

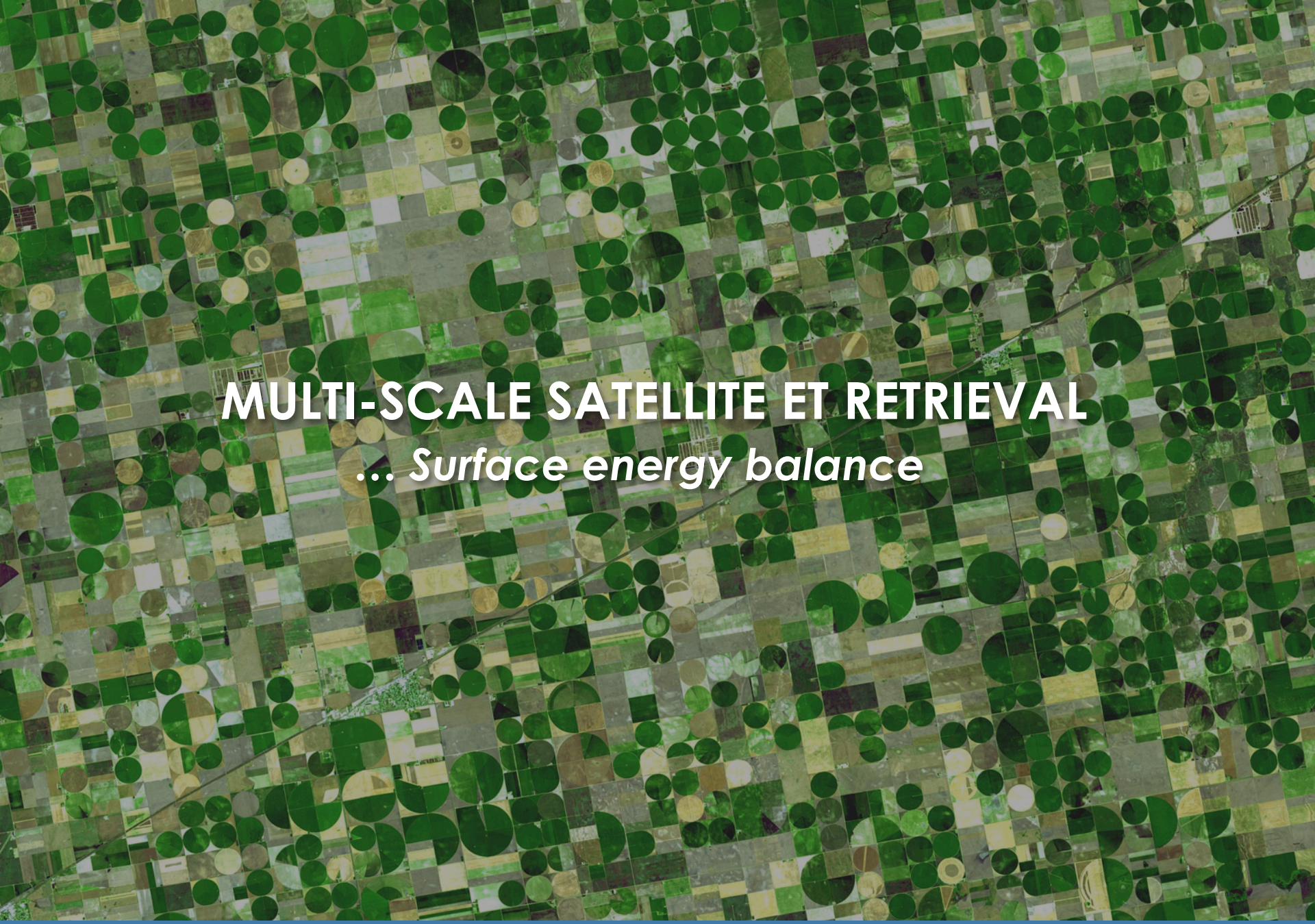
Daily Field-scale ET and Stress Mapping using ECOSTRESS

Yun Yang, Martha Anderson, Kate Semmens, Feng Gao, Bill Kustas, Mitchell Schull

USDA-Agricultural Research Service
Hydrology and Remote Sensing Laboratory
Beltsville, MD

Chris Hain

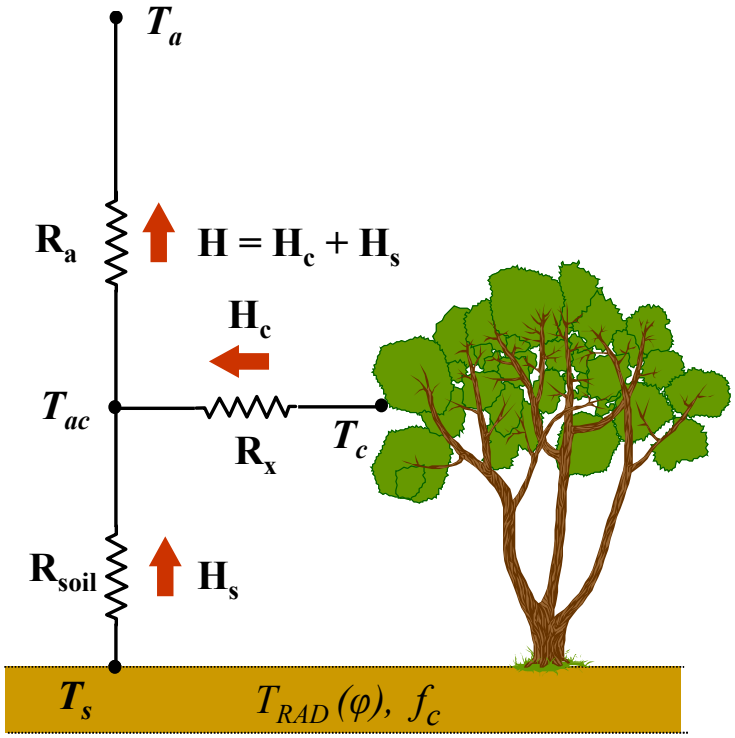
NOAA-NESDIS



MULTI-SCALE SATELLITE ET RETRIEVAL

… *Surface energy balance*

Two-Source Energy Balance (TSEB)



SENSIBLE HEAT FLUX

Norman and Kustas, et al. (1995)

System, soil, canopy budgets

$RN = H + LE + G$

$RN_S = H_S + LE_S + G$

$RN_C = H_C + LE_C$

Two-source approximation

$T_{RAD}(\theta)^4 \sim f_C(\theta)\, T_C^4 + [1-f_C(\theta)]\, T_S^4$

Temperature constraint

H_C, H_S, RN_C, RN_S, G

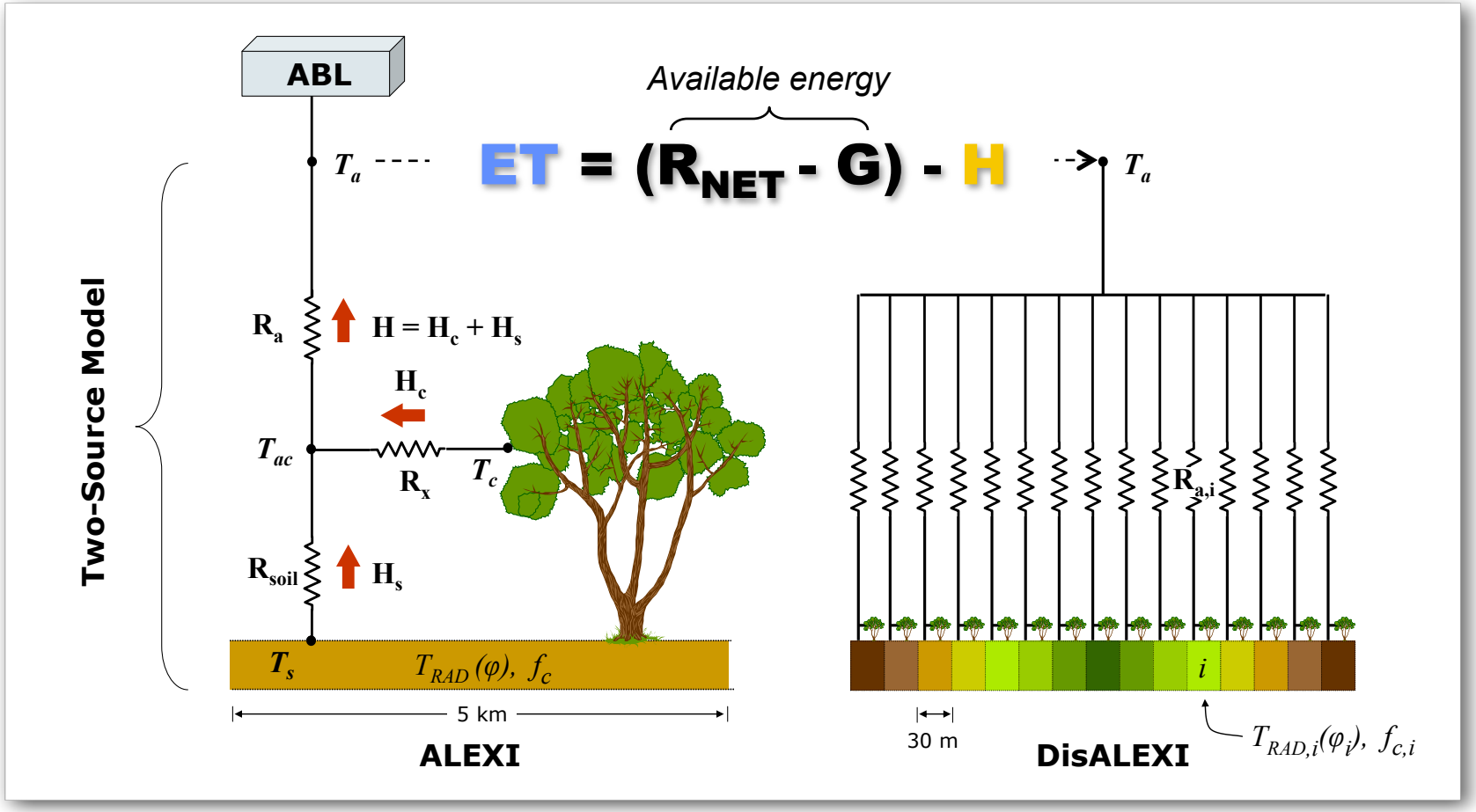
PT , PM or LUE R_C model

LE_C

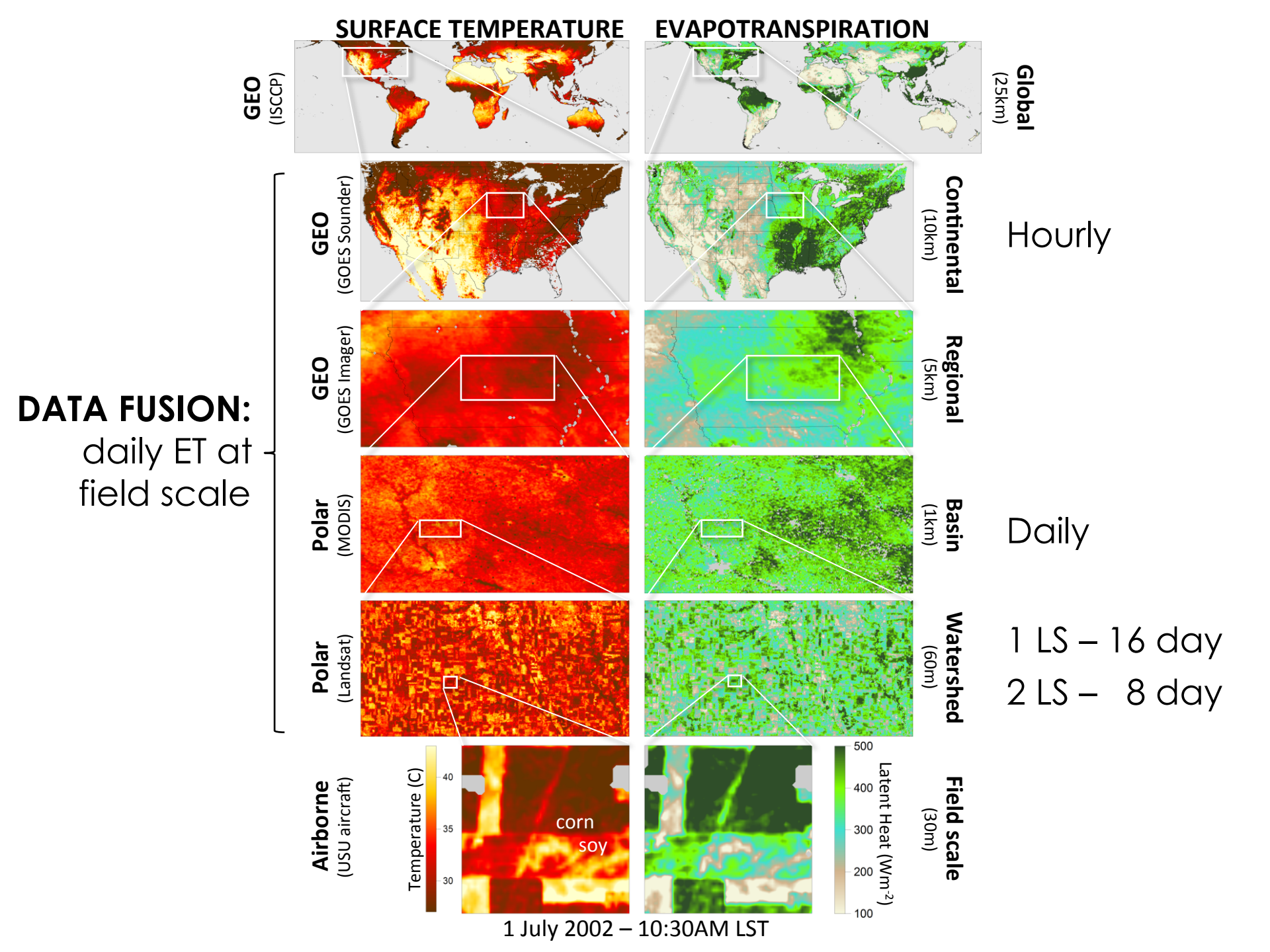
Residual

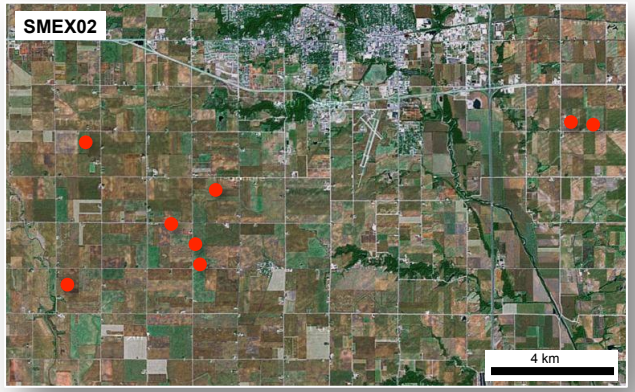
$LE_S = RN - H - G - LE_C$

Iterative solution



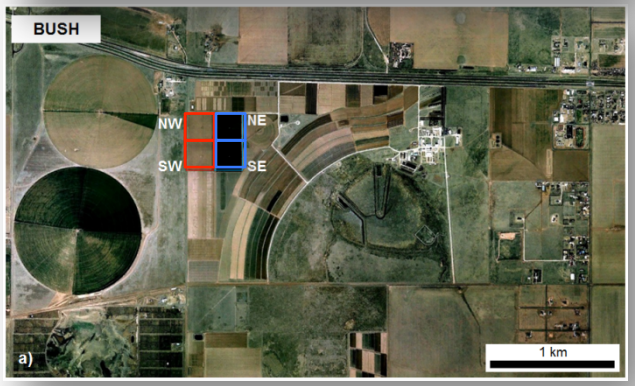
	Regional scale	Landscape scale
Surface temp:	ΔT_{RAD} - Geostationary	T_{RAD} - Landsat, MODIS
Air temp:	T_a - ABL model	T_a - ALEXI


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
Hourly
Daily
1 LS – 16 day
2 LS – 8 day



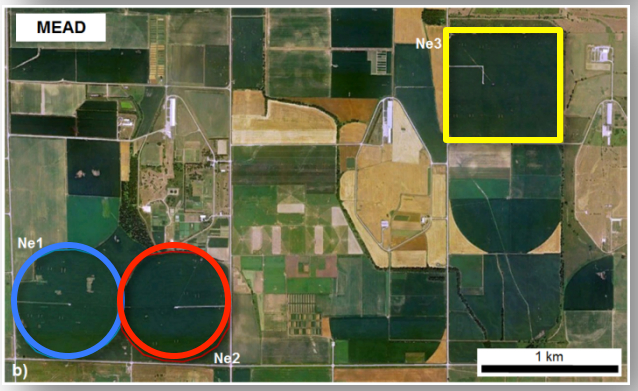
SMEX02

Soil Moisture Experiment 2002
Ames, Iowa
Rainfed corn and soybean



BEAREX08

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

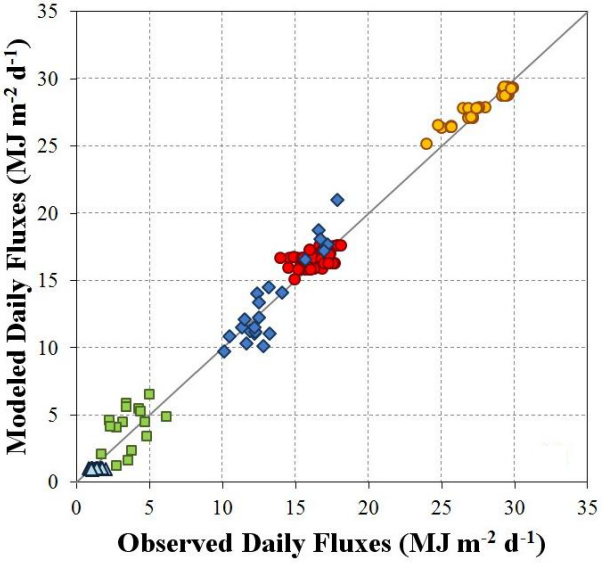


MEAD

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

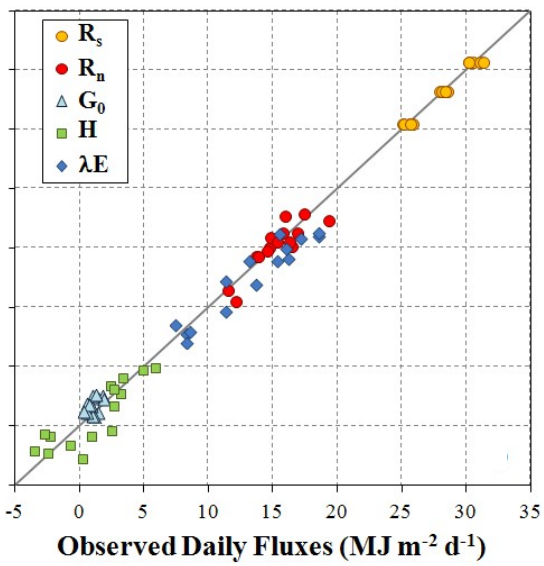
Model performance on Landsat dates

SMEX02



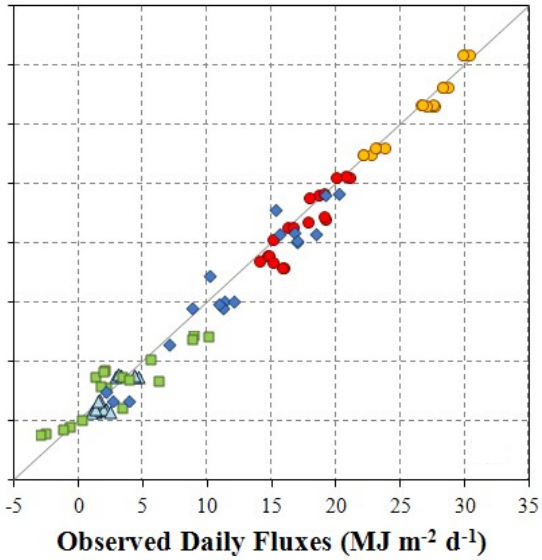
MAE: 1.08 MJ m^{-2} d^{-1}
RE: 8%

BEAREX08



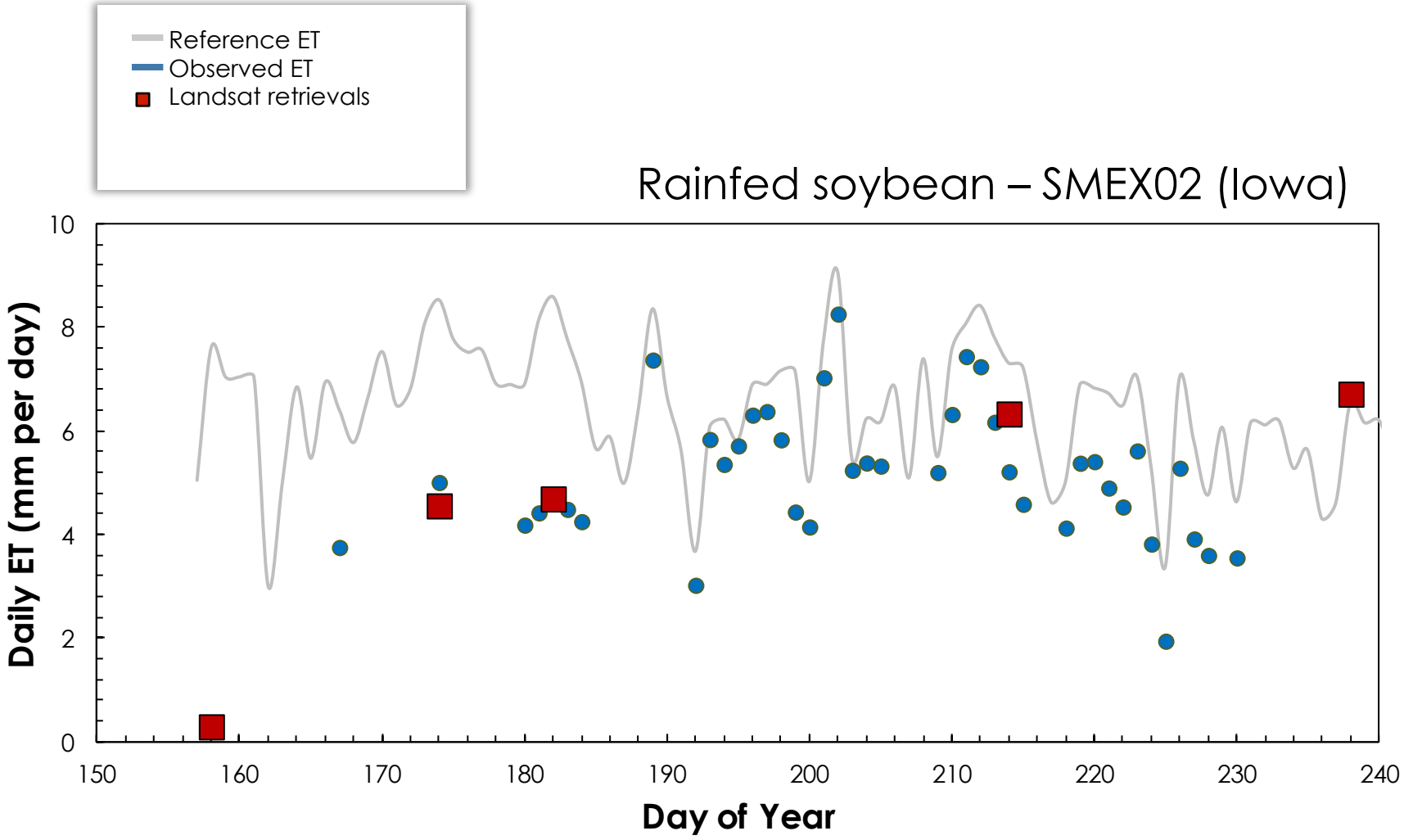
1.3 MJ m^{-2} d^{-1}
10%

MEAD

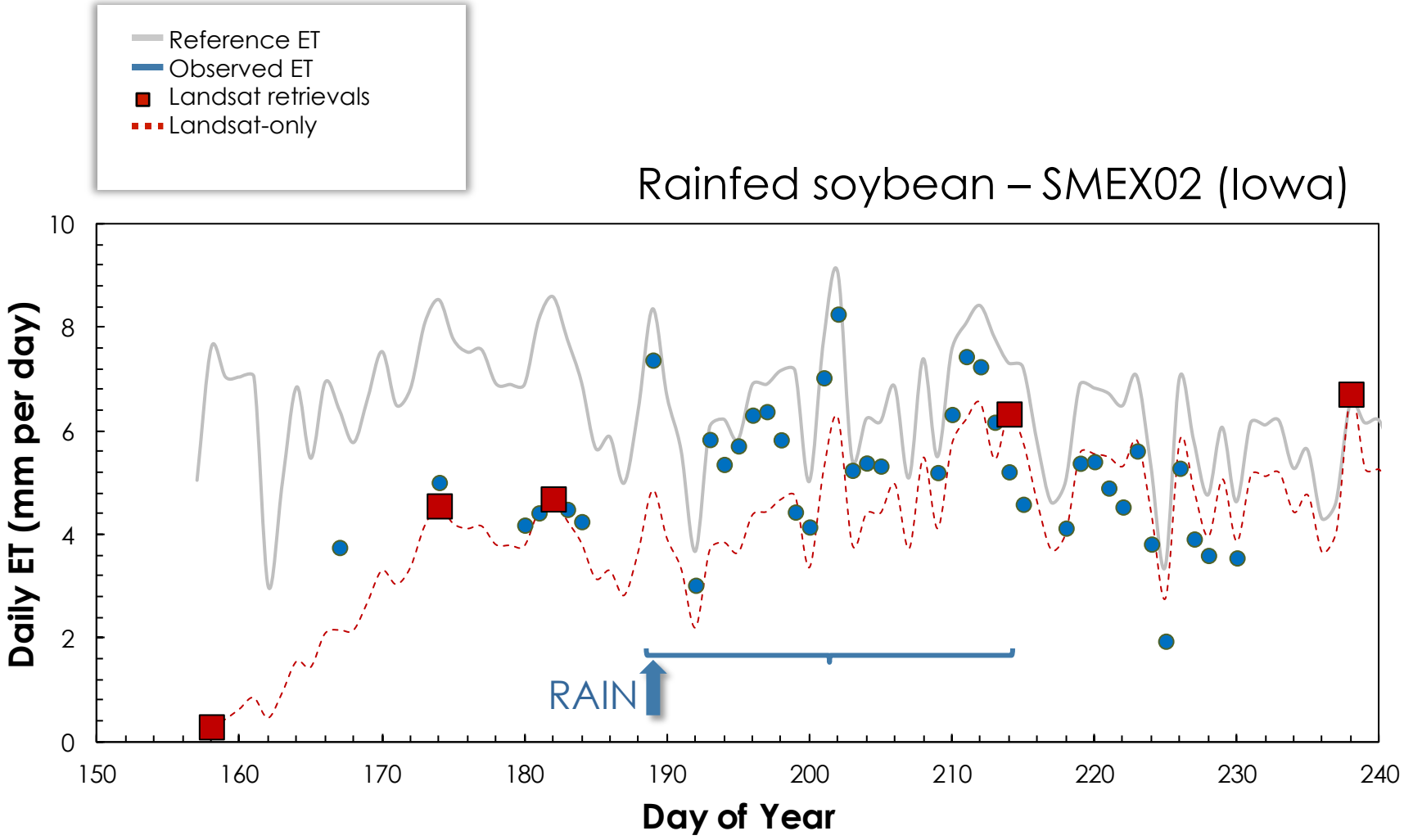


1.3 MJ m^{-2} d^{-1}
11%

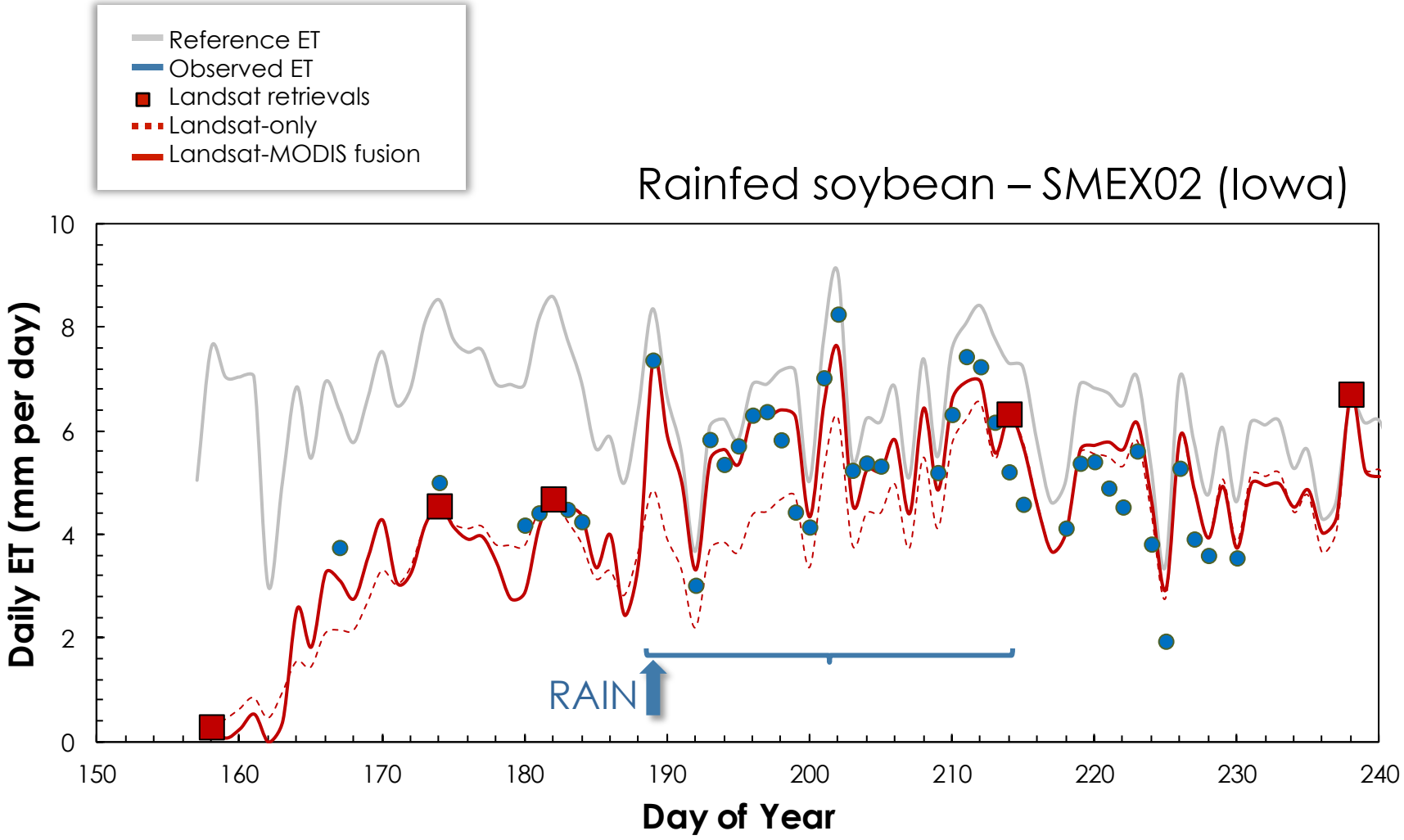
Validation using flux tower data



Validation using flux tower data

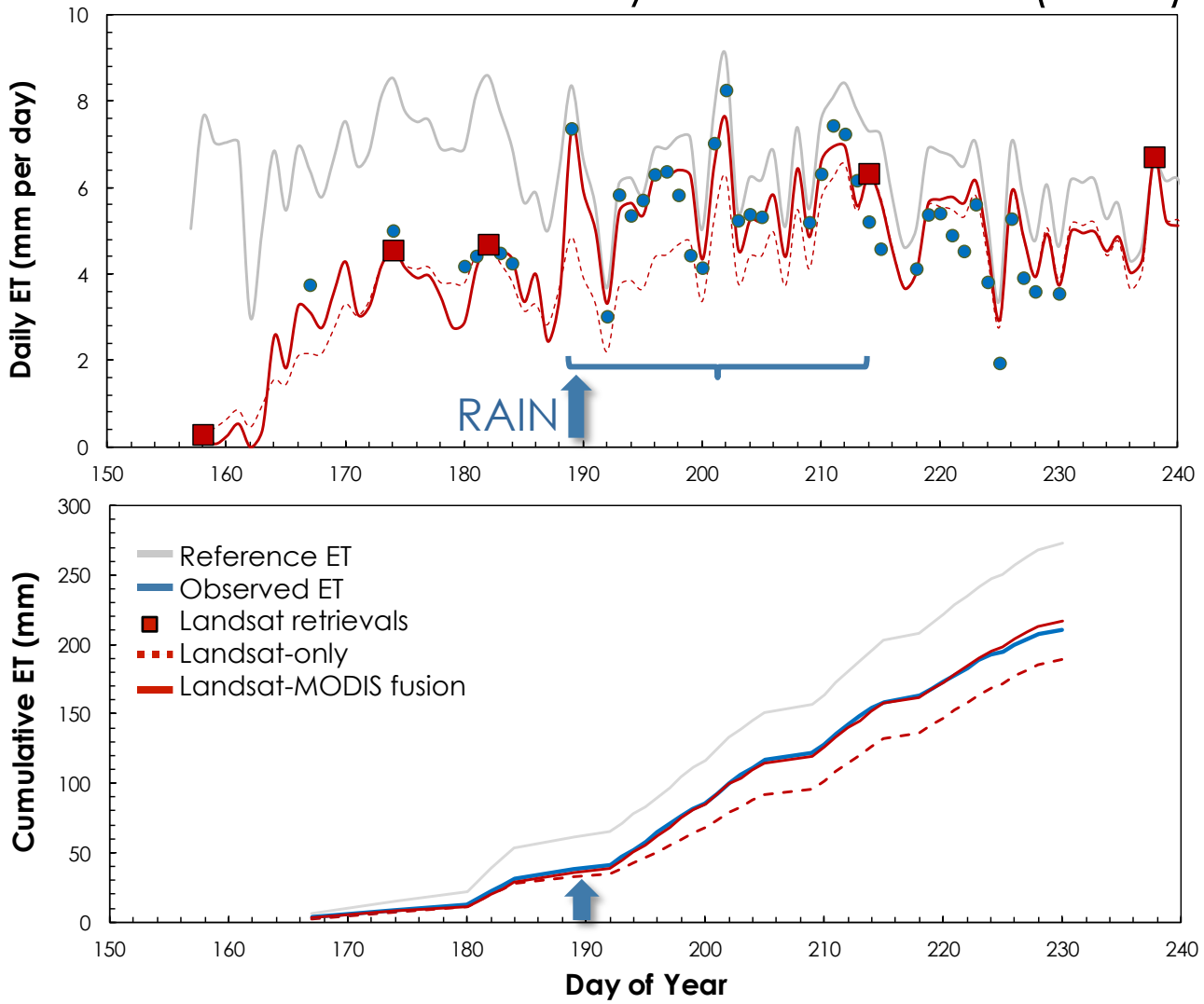


Validation using flux tower data



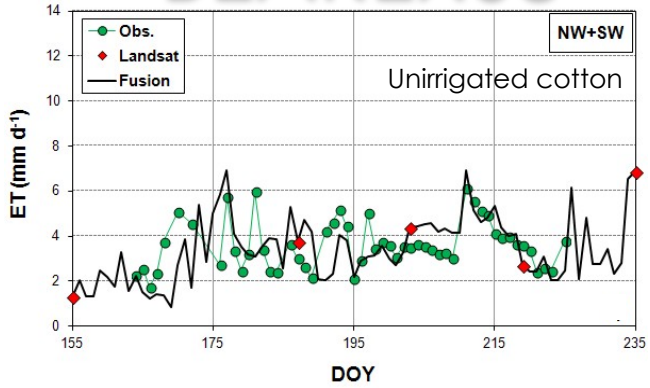
Validation using flux tower data

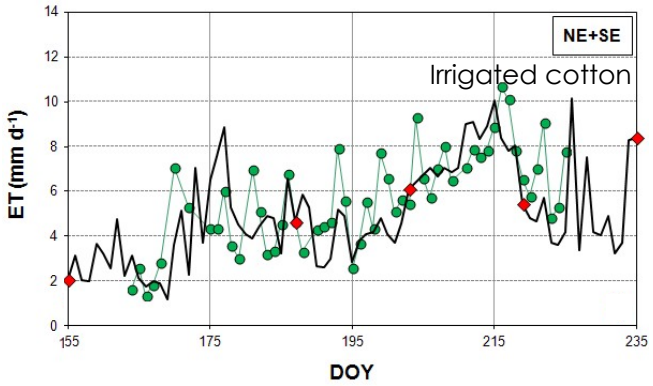
Rainfed soybean – SMEX02 (Iowa)

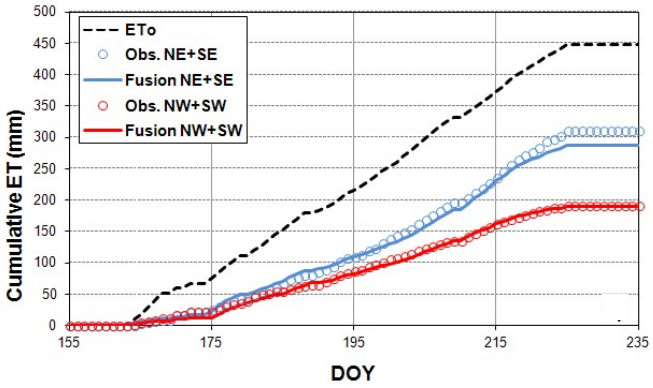


BEAREX08 and MEAD

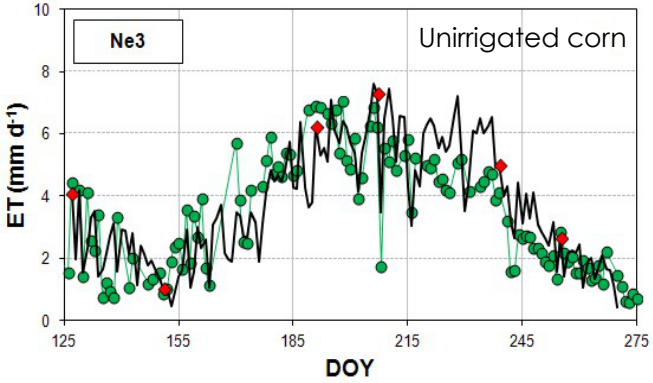
BEAREX08

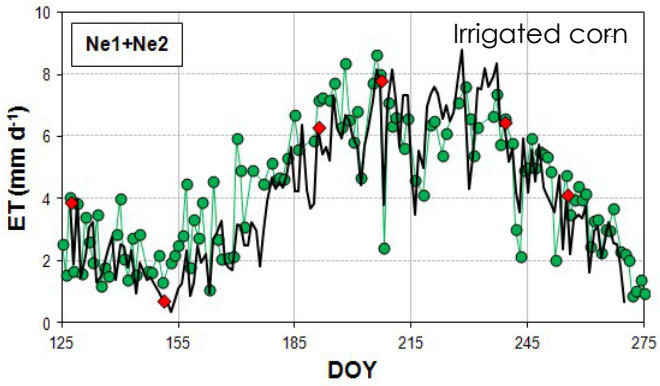


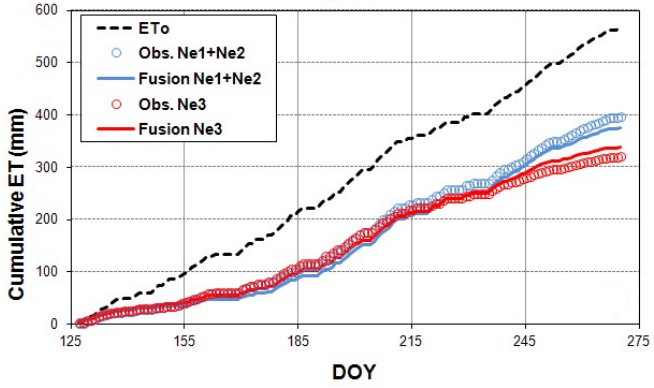




MEAD





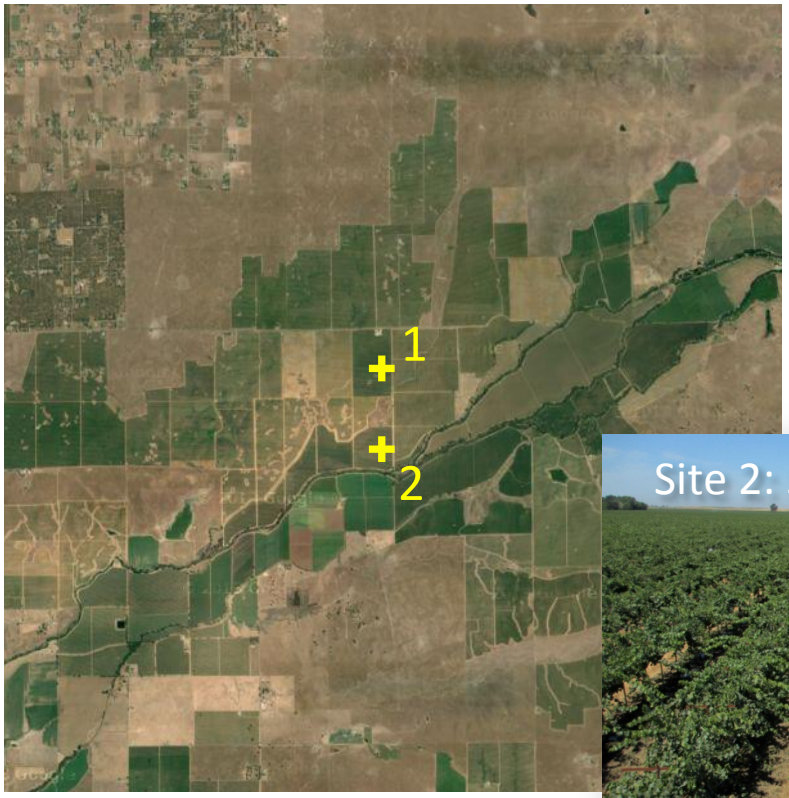




ONGOING FUSION EXPERIMENTS

… Landsats 5 and 8

Gallo Vineyards, Lodi CA





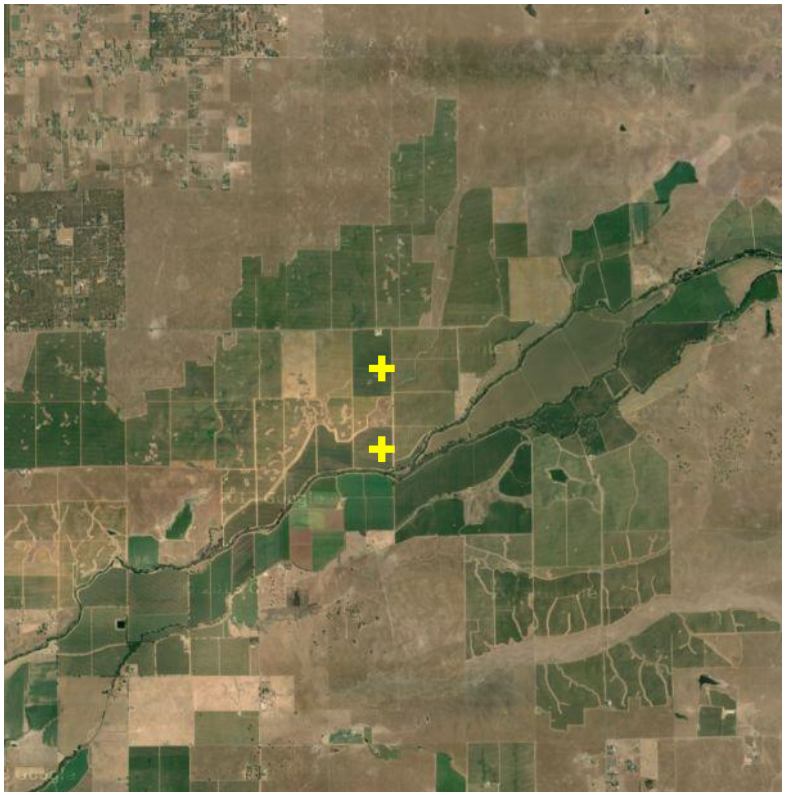


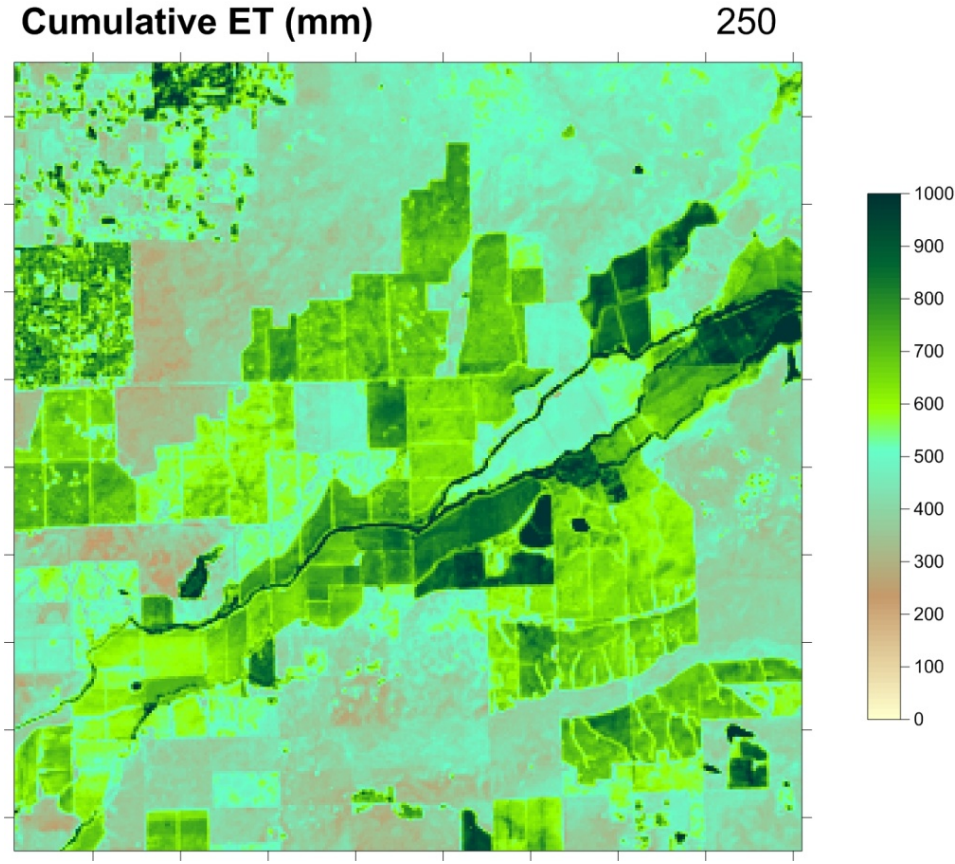


GRAPEX2013, 14

Gallo Vineyards, Lodi CA

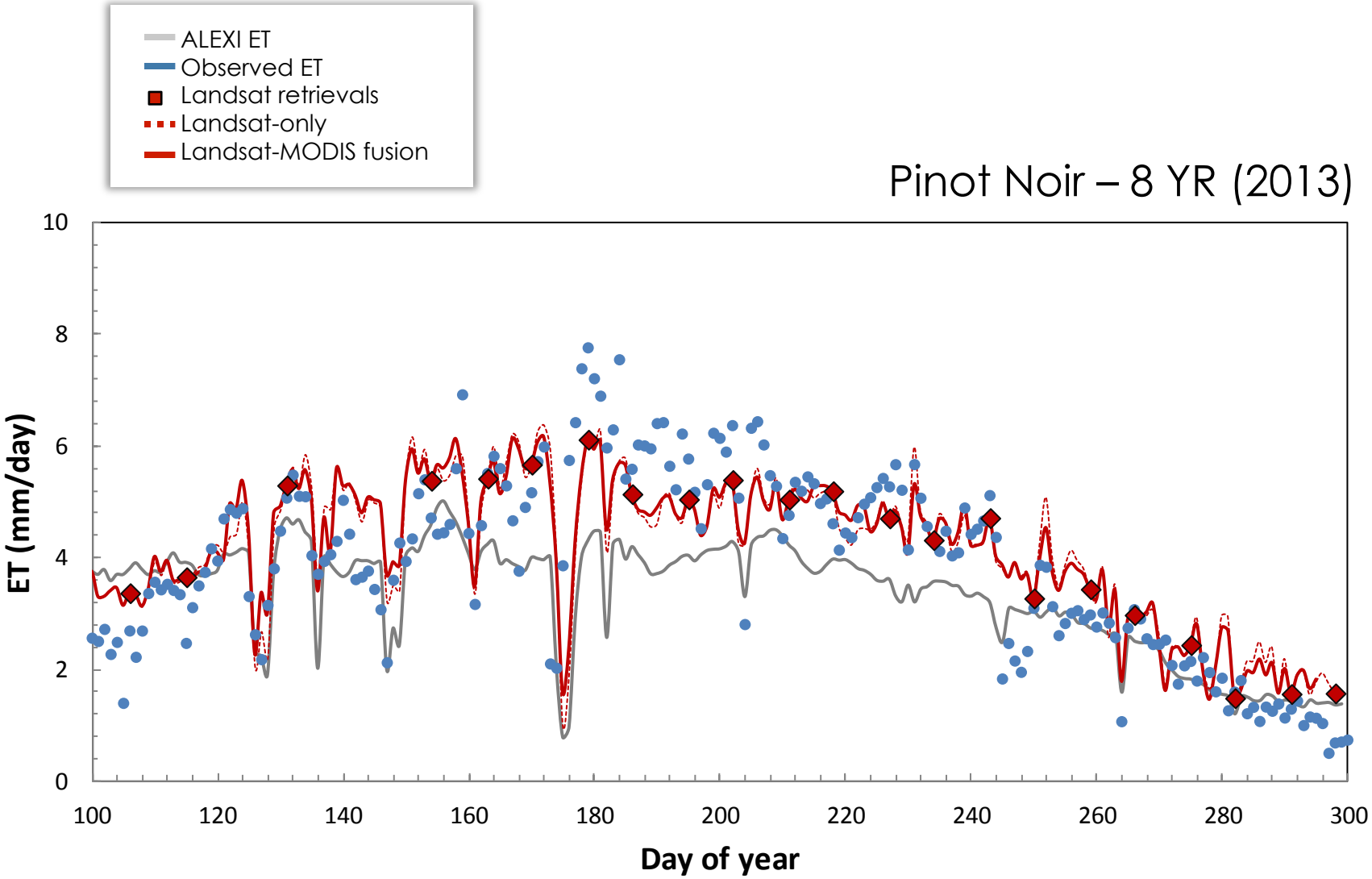
GRAPEX 2013-2014





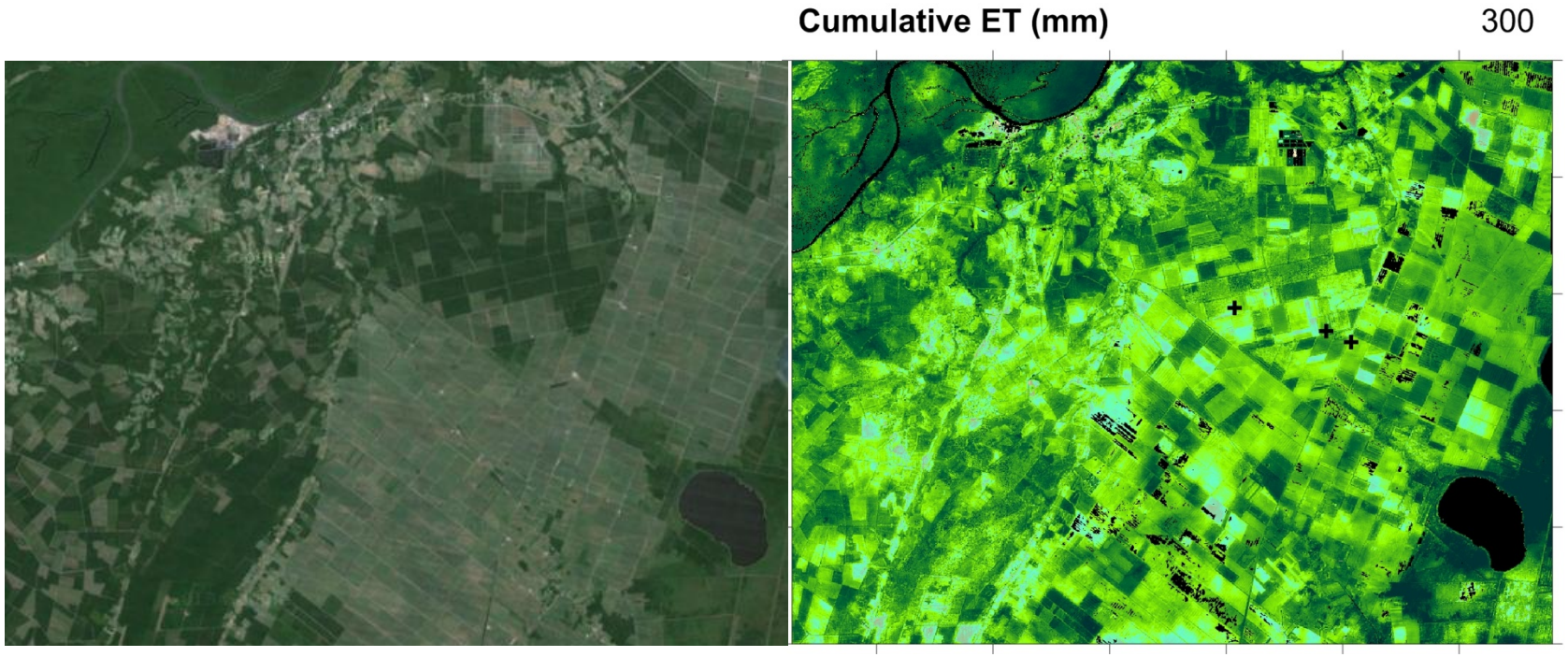
Landsat 8 - 2013

GRAPEX 2013-2014



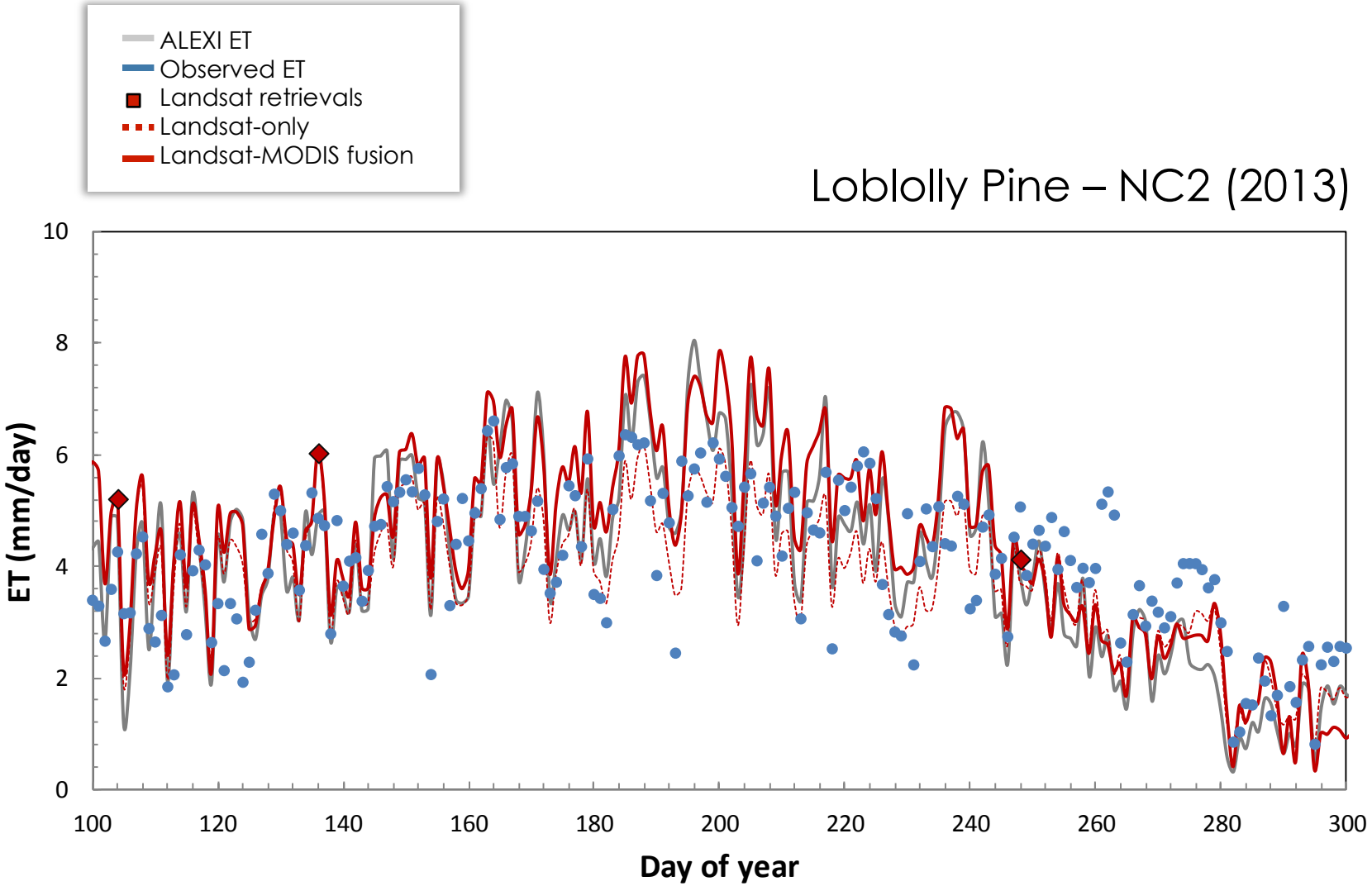
Loblolly Pine Plantation, NC

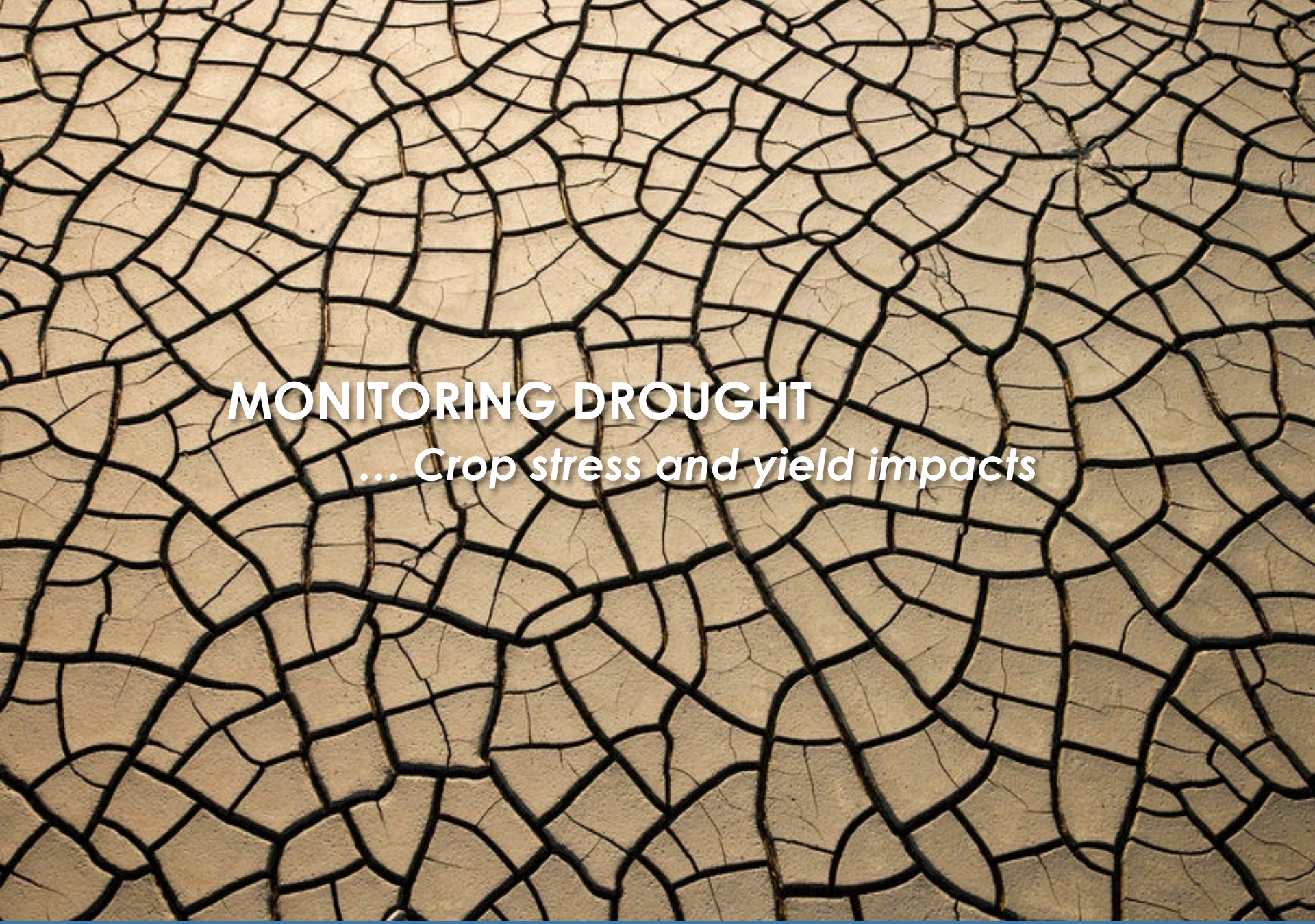
Effect of forest management



Landsat 8 - 2013

Effect of forest management

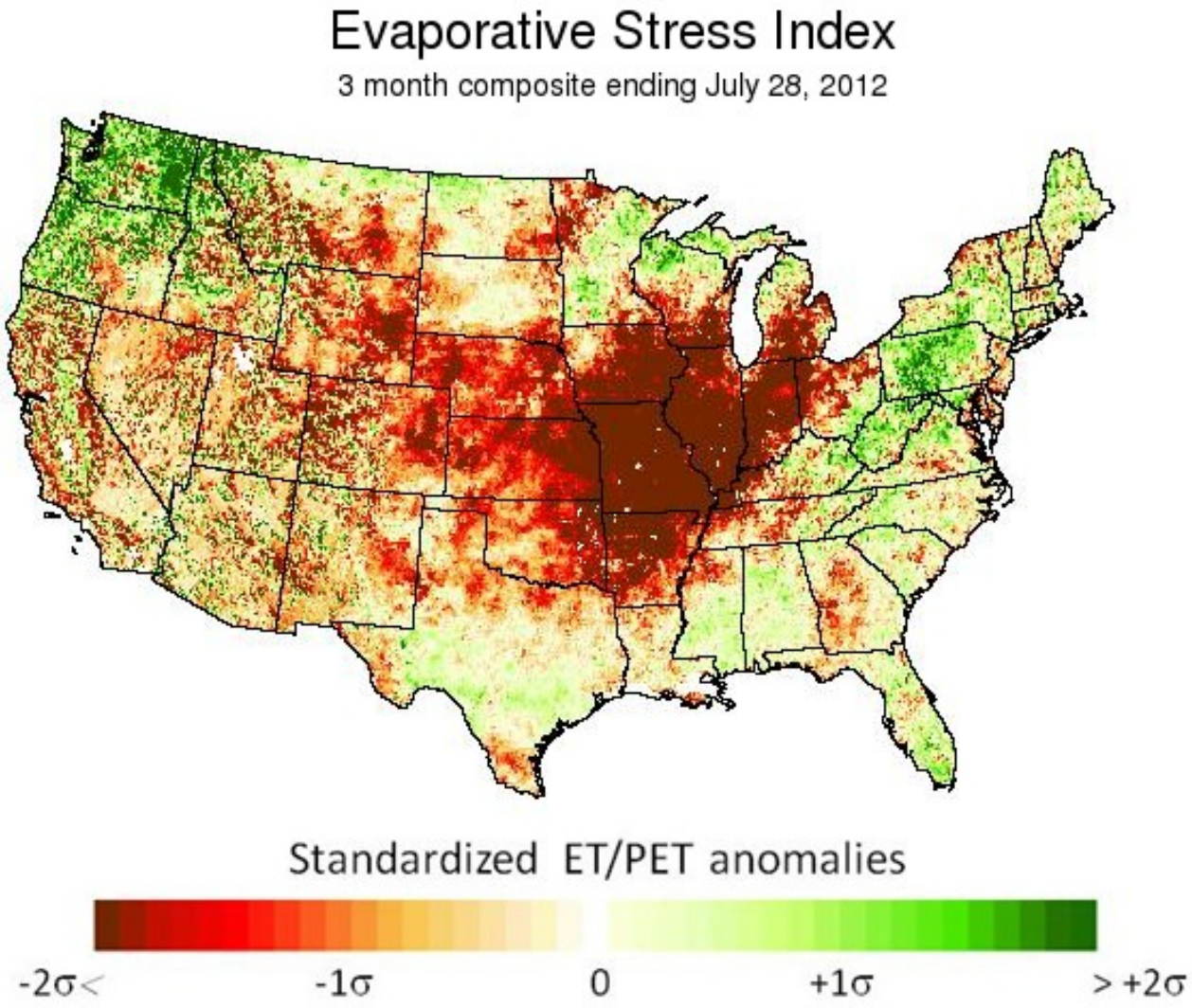




MONITORING DROUGHT

… Crop stress and yield impacts

Satellite ET Drought Indicator

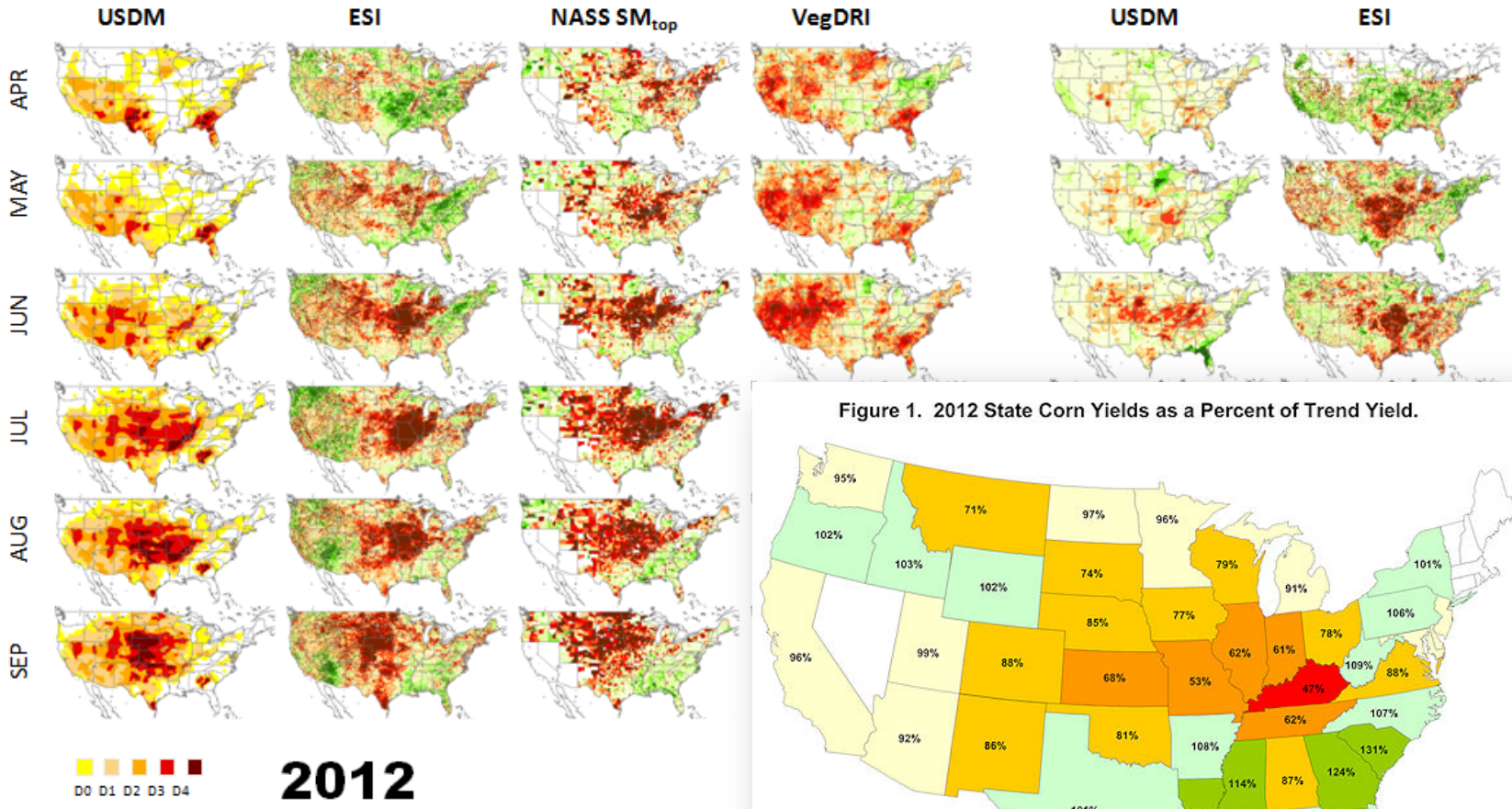


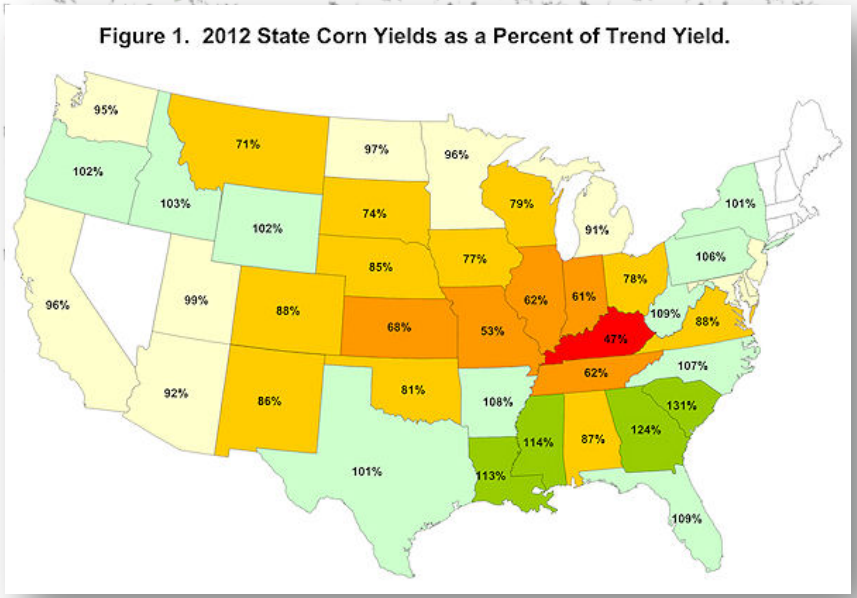
Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

2012 FLASH DROUGHT

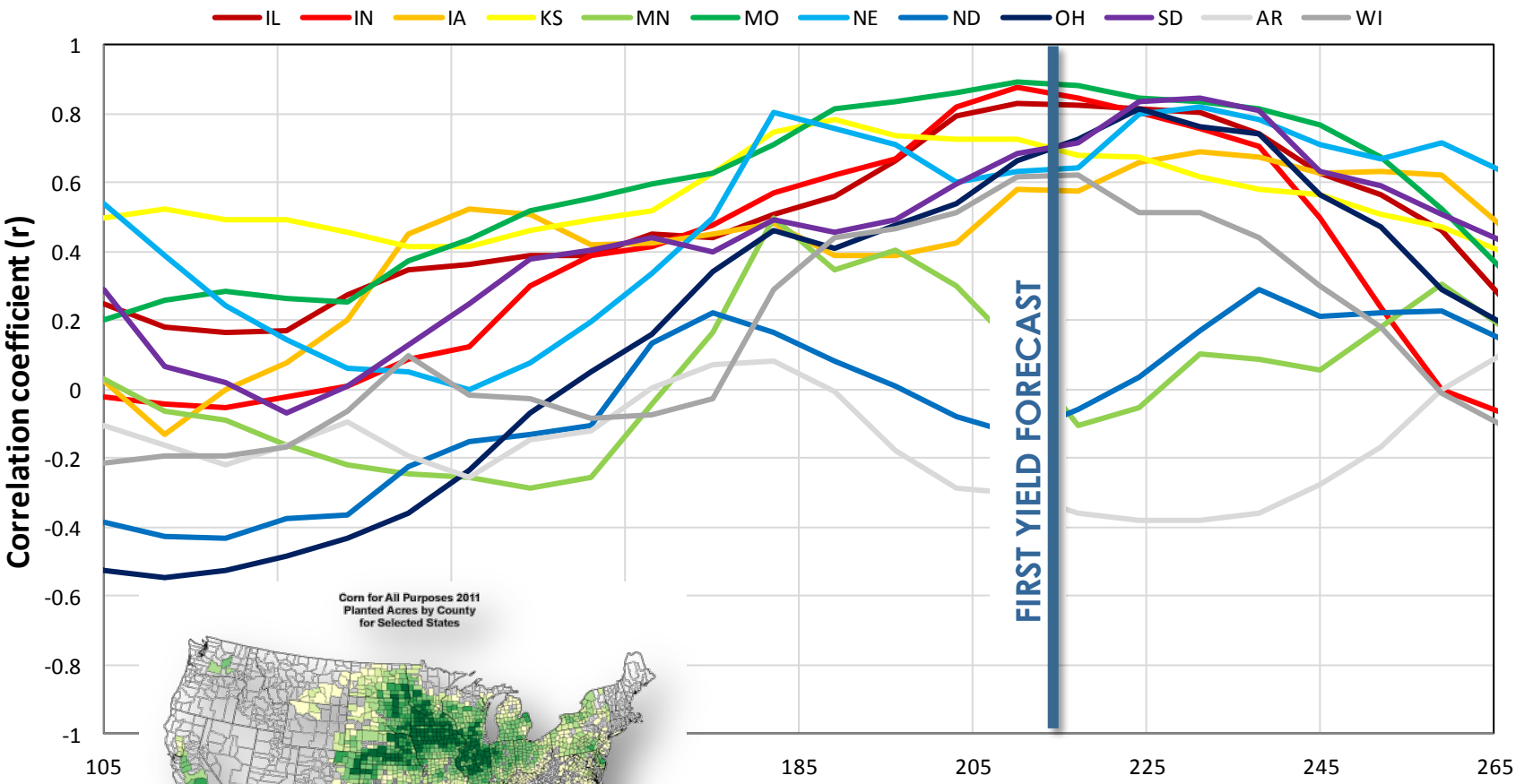
Monthly changes





ESI CORN YIELD CORRELATIONS

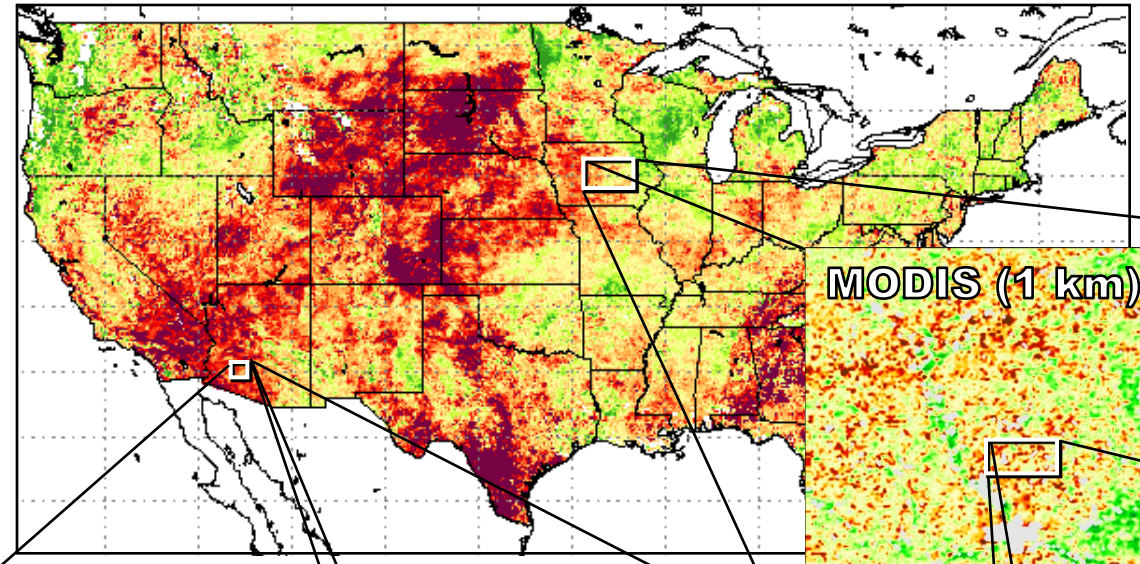
(10-km ESI vs. state level yields)

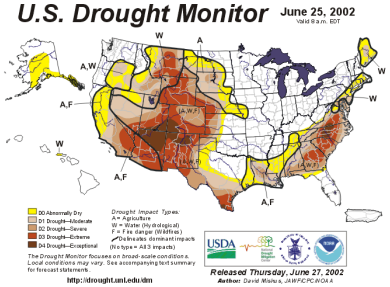


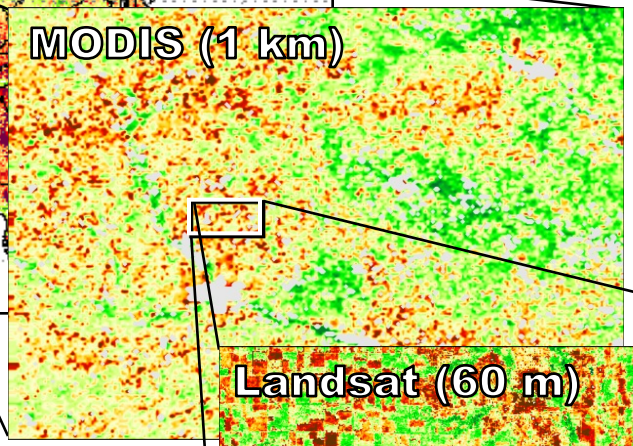
Dave Johnson,
National Agricultural Statistics Service

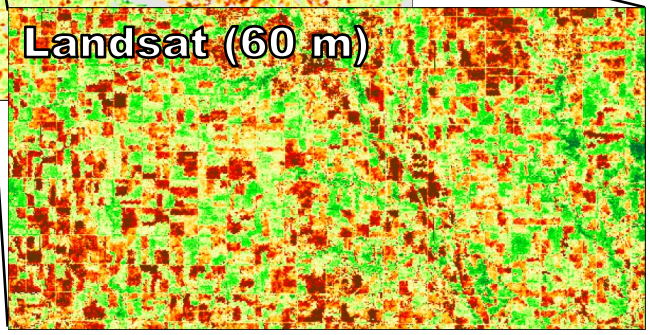
GOES Evaporative Stress Index

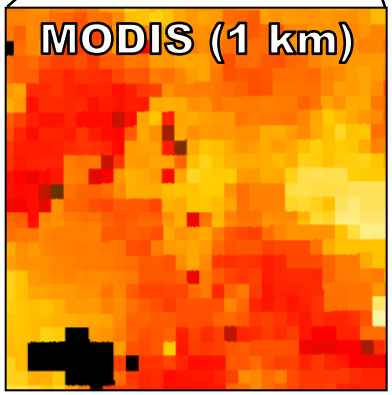
JUNE 2002

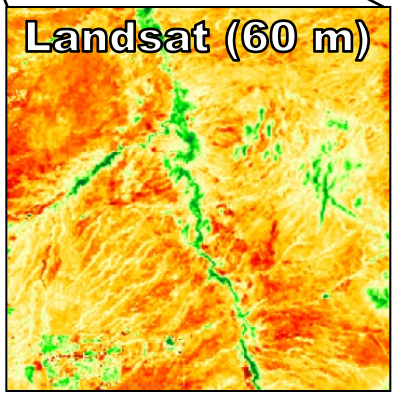












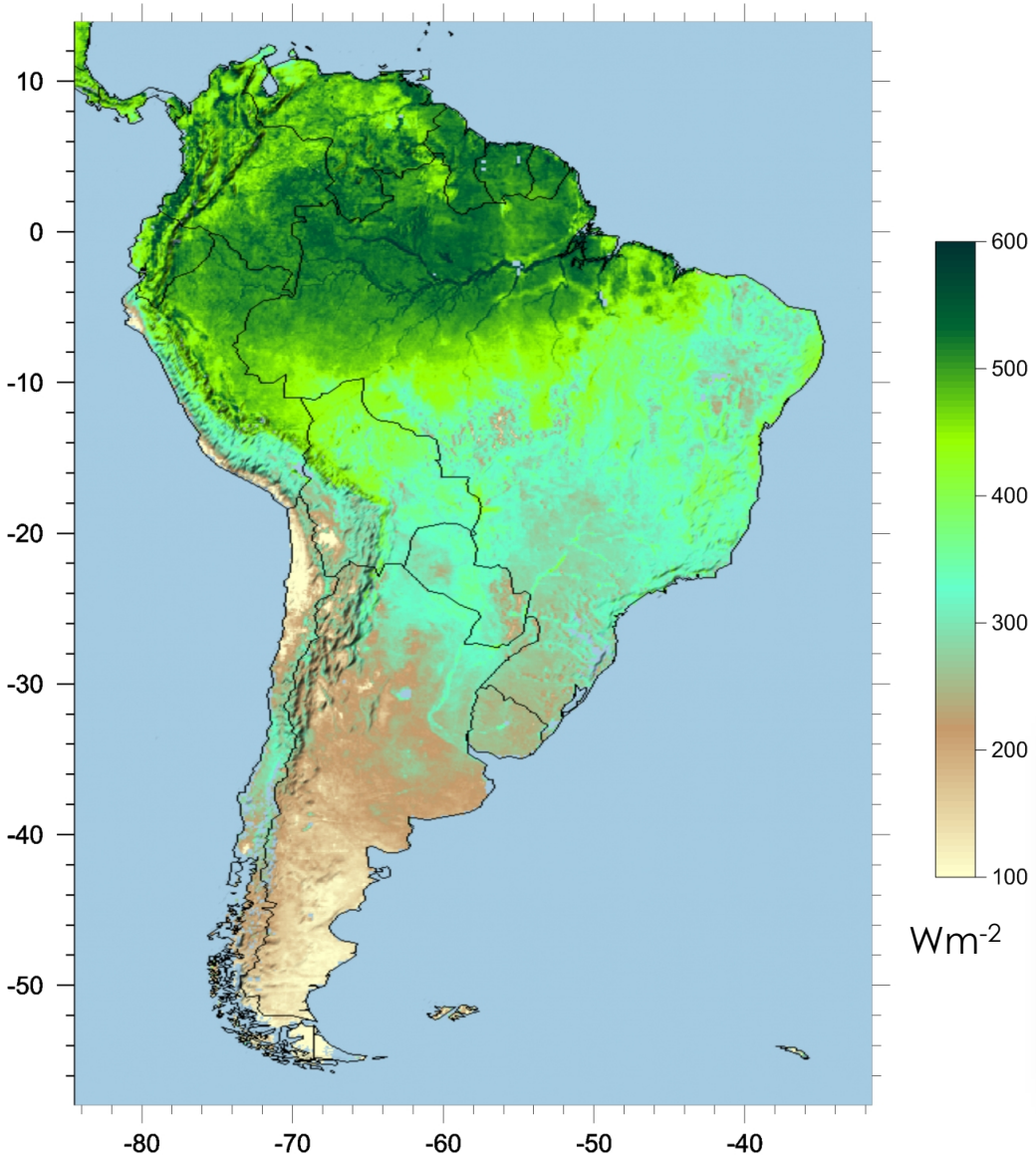


GLOBAL APPLICATIONS FOR SATELLITE ET

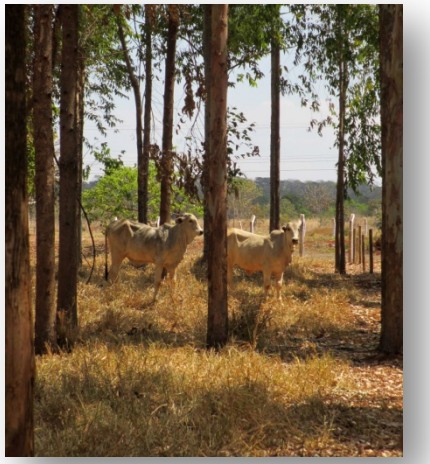
… Food and Water Security

Land-use impacts on water use

August-October composite of
clear-sky midday latent heat flux for 2013 (10 km)



Embrapa AgroHidro Rede



Integrated crop-livestock-forest system

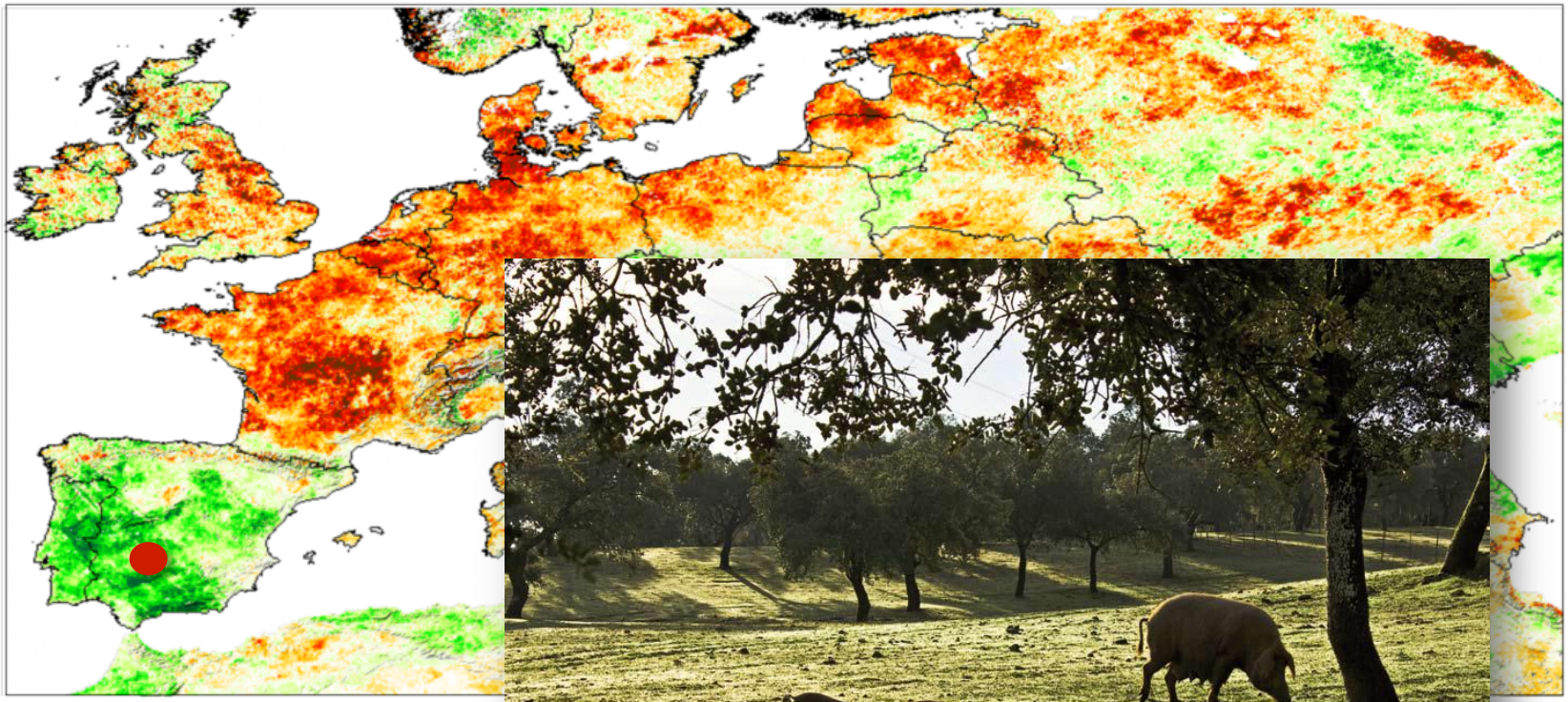


Intensive production in the Cerrado

ESI over Europe (3km – MSG)

JUNE 2011

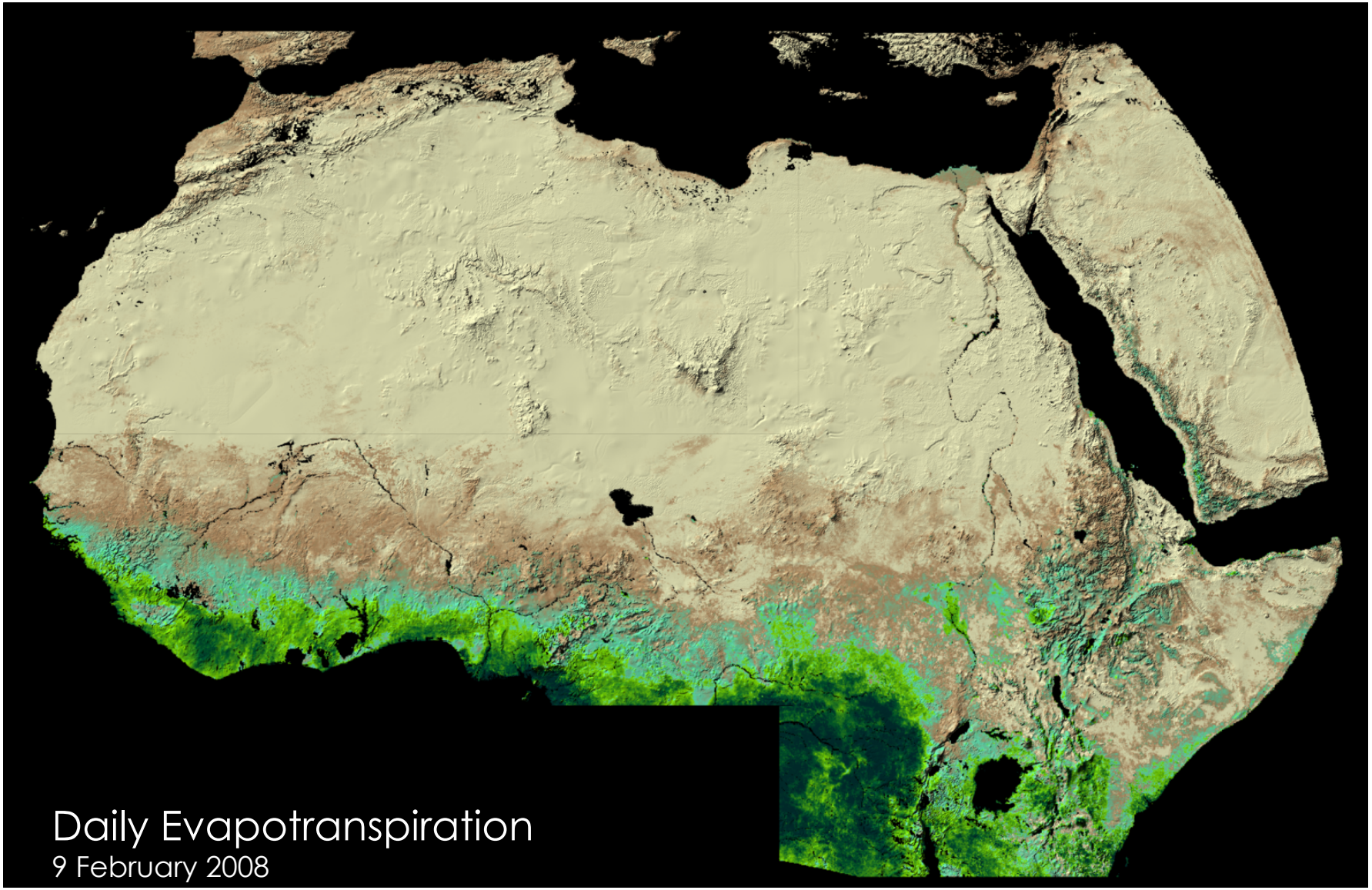
12-week composite



ET/PET anomaly (2009-2012 base

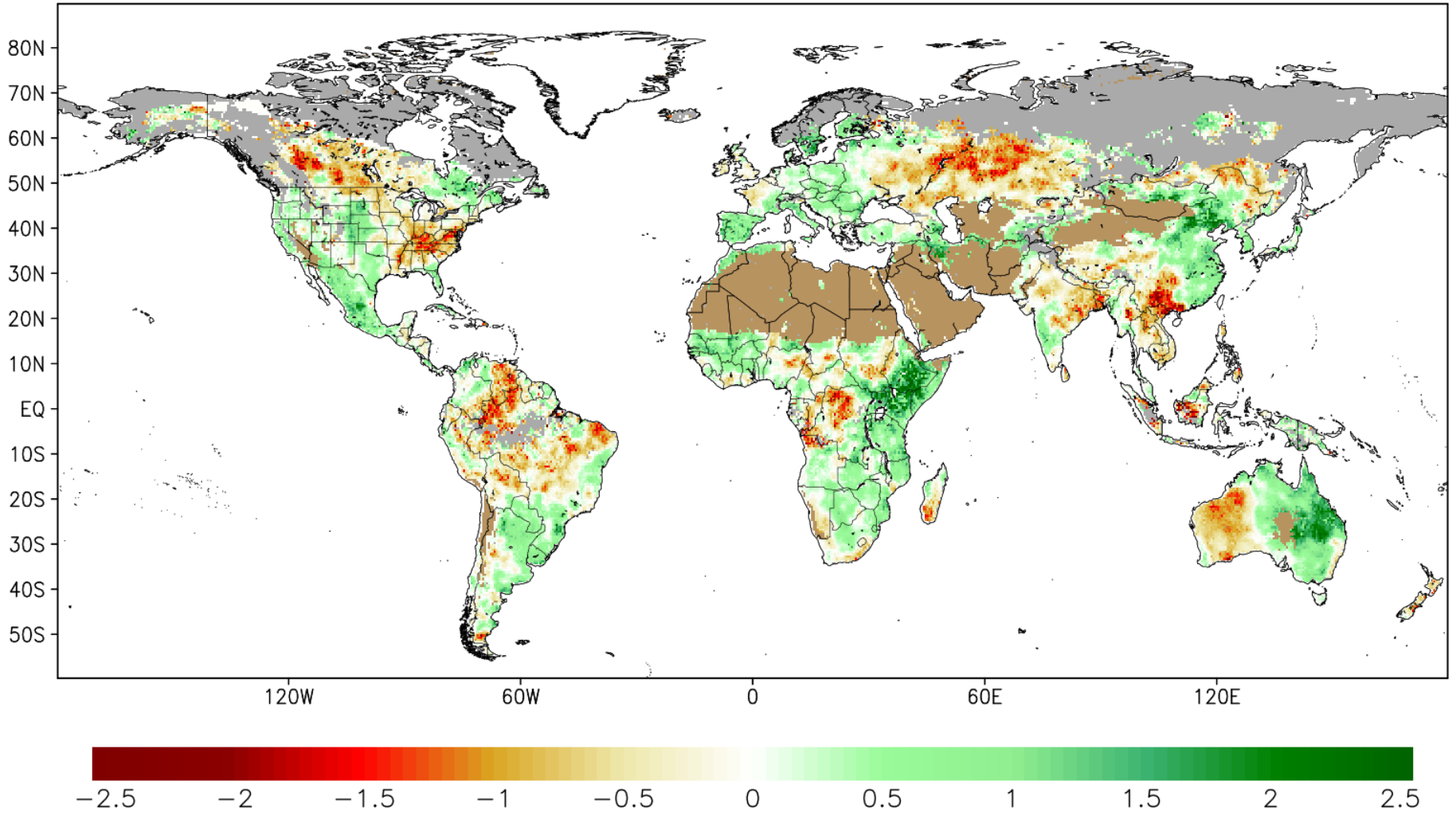
Dehesa project - Agricultural Research and Training Institute of Andalusia (IFAPA)

ALEXI ET over MENA Region (MSG)



APRIL 2010

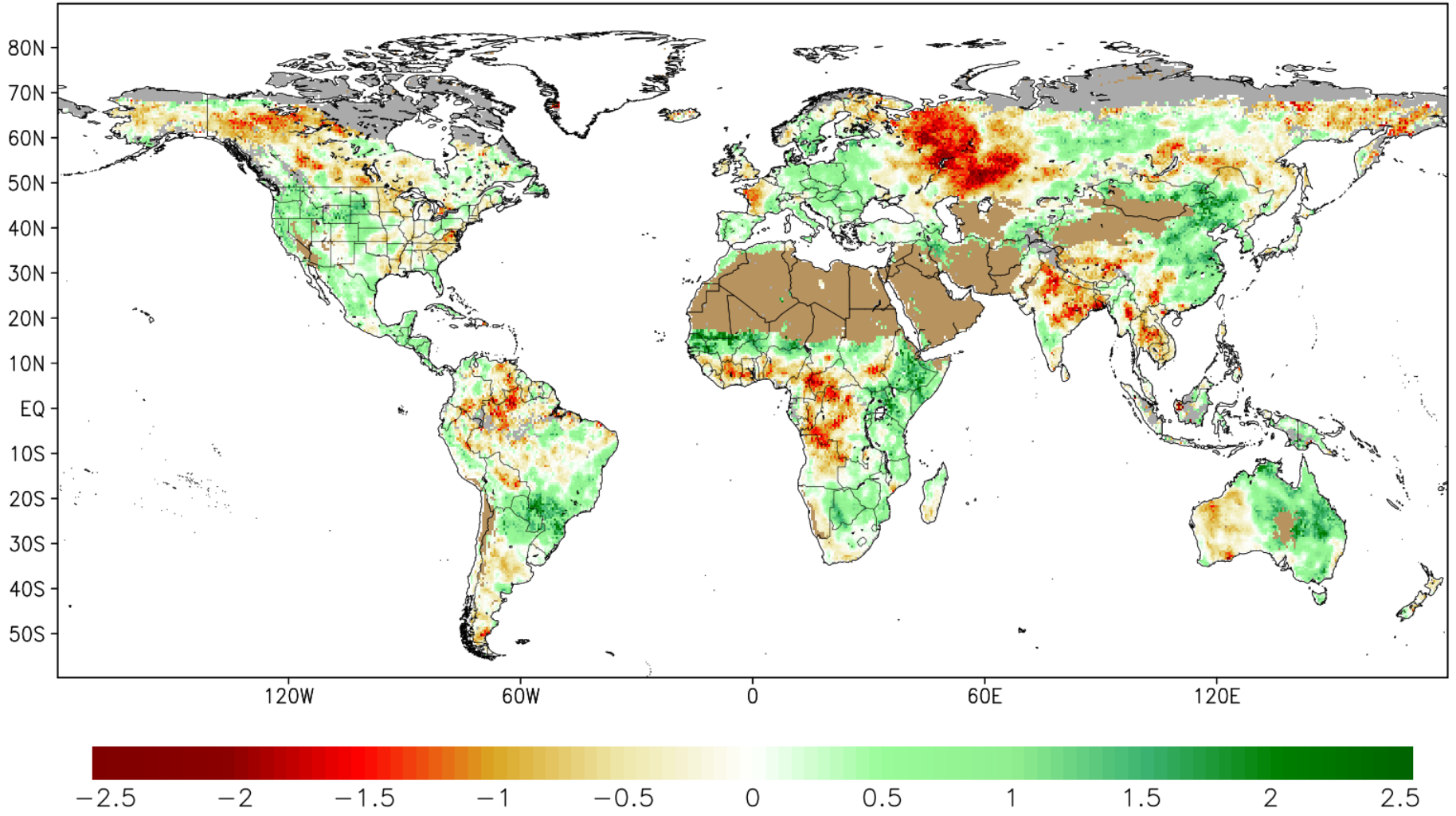
12-week composite



ET/PET standardized anomaly (2000-2011 baseline)

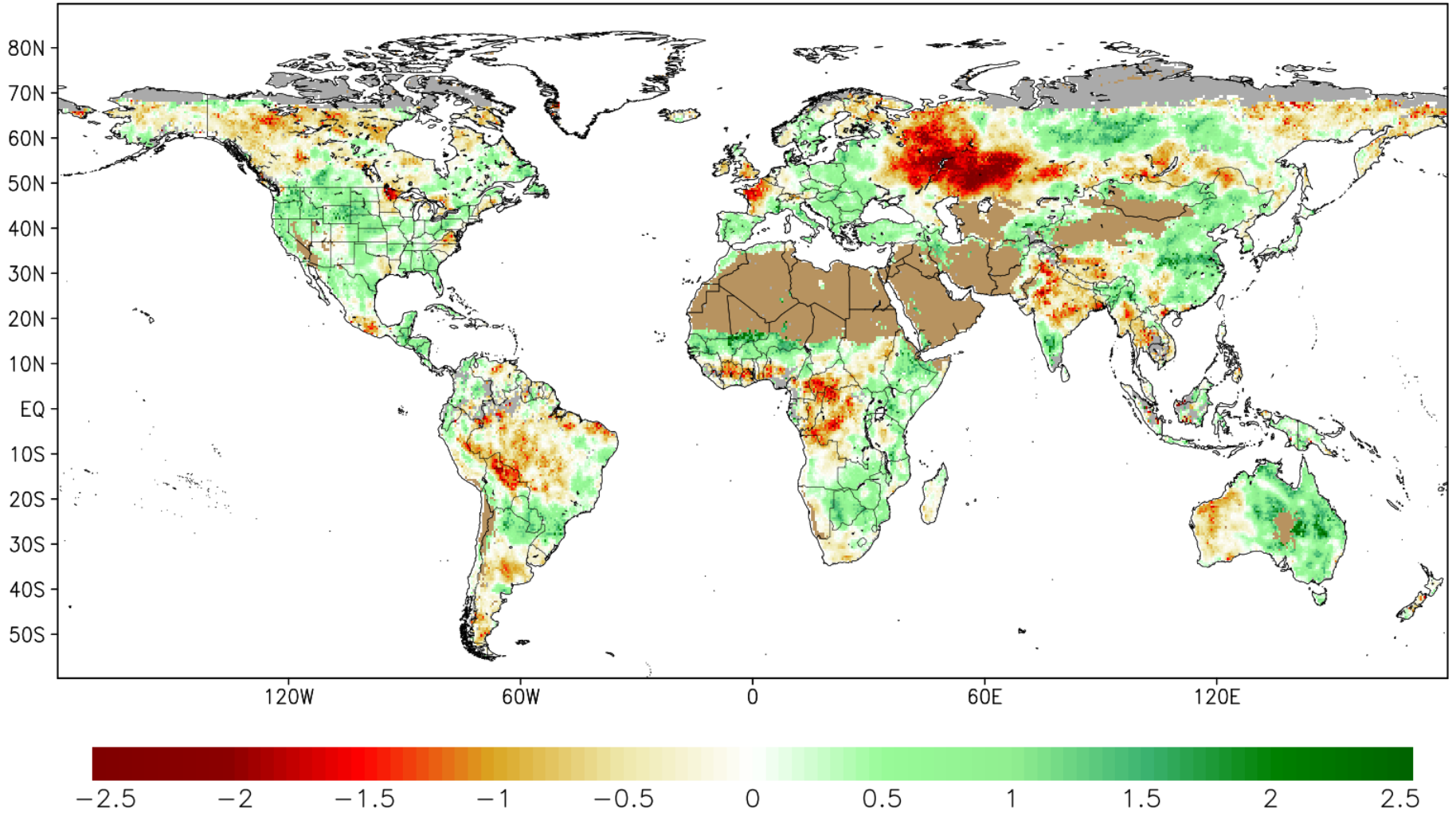
MAY 2010

12-week composite



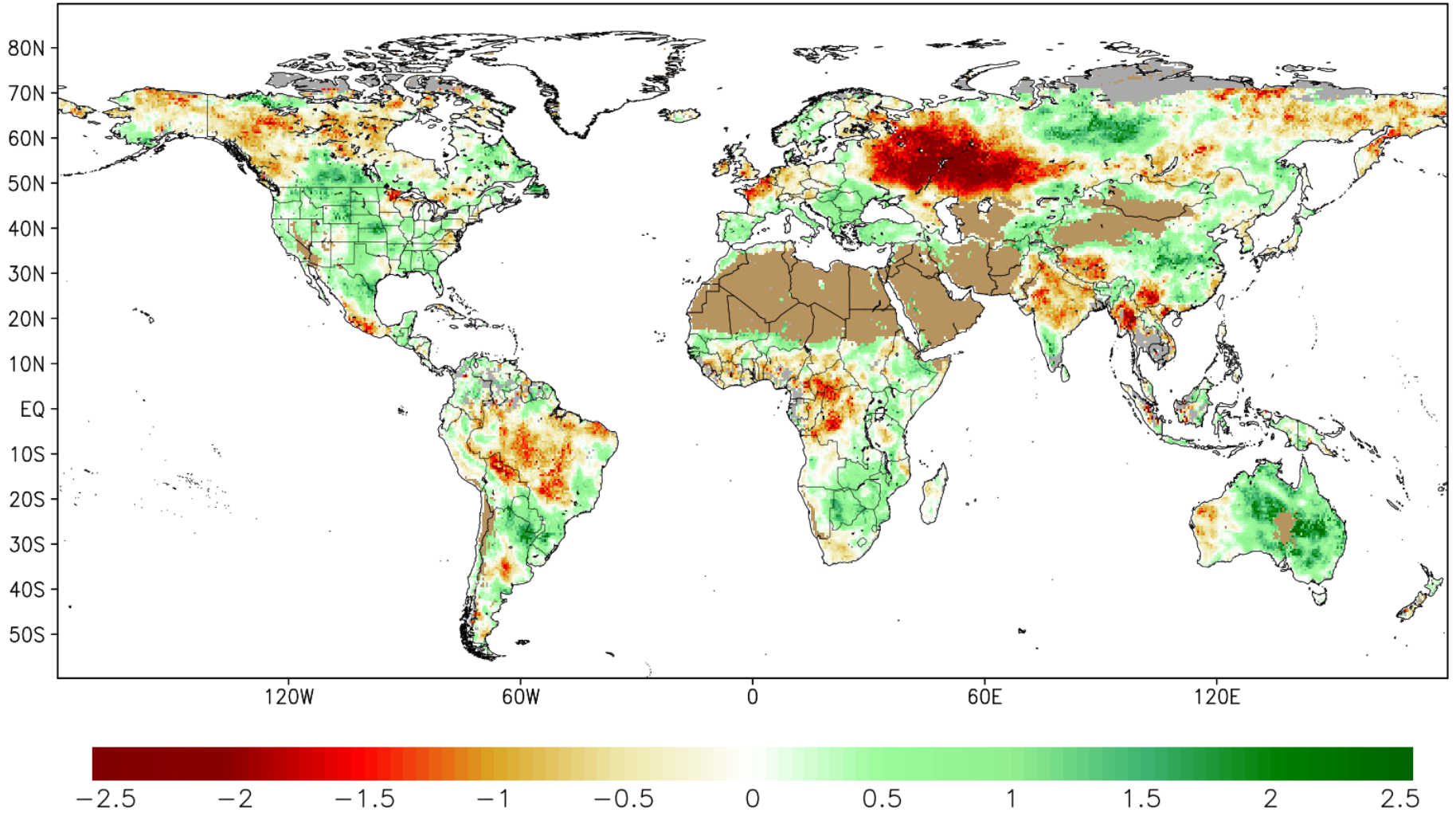
JUNE 2010

12-week composite



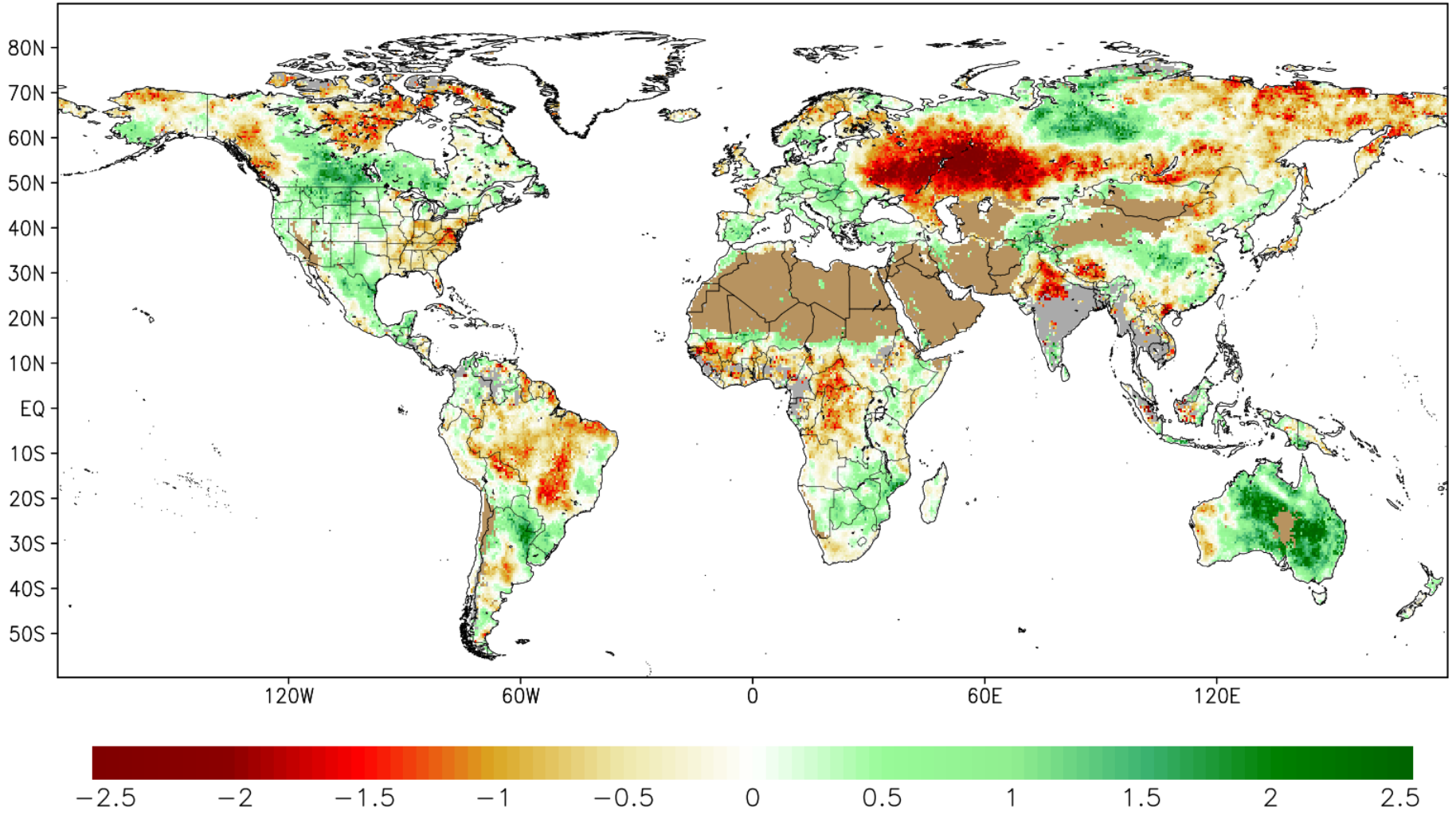
JULY 2010

12-week composite



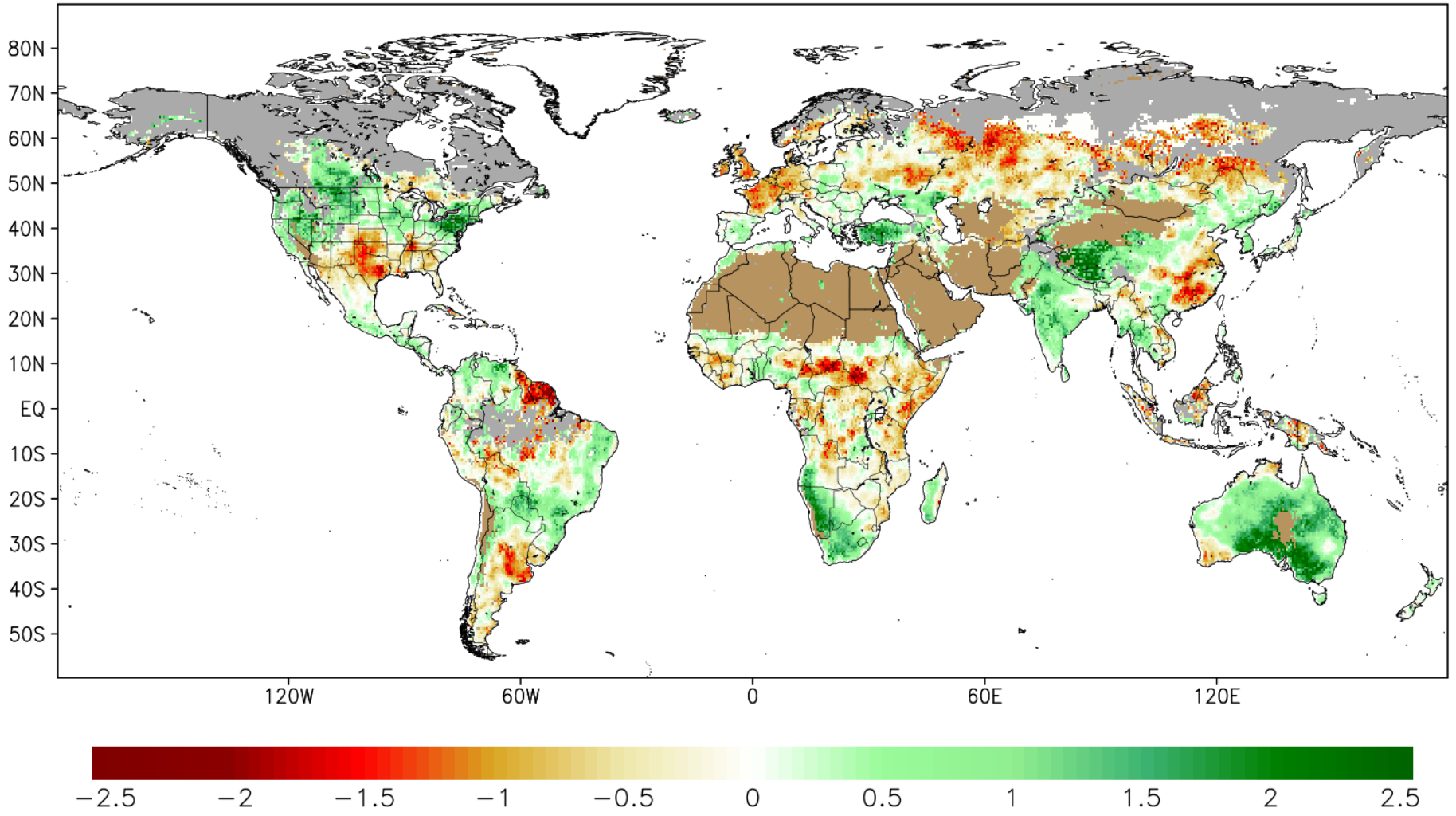
AUGUST 2010

12-week composite



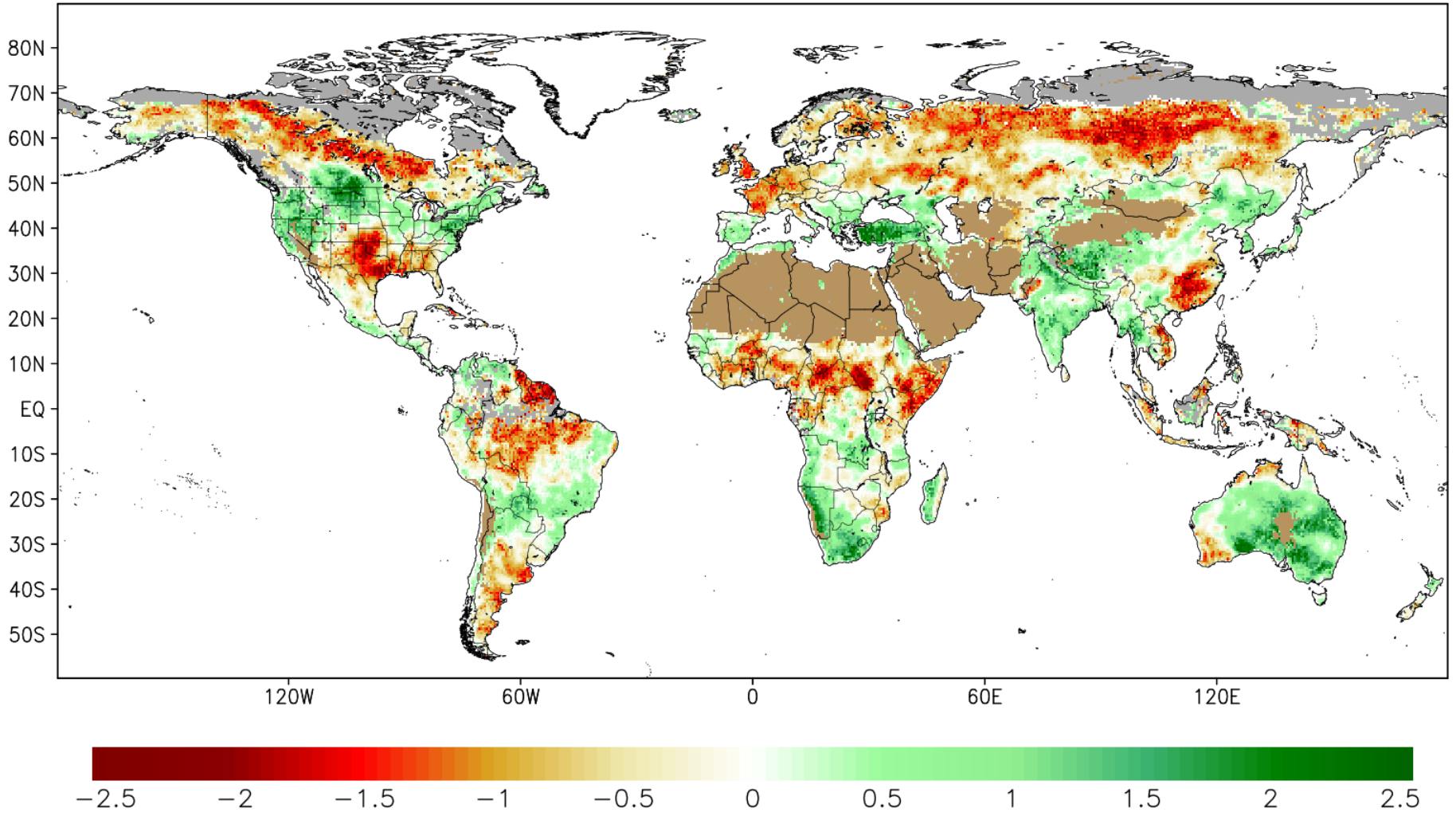
APRIL 2011

12-week composite



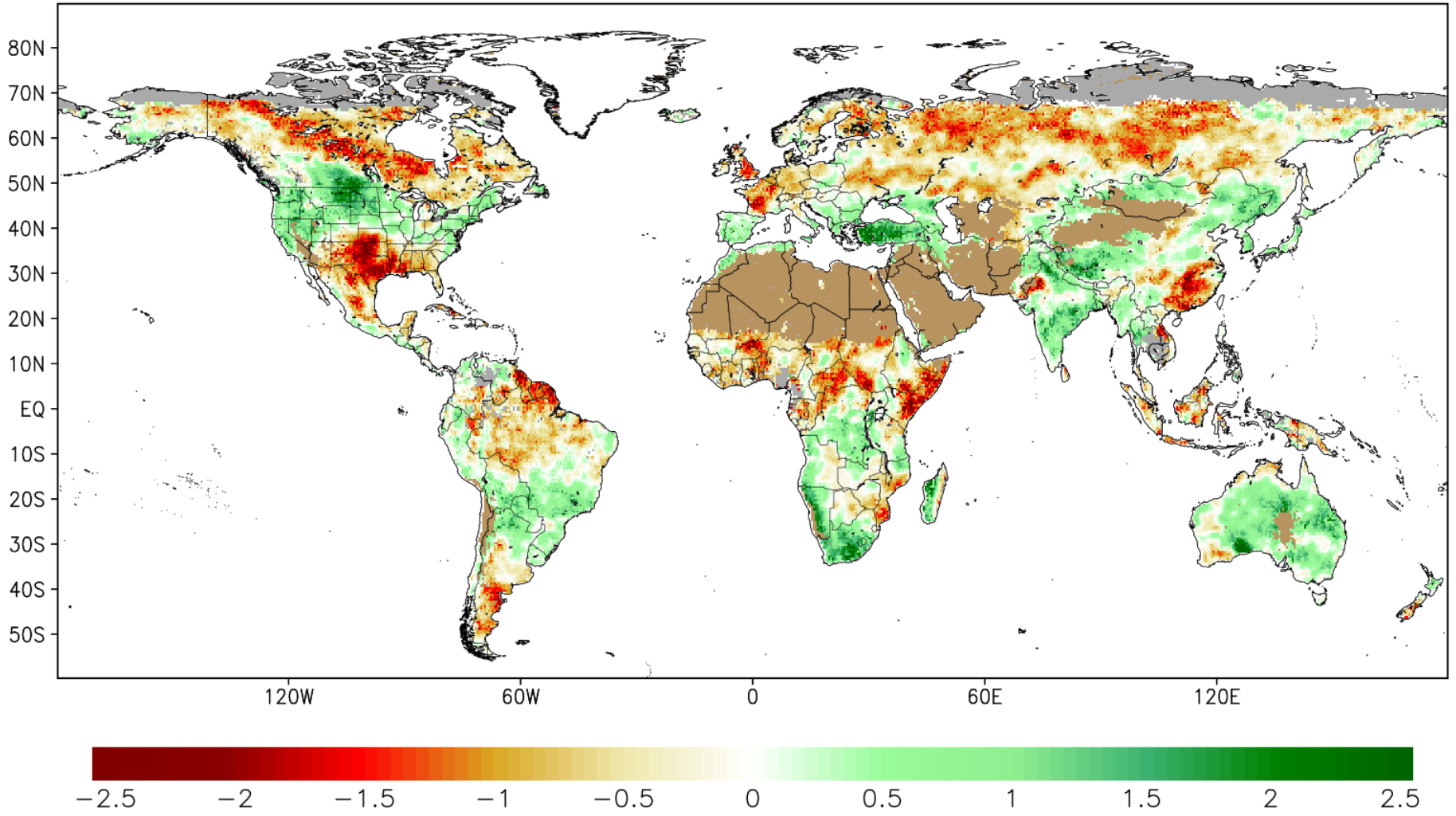
MAY 2011

12-week composite



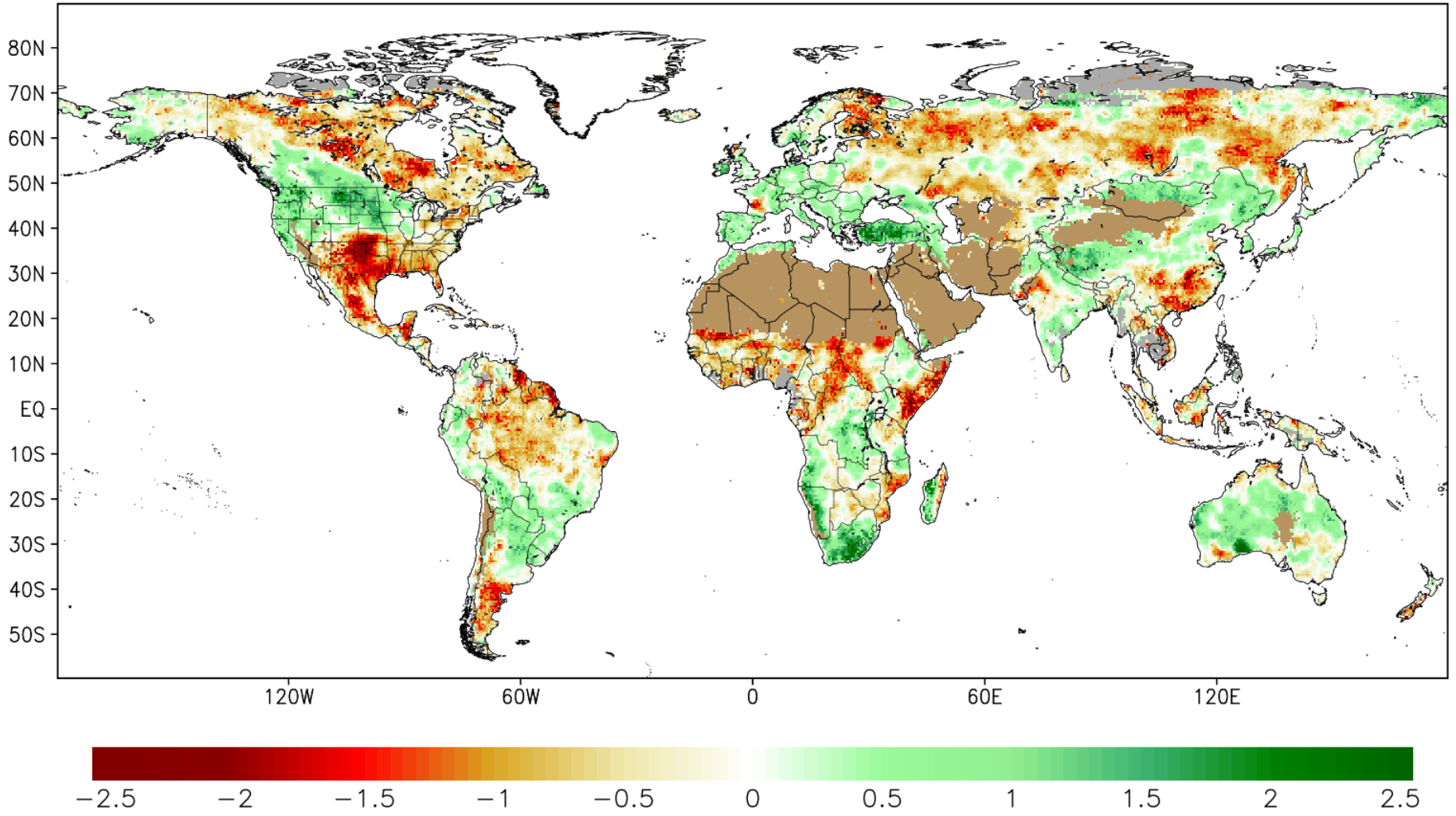
JUNE 2011

12-week composite



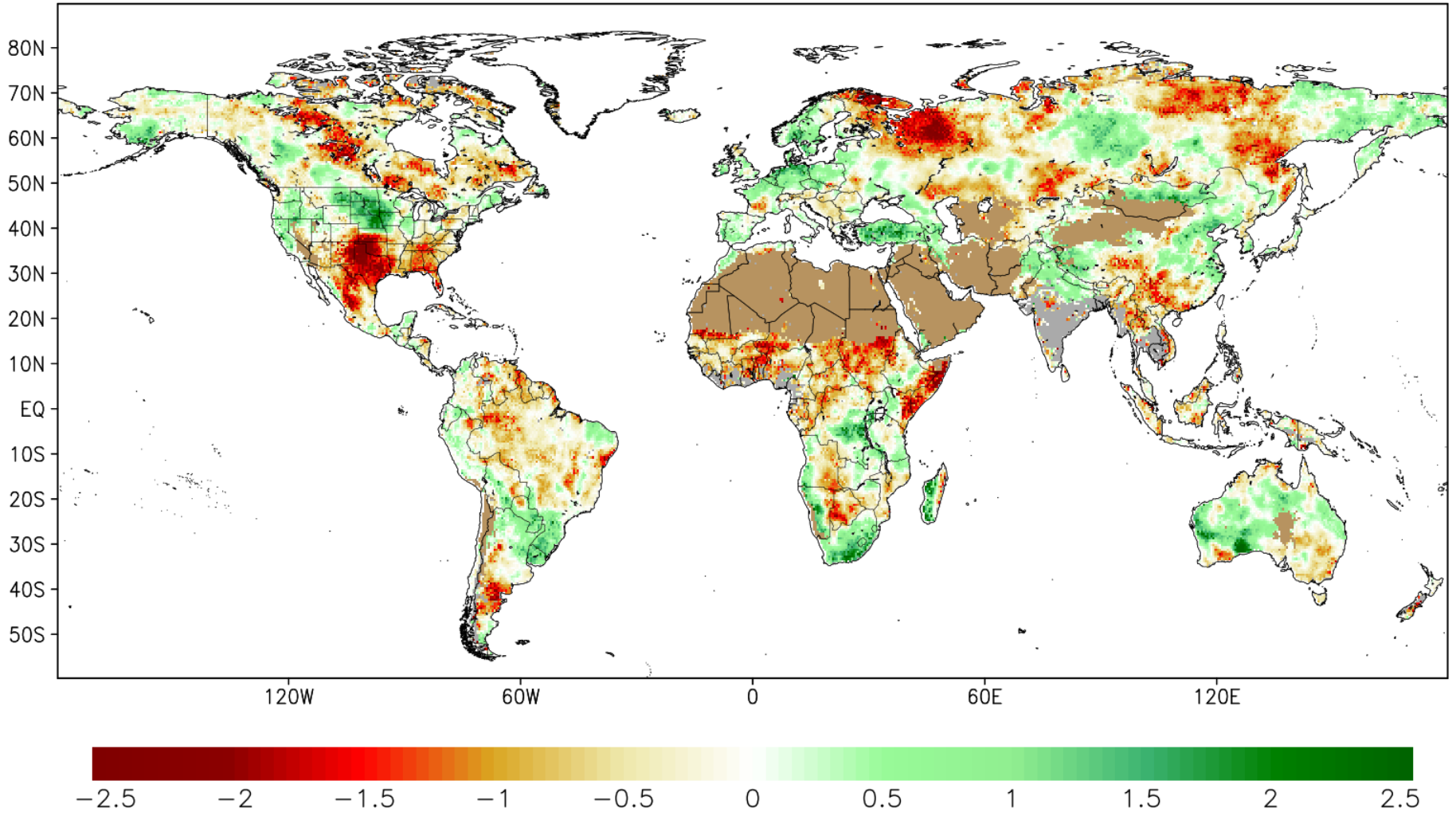
JULY 2011

12-week composite



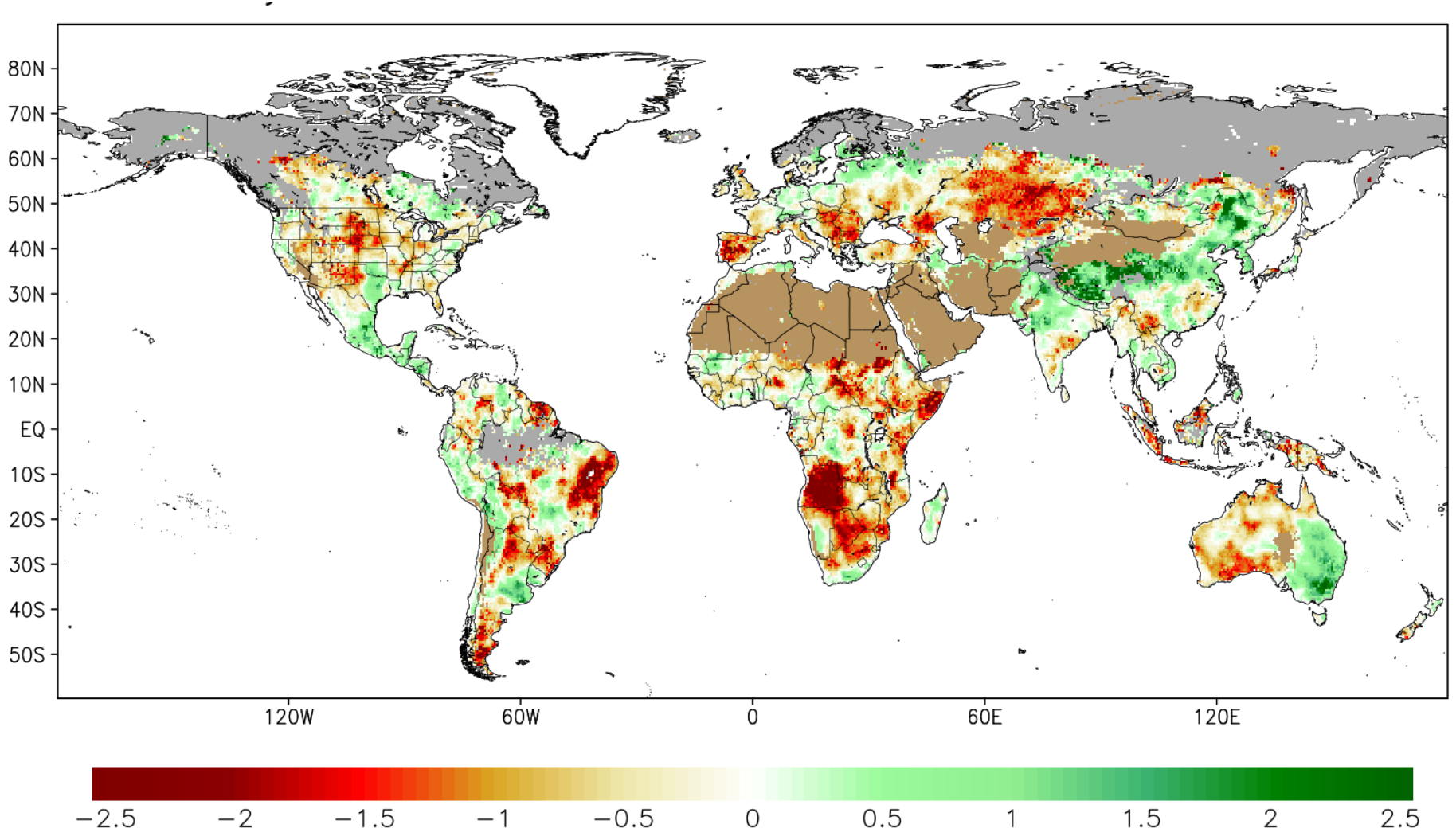
AUGUST 2011

12-week composite



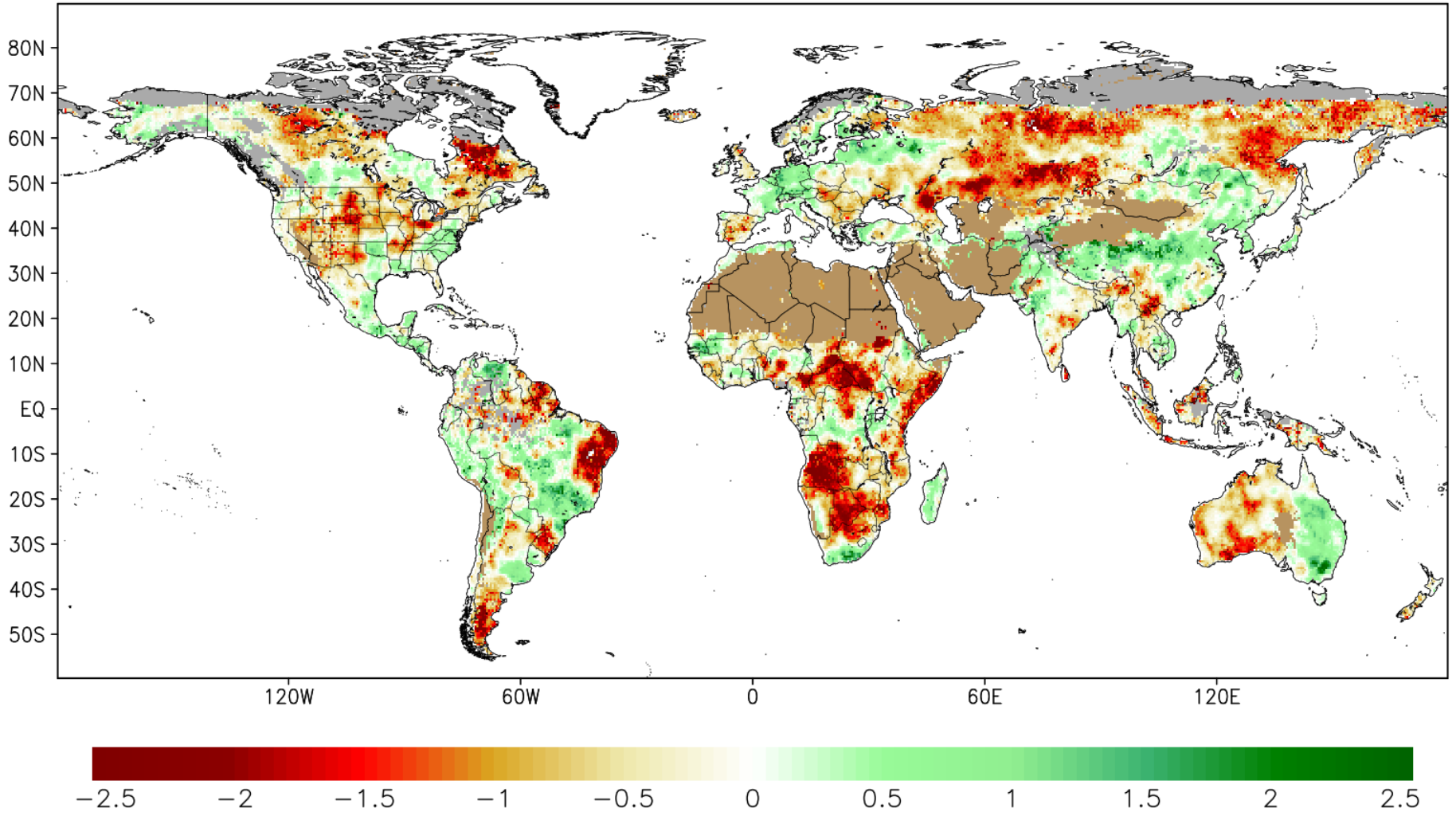
APRIL 2012

12-week composite



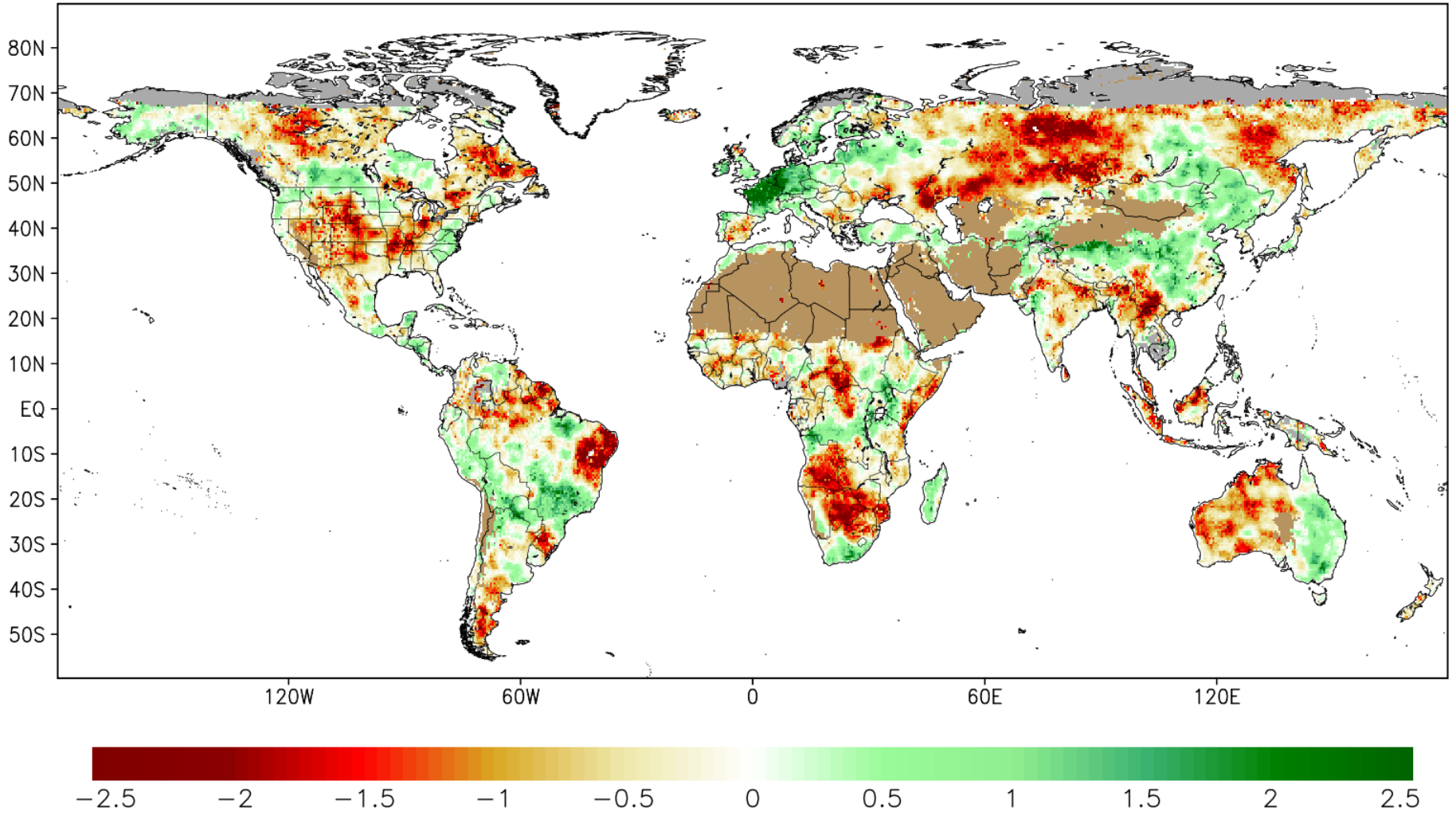
MAY 2012

12-week composite



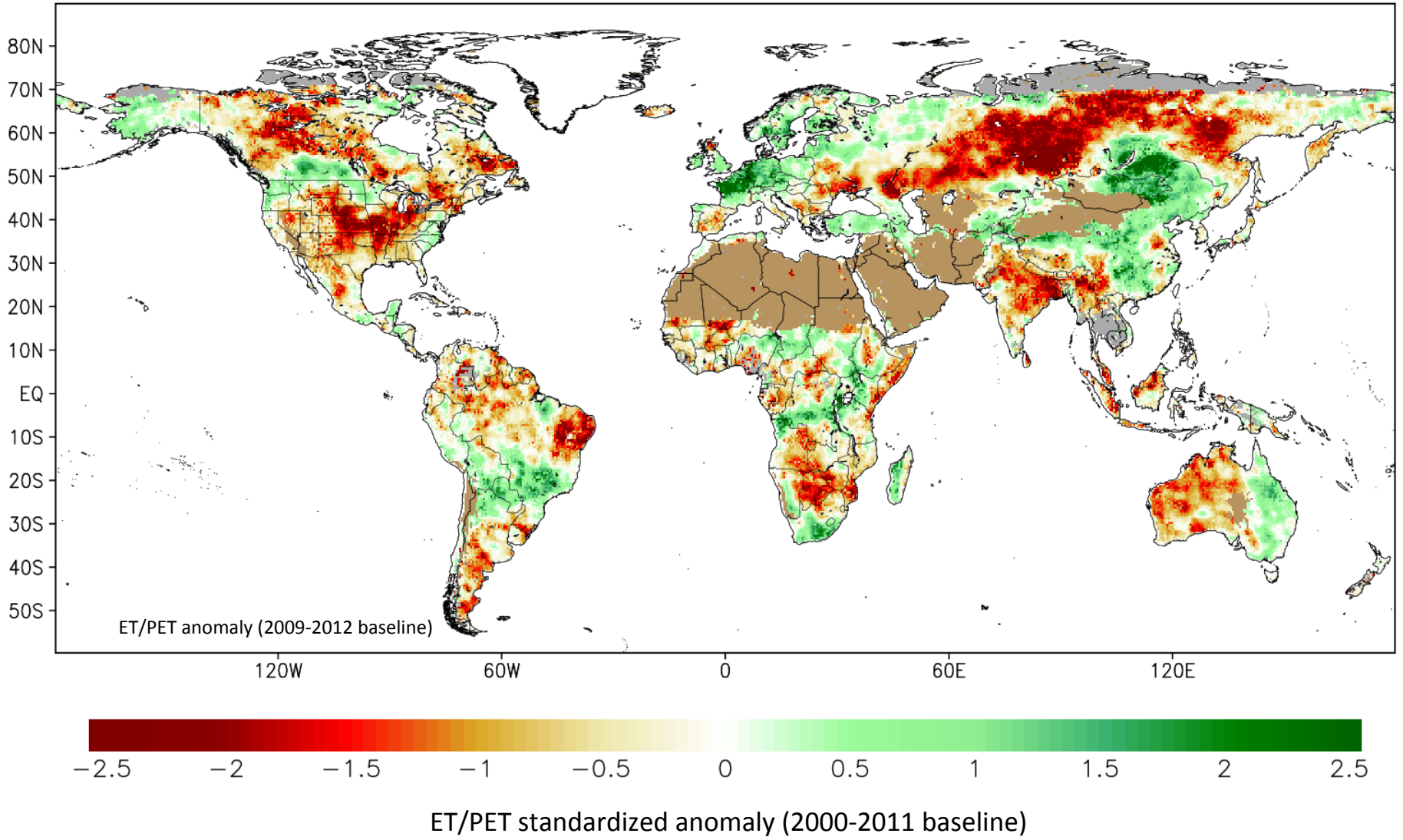
JUNE 2012

12-week composite



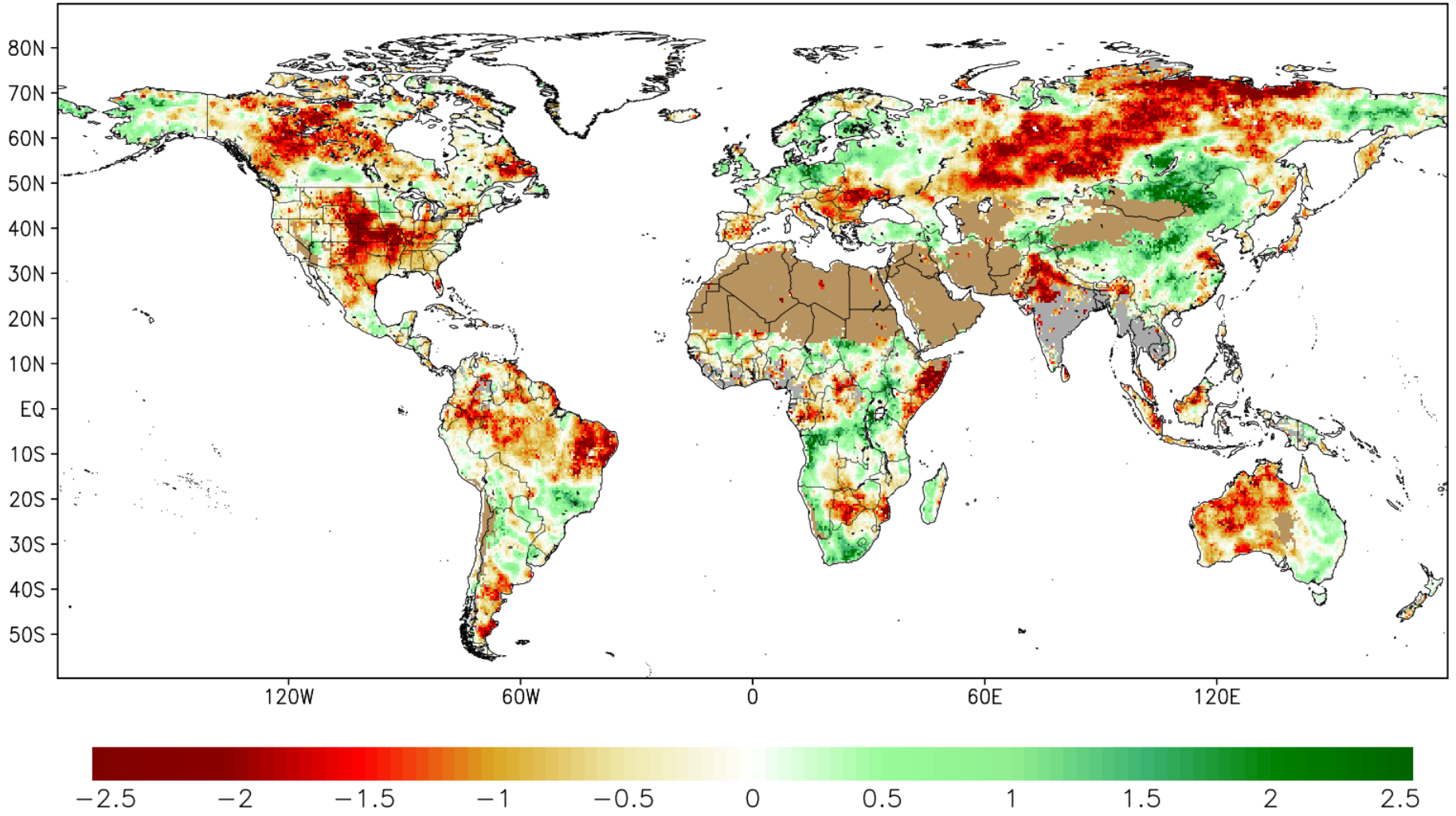
JULY 2012

12-week composite



AUGUST 2012

12-week composite



Satellite Evapotranspiration

- Using a multisensor and multiresolution technique to produce consistent daily ET maps over a wide range of scales and spatial resolution.
- Monitoring drought water use at field to continental scales which is of benefit for water management applications
- Applications in global water and food security

hrsl.arsusda.gov/drought



Conclusions

USDA is an equal opportunity provider and employer.