ALEXI/DisALEXI products for ECOSTRESS

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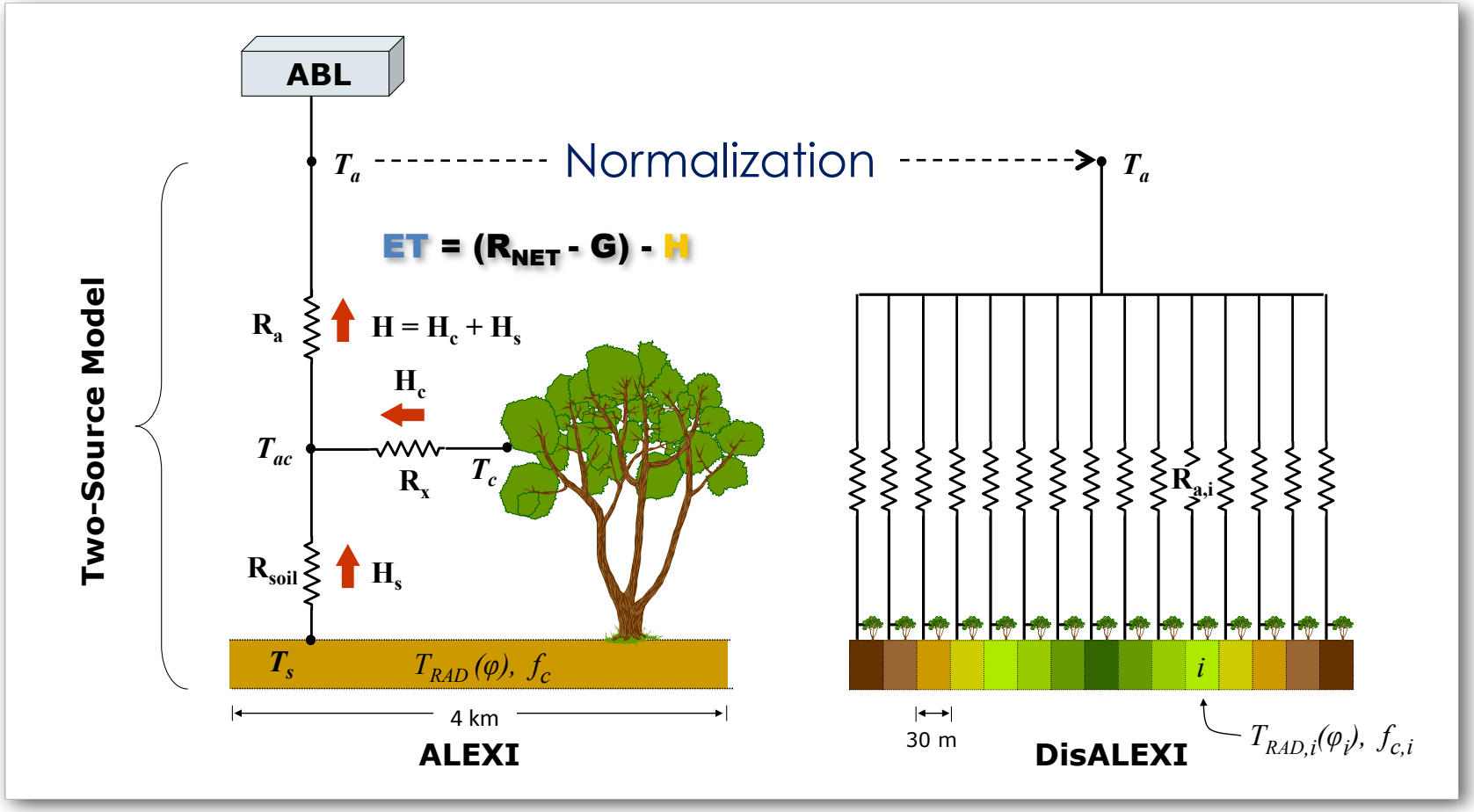
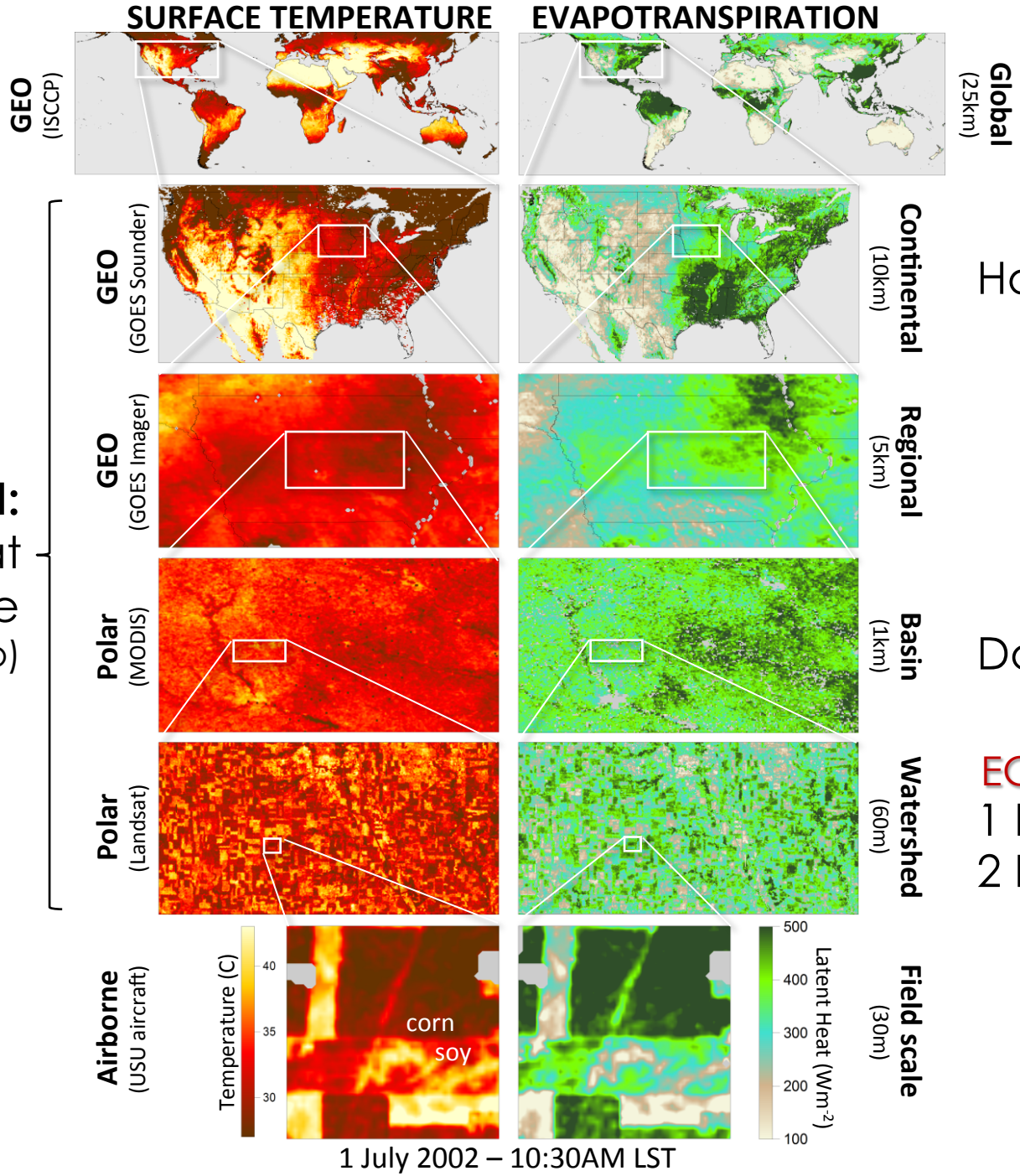
Atmosphere-Land Exchange Inverse



	Regional scale		Landscape scale	
Surface temp:	ΔT_{RAD}	- Geostationary	T_{RAD}	- Landsat, MODIS, ECO
Air temp:	T_a	- ABL model	T_a	- ALEXI
Veg cover:	f_c	- MODIS	f_c	- Landsat, MODIS



DATA FUSION:
daily ET at field scale
(F. Gao)

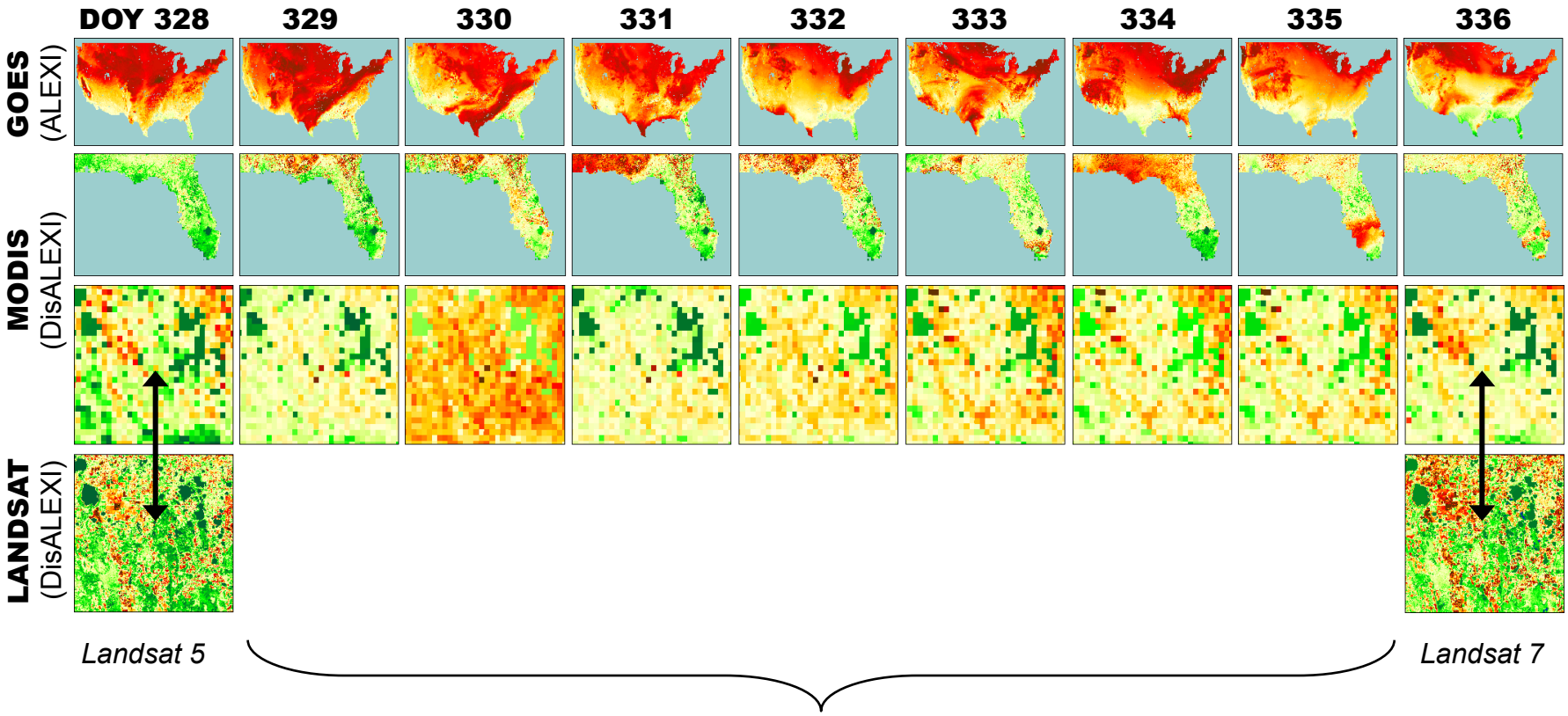
Hourly

Daily

ECO – 4 day
1 LS – 16 day
2 LS – 8 day

GOES/MODIS/Landsat FUSION

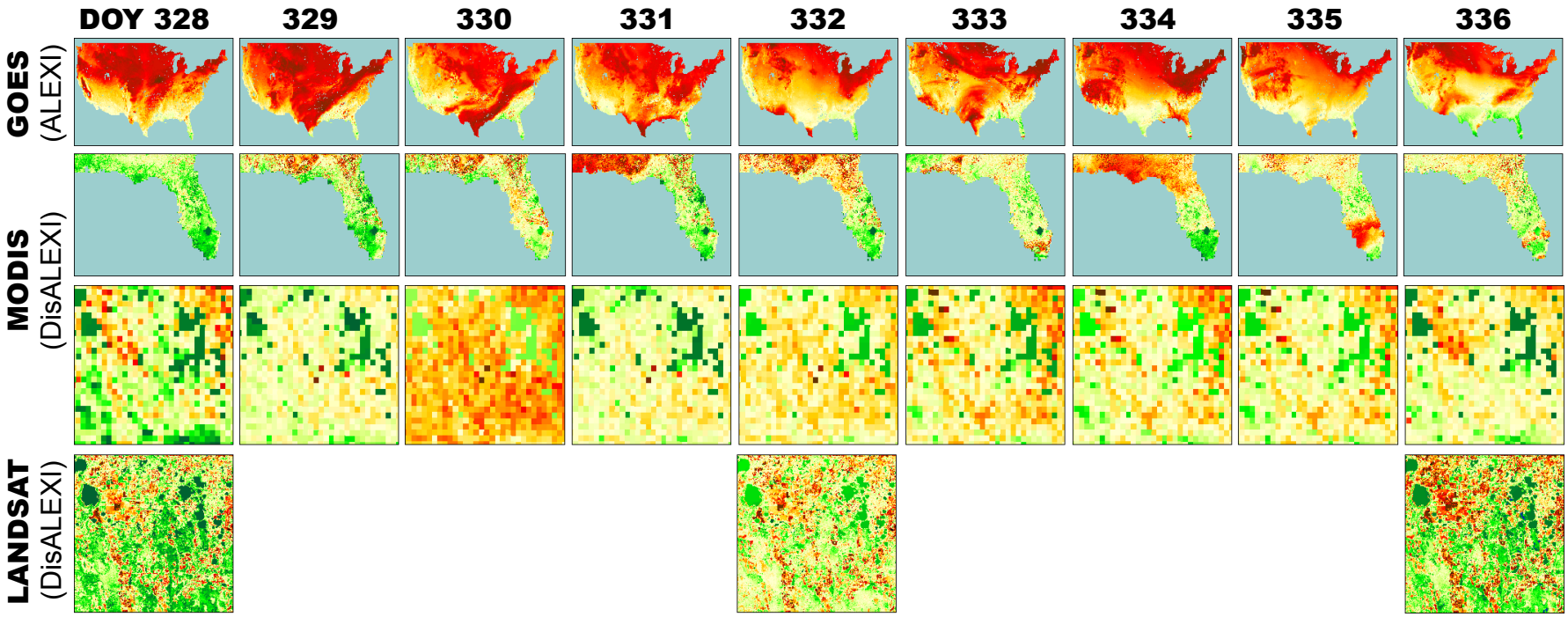
Daily Evapotranspiration – Orlando, FL, 2002



Spatial Temporal Adaptive Reflectance Fusion Model (STARFM) *(Gao et al, 2006)*

GOES/MODIS/Landsat/ECOSTRESS

Daily Evapotranspiration – Orlando, FL, 2002



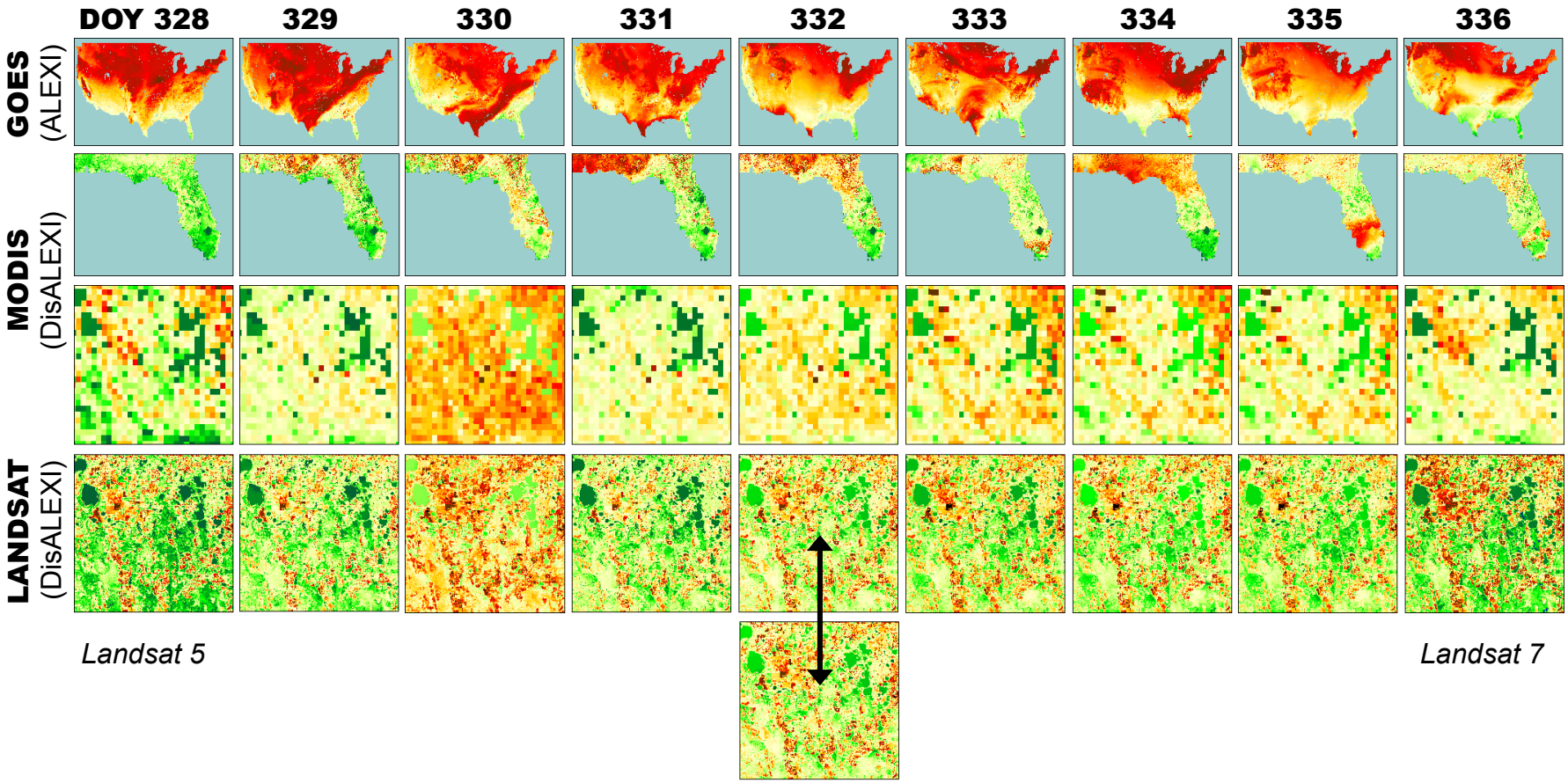
Landsat 8 *ECOSTRESS (LST)* *Landsat 7*

Albedo
NDVI
LAI

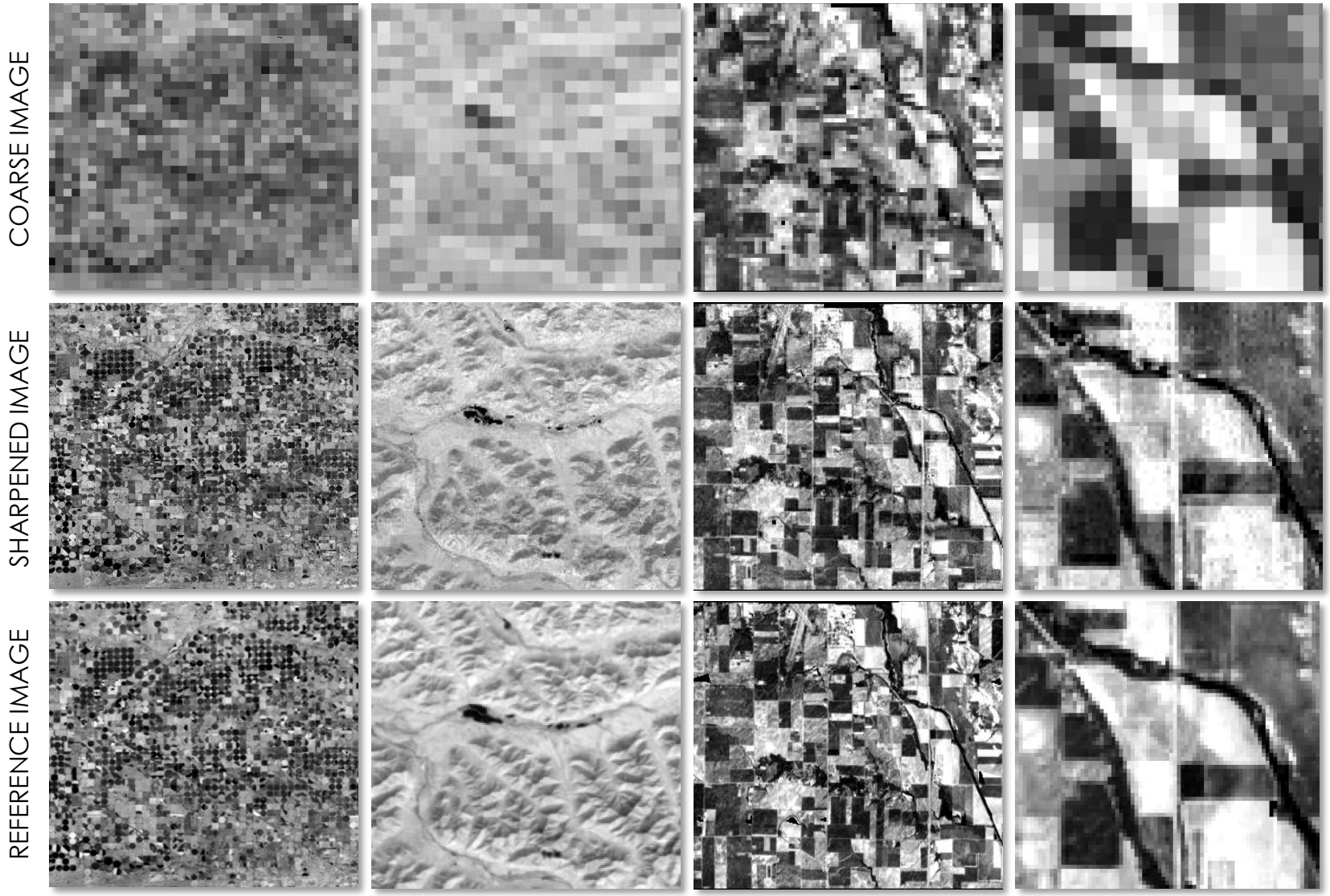
(SW inputs interpolated from bracketing clear Landsat scenes)

GOES/MODIS/Landsat/ECOSTRESS

Daily Evapotranspiration – Orlando, FL, 2002



Data Mining Sharpener



TEXAS (960 to 60 m) **ALASKA** (960 to 60 m) **IOWA** (120 to 30 m)

Processing for USDA L3/L4 products

On ECOSTRESS DAYS

INPUTS

ECOSTRESS (68 m)
LST
Emissivity

Landsat (30 m)
SR (Bands 3-7)

MODIS (1 km)
LAI (MCD15A3)

ALEXI (4 km)
ET (GET-D)

MET INPUTS (20 km)
CFSR:
Atmospheric pressure
Vapor pressure
Wind speed
Air Temperature
Insolation

PREPROCESSING

ECOSTRESS (68 m)
Resample onto Landsat grid
Sharpen LST to 30m

•Generate MODIS-consistent LAI
• Generate SW and NIR albedo

• Subset gridded LAI datasets
• Gap-fill LAI, remove outliers, apply spline filter

• Extract ALEXI ETd over Landsat grids

• Extract met data over Landsat grids
• Compute hourly and daily reference ET (RET)

DisALEXI

• Disaggregate ALEXI ETd (4km) to 30 m using ECOSTRESS LST

ETd at 30 m — L3

f_{RET} = ET/RET at 30 m — L4

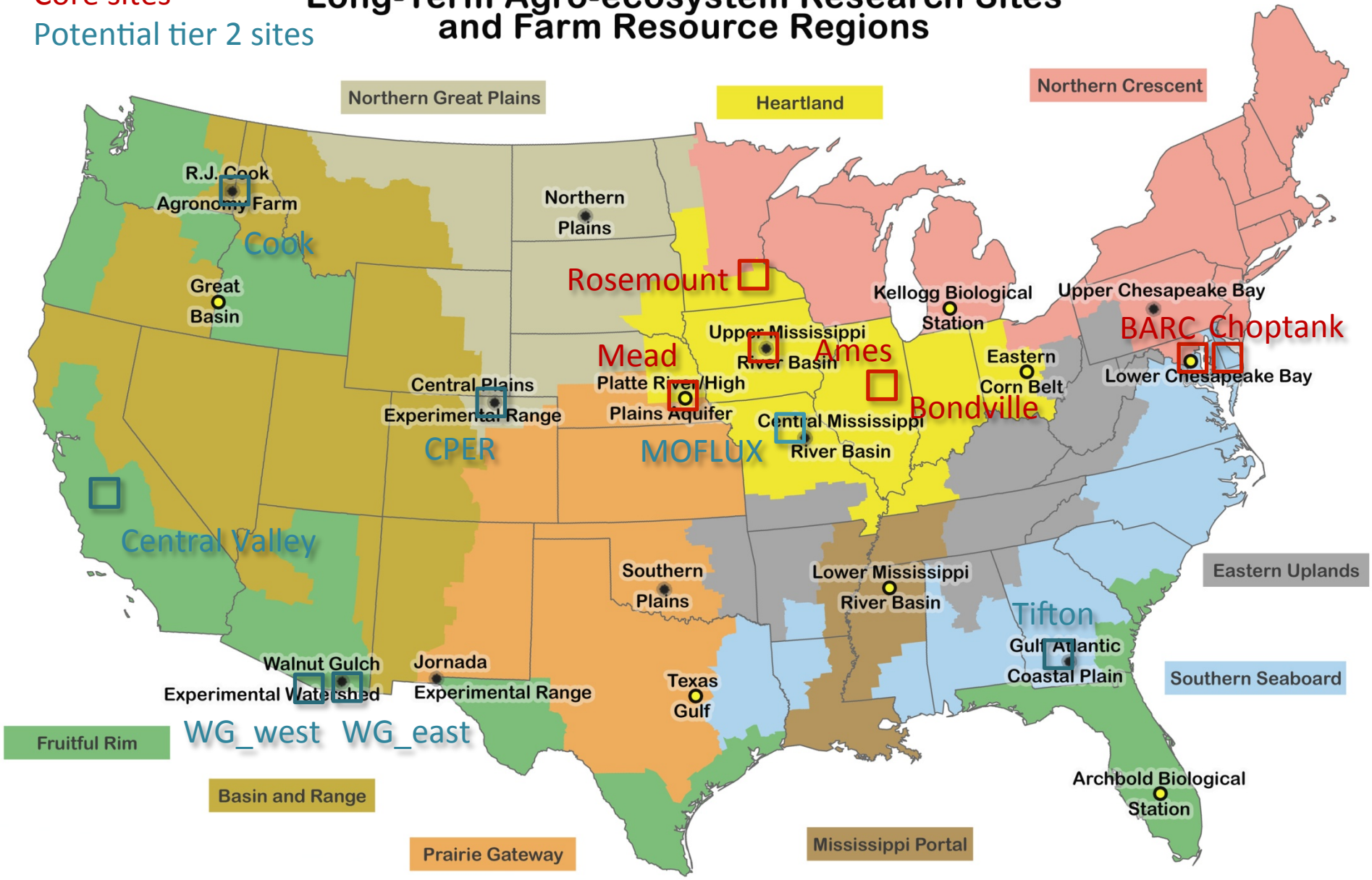
Landsat
MODIS
ALEXI
Met data
ECOSTRESS

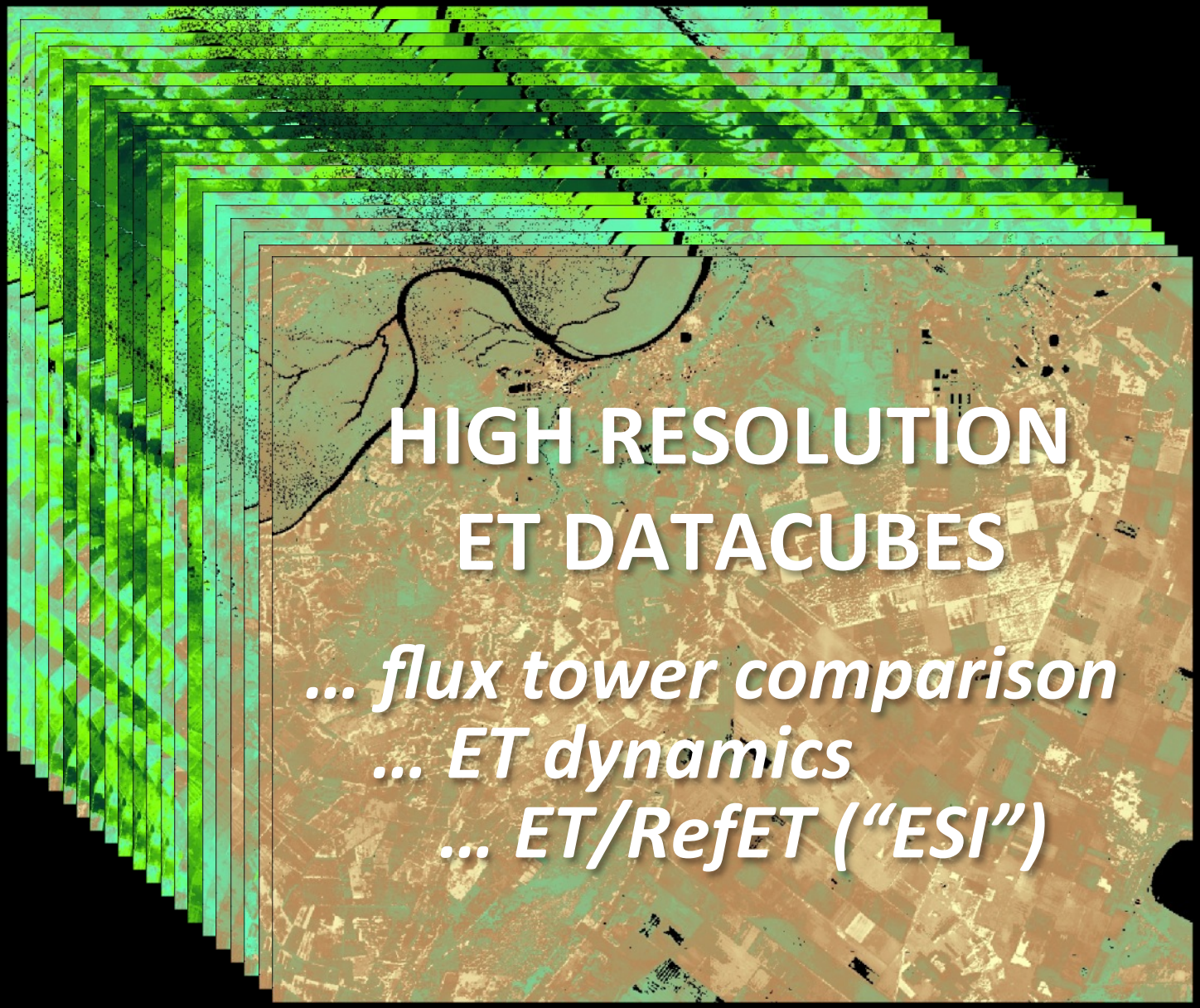
USDA-ARS LTAR NETWORK

Long-Term Agro-ecosystem Research Sites and Farm Resource Regions

Core sites

Potential tier 2 sites



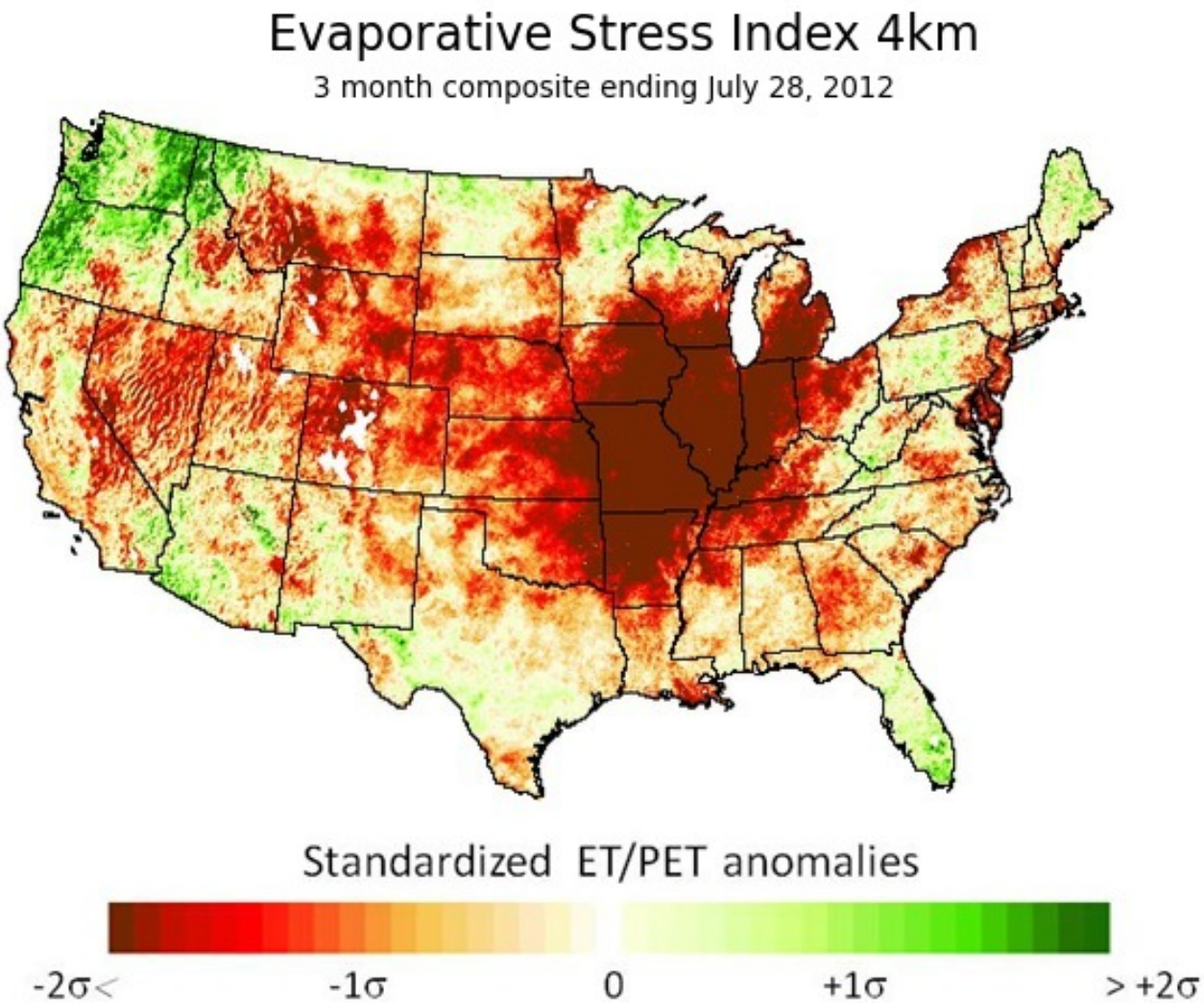


HIGH RESOLUTION ET DATACUBES

… flux tower comparison
… ET dynamics
… ET/RefET ("ESI")

Retrospective Landsat-based analyses in progress

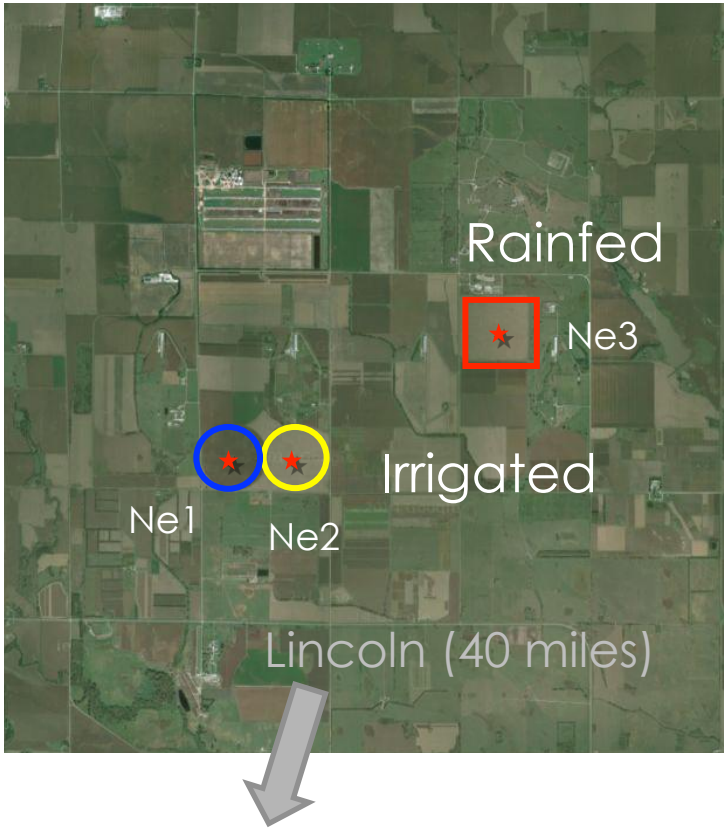
Satellite ET Drought Indicator

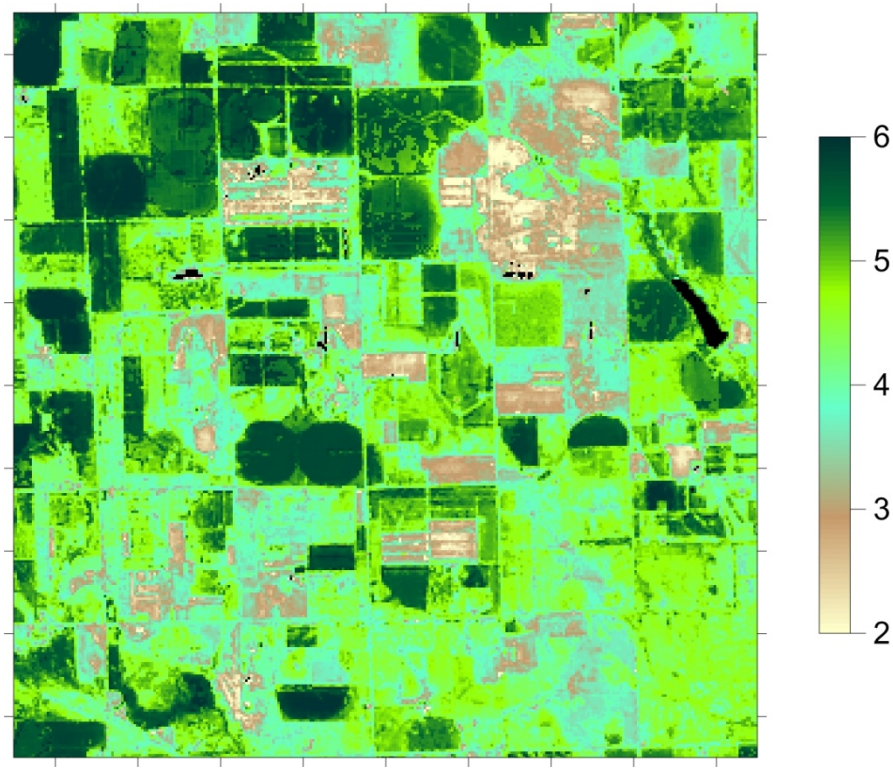


Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

Mead, NE

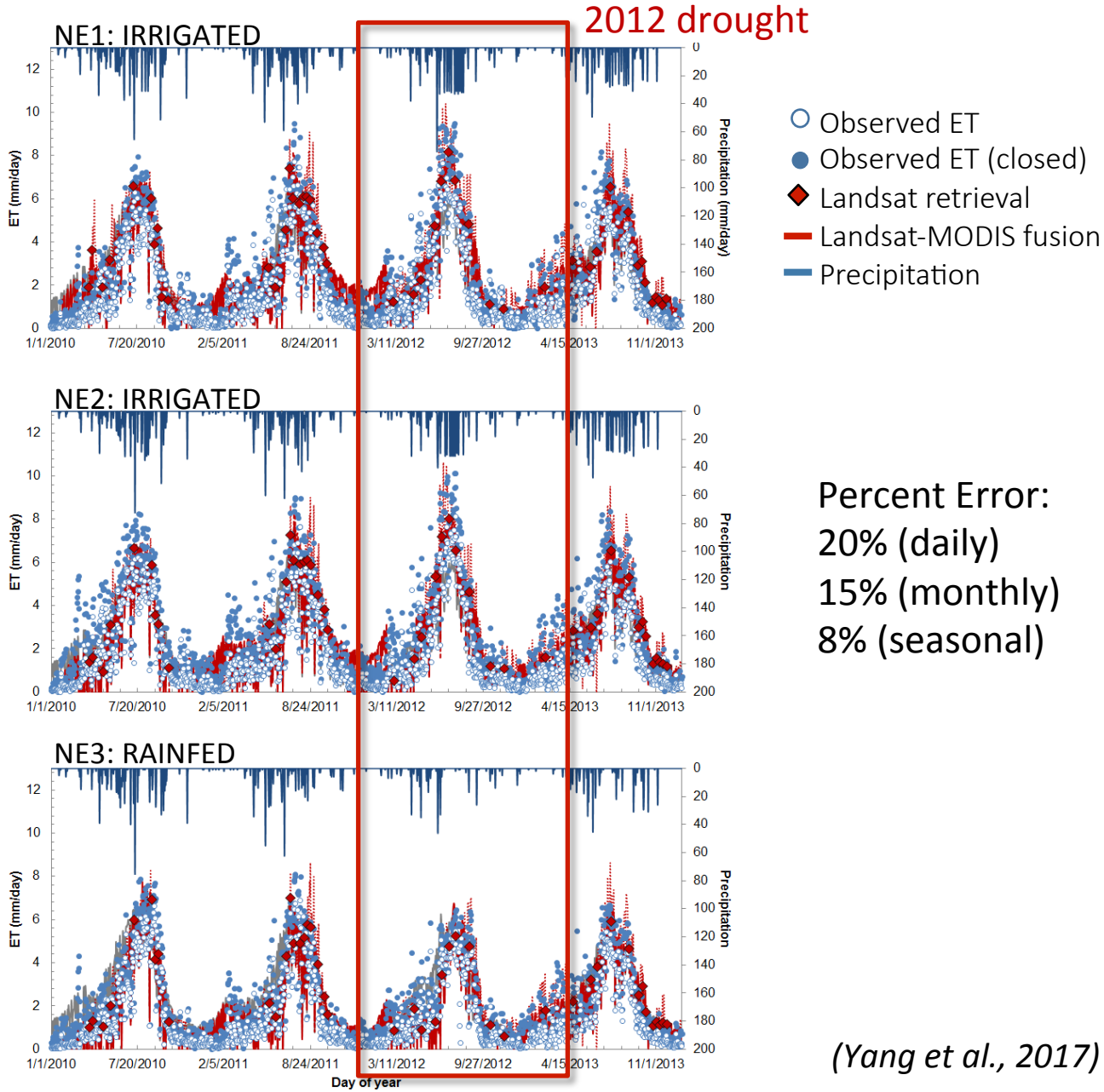




Landsat 8 - 2013

Yang, Y, et al. (2017) "Field-scale mapping of evaporative stress indicators of crop yield: an application over Mead, NE, *Remote Sensing Environ, in preparation.*

Rainfed corn and soybean in NE

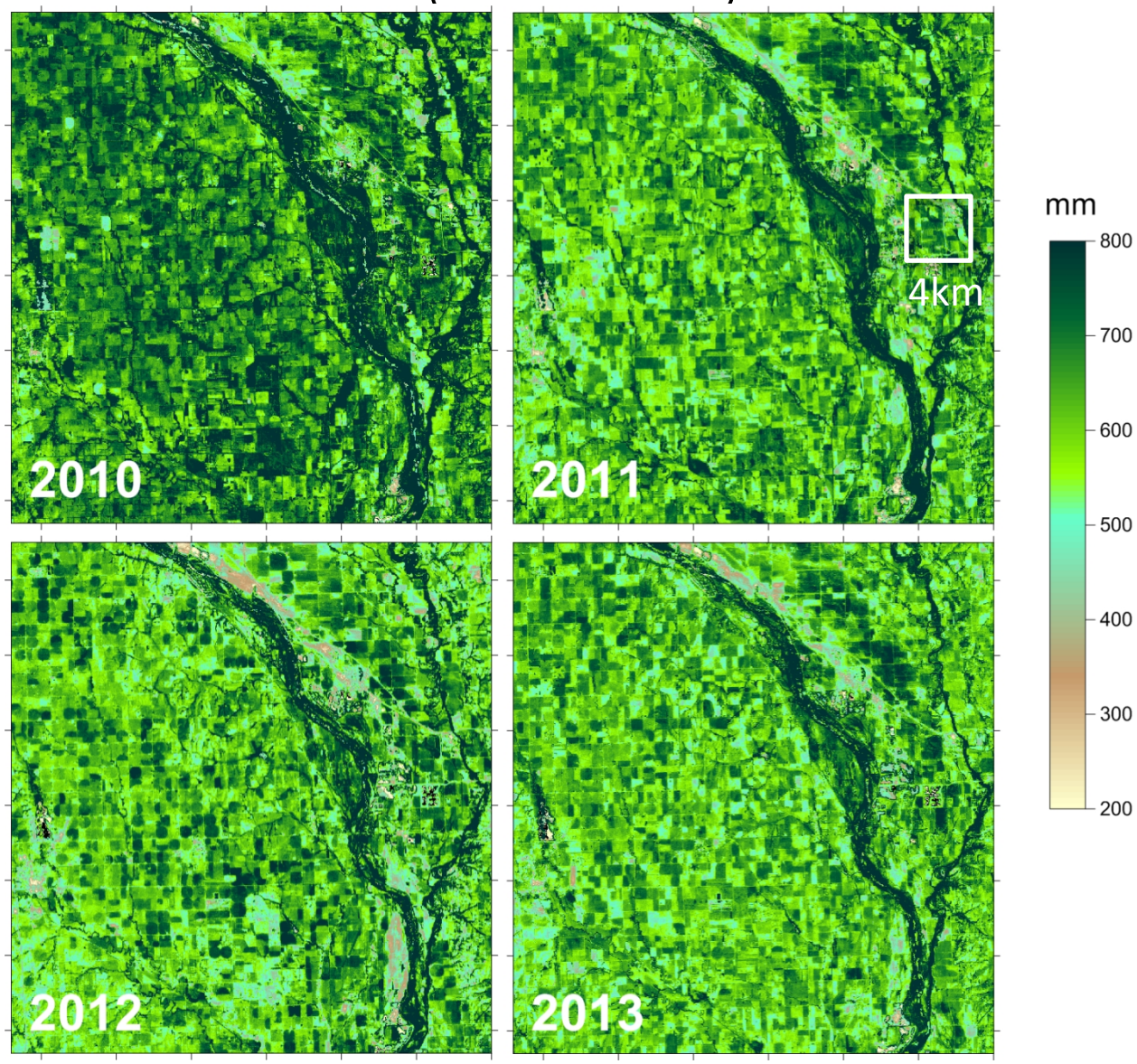


Percent Error:
20% (daily)
15% (monthly)
8% (seasonal)

(Yang et al., 2017)

Landsat/MODIS ET datacubes

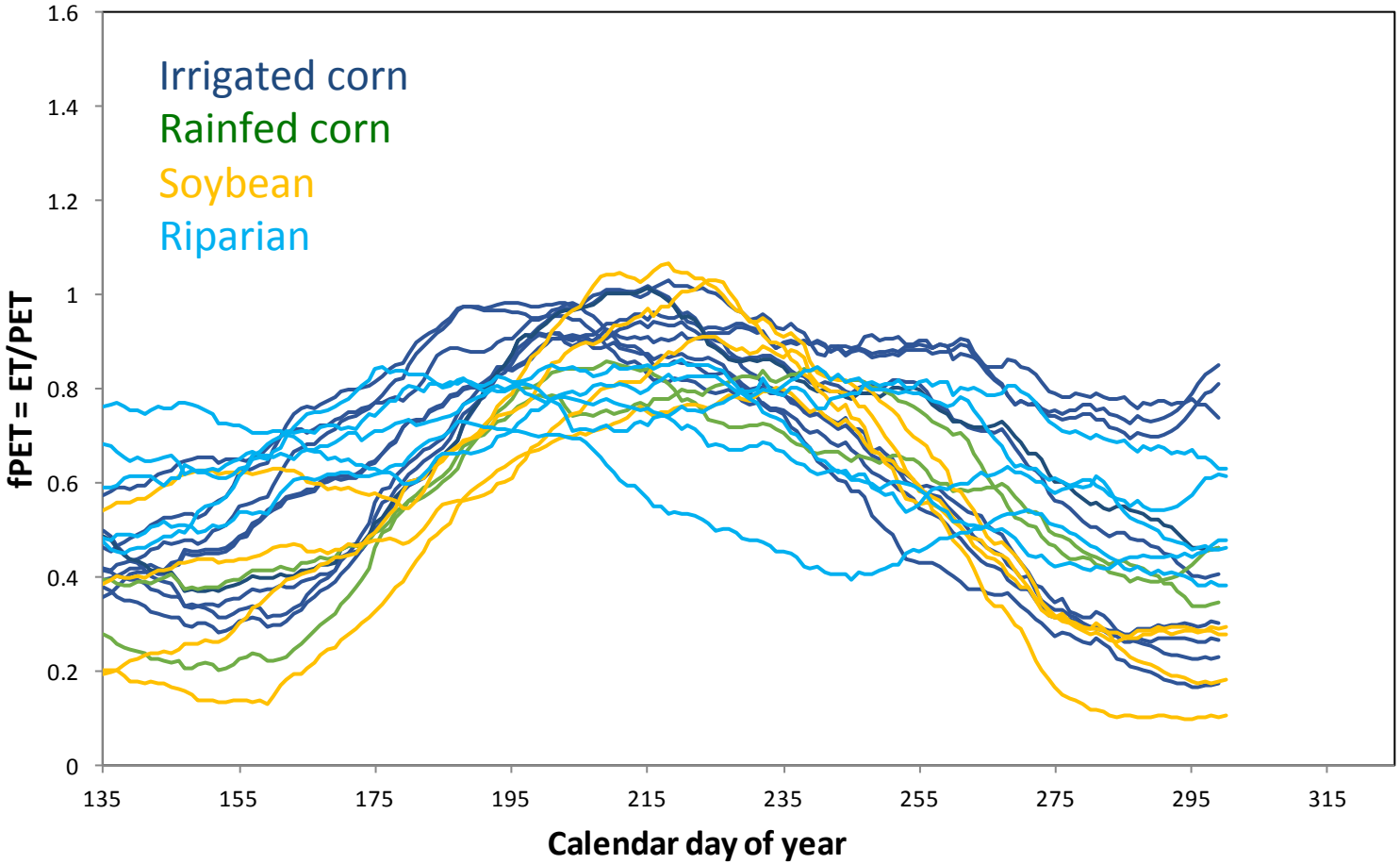
Mead, Nebraska (near Lincoln)



GROWING SEASON WATER USE

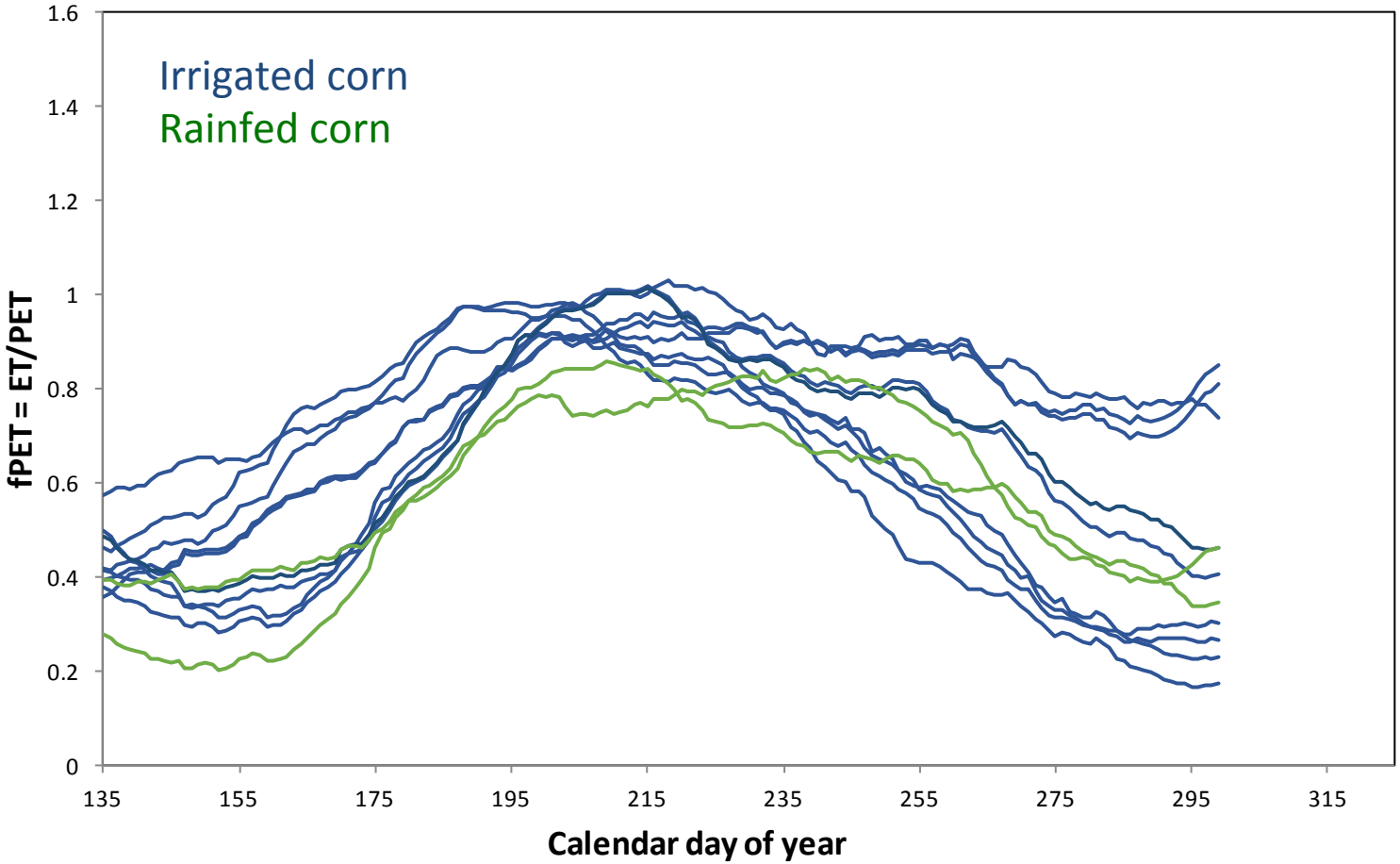
Corn fields at Mead site

Aligned on calendar date



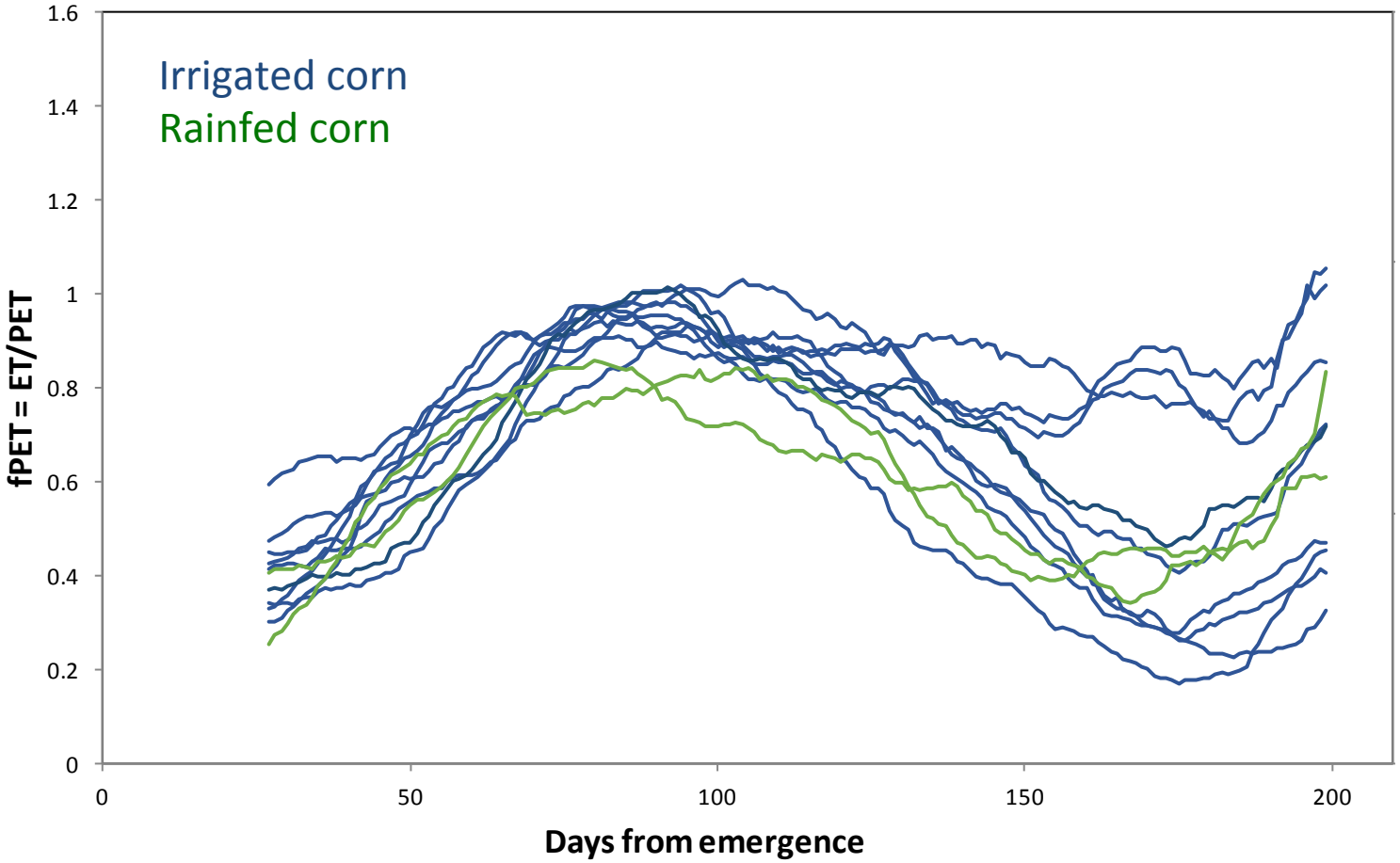
Corn fields at Mead site

Aligned on calendar date



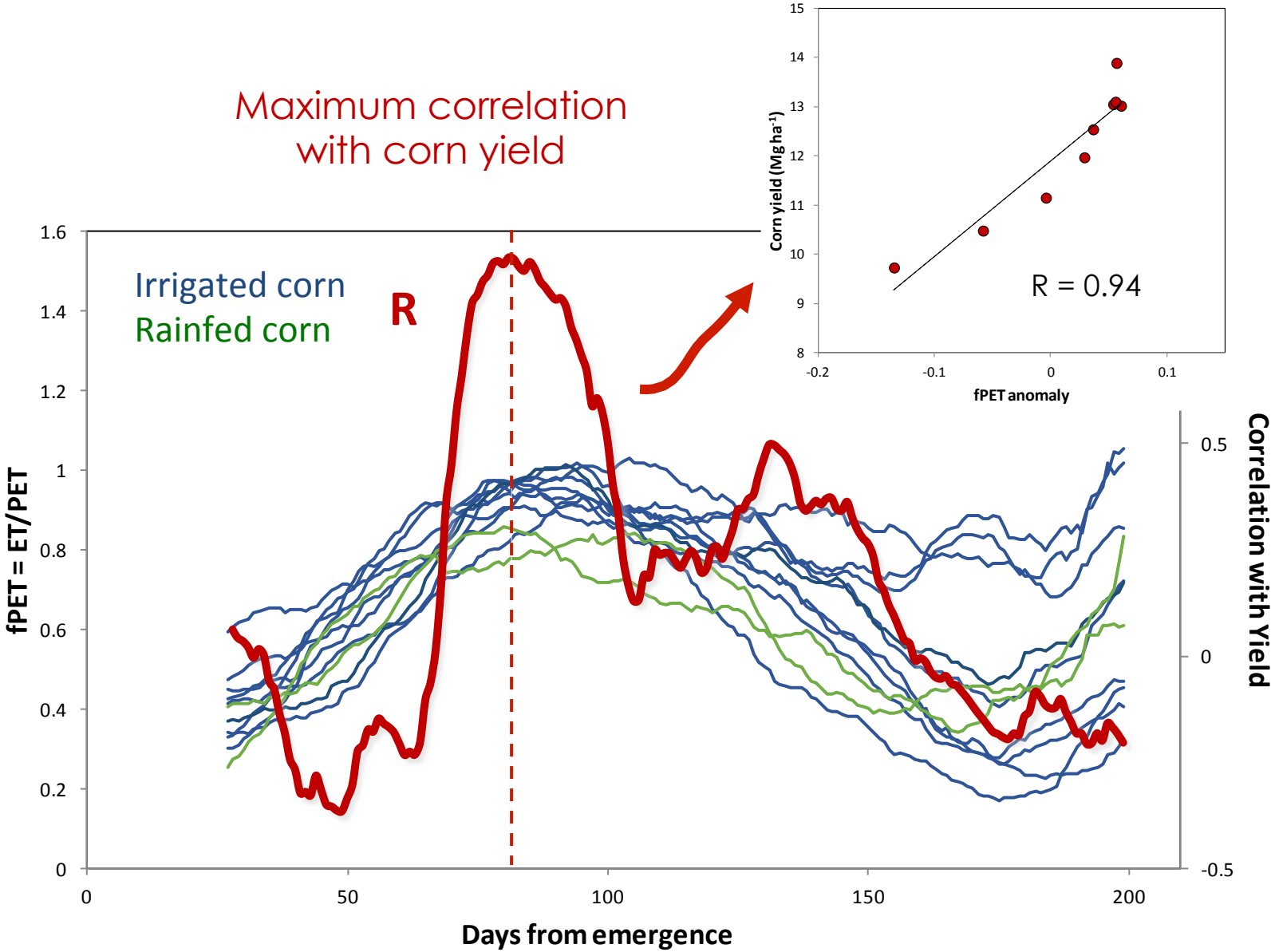
Corn fields at Mead site

Aligned on crop- (or field-) specific emergence date

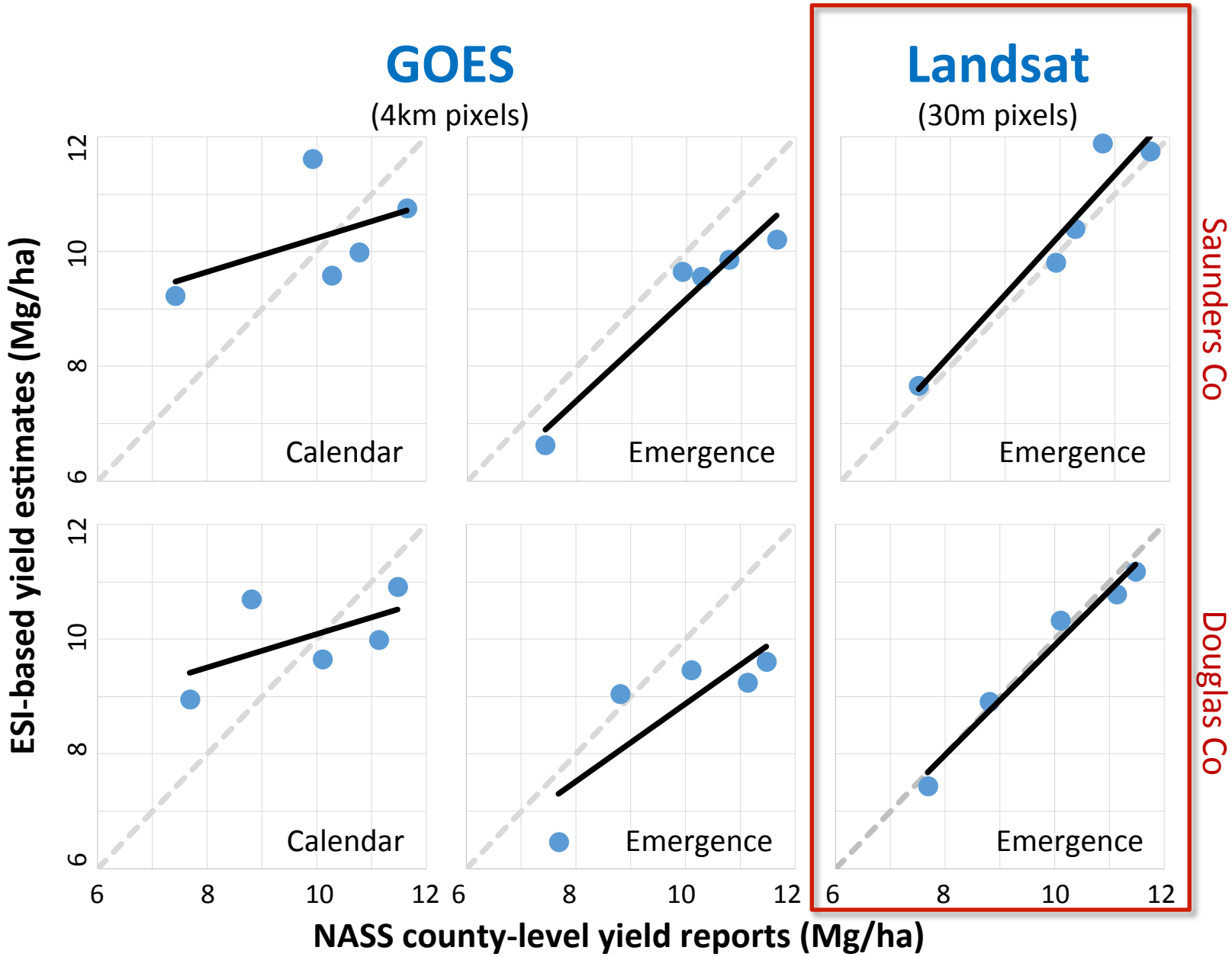


Corn fields at Mead site

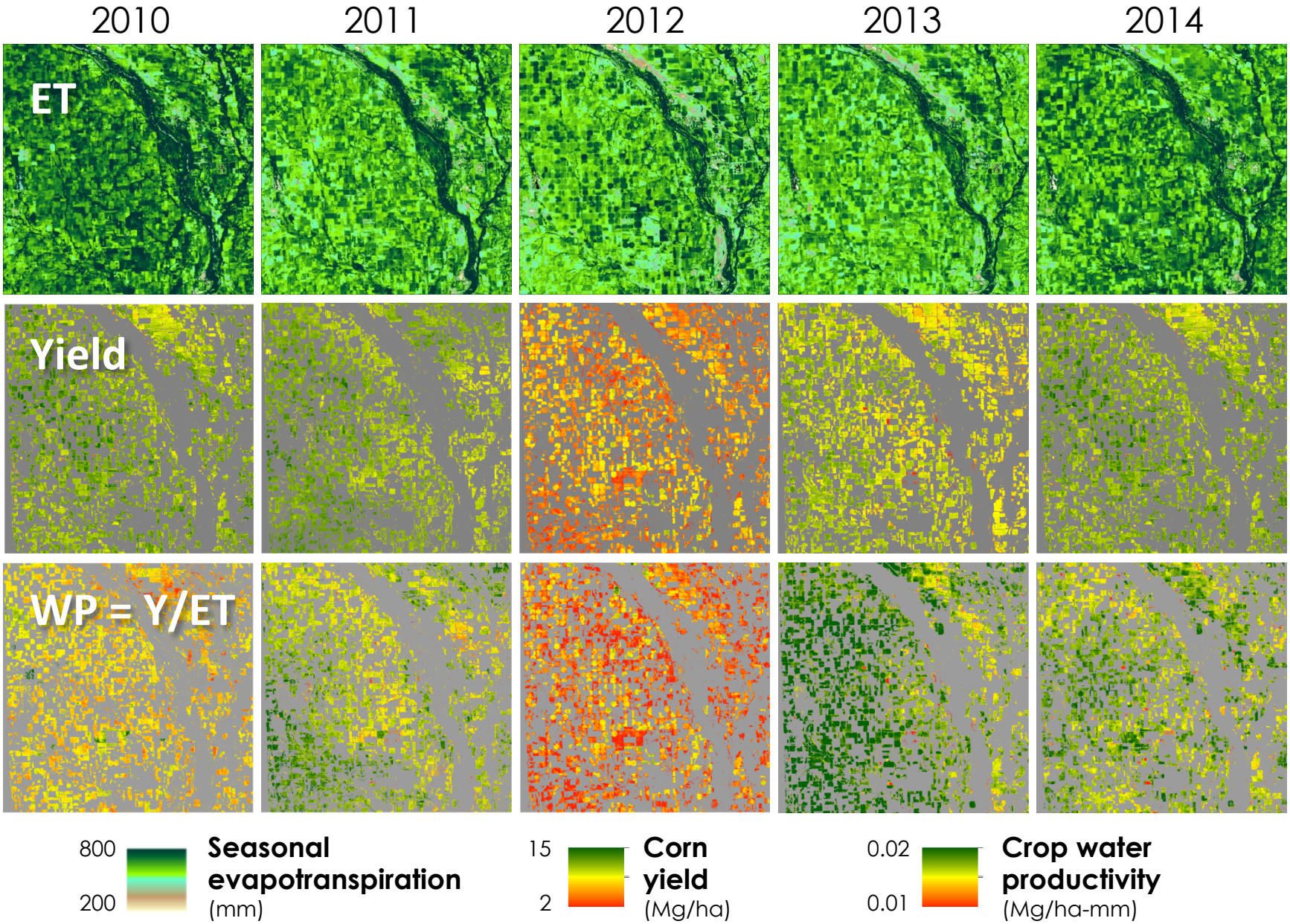
Maximum correlation with corn yield



Yield predictions improve at field scale



Water productivity: "Crop per drop"



Conclusions

Data production strategy

At core LTAR sites:

- USDA develops fully fused daily ET cubes with Landsat
- USDA processes ET, ET/RefET on ECOSTRESS days
    - Assess ECOSTRESS ET quality wrt fusion result
    - Assess value added by increased temporal sampling by ECOSTRESS (what is missed by Landsat only?)
- USDA products at core sites serve as benchmark for wider area coverage generated at JPL

hrsl.arsusda.gov/drought

USDA is an equal opportunity provider and employer.

Water quality in the Chesapeake Bay

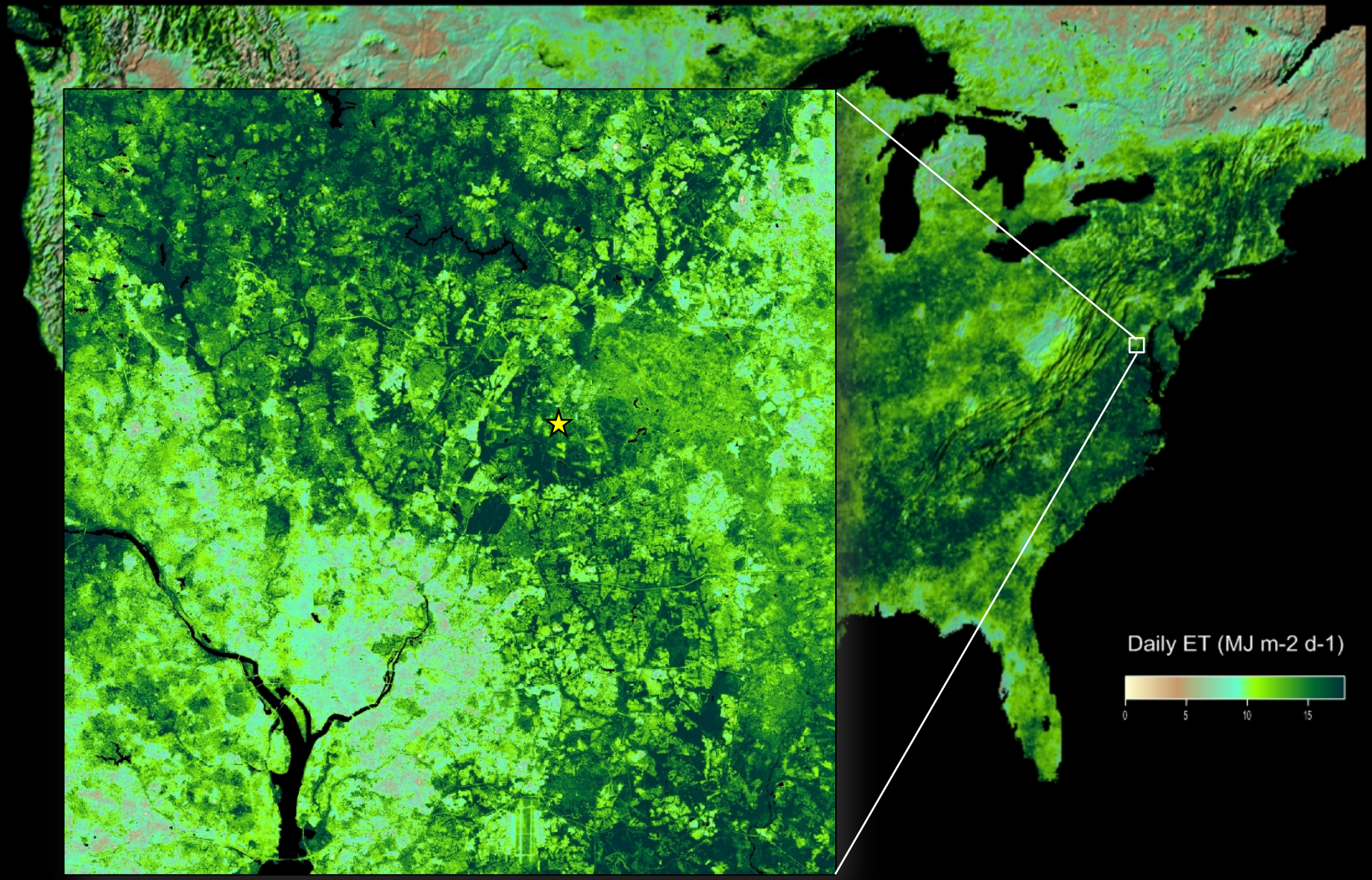
Liang Sun,
Amir Sharifi, 2016

Donna Smith Photography/Shutterstock

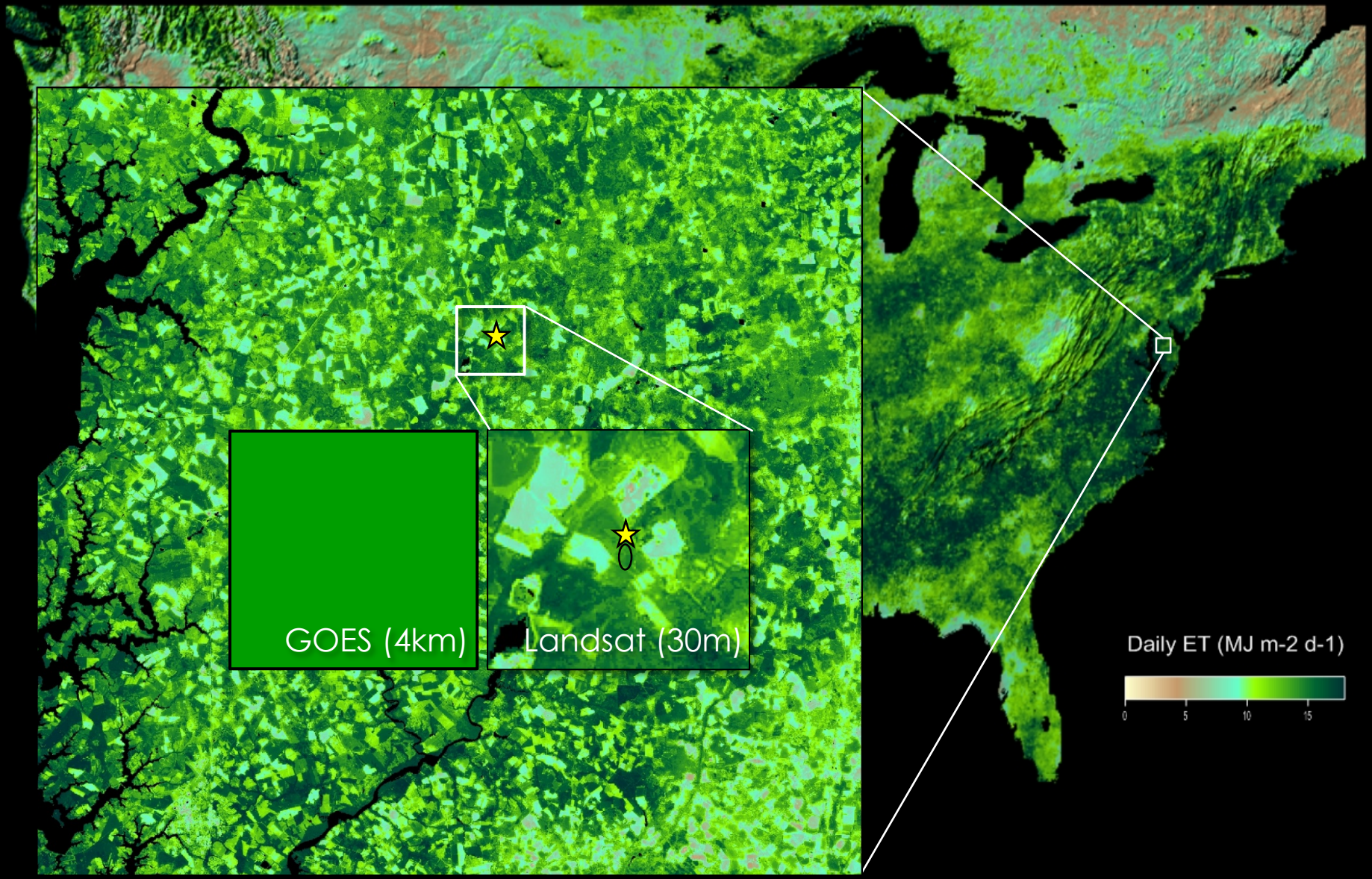
Chesapeake Bay Program

Chesapeake Bay Foundation

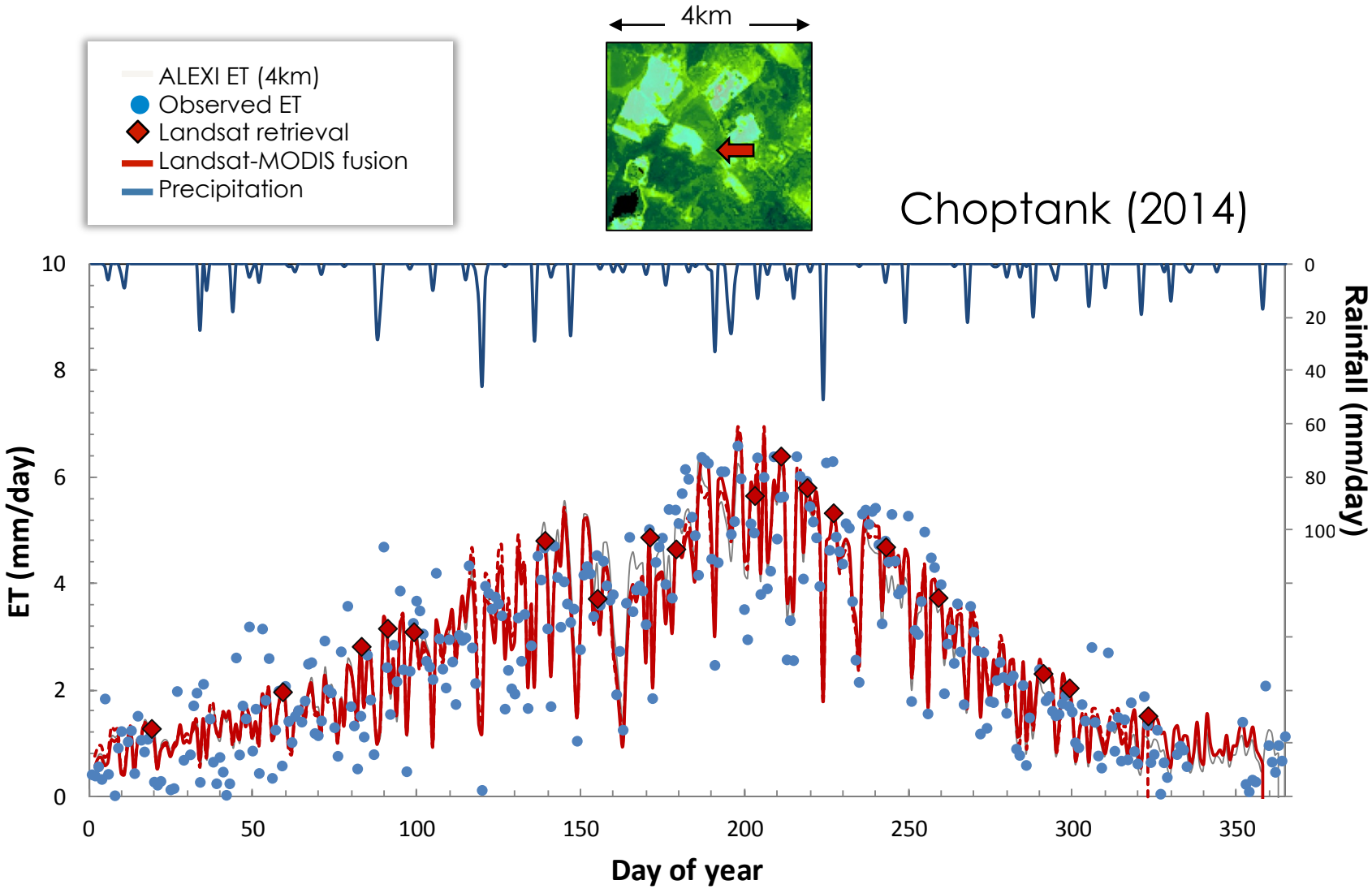
NOAA – NESDIS – STAR
GOES Evapotranspiration and Drought Product System (GET-D)



NOAA – NESDIS – STAR
GOES Evapotranspiration and Drought Product System (GET-D)

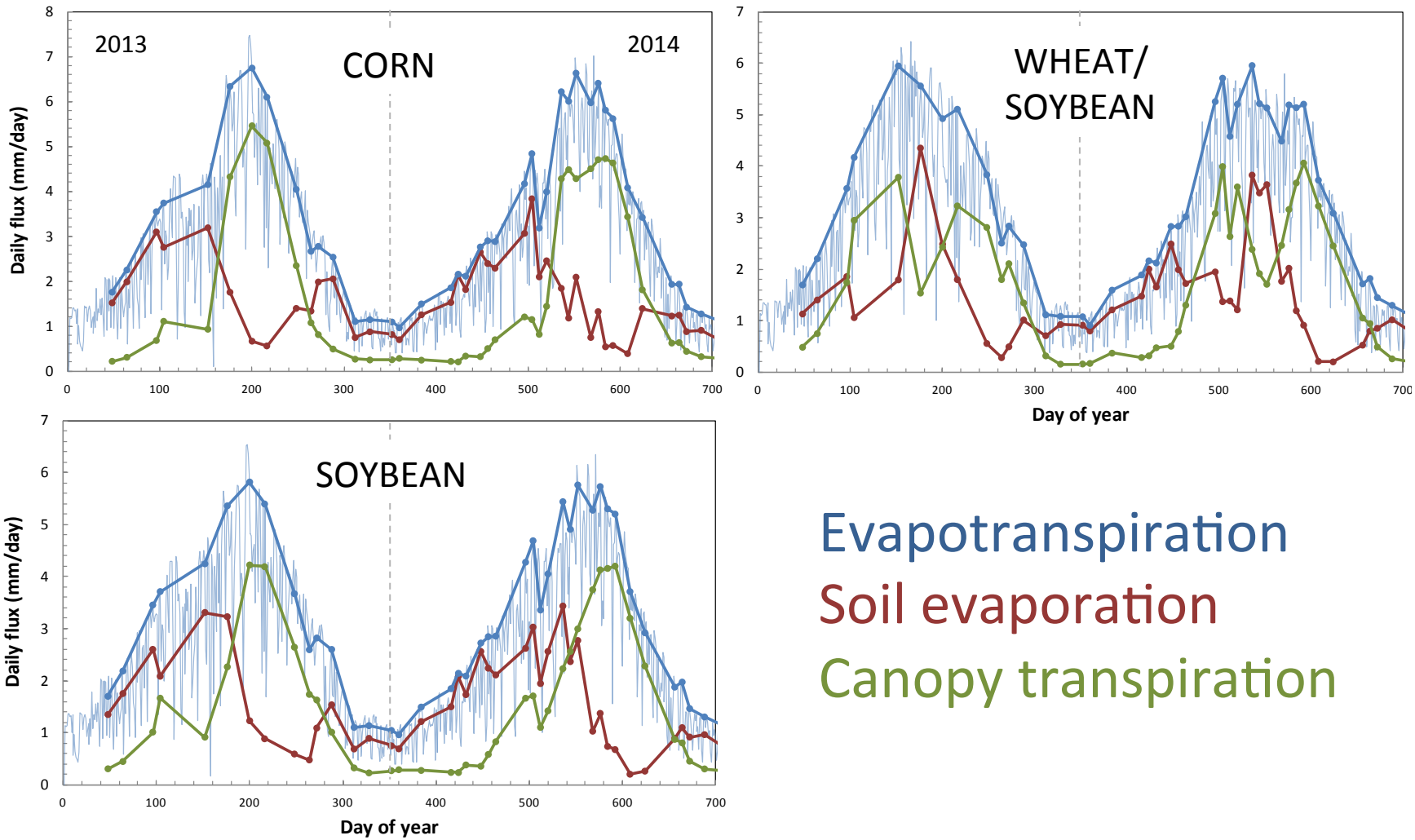


Comparisons with flux tower data



Sun, L. et al. (2017). Monitoring daily evapotranspiration at field-scale over an agricultural landscape on the Eastern Shore of Maryland. *Water Resources Res., in review*

T/E SEPARATION ON CLEAR LANDSAT DATES

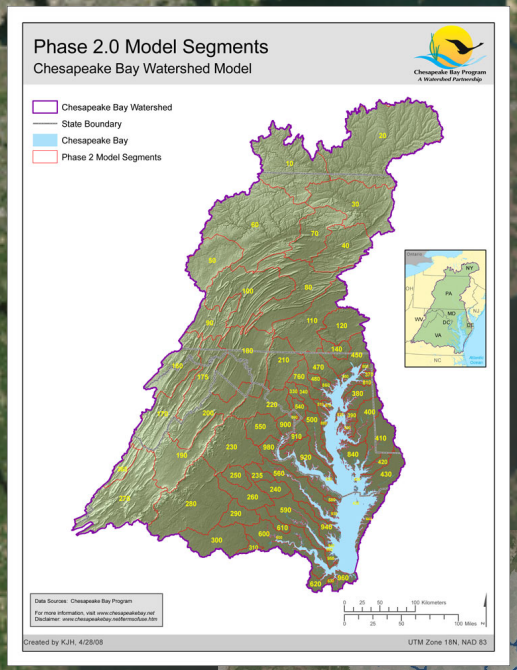


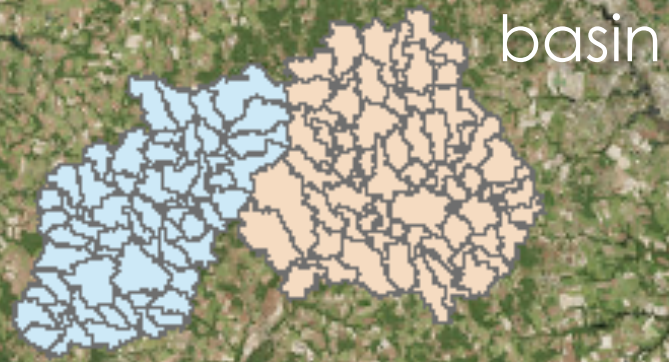
Evapotranspiration

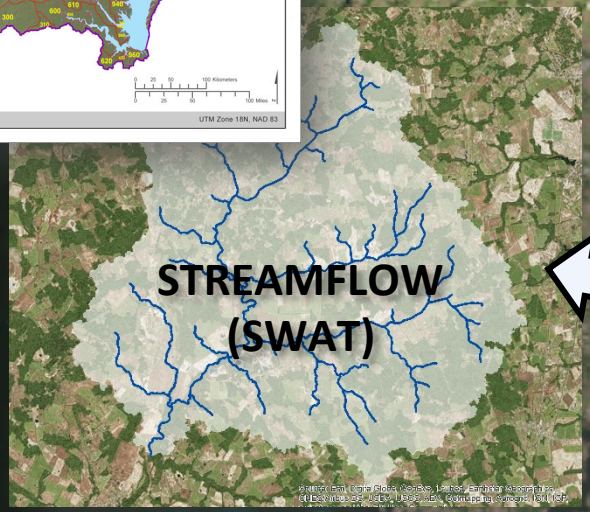
Soil evaporation

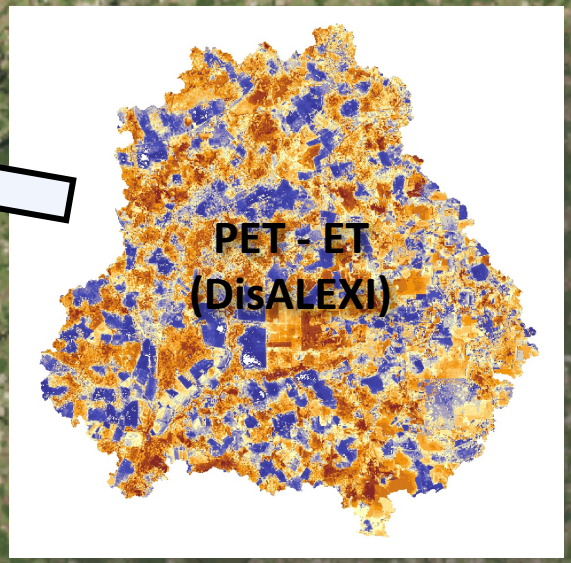
Canopy transpiration

Calibrating watershed model with ET



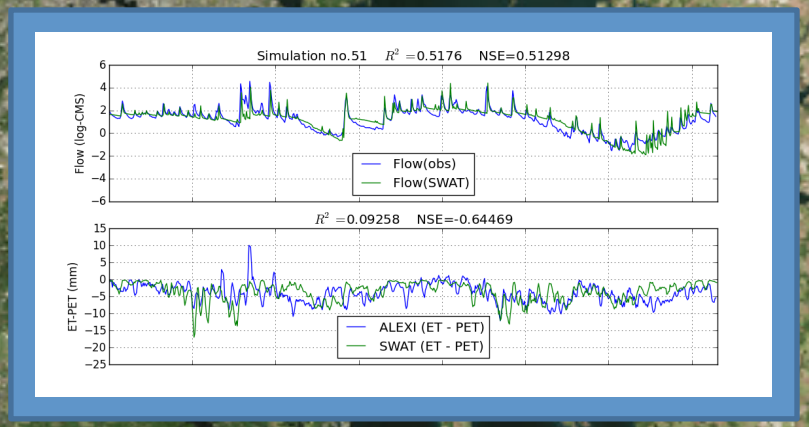


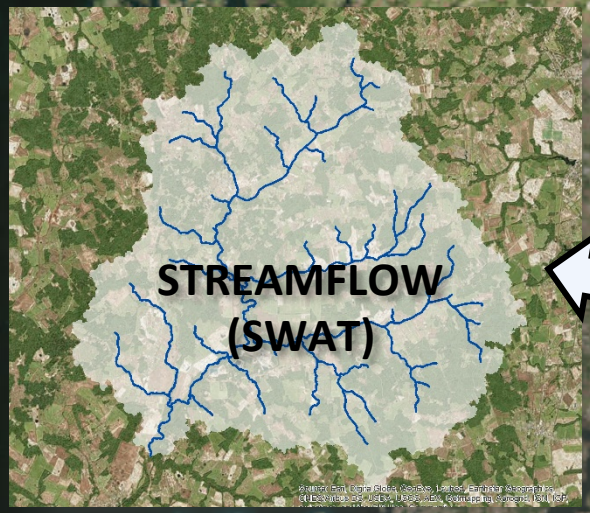


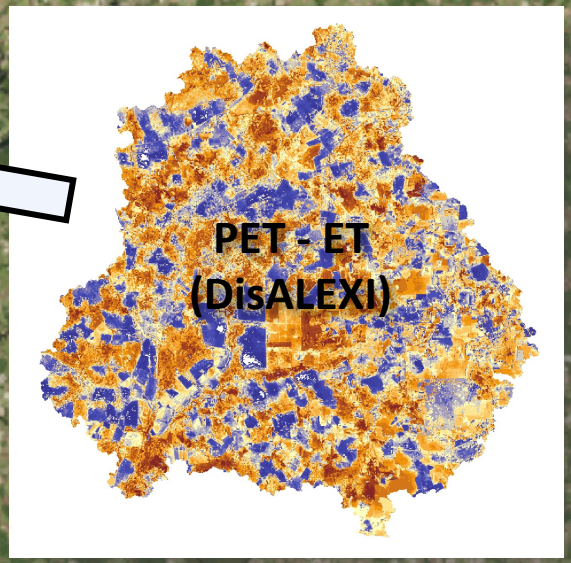


Strategy: Iteratively calibrate Soil Water Assessment Tool (SWAT) parameters using PET-ET from remote sensing aggregated to sub-basins. (Sharifi et al., 2017)

Calibrating watershed model with ET

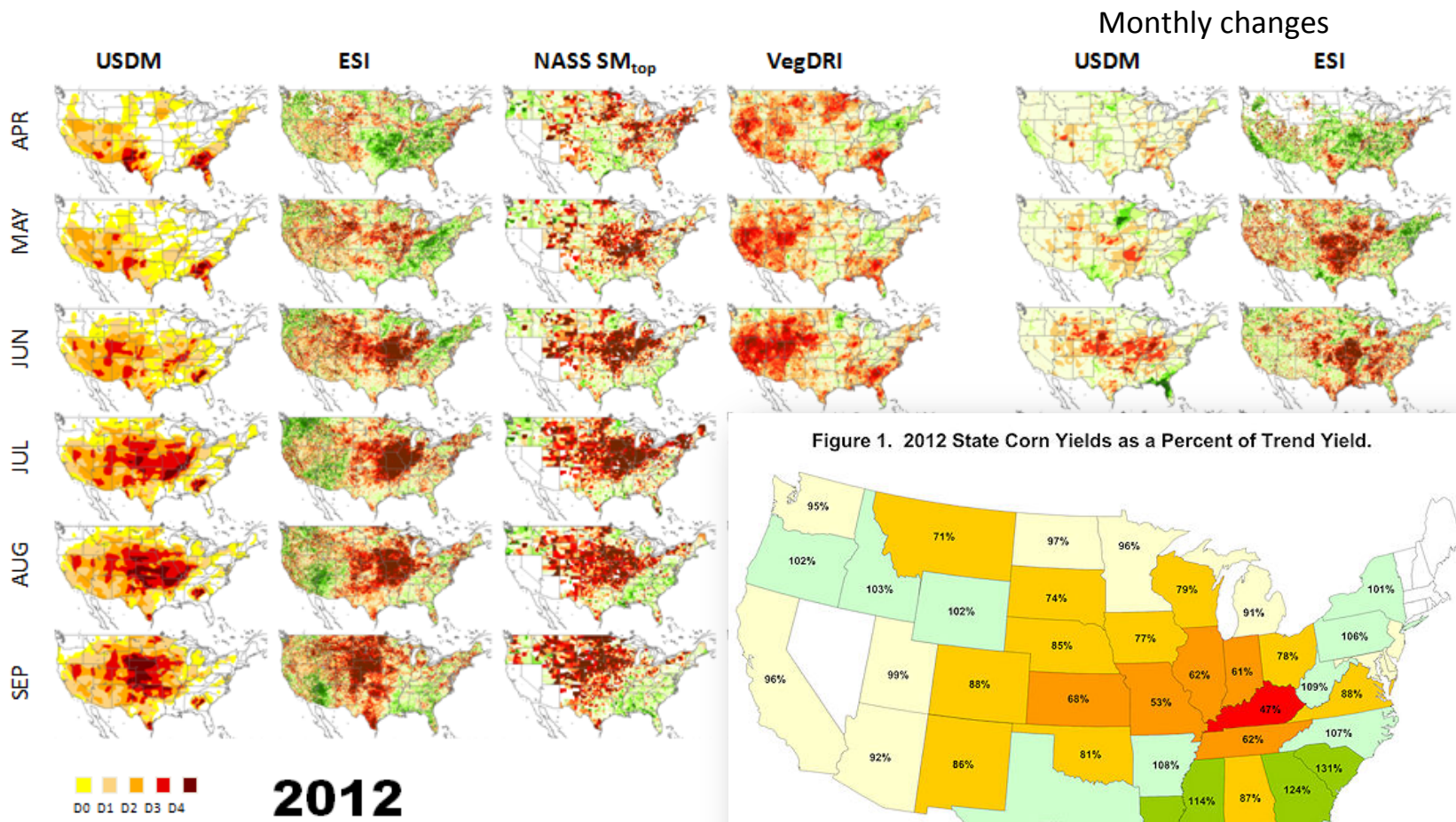




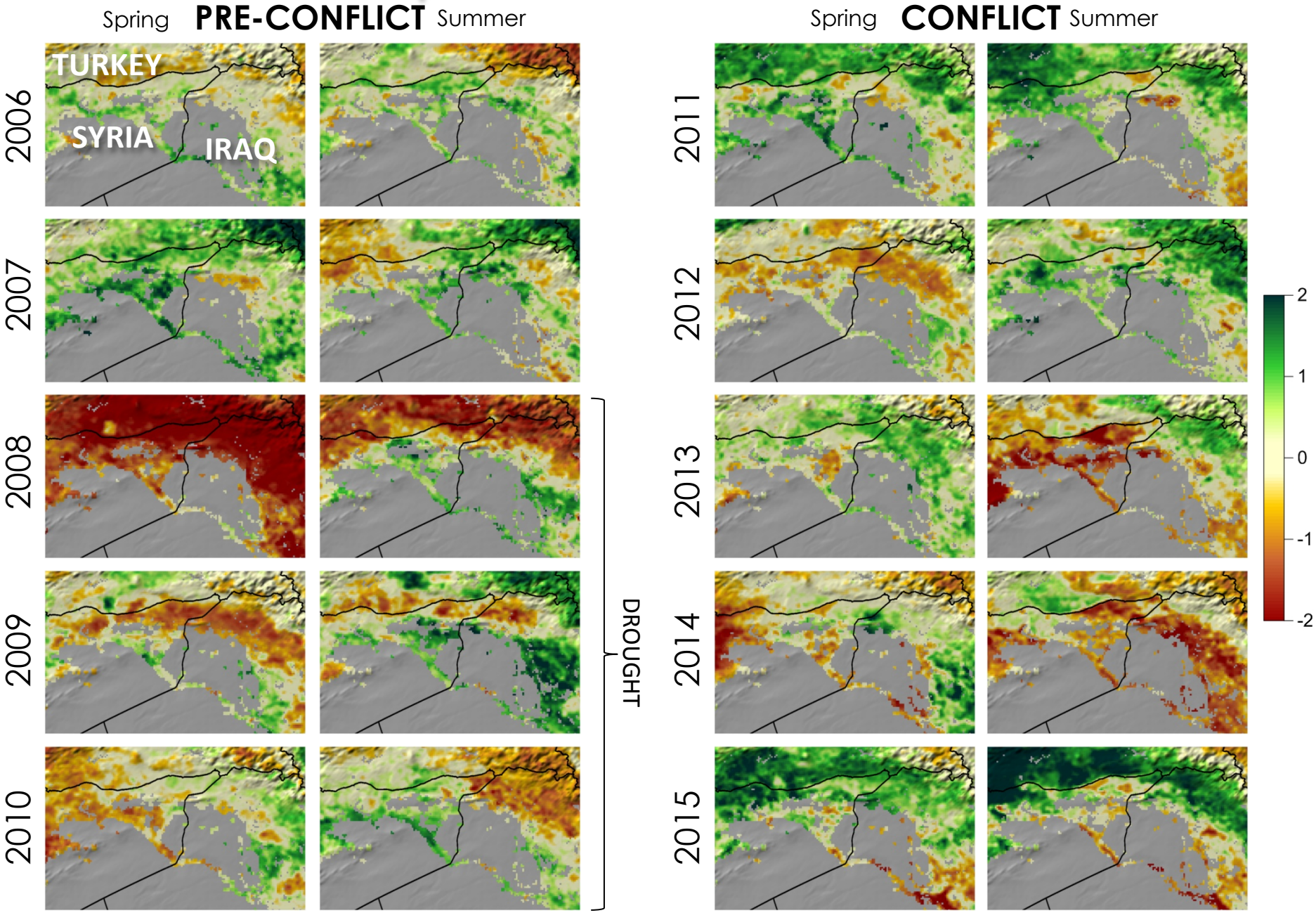


Strategy: Iteratively calibrate Soil Water Assessment Tool (SWAT) parameters using PET-ET from remote sensing aggregated to sub-basins. (Sharifi et al., 2017)

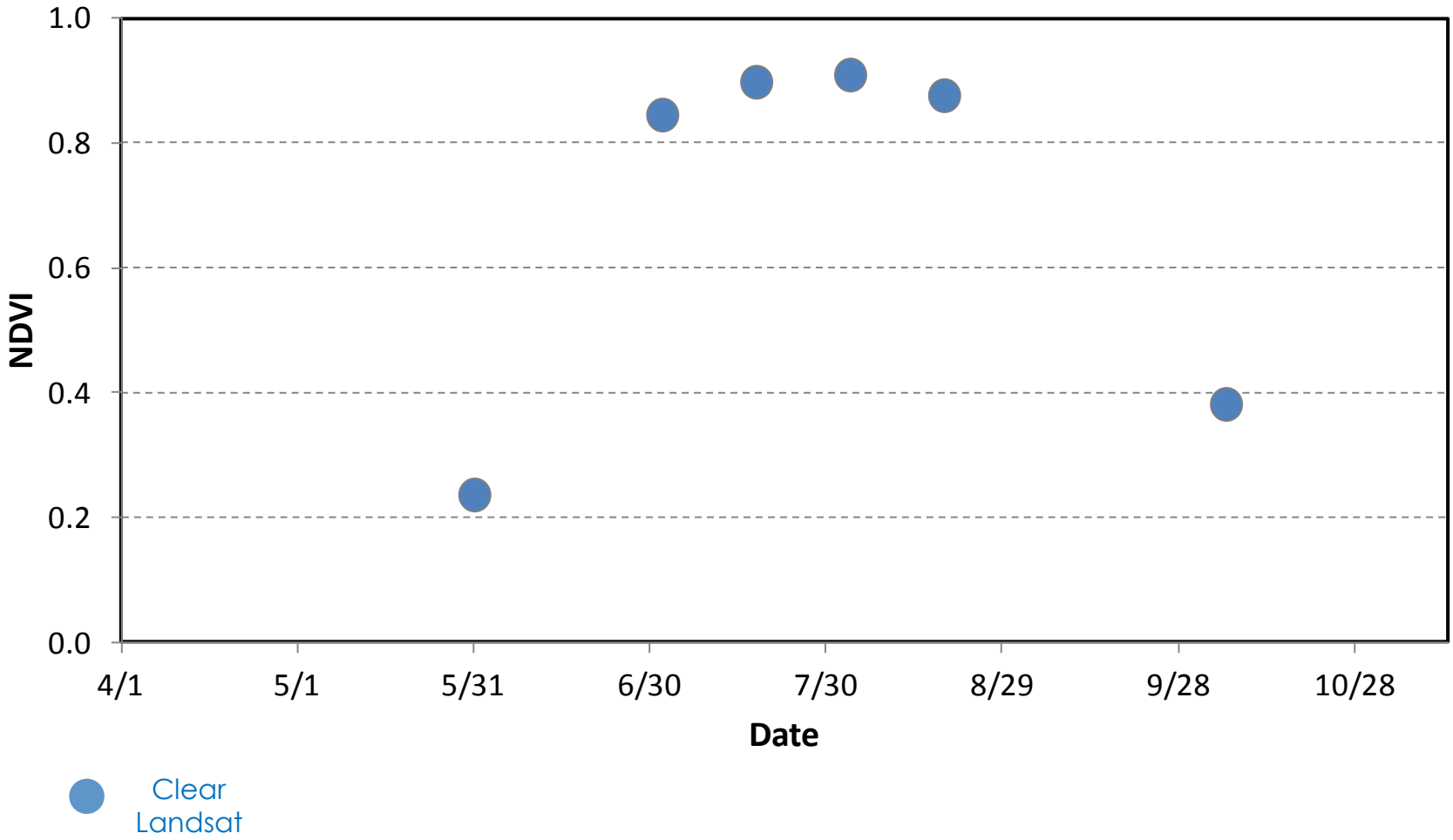
2012 FLASH DROUGHT



Evaporative Stress Index



Aligned phenology and stress signals



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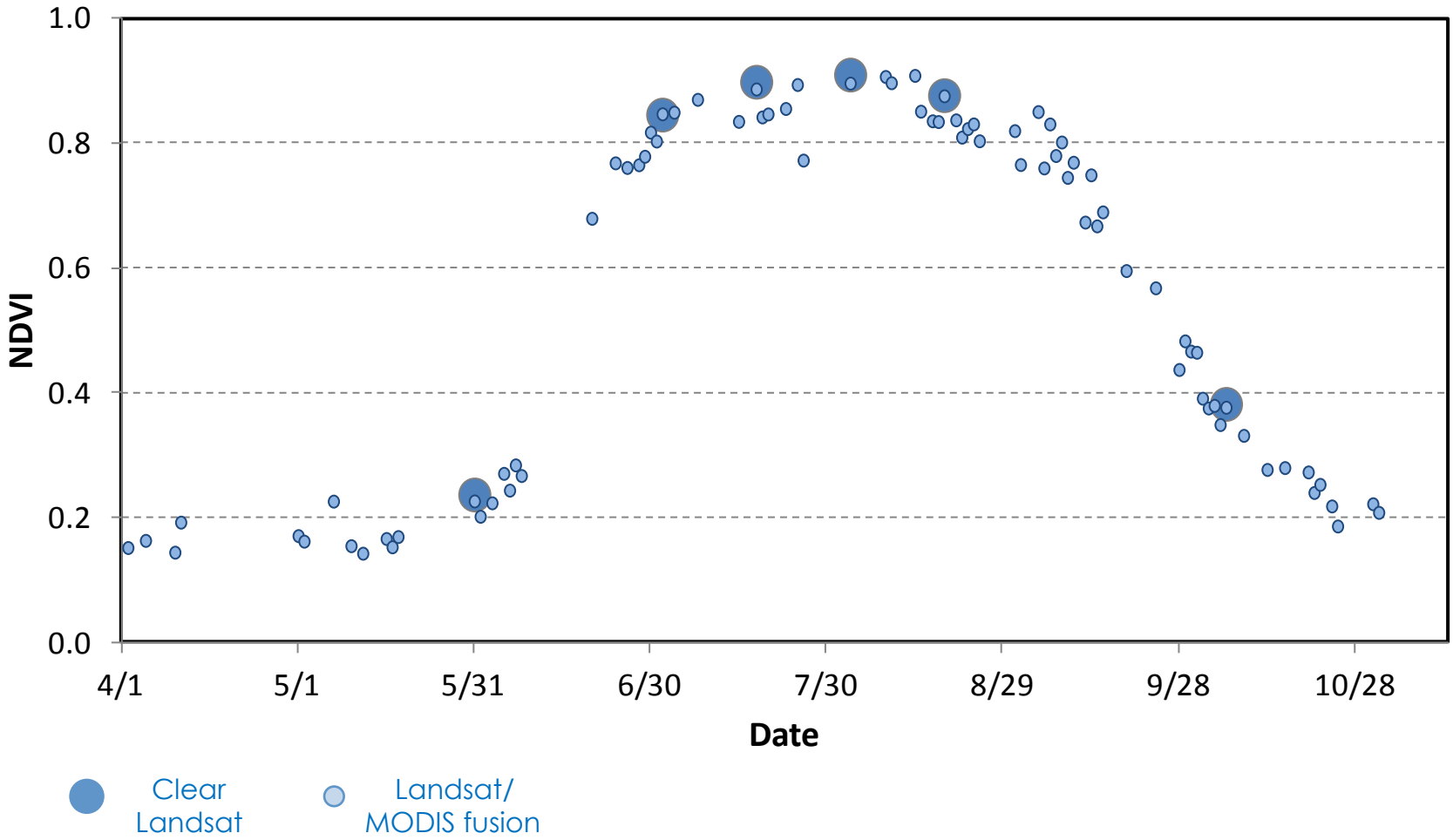

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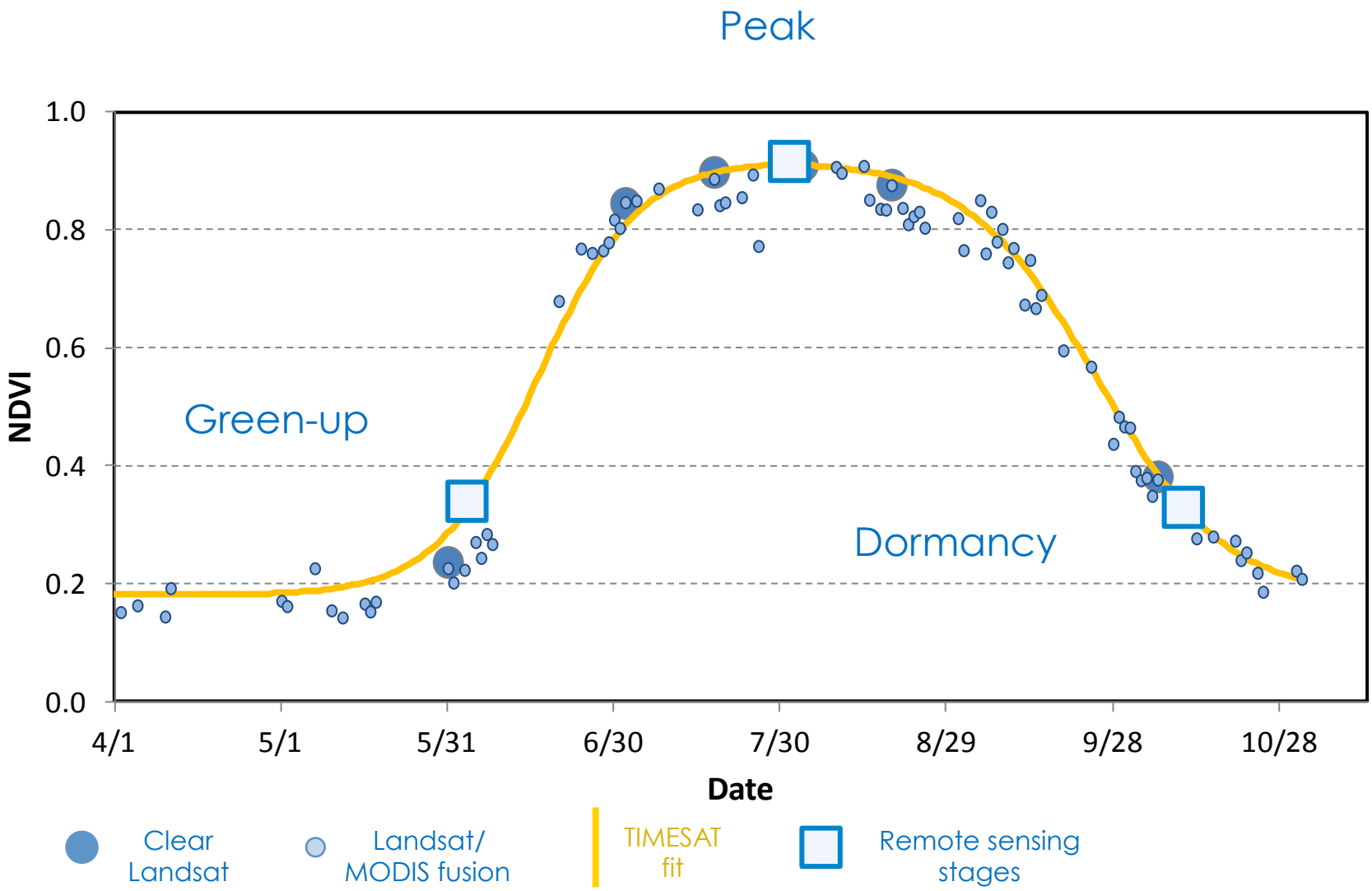
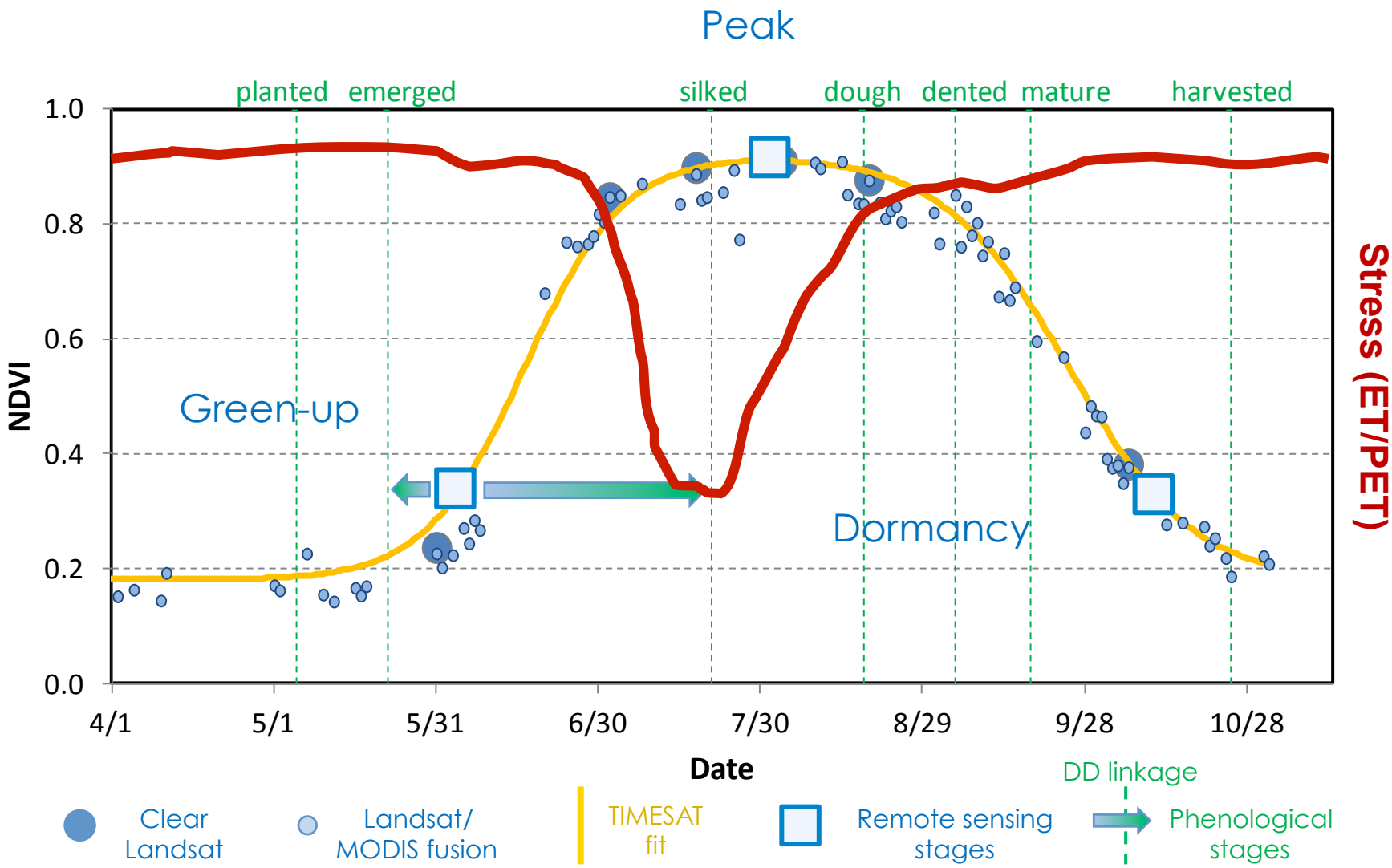
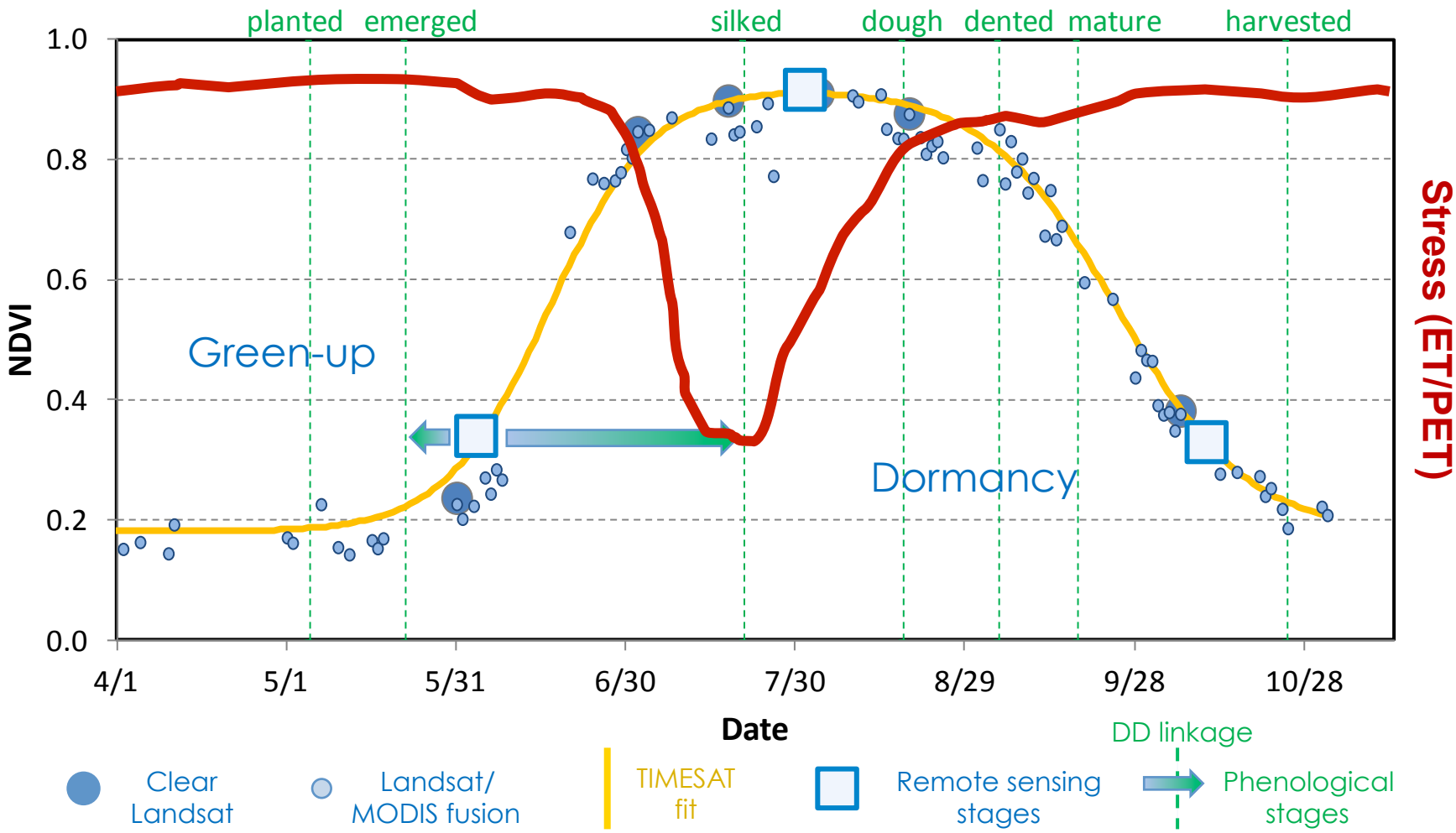


Aligned phenology and stress signals



Aligned phenology and stress signals

$$Yield = \sum_{i=greenup}^{dormancy} \left[PAR_i \times fPAR_i \times LUE_i(\varepsilon_{\max}, T, ET) \right] * HI$$

Peak