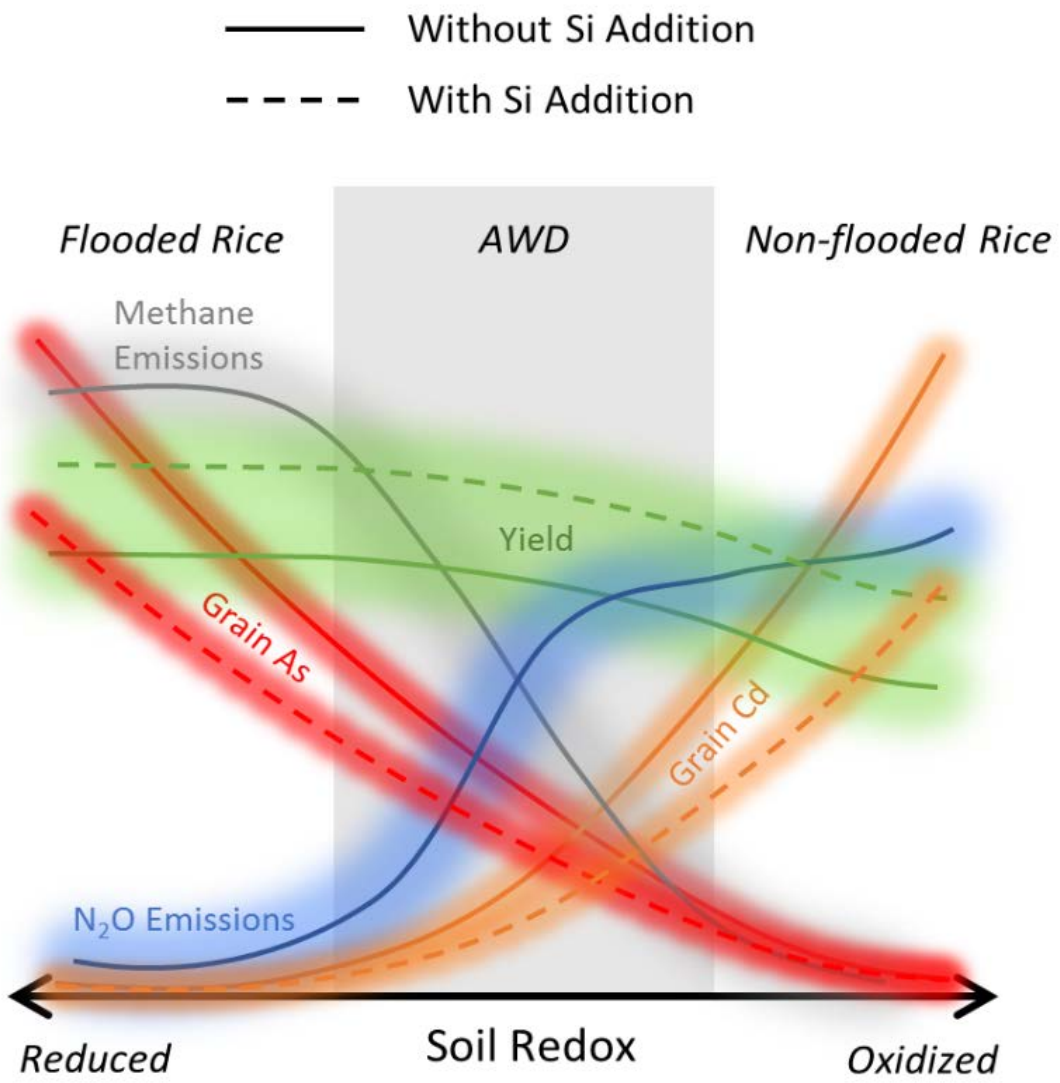
Many farmers were interested in the results and we saw a change in farmer behavior as the project progressed.

They learn:

Paddy methane is important, and avoidable

Water savings can bring co-benefits

Current work: Husk amendments to close the Si cycle in rice agroecosystems



Circular food systems approach

PI: Angelia Seyfferth (Delaware)

Co-I: Matt Reid (Cornell)

USDA-NIFA-AFRI grant

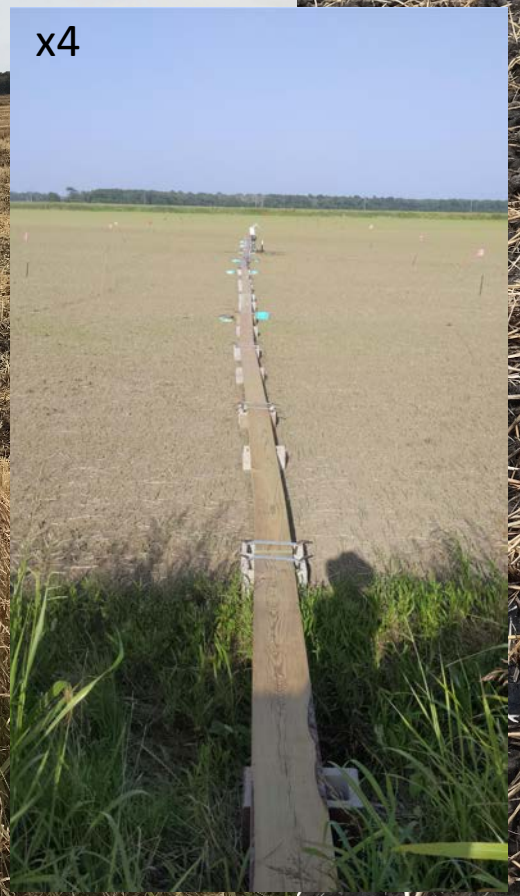
Runkle et al. 2021, *Frontiers in Agronomy*

USDA National Institute of Food and Agriculture
UNITED STATES DEPARTMENT OF AGRICULTURE

November 2021:

Testing rice-based Si-amendments (husk)

1. Si serves as a nutrient
2. Si out-competes As to get into the grain
3. Cd adsorption onto husks



Ratooning rice

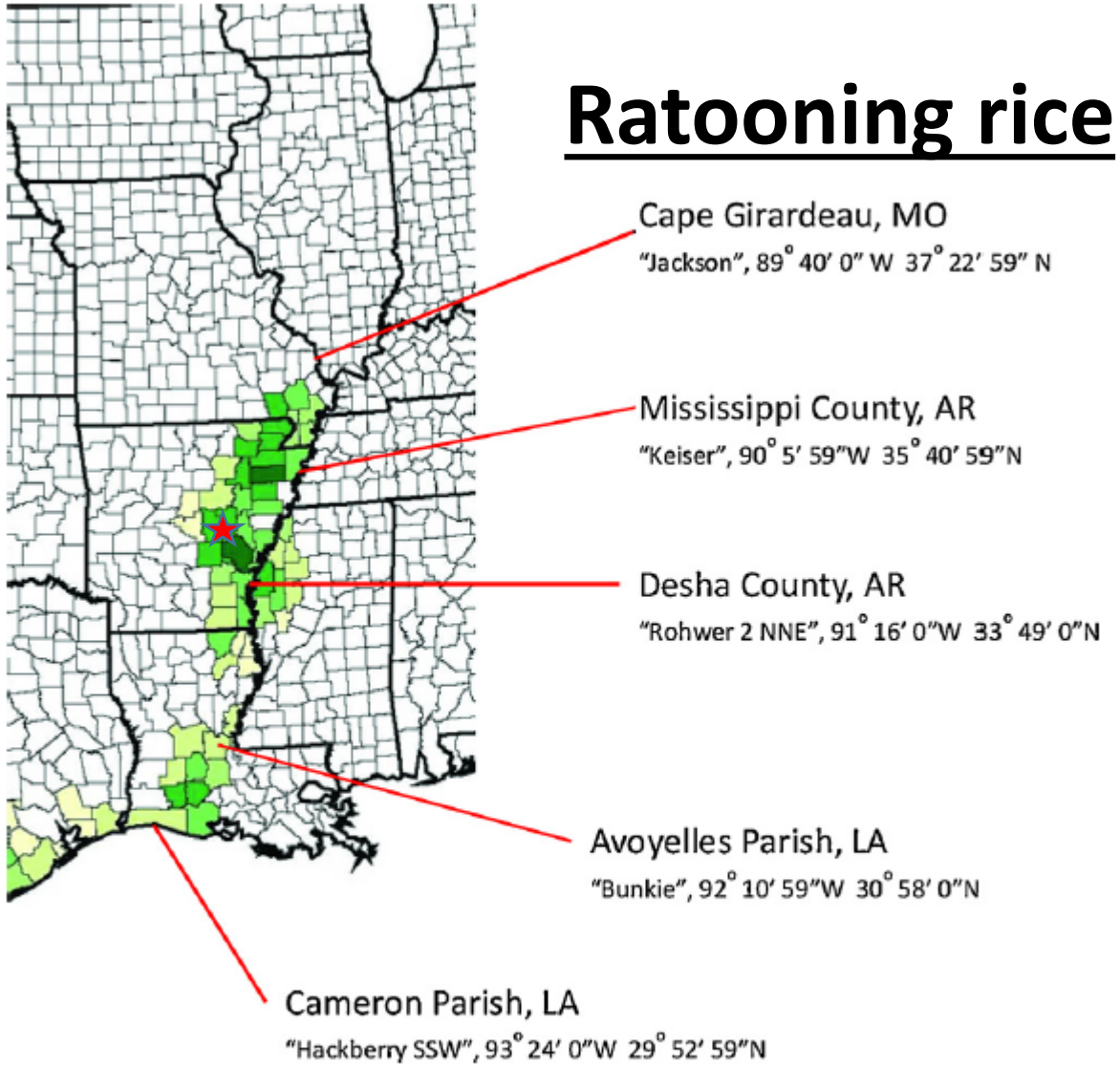


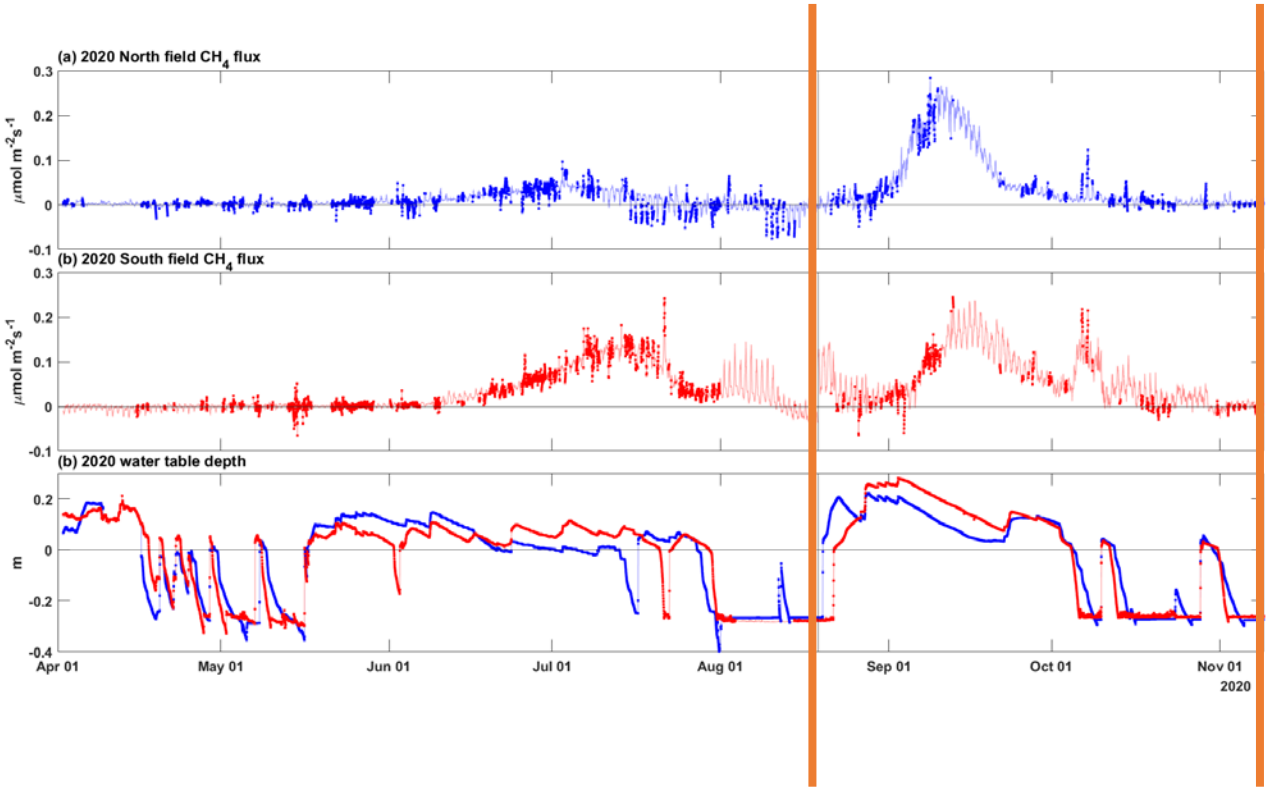
Fig. 1. Geographic description of weather stations by county/parish. Original map was extracted from USDA NASS (2010). Weather stations are from https://beaumont.tamu.edu/CLIMATICDATA/WorldMap.aspx.

Ziska et al 2018 AFM

"The recent and projected increases in temperature and seasonality indicate that ratooning could already be adopted in Avoyelles Parish, and is potentially possible as far north as Cape Girardeau County (37 °N) by the end of the 21st century"

Ziska et al. 2018, AFM, "Ratooning as an adaptive management tool for climatic change in rice systems along a north-south transect in the southern Mississippi valley"

2020 ratoon study
Led by graduate student Rita Leavitt



Note: Past ratoon studies range 8-540 kg ha^{-1}

Field	Yield (t ha^{-1})		Ratio	CH_4 flux/area (kg ha^{-1})		CH_4 flux/yield (kg CH_4 ton^{-1})	
	Main	Ratoon	%	Main	Ratoon	Main	Ratoon
North	10.9	1.3	12	11.0	39.7	1.0	30.5
South	10.8	1.5	14	40.7	50.7	3.8	33.8

And this winter…

Resource Renewal Institute
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FISH IN THE FIELDS

Fish in the Fields (FIF) addresses two of today's greatest human challenges – climate change and forage fish extinction – by harnessing ecological processes and borrowing from global agricultural traditions. FIF is designed to work towards large-scale adoption of fish/rice co-cultivation in viable areas and to become financially independent within 3-5 years.

Chance Cutrano, RRI

Fish in the Fields NEWS READ ALL NEWS »

"CALIFORNIA WATER RIGHTS ATLAS" OPENS TO PUBLIC:

12 Apr 2013

Empowers Citizens, Unlocks Information,
Water Management SACRAMENTO, CA
Administration Resources Secretary Hue
president of the Resource Renewal Instit
unveiled...

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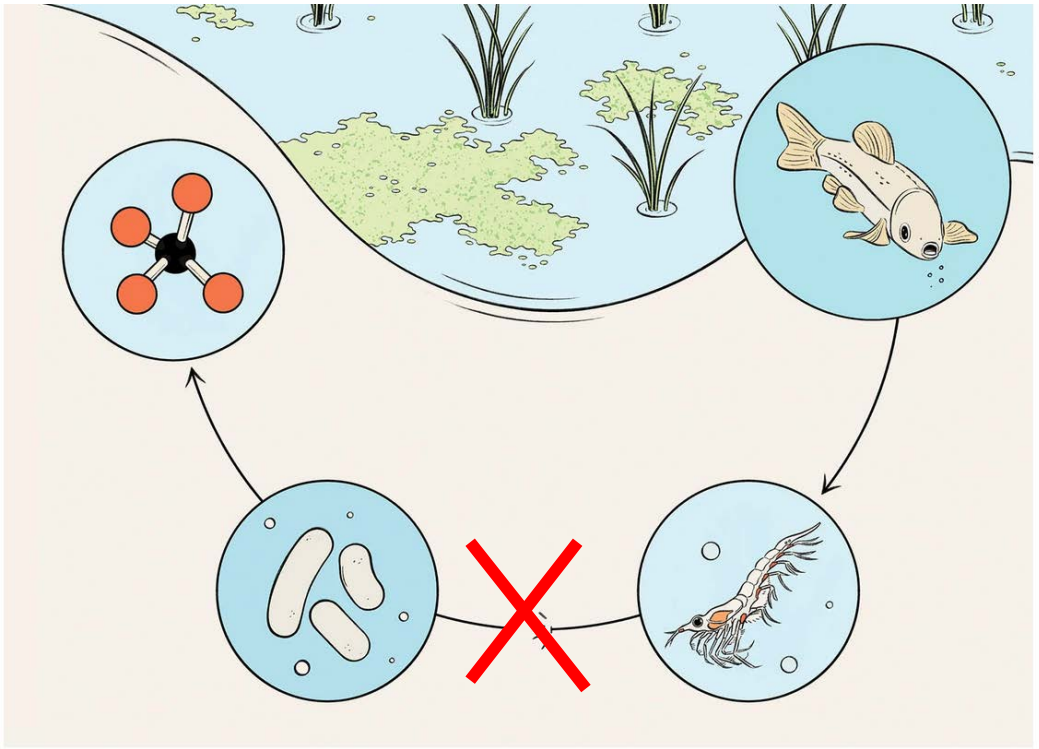
View Our Work in the Field

FISH IN THE FIELDS GALLERY



The fish eat the zooplankton that would have eaten the methanotrophs, so methanotrophy can continue… while creating an extra protein source

Concluding thoughts

- Flux towers provide benchmark data + process understanding at the scale of remote sensing observations and process models
- They fill in a gap at the critical ecosystem or management scale
- Couple with chamber measurements to test treatment effects (e.g., husk addition) or get fluxes of other gases (N_2O)

Photo: Dawson Oakley, summer 2021