Mapping ET at Multiple Scales using Multi-Sensor Data Fusion

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Multi-scale monitoring toolkit

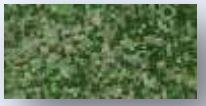
TOOLS

ALEXI	Multi-scale ET modeling
DMS	Thermal image sharpening
STARFM	Multi-sensor data fusion

ASSETS

		SW/TIR
GEO	Hourly	5km/5km
MODIS	Daily	250m/1km
Landsat	16 day	30m/100m
Lsat-like		~20-60m/ --

APPLICATIONS
(daily/30 m to 10 km)

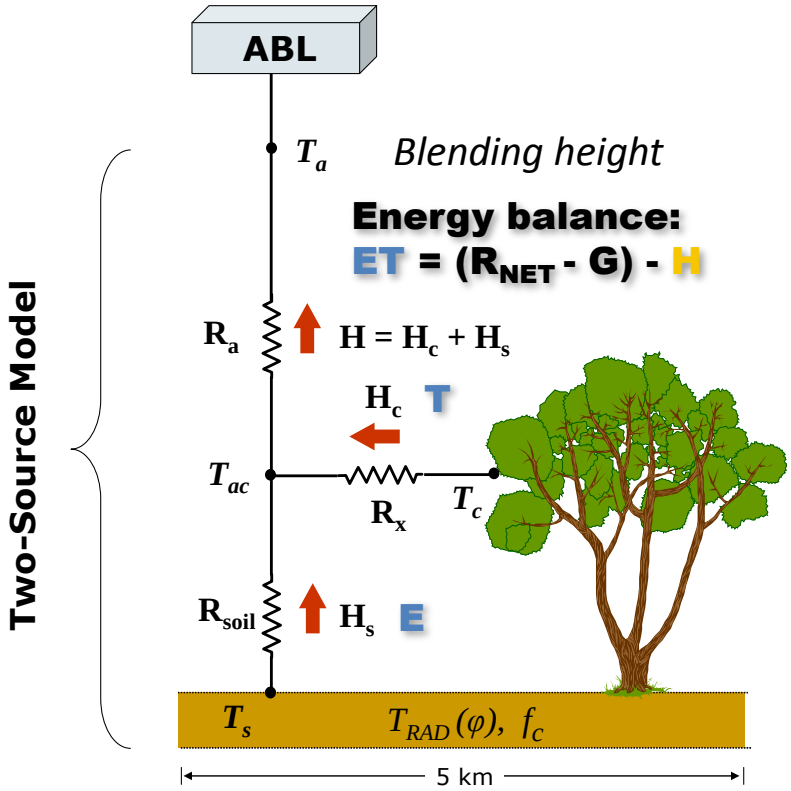

Crop water use
(Evapotranspiration)


Crop phenology metrics


Crop stress
(drought early warning)

MULTI-SCALE SATELLITE ET RETRIEVAL

… based on landsurface temperature



ALEXI
(Atmosphere-Land Exchange Inverse model)

ATMOSPHERE-**L**AND
EXCHANGE **I**NVERSE MODEL

ALEXI uses measurements of morning surface temperature rise from geostationary satellites…

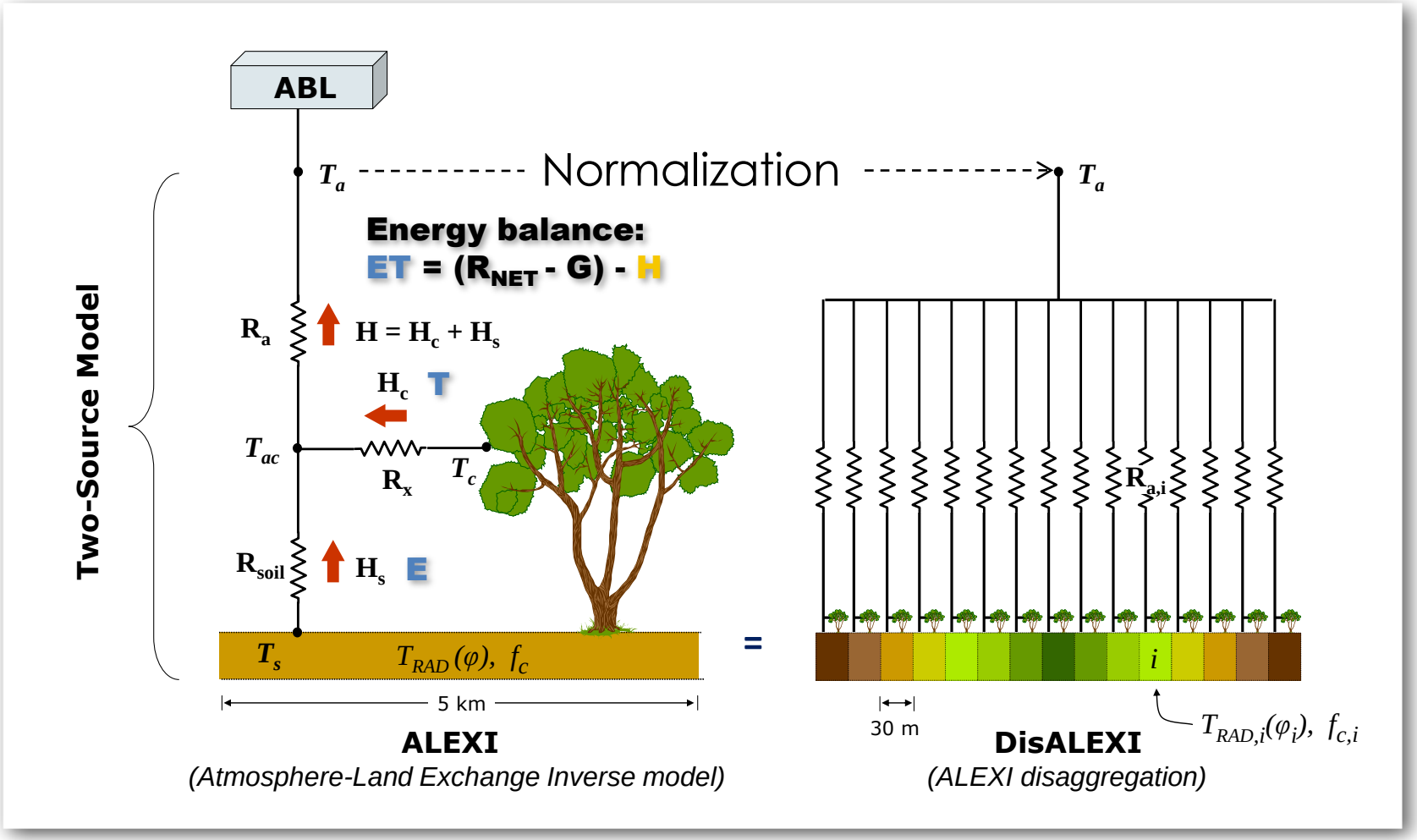
…time changes in temperature can be measured more accurately than instantaneous temperature.

Regional scale

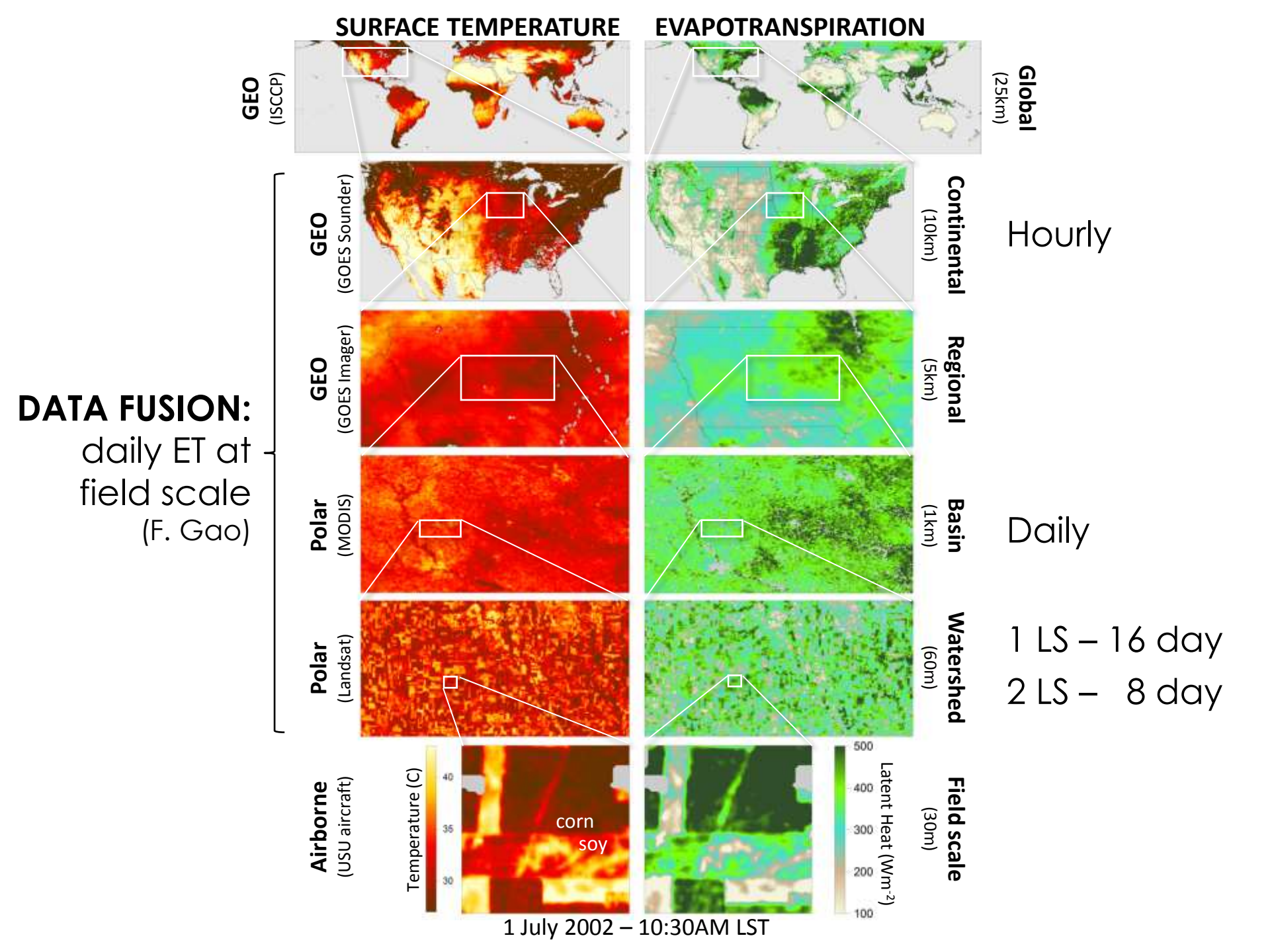
Surface temp: ΔT_{RAD} - Geostationary
Air temp: T_a - ABL model

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

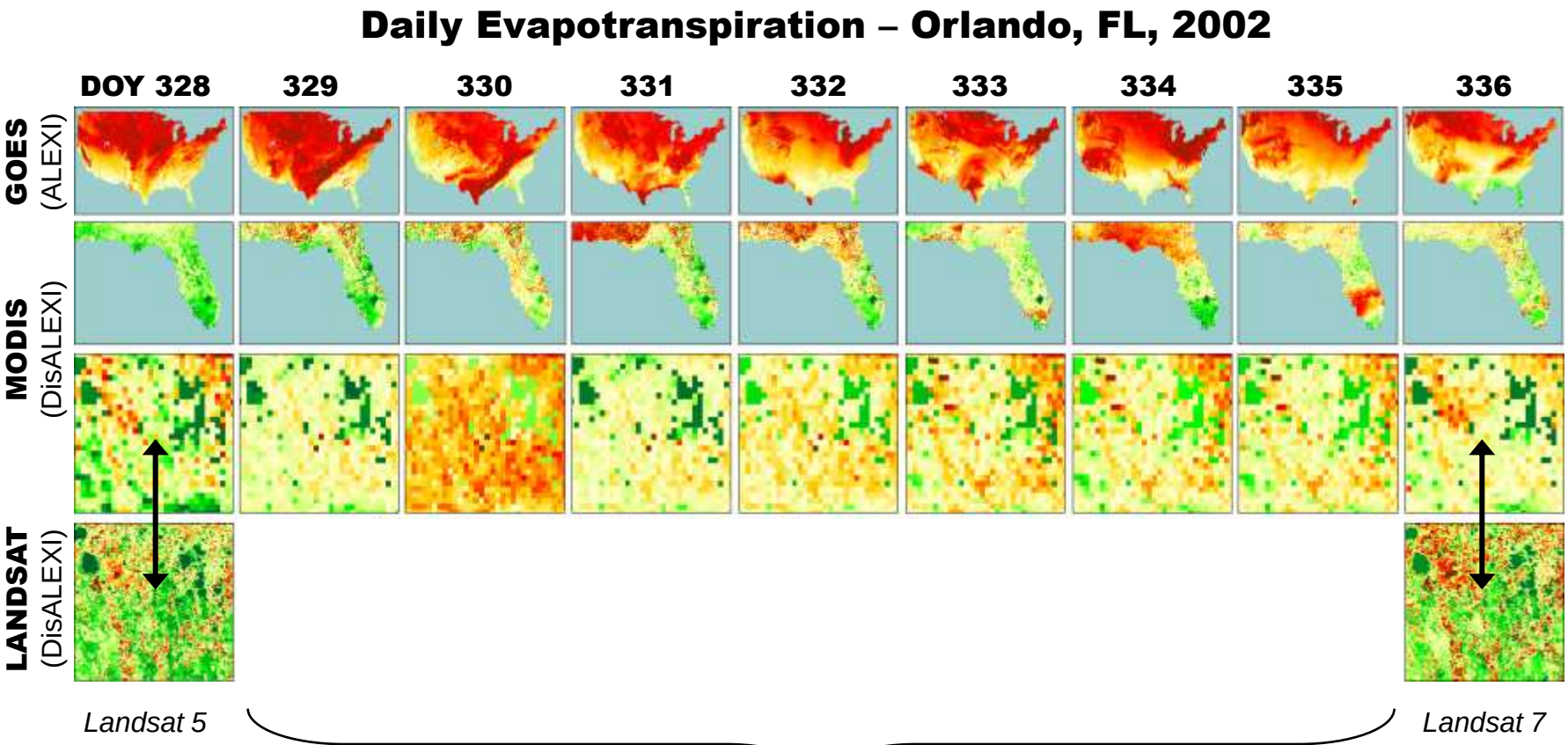
DisALEXI: ALEXI flux disaggregation



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


SURFACE TEMPERATURE
EVAPOTRANSPIRATION
GEO (ISCCP)
Global (25km)
GEO (GOES Sounder)
Continental (10km)
GEO (GOES Imager)
Regional (5km)
Polar (MODIS)
Basin (1km)
Polar (Landsat)
Watershed (60m)
Airborne (USU aircraft)
Field scale (30m)
Temperature (C)
40
35
30
corn
soy
500
400
300
200
100
Latent Heat (Wm-2)
1 July 2002 – 10:30AM LST
DATA FUSION:
daily ET at field scale
(F. Gao)
Hourly
Daily
1 LS – 16 day
2 LS – 8 day

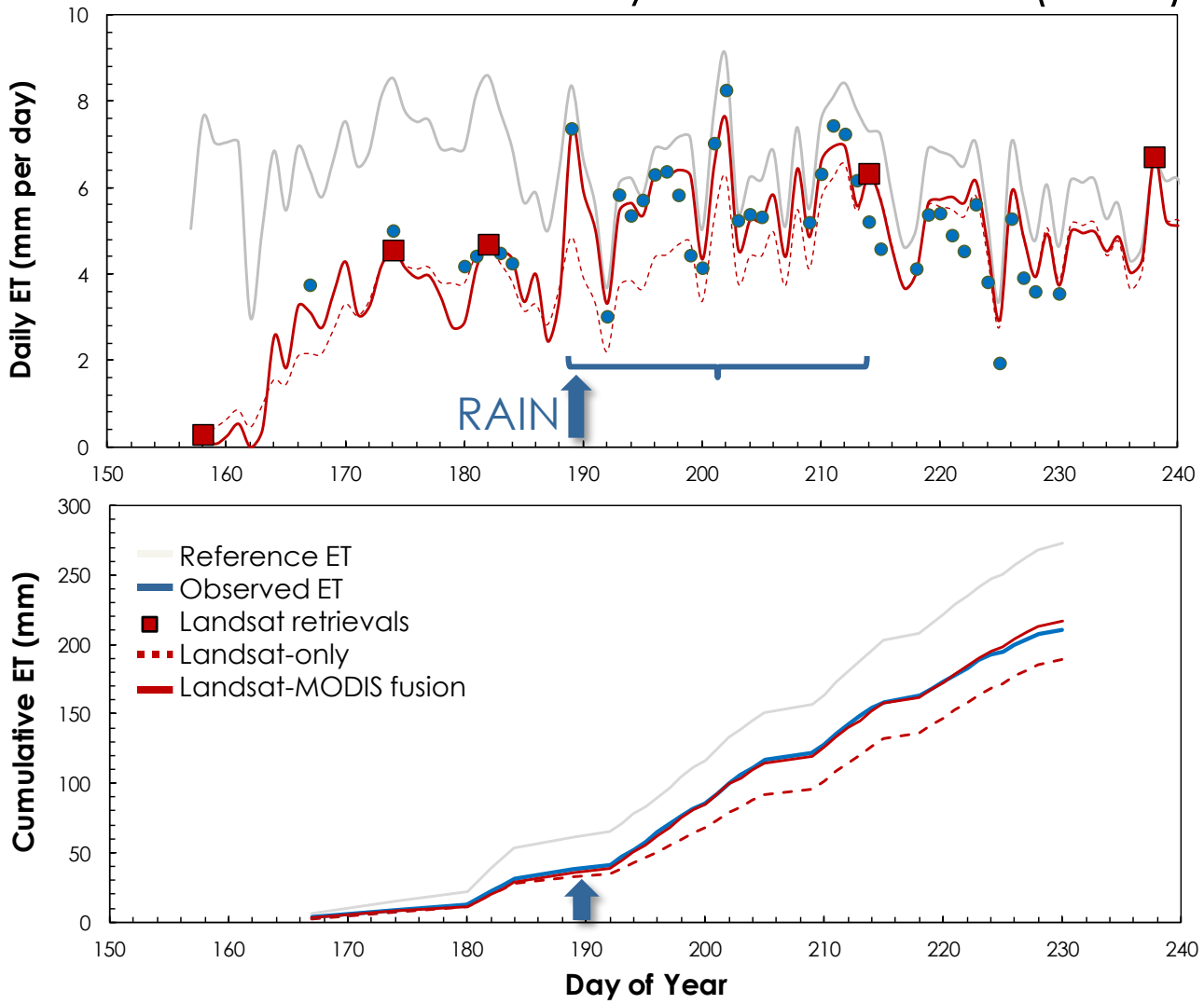
GOES/MODIS/Landsat FUSION



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

Validation using flux tower data

Rainfed soybean – SMEX02 (Iowa)



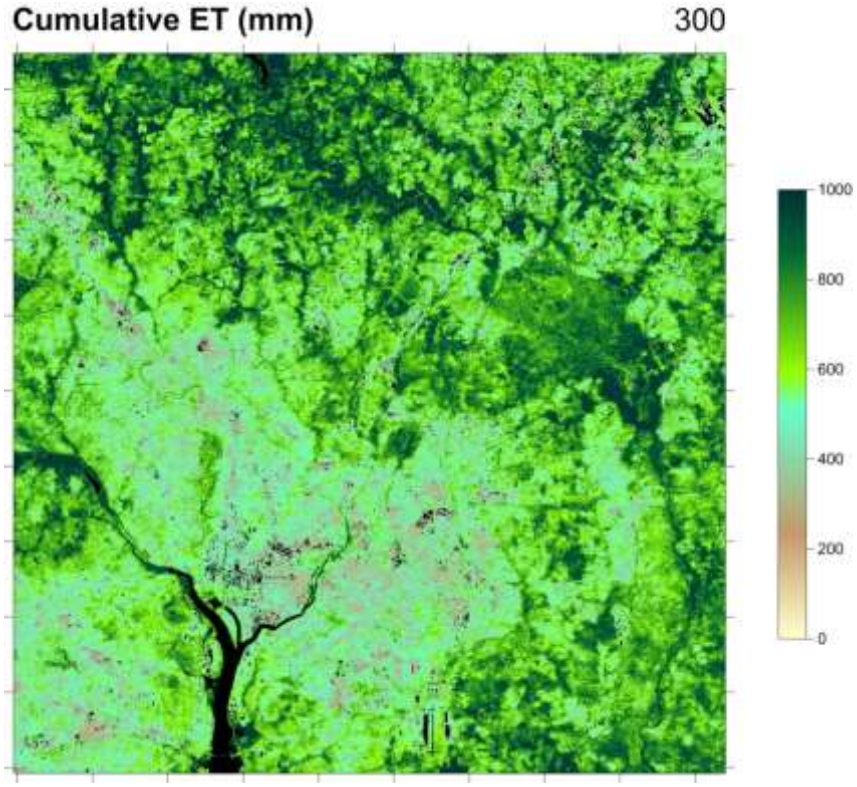
APPLICATIONS FOR HIGH RESOLUTION ET DATACUBES

… water quality

… water use

… drought early warning and yield estimation

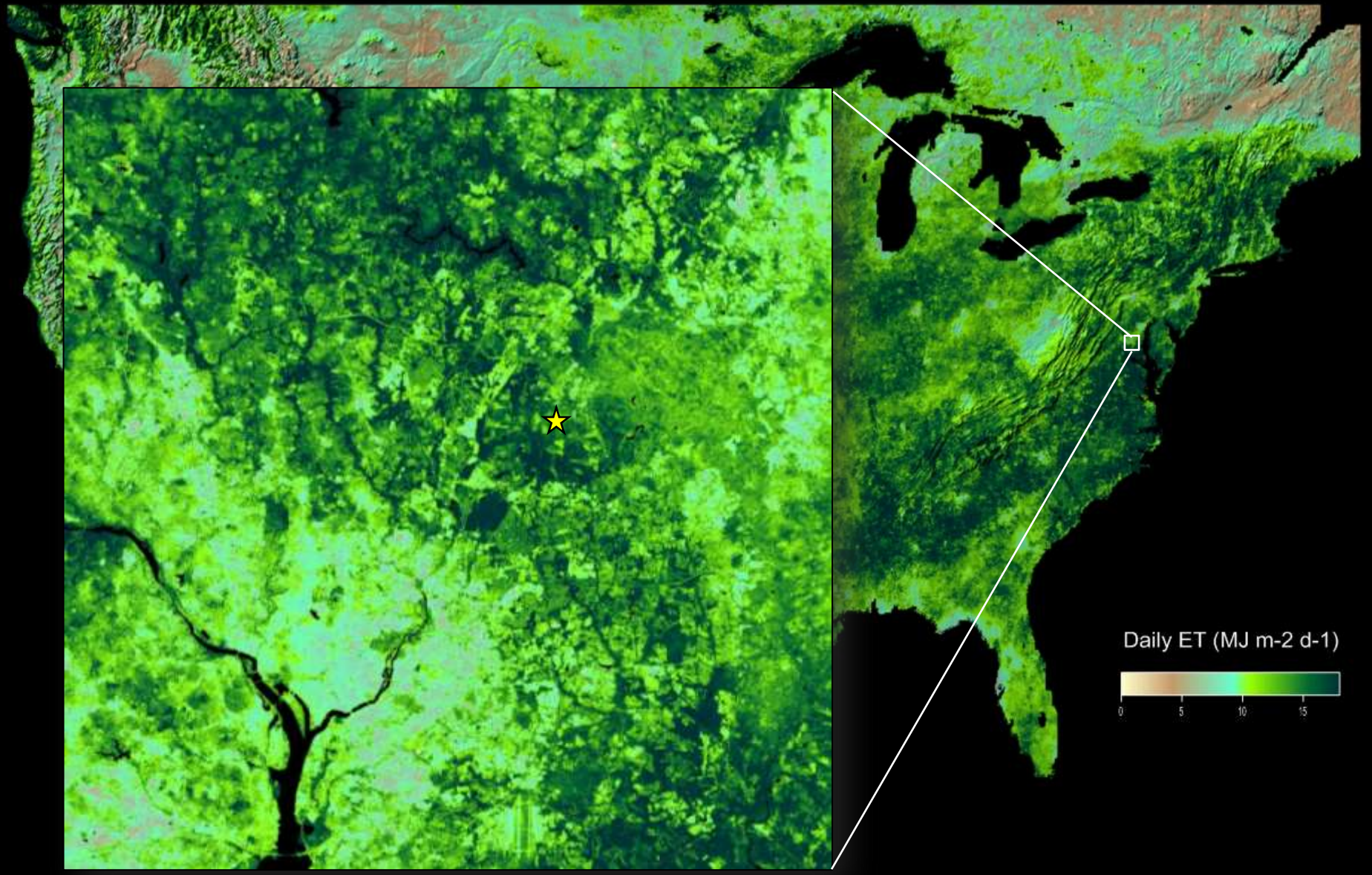
Lower Chesapeake Bay LTAR



Liang Sun, Amir Sharifi, 2016

Landsat 8 - 2014

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



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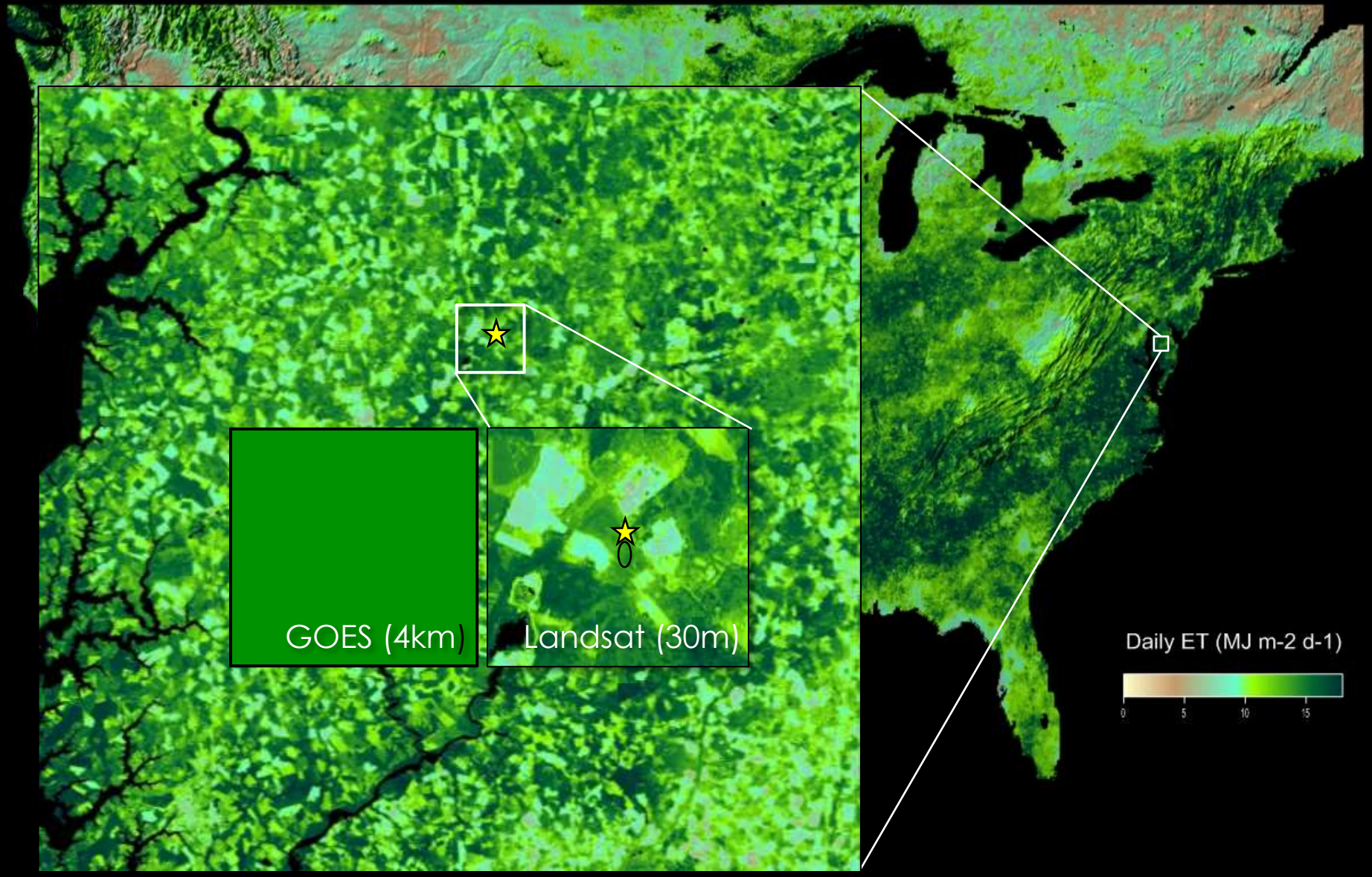
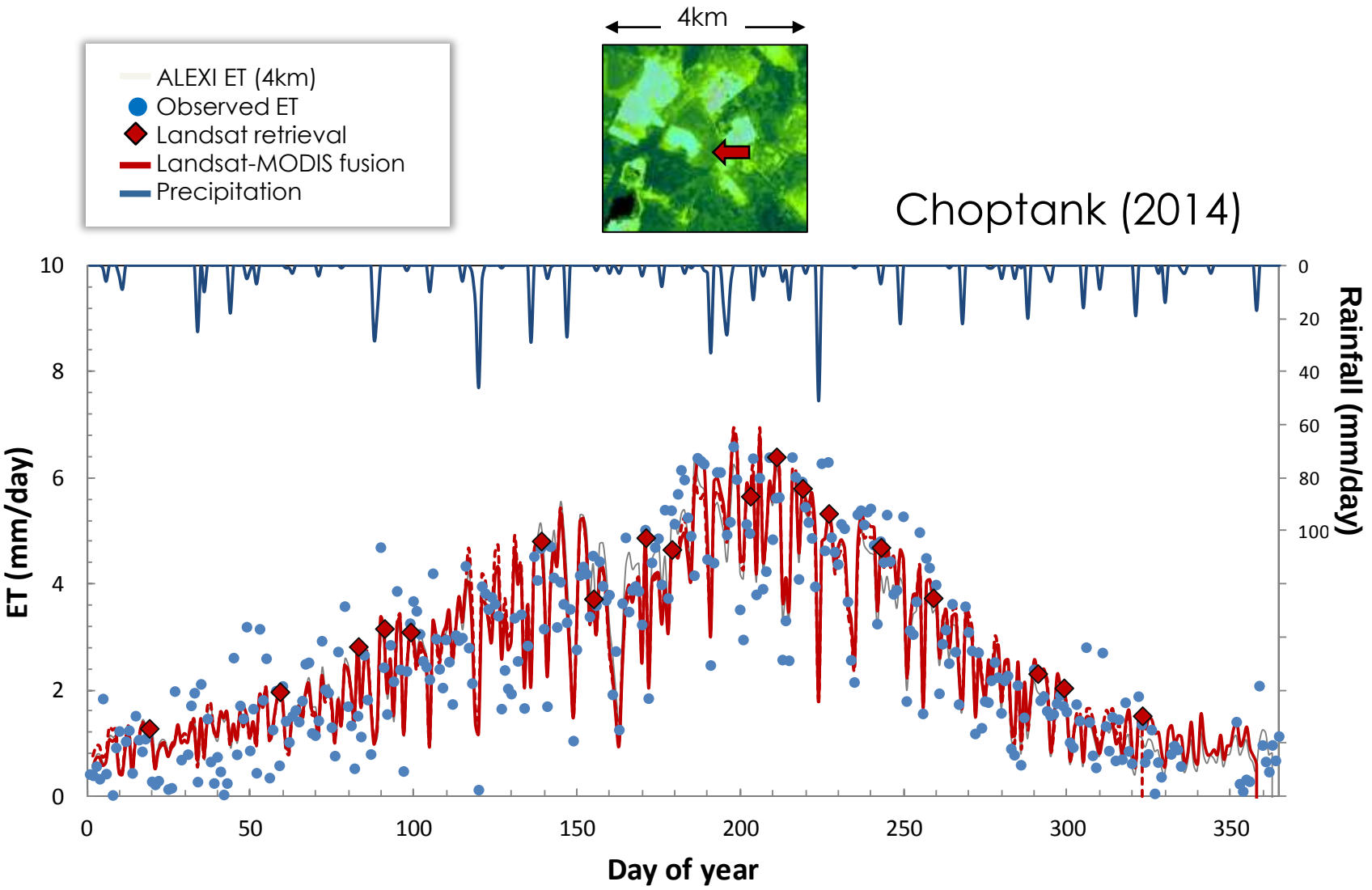
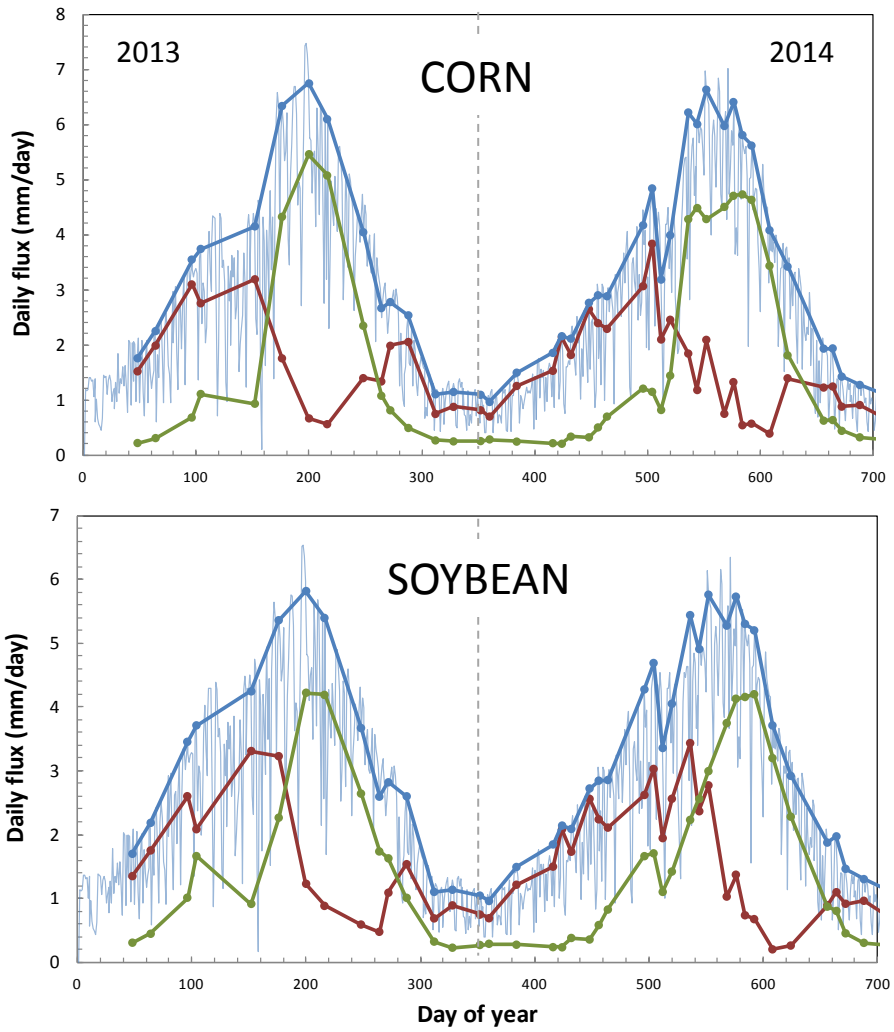


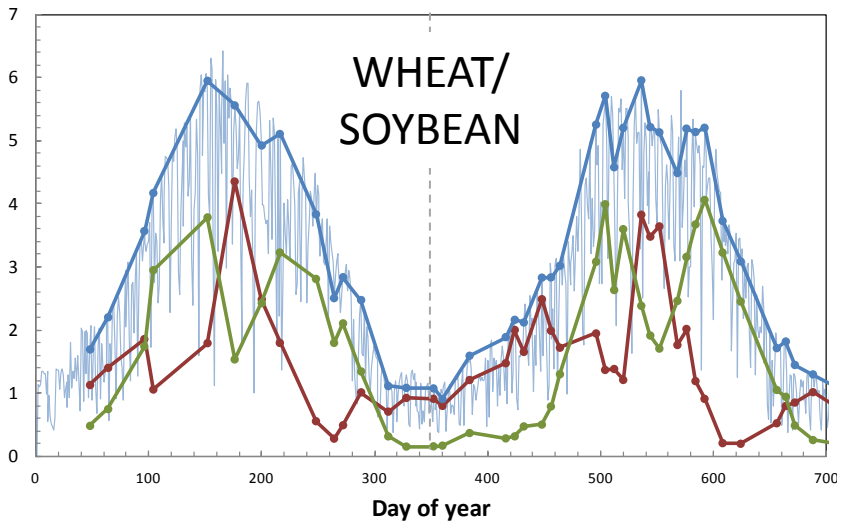
Comparisons with flux tower data



Sun, L. et al. (2016). Monitoring daily evapotranspiration at field-scale over an agricultural landscape on the Eastern Shore of Maryland. *Remote Sens. Environ., in preparation*

T/E SEPARATION ON CLEAR LANDSAT DATES



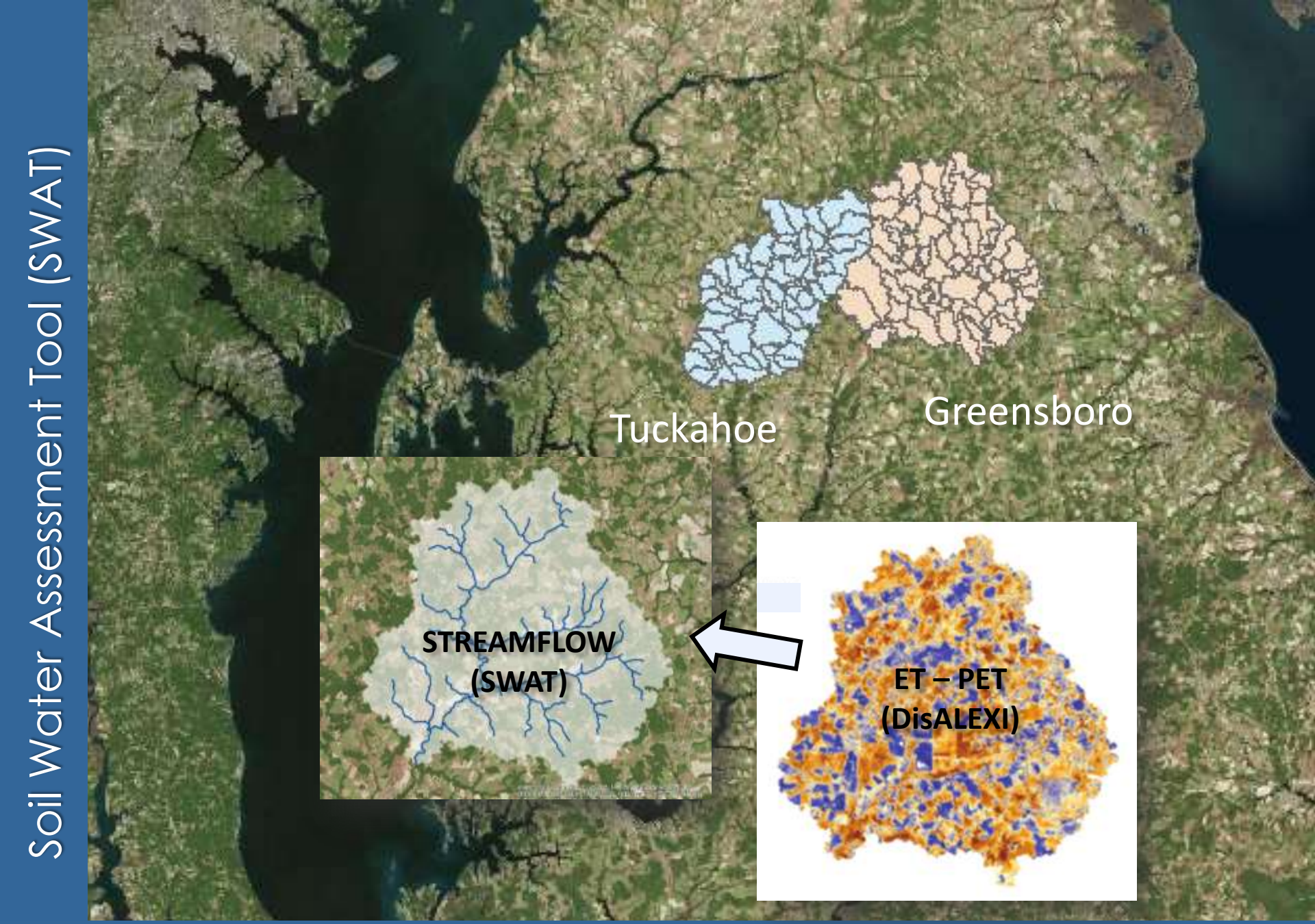


Evapotranspiration

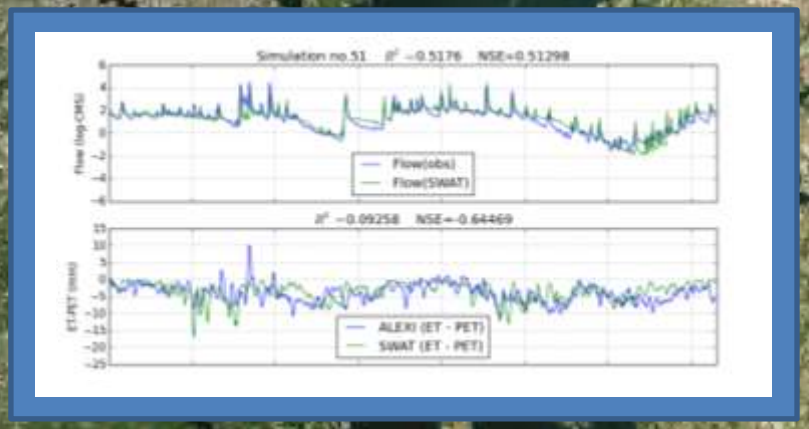
Soil evaporation

Canopy transpiration

Soil Water Assessment Tool (SWAT)



Soil Water Assessment Tool (SWAT)



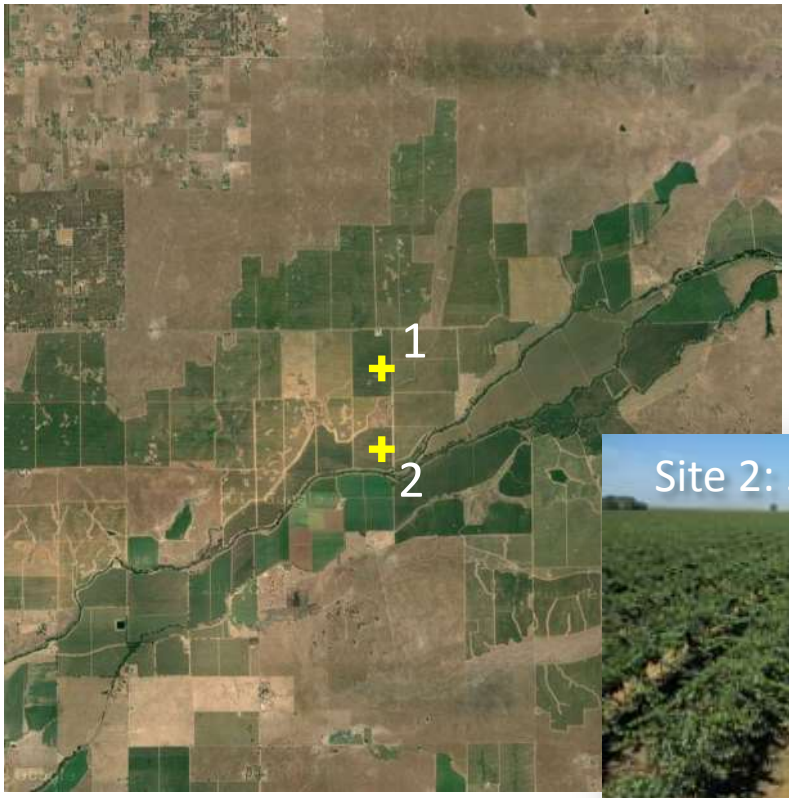
Tuckahoe

Greensboro

STREAMFLOW (SWAT)

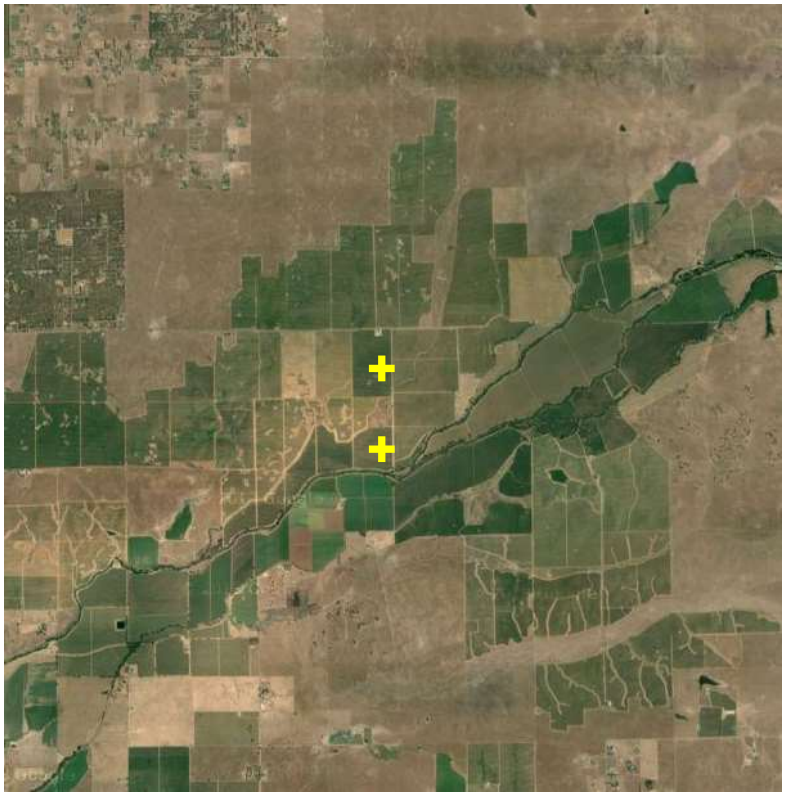
ET – PET (DisALEXI)

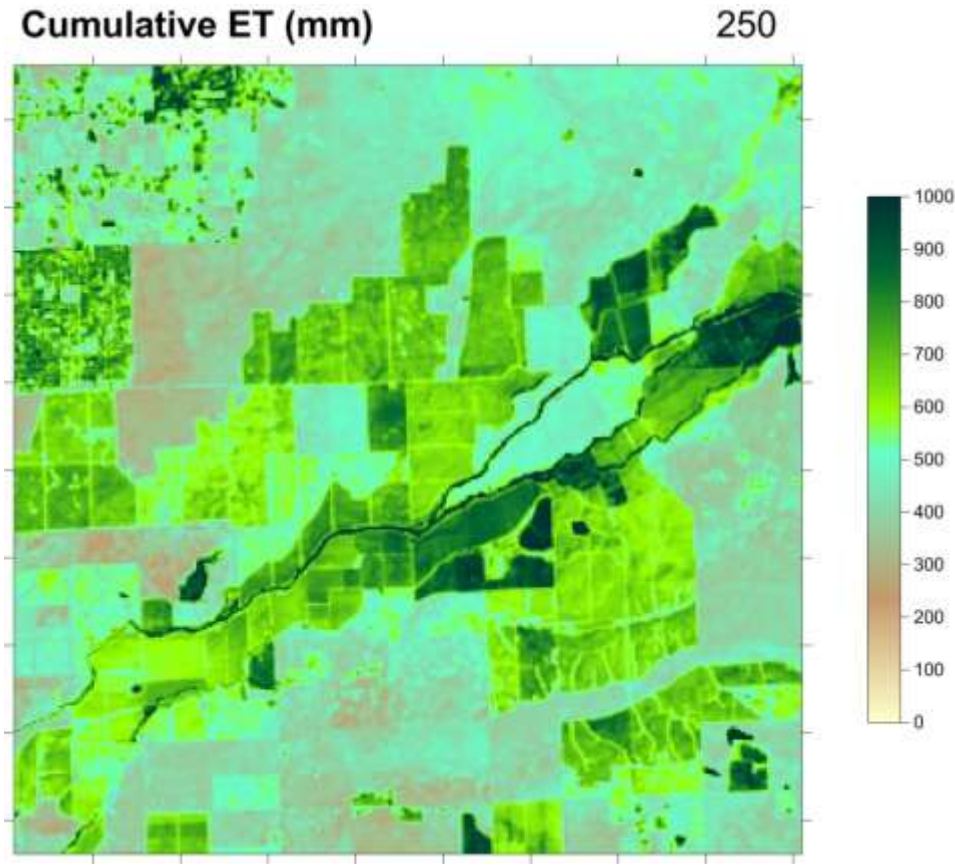
Gallo Vineyards, Lodi CA



GRAPEX2013, 14, 15

Gallo Vineyards, Lodi CA

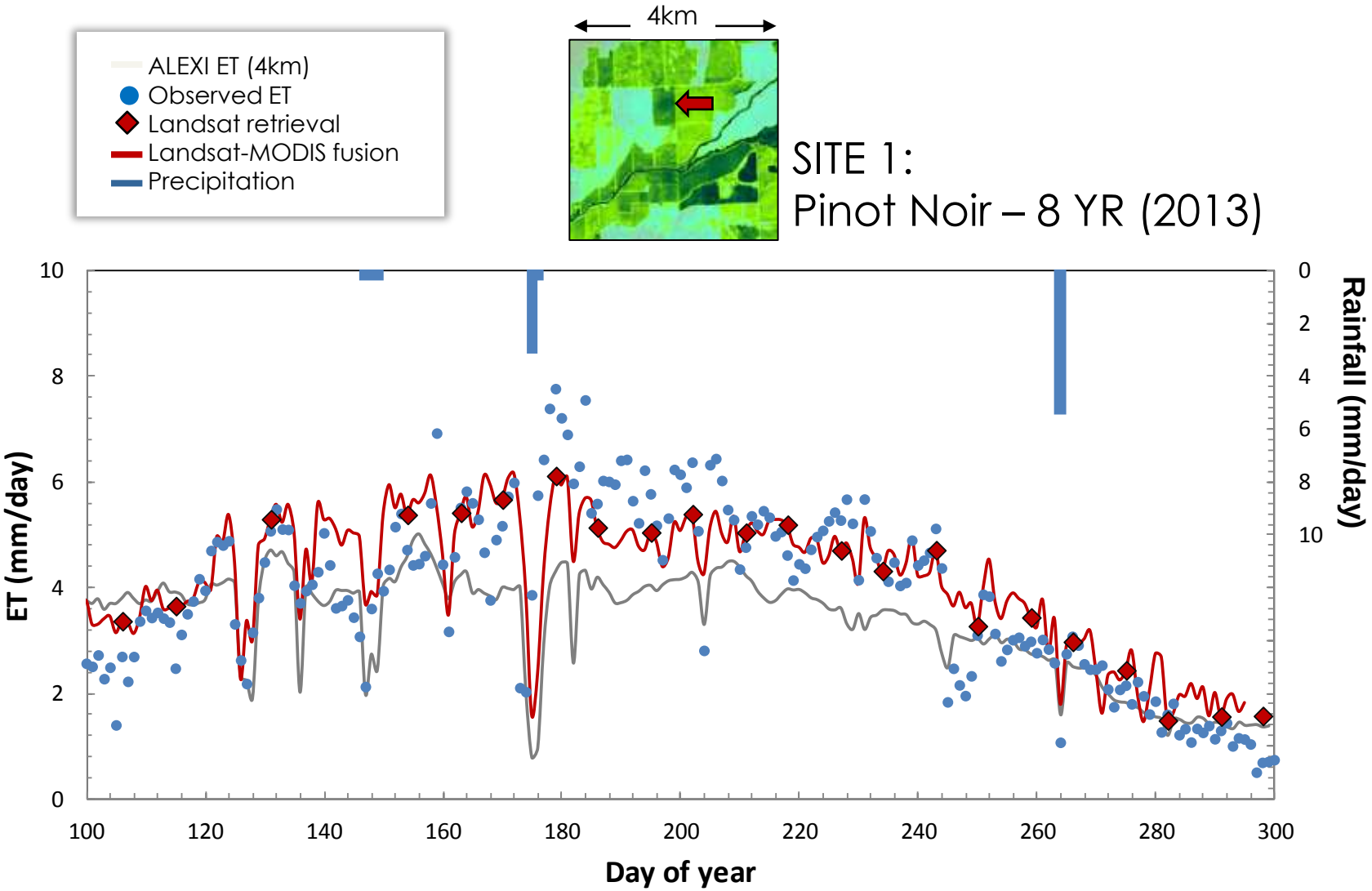




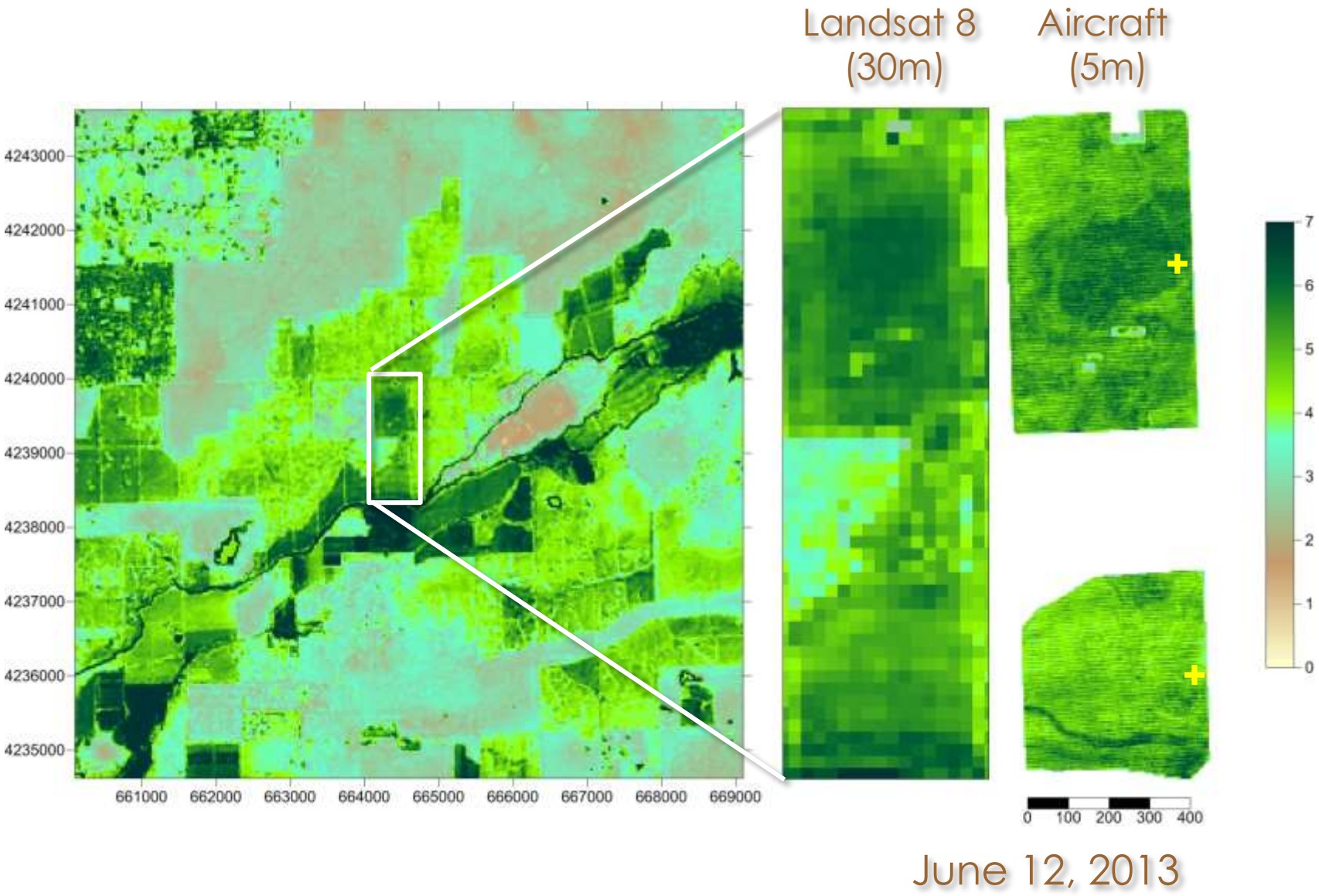
Landsat 8 - 2013

Semmens, K.A., et al.(2015). Monitoring daily evapotranspiration over two California vineyards using Landsat 8 in a multi-sensor data fusion approach. *Remote Sens. Environ., doi:10.1016/j.rse.2015.1010.1025*

Comparisons with flux tower data



Utility of aircraft thermal imaging

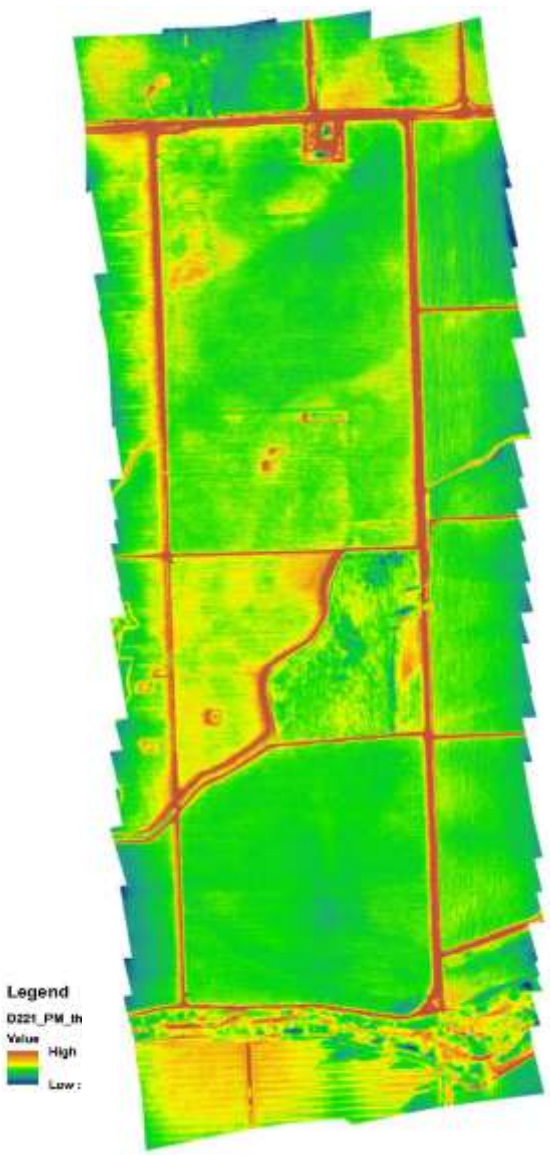


June 12, 2013

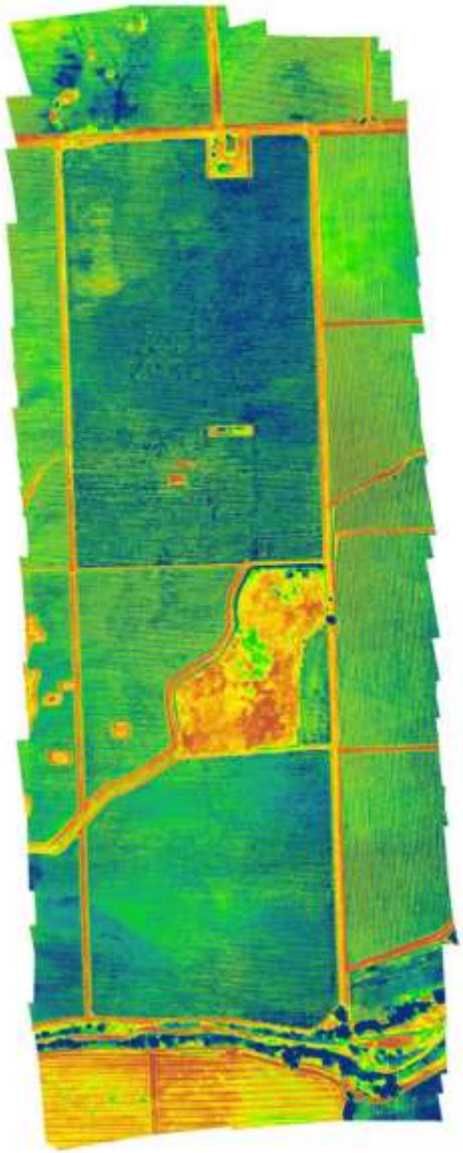
Utility of UAV thermal imaging

UAV LST – 0.6 m (August 9, 2014)

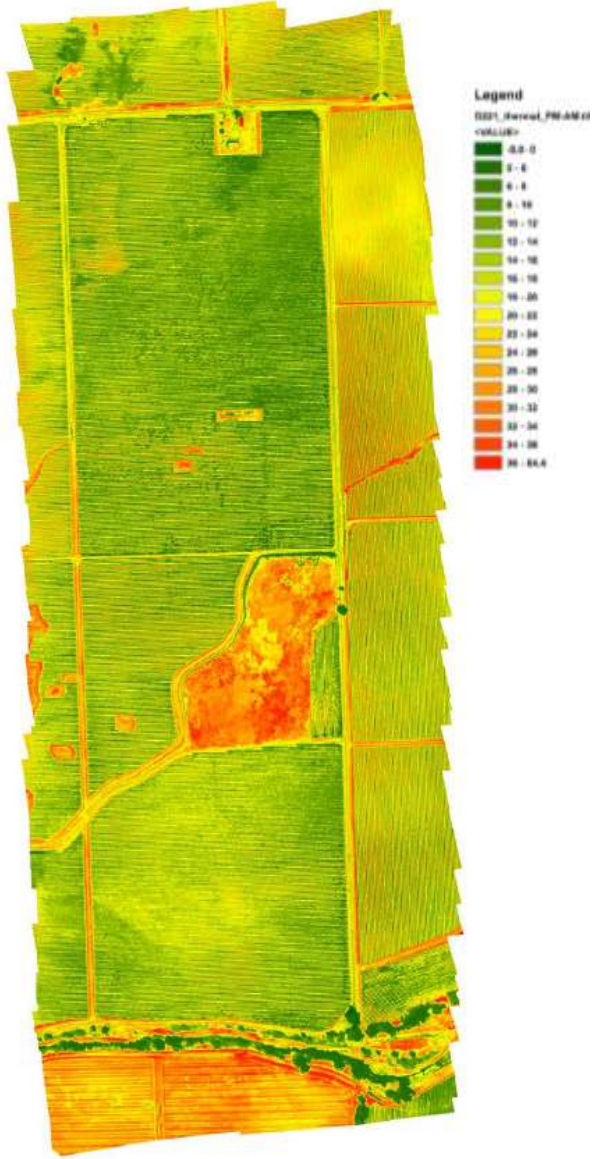
7 AM

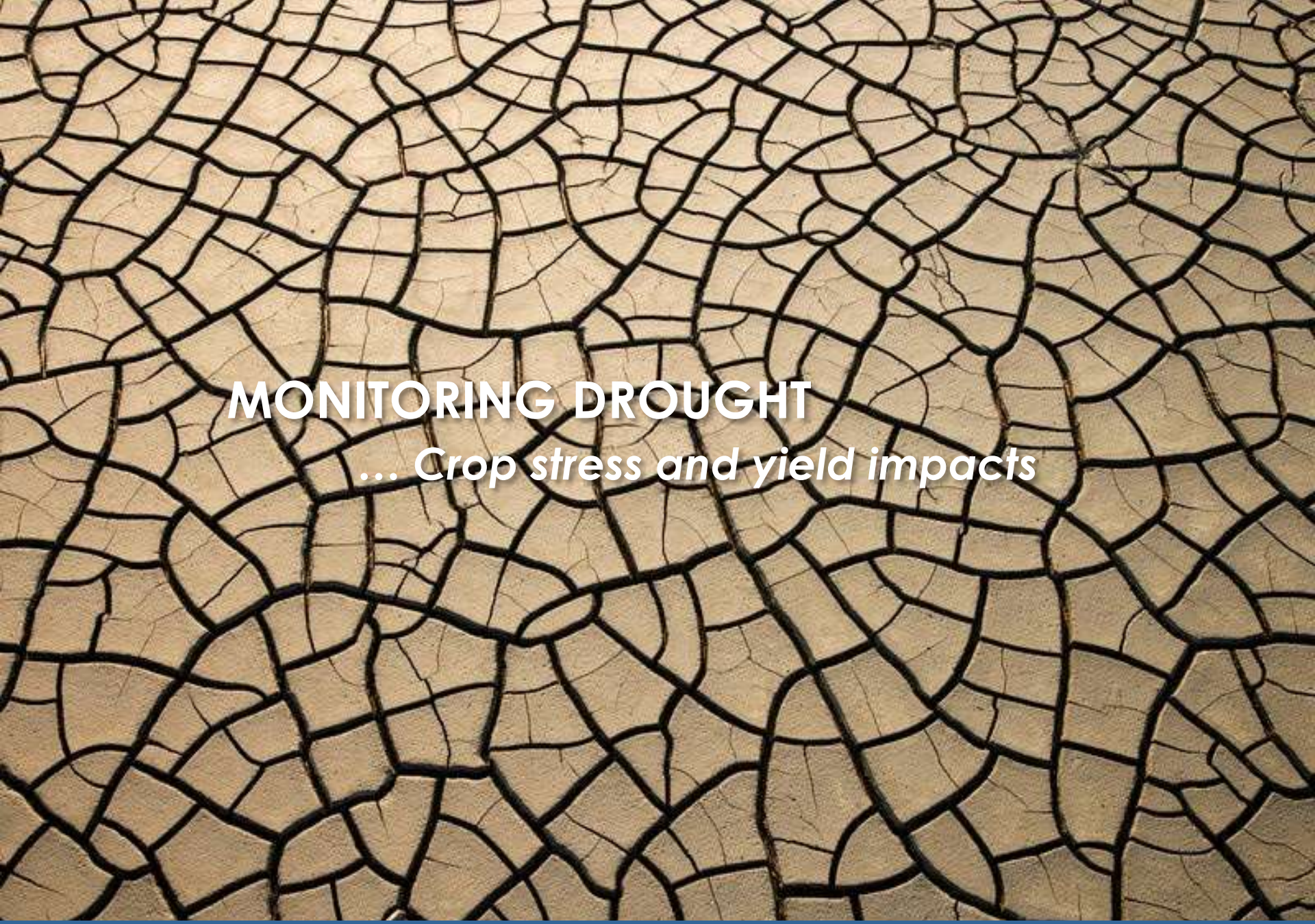


11 AM



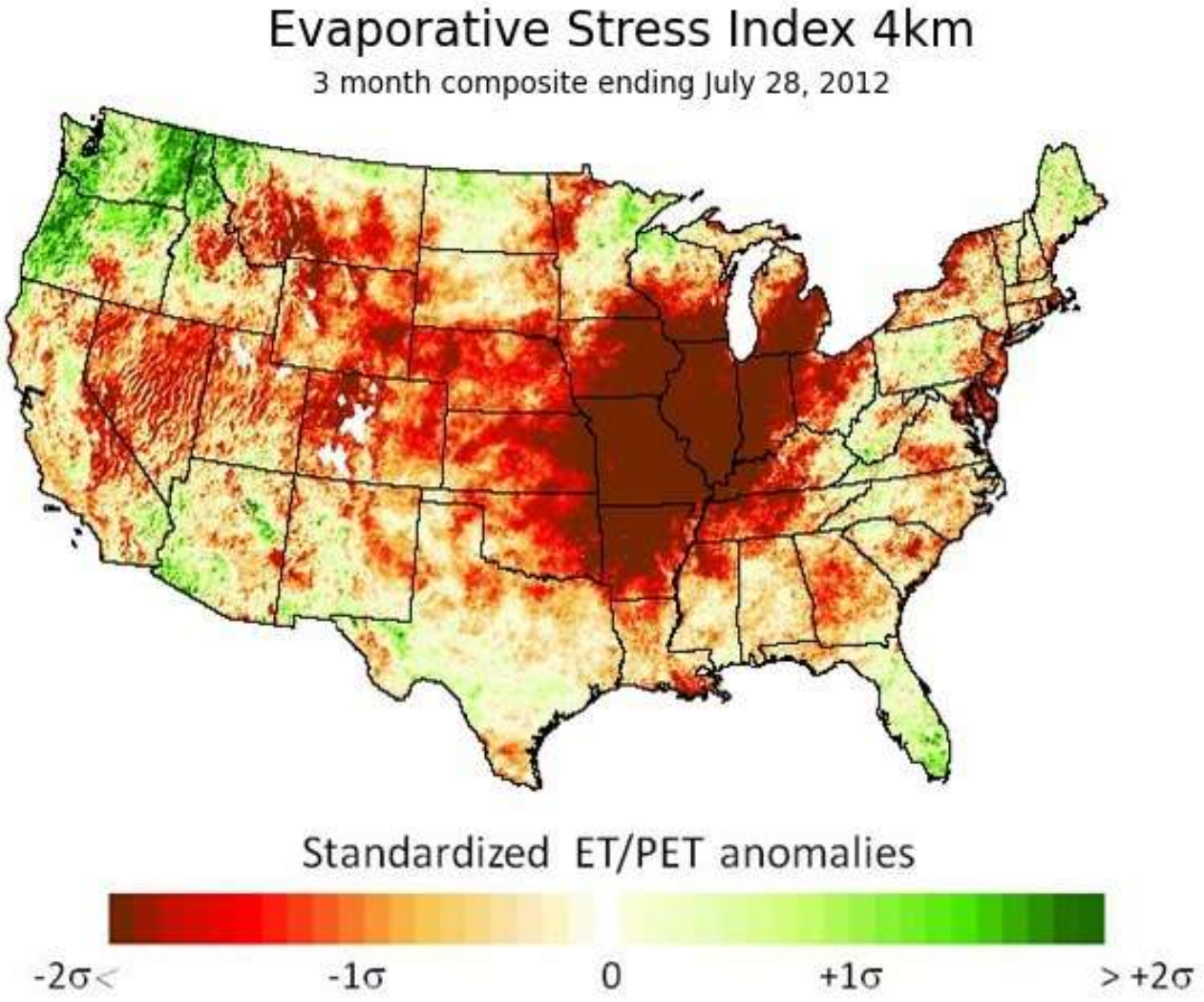
Time difference





MONITORING DROUGHT

… Crop stress and yield impacts

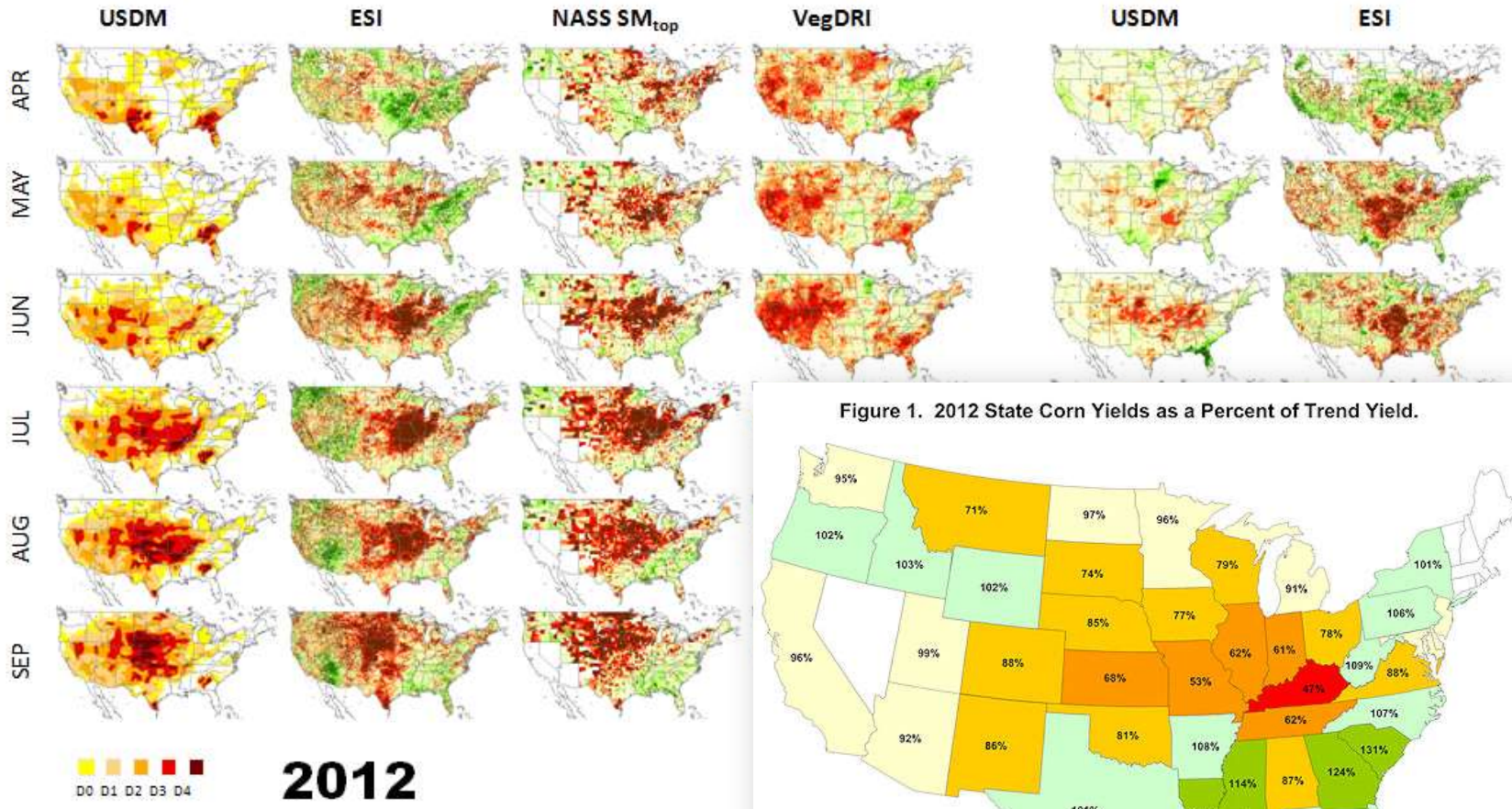


Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

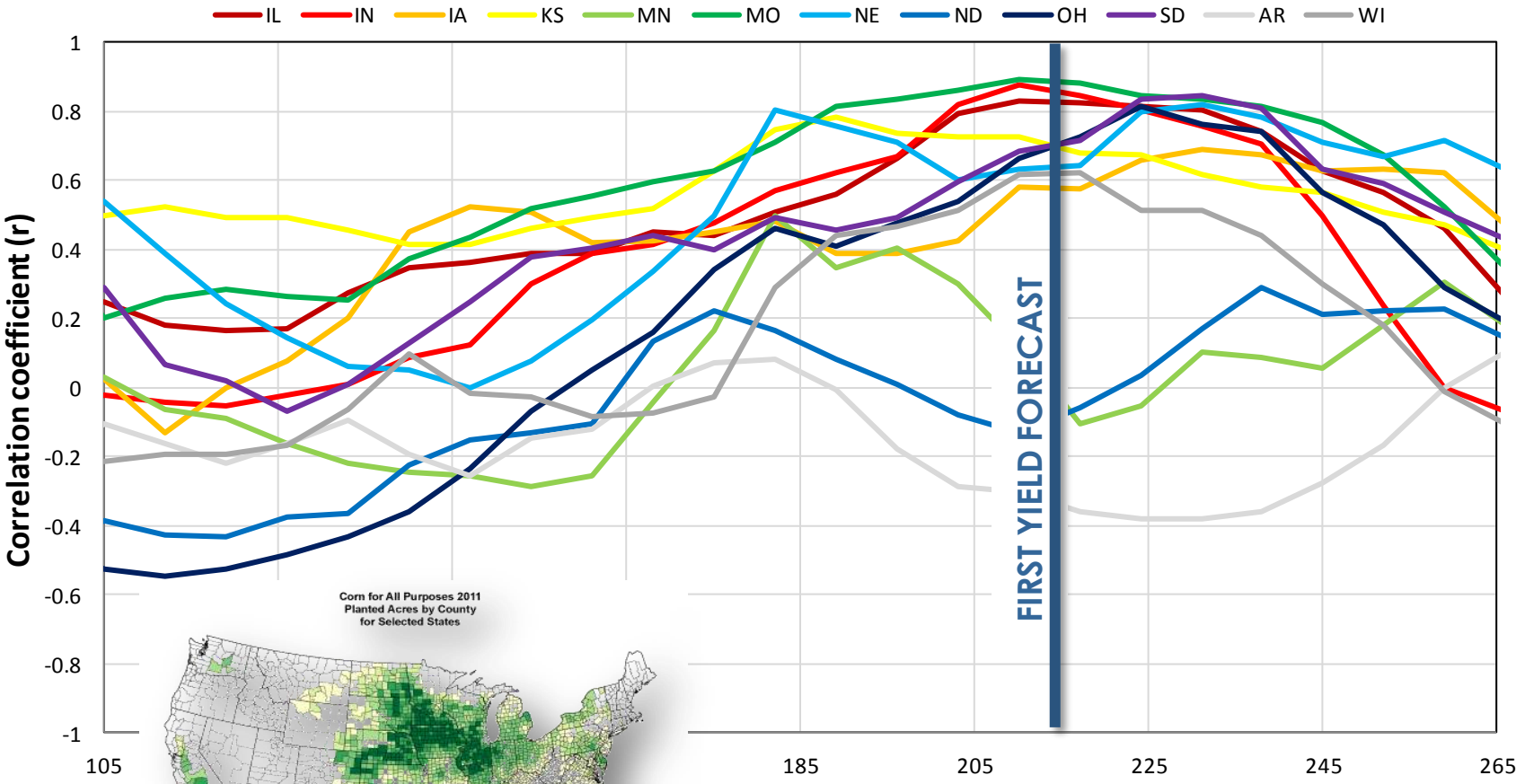
2012 FLASH DROUGHT

Monthly changes



ESI CORN YIELD CORRELATIONS

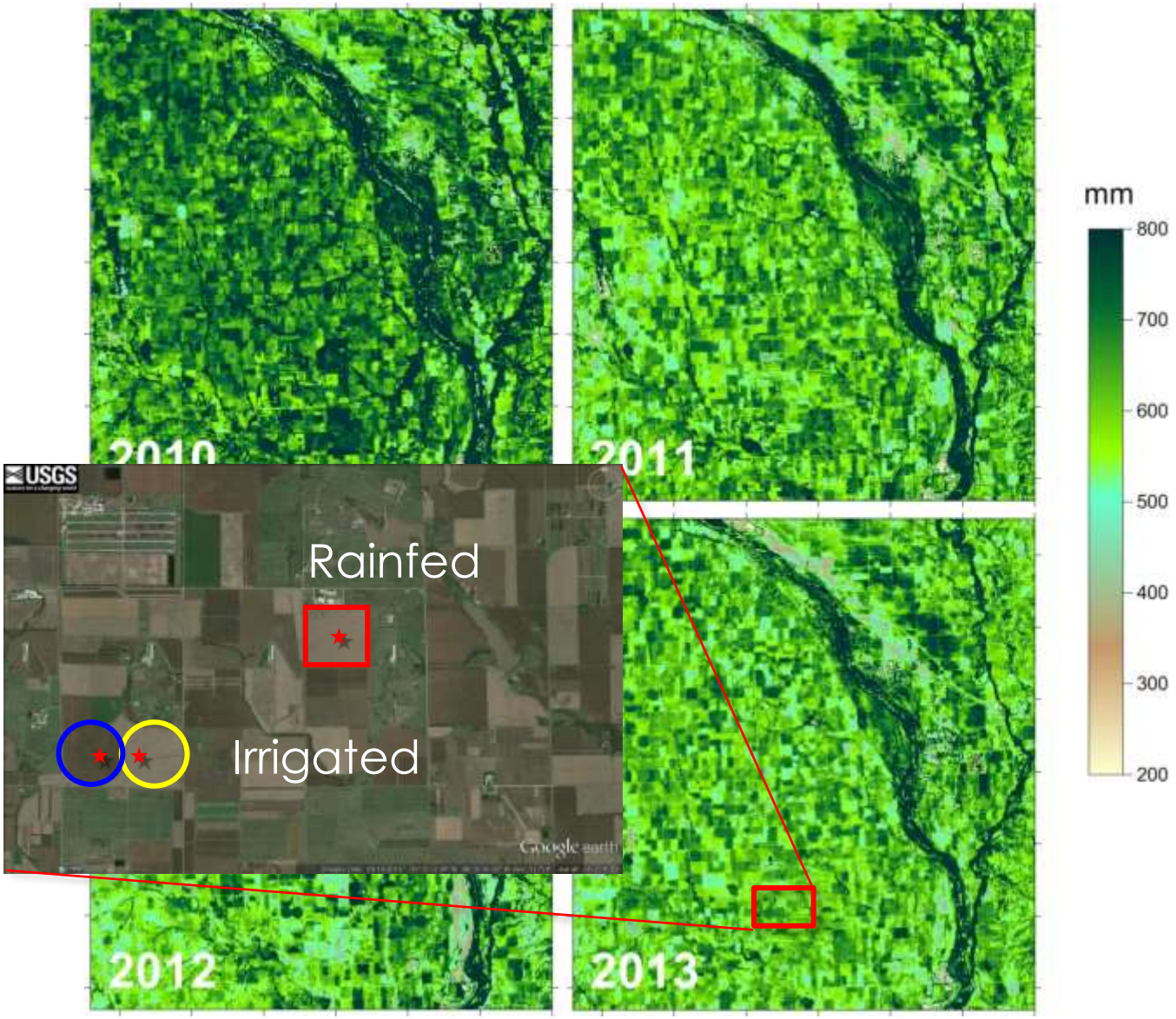
(10-km ESI vs. state level yields)



Dave Johnson,
National Agricultural Statistics Service

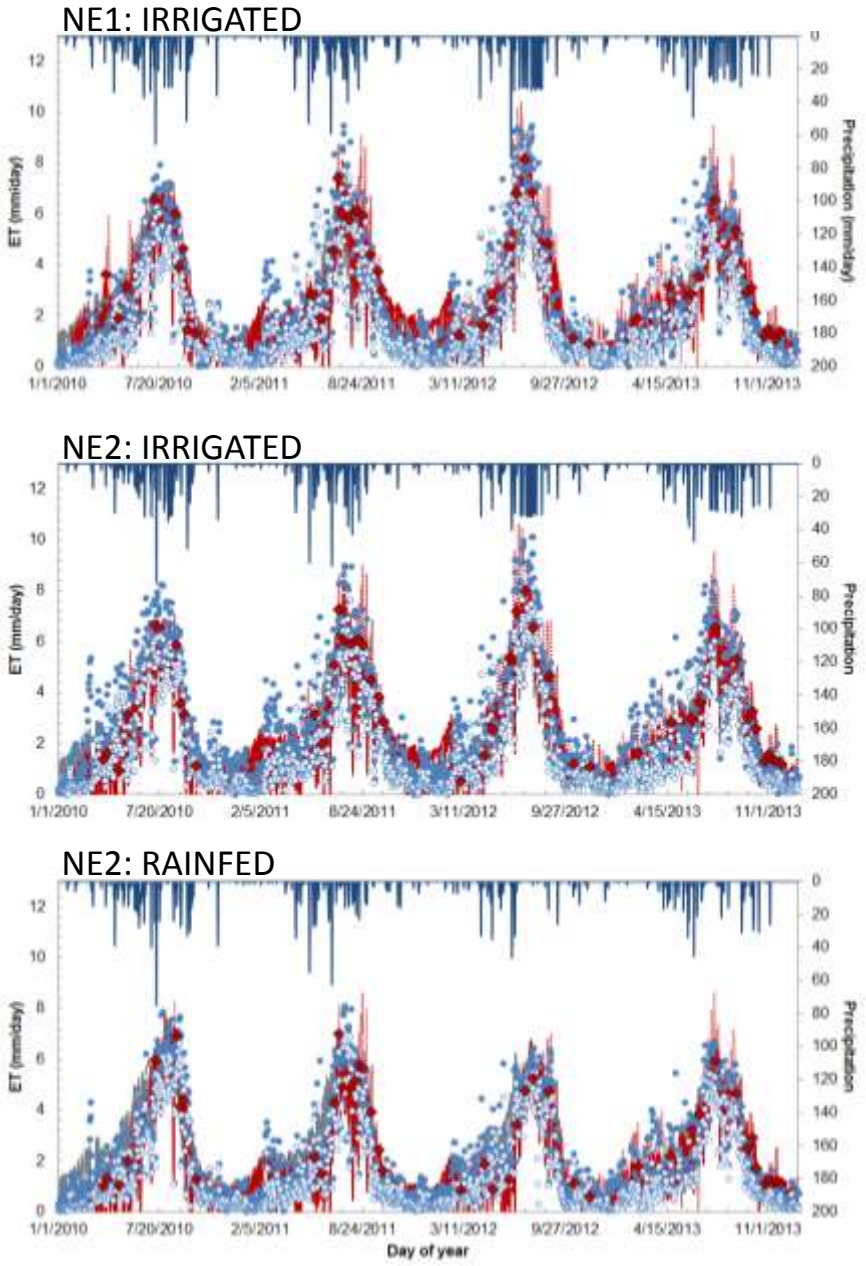
Rainfed corn and soybean in NE

Mead, Nebraska (near Lincoln)

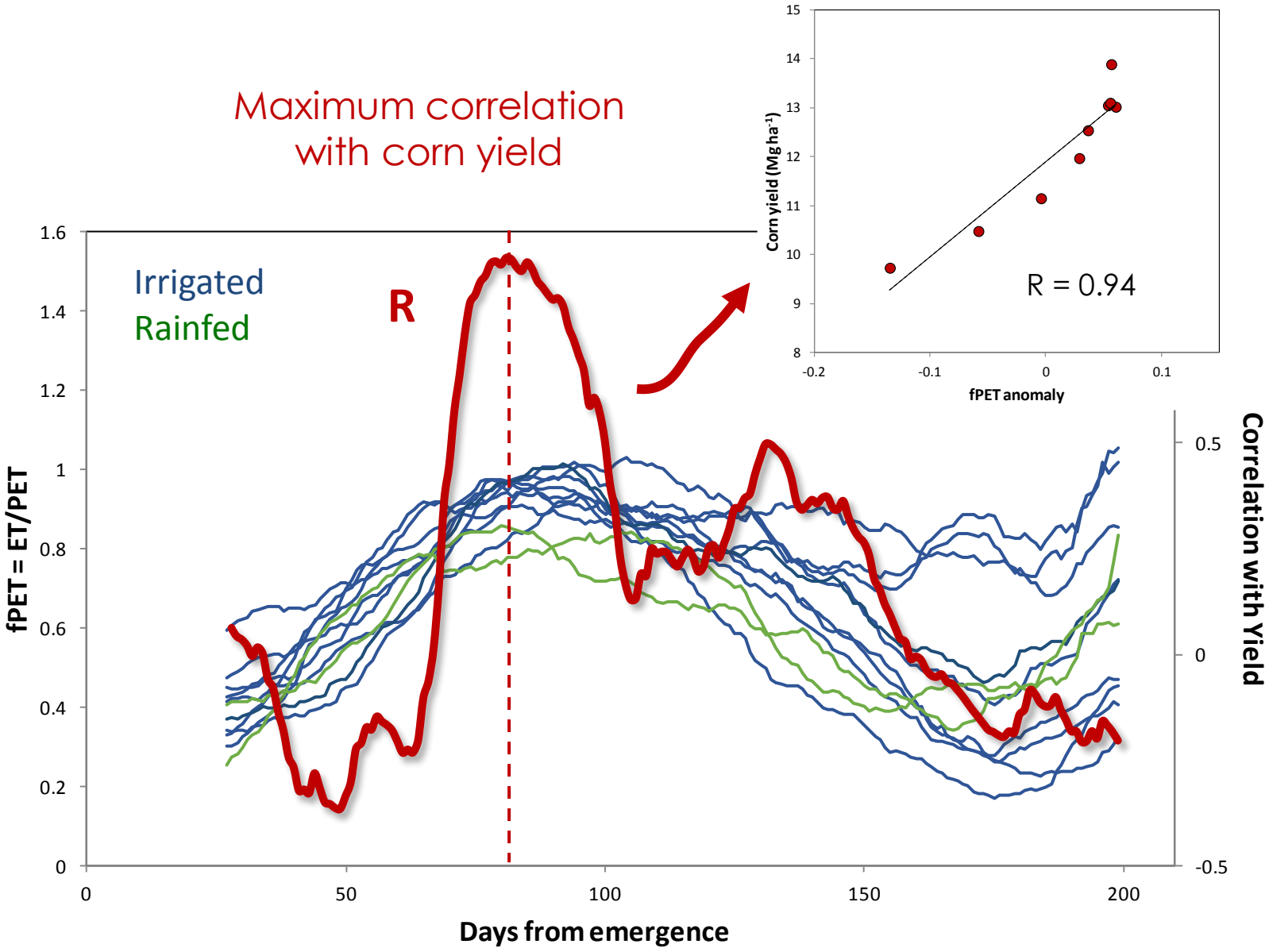


GROWING SEASON WATER USE

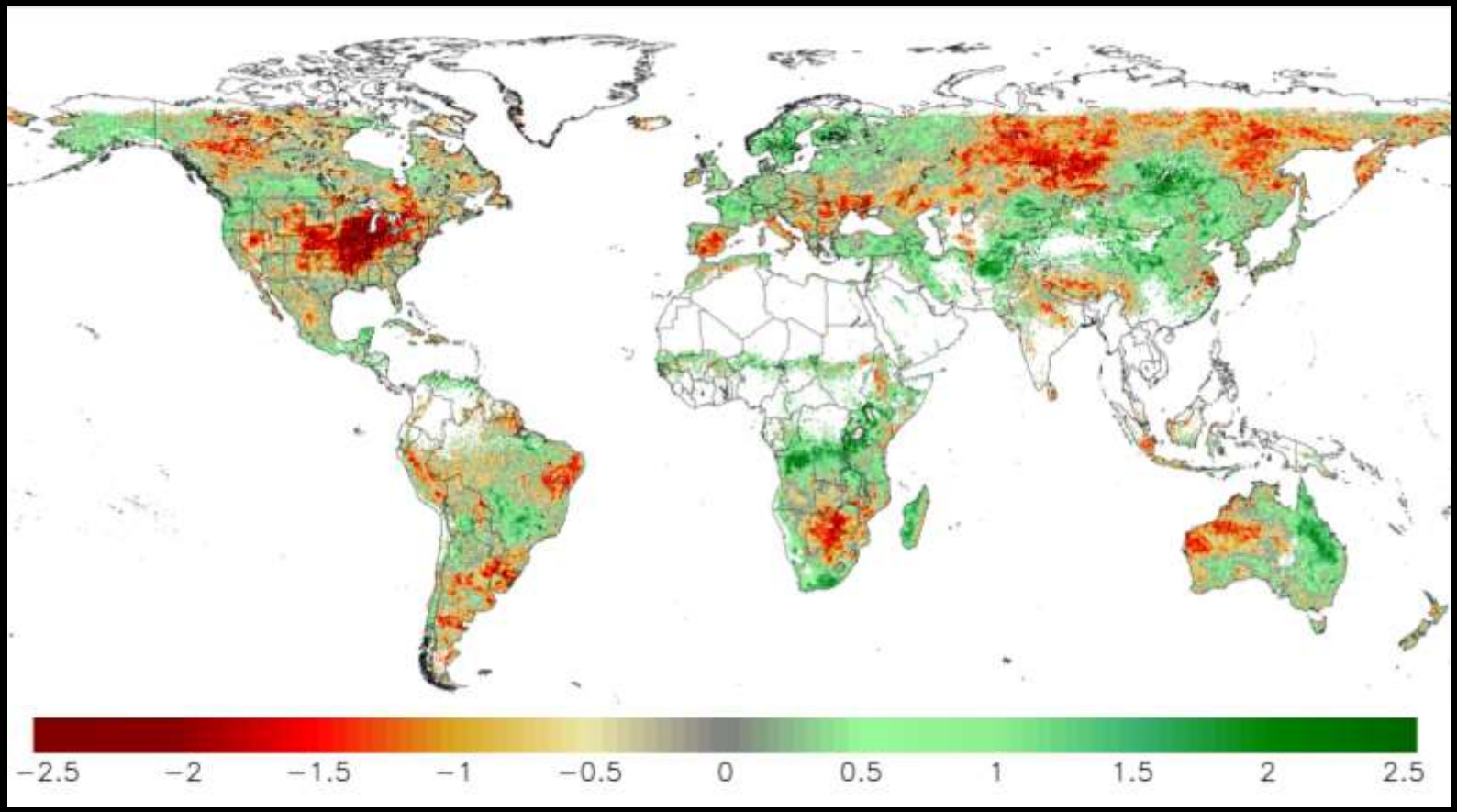
Rainfed corn and soybean in NE



Rainfed corn and soybean in NE



Global drought monitoring



GEOGLAM Global Crop Monitor : Provides multi-source consensus info on global crop conditions

Partners: University of Maryland, FAO, Group on Earth Observations

WATER ACCOUNTING AND FOOD SECURITY

- Monitoring changes in water use with changing climate, land-use and population
- Improved hydrologic monitoring (flood, drought, runoff) to better cope with extremes
- Improved accounting of current water use and crop water productivity (crop per drop)
- Crop stress detection and yield estimation

We can't manage what we can't measure …