Mapping Water Use and Drought from Space

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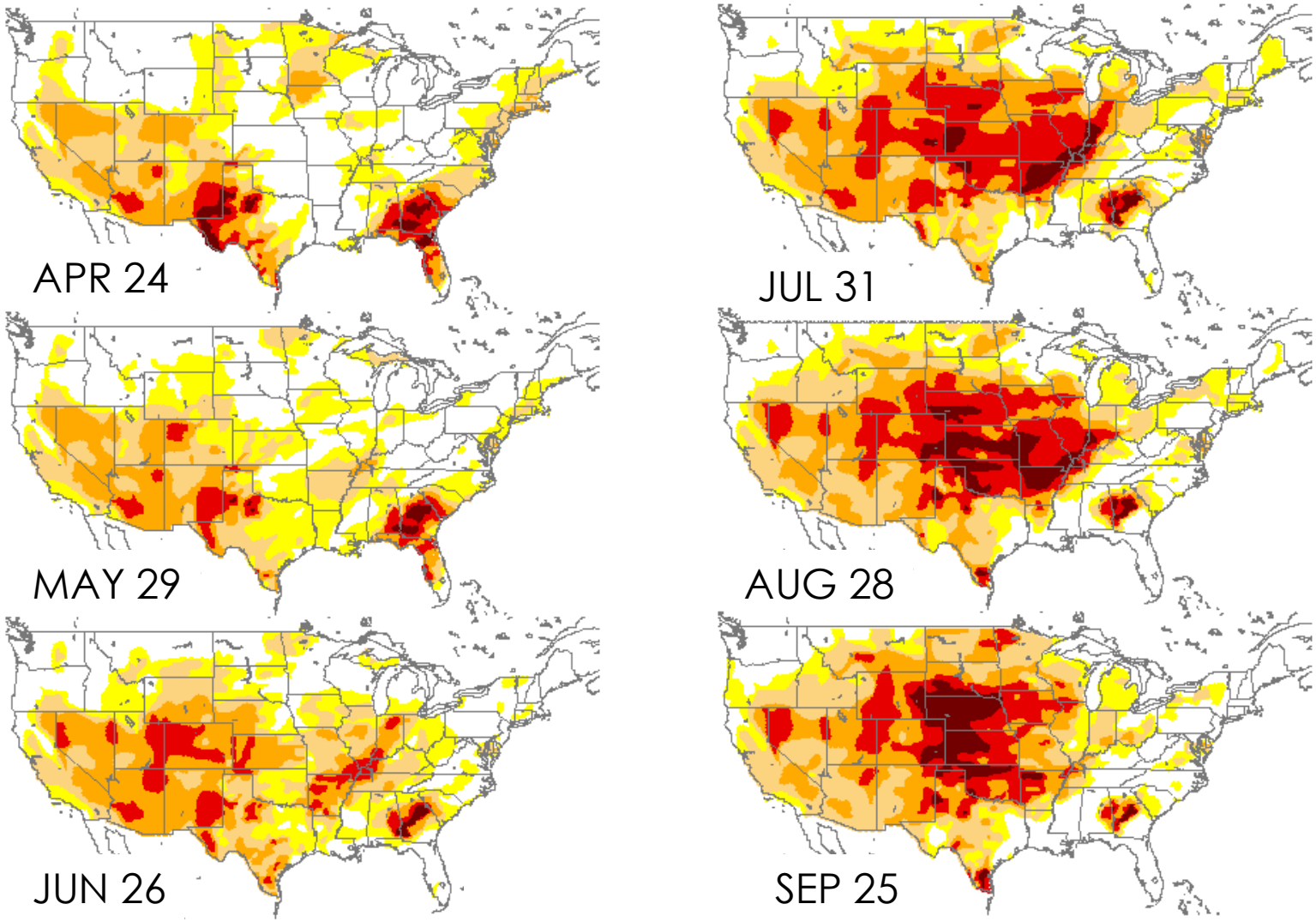
NOAA-NESDIS, College Park, MD

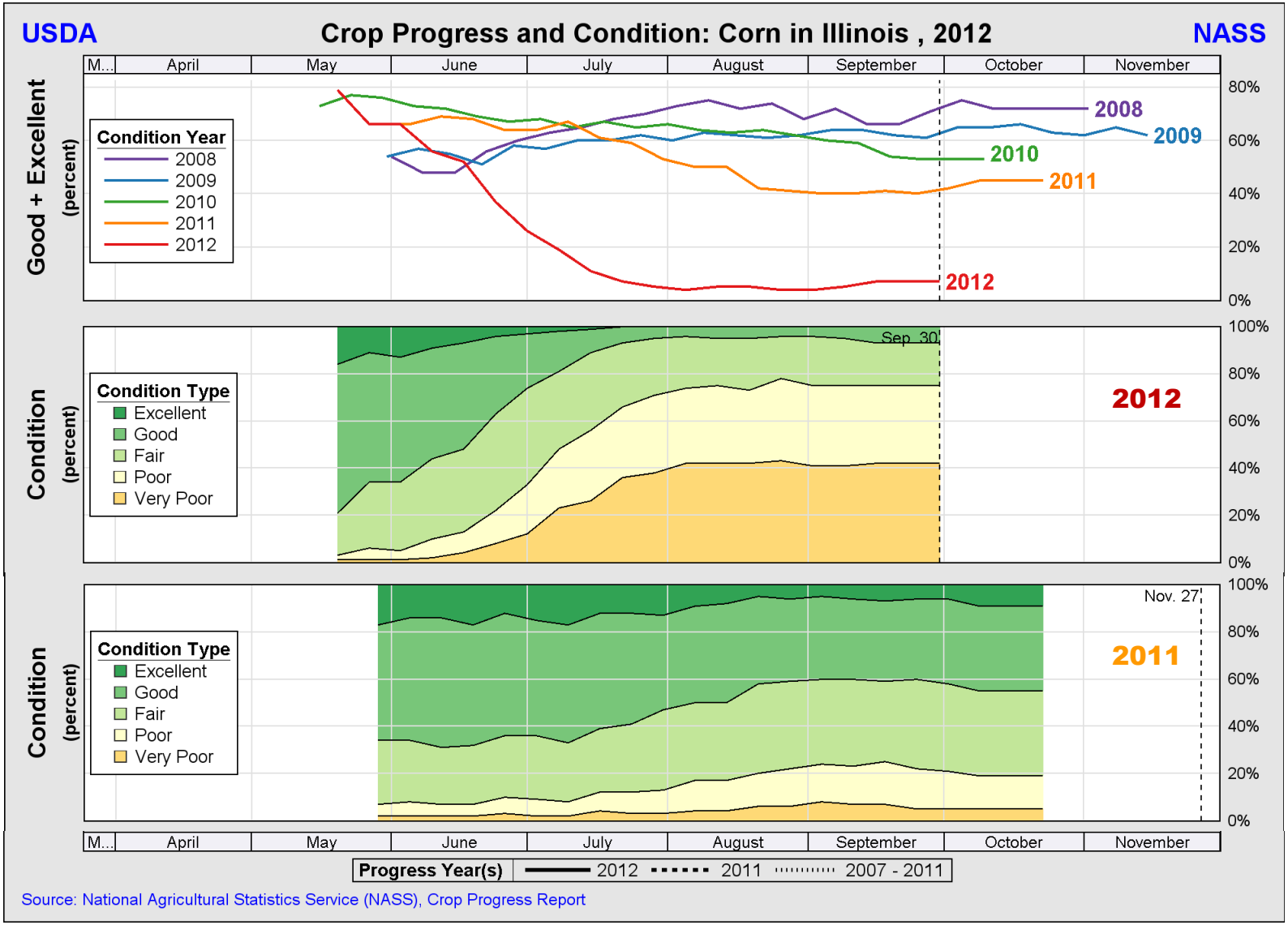
Jason Otkin
CIMSS, UW-Madison, WI

US DROUGHT MONITOR



Flash Drought of 2012

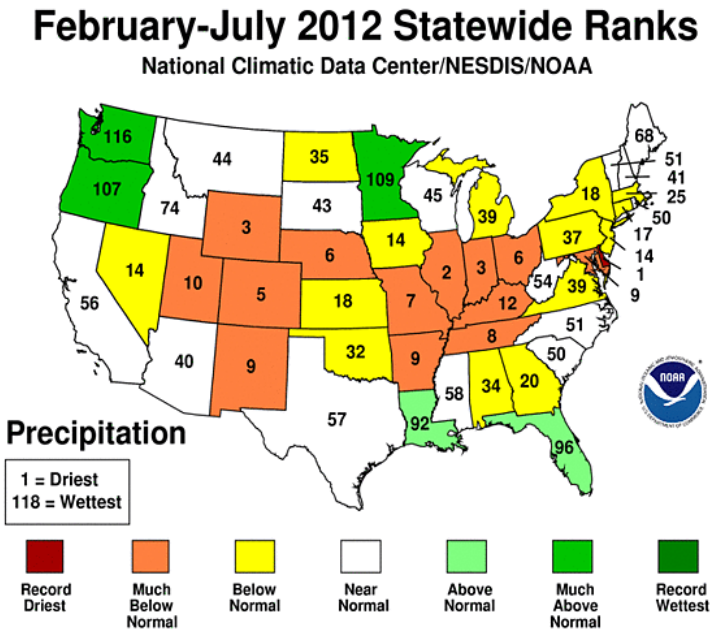
Flash Drought of 2012

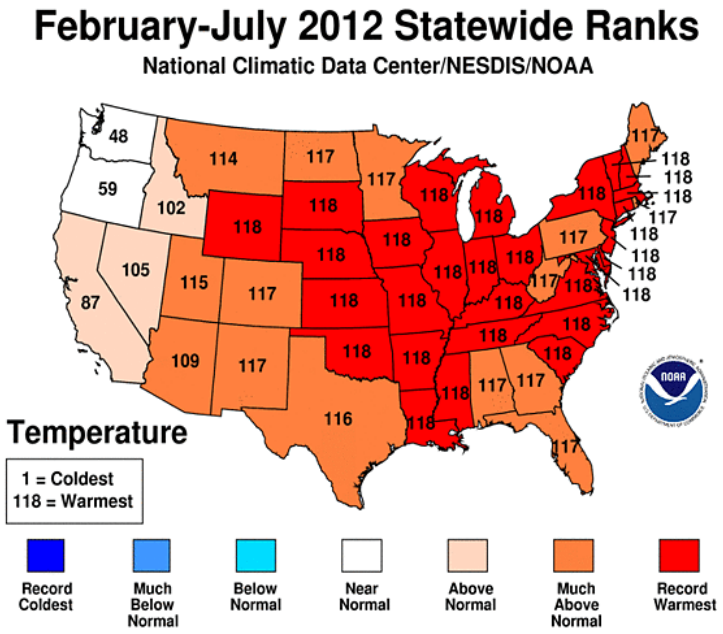


Source: National Agricultural Statistics Service (NASS), Crop Progress Report

Flash Drought of 2012

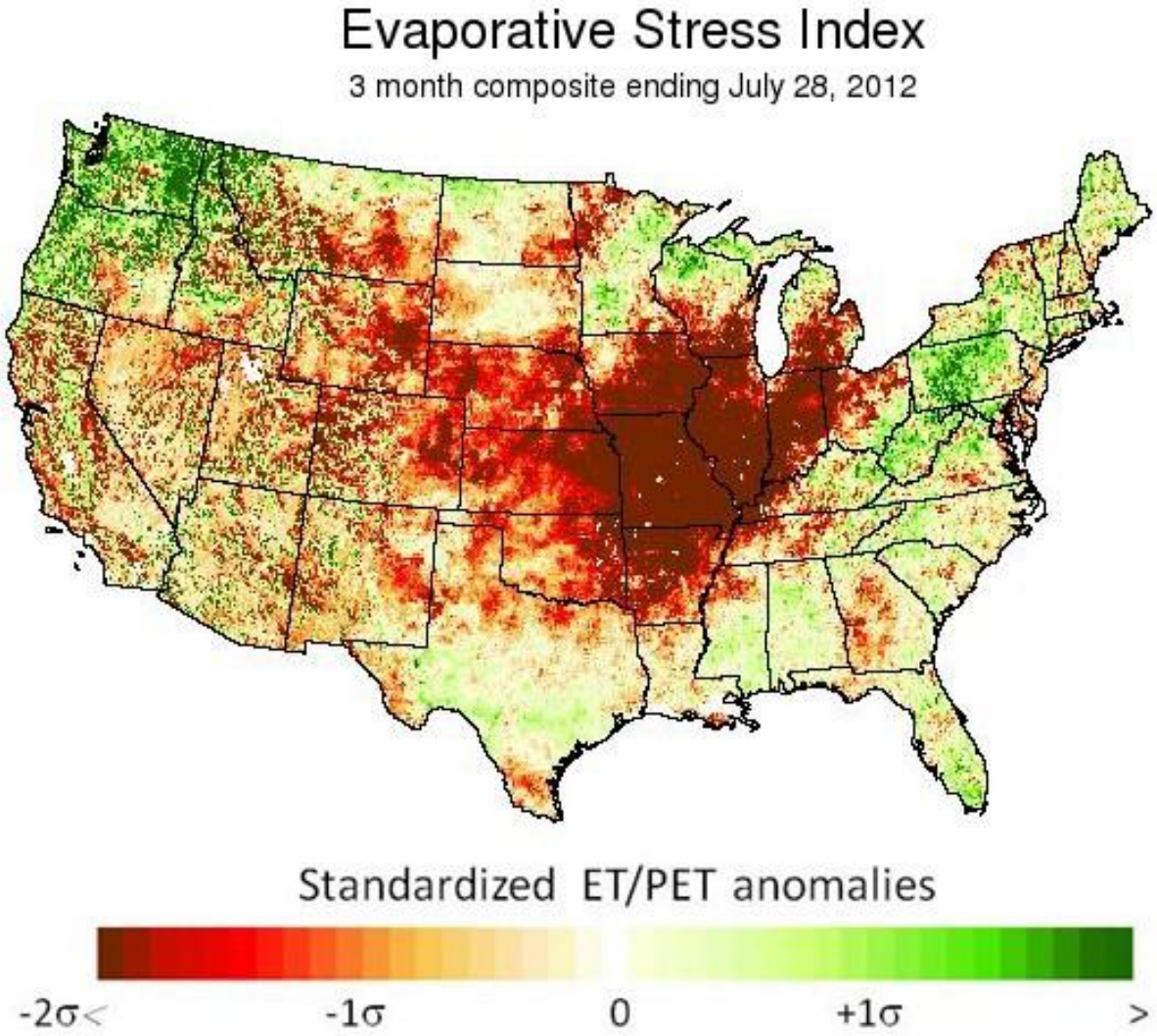
"FLASH DROUGHT" CONDITIONS





Heatwave fueled enhanced Evapotranspiration (ET)

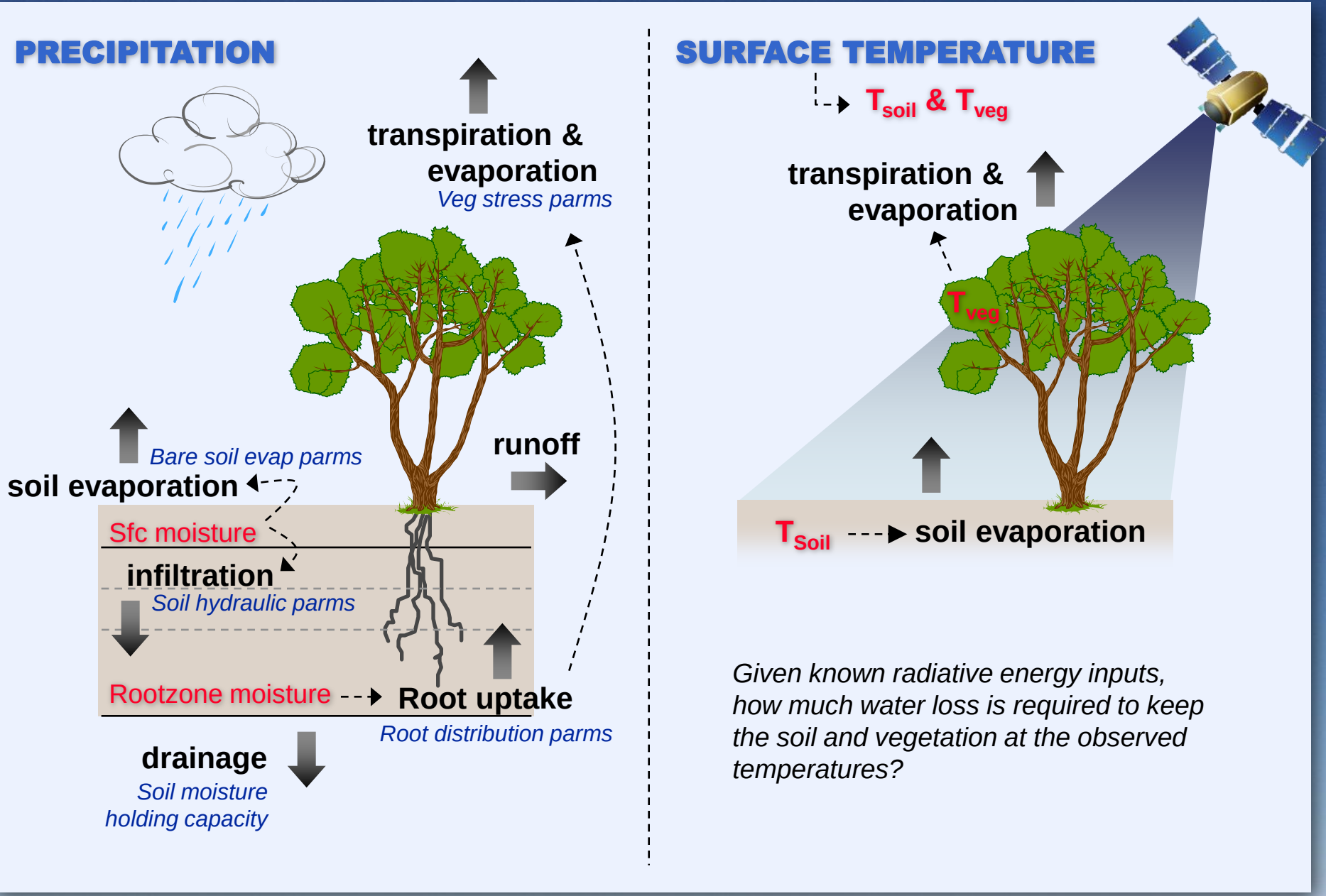
Satellite ET Drought Indicator



Lower than normal

Higher than normal

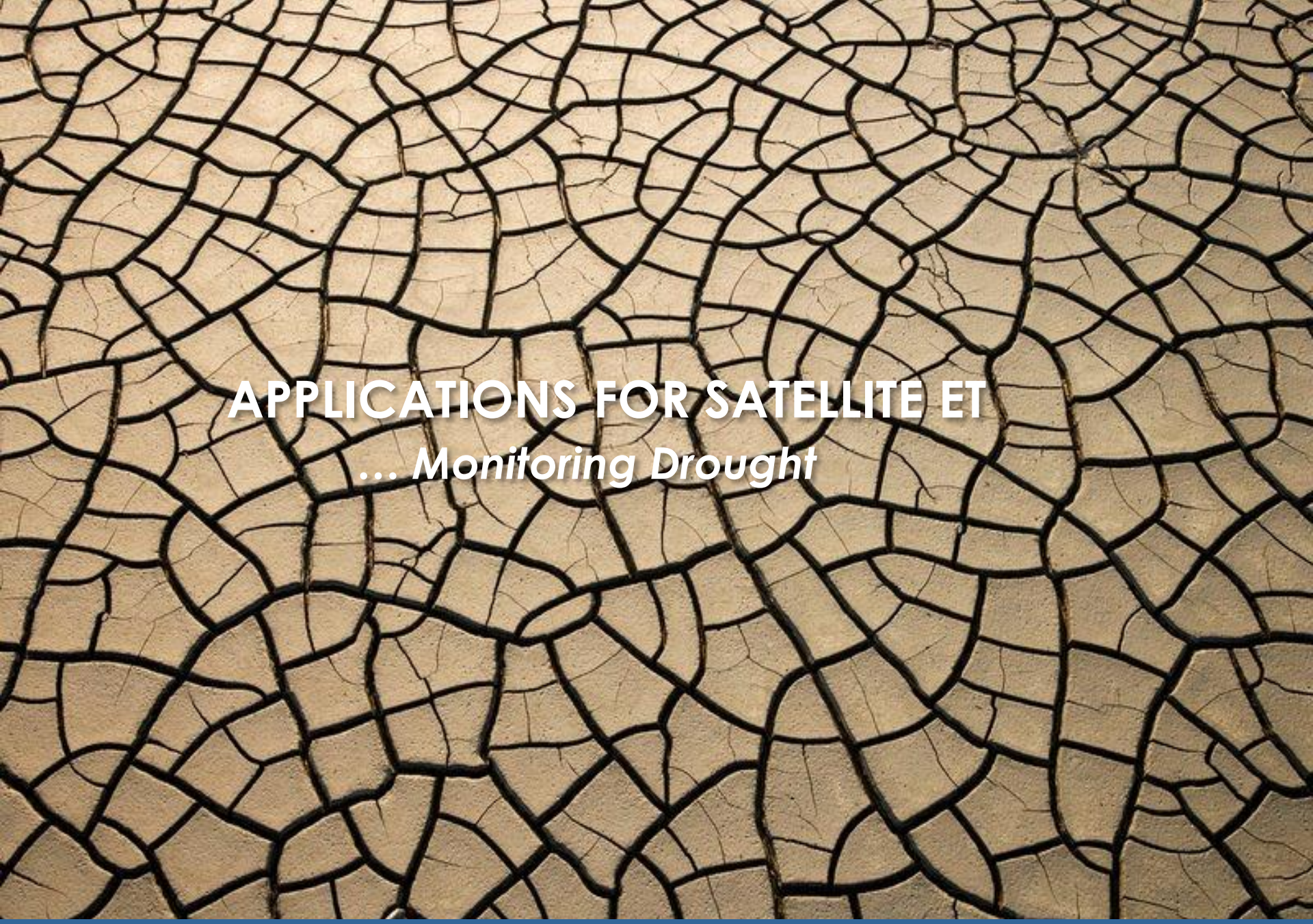

MAPPING EVAPOTRANSPIRATION
… Water balance vs.
energy balance
(Rick Allen, U Idaho)



WATER BALANCE APPROACH
("prognostic modeling")

ENERGY BALANCE APPROACH
("diagnostic modeling")

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

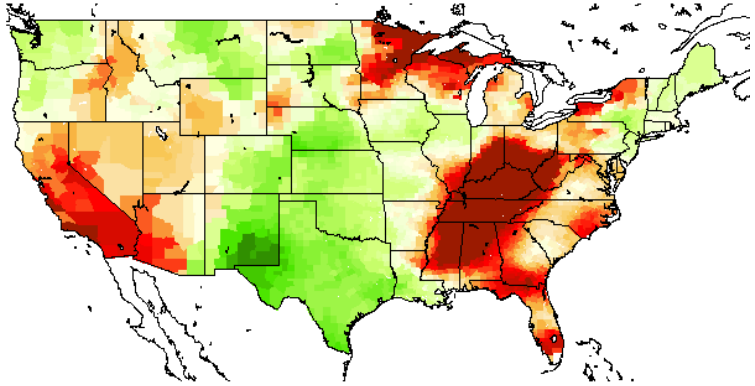


APPLICATIONS FOR SATELLITE ET

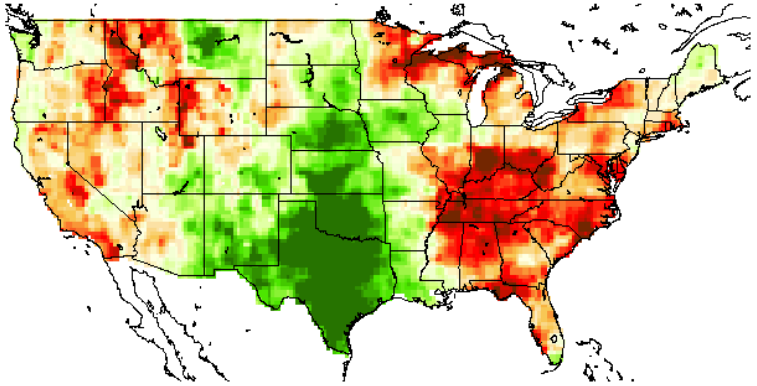
… *Monitoring Drought*

2007 SEASONAL ANOMALIES

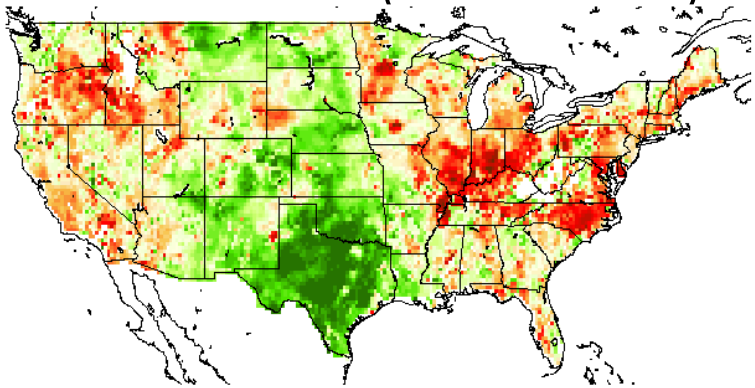
US Drought Monitor



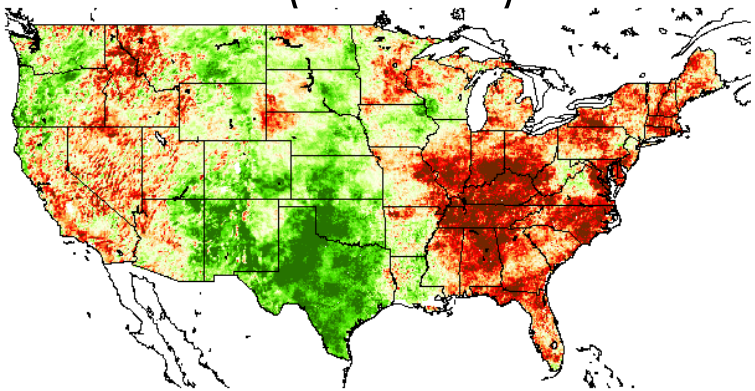
Soil moisture (rainfall)



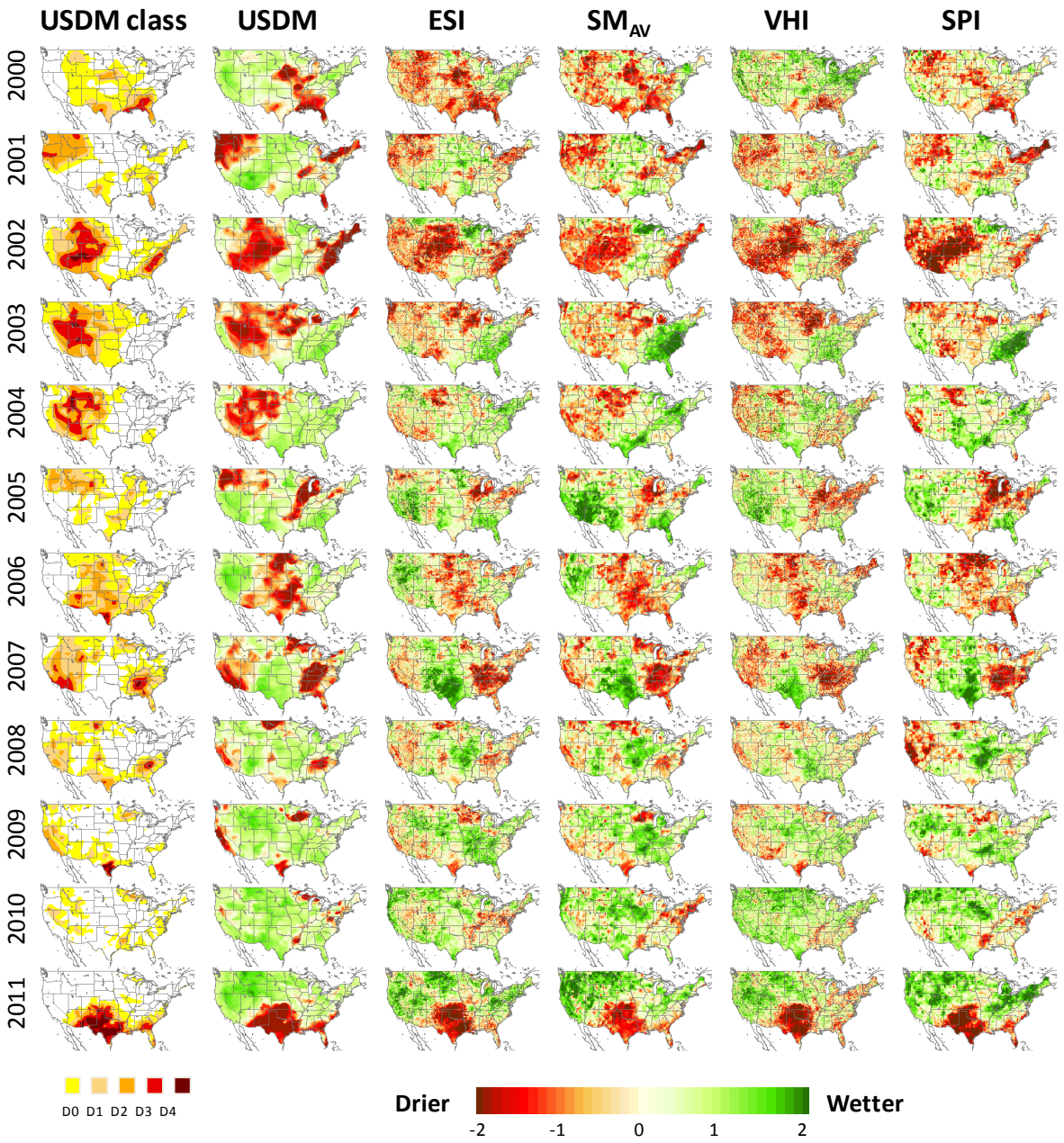
Soil moisture (microwave)

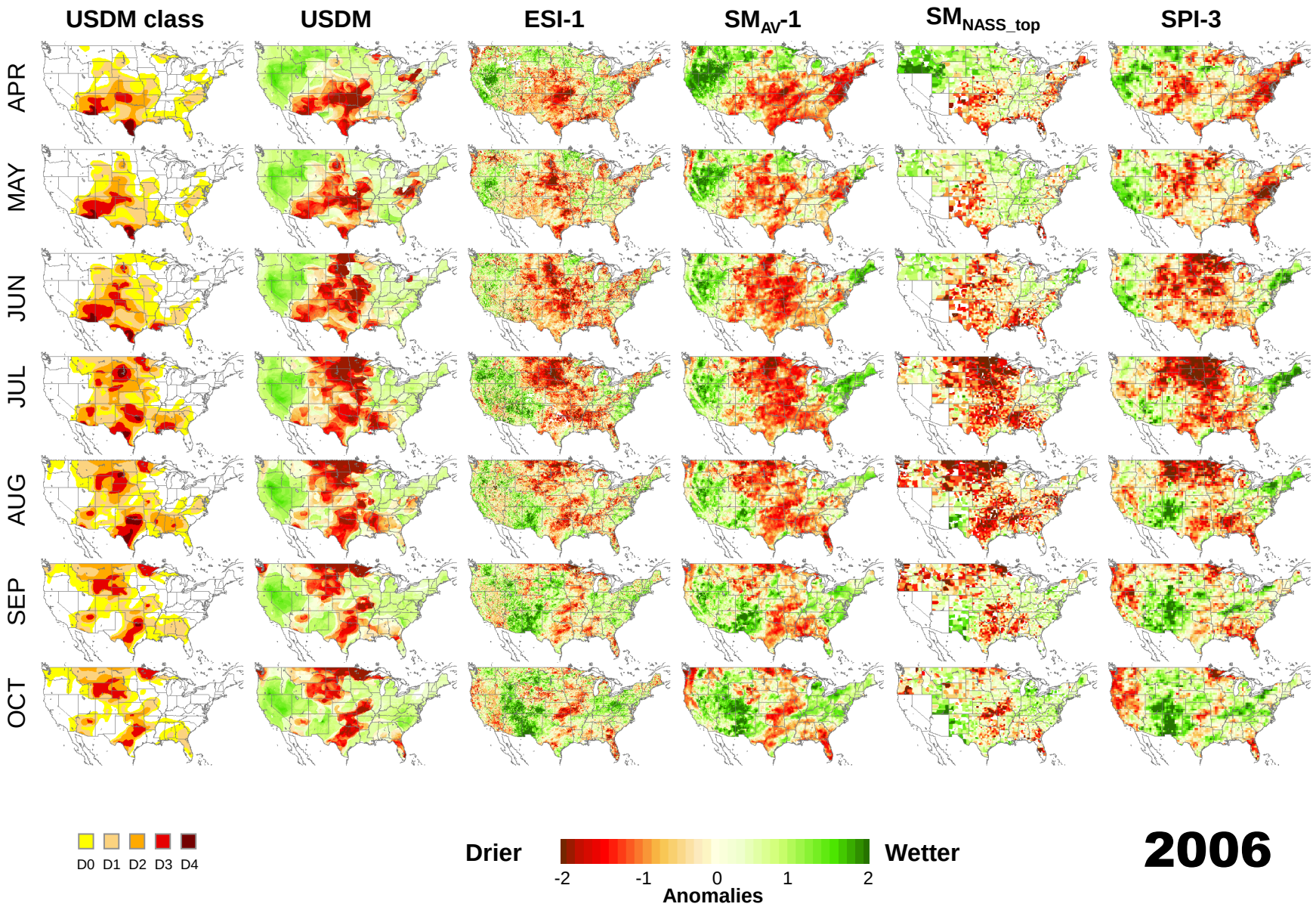


ESI (thermal)



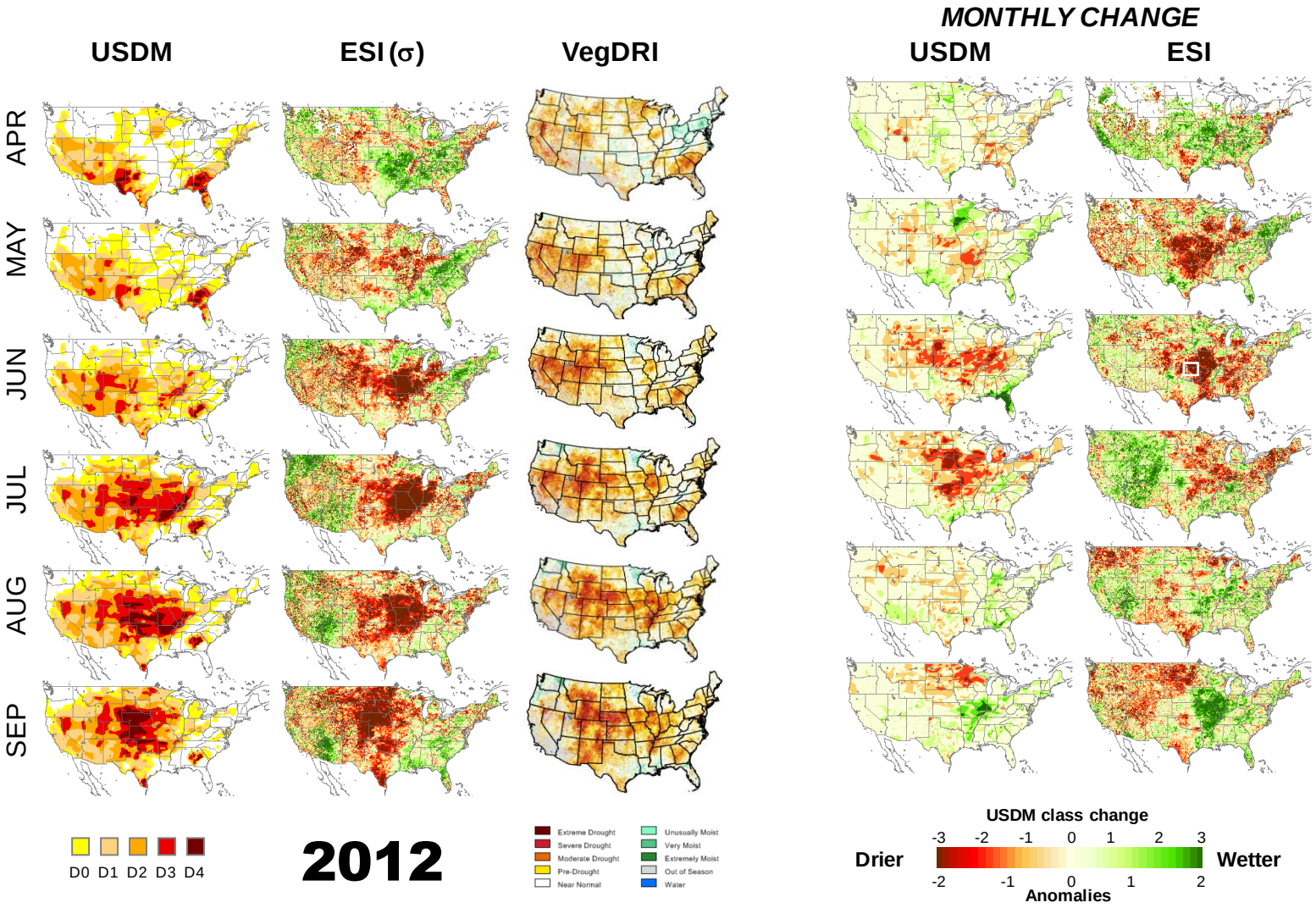
Satellite ET Drought Indicator



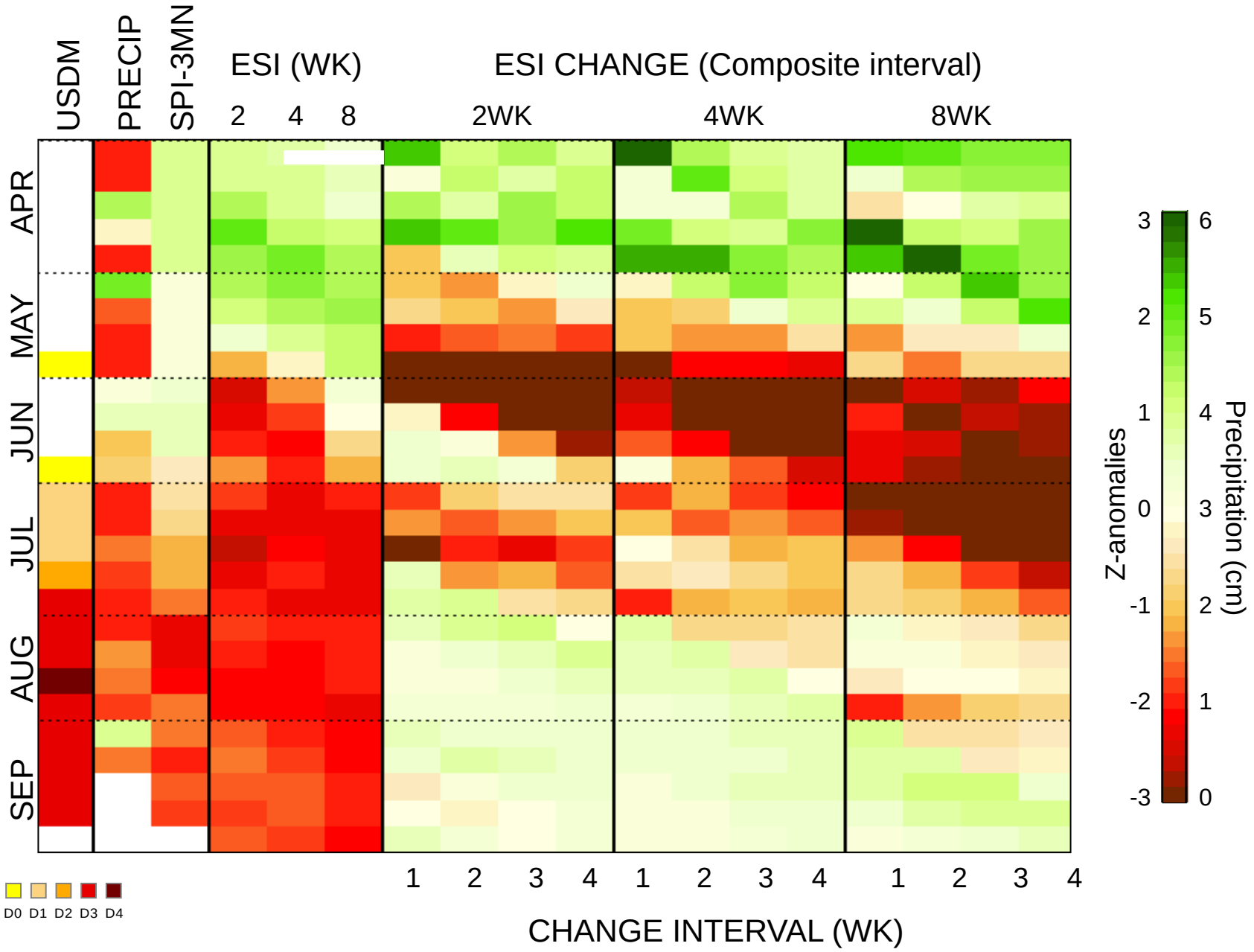

USDM class
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2006

Realtime Drought Monitoring

2012 FLASH DROUGHT



ESI Change over NE Oklahoma



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/index.php

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USDA

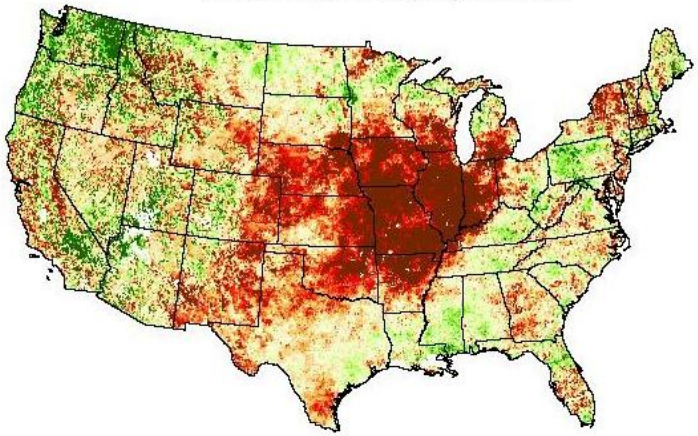
Evaporative Stress Index

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.

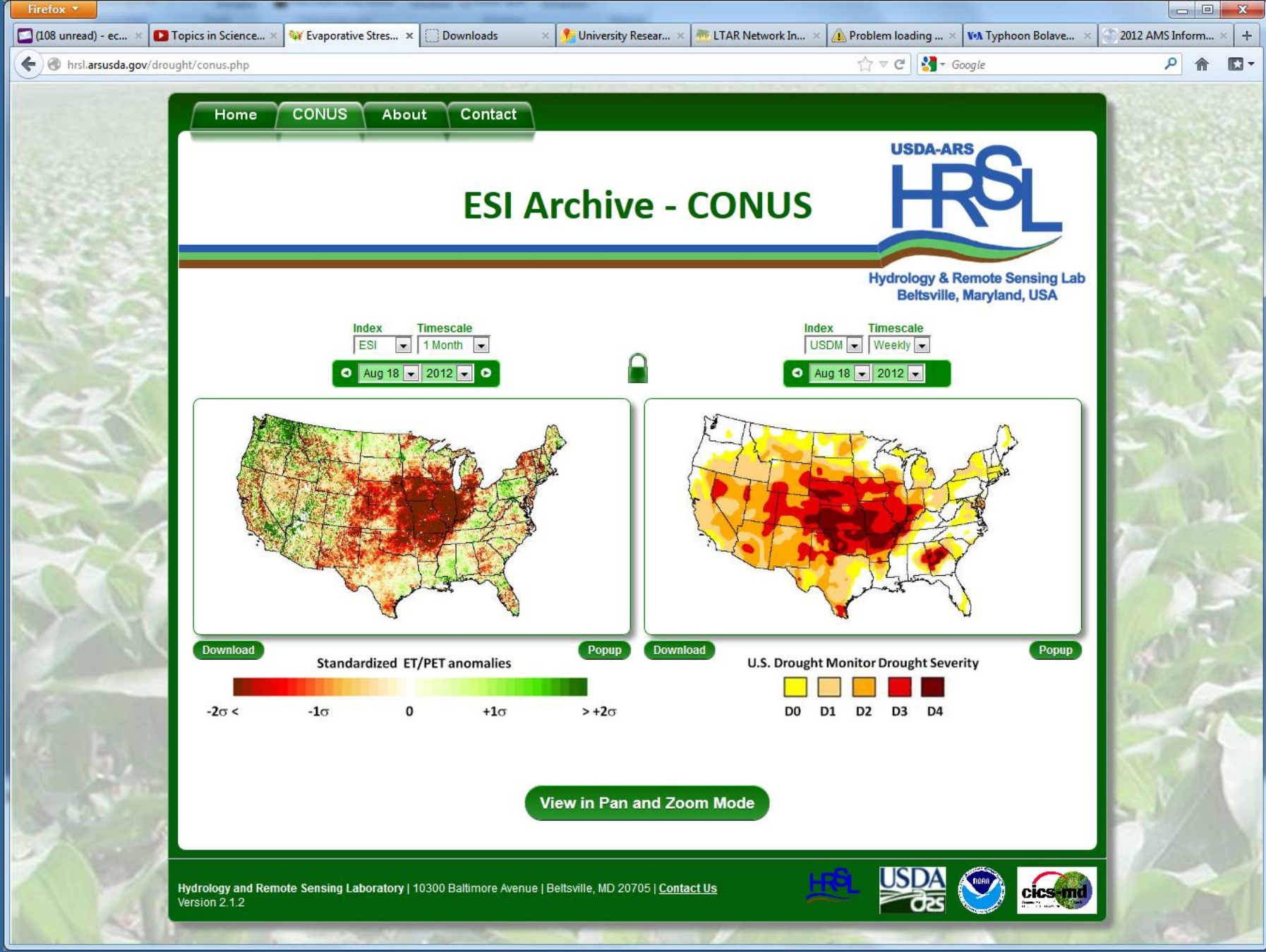
Coverage

Current Conditions

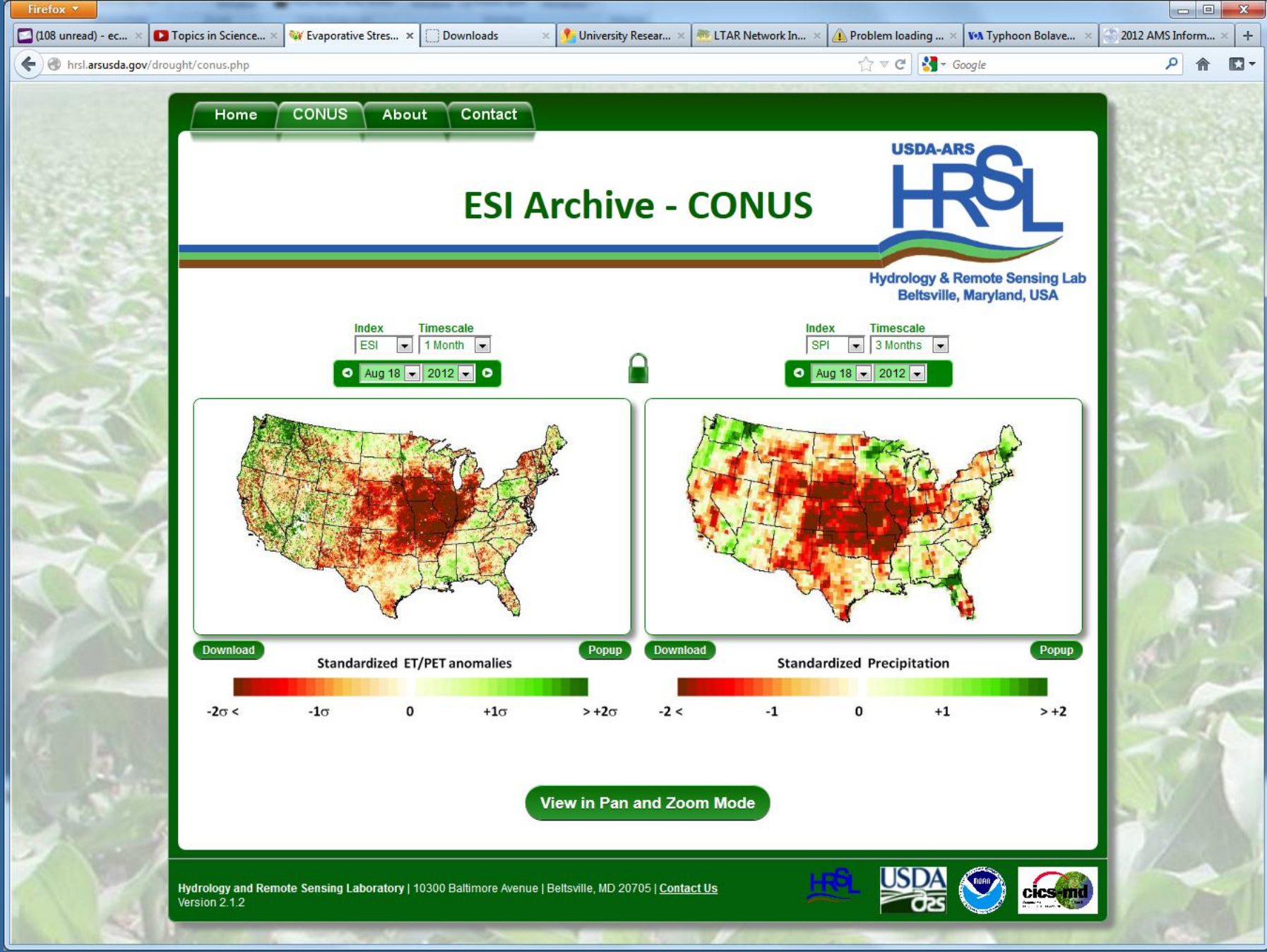
Hydrology and Remote Sensing Laboratory | 10300 Baltimore Avenue | Beltsville, MD 20705 | Contact Us
Version 2.1.2

hrsl.arsusda.gov/drought/index.php

Realtime Drought Monitoring

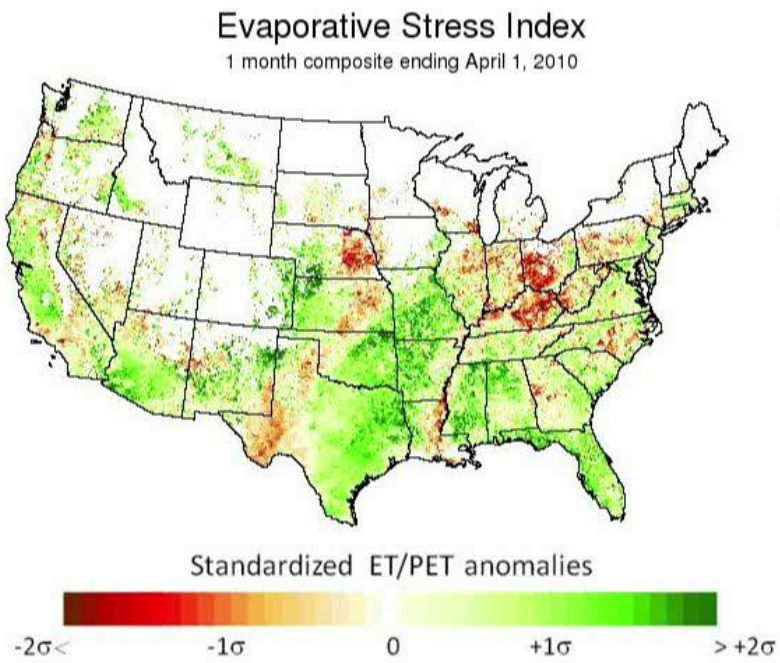


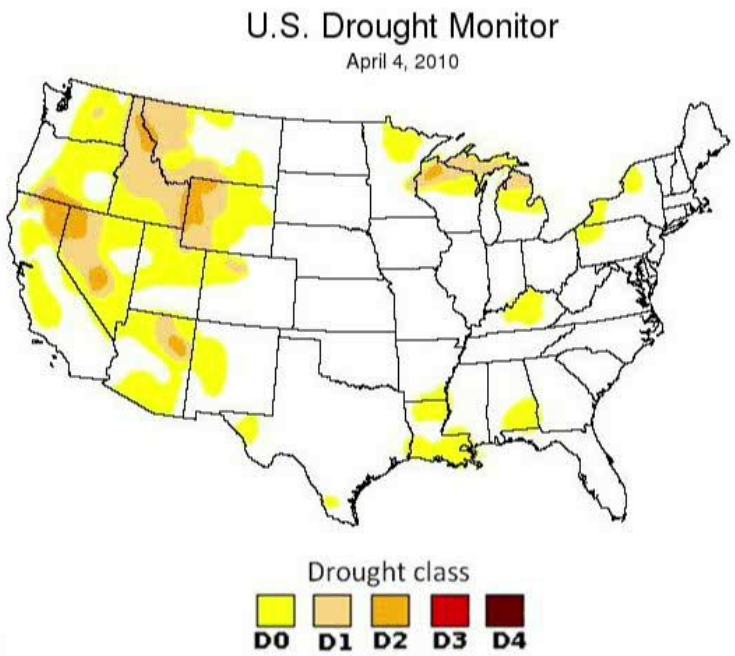
Realtime Drought Monitoring



Realtime Drought Monitoring

DROUGHT: 2010-2012

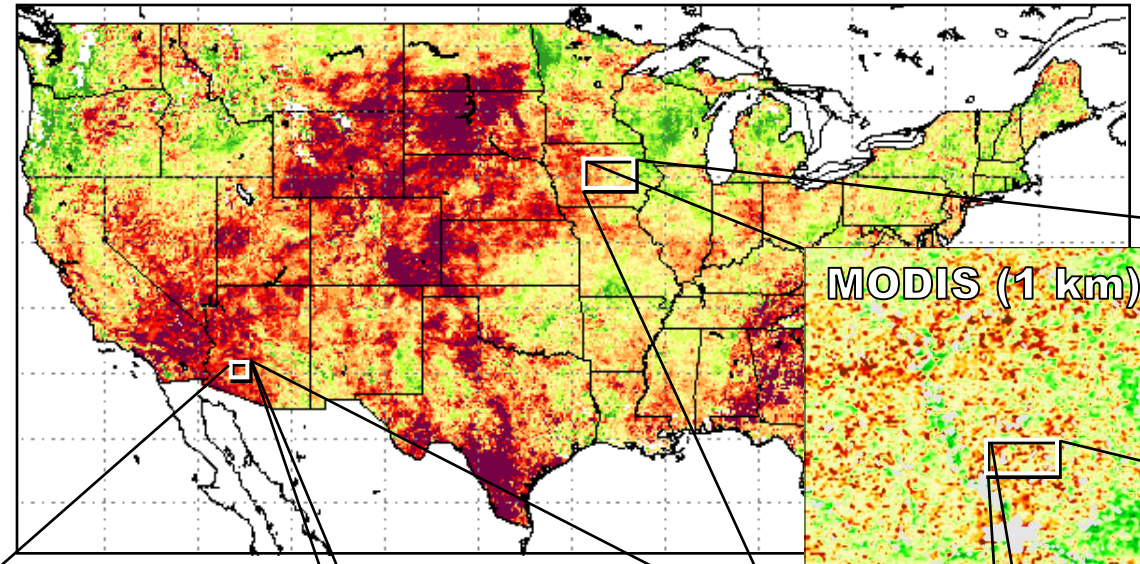


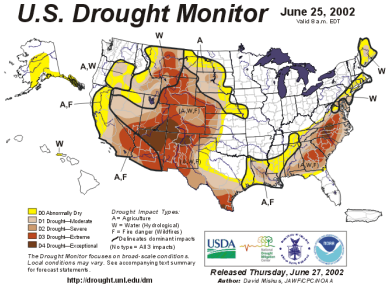


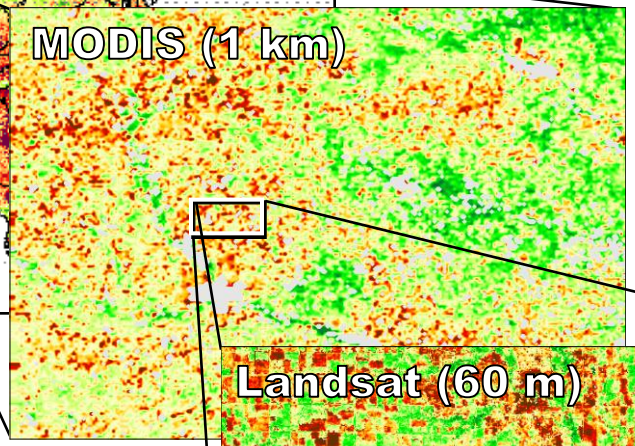
Multiscale Drought Monitoring

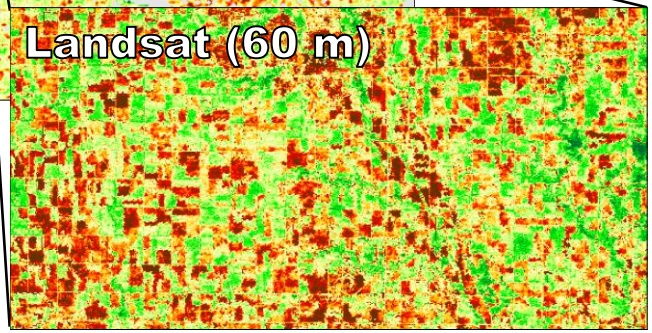
GOES Evaporative Stress Index

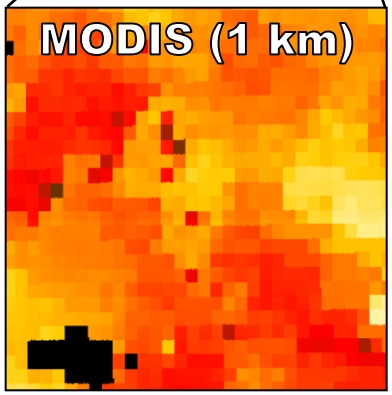
JUNE 2002

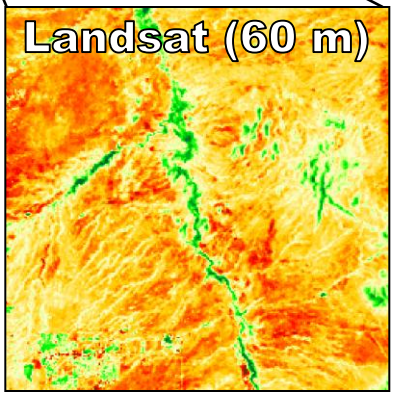








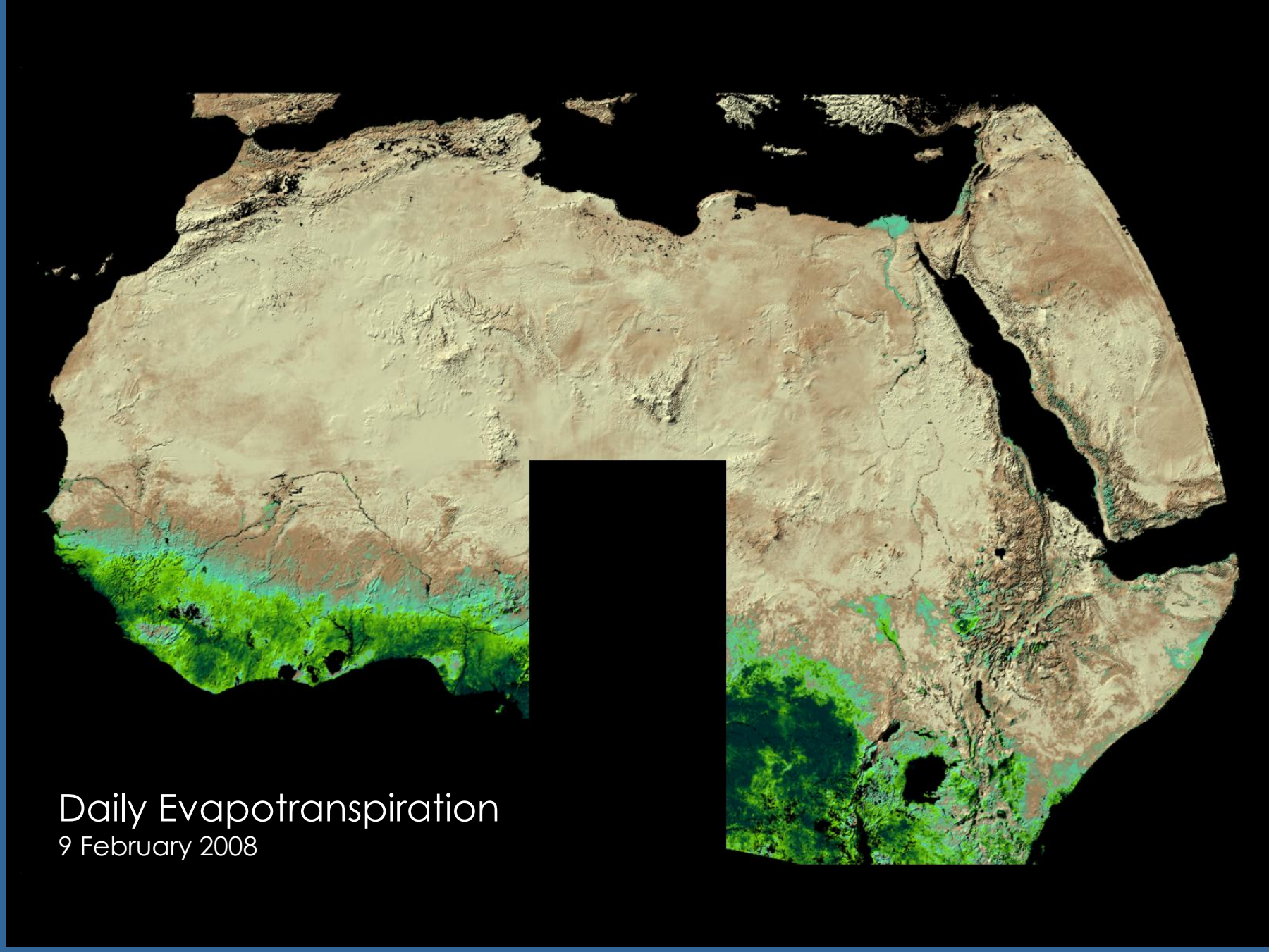




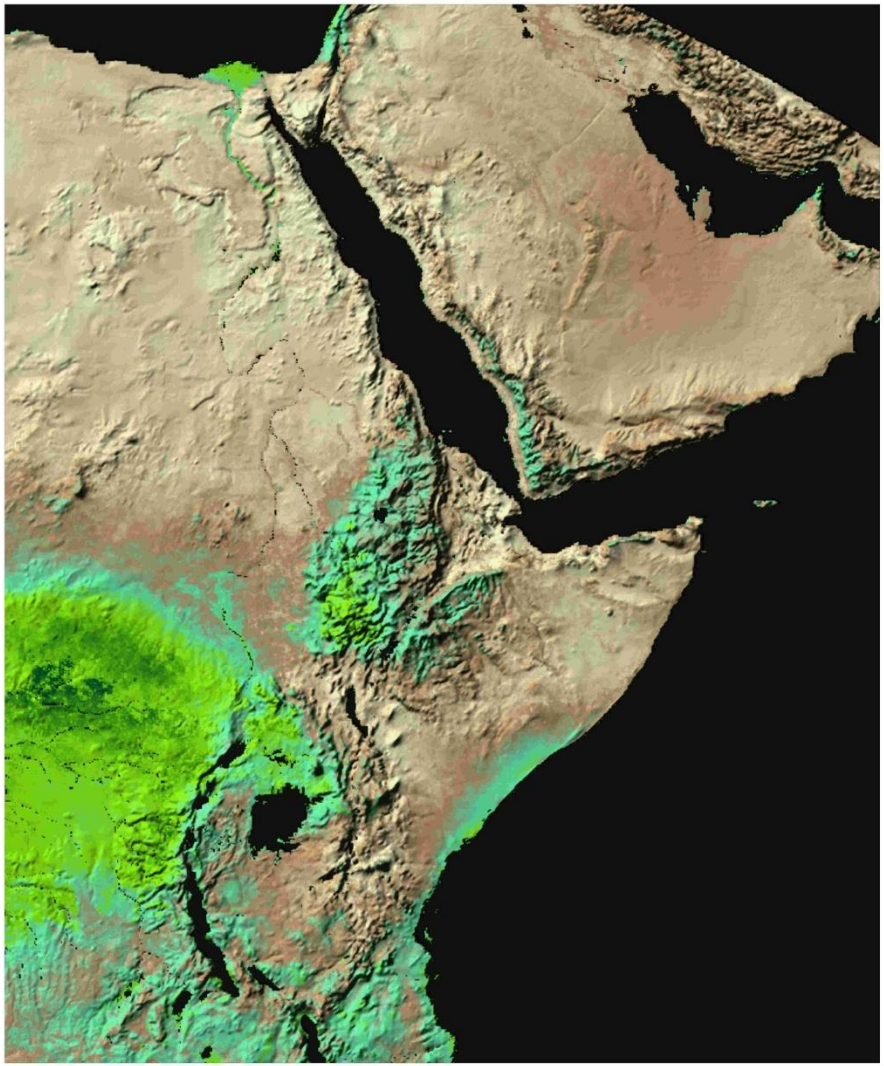
APPLICATIONS FOR SATELLITE ET

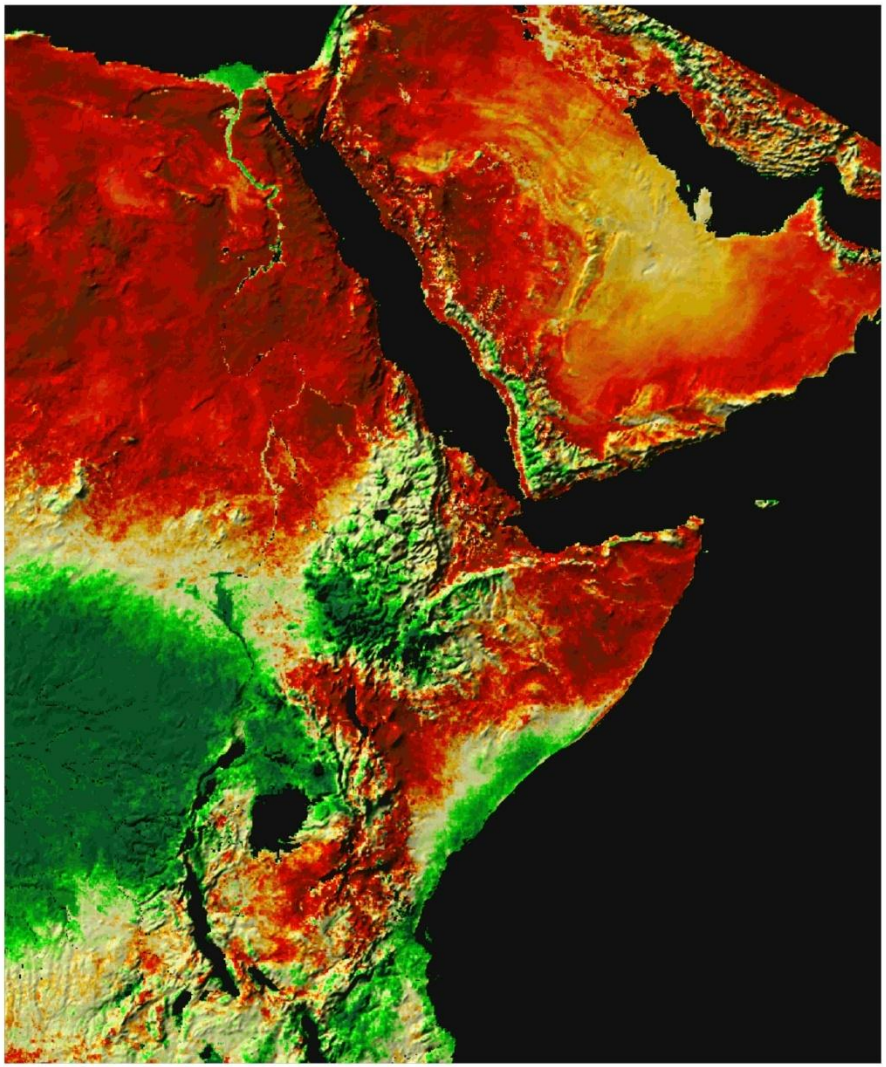
… Food and Water Security

ALEXI MENA Domains

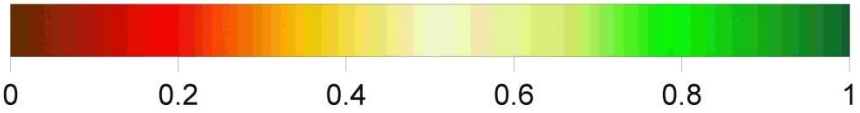


2009 APRIL-SEPTEMBER



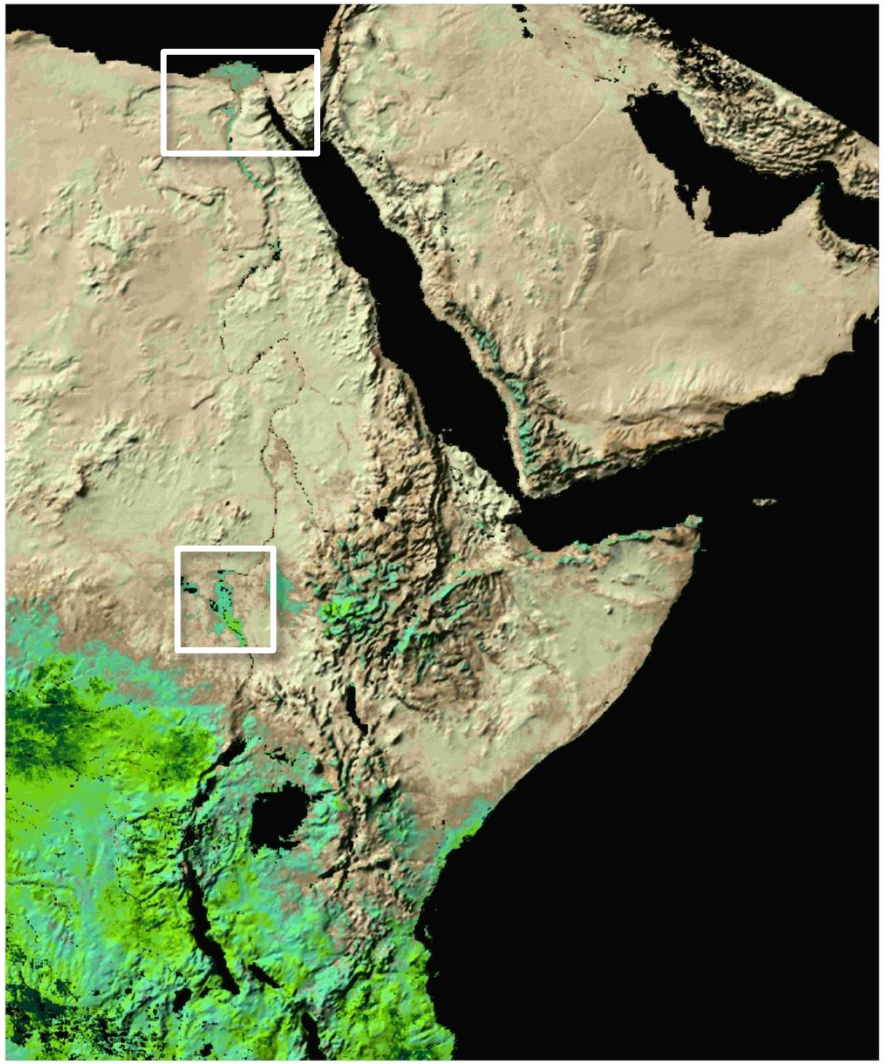


Average ALEXI ET (MJ m^{-2} d^{-1})

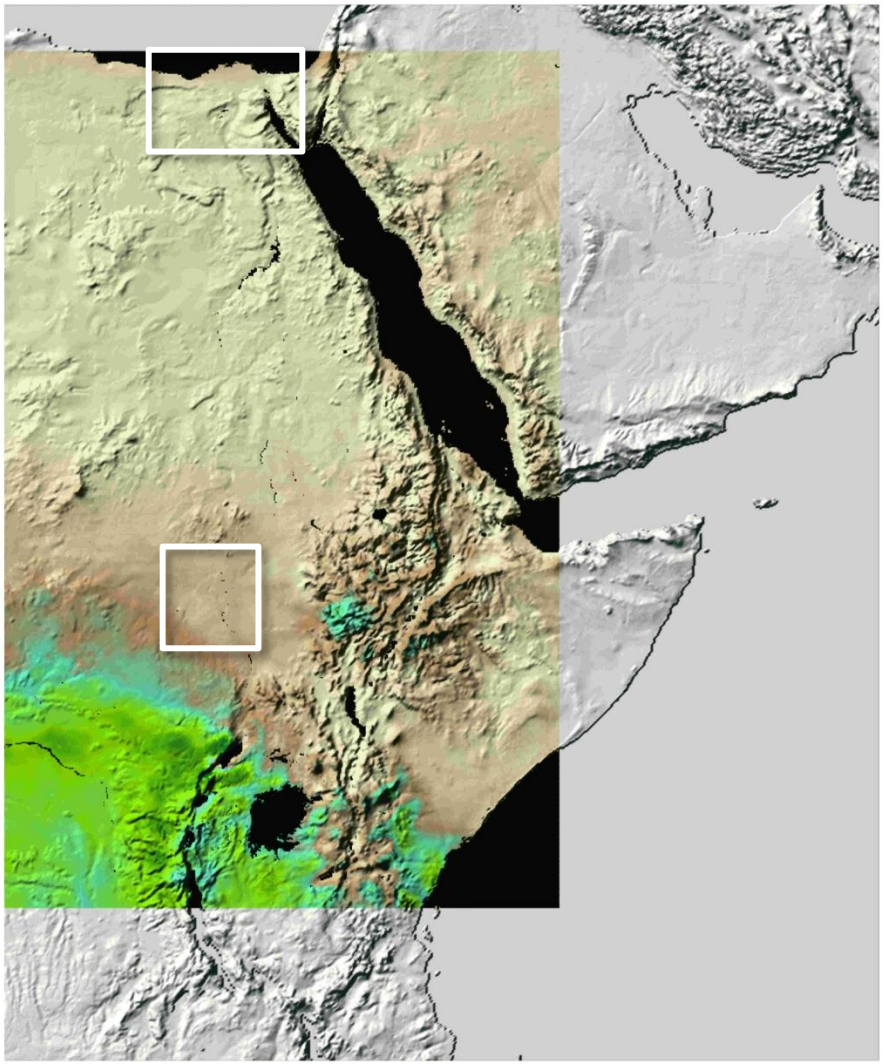


Average ALEXI ET/PET

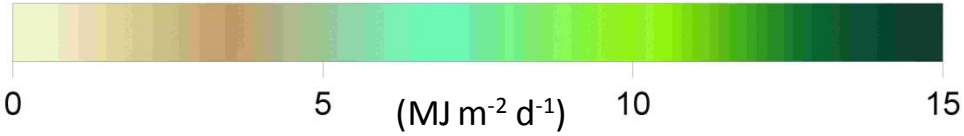
2009 FEBRUARY



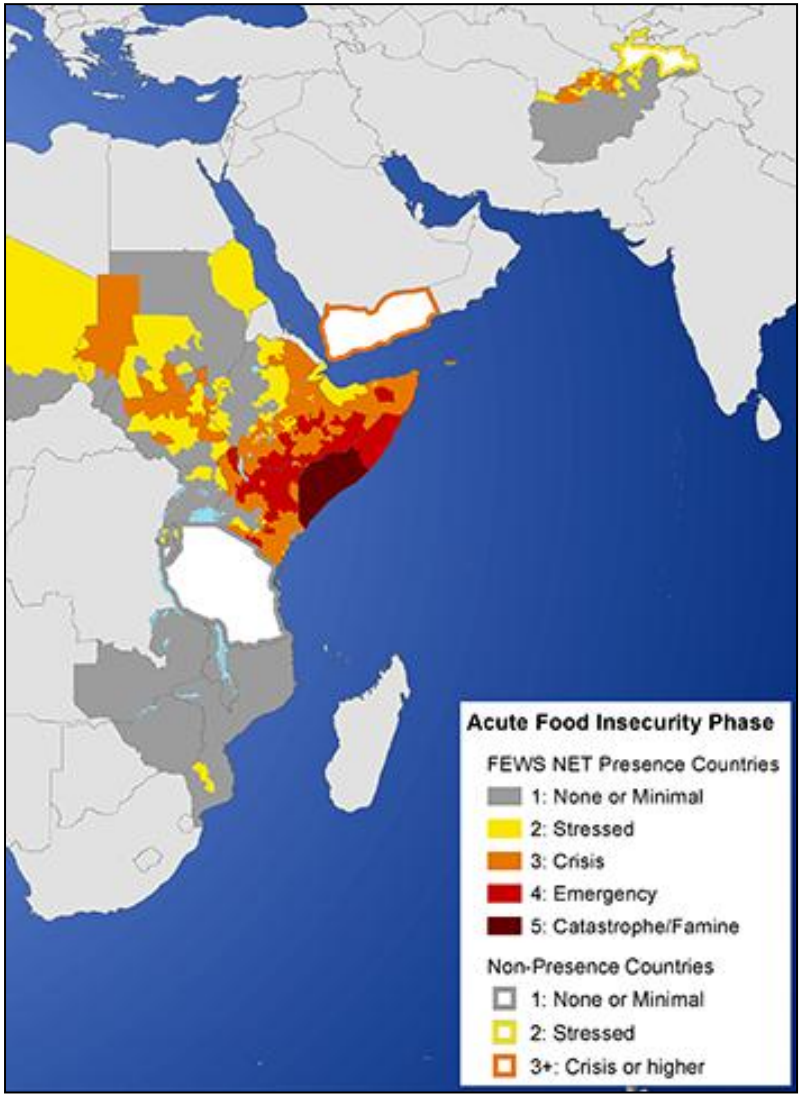
Average ALEXI ET

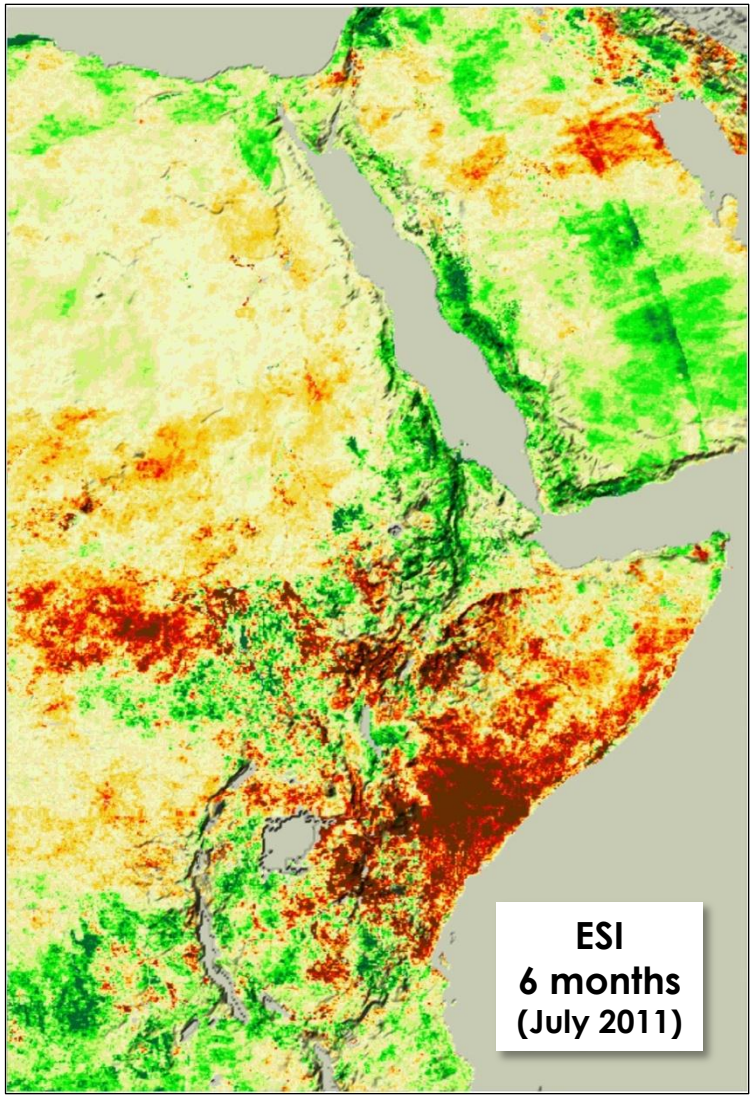


Average Noah ET



2011 Famine in Somalia





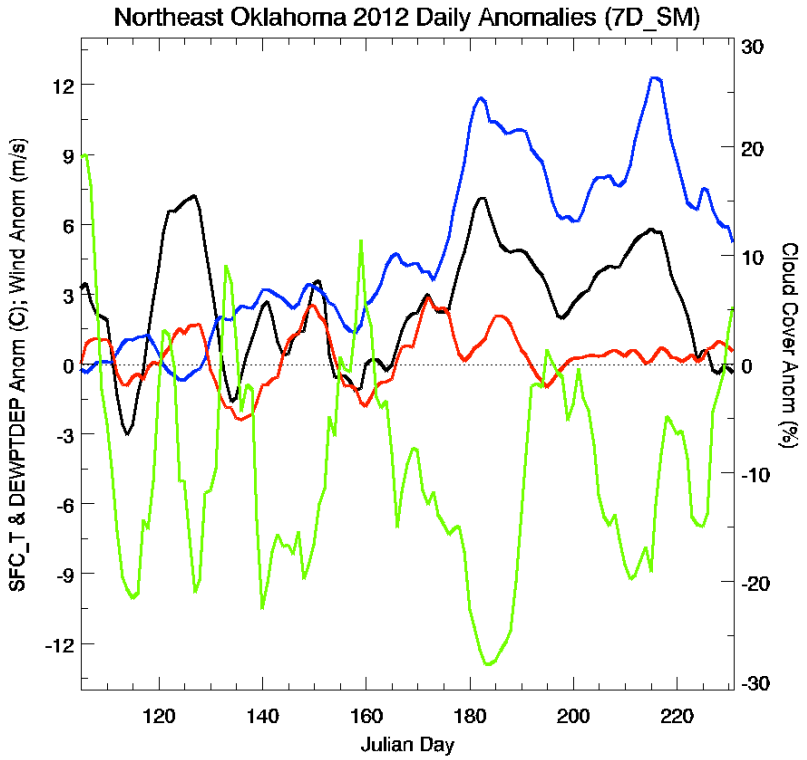
Evaporative Stress Index

- Monitors anomalous water use patterns related to agricultural drought
- Land-surface temperature conveys early warning of vegetation stress
- Independent check on precipitation-based indices
- Applications in global water and food security

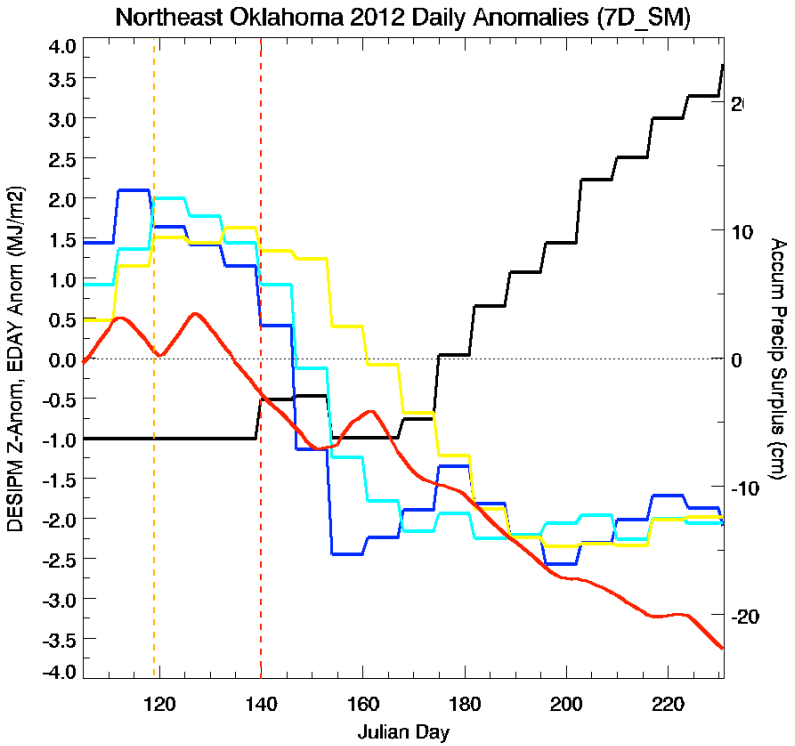
Conclusions

ESI Change over NE Oklahoma

Air temp
Dewpoint temp
Wind
Cloud cover

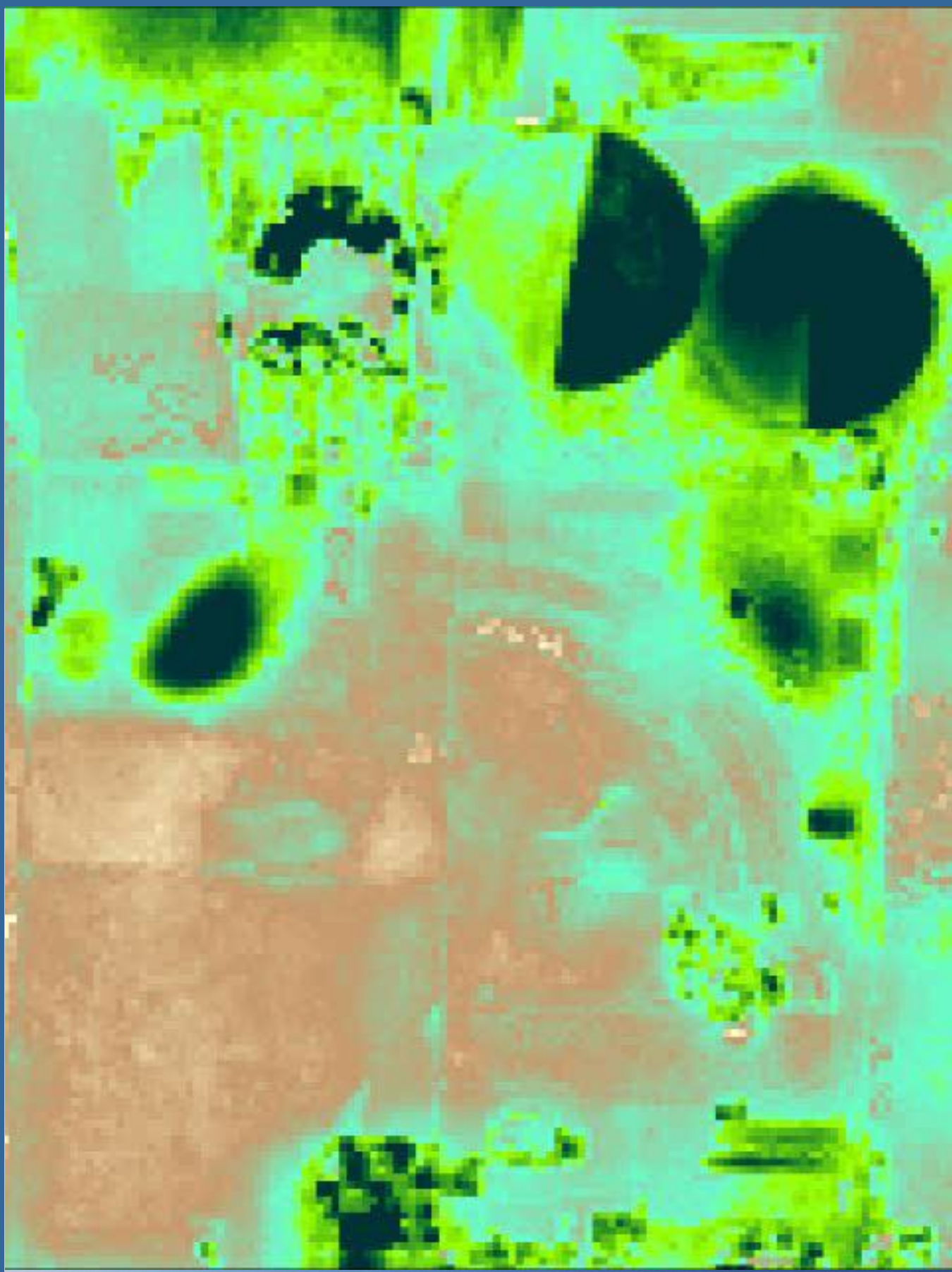


USDM
ESI – 2WK
ESI – 4WK
ESI – 8WK
Precip surplus

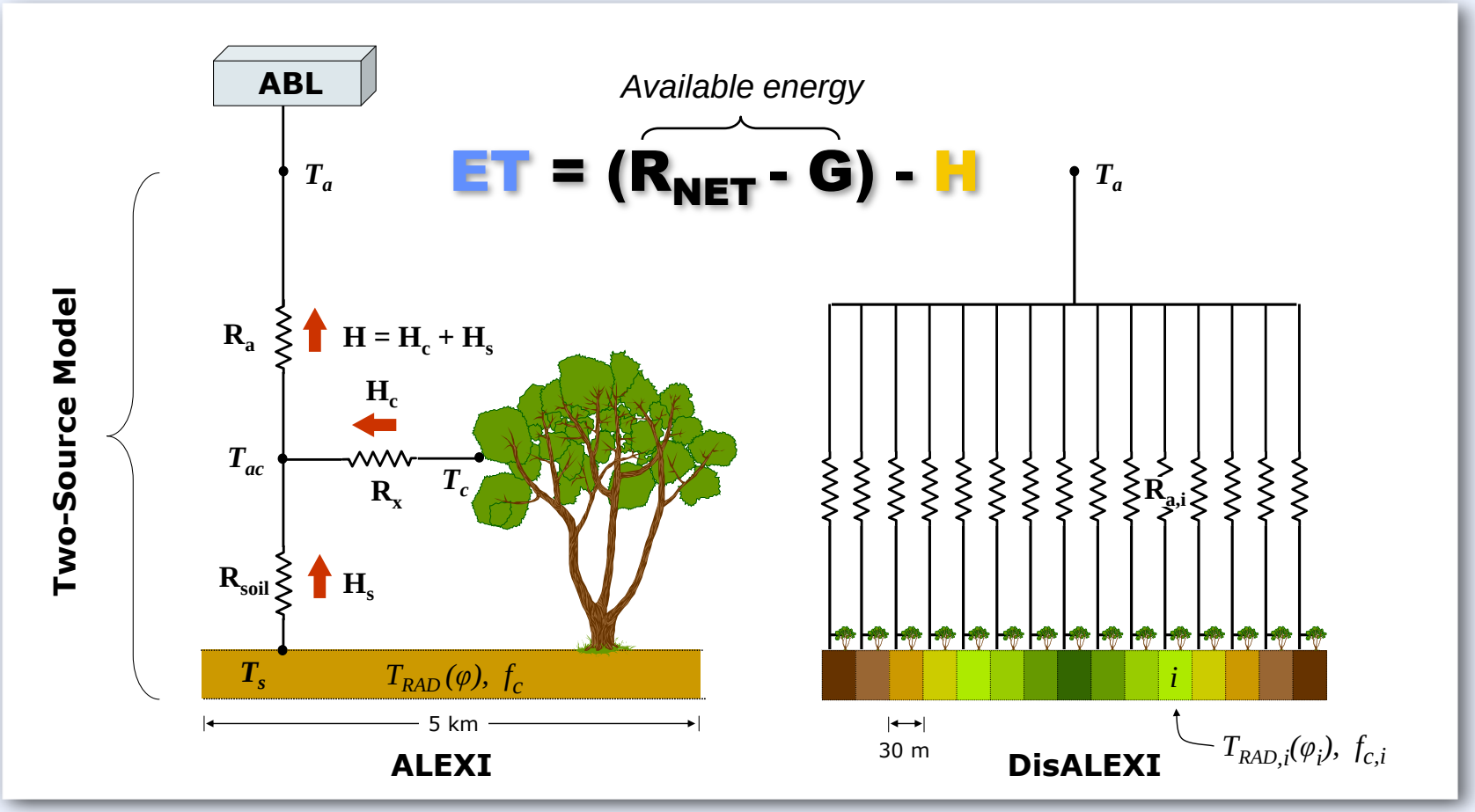


PIXEL SCALE	SPATIAL RESOLUTION	TEMPORAL RESOLUTION	EXAMPLE
Coarse	5-10 km	15 min	**GOES**
Moderate	1 km	Daily	**MODIS**
Fine	60–120 m	Once every 16 days	**Landsat**

Daily ET at field scale



Atmosphere-Land Exchange Inverse (ALEXI)



Regional scale

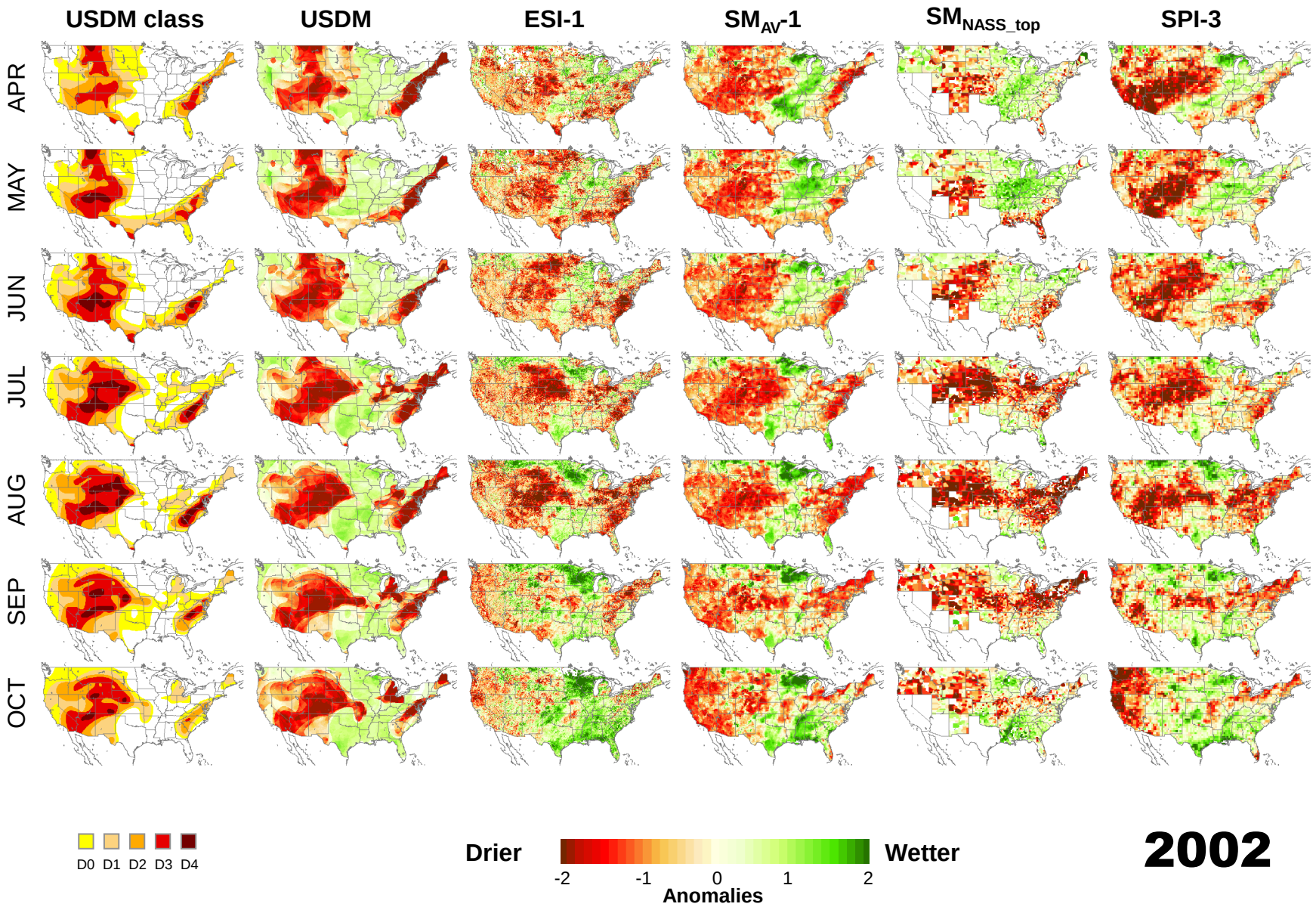
Surface temp: ΔT_{RAD} - GOES

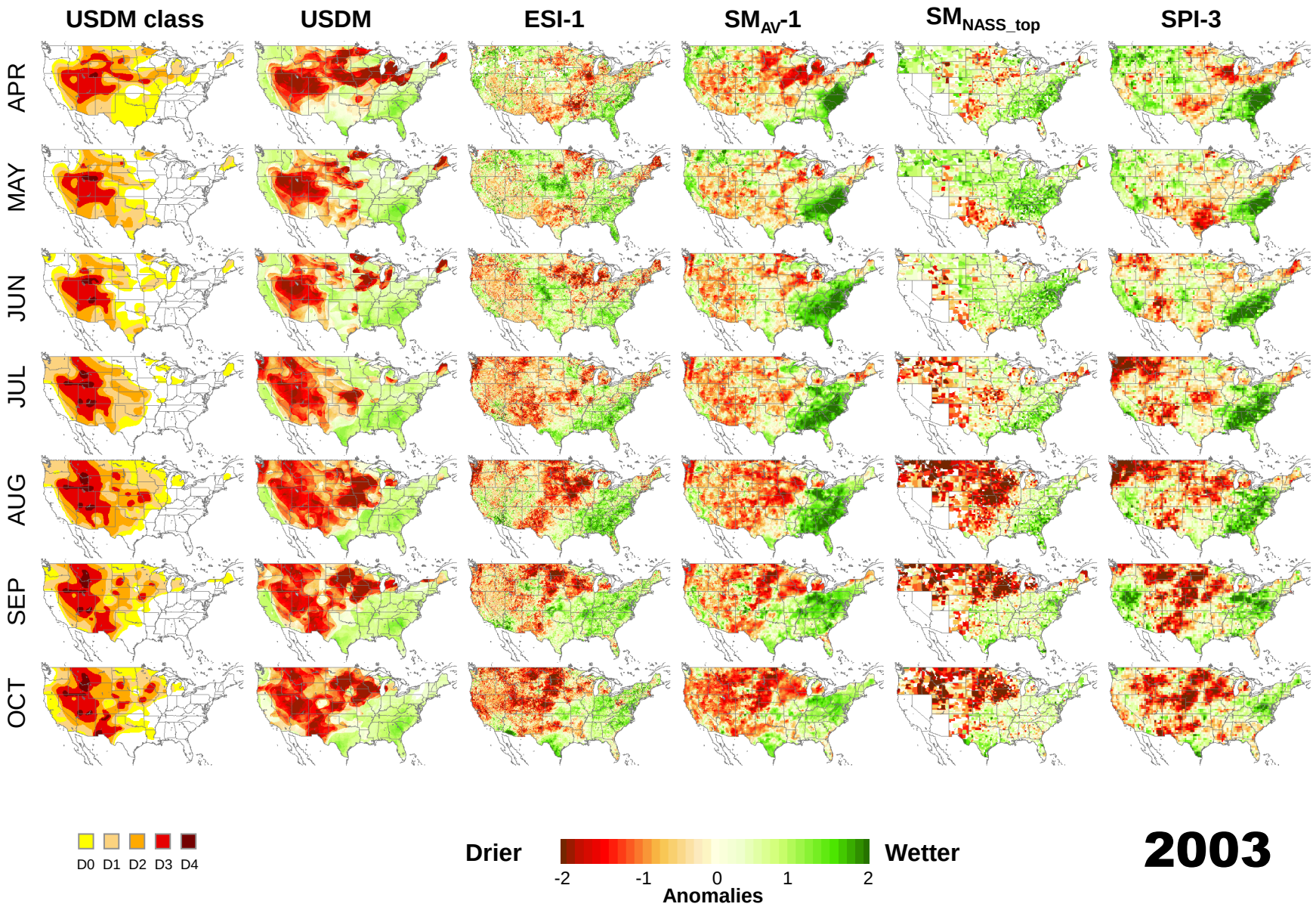
Air temp: T_a - ABL model

Landscape scale

T_{RAD} - TM, MODIS, HyspIRI

T_a - ALEXI


USDM class
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2002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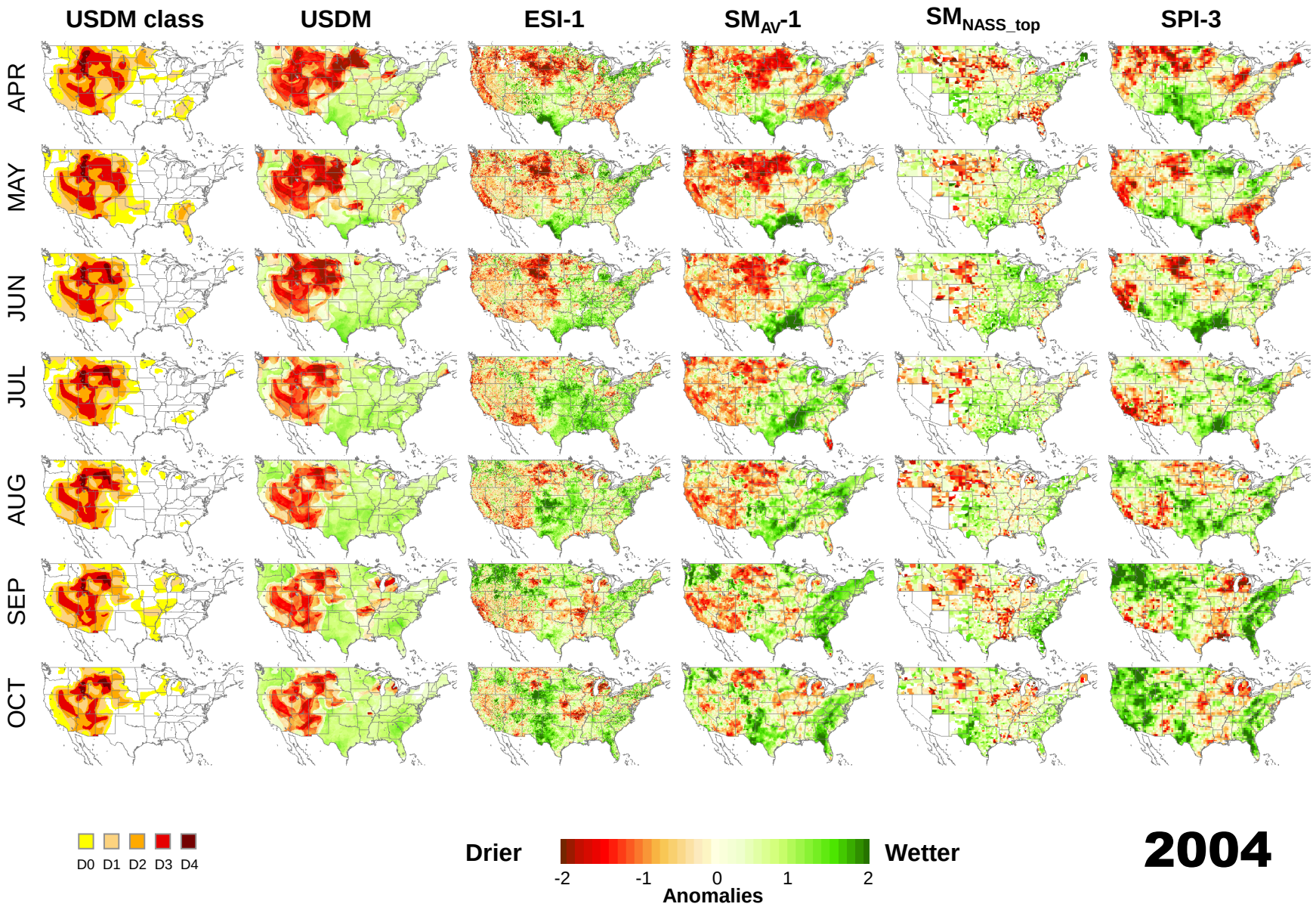
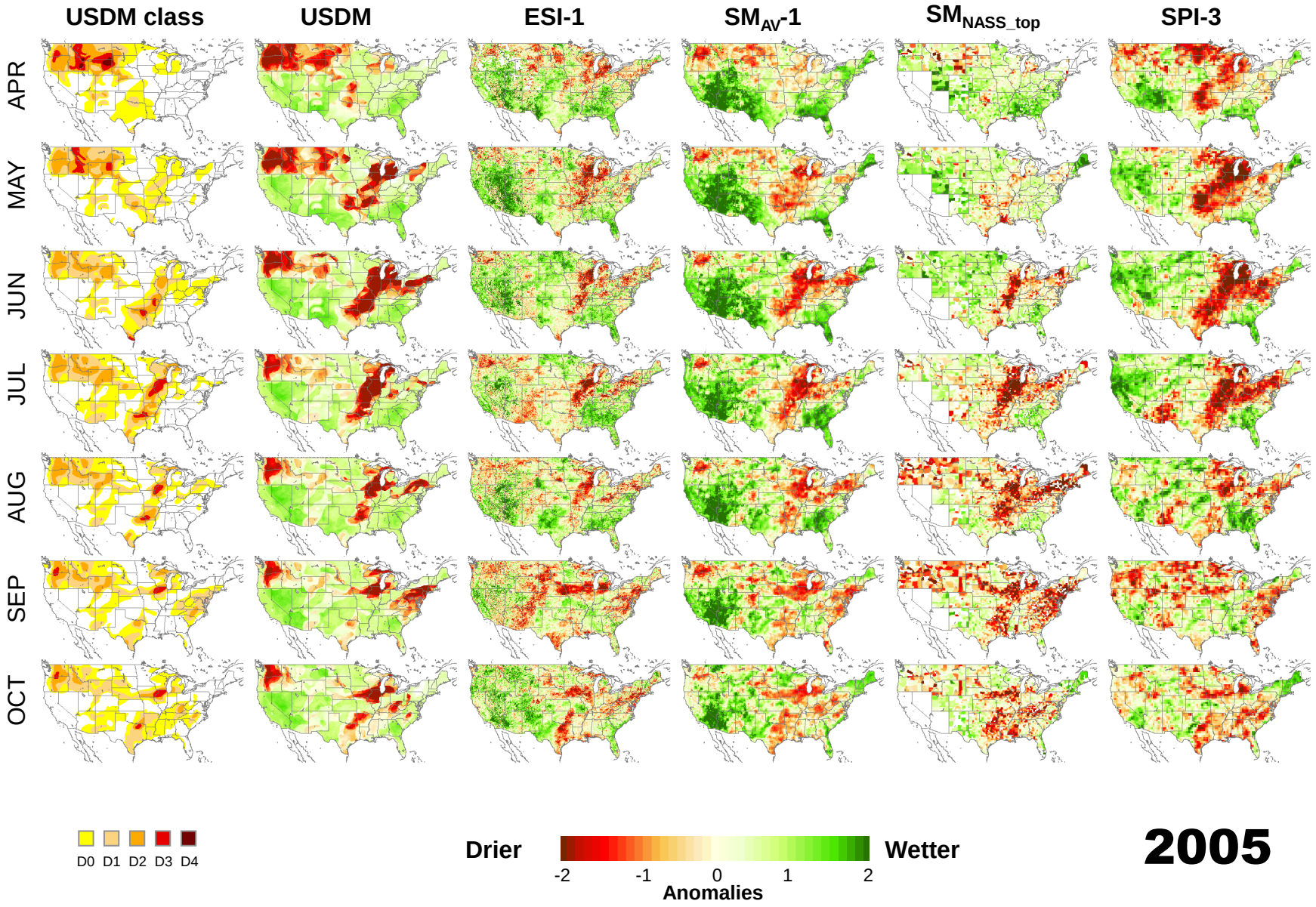
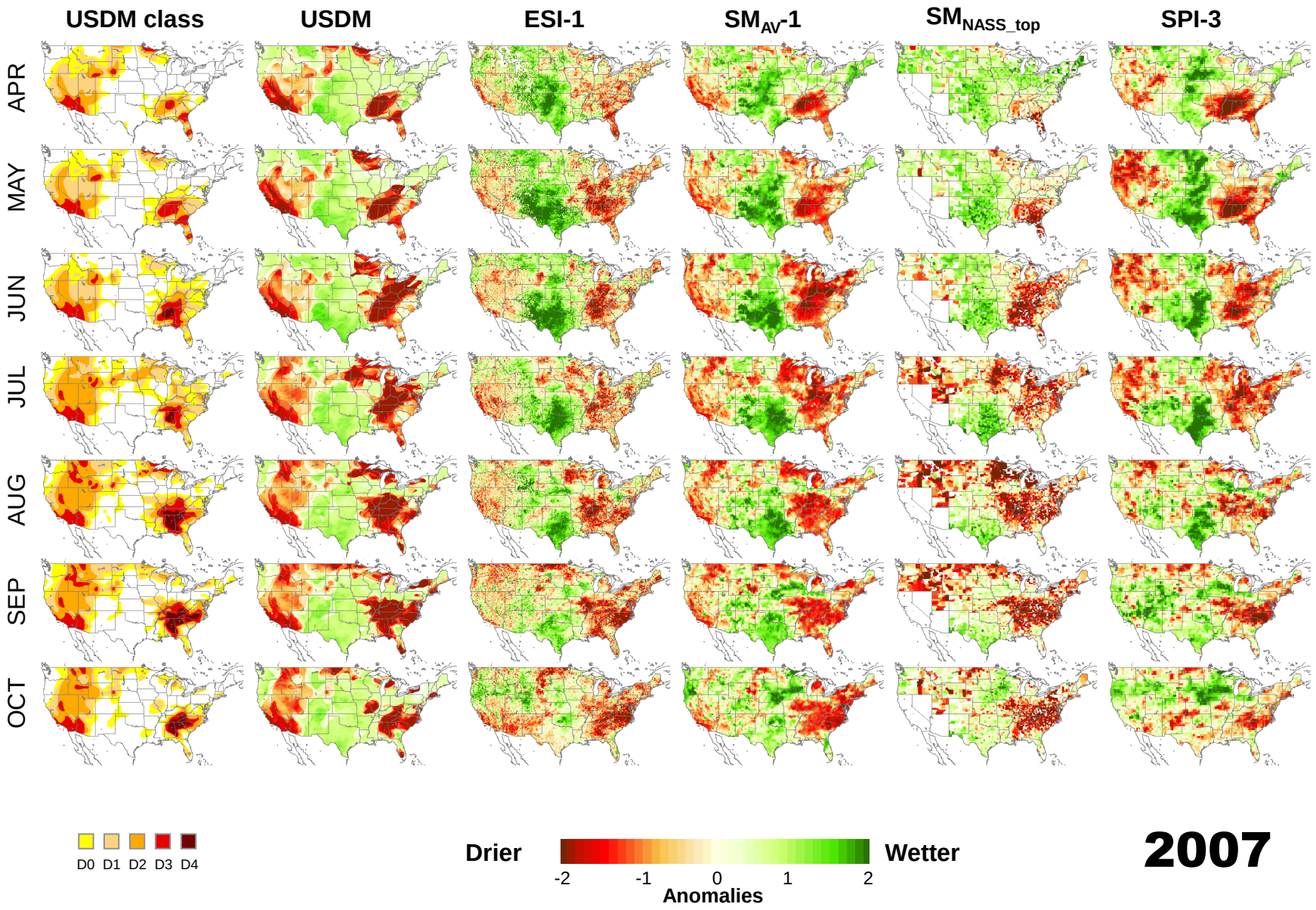
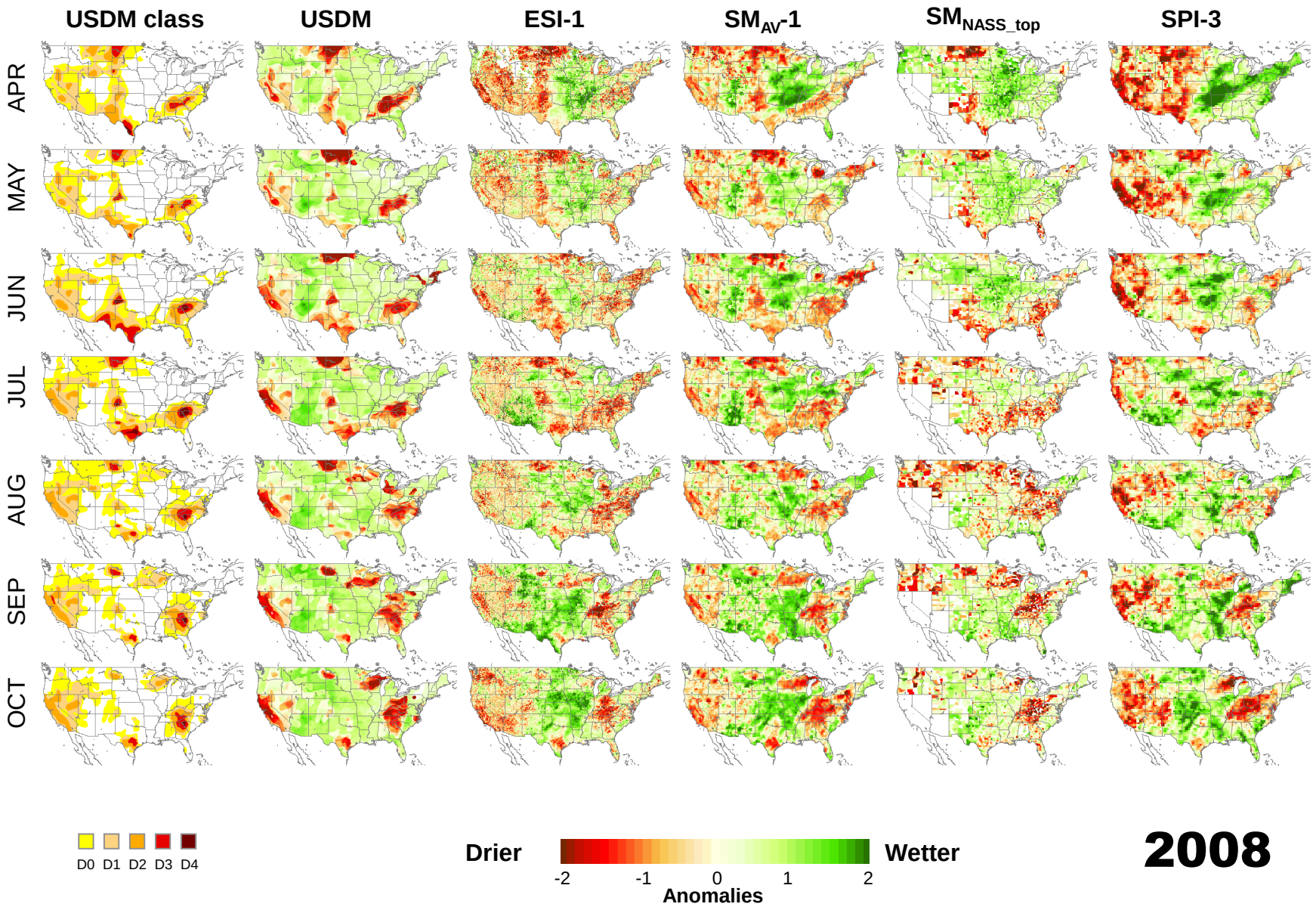
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2003


USDM class
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2004


USDM class
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2005


USDM class
USDM
ESI-1
SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2007


USDM class
USDM
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SM$_{NASS_top}$
SPI-3
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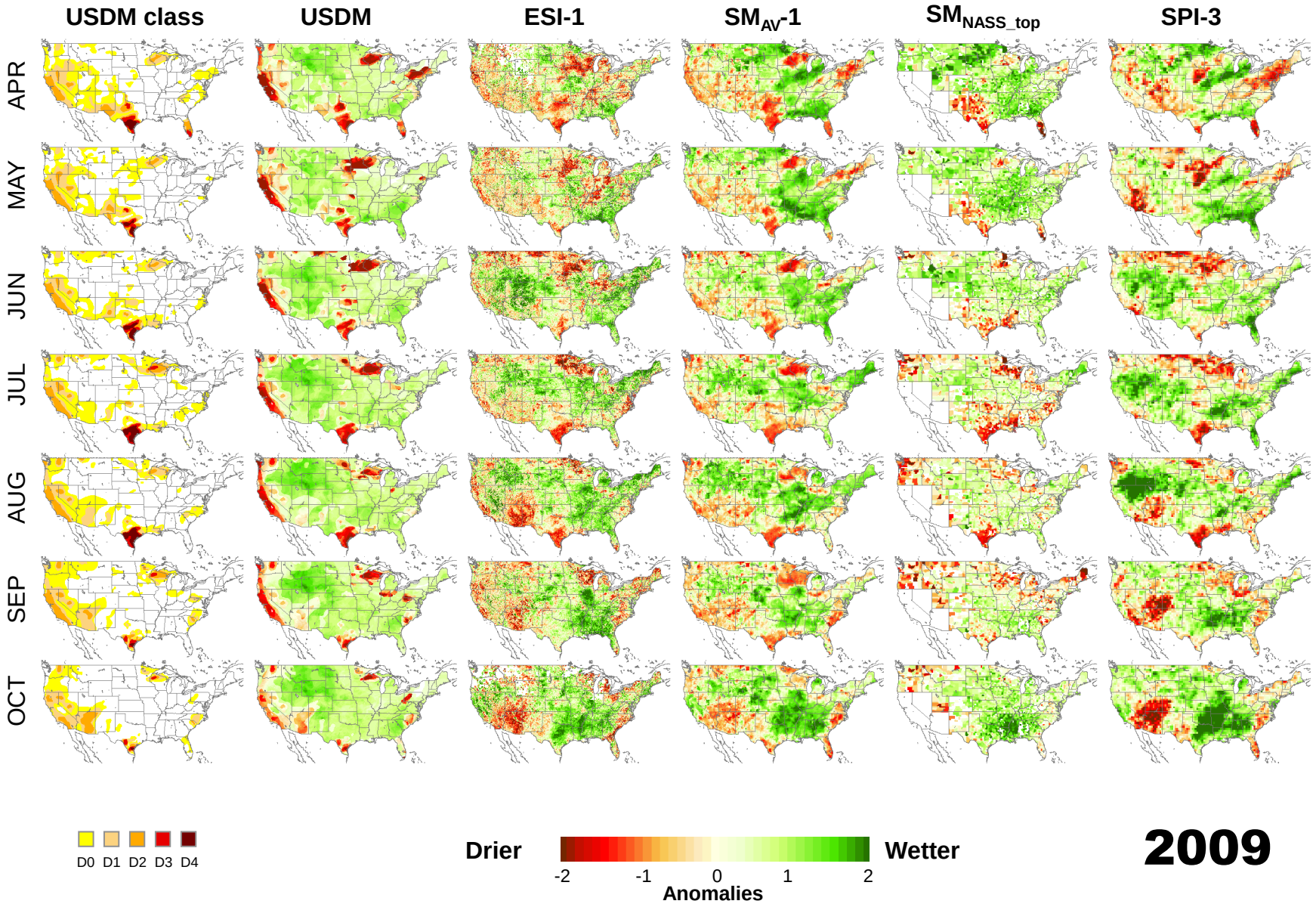
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2008


USDM class
USDM
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SM$_{AV}$-1
SM$_{NASS_top}$
SPI-3
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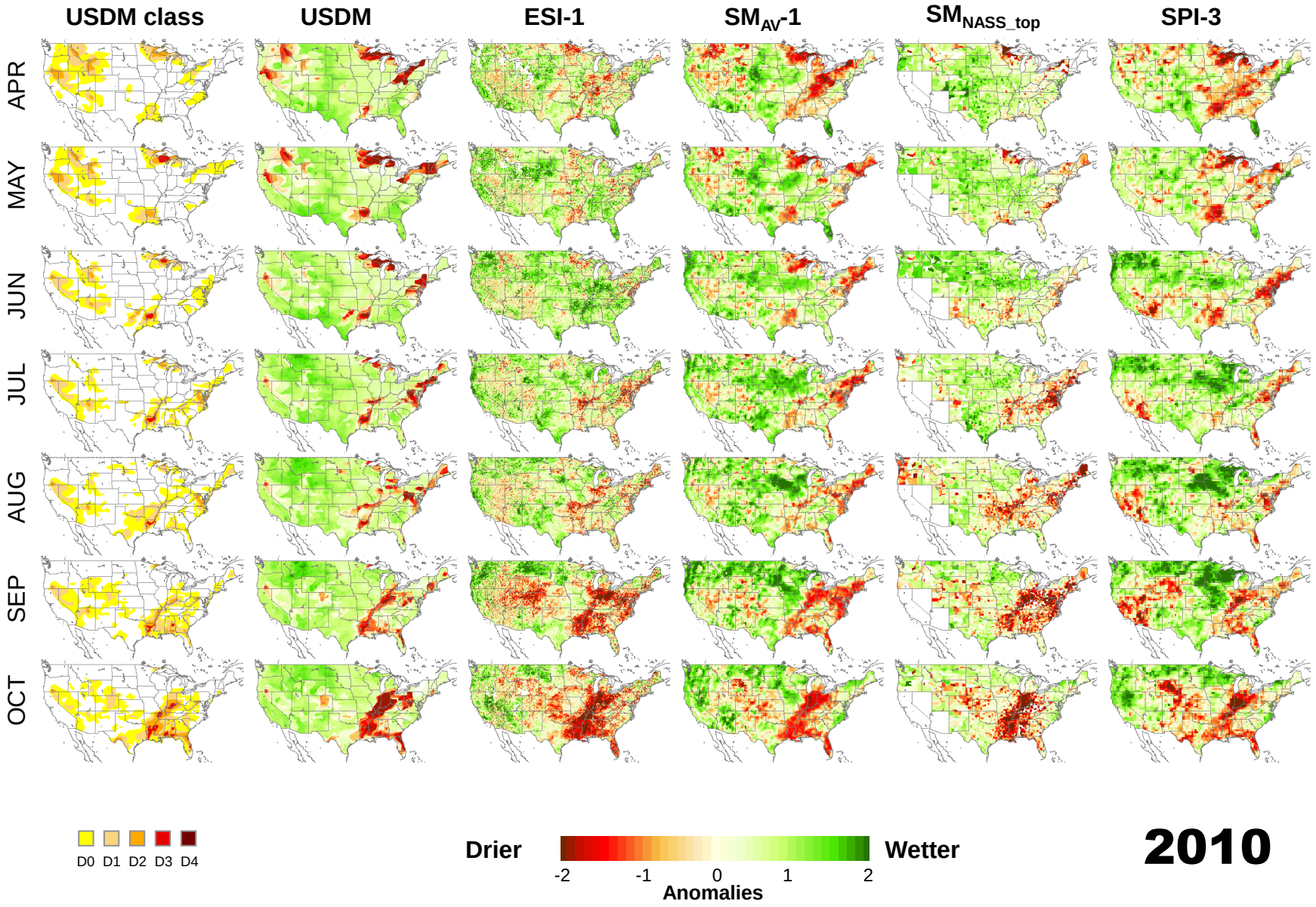
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2009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SPI-3
APR
MAY
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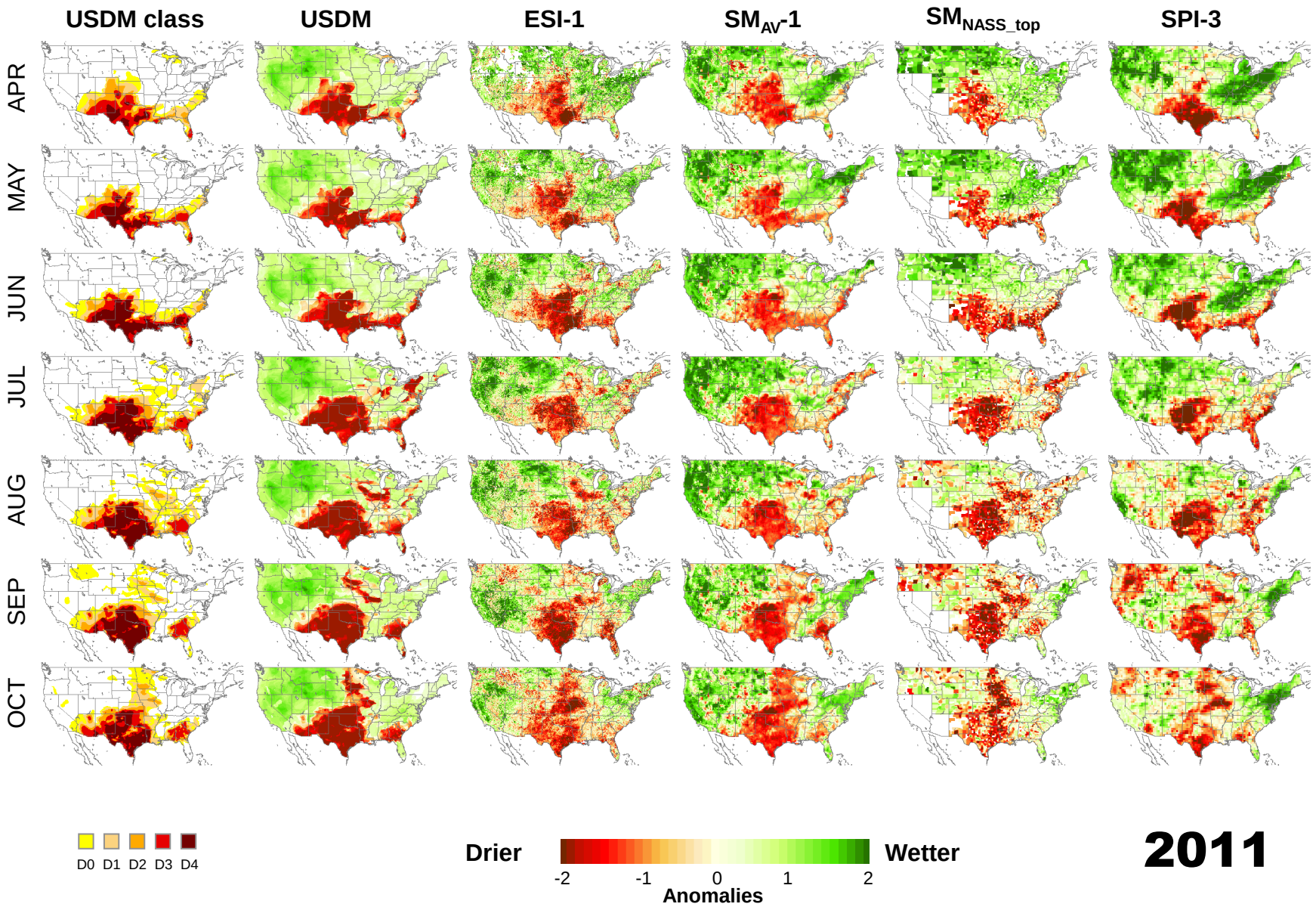
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2010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APR
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D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
Anomalies
2011