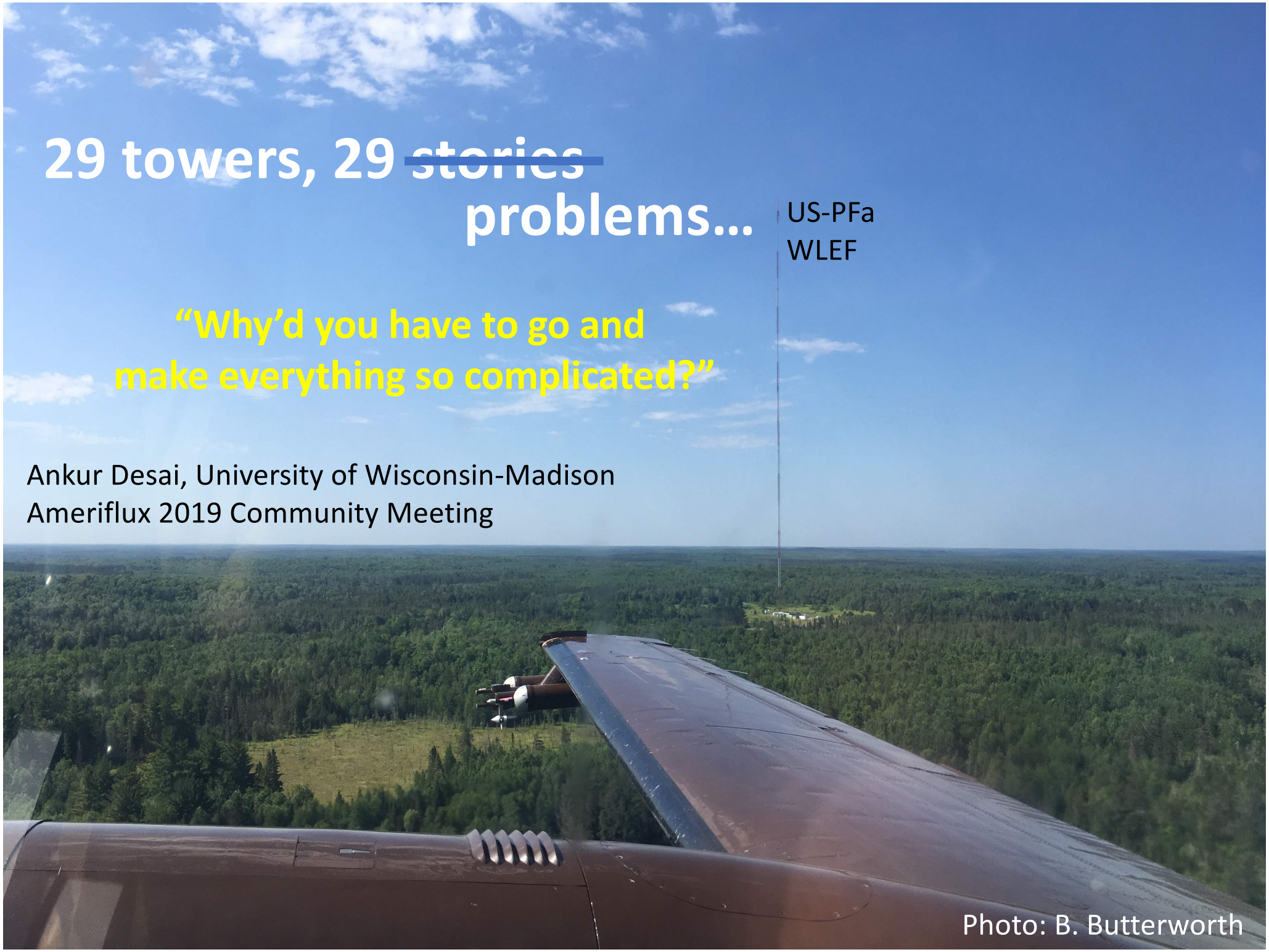

29 towers, 29 stories
problems…
US-PFa
WLEF
"Why'd you have to go and
make everything so complicated?"
Ankur Desai, University of Wisconsin-Madison
Ameriflux 2019 Community Meeting
Photo: B. Butterworth

COMPLEX PEOPLE

Brian Butterworth
UW-Madison, post-doc
CHEESEHEAD
US-PF*

Jonathan Thom
UW-Madison researcher
Ameriflux core sites
US-PFa, US-WCr, US-Syv,
US-WCr et al

Ammara Talib
UW-Madison PhD student
US-CS1, US-CS2, US-CS3
Ag forecasting

Susi Wiesner
UW-Madison/USDA
Post-doc
US-DFC, US-DFK
Ag scaling

Jess Turner
UW-Madison
MS student
US-Alq, wetlands

Katie Zarada
Boston University
Research Fellow
PEcAn eco forecasting

Bailey Murphy
UW-Madison MS
PEcAn project /
ED2

Steve Oncley
NCAR Scientist
CHEESEHEAD
US-PF*

David Reed
Michigan State
US-Men, US-Pnp
lakes

Gosia Golub
Uppsala (Sweden)
US-Men, US-Pnp

Angela Baldocchi
UW-Madison
US-Men, US-Pnp

James Mineau
UW-Madison undergrad
CHEESEHEAD mapping

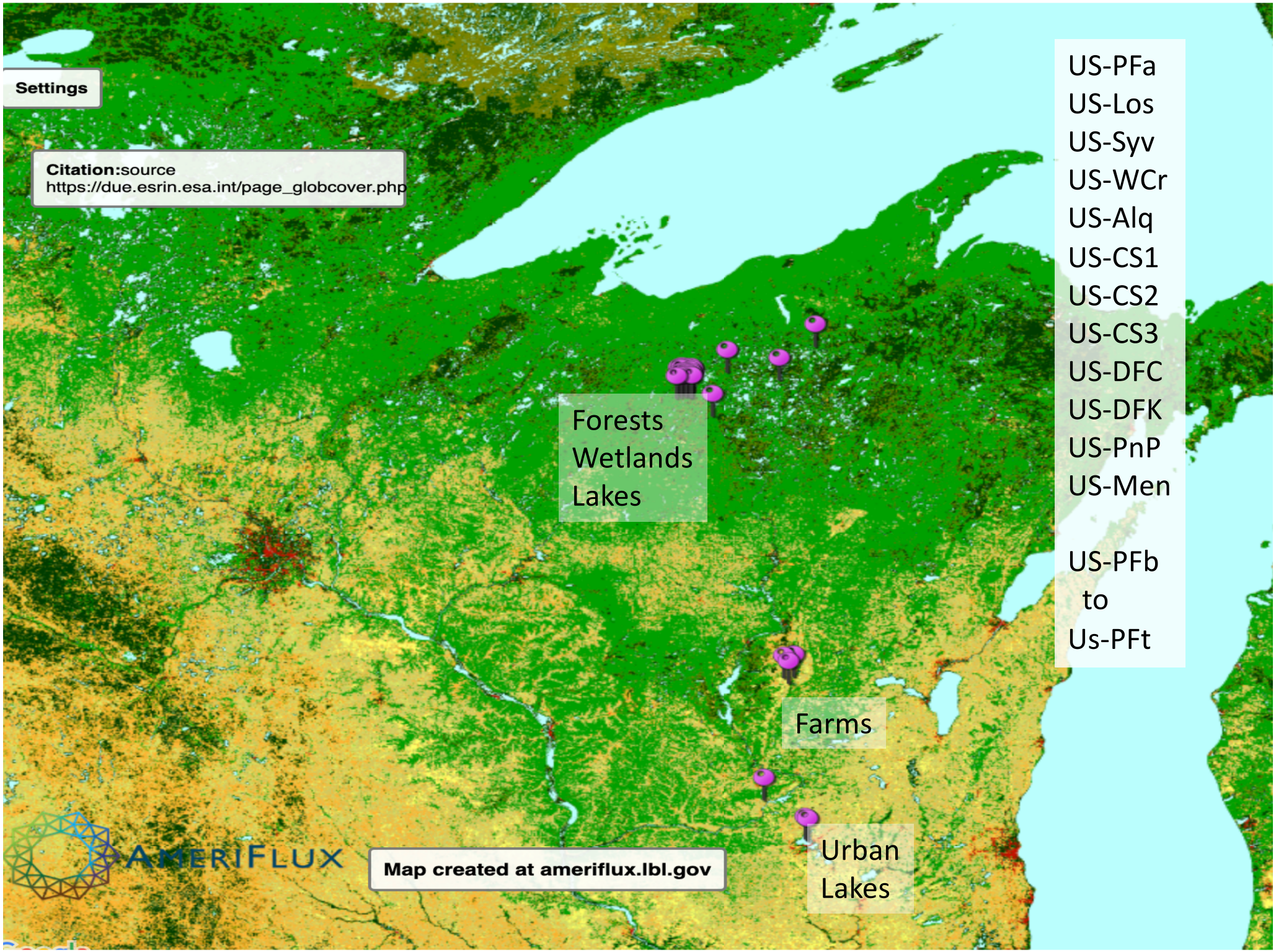
Sreenath Paleri
UW-Madison PhD
CHEESEHEAD LES

Stefan Metzger
NEON
CHEESEHEAD scaling

Dave Durden
NEON
CHEESEHEAD
Airborne fluxes

Ke Xu
U Michigan
CHEESEHEAD
scaling

Paul Stoy
UW-Madison
faculty
CHEESEHEAD
US-PFo, US-PFf

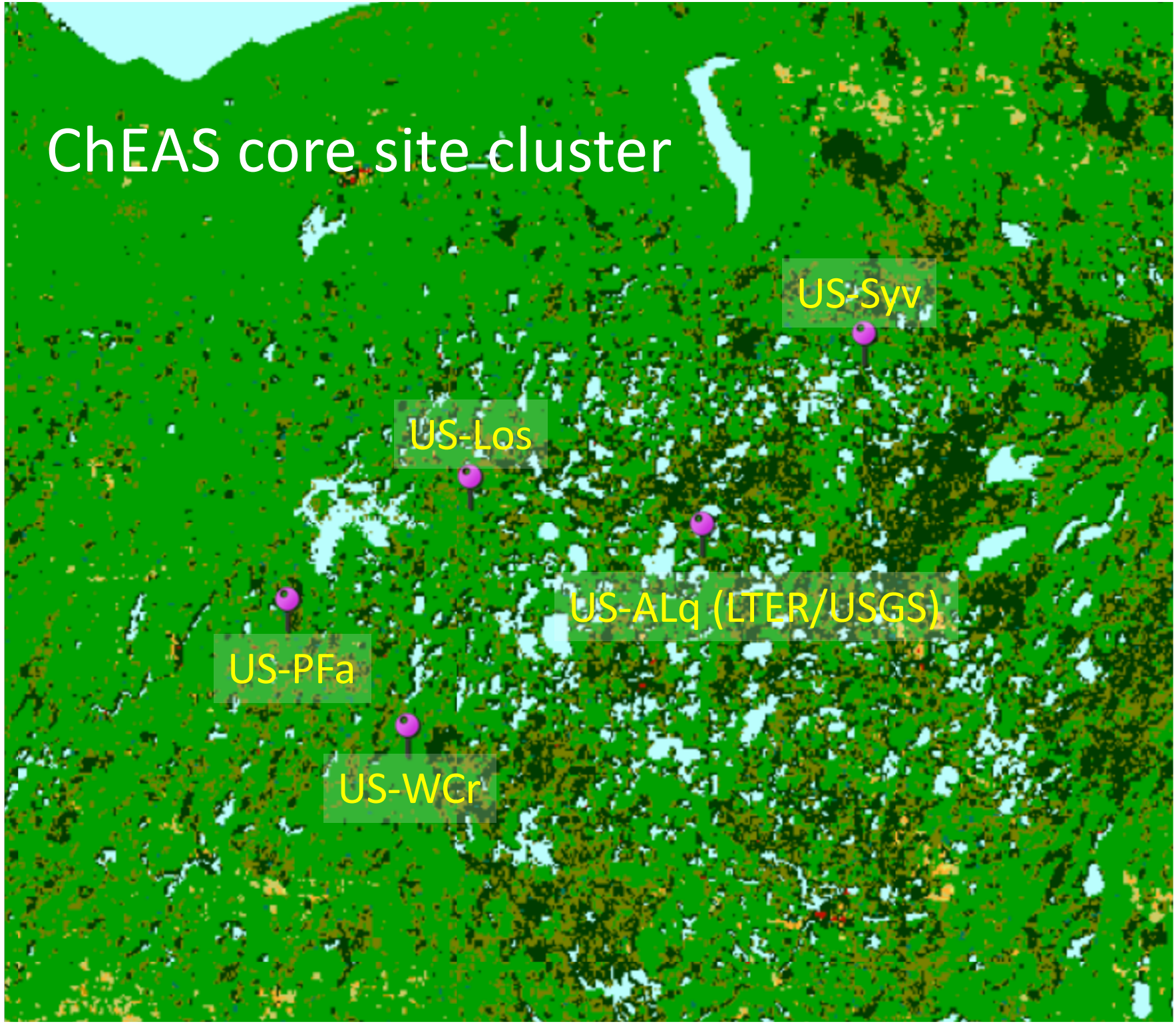

Settings
Citation:source
https://due.esrin.esa.int/page_globcover.php
US-PFa
US-Los
US-Syv
US-WCr
US-Alq
US-CS1
US-CS2
US-CS3
US-DFC
US-DFK
US-PnP
US-Men
US-PFb
to
Us-PFt
Forests
Wetlands
Lakes
Farms
Urban
Lakes
AMERIFLUX
Map created at ameriflux.lbl.gov

Moral of this journey

- We should disabuse ourselves of the notion that “homogeneity” is common across landscapes and in flux tower footprints

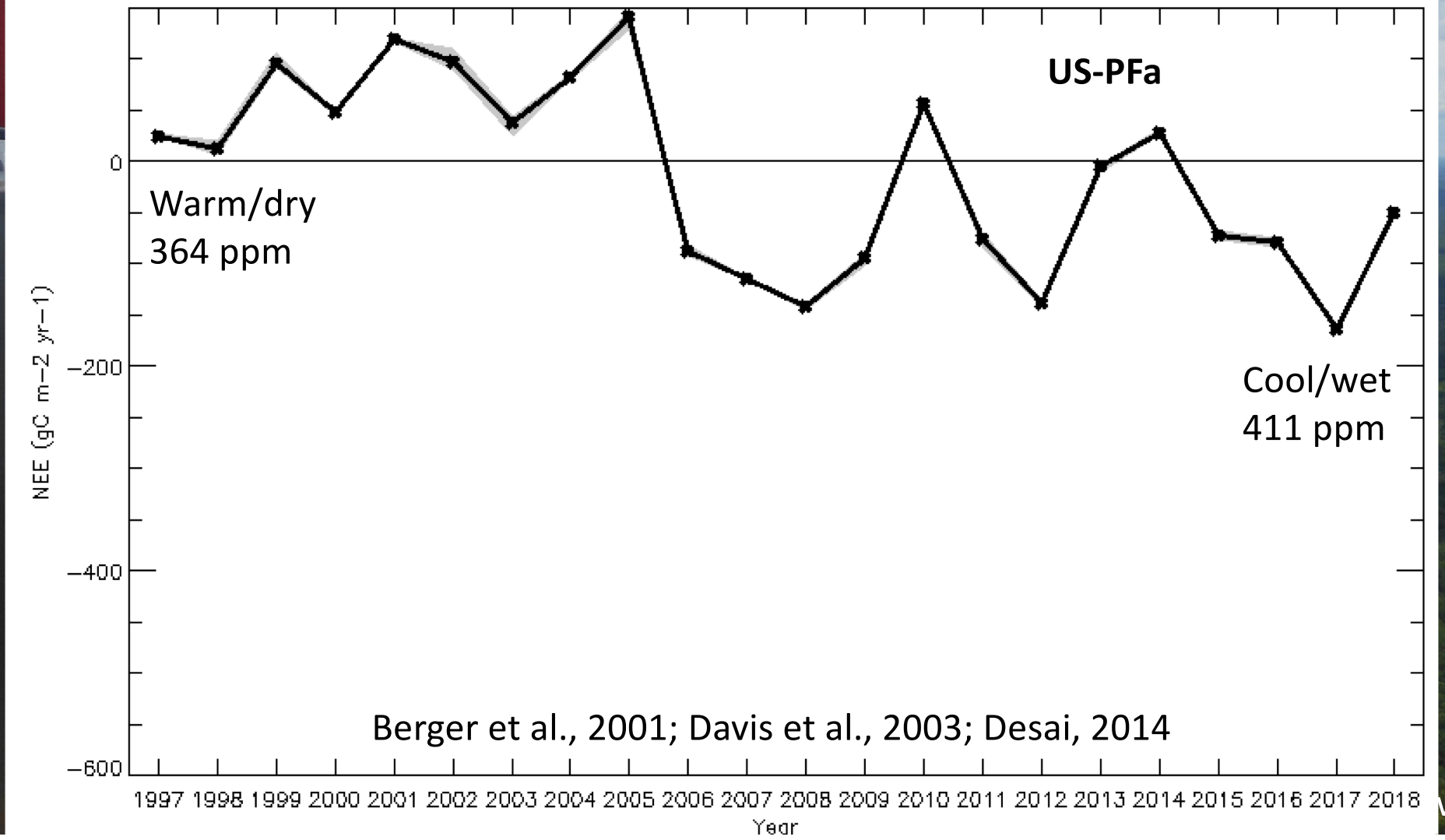
- Consider space and time variation jointly
- Scale with what makes a place “complex”
- Confront models with this complexity, expressed as uncertainty and bias

How did we get here?

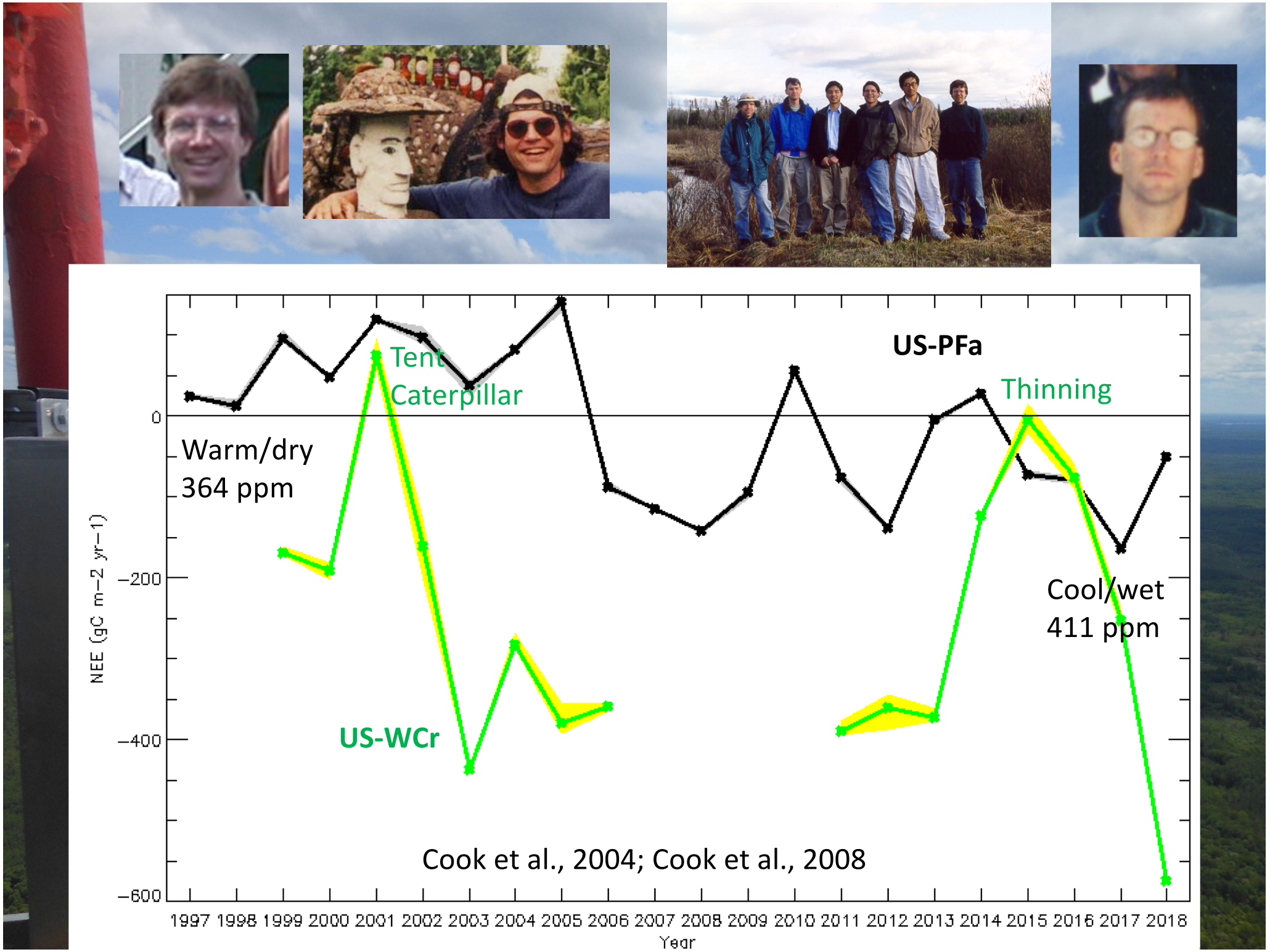

ChEAS core site cluster
US-Syv
US-Los
US-ALq (LTER/USGS)
US-PFa
US-WCr

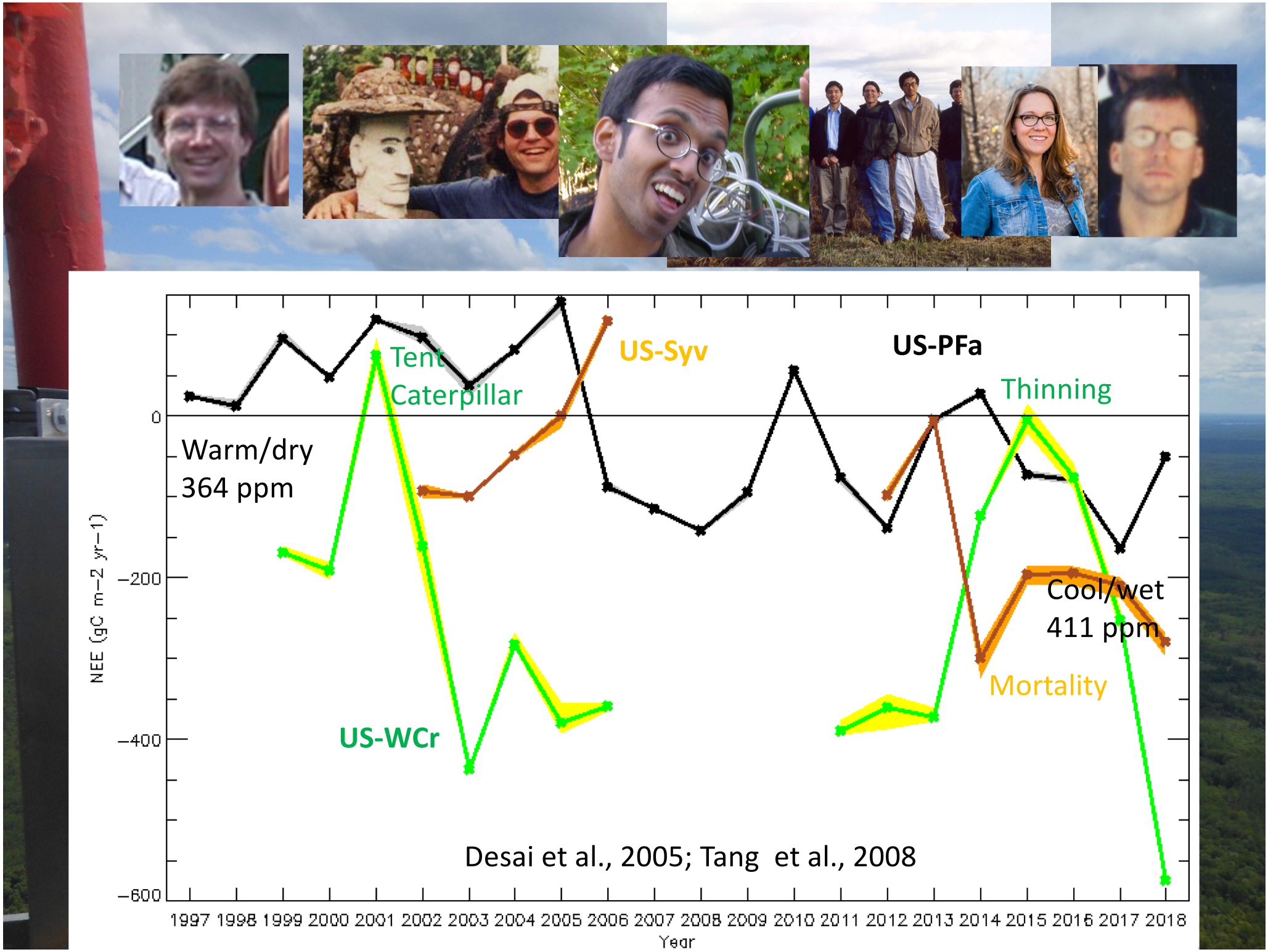
The Original "ChEAS"-heads

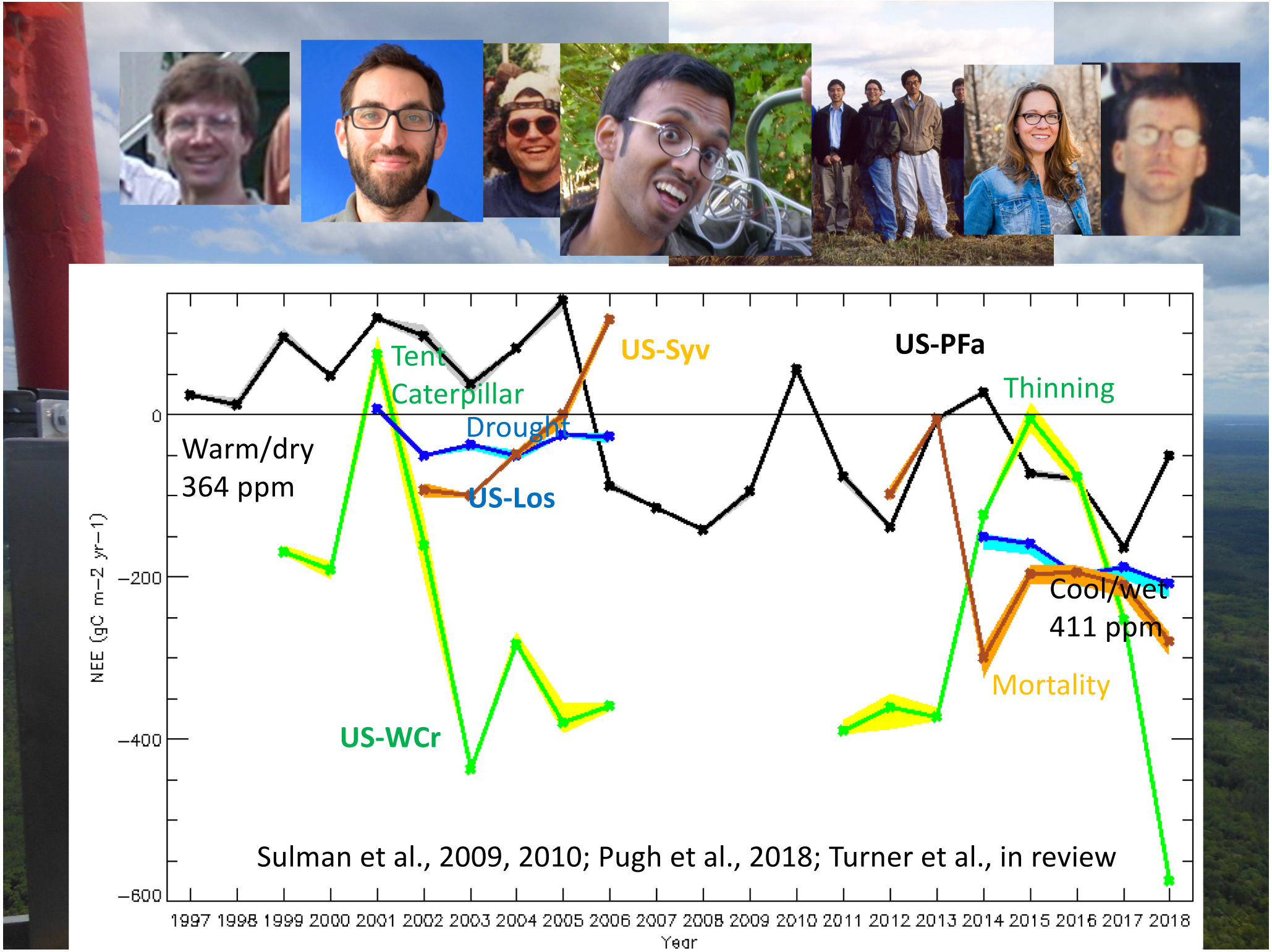
Chequamegon Ecosystem-Atmosphere Study



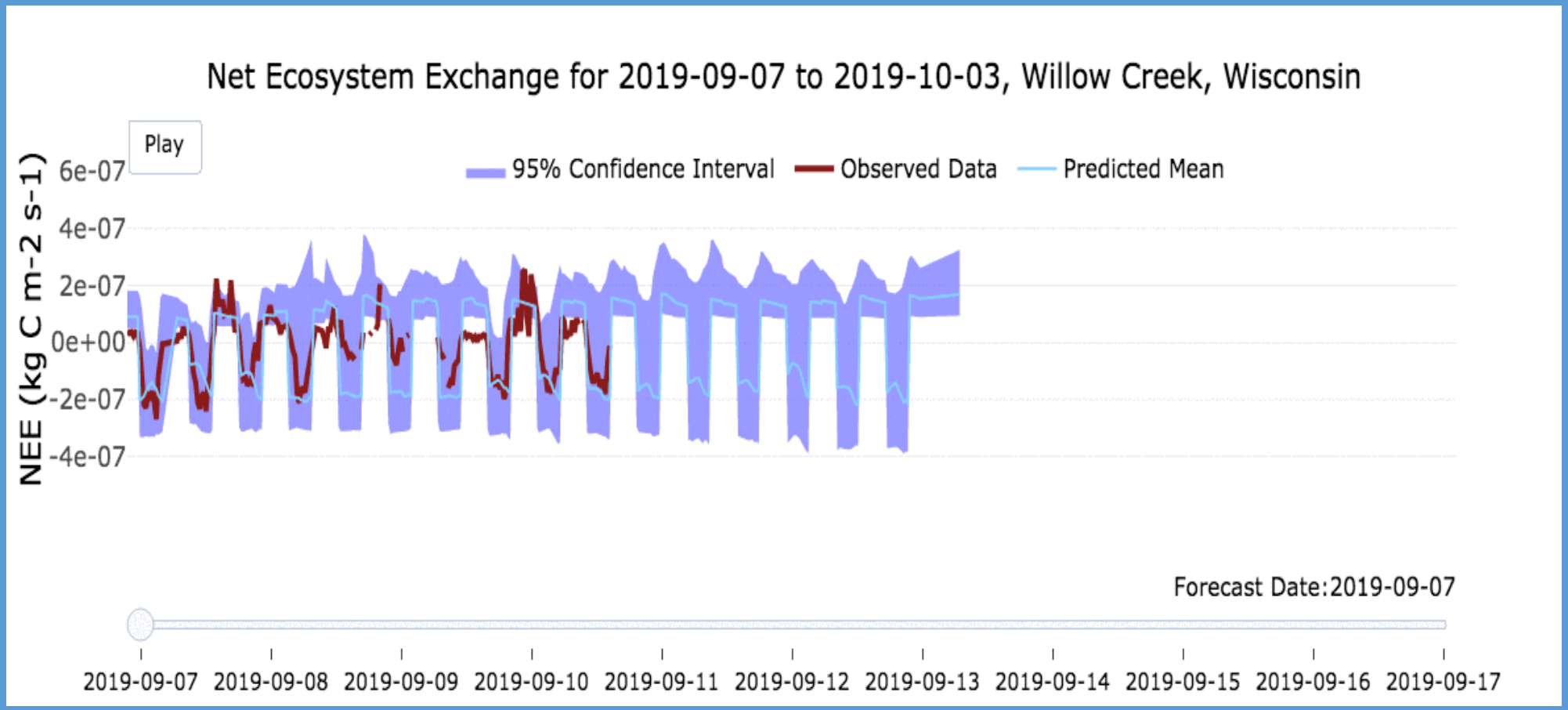
wer


US-PFa
Tent
Caterpillar
Thinning
Warm/dry
364 ppm
Cool/wet
411 ppm
US-WCr
Cook et al., 2004; Cook et al., 2008
NEE (gC m−2 yr−1)
0
−200
−400
−600
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year


Tent Caterpillar
US-Syv
US-PFa
Thinning
Warm/dry
364 ppm
Cool/wet
411 ppm
Mortality
US-WCr
Desai et al., 2005; Tang et al., 2008
NEE (gC m−2 yr−1)
0
−200
−400
−600
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year

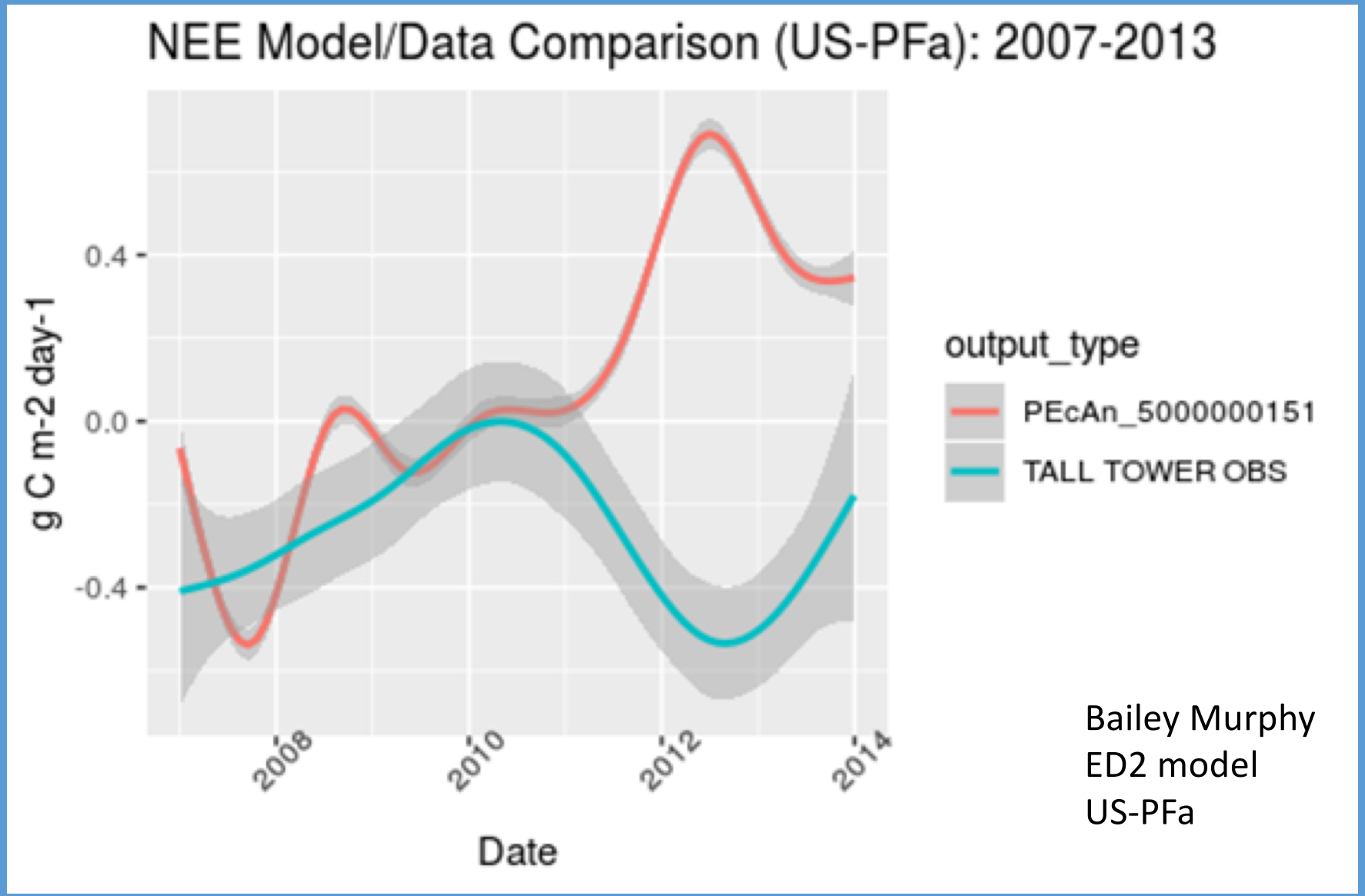

Tent
Caterpillar
Drought
US-Syv
US-PFa
Thinning
Warm/dry
364 ppm
US-Los
Cool/wet
411 ppm
Mortality
US-WCr
Sulman et al., 2009, 2010; Pugh et al., 2018; Turner et al., in review
NEE (gC m−2 yr−1)
0
−200
−400
−600
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year

We can make nightly flux site forecasts!



Katie Zarada, PEcAn project

But struggle modeling over longer time and space scales…



Bailey Murphy
ED2 model
US-PFa

Forest management is part of it

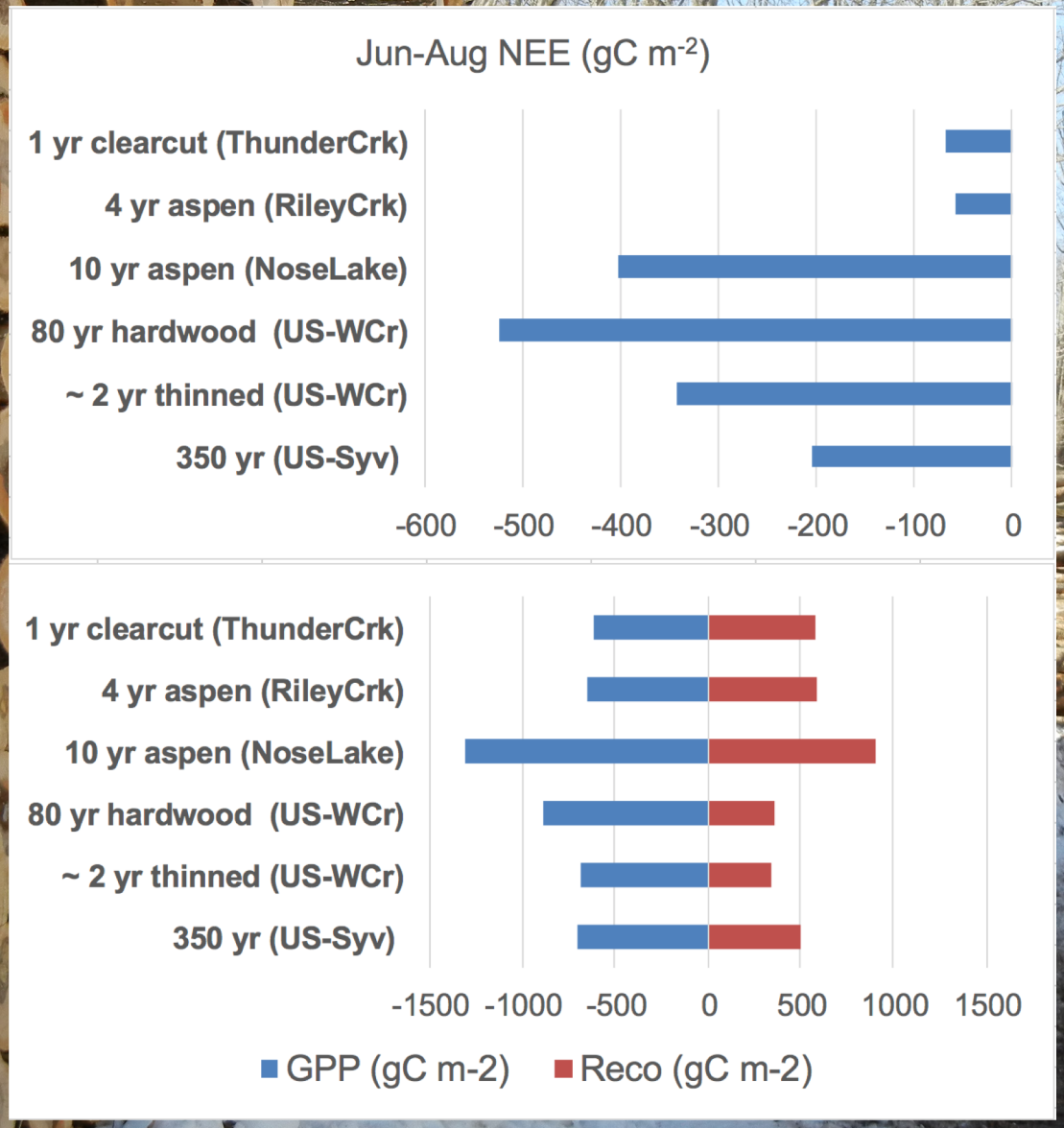
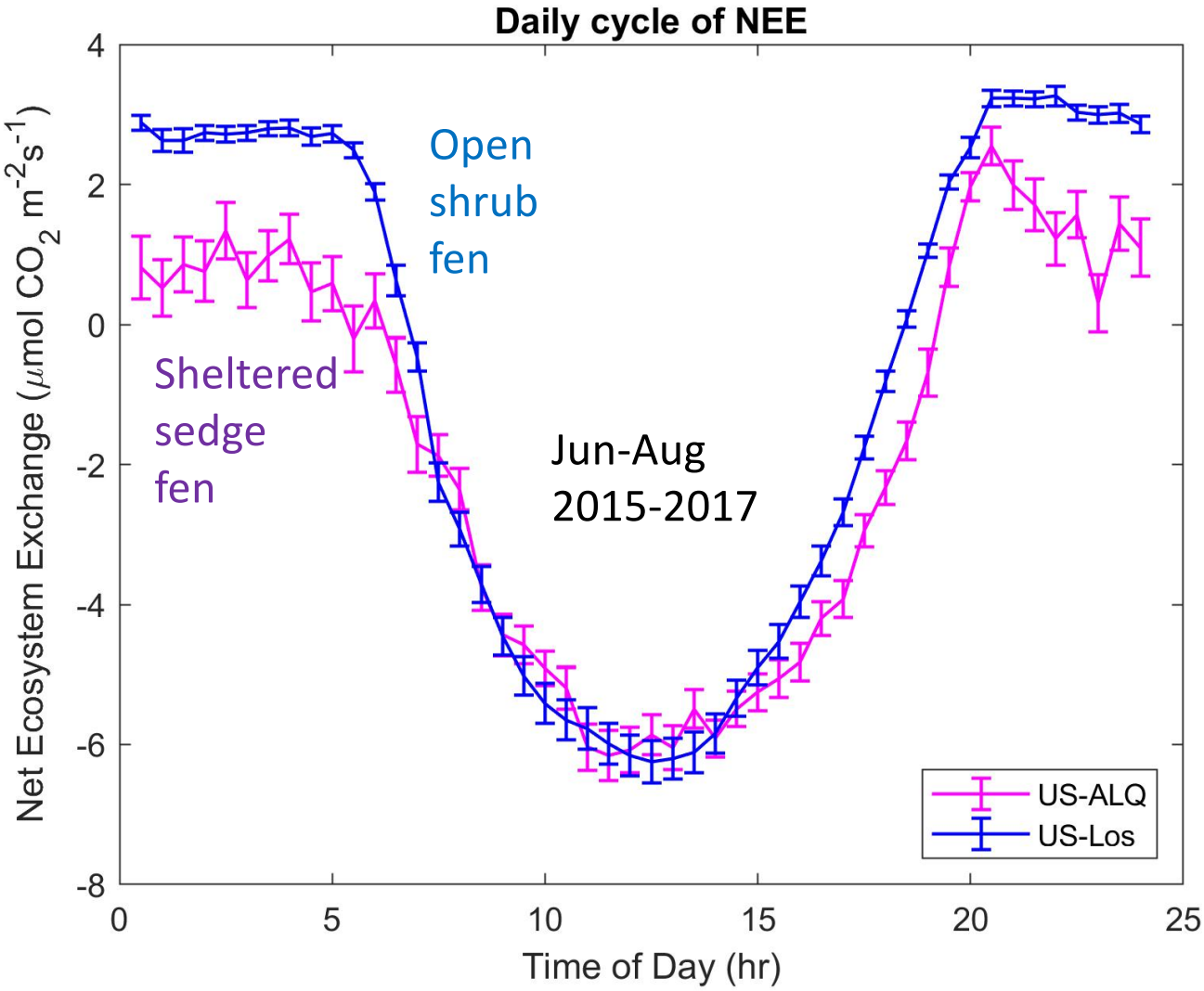
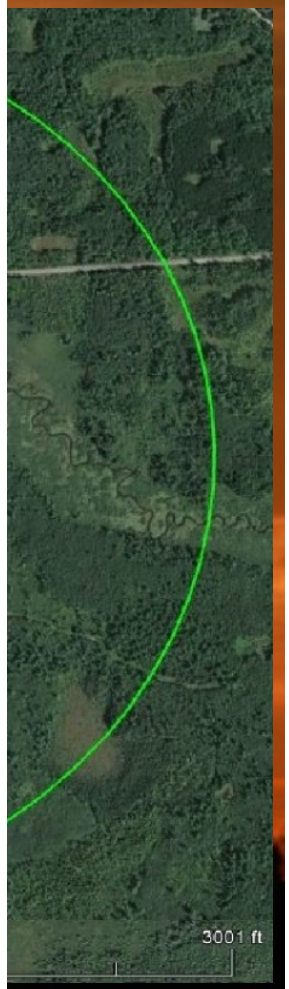


Photo: J Thom
Figure:
J McCarty
A Desai

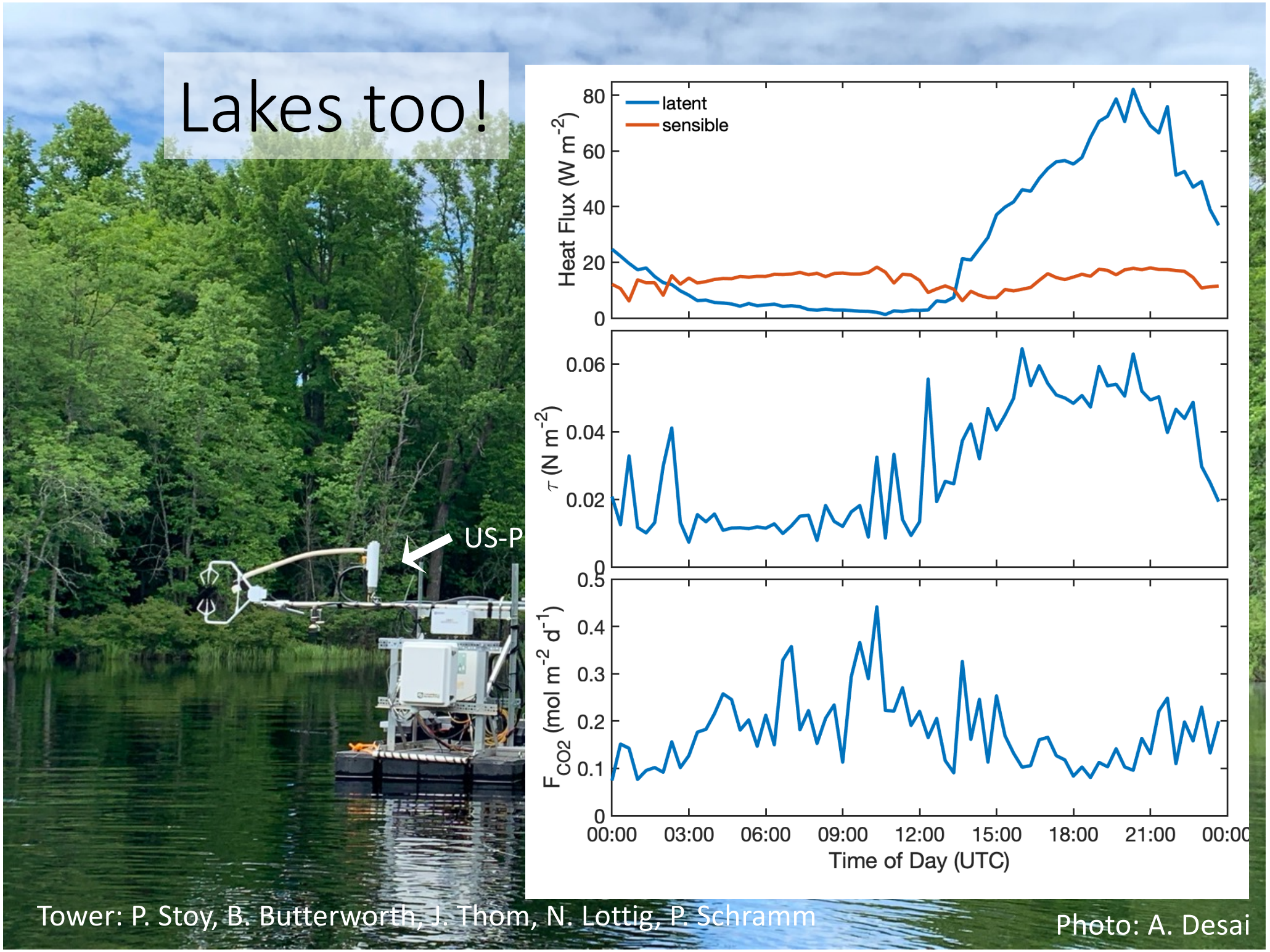
Wetlands are another part of it





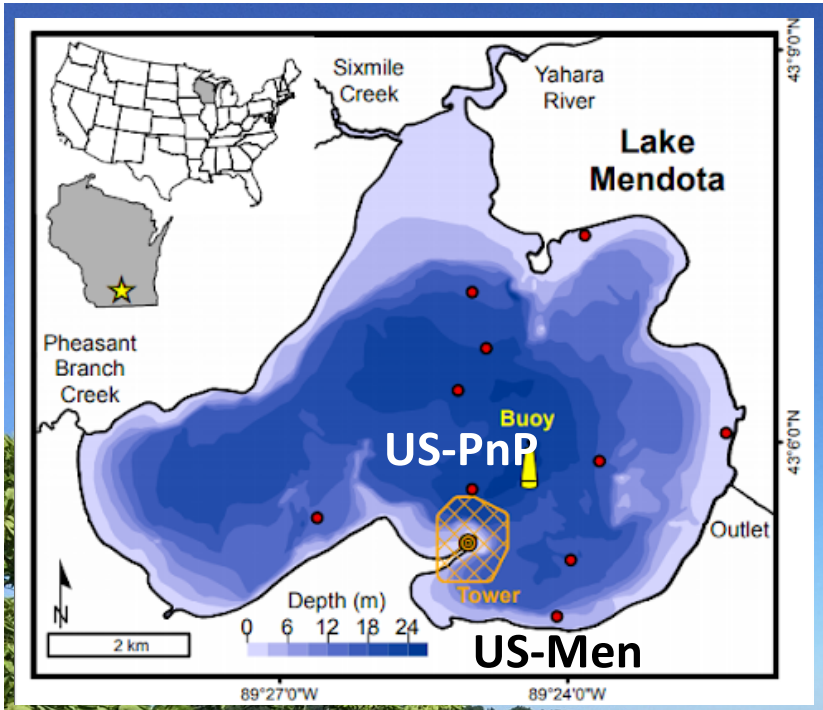
Turner et al., in review

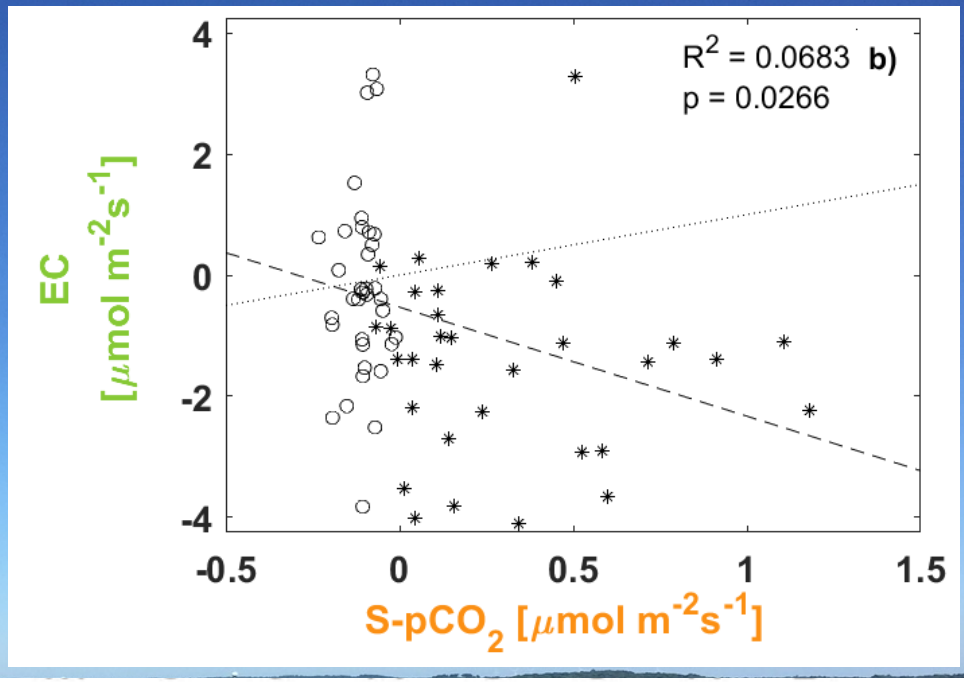
Lakes too!

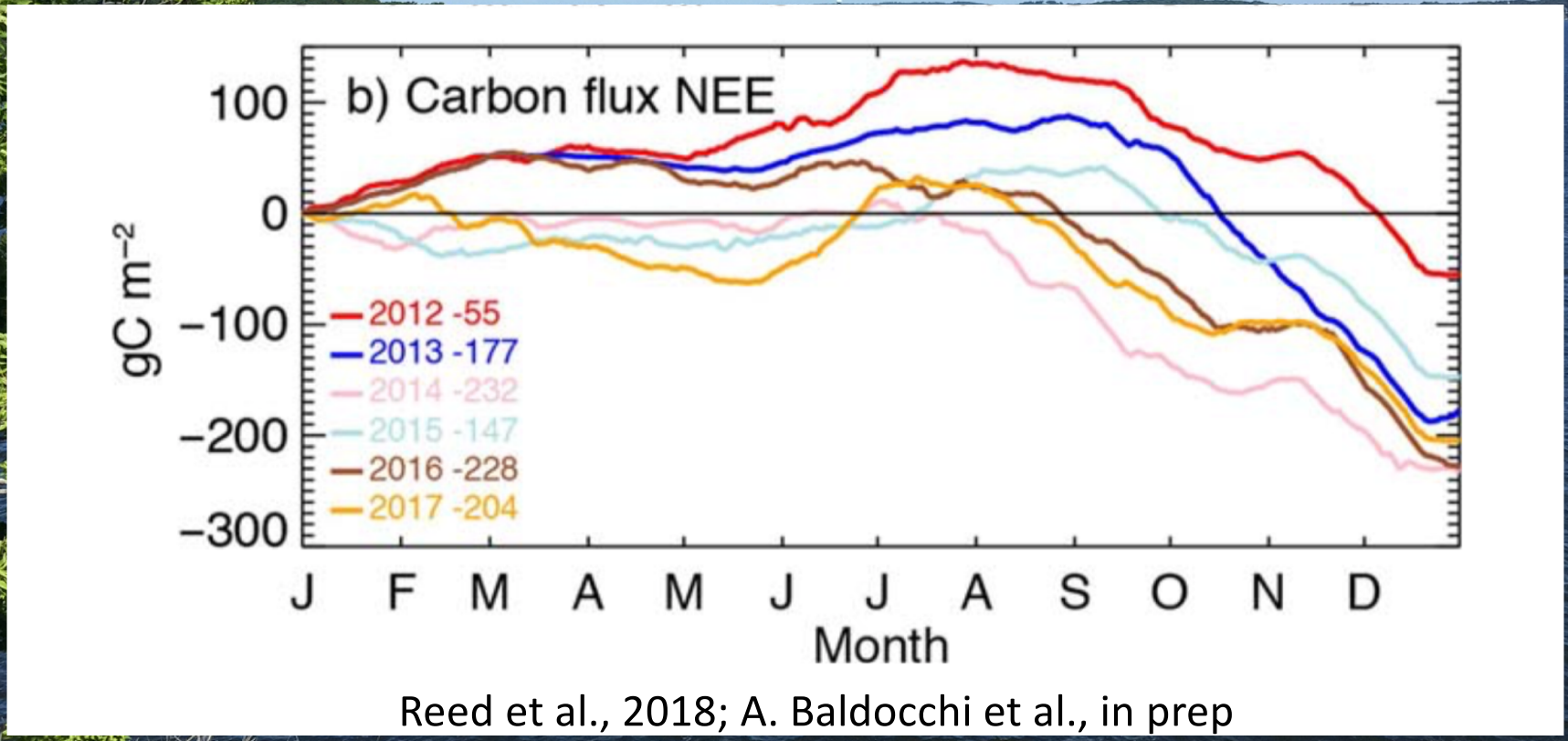


Tower: P. Stoy, B. Butterworth, J. Thom, N. Lottig, P. Schramm

Photo: A. Desai

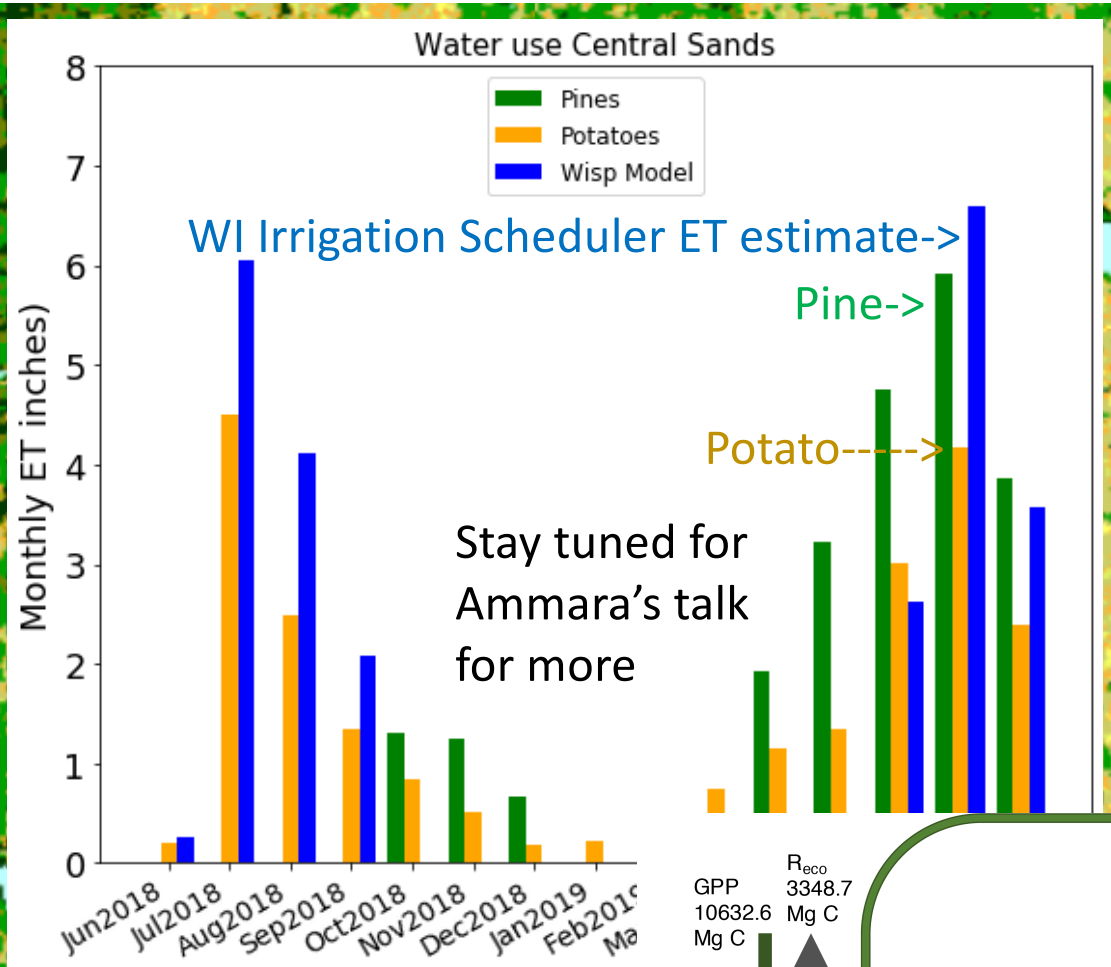


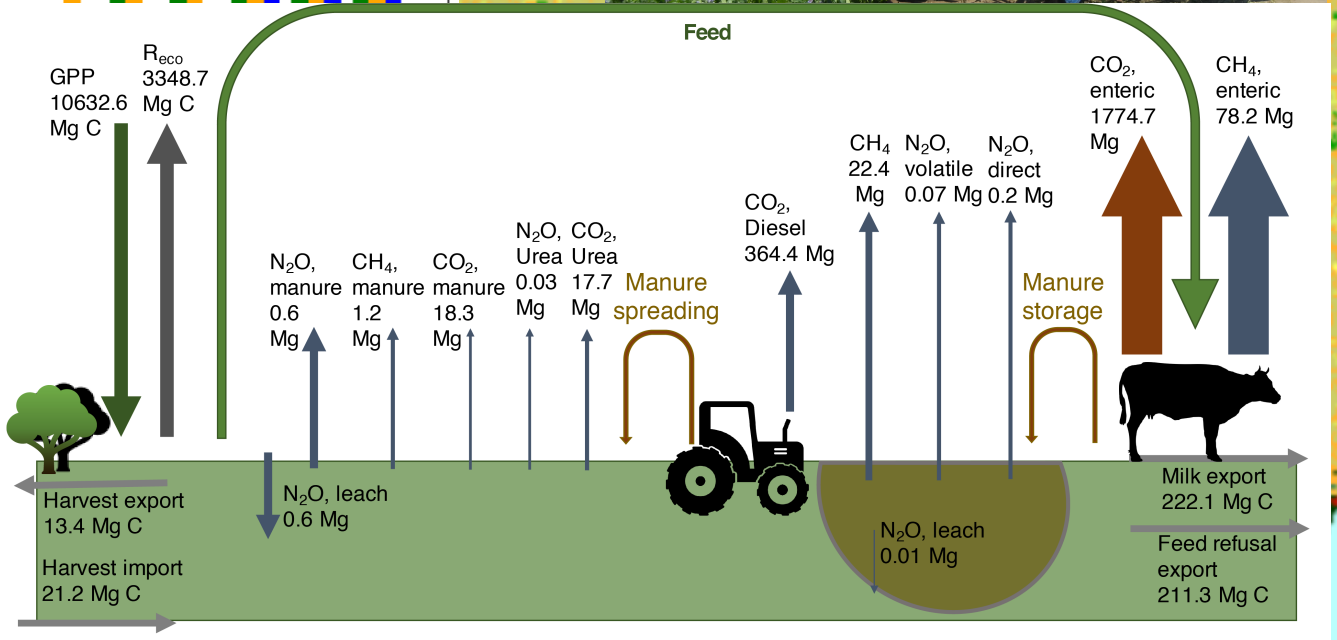




Reed et al., 2018; A. Baldocchi et al., in prep

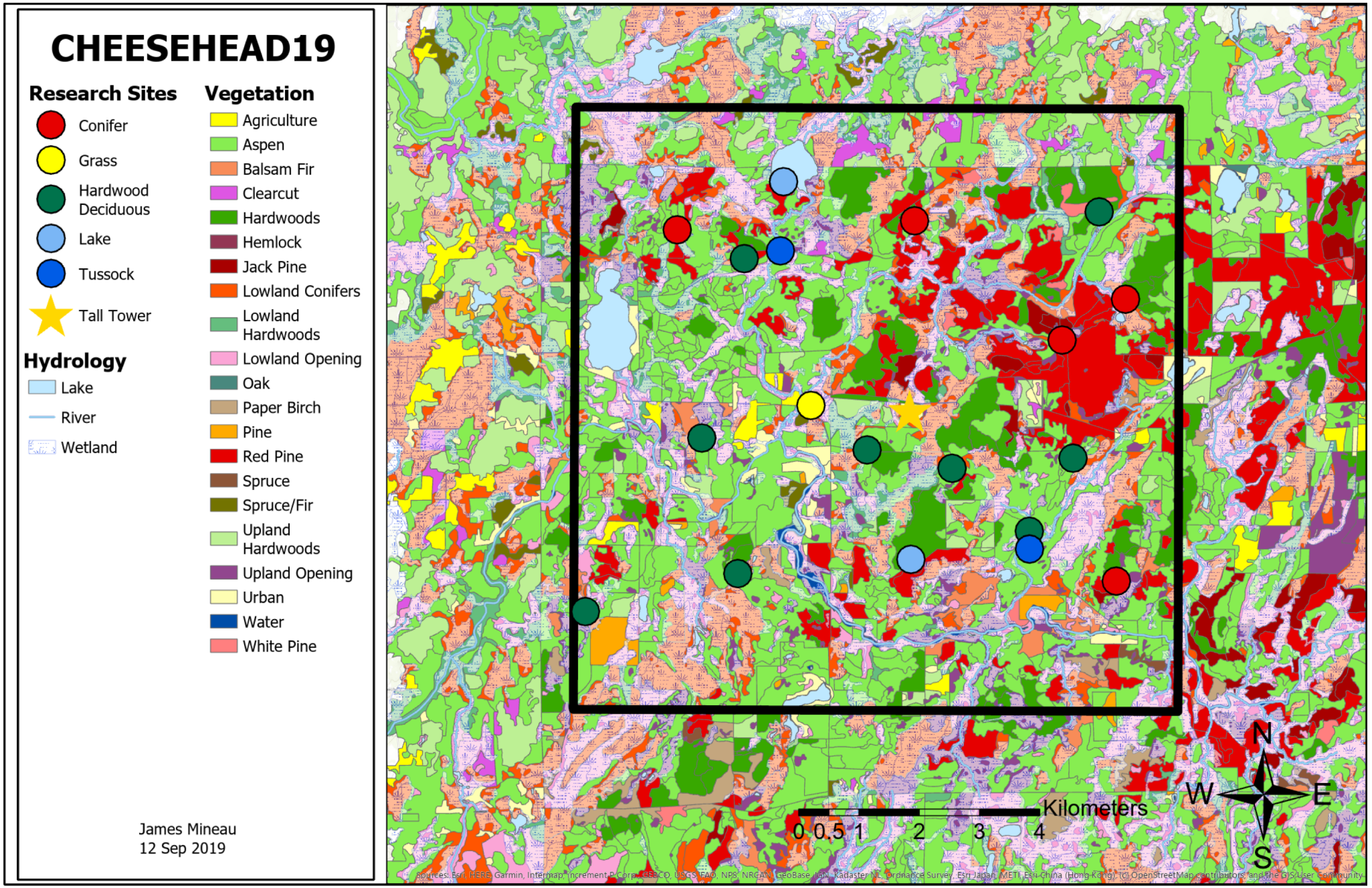
Agriculture needs food for thought





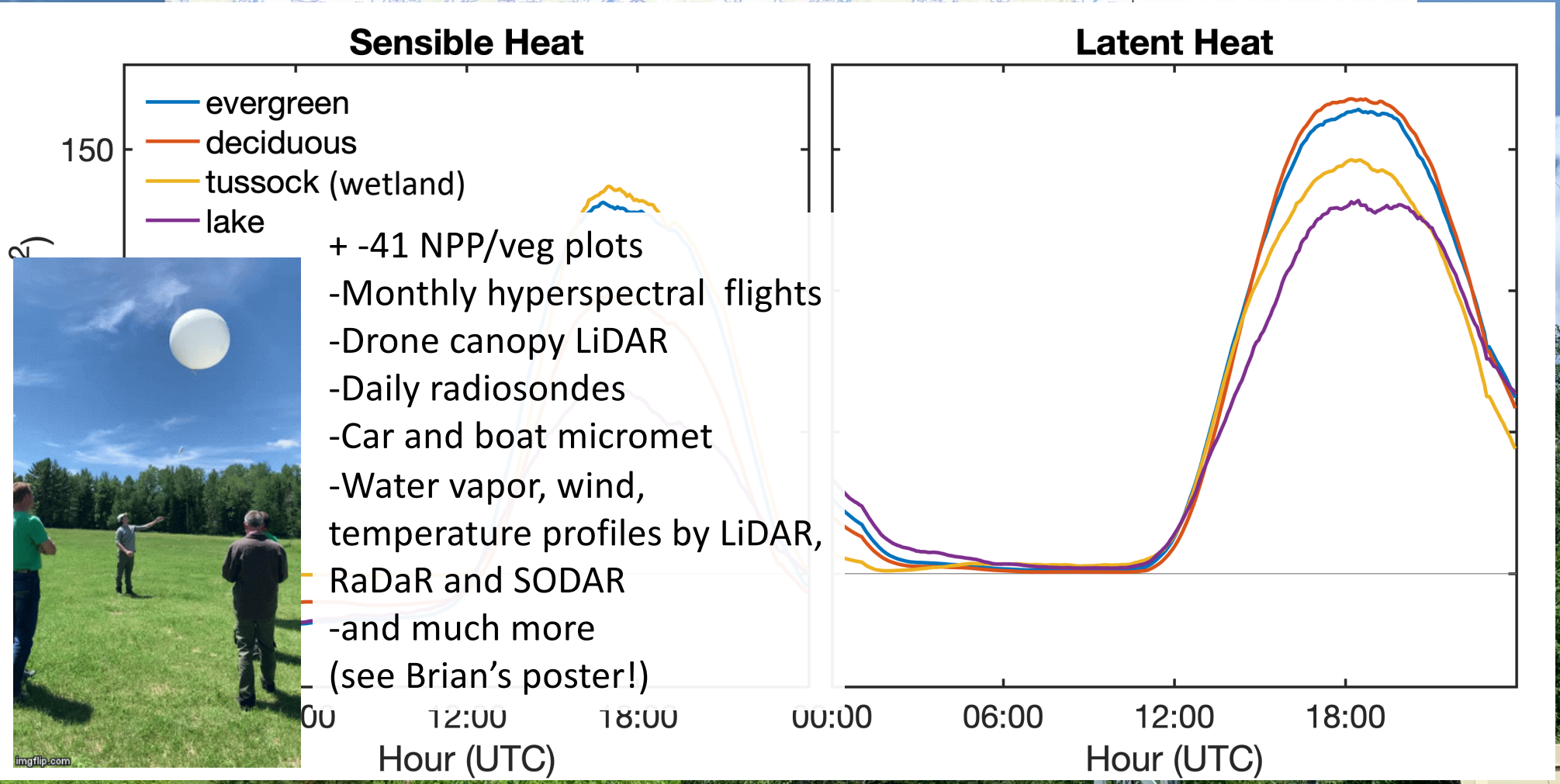
US-DFC (integrated dai
US-DFK (Kernza perenr

Wiesner et al., in prep; Talib et al., in prep



Desai et al., 2007, 2008; Xu et al., 2017, 2018; Sühring et al., 2019

19 towers allowed us to have replicates across all major vegetation types in one 10x10 km area!



+ -41 NPP/veg plots
-Monthly hyperspectral flights
-Drone canopy LiDAR
-Daily radiosondes
-Car and boat micromet
-Water vapor, wind, temperature profiles by LiDAR, RaDaR and SODAR
-and much more
(see Brian's poster!)

https://www.eol.ucar.edu/field_projects/cheesehead

Low-altitude (100m) airborne fluxes and PBL by U Wyoming King Air connects the dots

July 9, 2019
15 Z (10 CDT)

Sensible Heat flux

Latent Heat flux

CHEESEHEAD 2019

Legend

Research Sites
- Conifer
- Grass
- Hardwood Deciduous
- Lake
- Tussock
- Tall Tower
- Research Boundary

Water Features
- Lake
- River
- Wetland

Land Ownership
- Private
- USDA FOREST SERVICE

King Air Flight
Alt
- ≤600 MSL
- ≤1300 MSL
- ≤3000 MSL

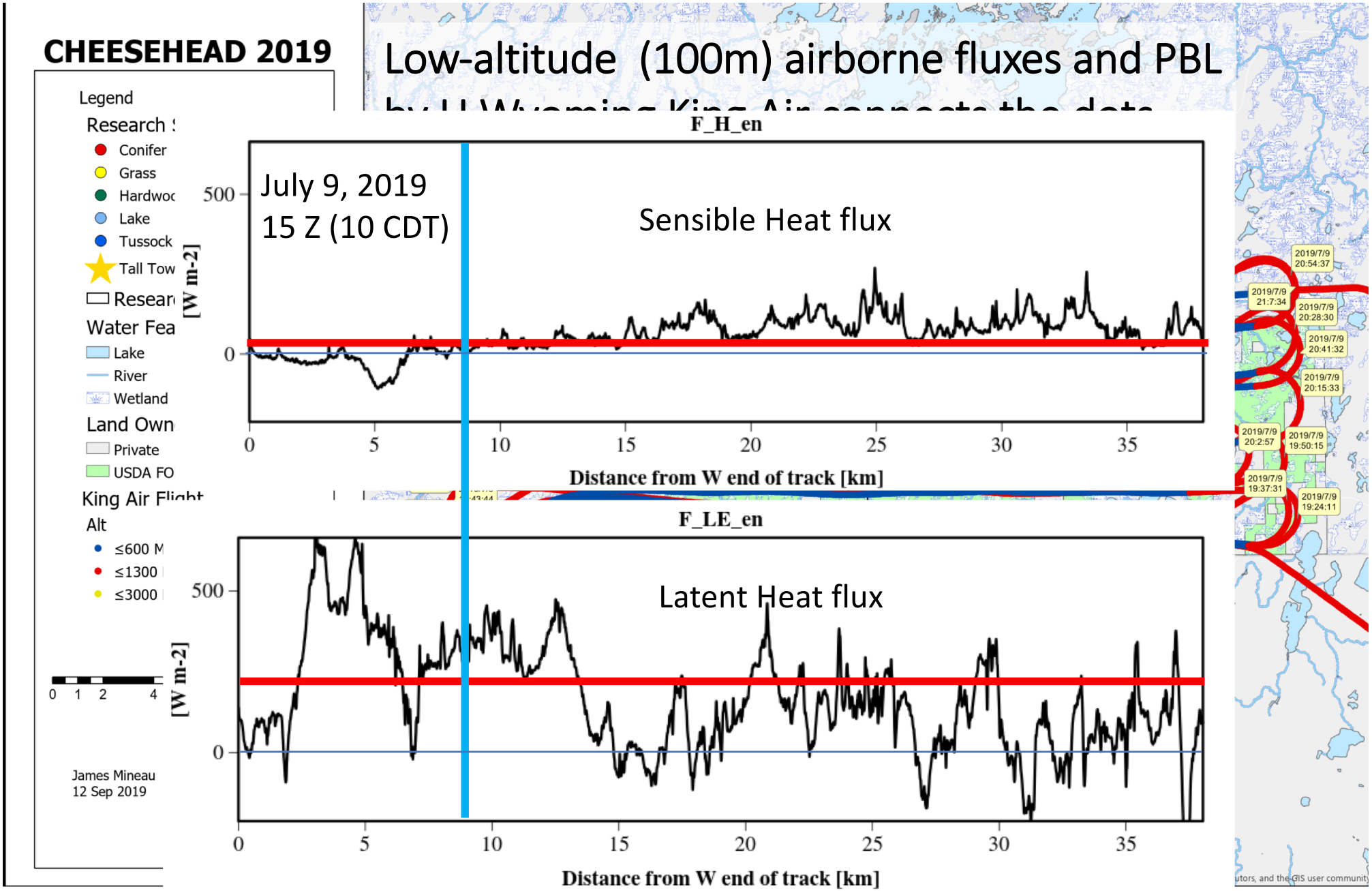
Kilometers
0 1 2 4 6 8

N W E S

James Mineau
12 Sep 2019

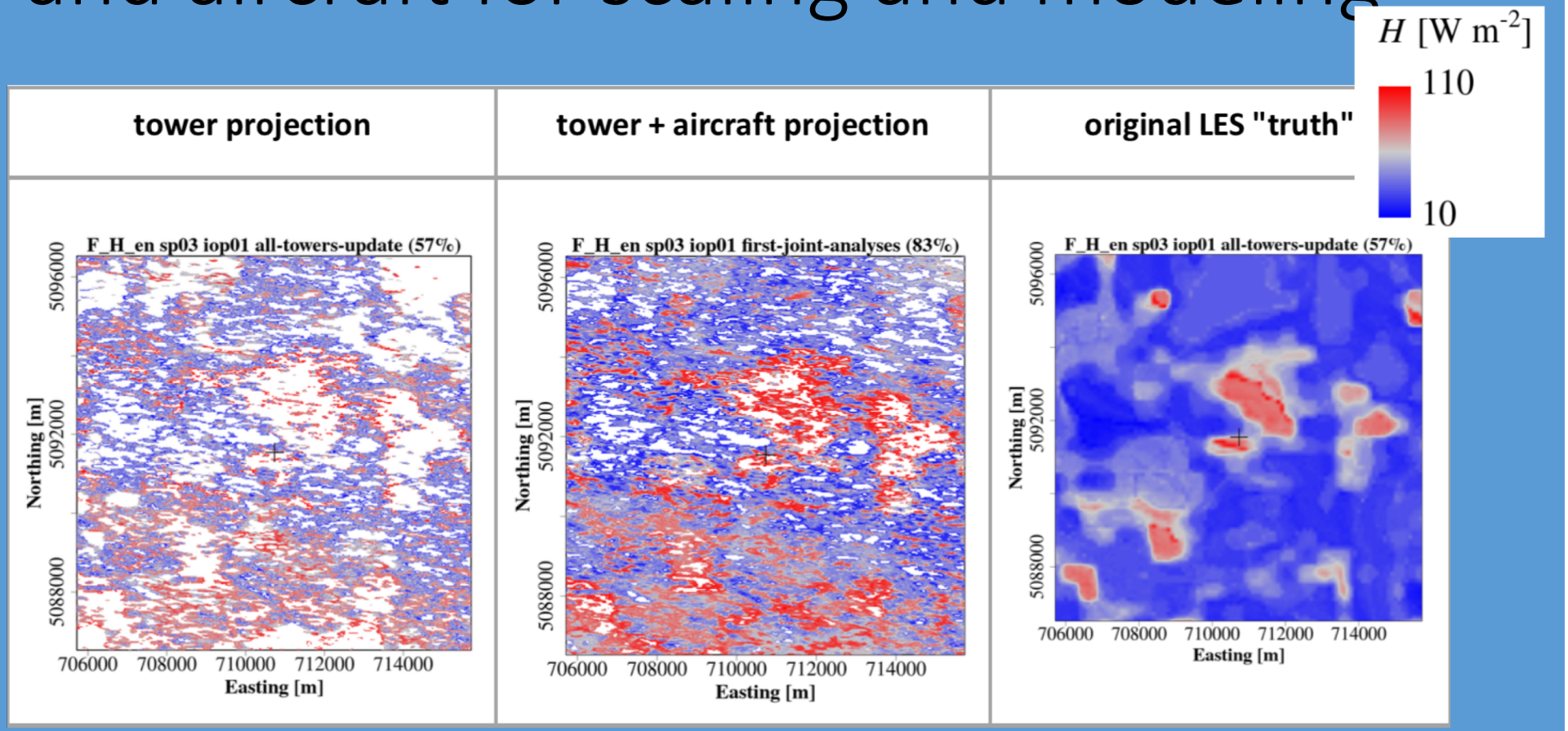
Map: J. Mineau
Photo: B. Butterworth
Figure: D. Durden + A. Desai

Low-altitude (100m) airborne fluxes and PBL



Map: J. Mineau
Photo: B. Butterworth
Figure: D. Durden + A. Desai

LES models and advanced scaling methods (ERF) tell us how to maximize information from towers and aircraft for scaling and modeling



Metzger et al., 2013; Xu et al., 2017, 2018;

S. Metzger, S. Paleri, K. Xu

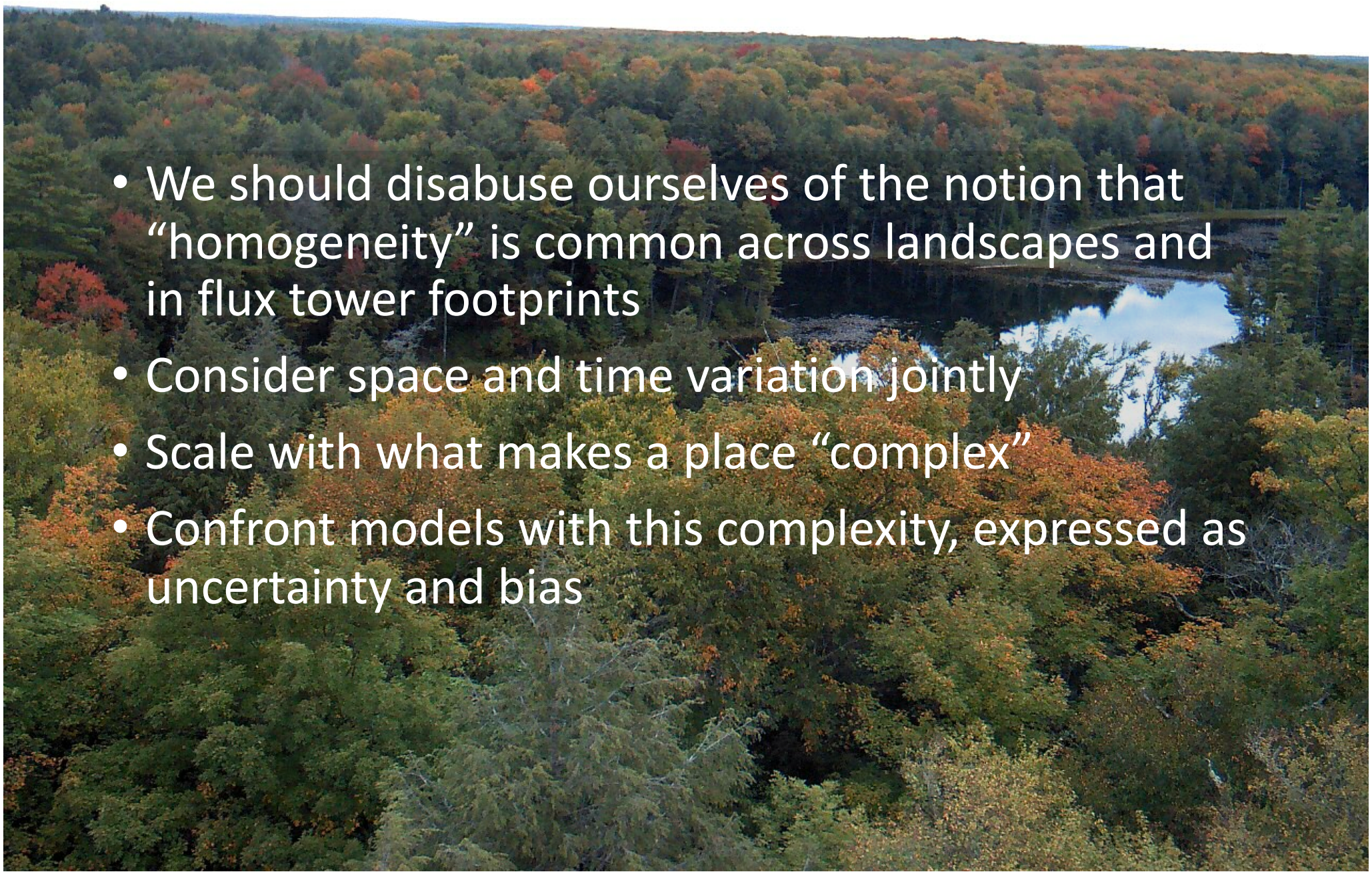
A small note on data processing

- Automation is key
- Cellular 4G raw data transfer every hour
- Grafana for real-time quicklook dashboard
- Loggernet server for remote access
- Bi-weekly site visits by local partners
- Nightly processing to Ameriflux format by custom scripts, Linux version of EddyPro (future: Eddy4R, OneFlux)
- Nightly upload of raw data to LBL + status email to me + all data and code real-time open, on web:
  - http://flux.aos.wisc.edu/fluxdata
- Support from Ameriflux Data/Tech team and QA/QC!
- PEcAn for fusing models and data
- Cyverse for bringing code to models and data
- Hire great staff, pay them well, lots of $$ on fleet + supplies!

Metzger et al., 2017
Xu et al., 2019
Andrews et al., 2014
Desai et al., 2008b

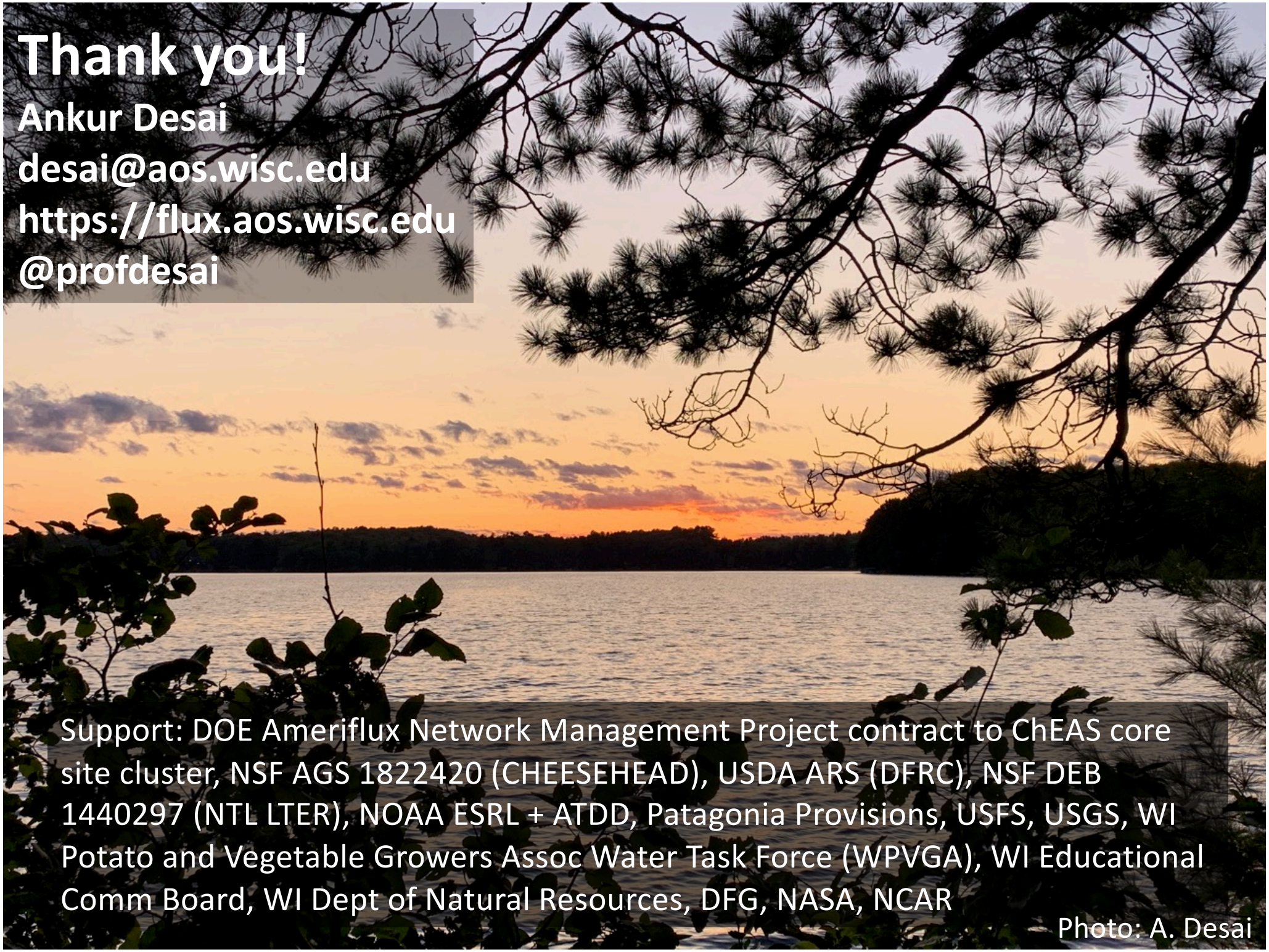
☆ **Ankur Desai <adesai@co2.aos.wisc.edu>**
ChEAS Diagnostic 2019 DOY 256
Cc: Jonathan E. Thom <jthom@ssec.wisc.edu>

```
WLEF MET

Last NOAA CH4/CO2 data:      254

WLEF FLUX

WLEF FLUX CH4

WLEF DIAG CH4

LCREEK FLUX
co2       83.3333% missing
```



Journey recap

- We should disabuse ourselves of the notion that "homogeneity" is common across landscapes and in flux tower footprints
- Consider space and time variation jointly
- Scale with what makes a place "complex"
- Confront models with this complexity, expressed as uncertainty and bias


Thank you!
Ankur Desai
desai@aos.wisc.edu
https://flux.aos.wisc.edu
@profdesai
Support: DOE Ameriflux Network Management Project contract to ChEAS core site cluster, NSF AGS 1822420 (CHEESEHEAD), USDA ARS (DFRC), NSF DEB 1440297 (NTL LTER), NOAA ESRL + ATDD, Patagonia Provisions, USFS, USGS, WI Potato and Vegetable Growers Assoc Water Task Force (WPVGA), WI Educational Comm Board, WI Dept of Natural Resources, DFG, NASA, NCAR
Photo: A. Desai