Data Fusion Techniques for Mapping Daily Water Use at Field Scales

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Hydrology and Remote Sensing Laboratory
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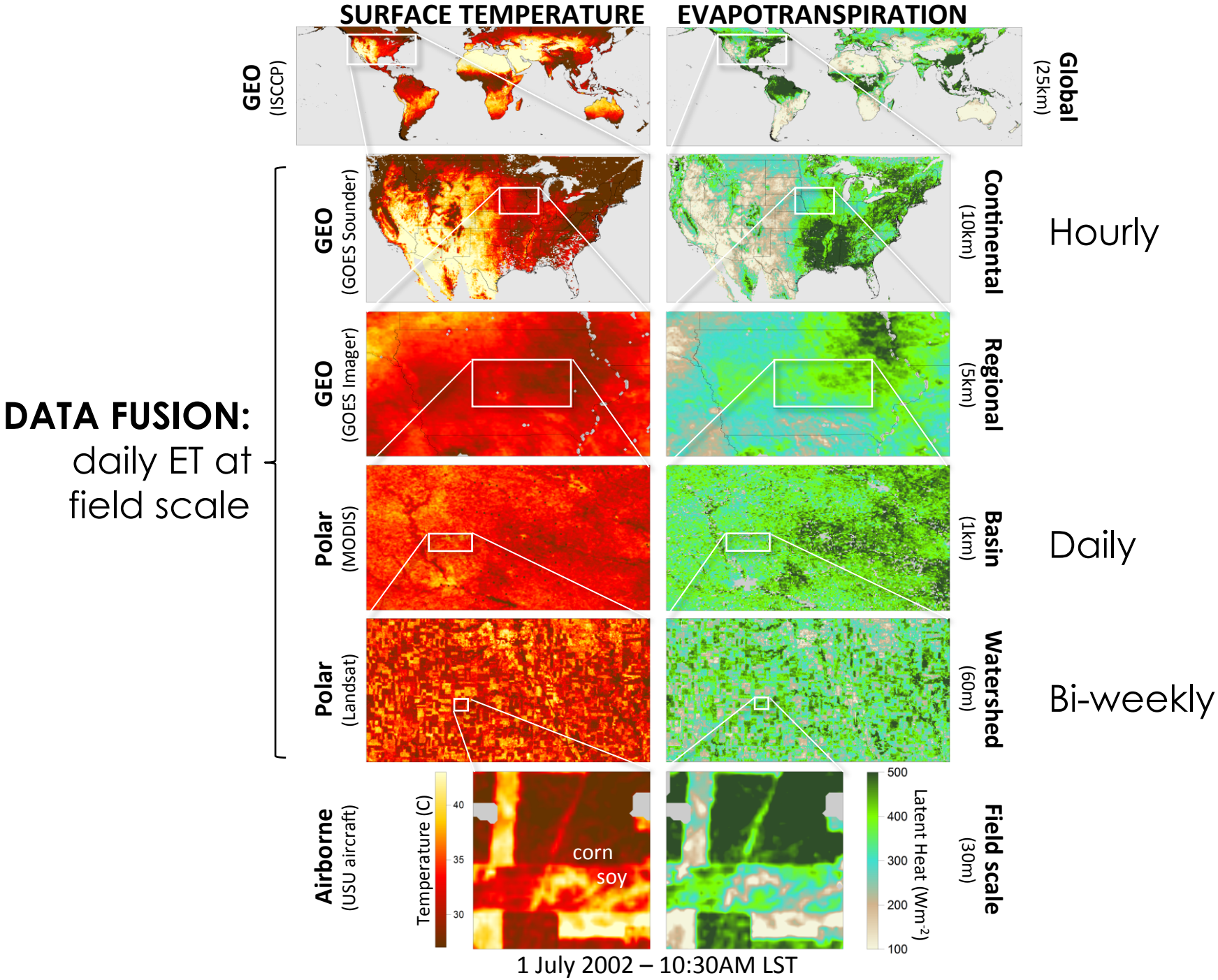
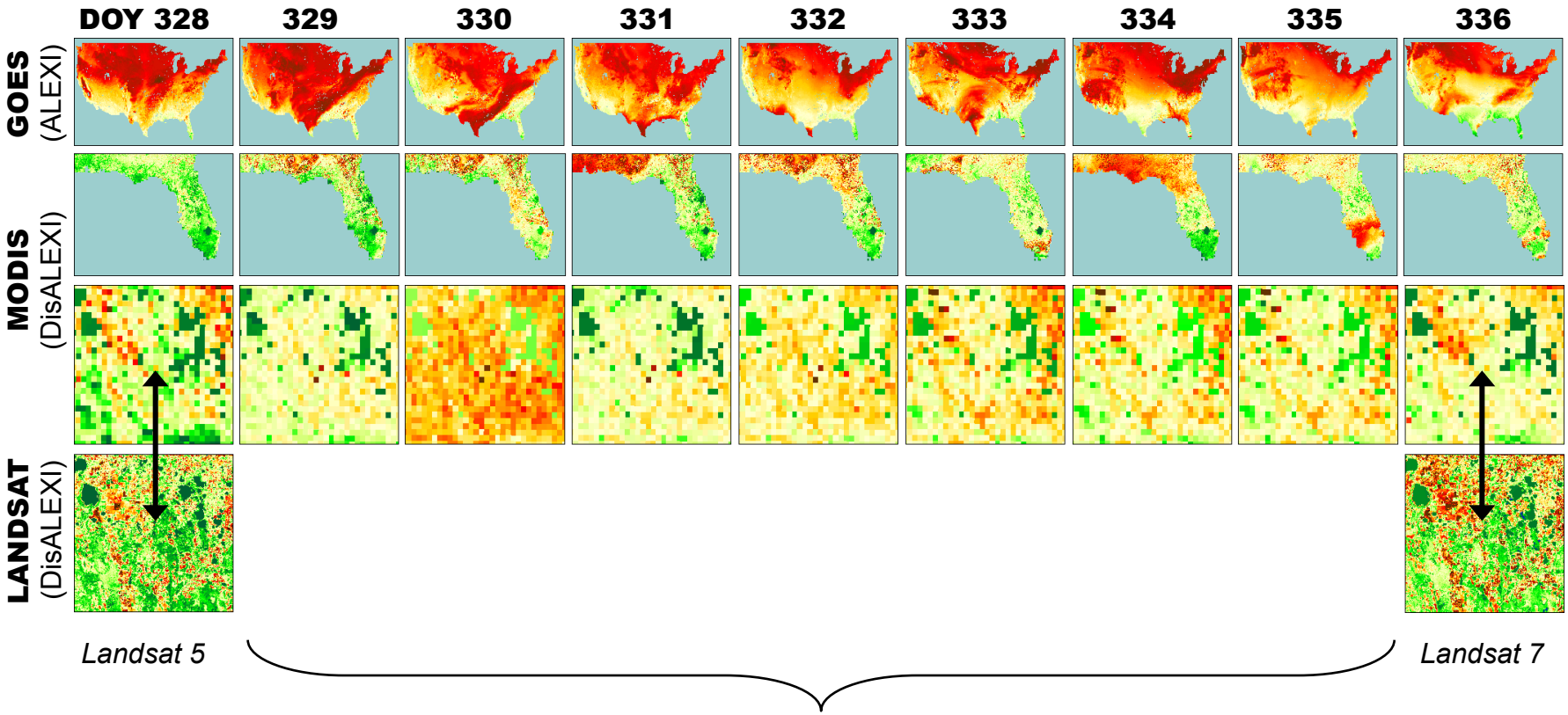

SURFACE TEMPERATURE
EVAPOTRANSPIRATION
GEO (ISCCP)
Global (25km)
GEO (GOES Sounder)
Continental (10km)
Hourly
GEO (GOES Imager)
Regional (5km)
DATA FUSION:
daily ET at field scale
Polar (MODIS)
Basin (1km)
Daily
Polar (Landsat)
Watershed (60m)
Bi-weekly
Airborne (USU aircraft)
Field scale (30m)
Temperature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

GOES/MODIS/Landsat FUSION

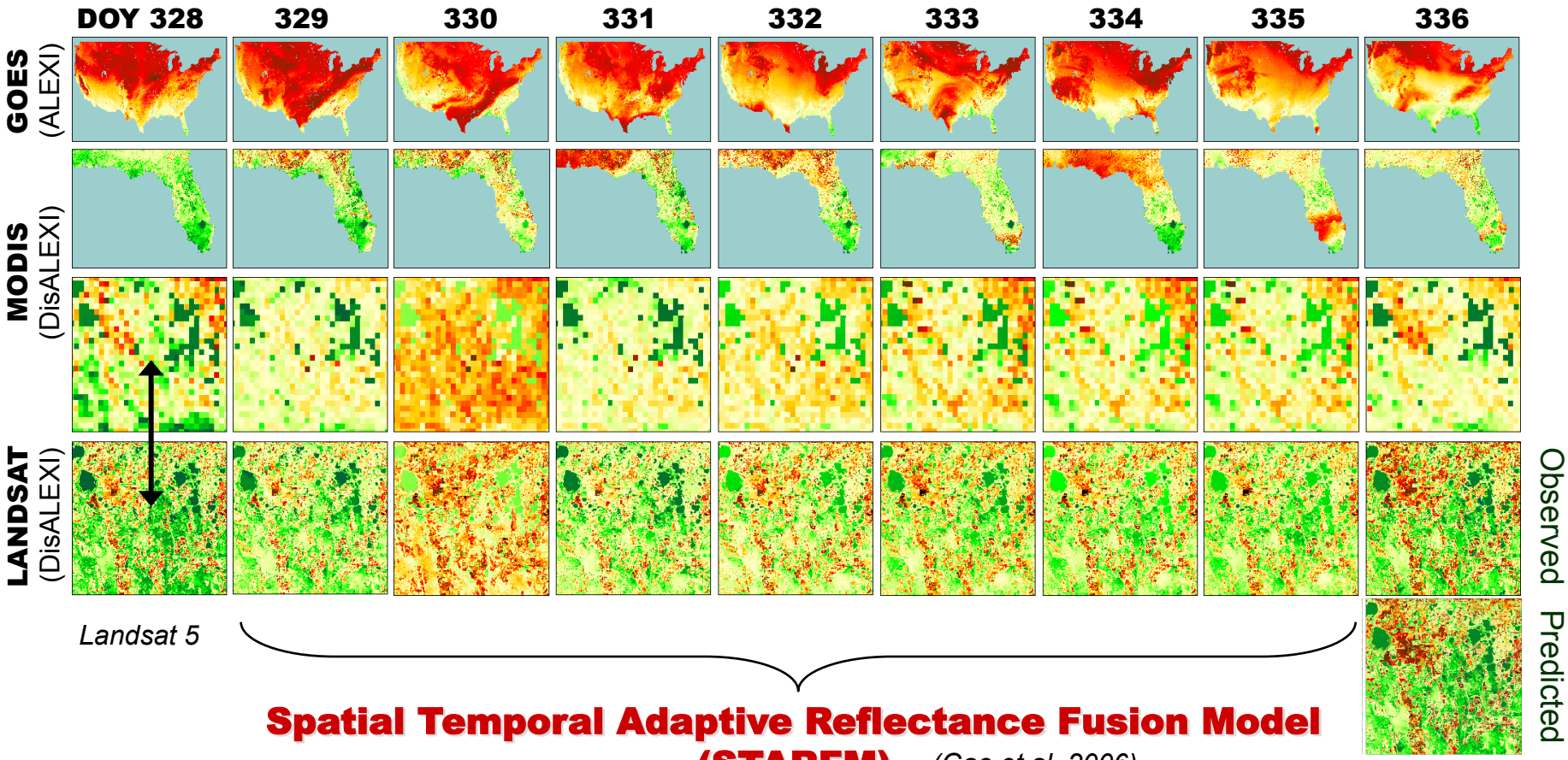
Daily Evapotranspiration – Orlando, FL, 2002



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

GOES/MODIS/Landsat FUSION

Daily Evapotranspiration – Orlando, FL, 2002



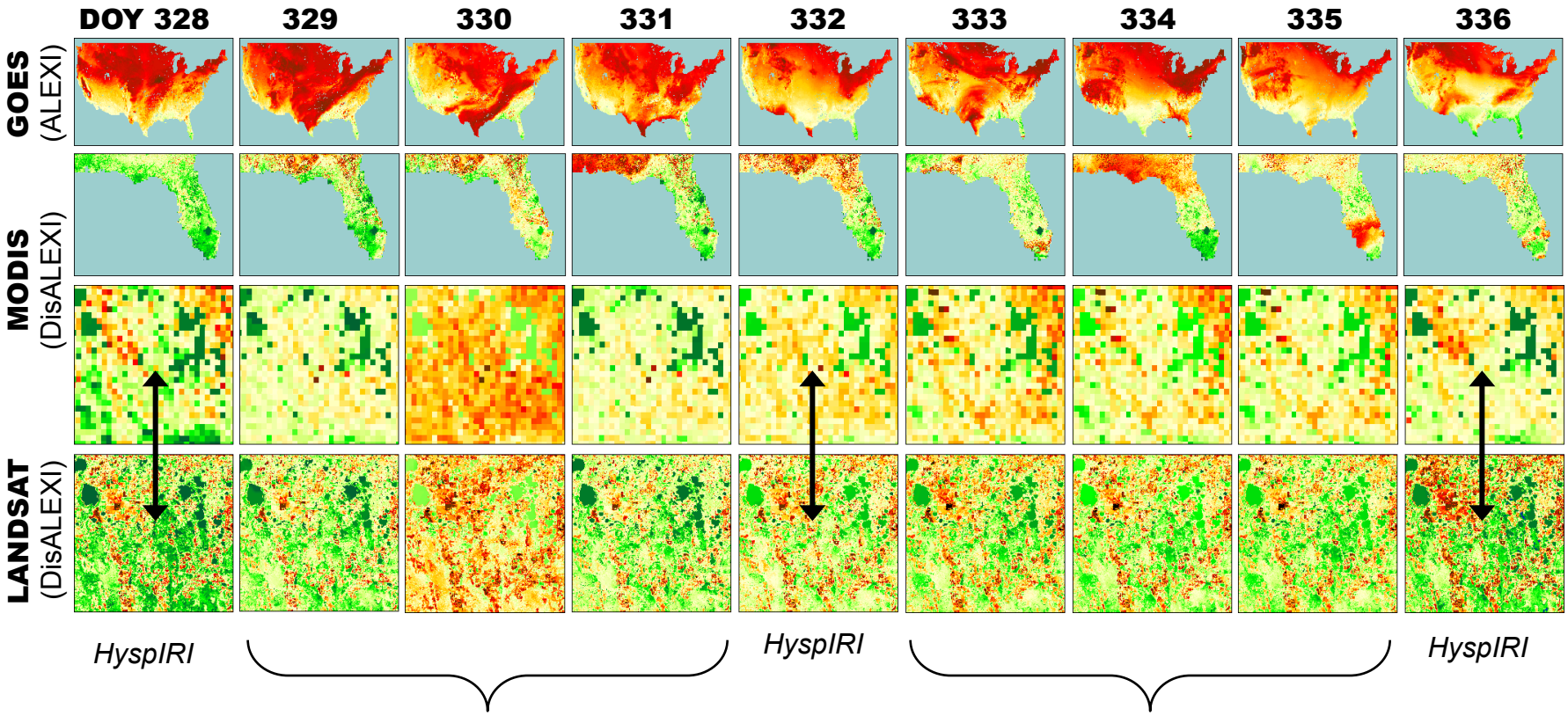
Landsat 5

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

R^2: 0.83
(9% error)

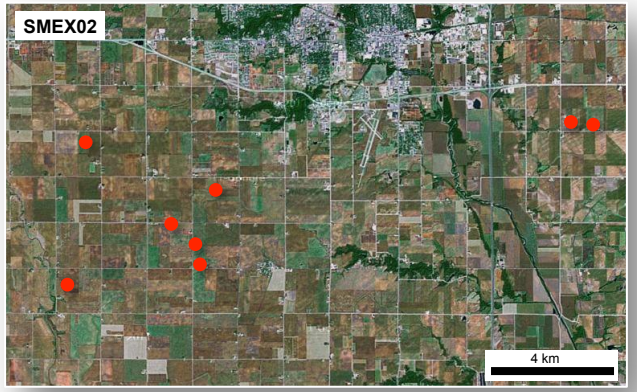
GOES/MODIS/HyspIRI FUSION

Daily Evapotranspiration – Orlando, FL, 2002



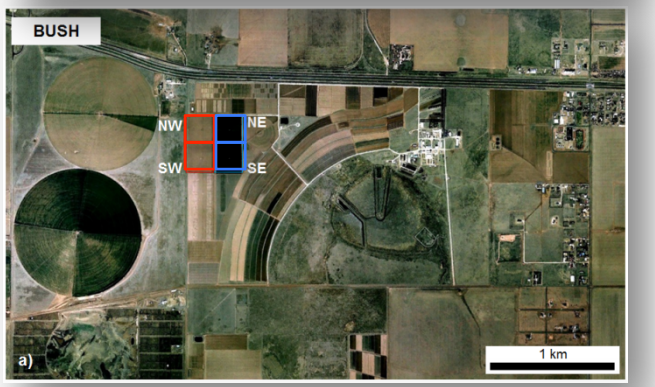
Spatial Temporal Adaptive Reflectance Fusion Model (STARFM) *(Gao et al, 2006)*

Evaluation of fused ET fluxes



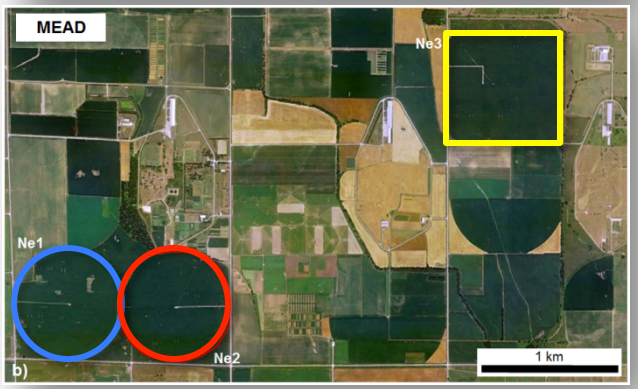
SMEX02

Soil Moisture Experiment 2002
Ames, Iowa
Rainfed corn and soybean



BEAREX08

Bushland ET and Remote sensing Experiment 2008
Bushland, Texas
Rainfed and irrigated cotton

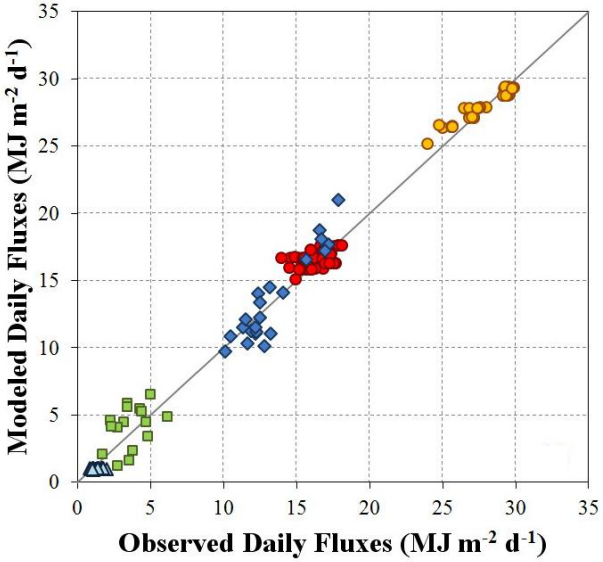


MEAD

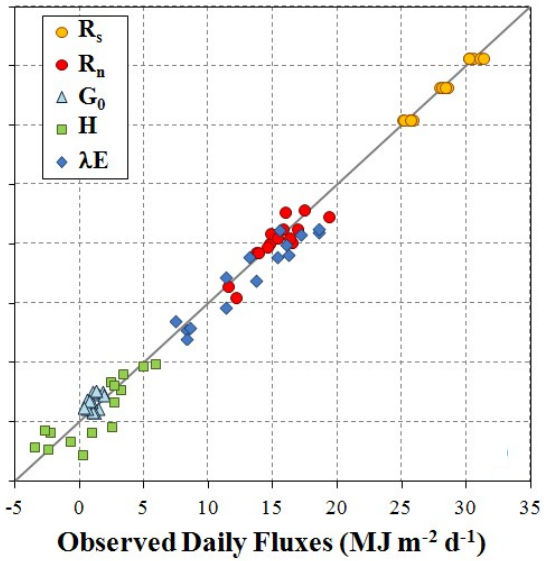
Ameriflux site (S. Verma)
Mead, NE
Rainfed and irrigation corn and soybean

Model performance on Landsat dates

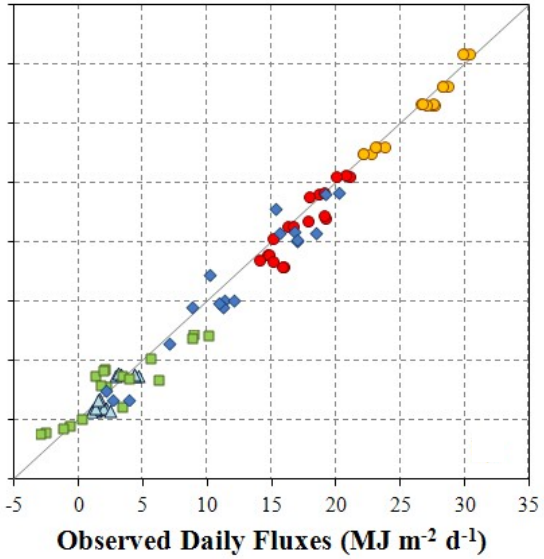
SMEX02



BEAREX08

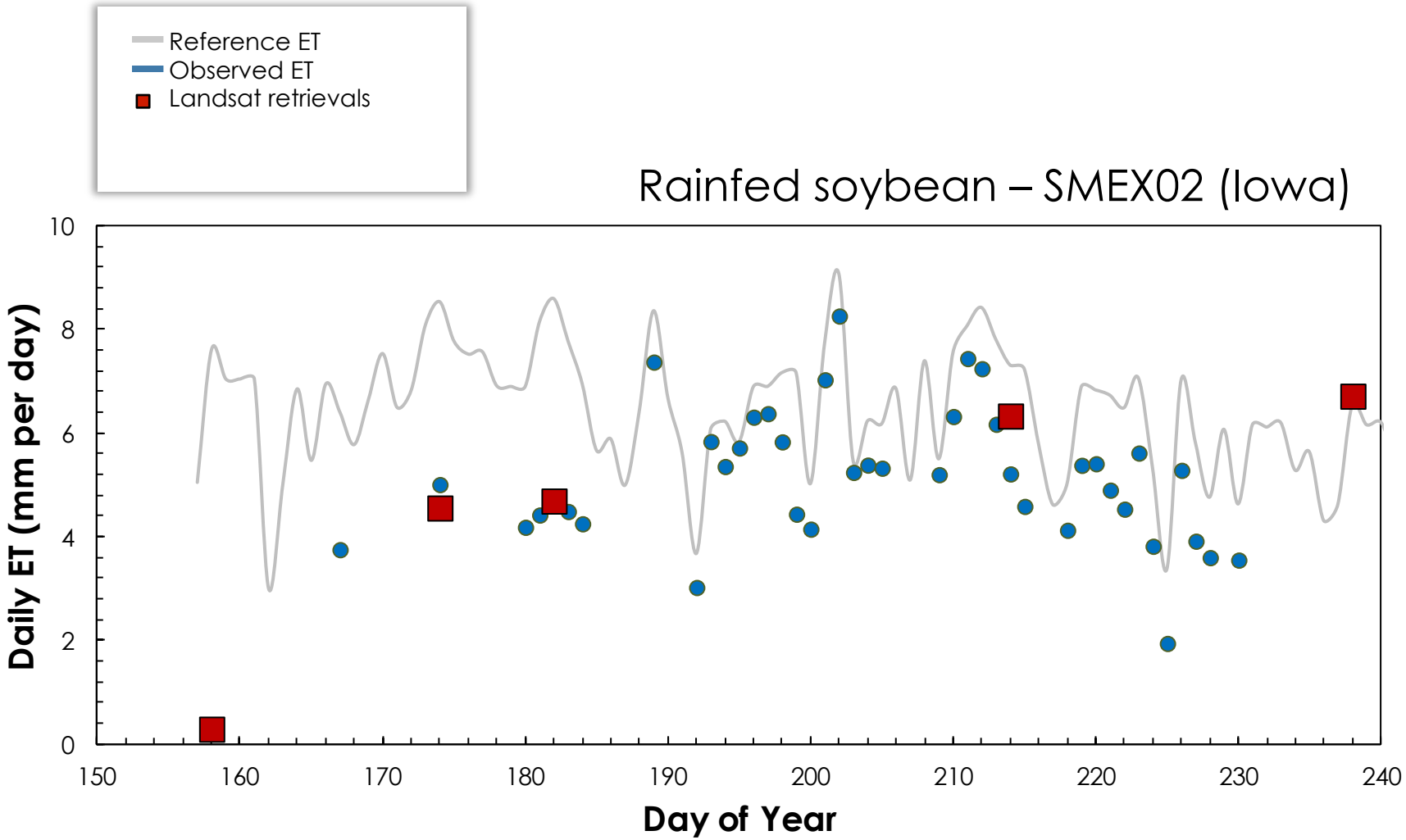


MEAD

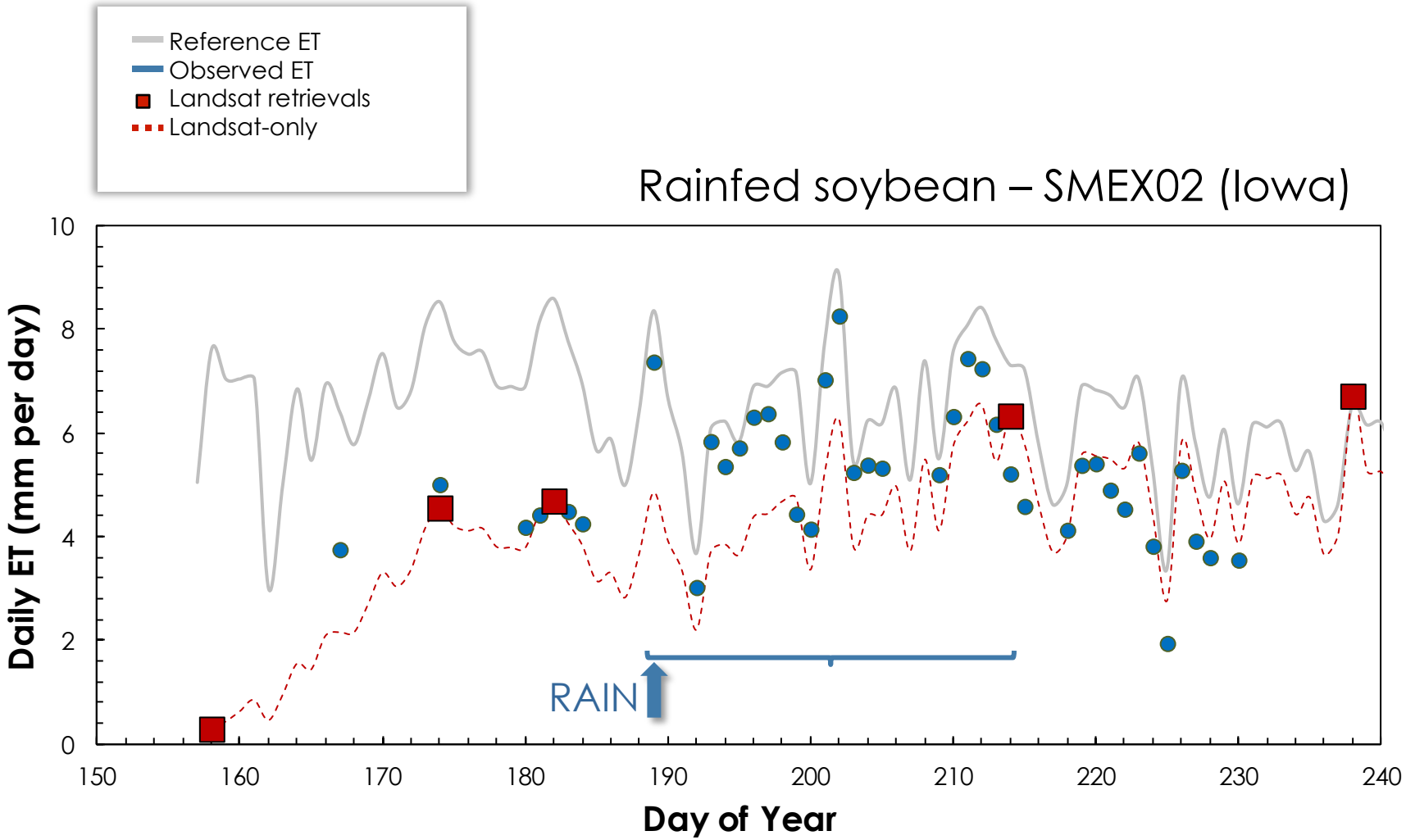


	SMEX02	BEAREX08	MEAD
MAE:	1.08 MJ m^{-2} d^{-1}	1.3 MJ m^{-2} d^{-1}	1.3 MJ m^{-2} d^{-1}
RE:	8%	10%	11%

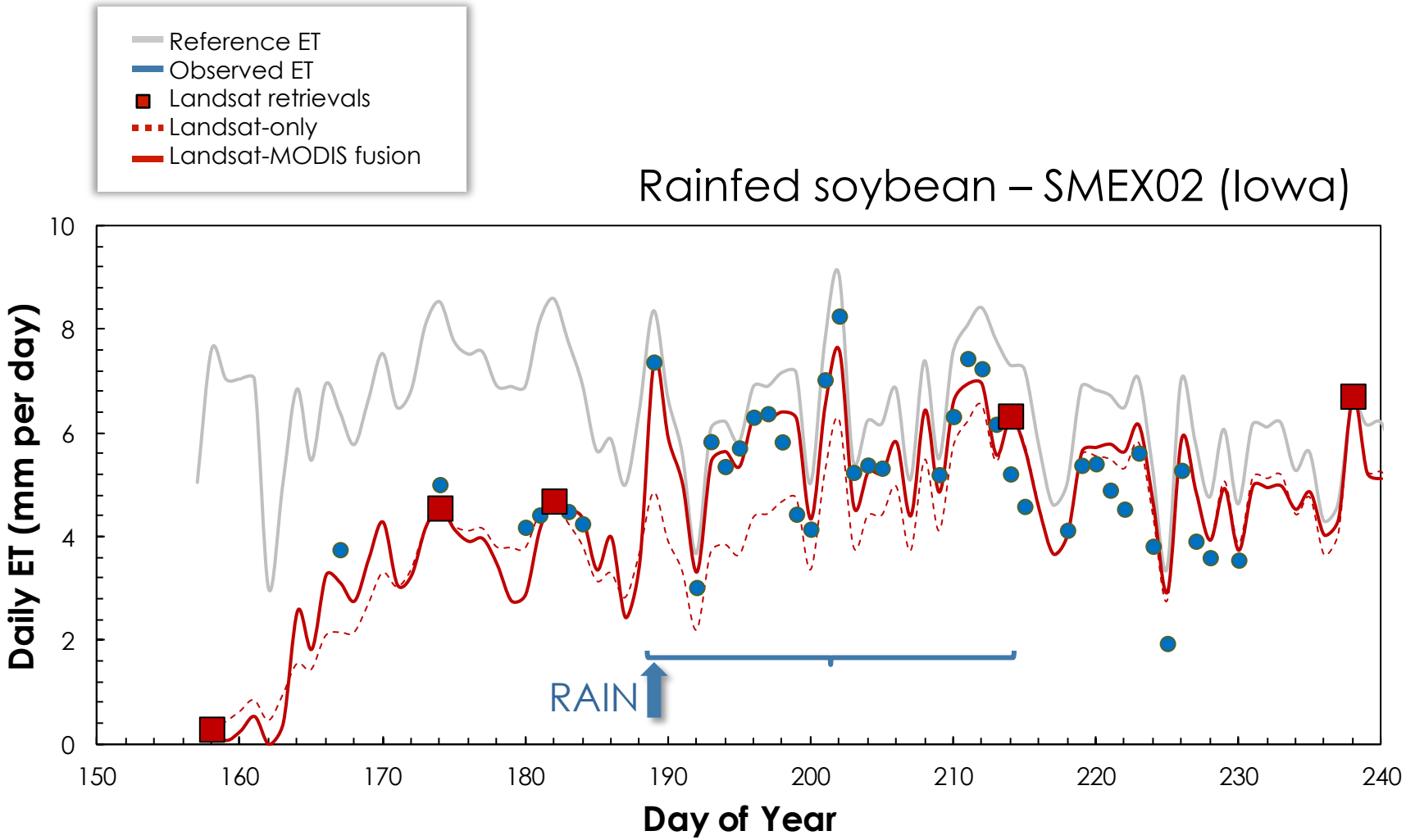
Validation using flux tower data



Validation using flux tower data

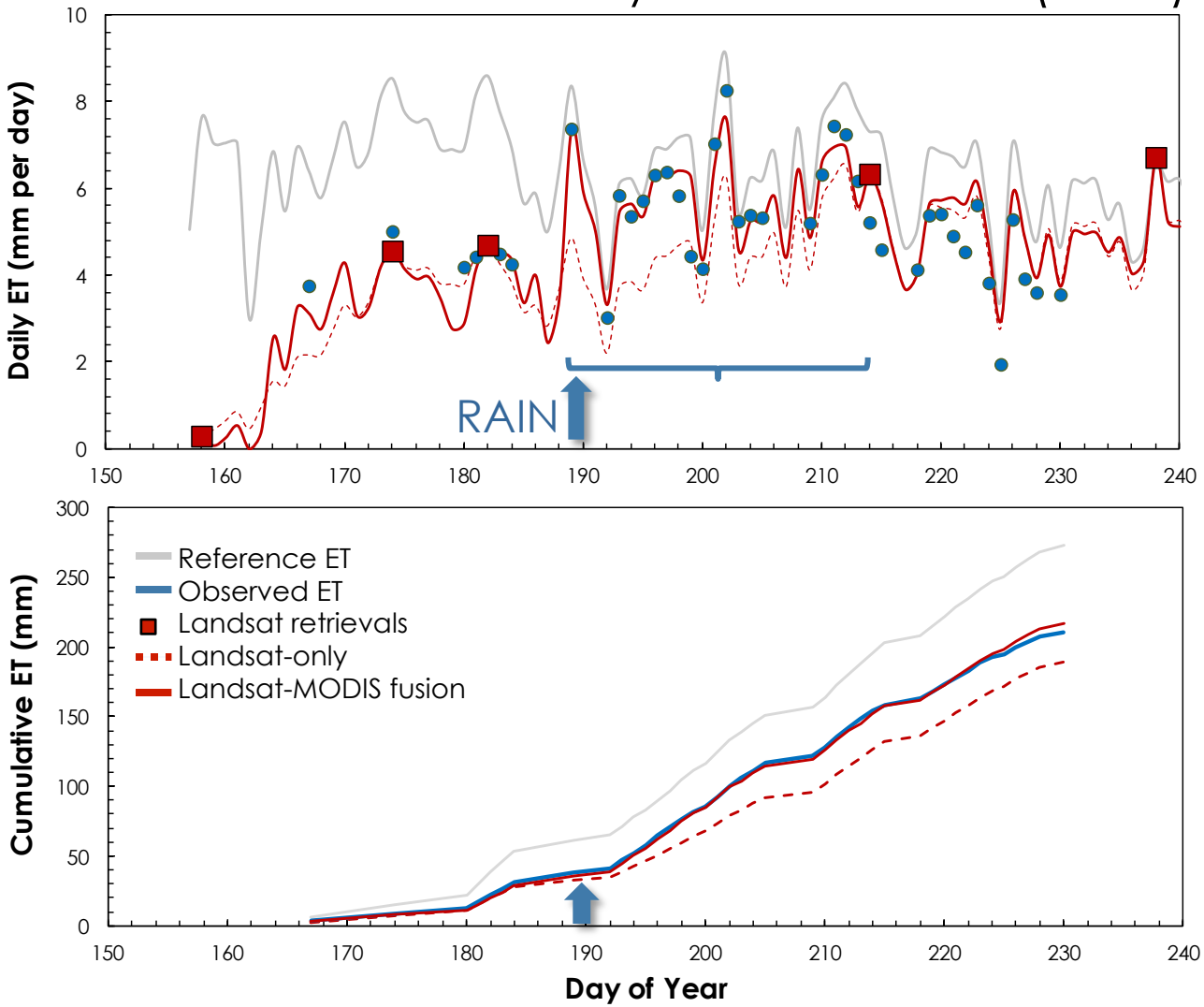


Validation using flux tower data

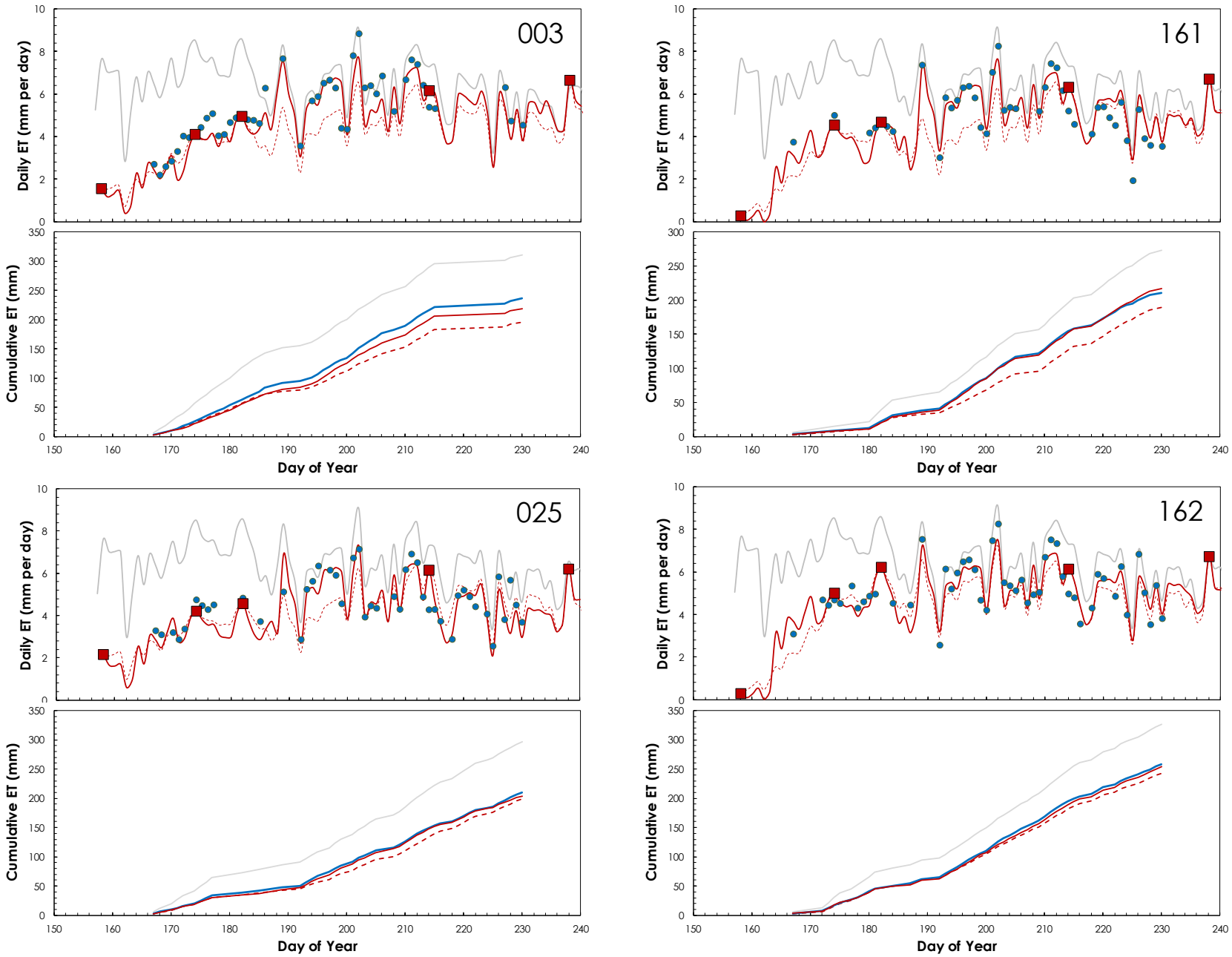


Validation using flux tower data

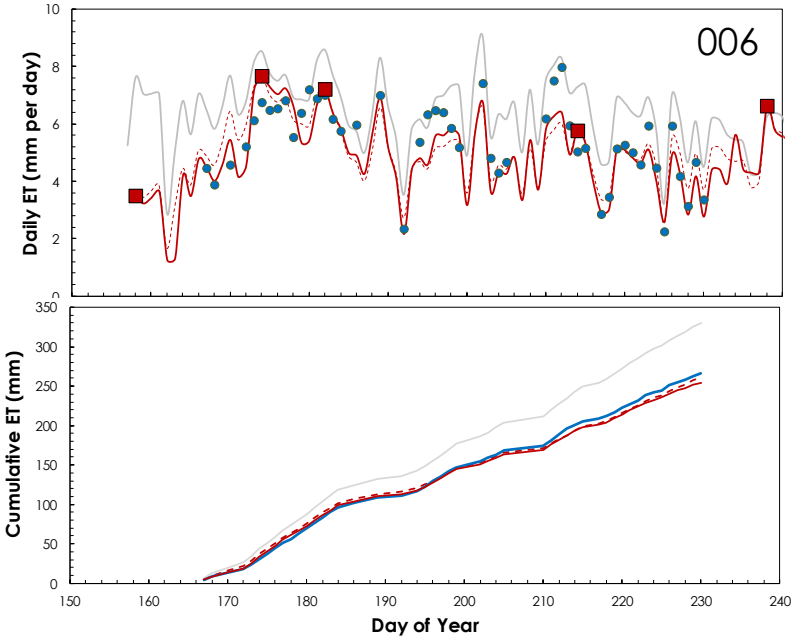
Rainfed soybean – SMEX02 (Iowa)

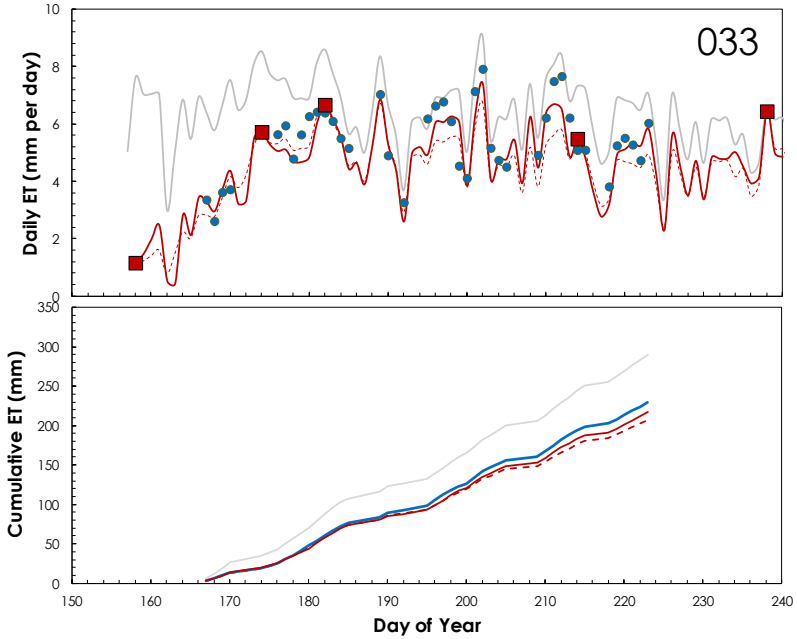


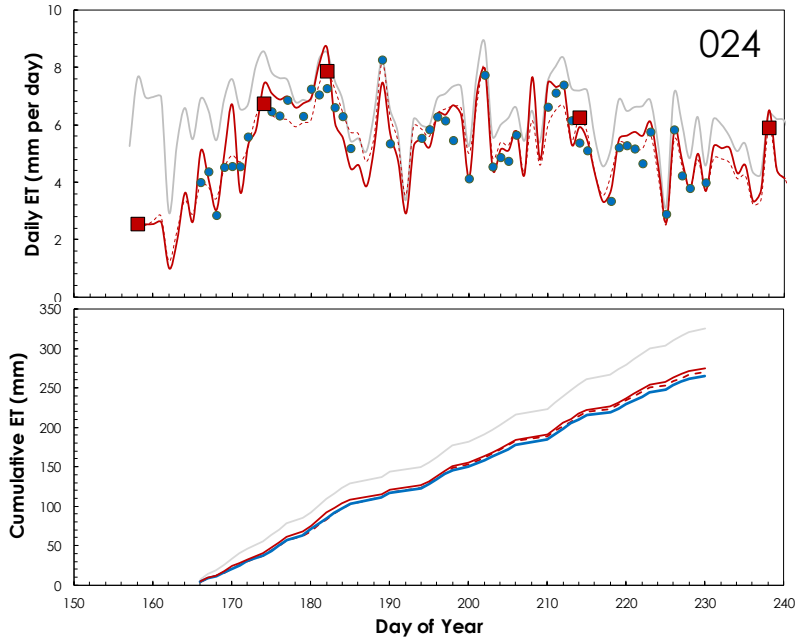
SMEX02: soybean and stunted corn

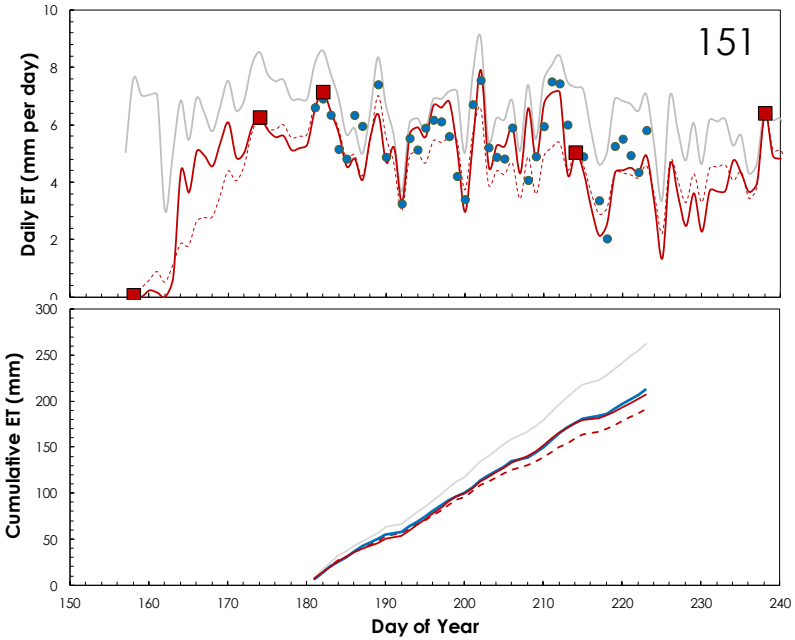


SMEX02: healthy corn

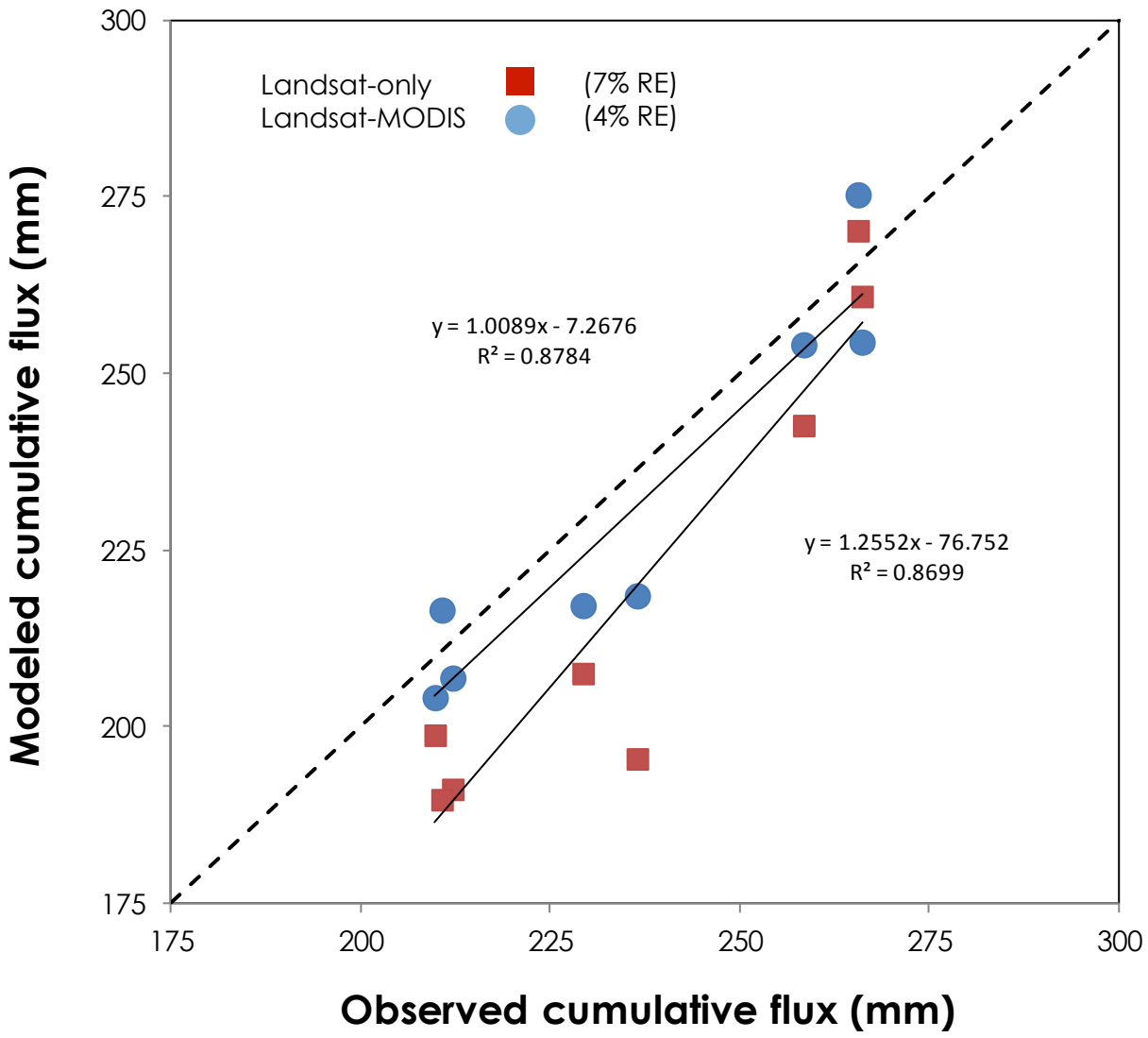




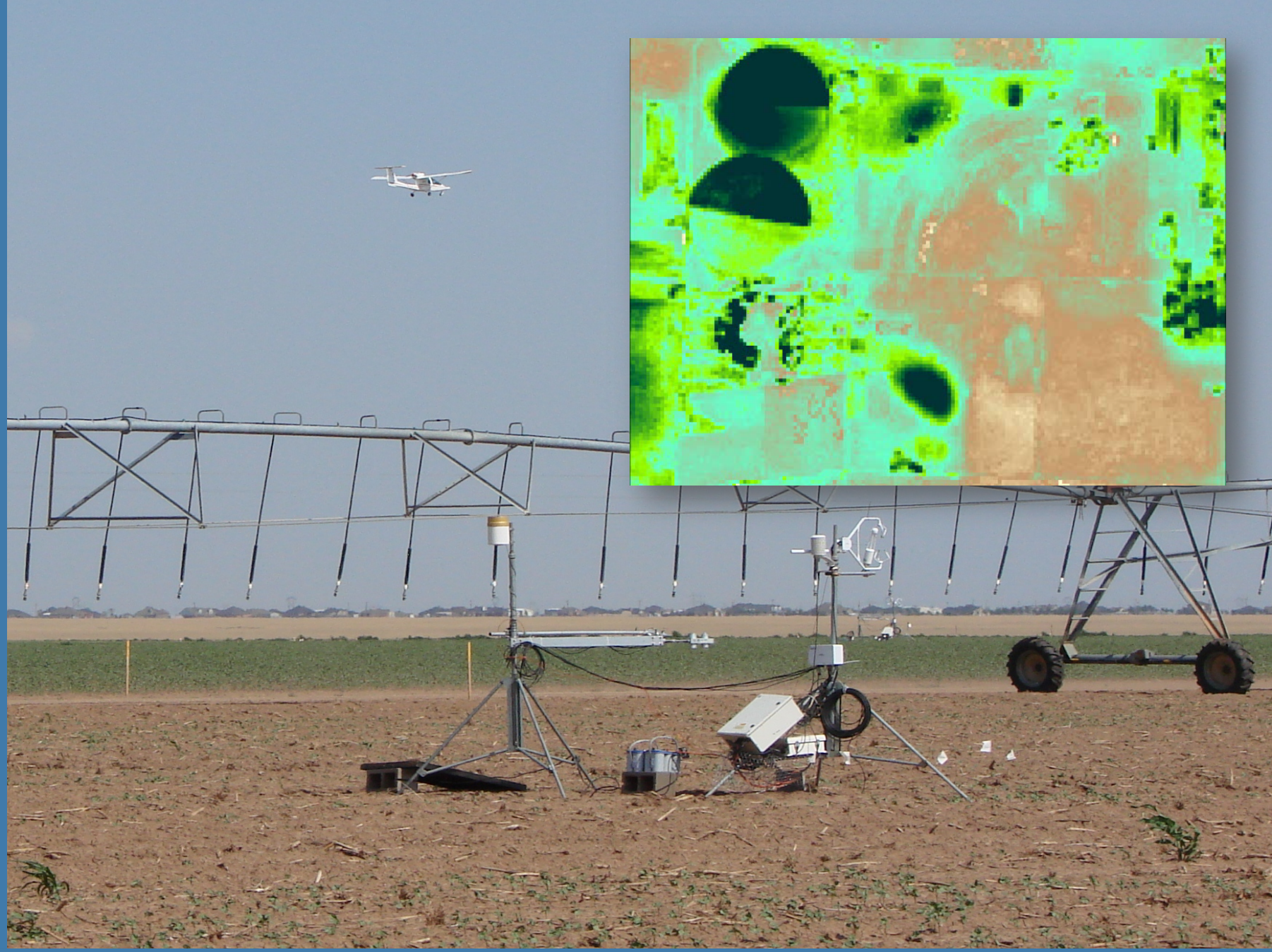




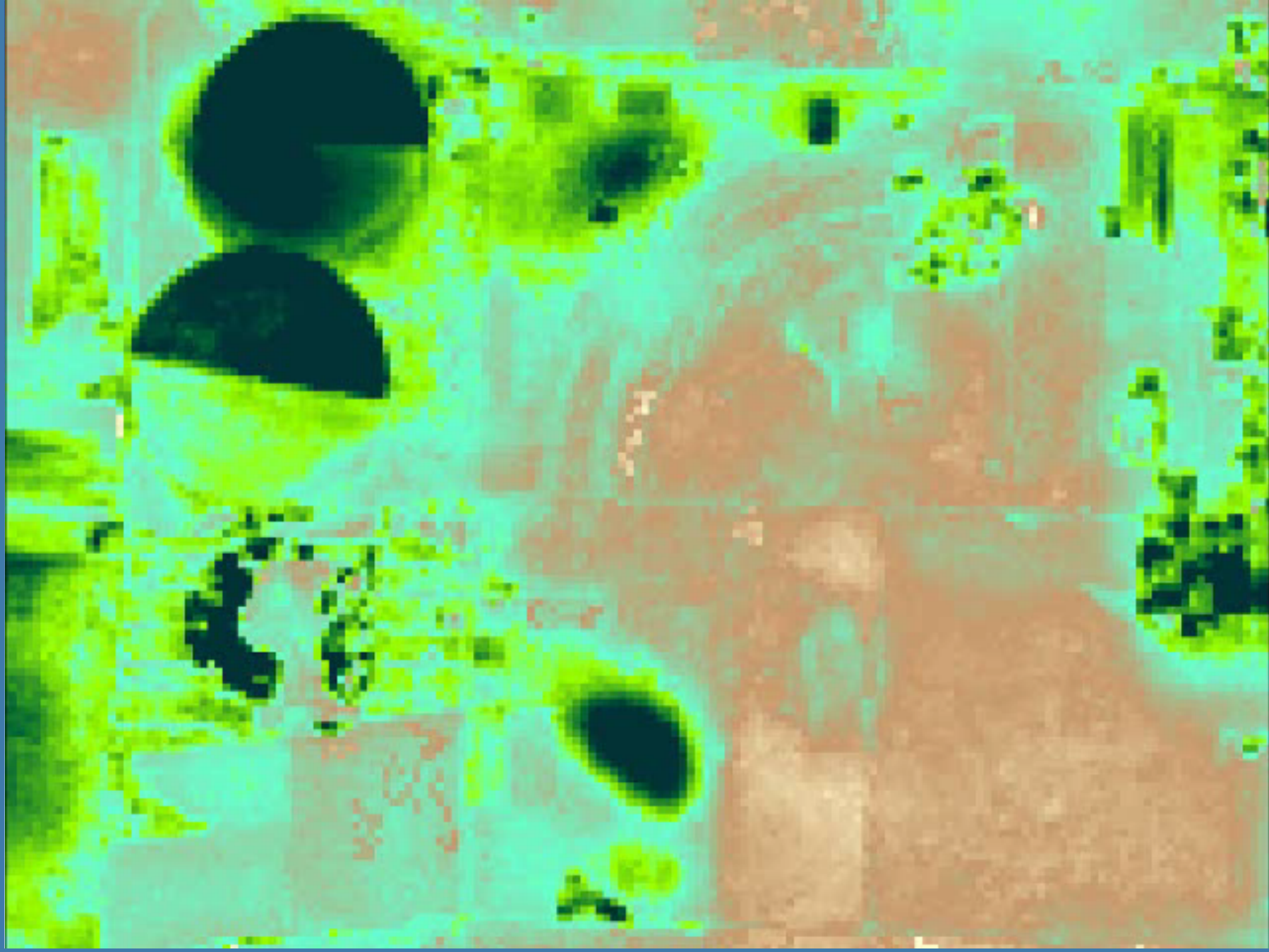
SMEX02 cumulative fluxes



BEAREX08

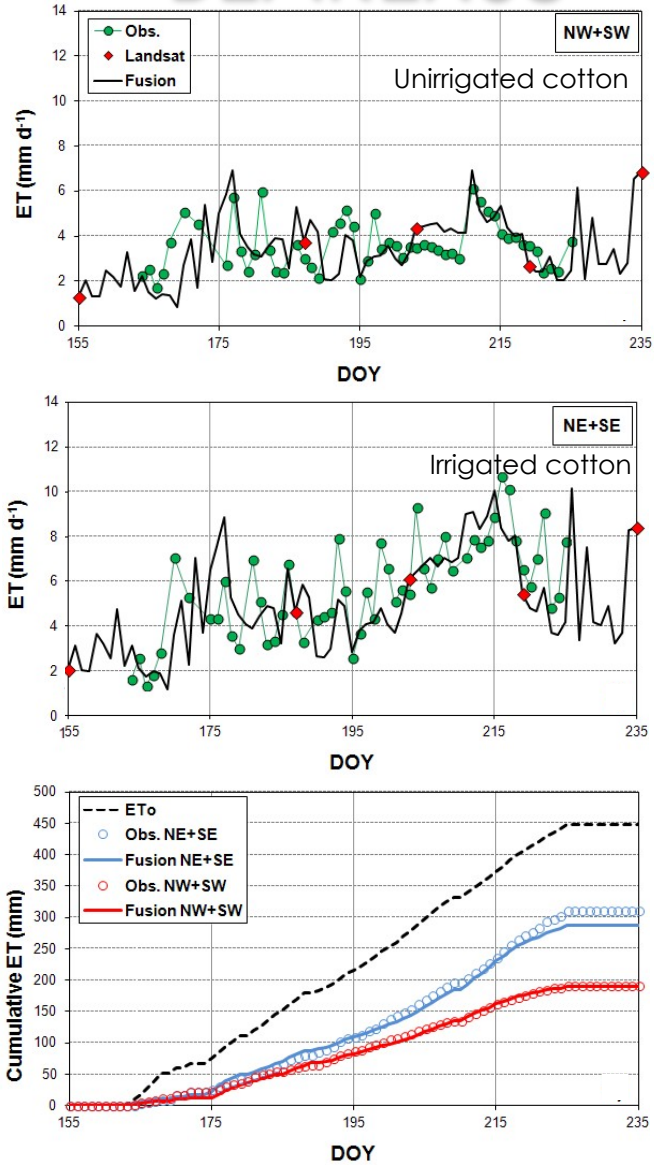


Daily ET at field scale (Landsat+MODIS)

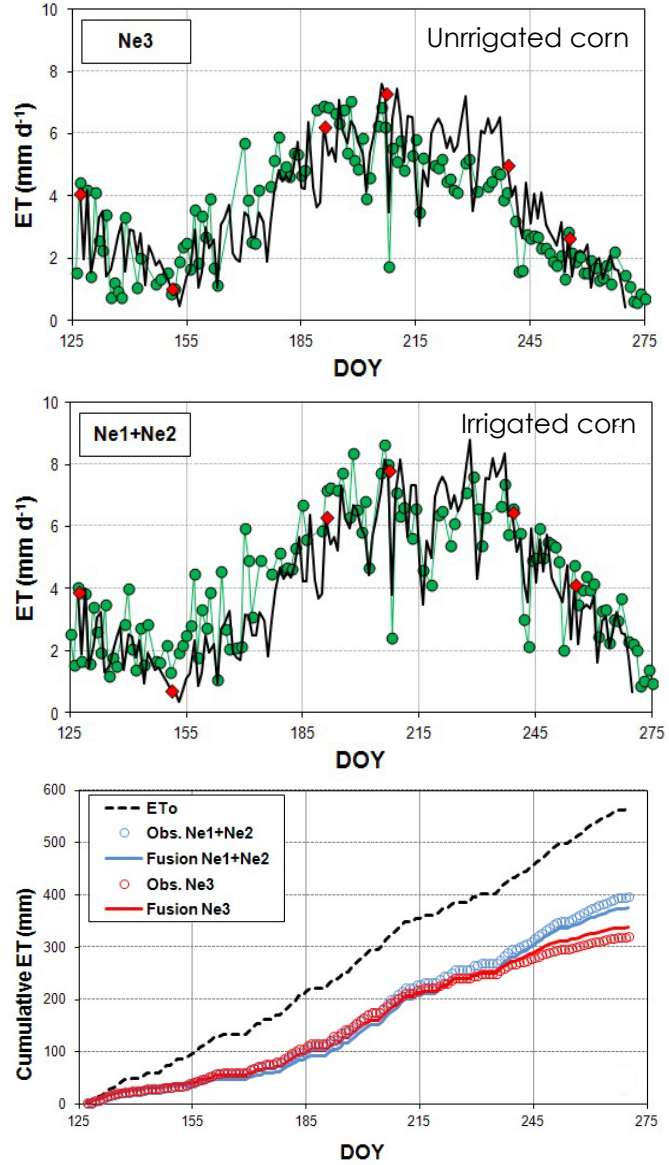


BEAREX08 and MEAD

BEAREX08



MEAD



Applications for Remotely Sensed ET

WATER MANAGEMENT

DROUGHT MONITORING

FOOD AND WATER SECURITY

APPLICATIONS FOR SATELLITE ET

… *Monitoring Drought*

Realtime Drought Monitoring

Firefox

(109 unread) - ec... | Topics in Science... | Evaporative Stres... | Downloads | University Resear... | LTAR Network In... | Problem loading ... | Typhoon Bolave... | 2012 AMS Inform...

hrsl.arsusda.gov/drought

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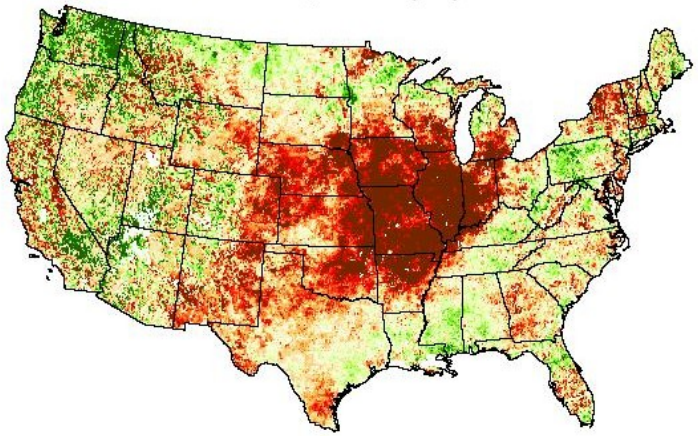
USDA

Evaporative Stress Index

USDA-ARS HRSL
Hydrology & Remote Sensing Lab
Beltsville, Maryland, USA

Evaporative Stress Index

1 month composite ending August 27, 2012



Standardized ET/PET anomalies

-2σ< | -1σ | 0 | +1σ | > +2σ

Download

Description

The Evaporative Stress Index (ESI) describes temporal anomalies in evapotranspiration (ET), highlighting areas with anomalously high or low rates of water use across the land surface. Here, ET is retrieved via energy balance using remotely sensed land-surface temperature (LST) time-change signals. LST is a fast-response variable, providing proxy information regarding rapidly evolving surface soil moisture and crop stress conditions at relatively high spatial resolution. The ESI also demonstrates capability for capturing early signals of "flash drought", brought on by extended periods of hot, dry and windy conditions leading to rapid soil moisture depletion.

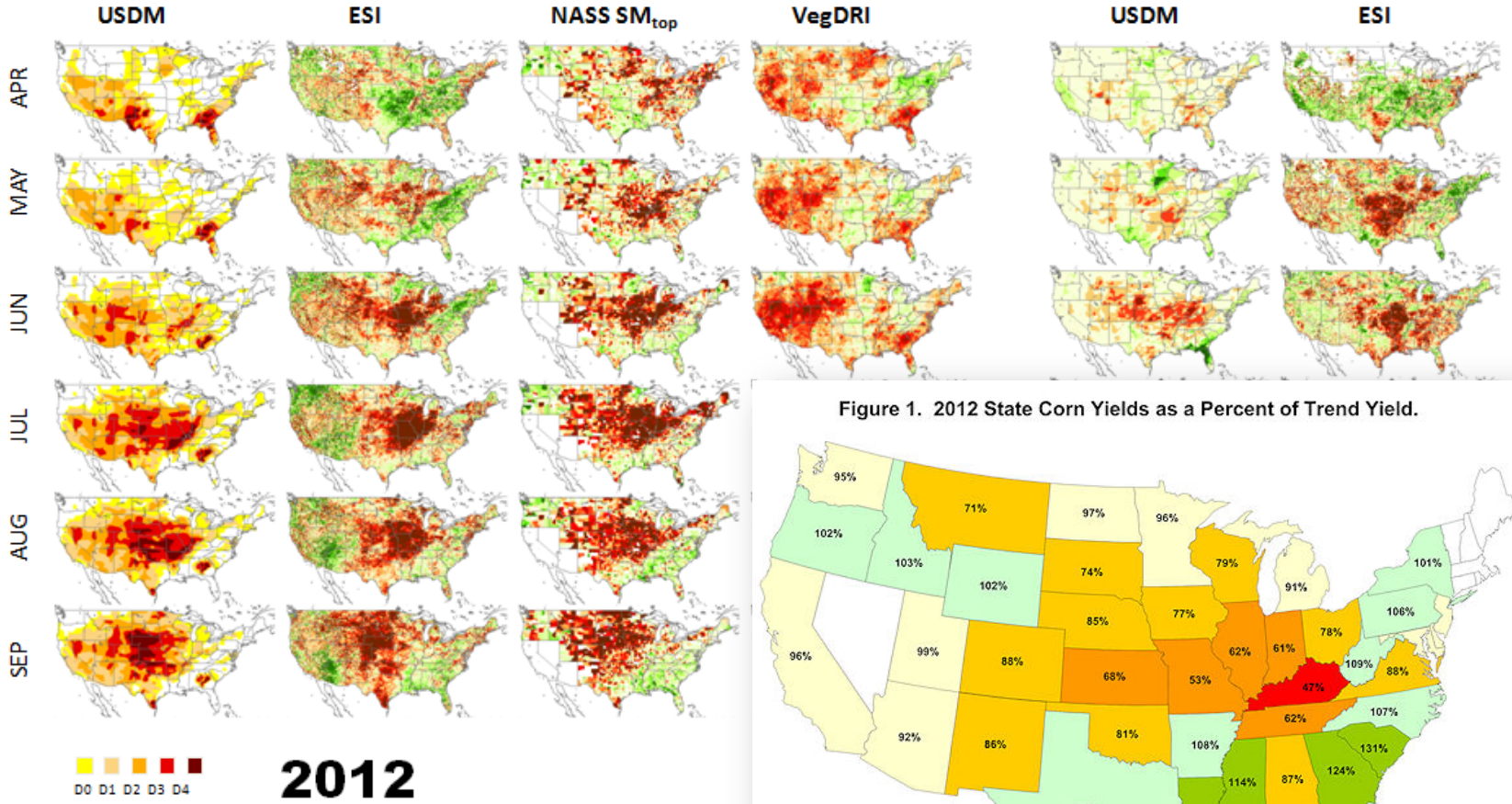
Coverage

Current Conditions

Hydrology and Remote Sensing Laboratory | 10300 Baltimore Avenue | Beltsville, MD 20705 | Contact Us
Version 2.1.2

hrsl.arsusda.gov/drought/index.php

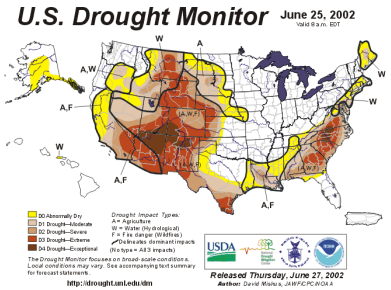
2012 FLASH DROUGHT

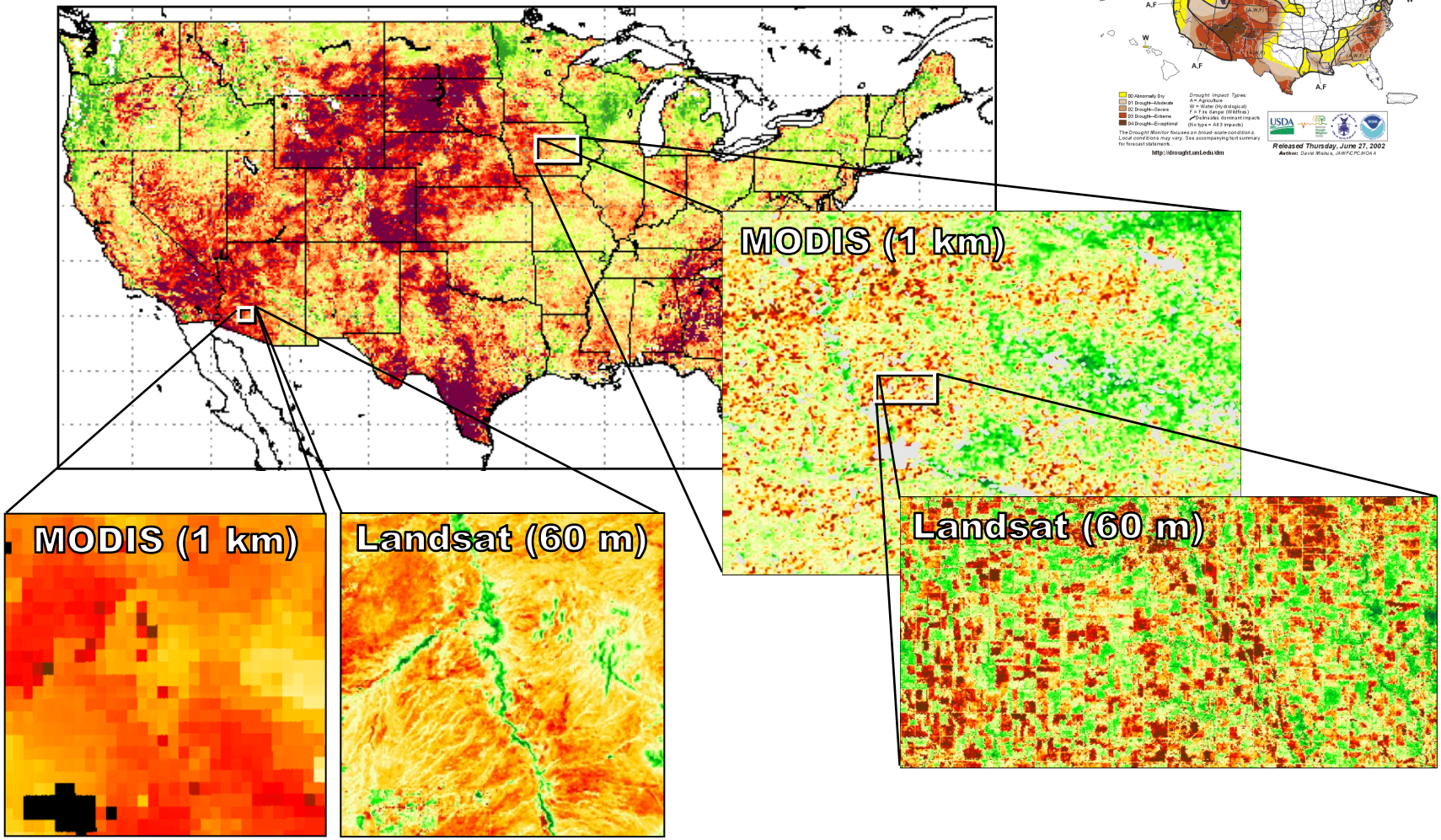


Multiscale Drought/Stress Monitoring

GOES Evaporative Stress Index

JUNE 2002

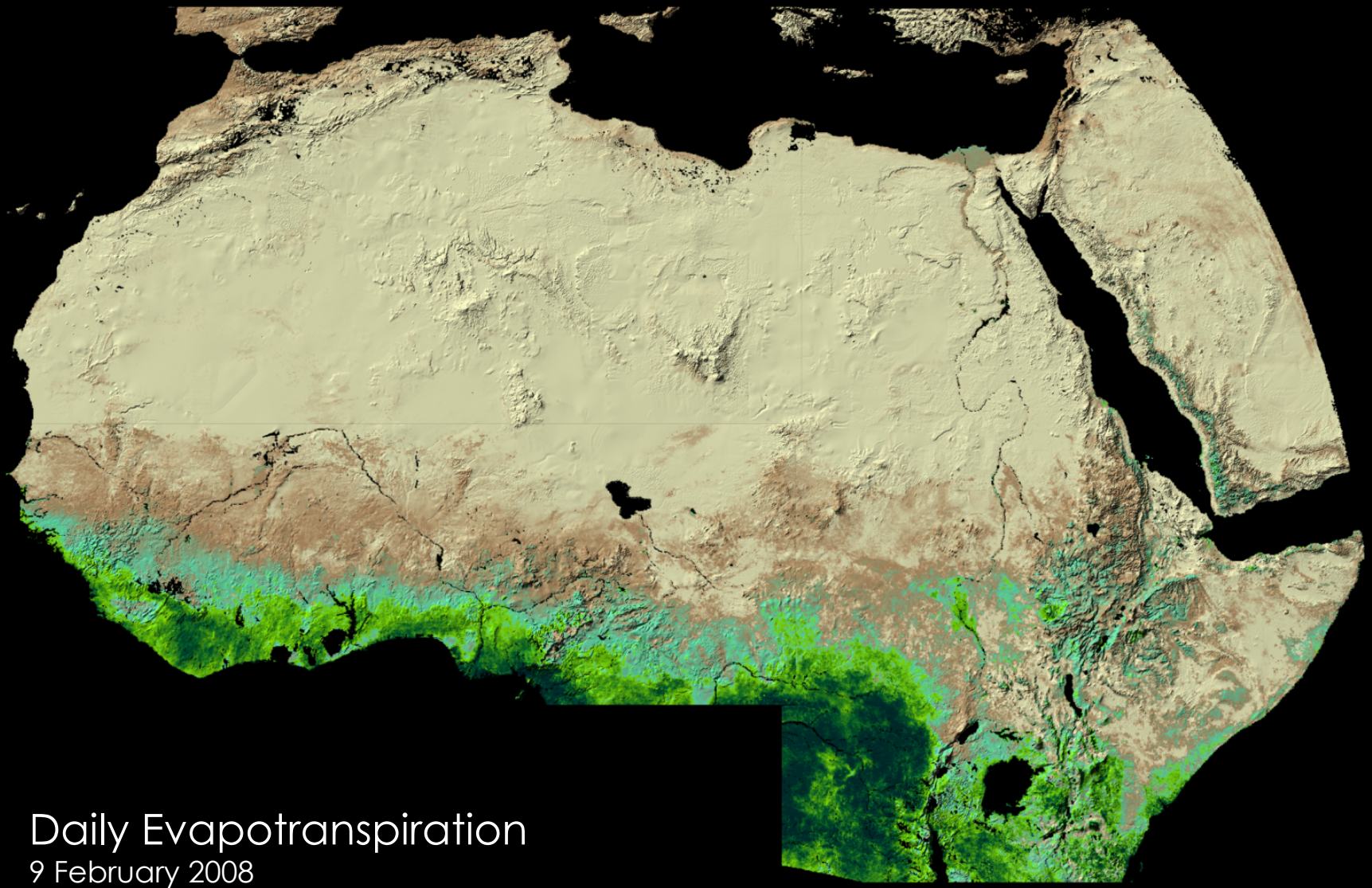




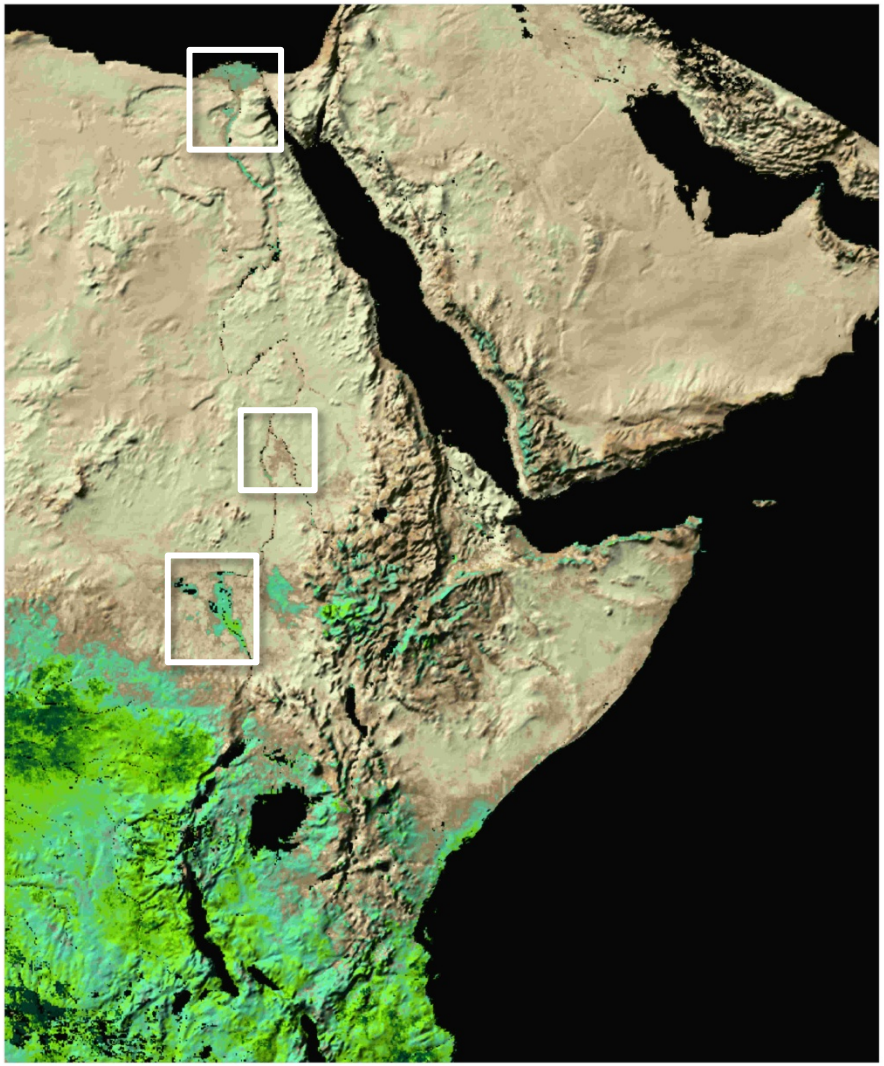
APPLICATIONS FOR SATELLITE ET

… Food and Water Security

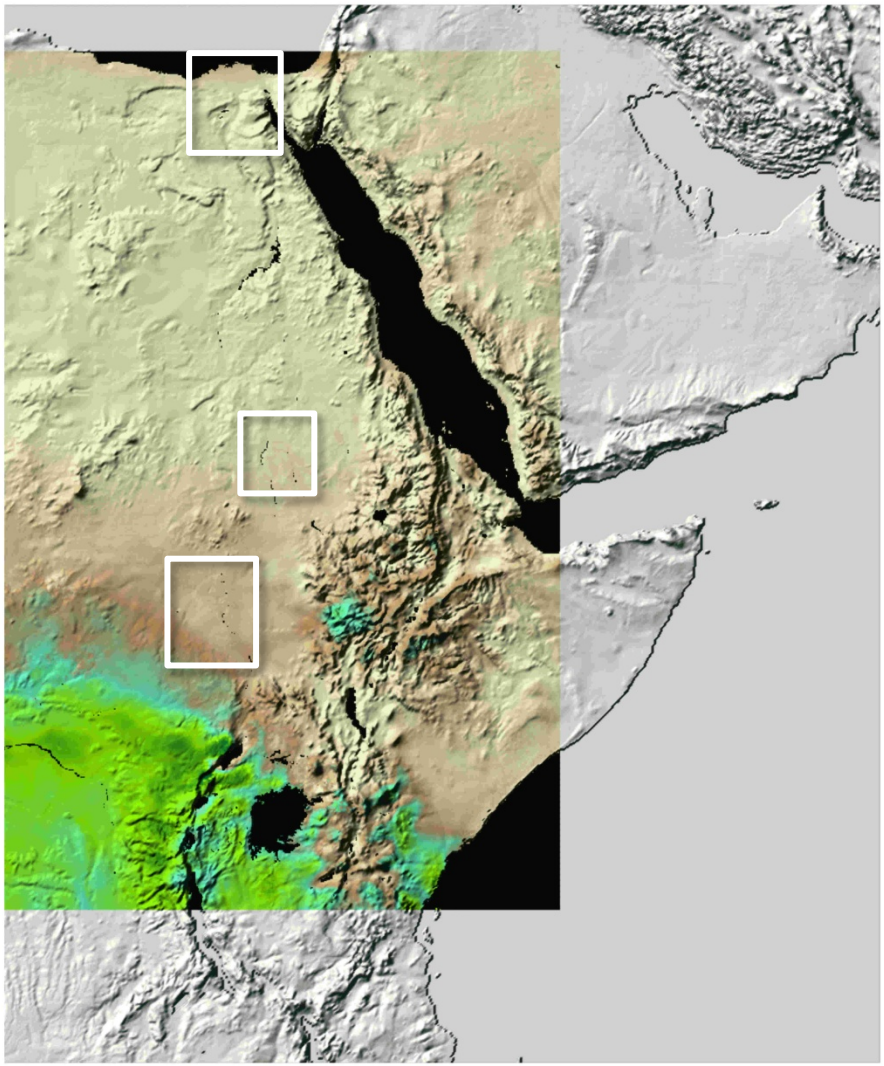
ALEXI ET over MENA Region



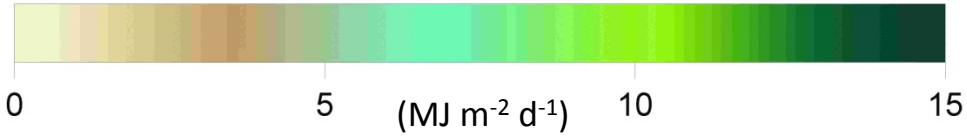
2009 FEBRUARY



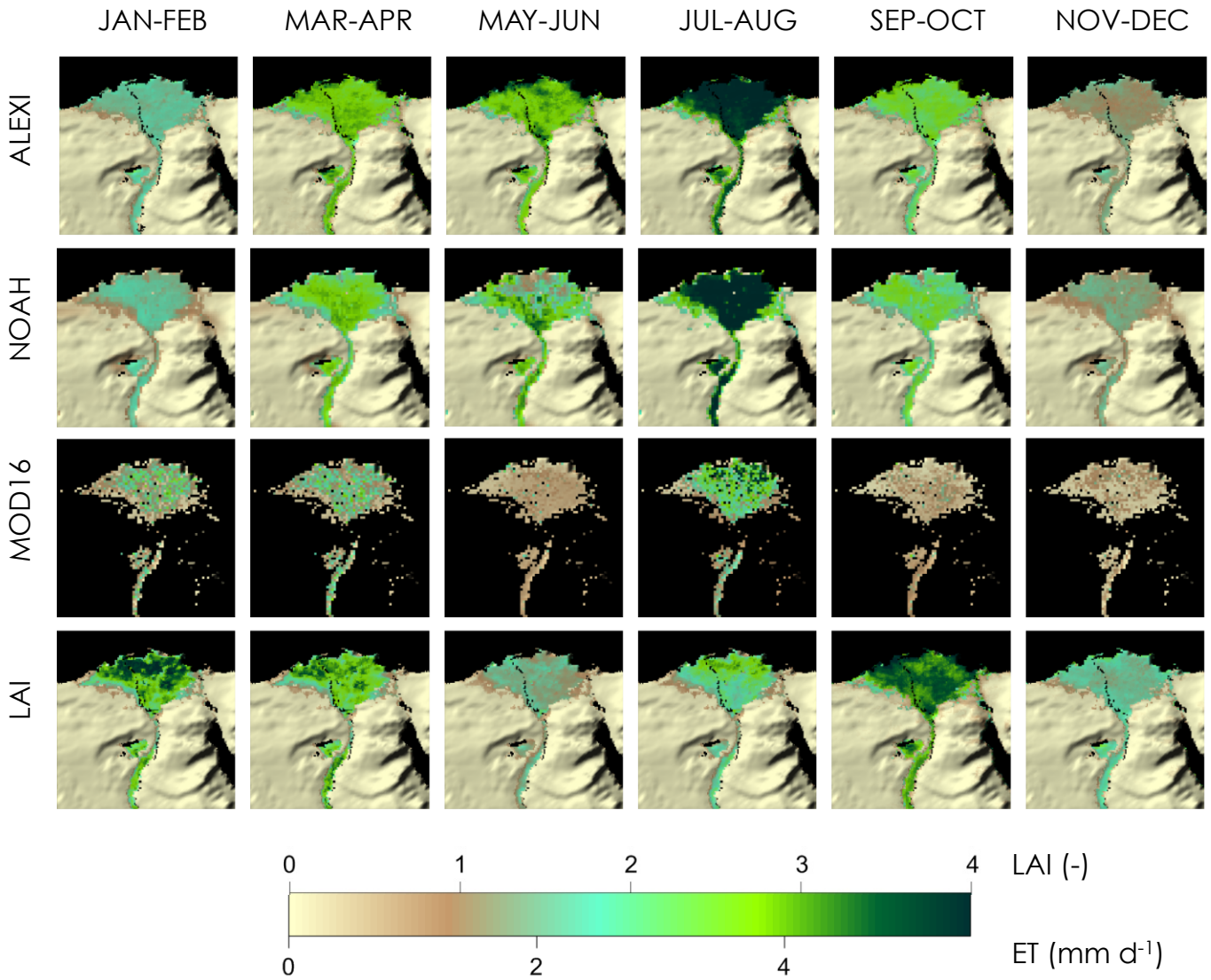
Average ALEXI ET



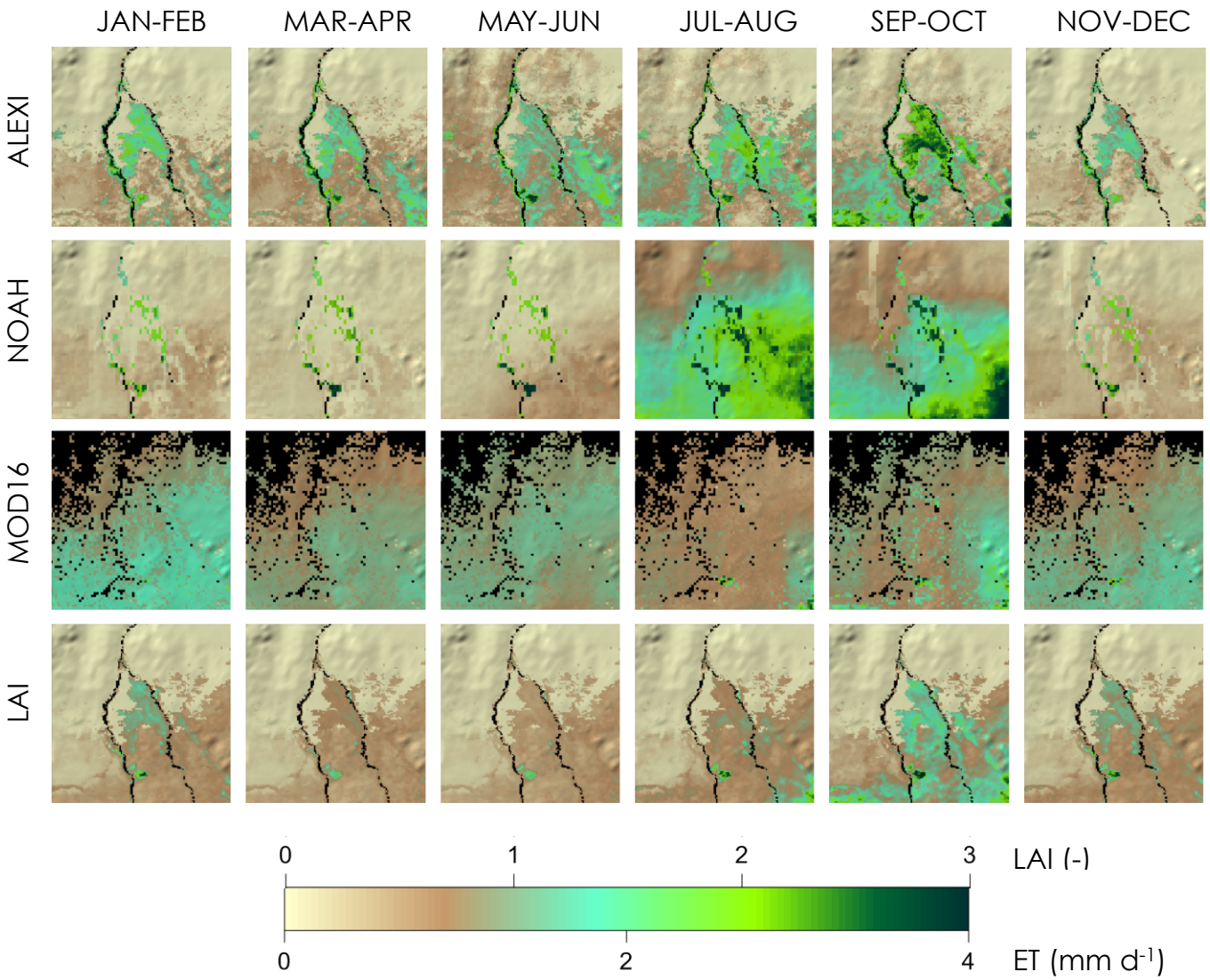
Average Noah ET



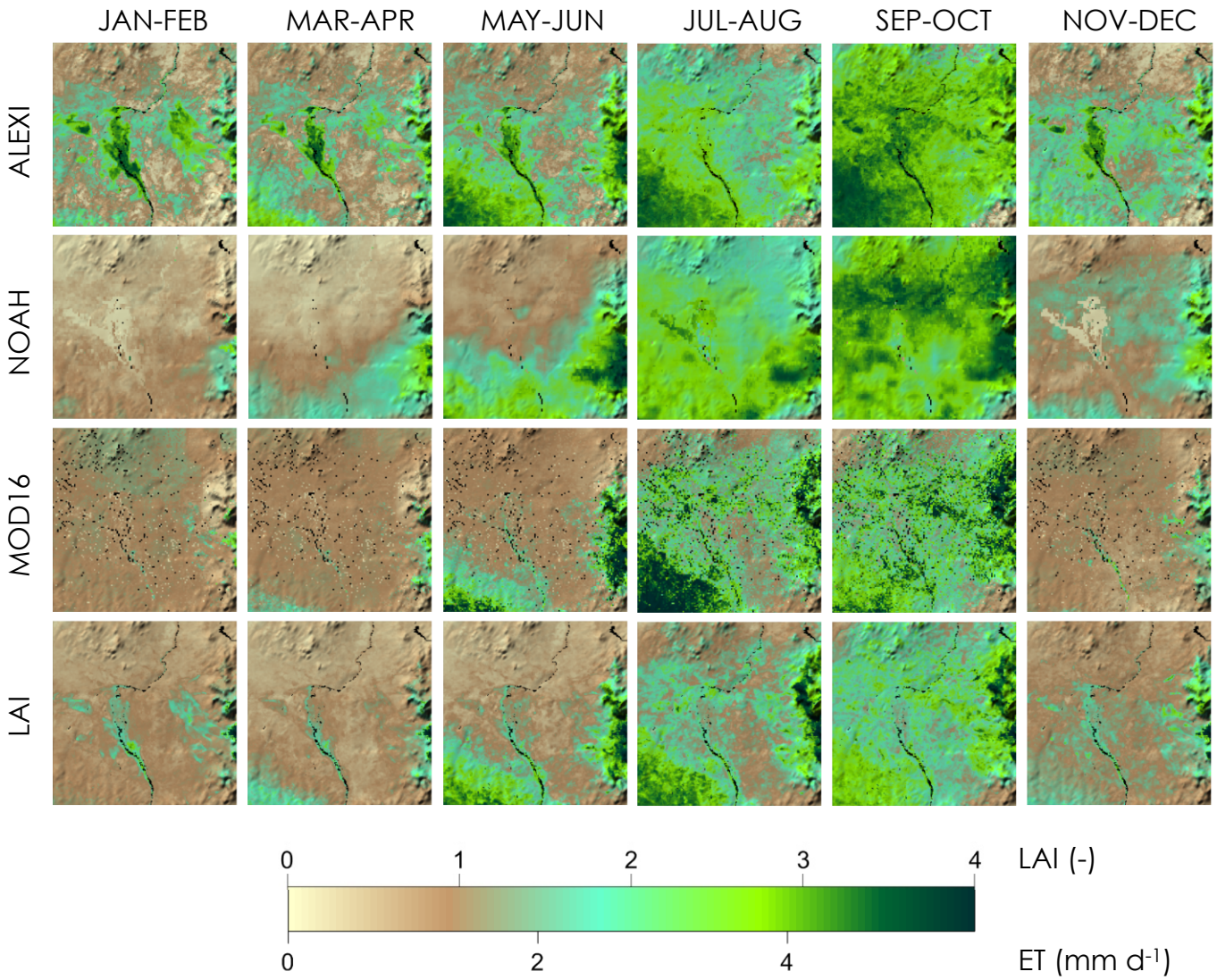
NILE DELTA


JAN-FEB
MAR-APR
MAY-JUN
JUL-AUG
SEP-OCT
NOV-DEC
ALEXI
NOAH
MOD16
LAI
0
1
2
3
4
LAI (-)
0
2
4
ET (mm d-1)

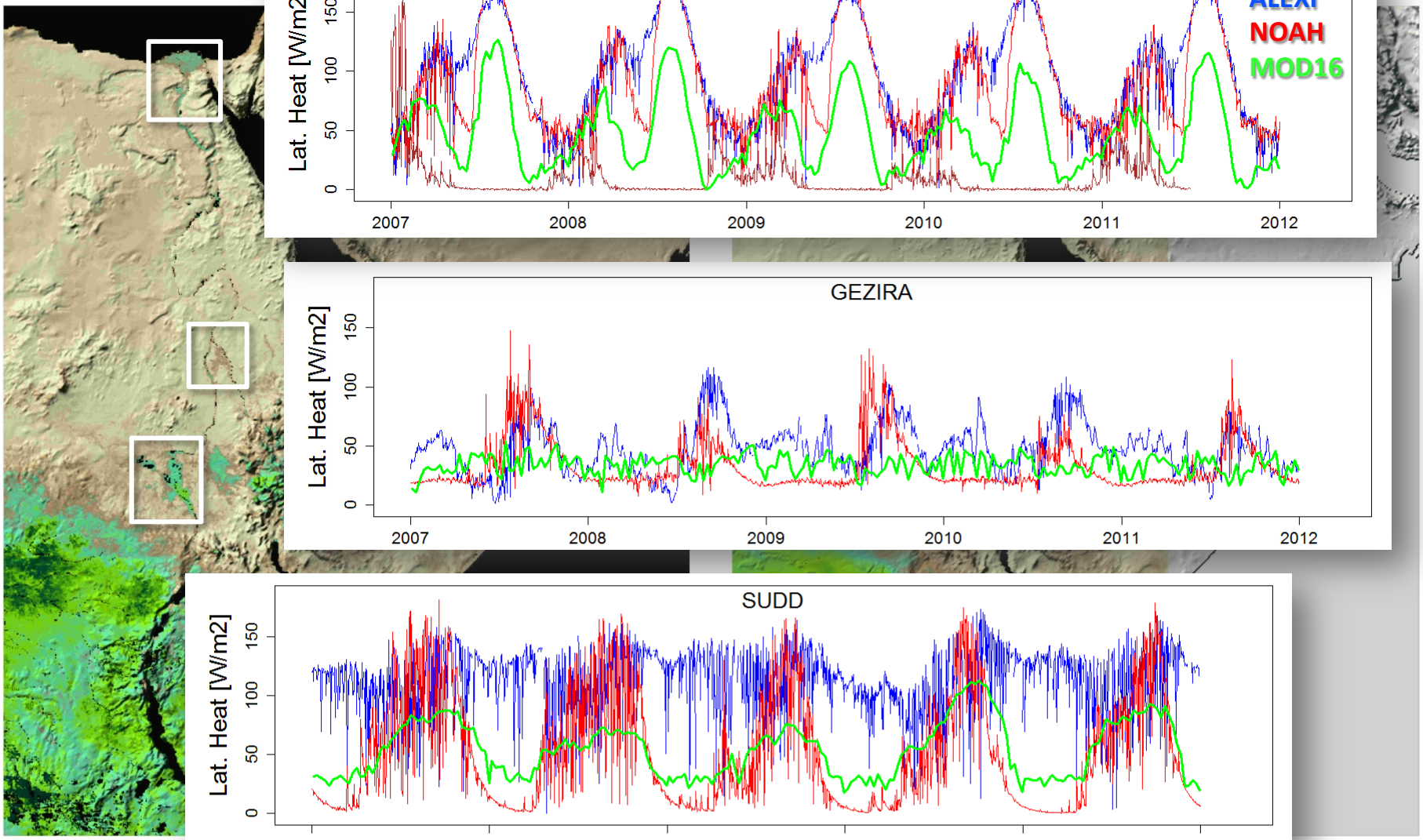
GEZIRA IRRIGATION SCHEME



SUDD WETLAND

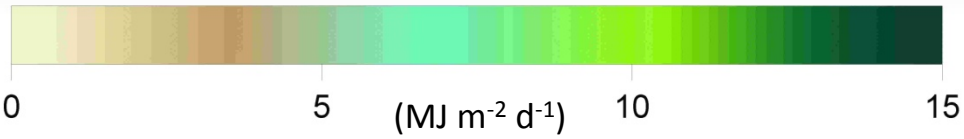


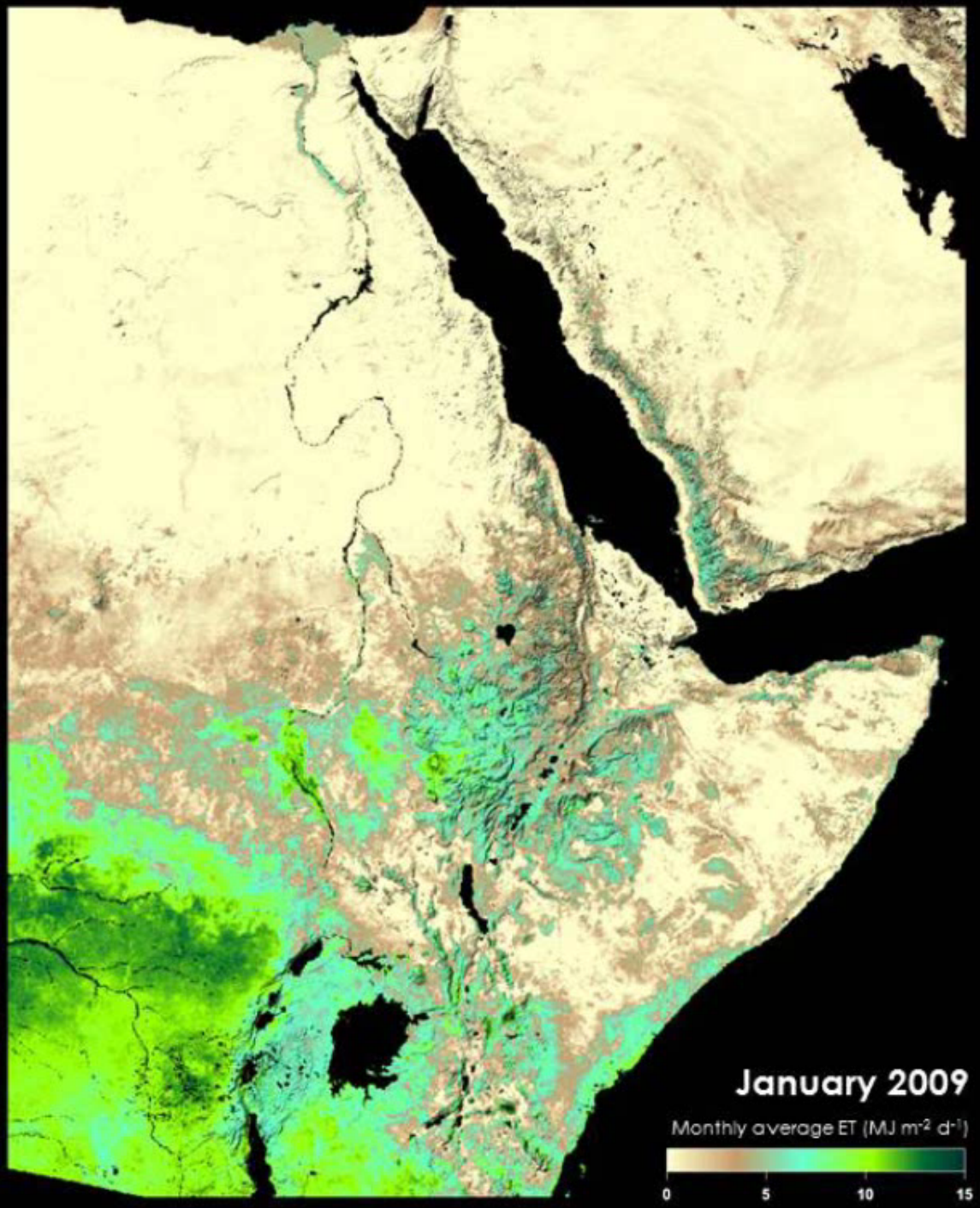
2009 FEBRUARY



Average ALEXI ET

Average Noah ET




January 2009
Monthly average ET (MJ m-2 d-1)
0
5
10
15

Conclusions

Satellite Evapotranspiration

- Monitoring water use at field to continental scales
- Land-surface temperature conveys early warning of vegetation stress
- Independent check on precipitation-based drought indices
- Applications in global water and food security

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

USDA is an equal opportunity provider and employer.

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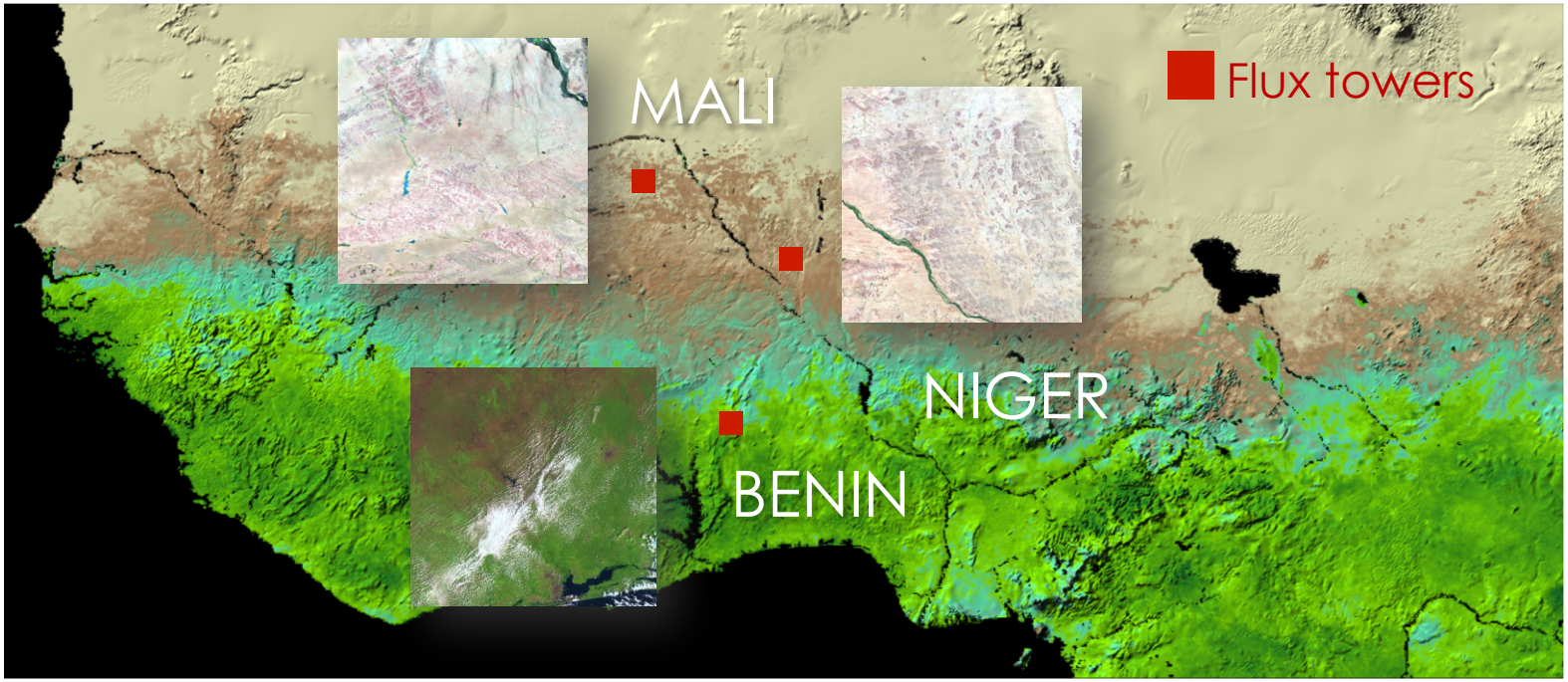
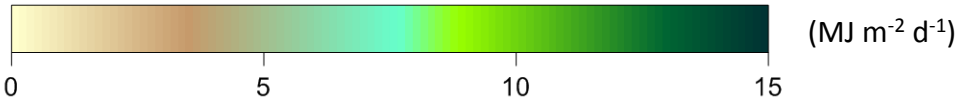
African Monsoon Project

ALMIP AMMA Land Surface Model Intercomparison Project

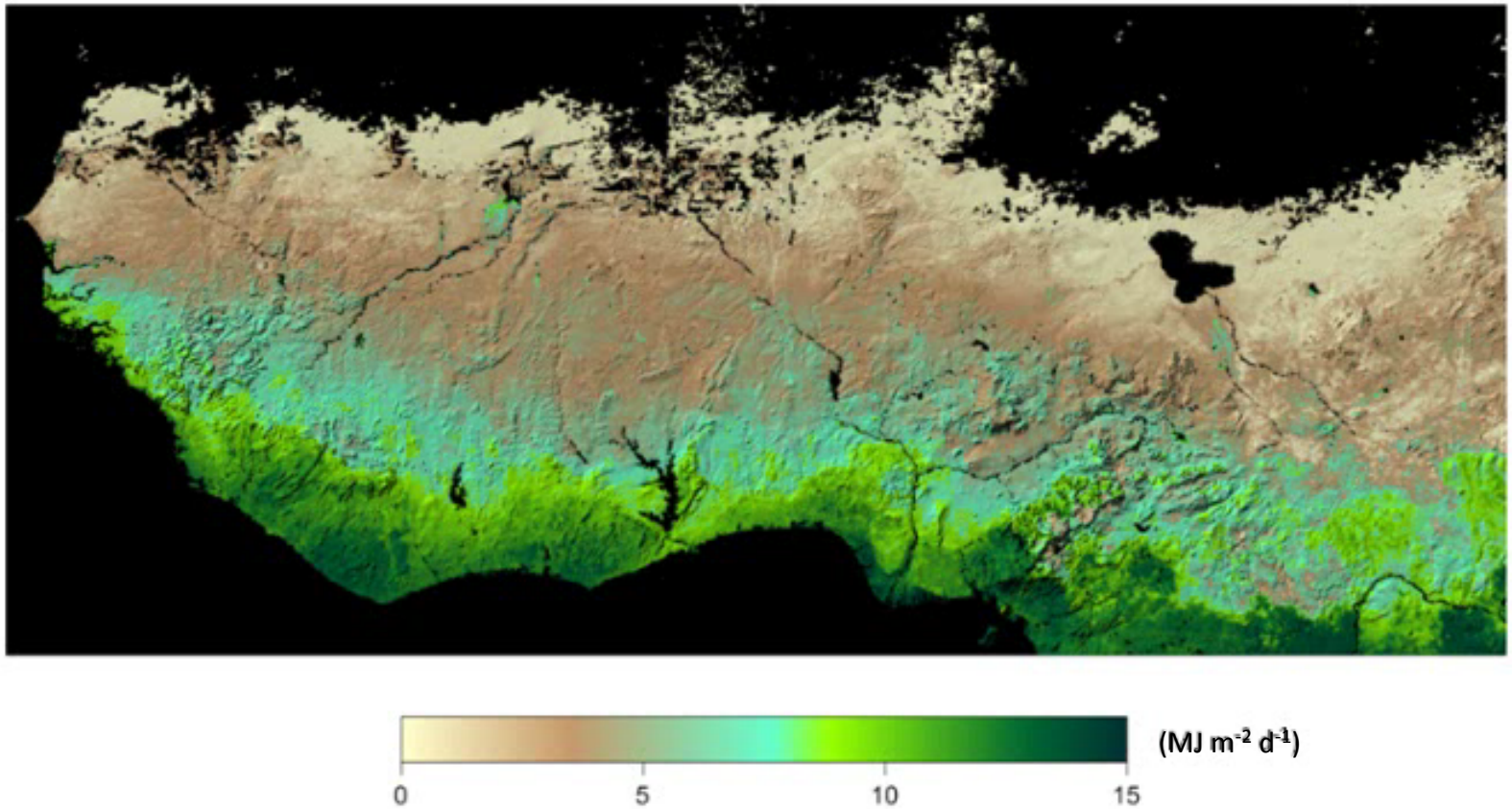


African Monsoon Multidisciplinary Analysis (CNRM, CESBIO)

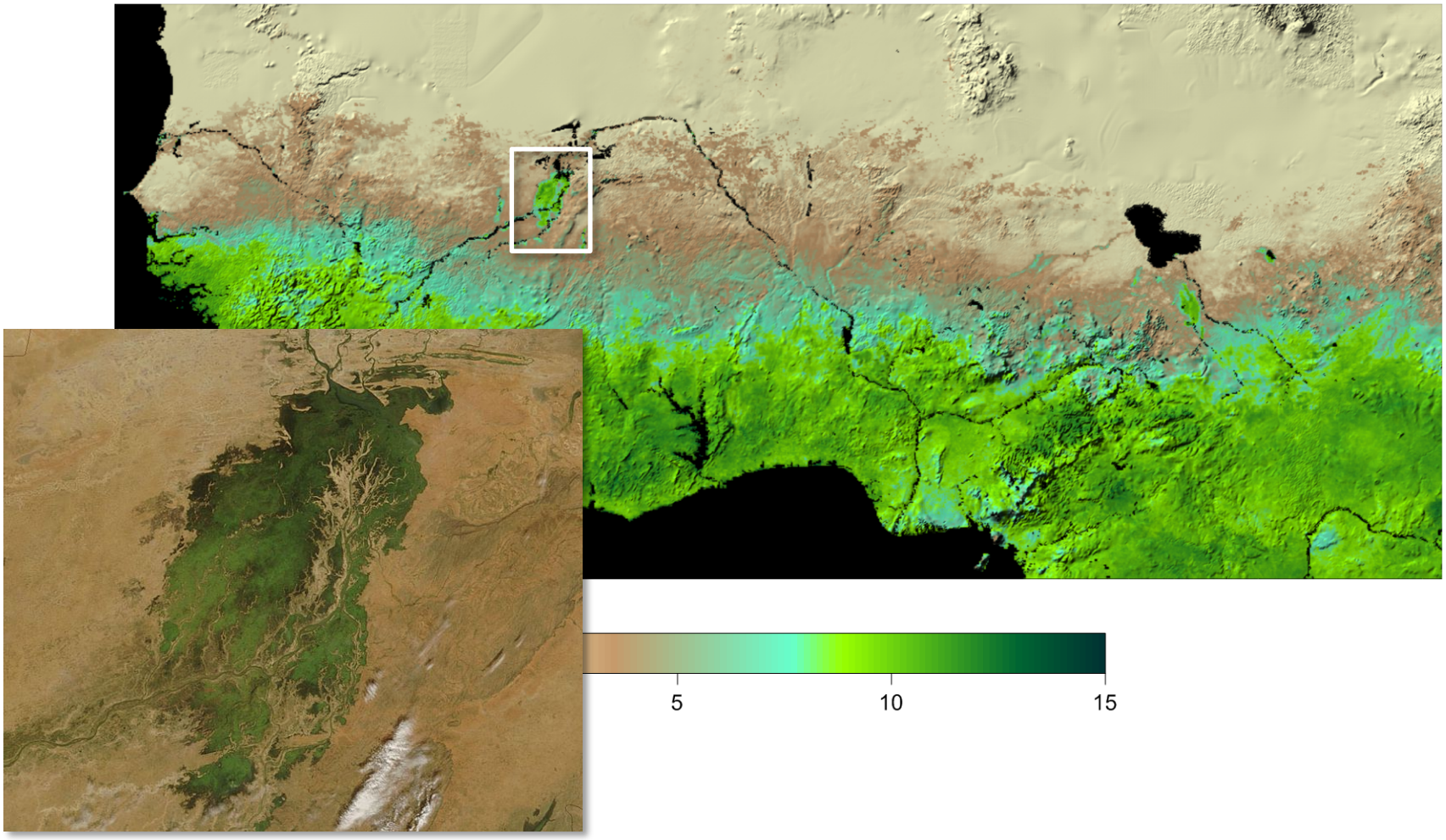


MONTHLY AVERAGE LATENT HEAT

2007 JANUARY



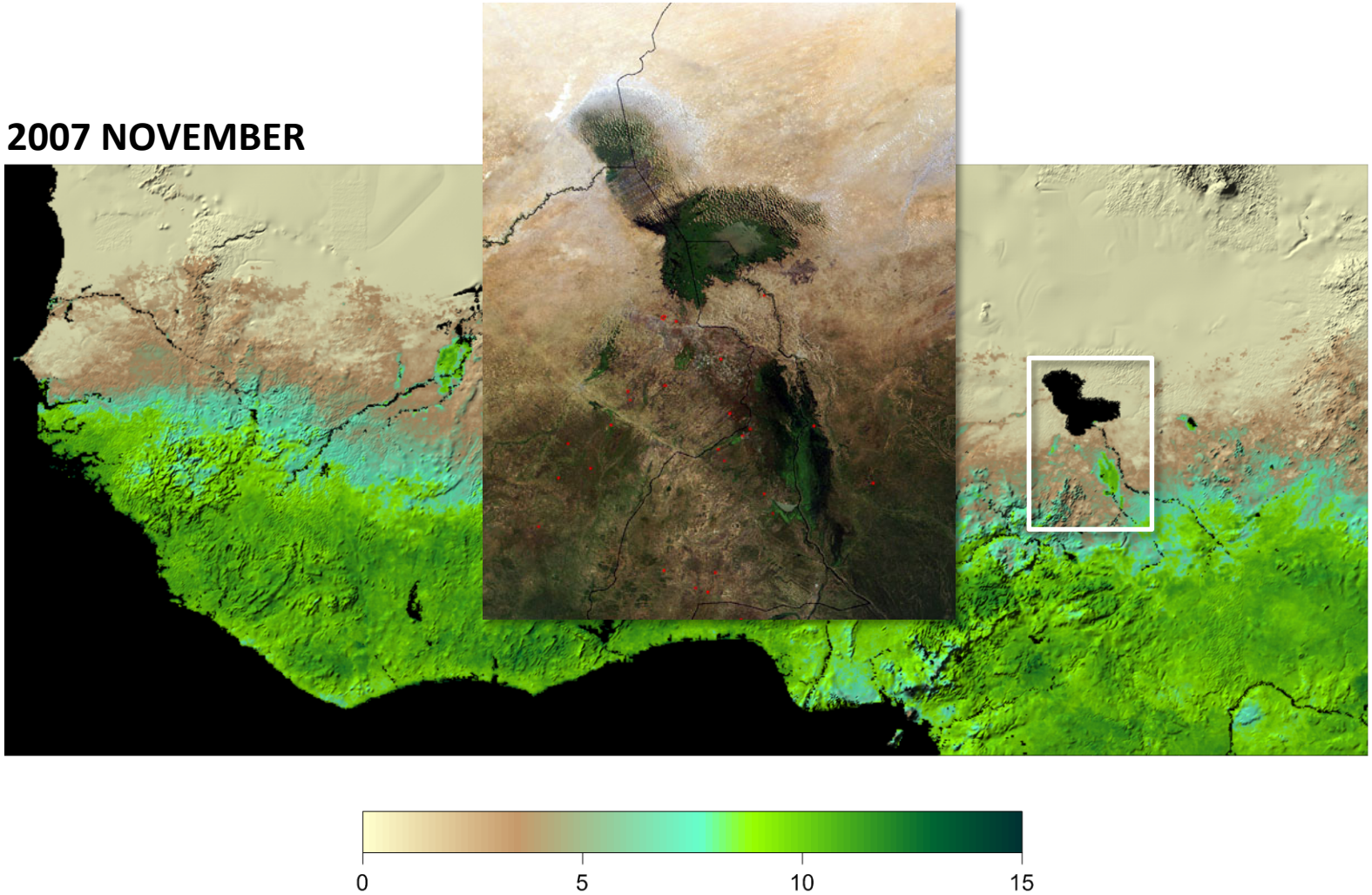
2007 NOVEMBER



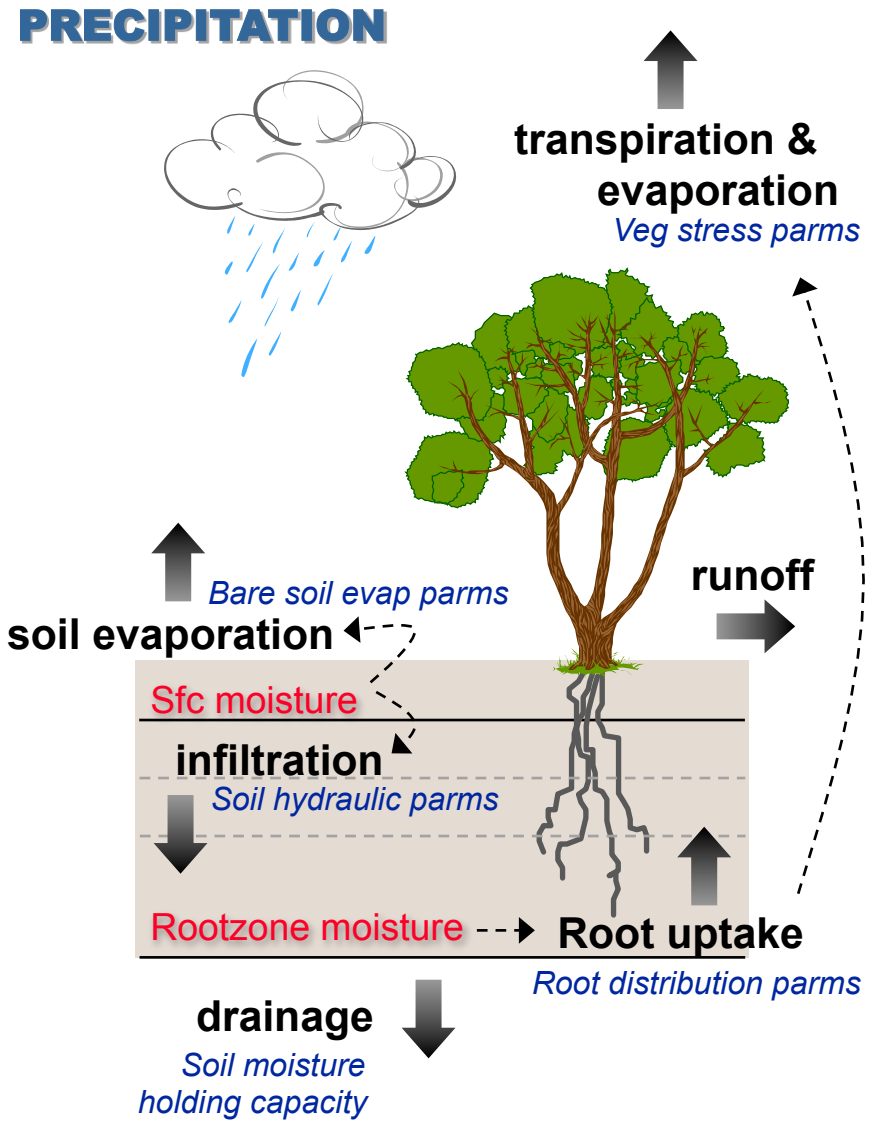
Inland Niger Delta, MODIS

Lake Chad and Logone floodplain, MODIS

2007 NOVEMBER

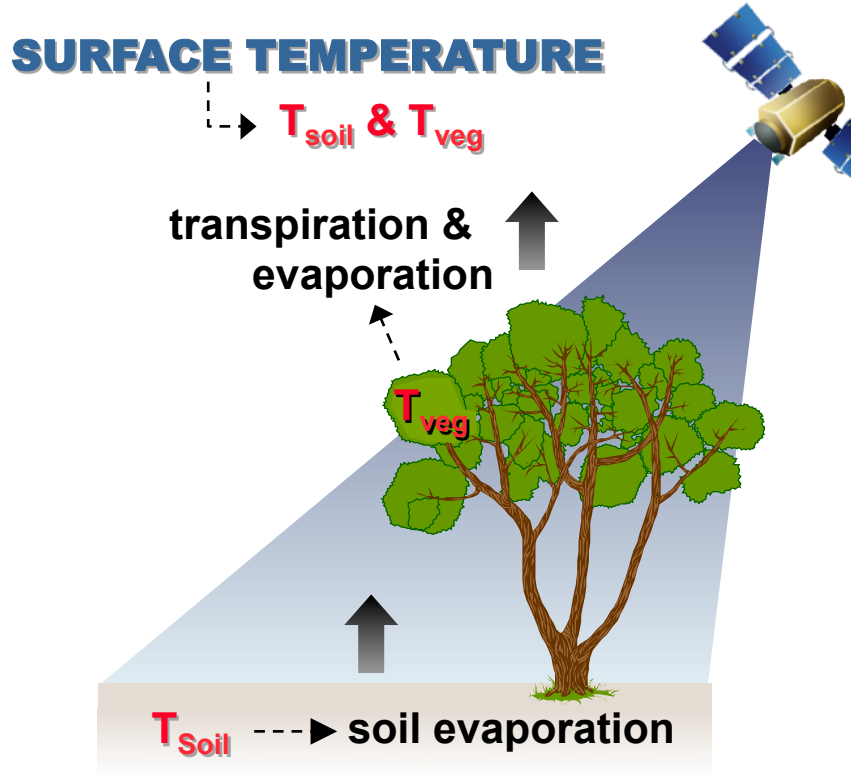


Technical approach to mapping ET



WATER BALANCE APPROACH

(prognostic modeling)

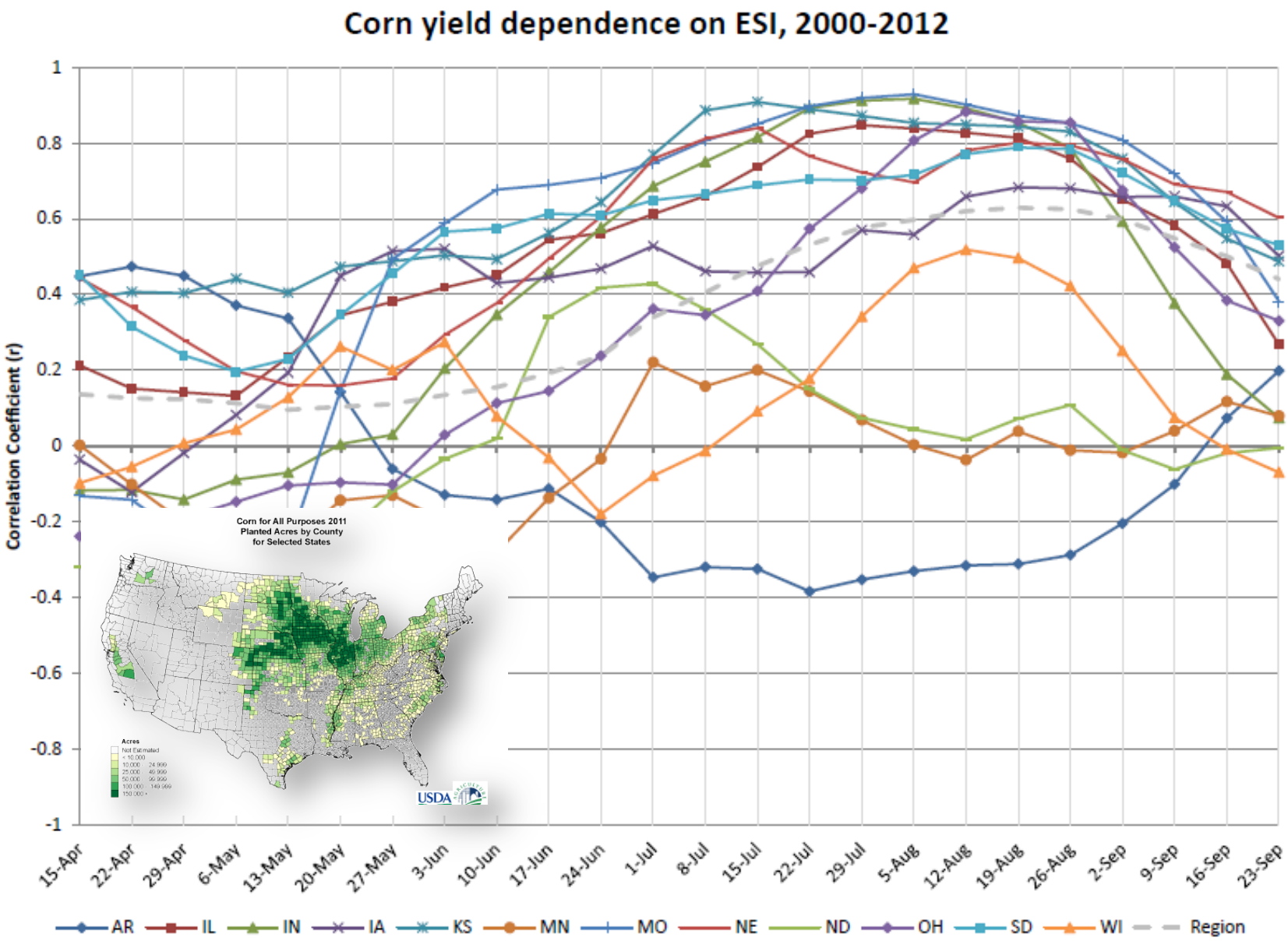


Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

ENERGY BALANCE APPROACH

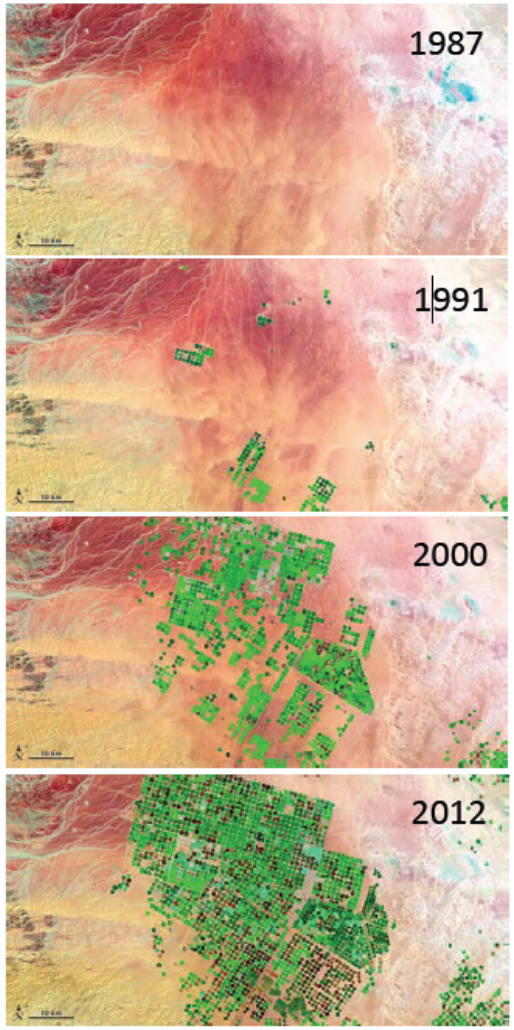
(diagnostic modeling)

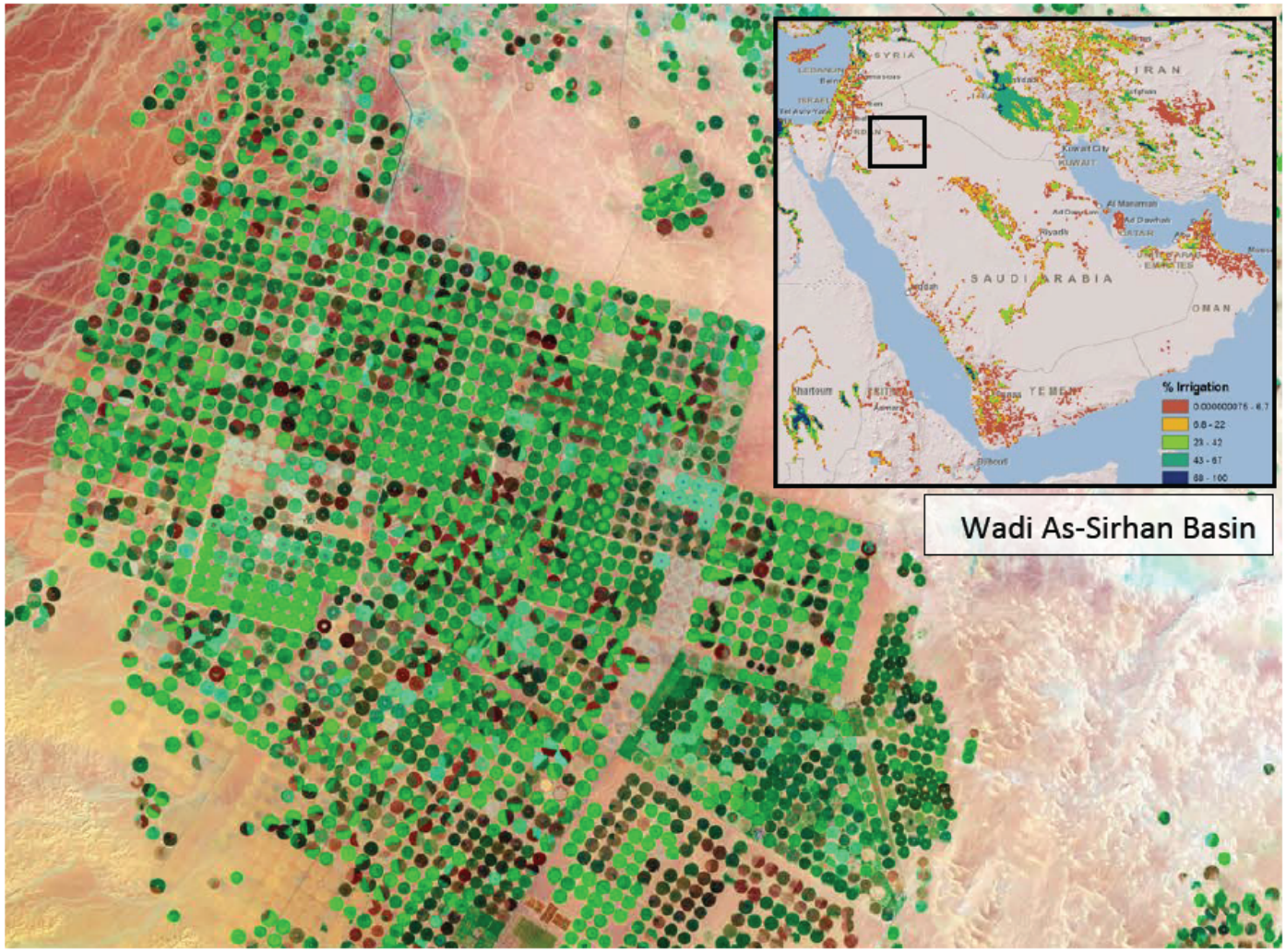
Correlations of ESI with corn yield



(Dave Johnson, NASS)

EXPANSION of IRRIGATION



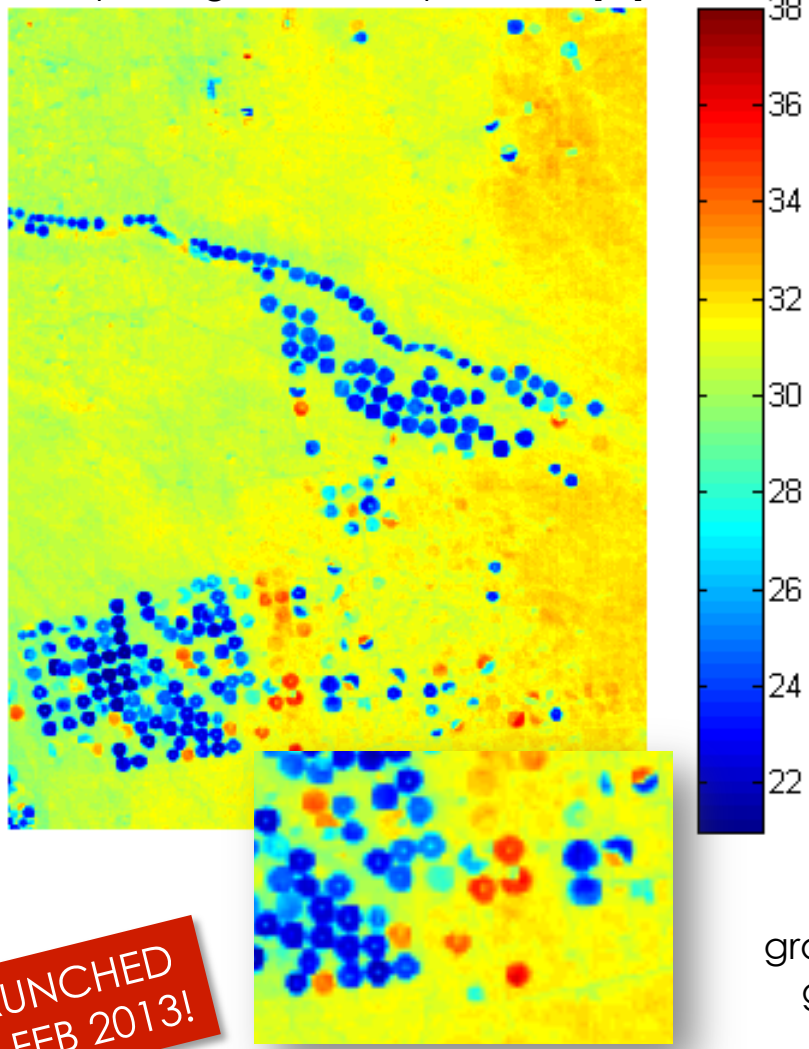


http://earthobservatory.nasa.gov/IOTD/view.php?id=77900

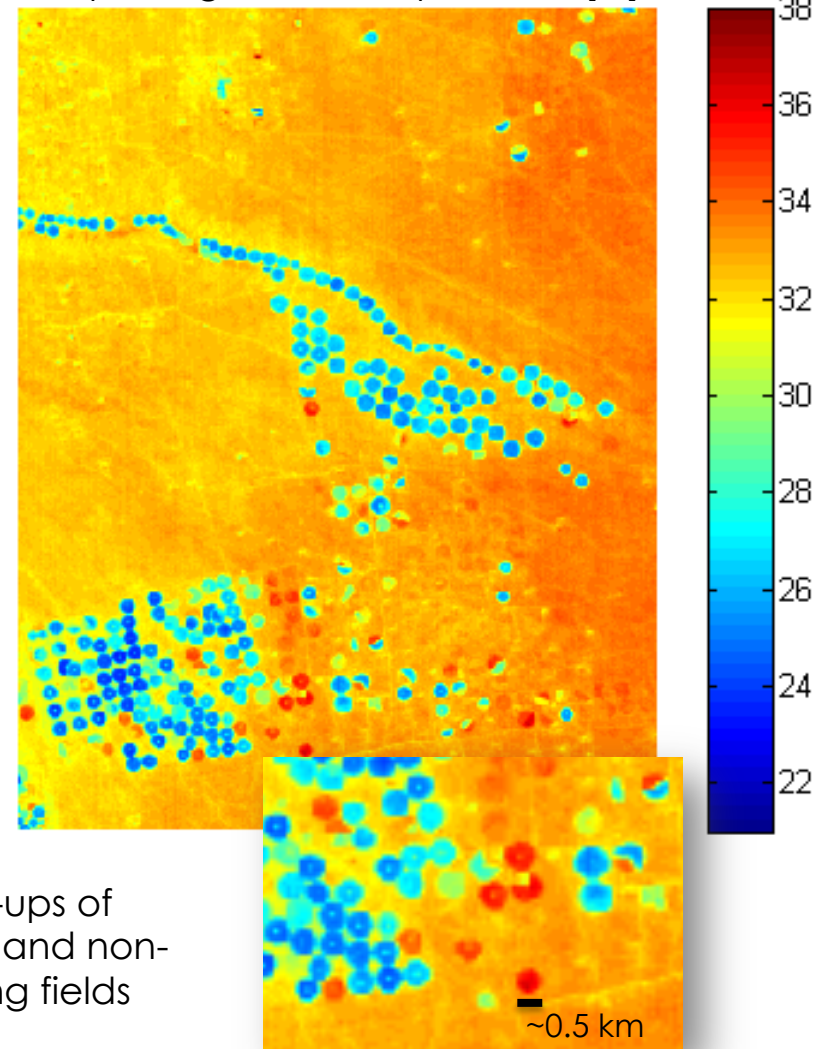
Landsats 4,5,7 – visible, near infrared bands: vegetation amount

CONSUMPTIVE WATER USE

10.8 μm Brightness Temperature [C]



12.0 μm Brightness Temperature [C]



Close-ups of growing and non-growing fields

~0.5 km

LAUNCHED 11 FEB 2013!

Landsat 8 – thermal infrared bands: vegetation status and water use