



Mapping Water Use and Drought from Space

Martha C. Anderson,

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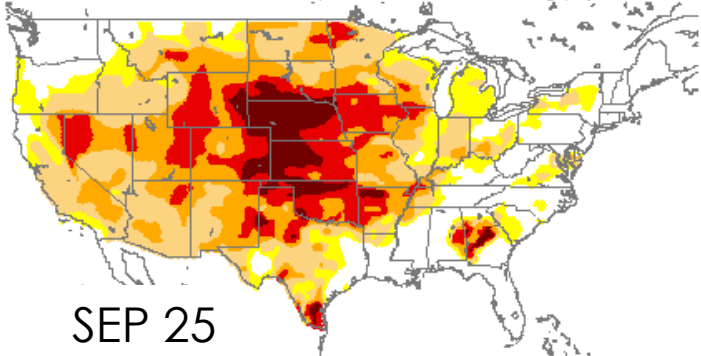
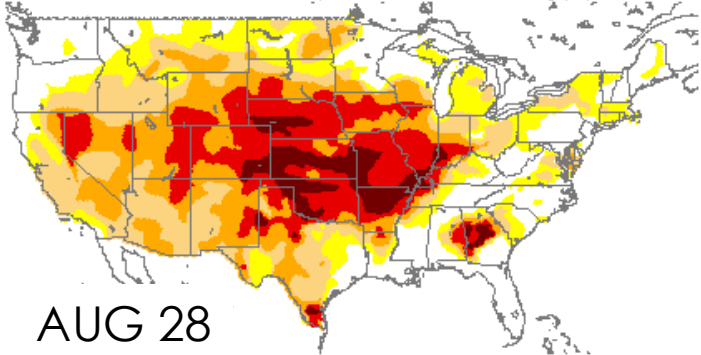
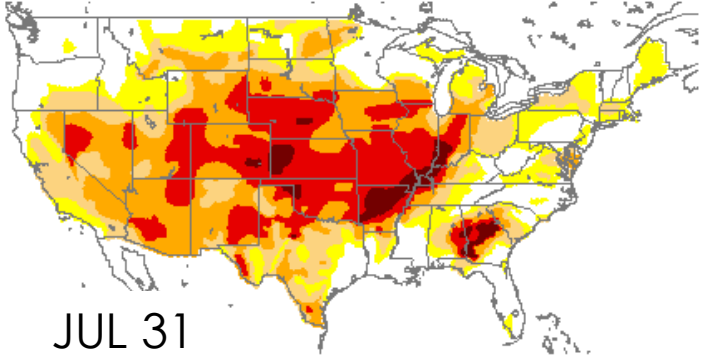
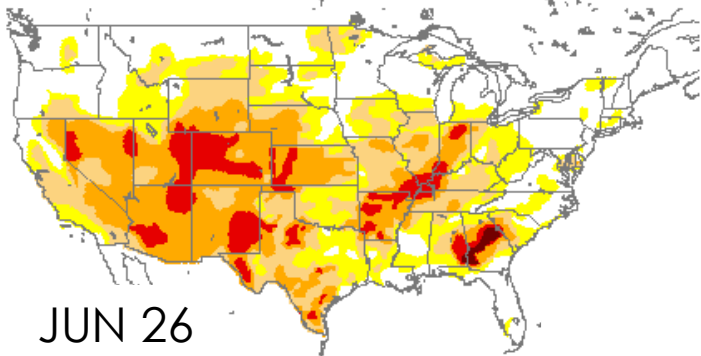
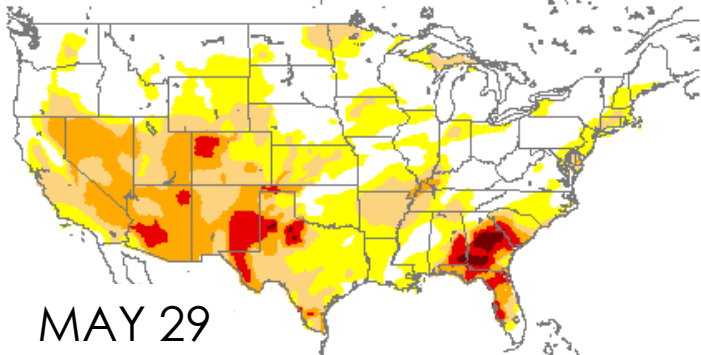
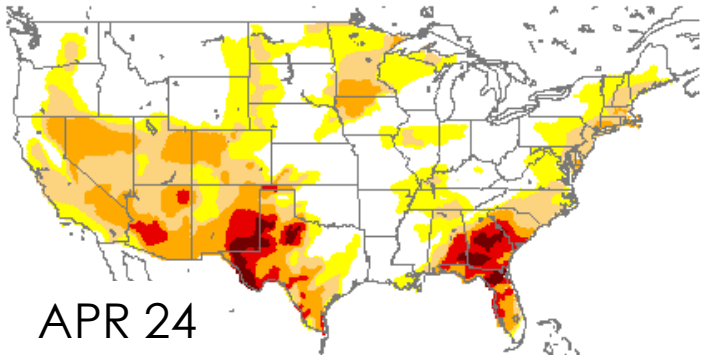
Chris Hain, Xiwu Zhan

NOAA-NESDIS, College Park, MD

Jason Otkin

CIMSS, UW-Madison, WI

US DROUGHT MONITOR

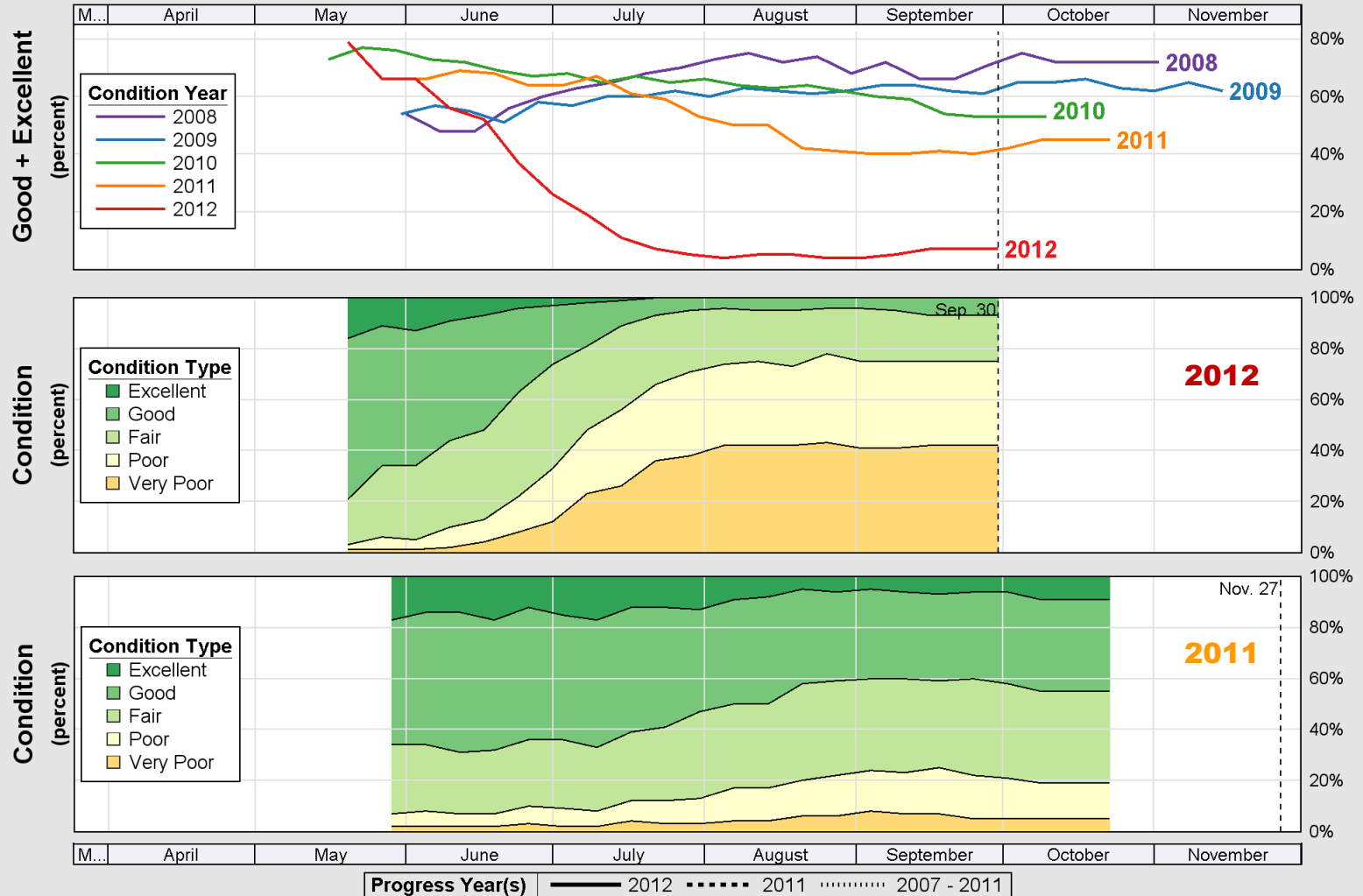


Flash Drought of 2012

USDA

Crop Progress and Condition: Corn in Illinois , 2012

NASS

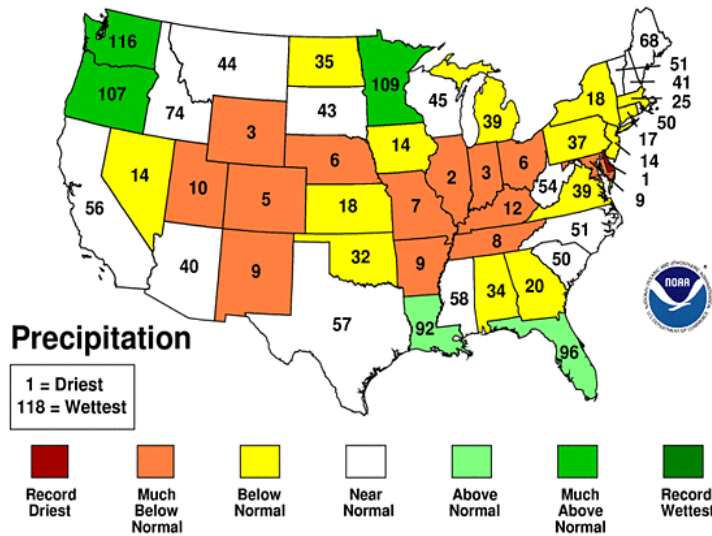


Source: National Agricultural Statistics Service (NASS), Crop Progress Report

“FLASH DROUGHT” CONDITIONS

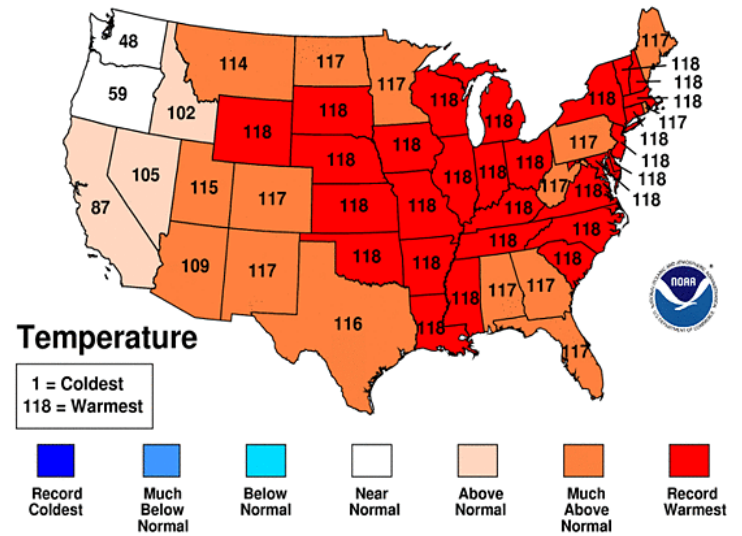
February-July 2012 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



February-July 2012 Statewide Ranks

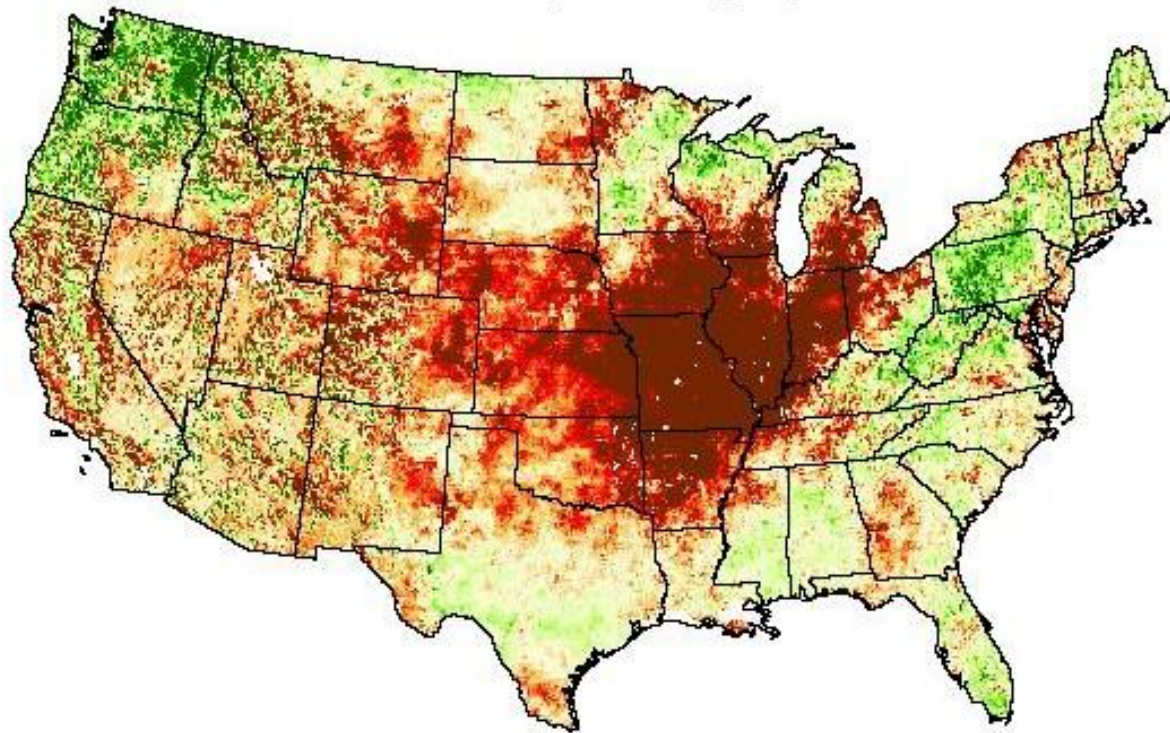
National Climatic Data Center/NESDIS/NOAA



Heatwave fueled enhanced
Evapotranspiration (ET)

Evaporative Stress Index

3 month composite ending July 28, 2012



Standardized ET/PET anomalies



-2σ

-1σ

0

$+1\sigma$

$> +2\sigma$

Lower than normal

Higher than normal

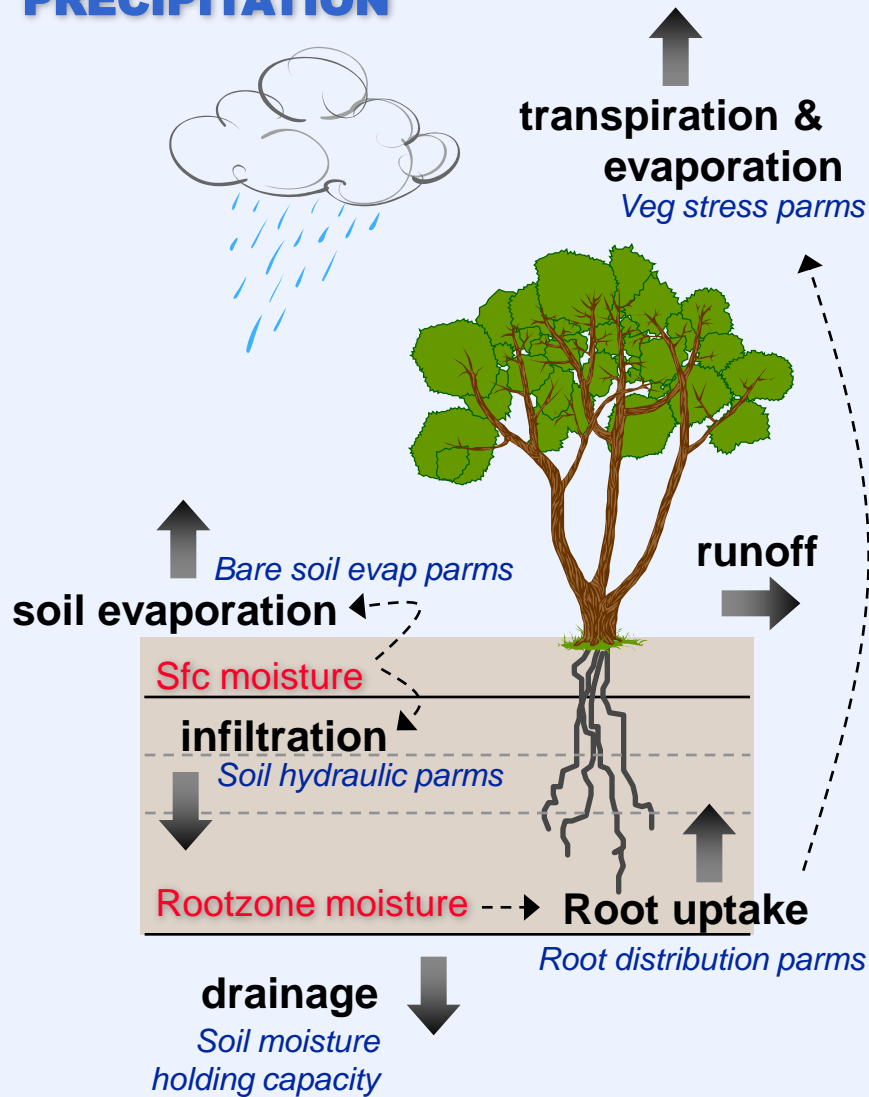
The background of the slide is a dark, almost black, textured surface that resembles a topographic map or a satellite image of a rugged terrain. In the upper portion, a clear blue sky is visible above a dark silhouette of a mountain range. The overall aesthetic is scientific and data-driven.

MAPPING EVAPOTRANSPIRATION

*... Water balance vs.
energy balance*

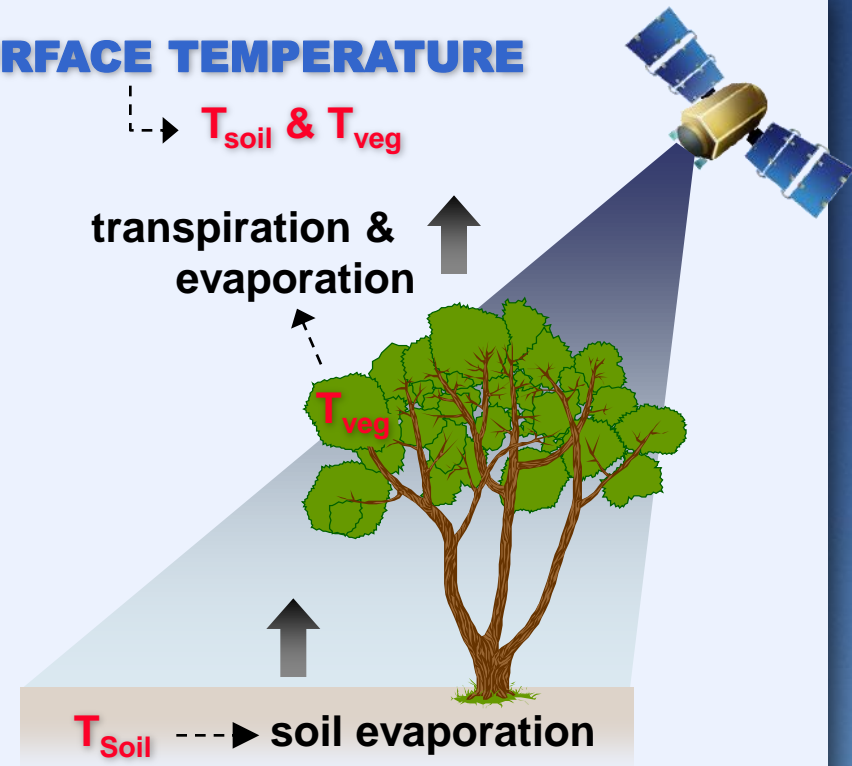
(Rick Allen, U Idaho)

PRECIPITATION



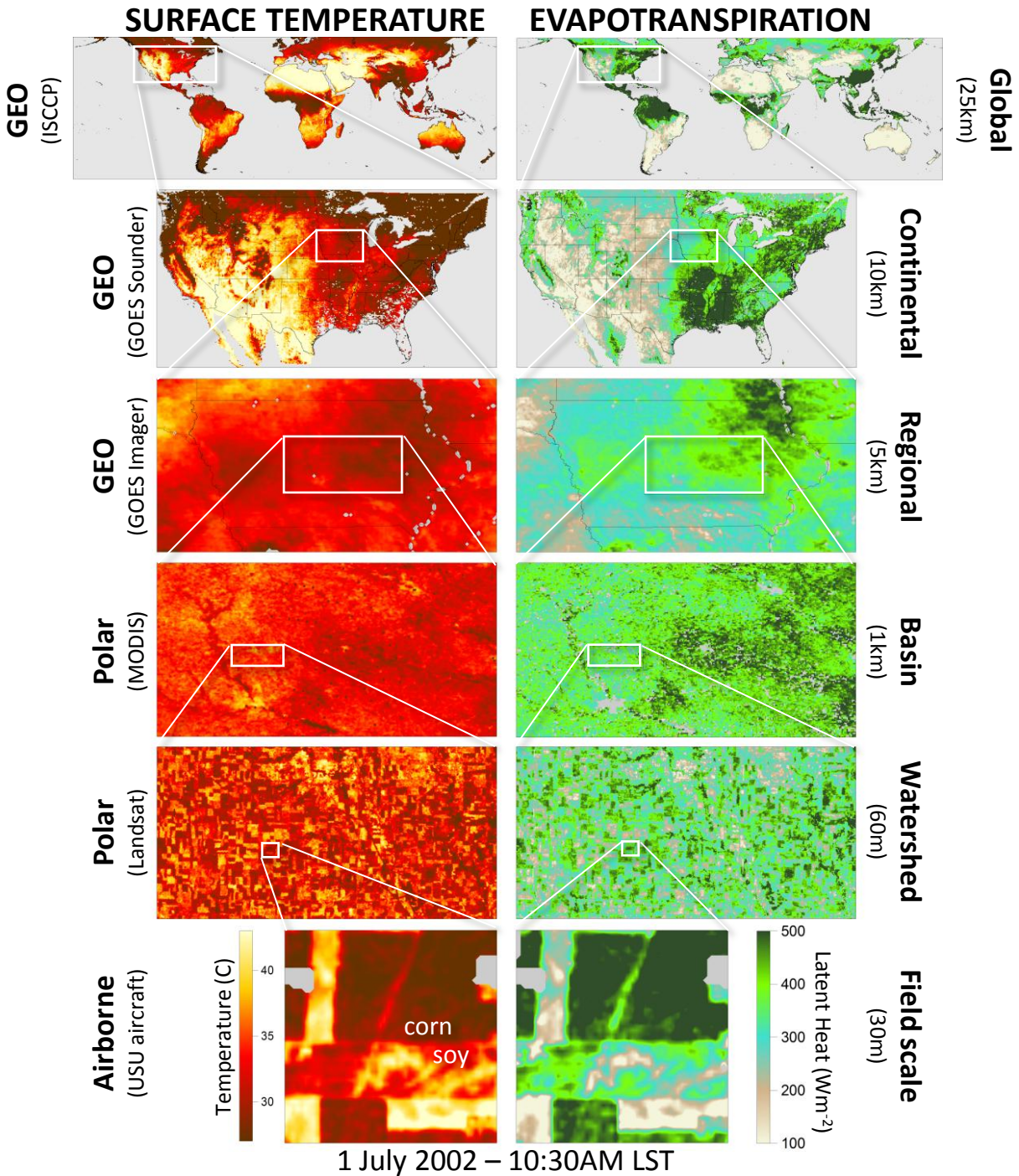
WATER BALANCE APPROACH
("prognostic modeling")

SURFACE TEMPERATURE



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")

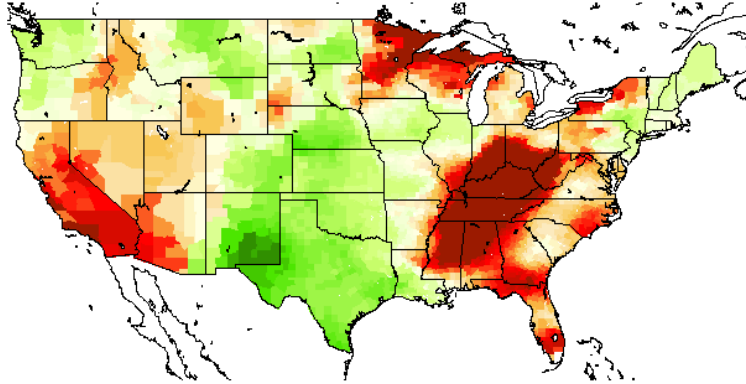


The background of the slide is a close-up photograph of parched, cracked soil, showing a complex network of dark, irregular fissures. At the bottom of the slide, there is a horizontal strip showing a range of blue mountains under a clear sky.

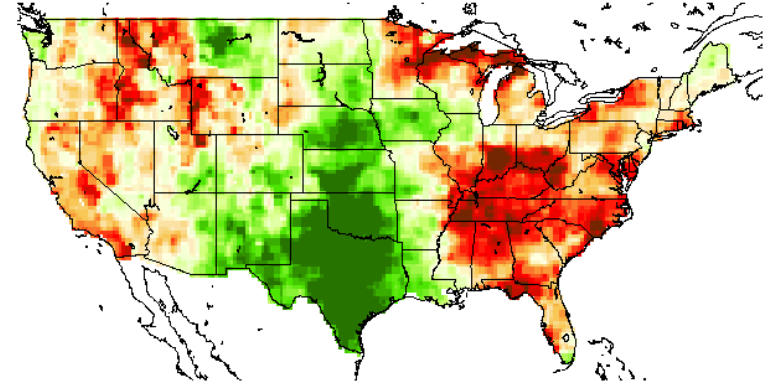
APPLICATIONS FOR SATELLITE ET
... Monitoring Drought

2007 SEASONAL ANOMALIES

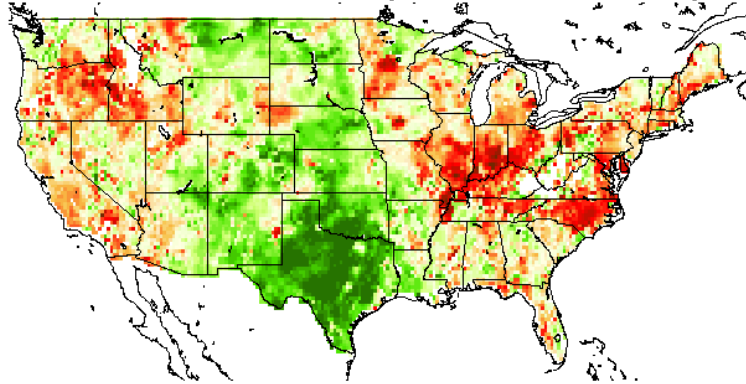
US Drought Monitor



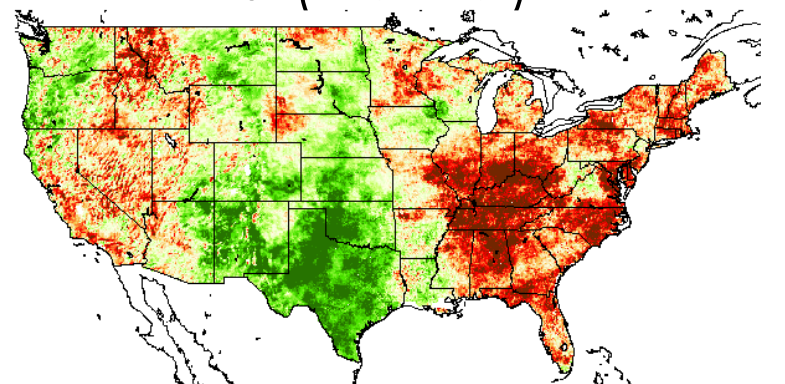
Soil moisture (rainfall)



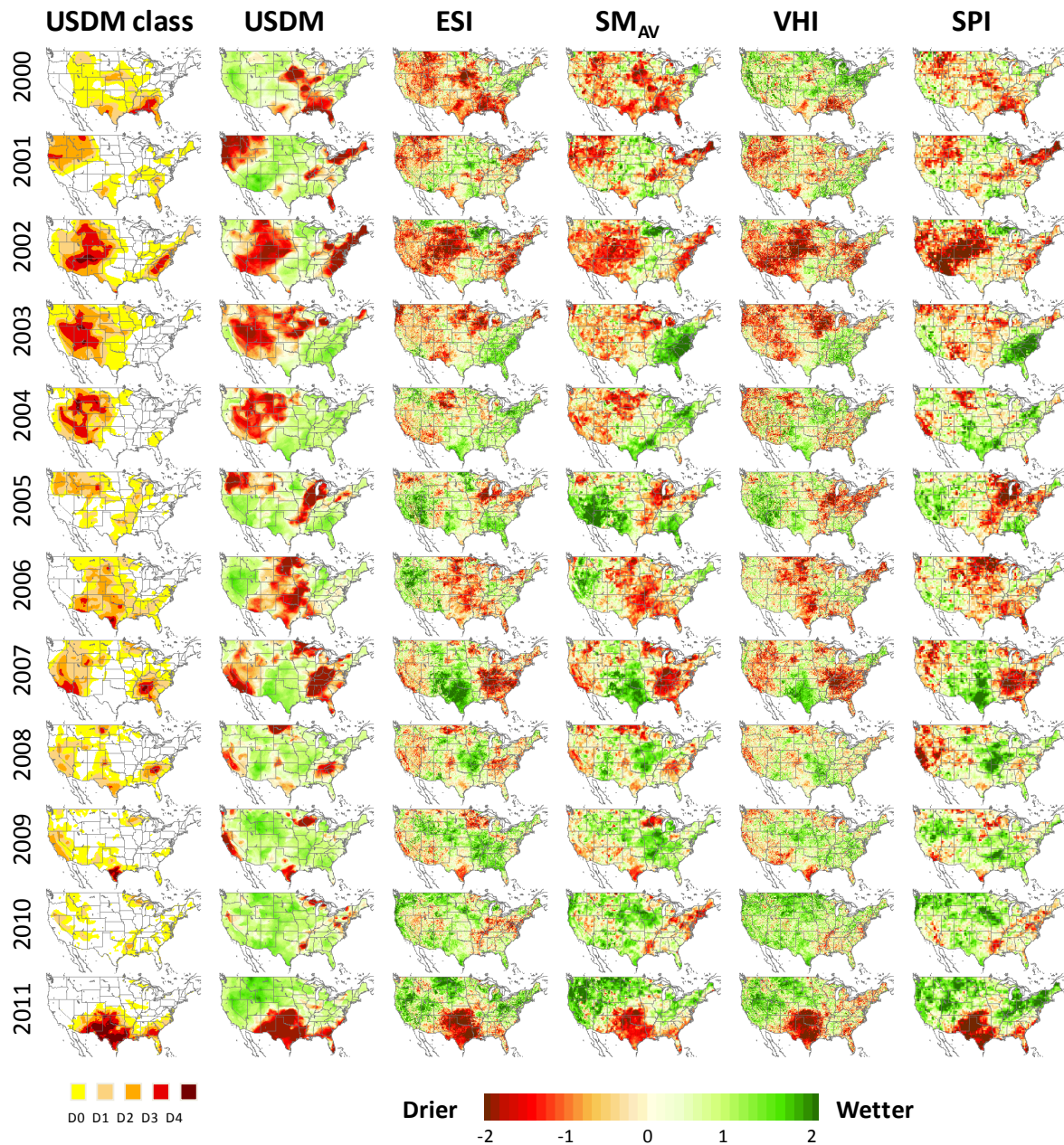
Soil moisture (microwave)

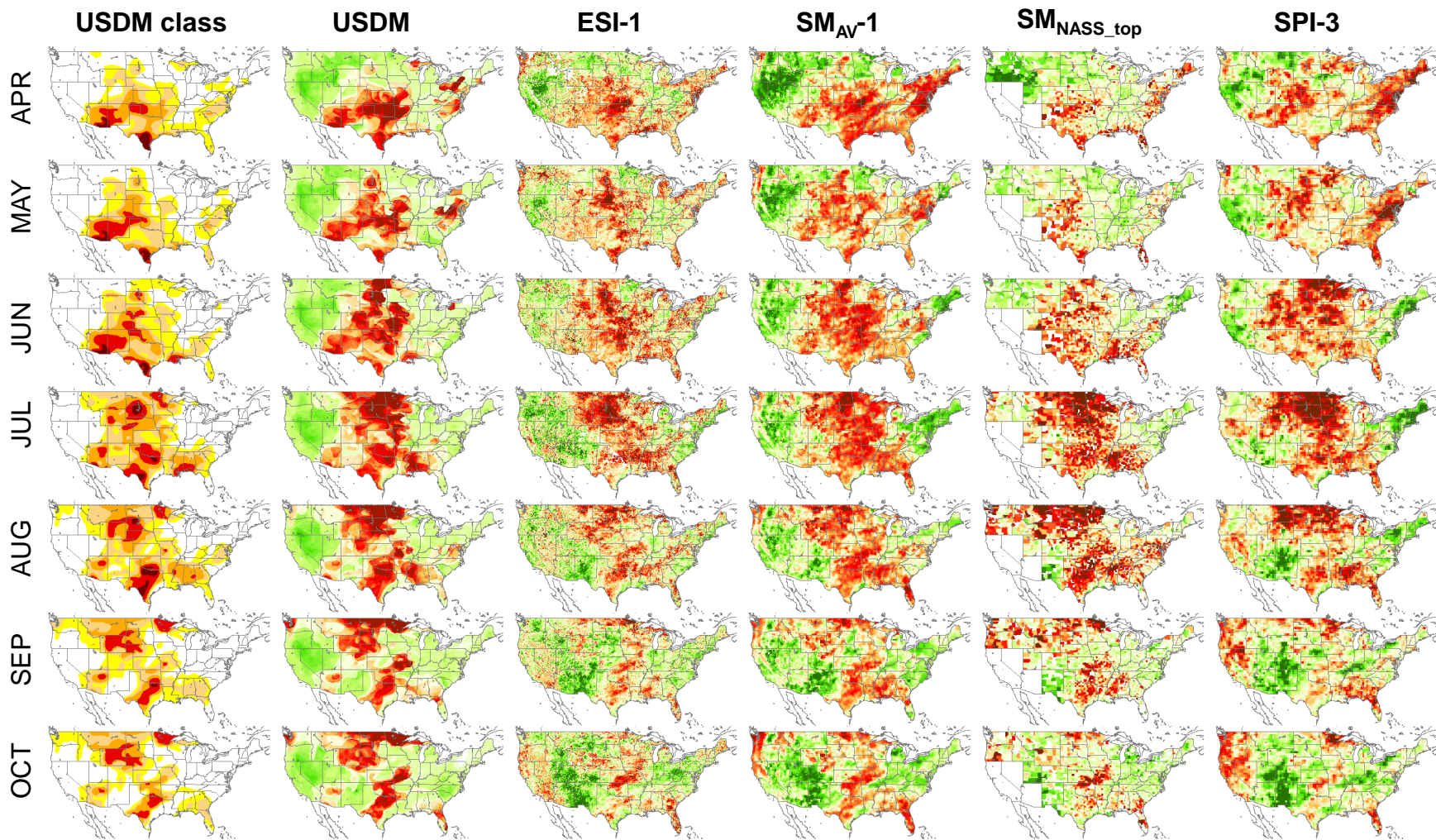


ESI (thermal)



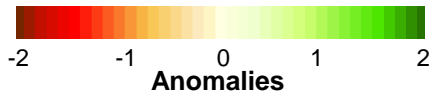
Satellite ET Drought Indicator





D0 D1 D2 D3 D4

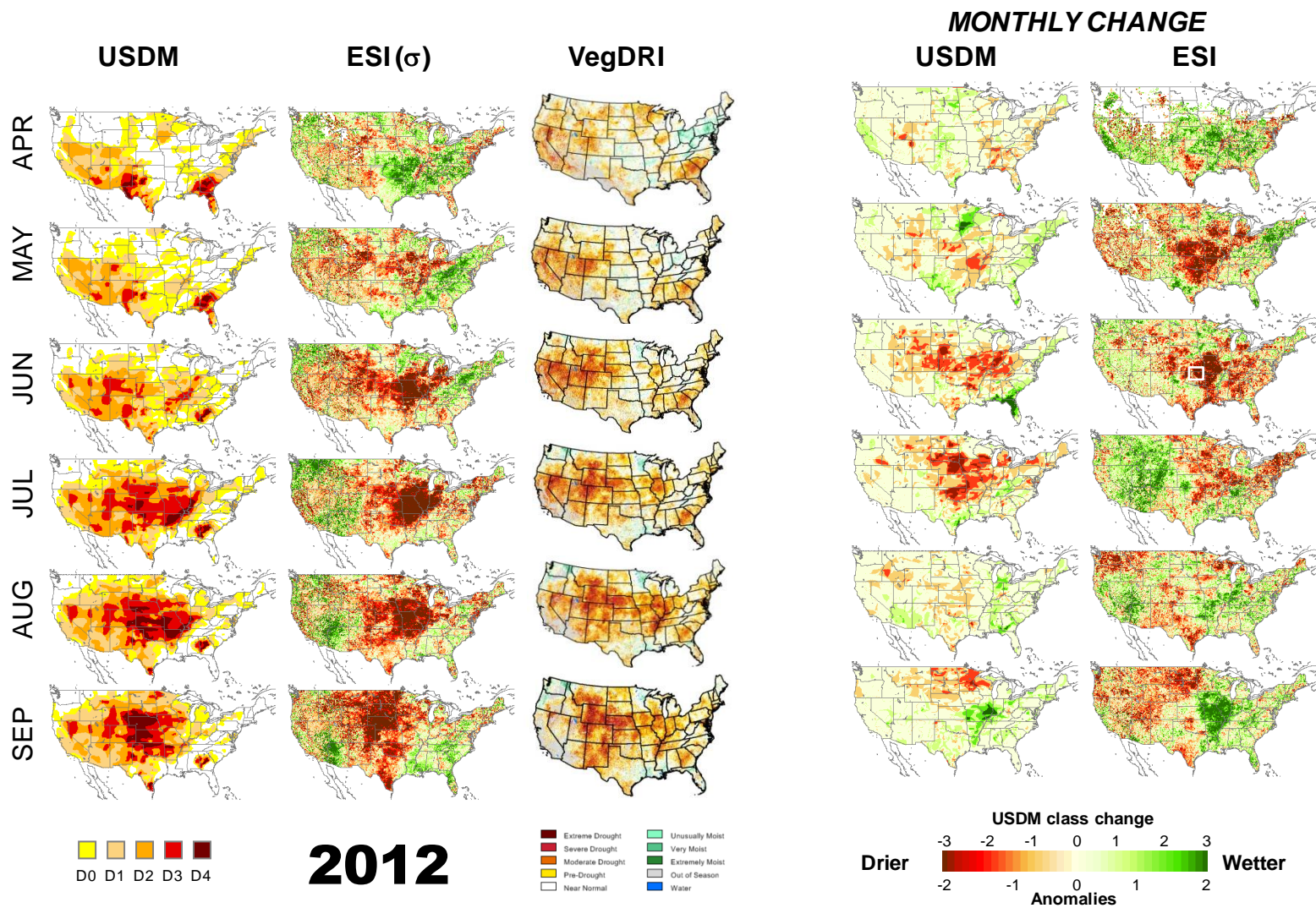
Drier



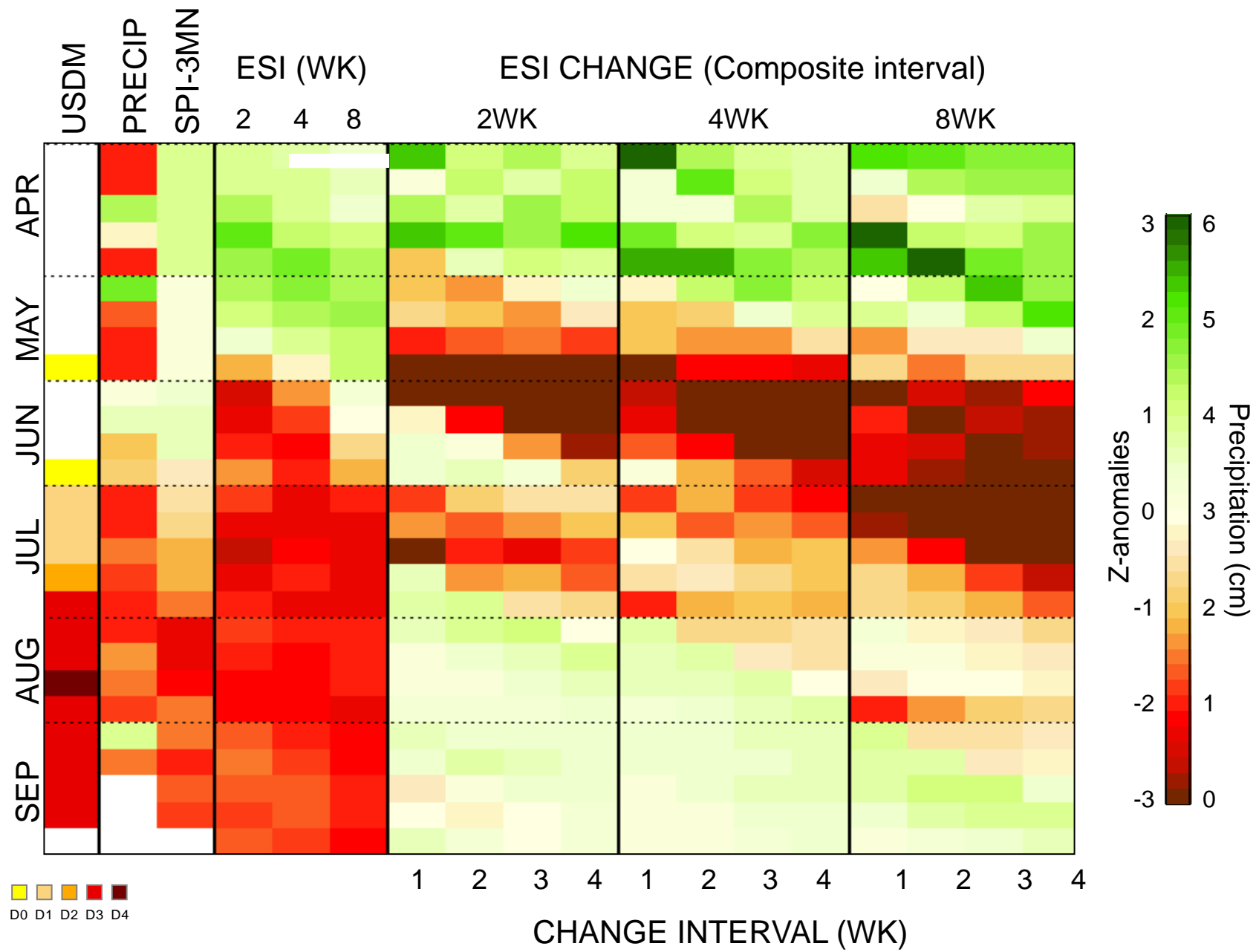
Wetter

2006

2012 FLASH DROUGHT



ESI Change over NE Oklahoma



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

$-2\sigma <$ -1σ 0 $+1\sigma$ $> +2\sigma$

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

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Version 2.1.2



hrsl.arsusda.gov/drought/index.php

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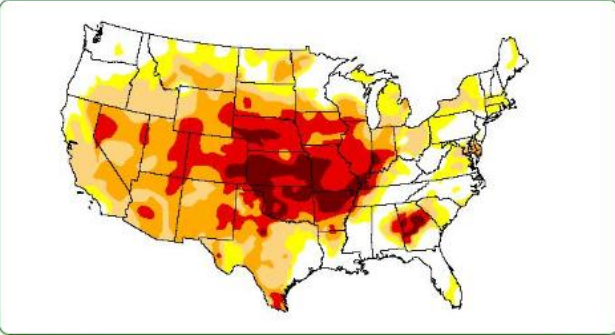
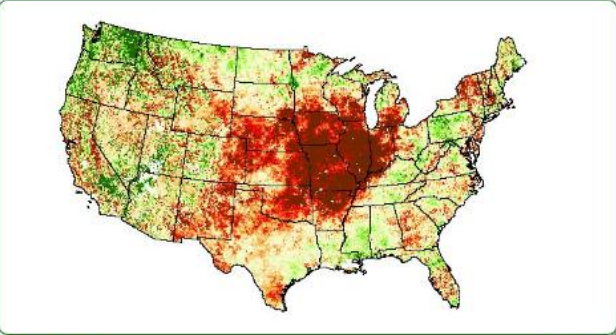
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ESI Archive - CONUS

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

Index Timescale
ESI 1 Month
Aug 18 2012

Index Timescale
USDM Weekly
Aug 18 2012



Download Standardized ET/PET anomalies Popup


Download U.S. Drought Monitor Drought Severity Popup

$-2\sigma <$ -1σ 0 $+1\sigma$ $>+2\sigma$

D0 D1 D2 D3 D4

View in Pan and Zoom Mode

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hrsl.arsusda.gov/drought/conus.php

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ESI Archive - CONUS

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Beltsville, Maryland, USA

Index Timescale
ESI 1 Month
Aug 18 2012

Index Timescale
SPI 3 Months
Aug 18 2012

Download Standardized ET/PET anomalies Popup

-2 σ < -1 σ 0 +1 σ >+2 σ

Download Standardized Precipitation Popup

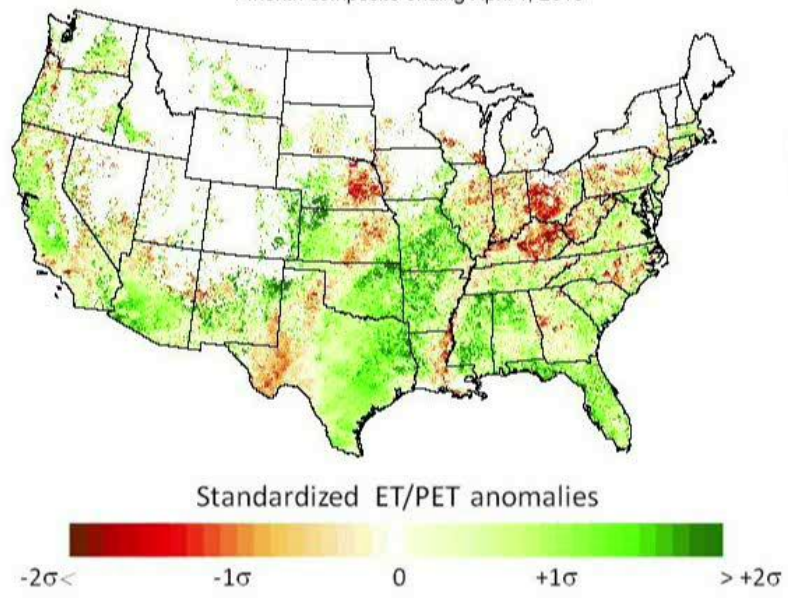
-2 < -1 0 +1 >+2

View in Pan and Zoom Mode

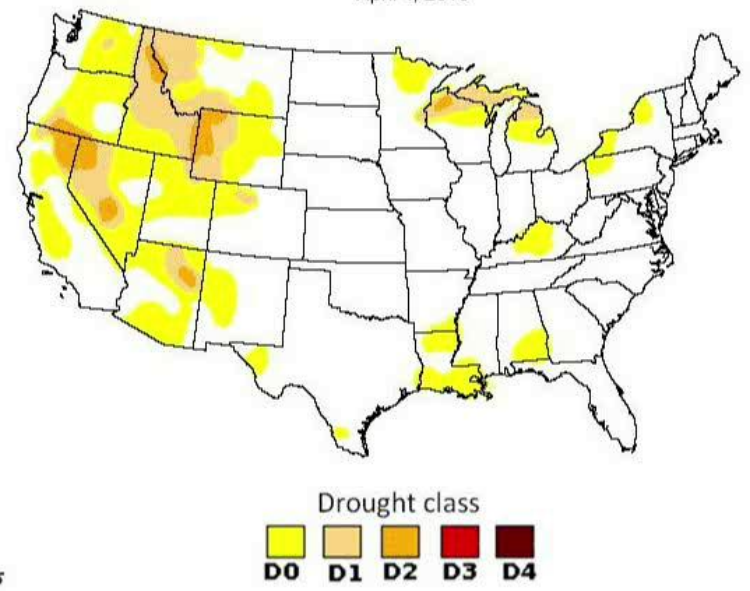
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DROUGHT: 2010-2012

Evaporative Stress Index
1 month composite ending April 1, 2010

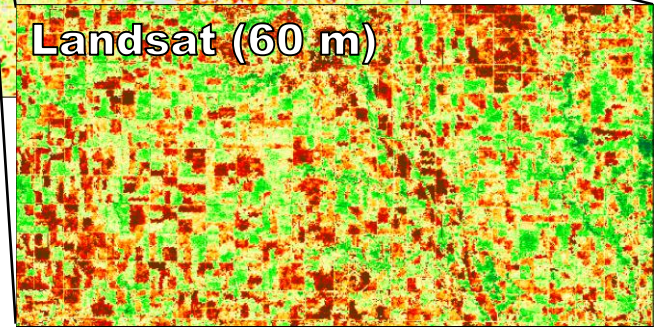
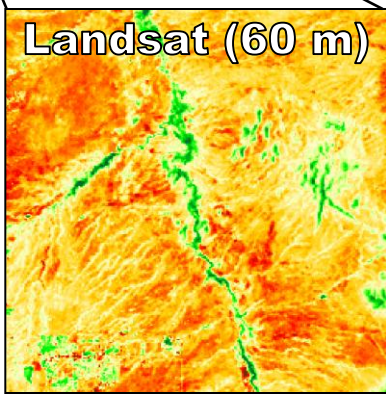
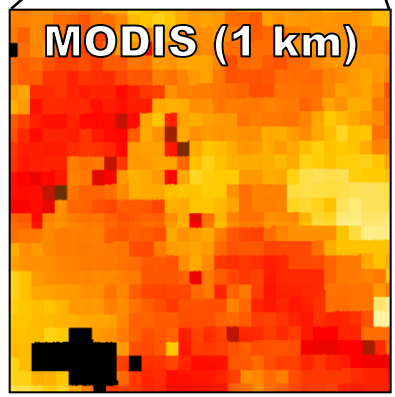
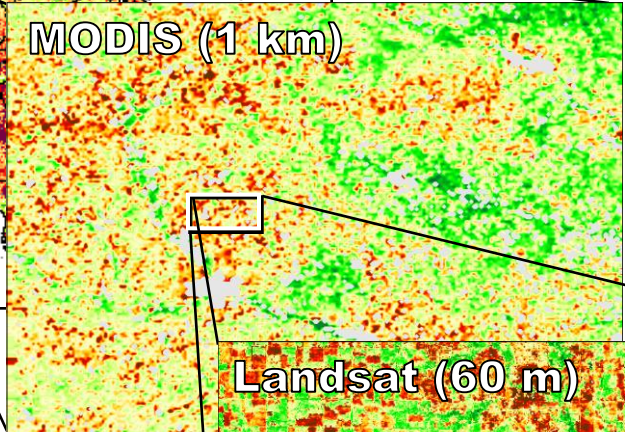
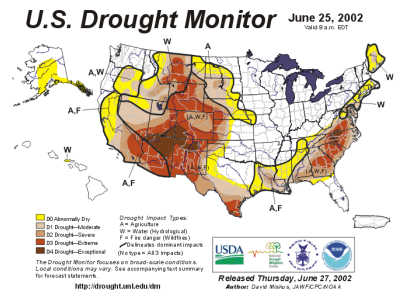
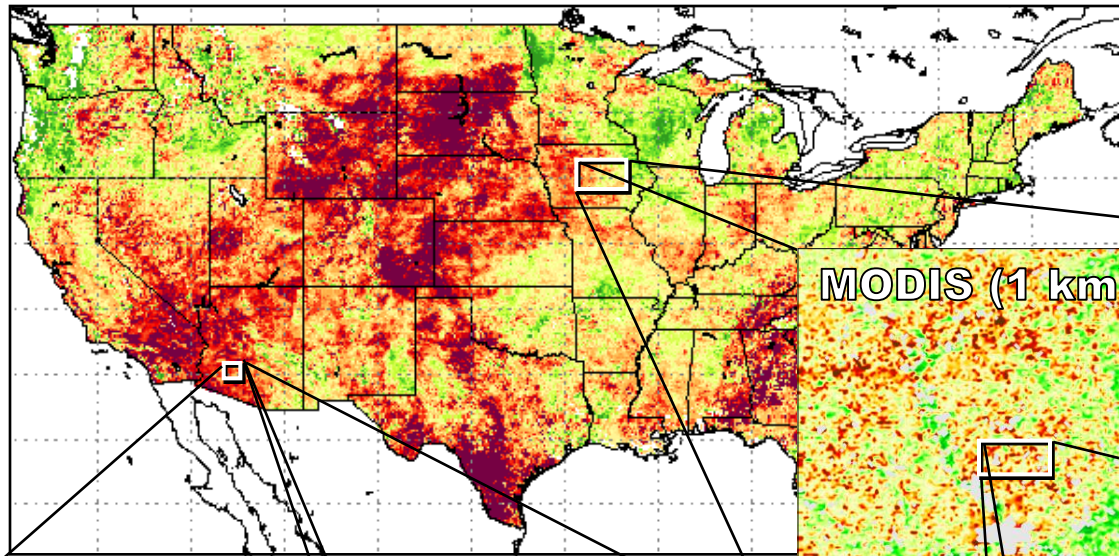


U.S. Drought Monitor
April 4, 2010



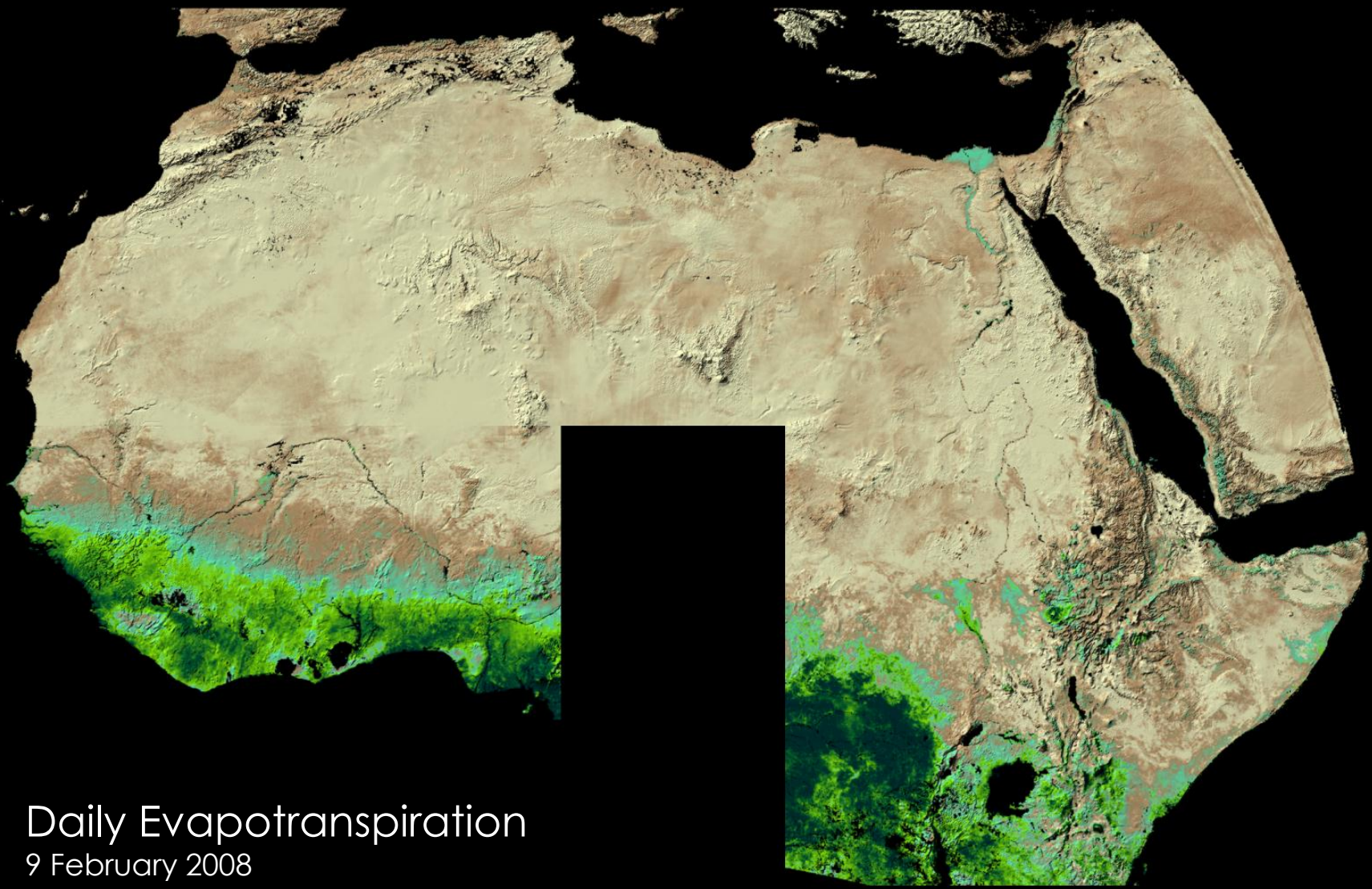
GOES Evaporative Stress Index

JUNE 2002



A satellite image of the Nile river basin in Africa. The Nile river is visible as a dark blue-green line winding through the arid, brownish-yellow landscape. The river flows from the south towards the north, where it branches into the Mediterranean Sea. The surrounding land is mostly flat and dry, with some green patches indicating agricultural areas or wetlands. The text is overlaid in the center of the image.

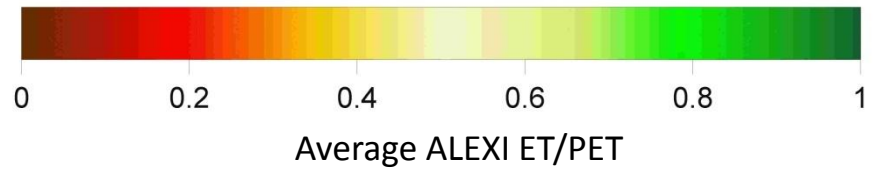
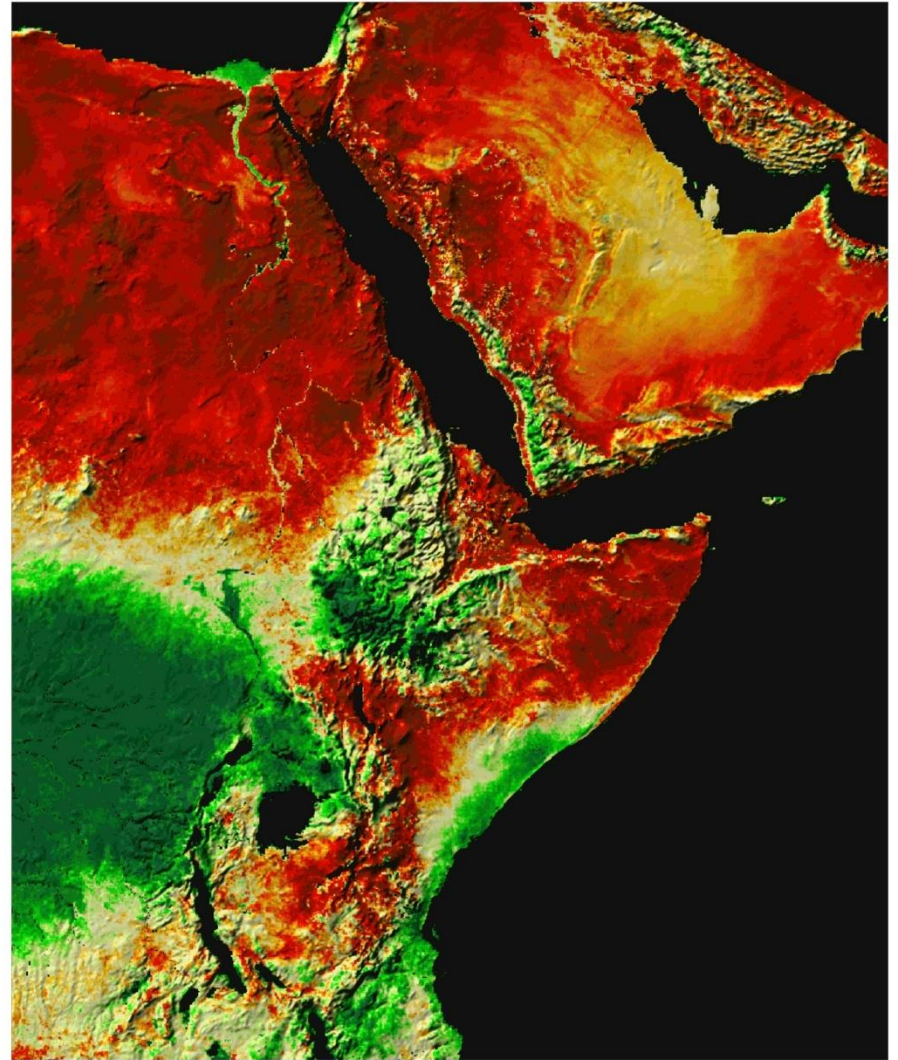
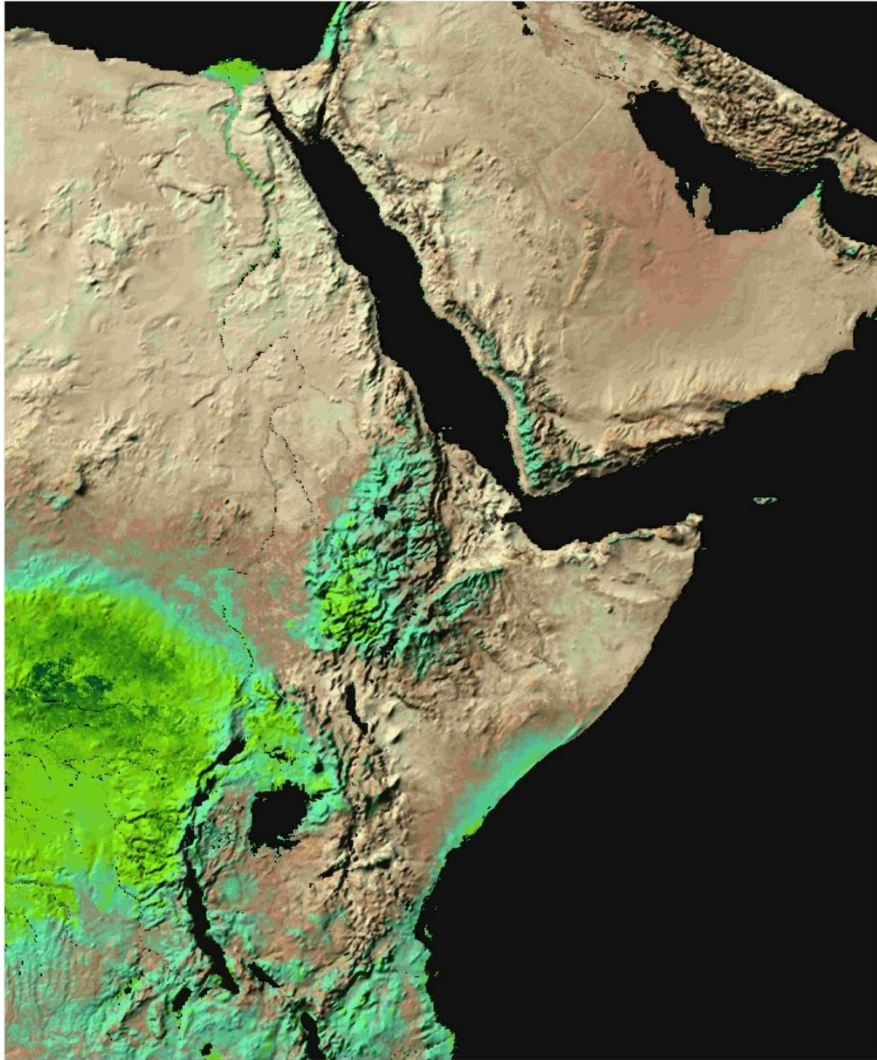
APPLICATIONS FOR SATELLITE ET
... Food and Water Security



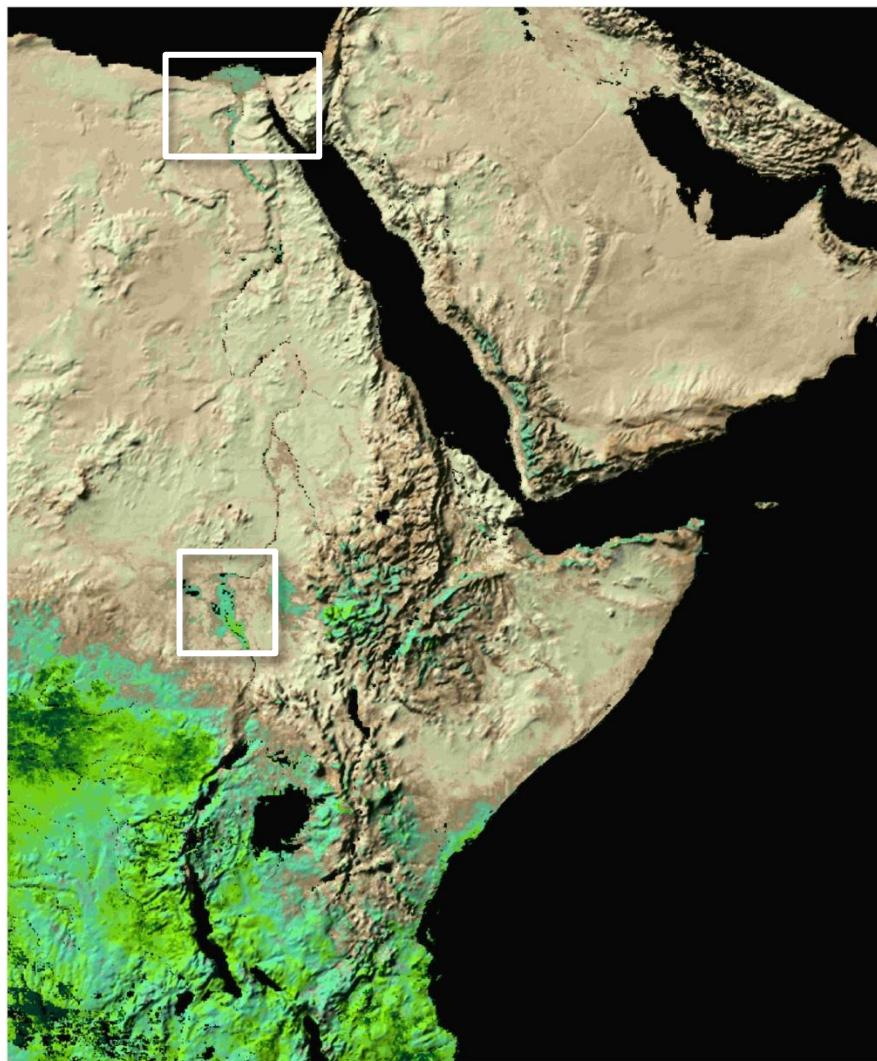
Daily Evapotranspiration
9 February 2008



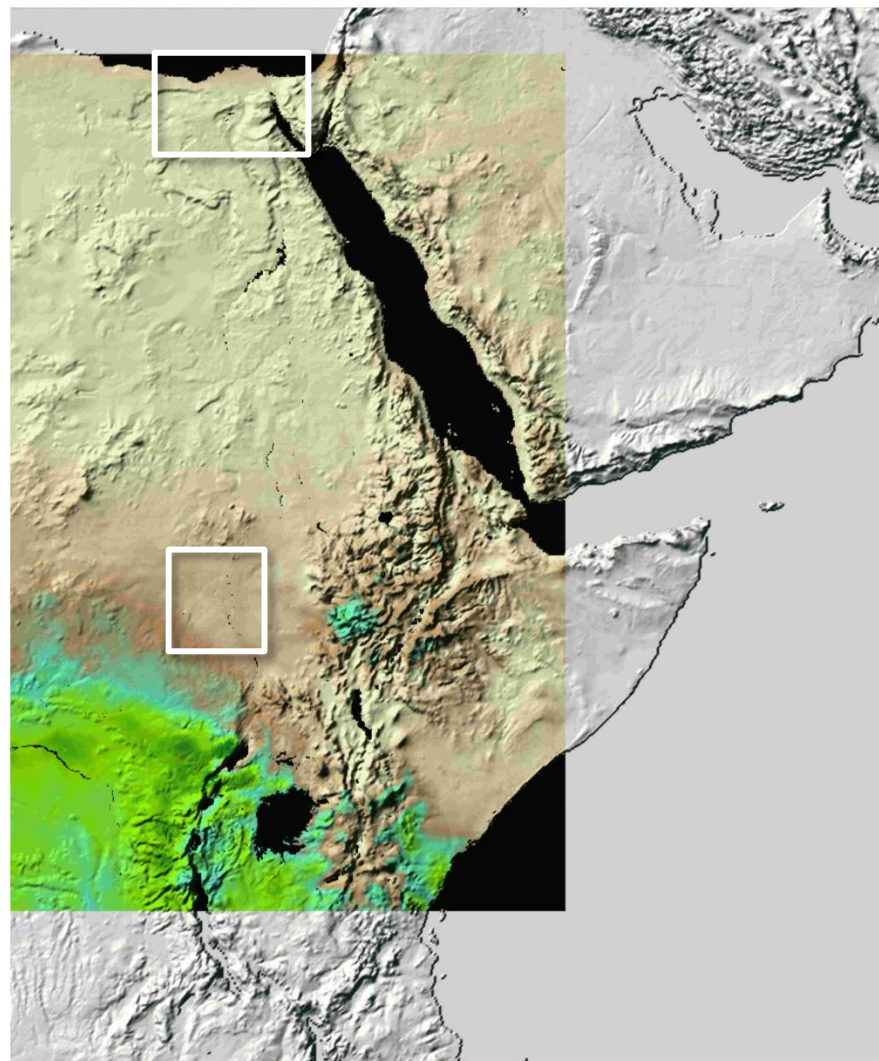
2009 APRIL-SEPTEMBER



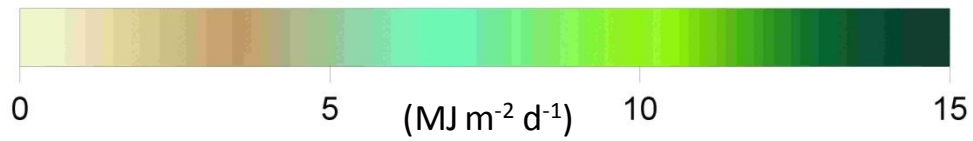
2009 FEBRUARY



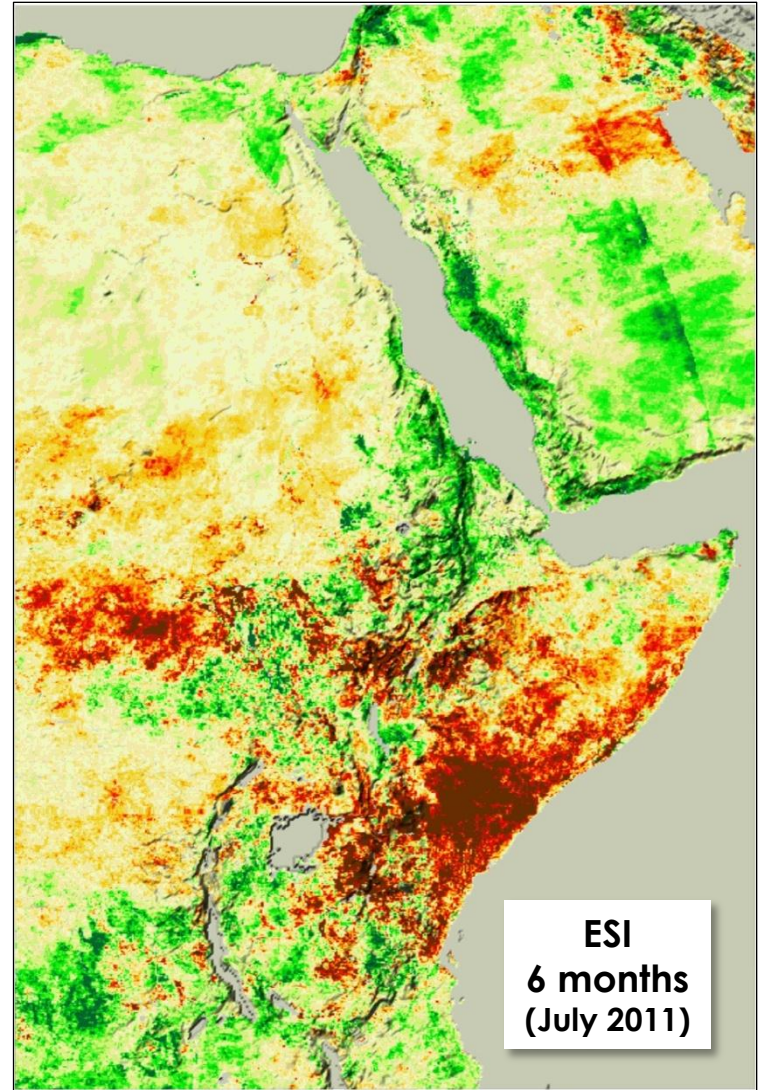
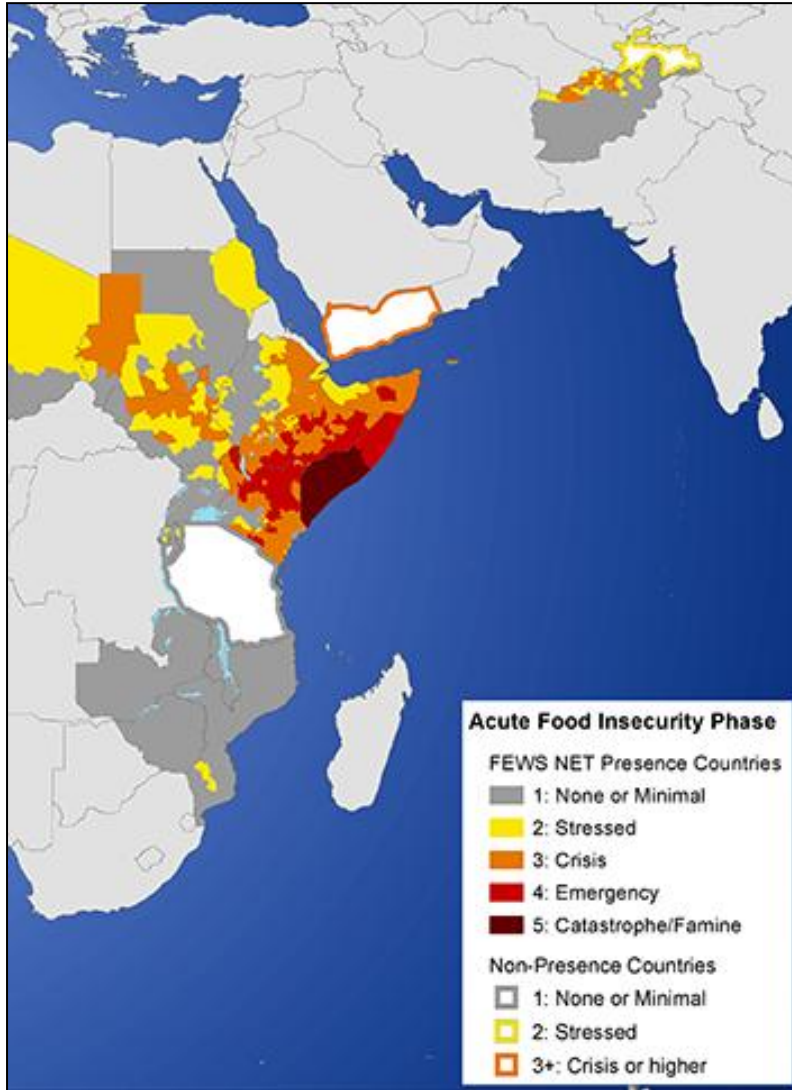
Average ALEXI ET



Average Noah ET



2011 Famine in Somalia



Evaporative Stress Index

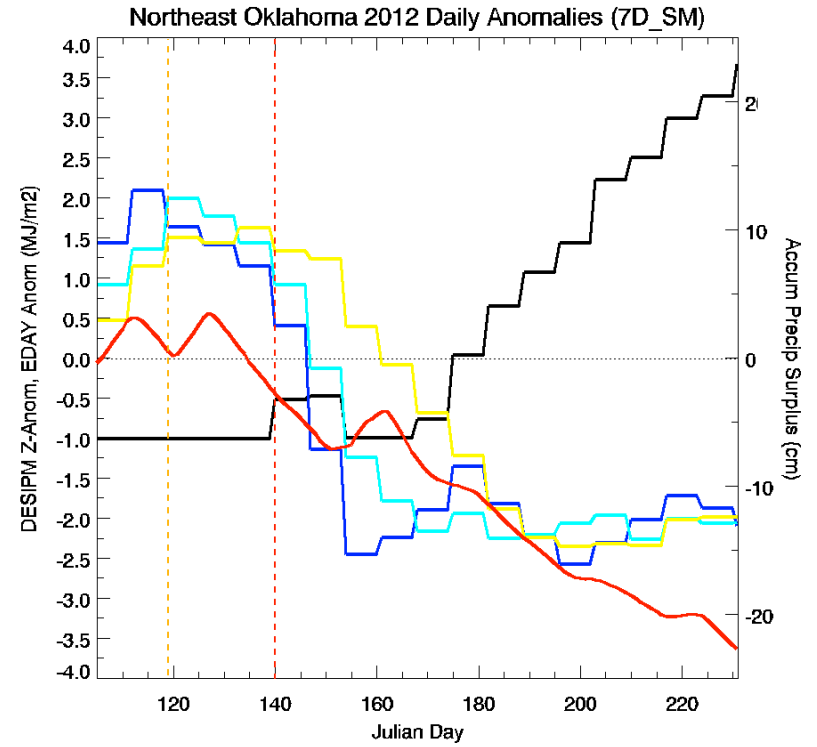
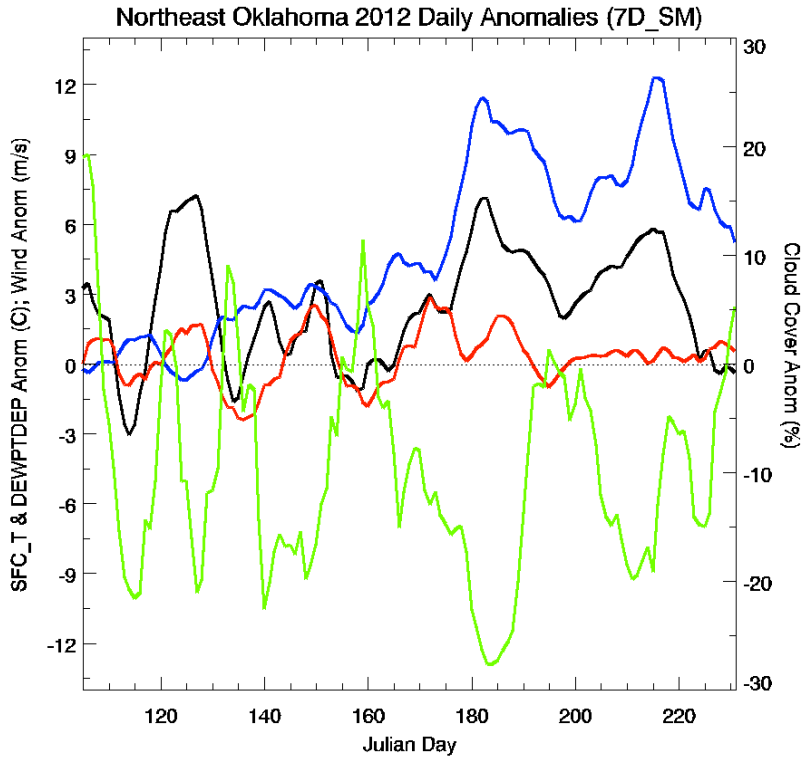
- Monitors anomalous water use patterns related to agricultural drought
- Land-surface temperature conveys early warning of vegetation stress
- Independent check on precipitation-based indices
- Applications in global water and food security



ESI Change over NE Oklahoma

Air temp
Dewpoint temp
Wind
Cloud cover

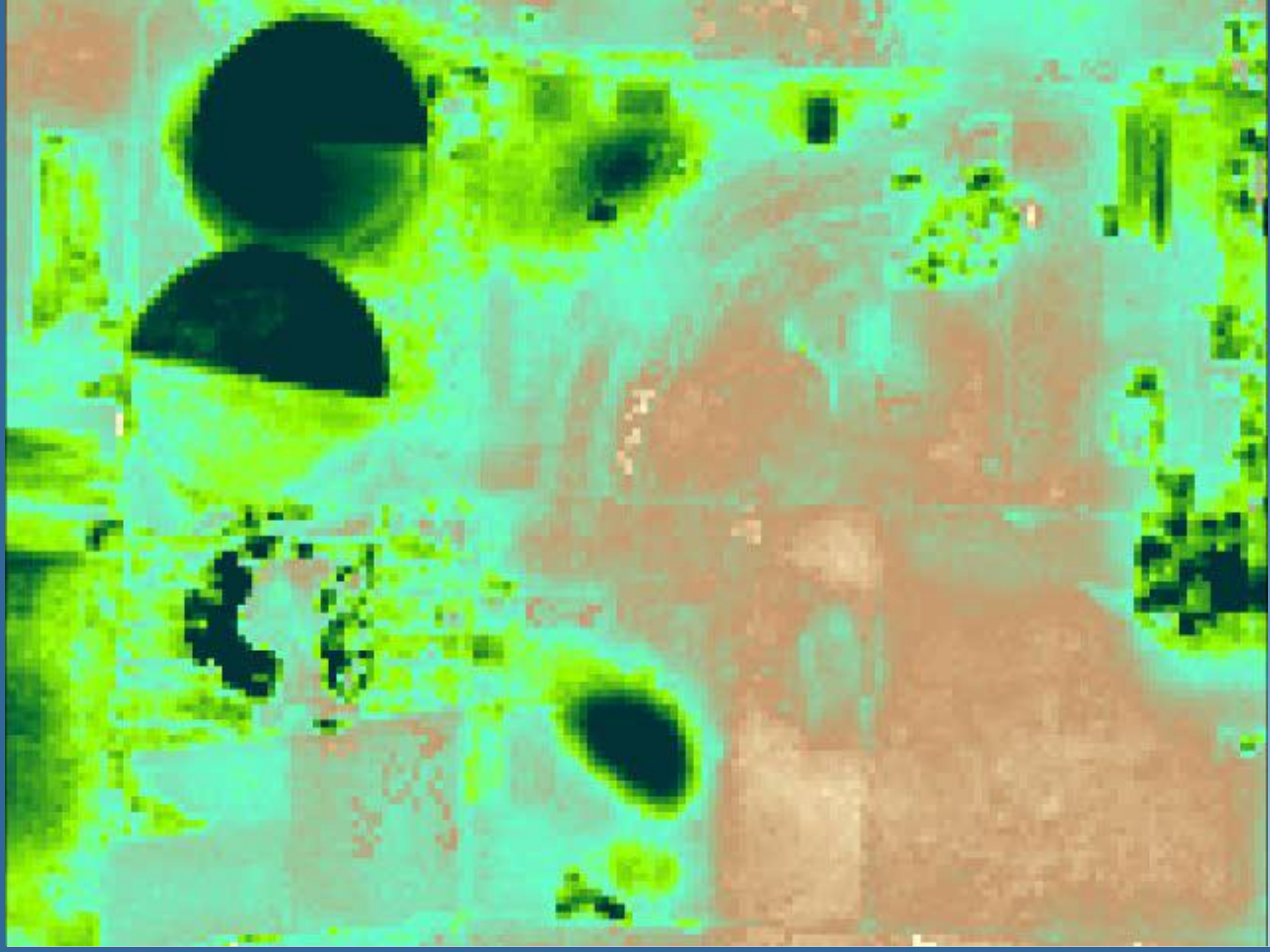
USDM
ESI - 2WK
ESI - 4WK
ESI - 8WK
Precip surplus



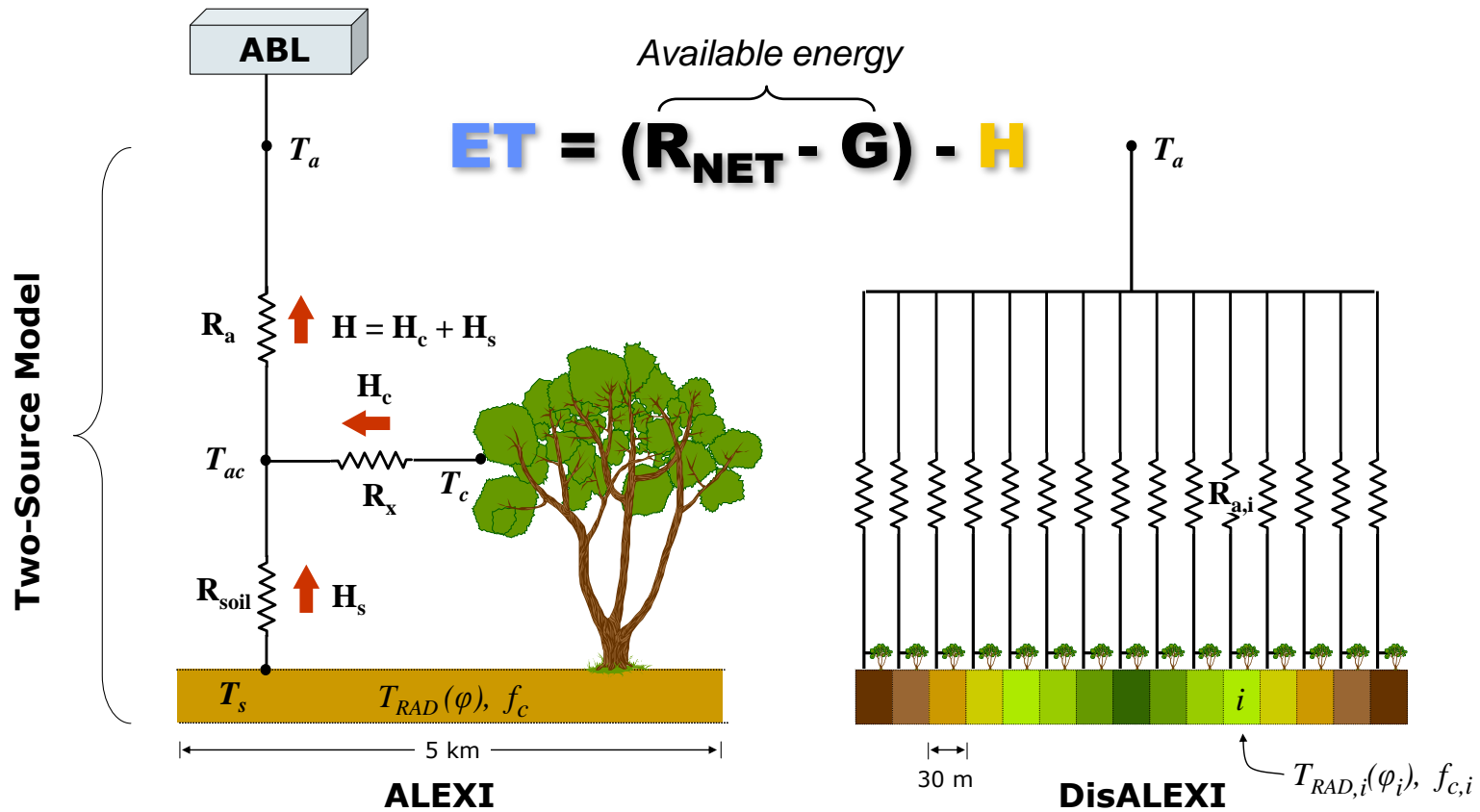
PIXEL SCALE	SPATIAL RESOLUTION	TEMPORAL RESOLUTION	EXAMPLE
Coarse	5-10 km	15 min	GOES
Moderate	1 km	Daily	MODIS
Fine	60–120 m	Once every 16 days	Landsat



Daily ET at field scale



Atmosphere-Land Exchange Inverse (ALEXI)

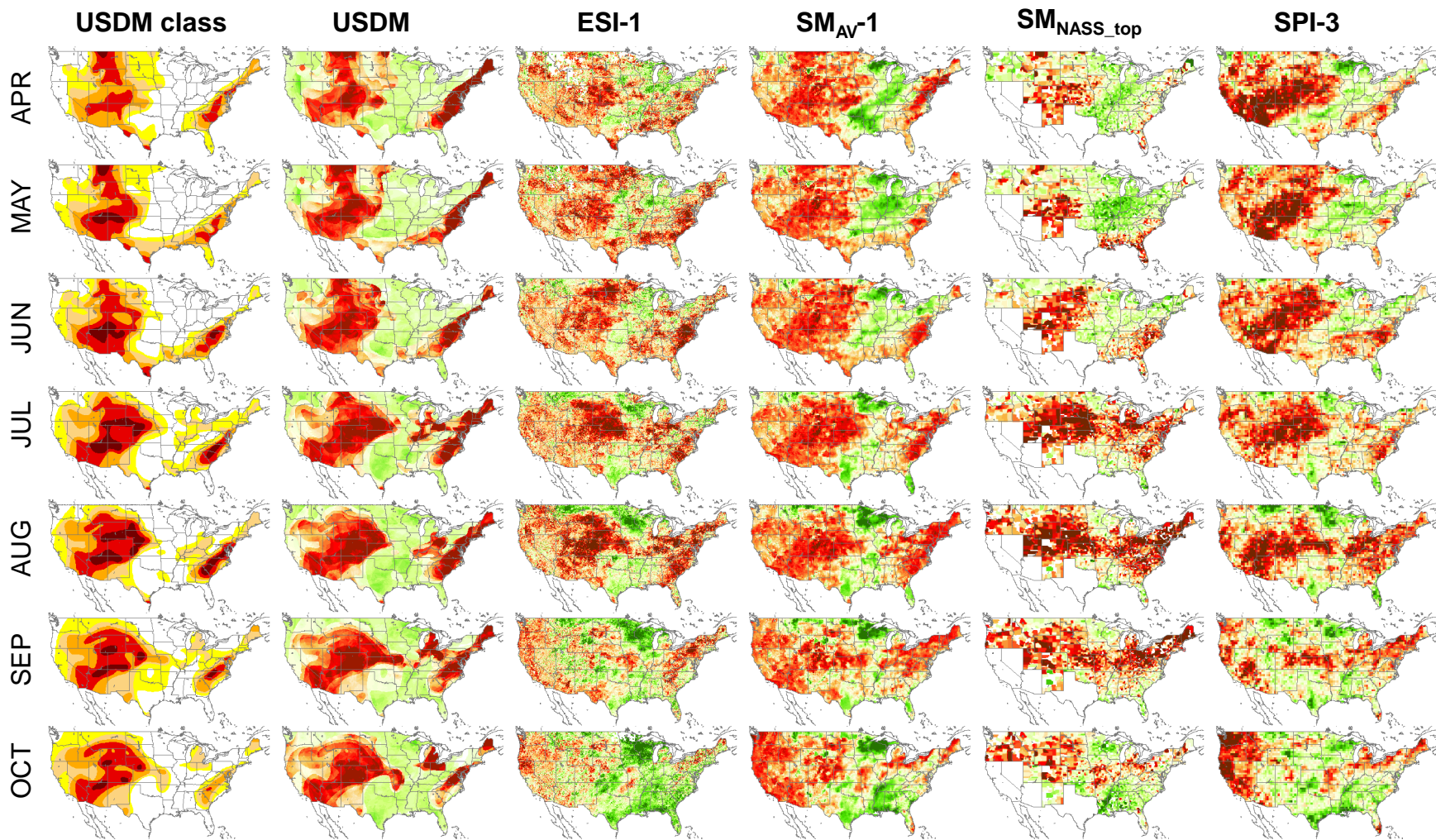


Regional scale

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

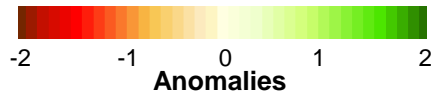
Landscape scale

T_{RAD} - TM, MODIS, HypsIRI
 T_a - ALEXI



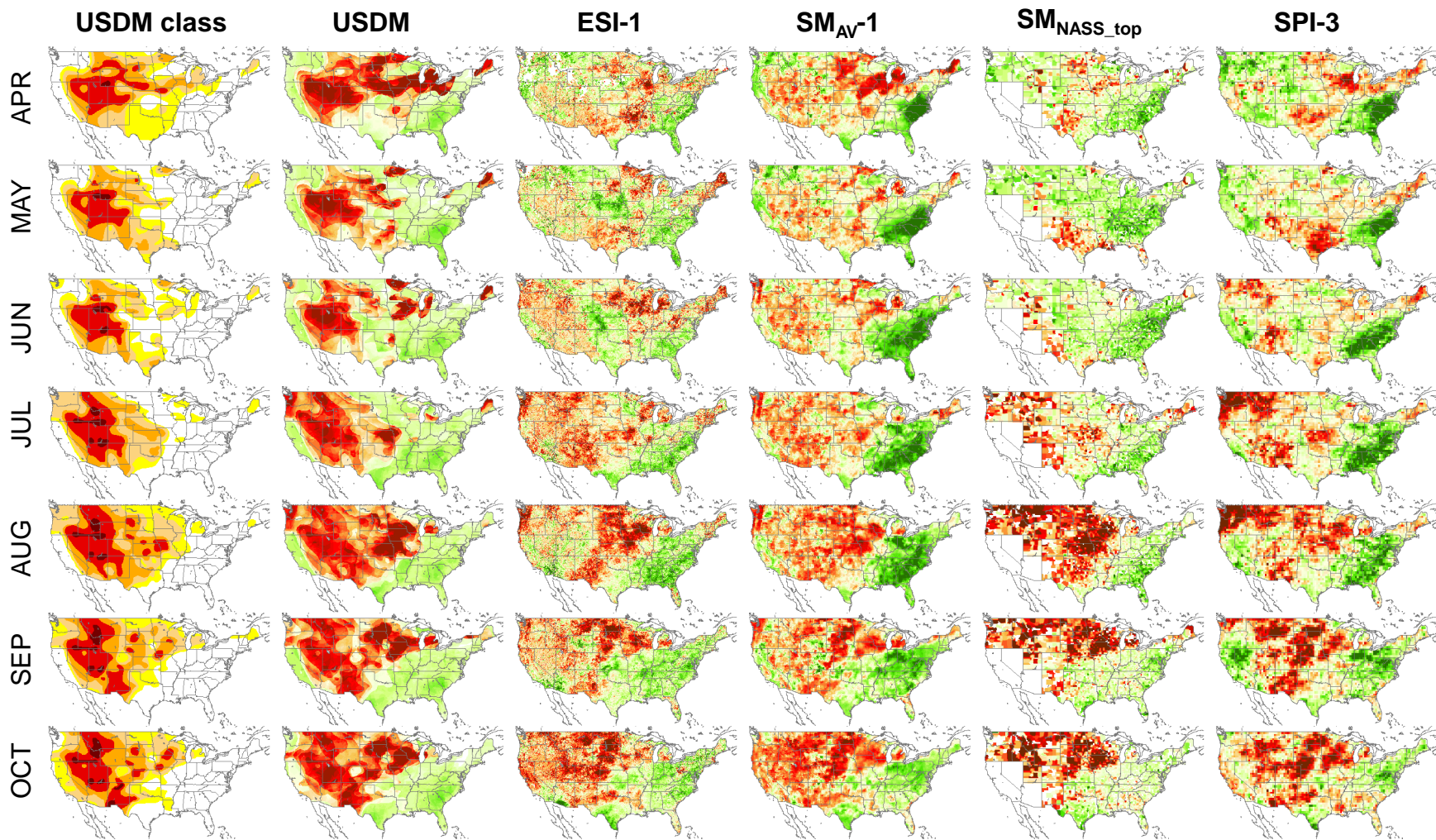
D0 D1 D2 D3 D4

Drier



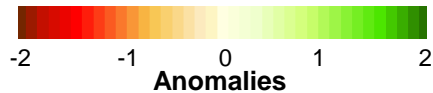
Wetter

2002



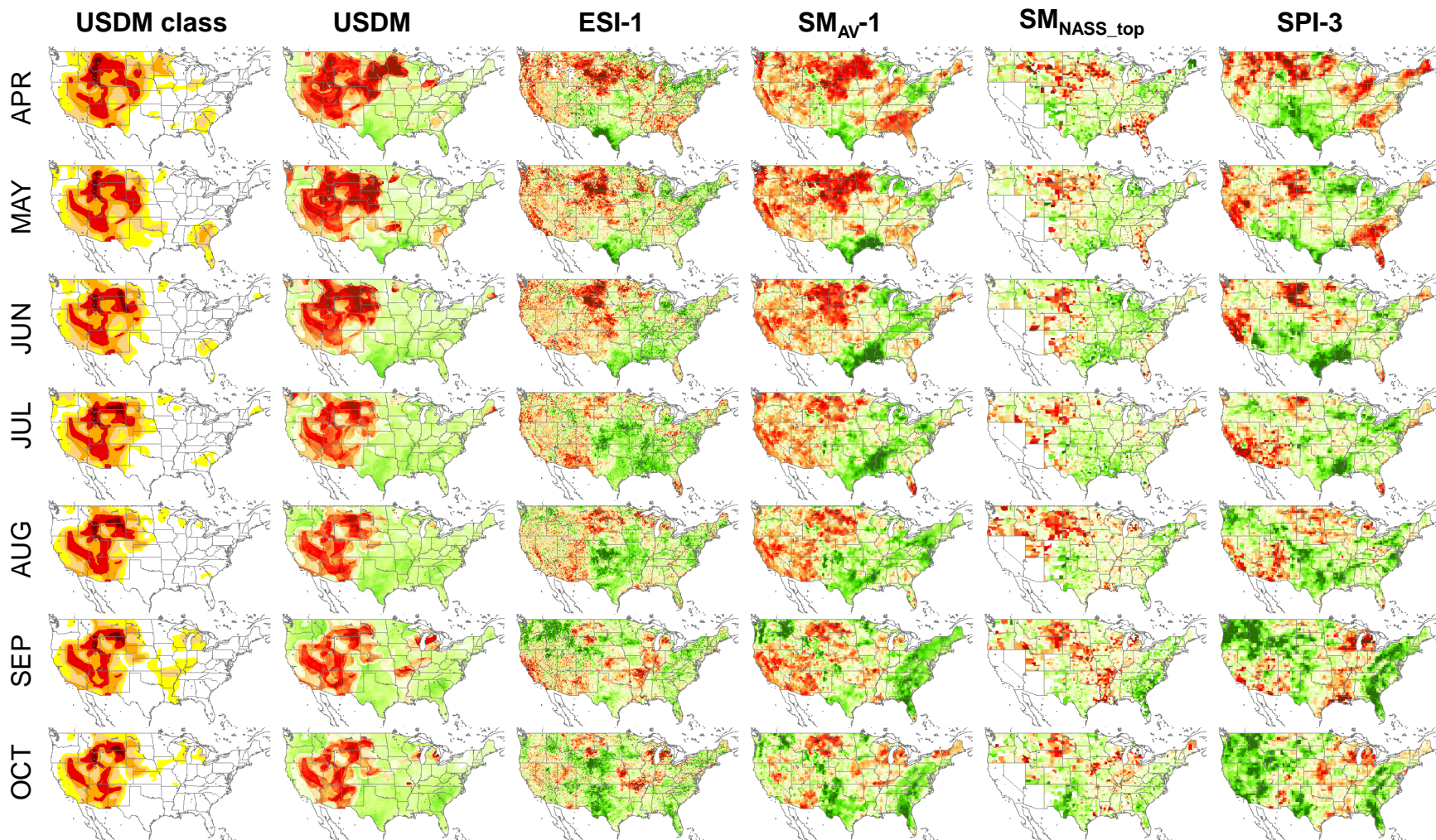
D0 D1 D2 D3 D4

Drier



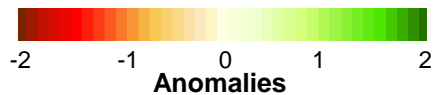
Wetter

2003



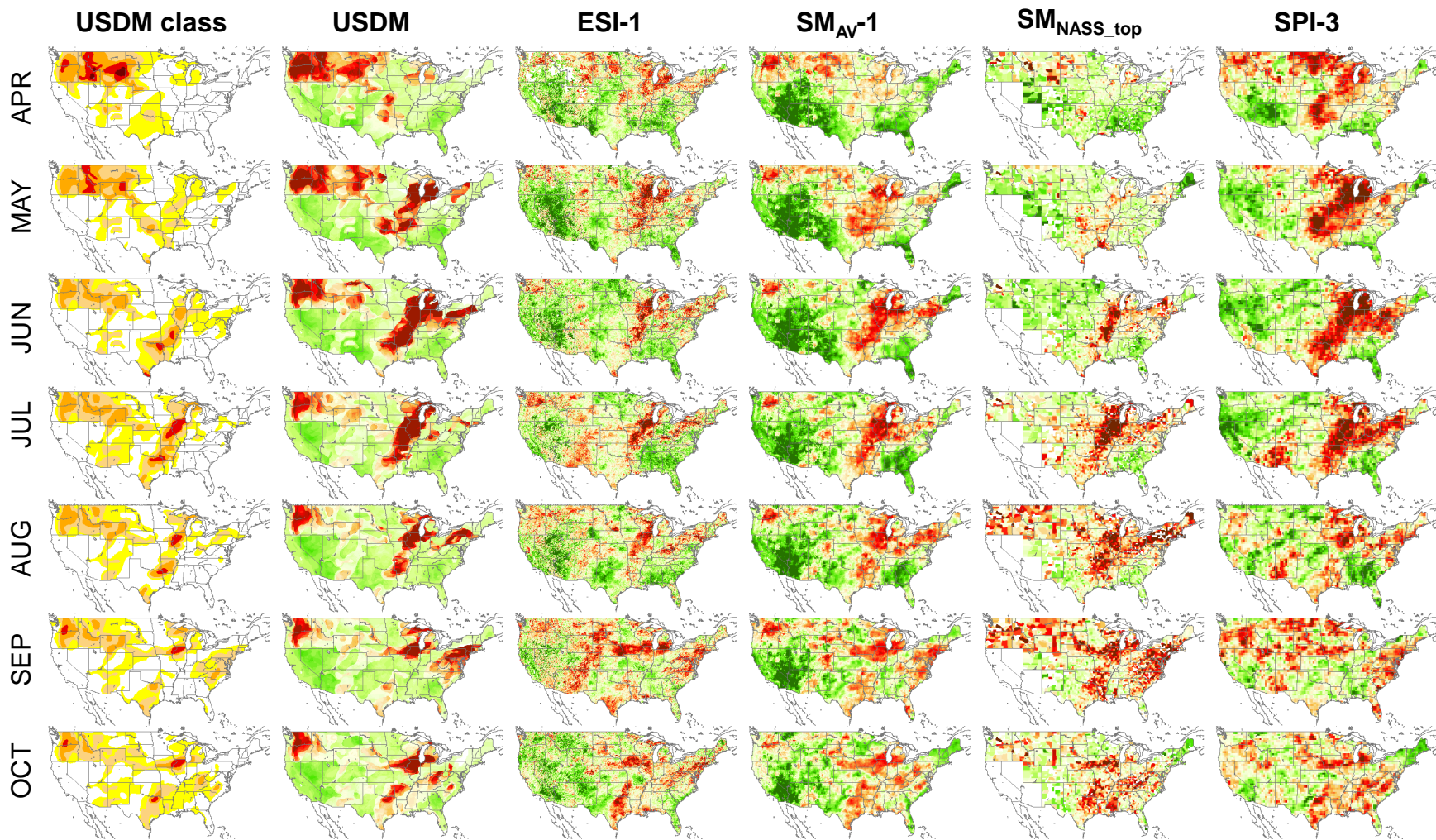
D0 D1 D2 D3 D4

Drier



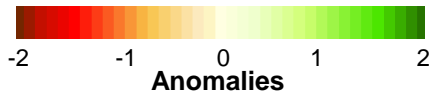
Wetter

2004



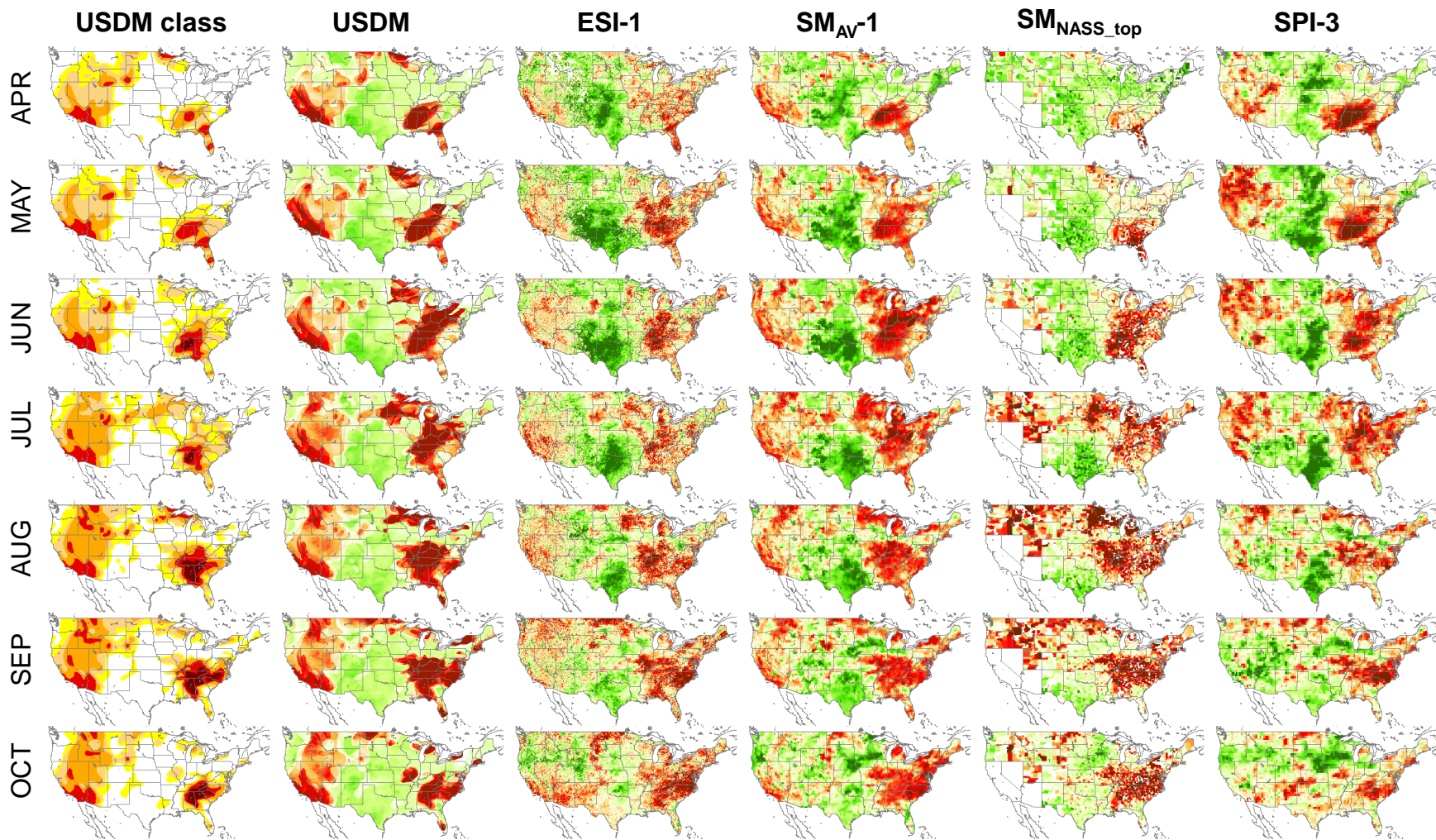
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Drier



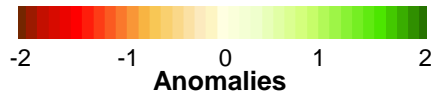
Wetter

2005



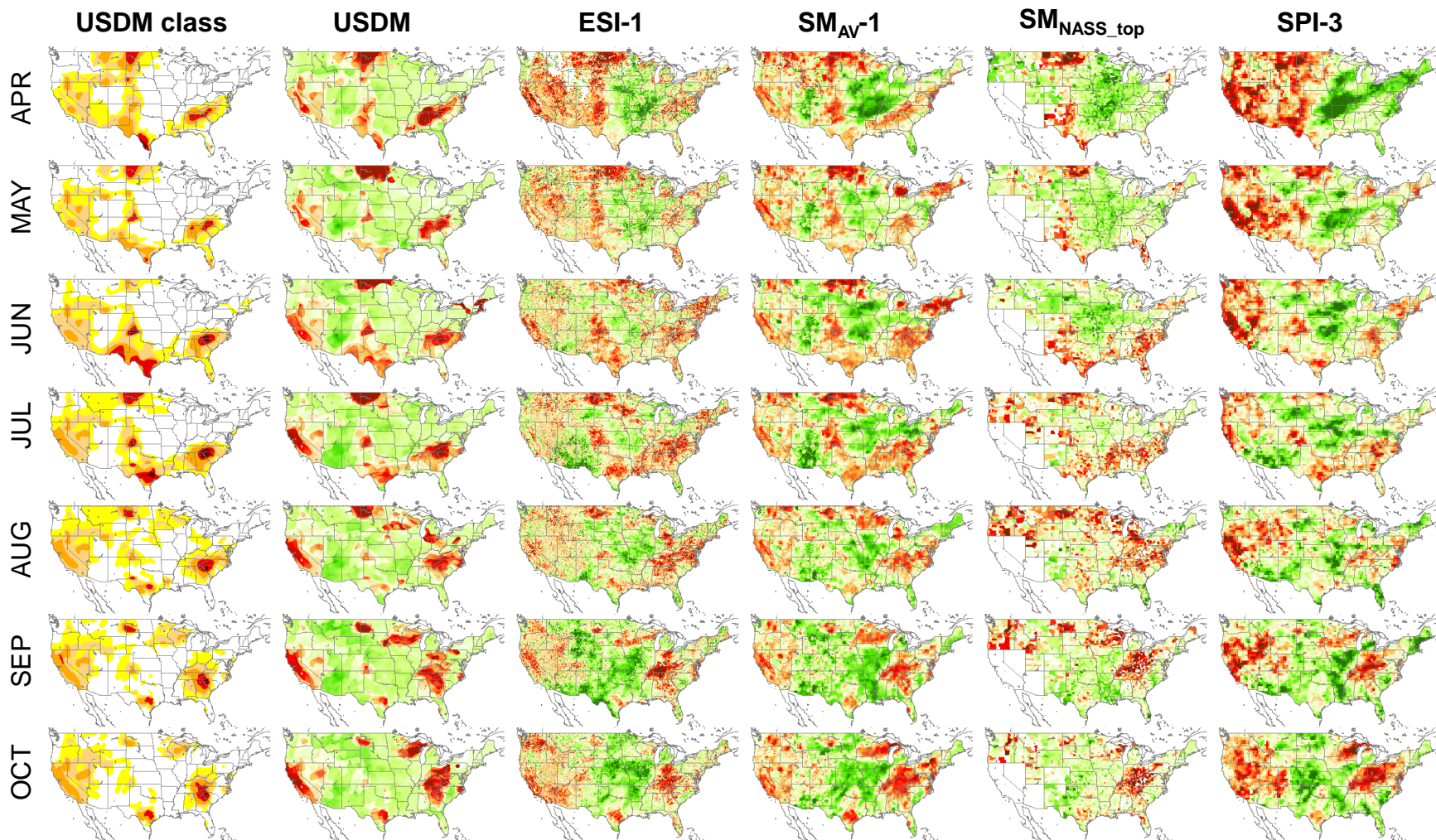
D0 D1 D2 D3 D4

Drier



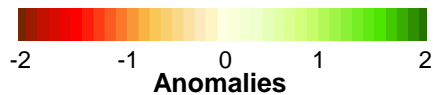
Wetter

2007



D0 D1 D2 D3 D4

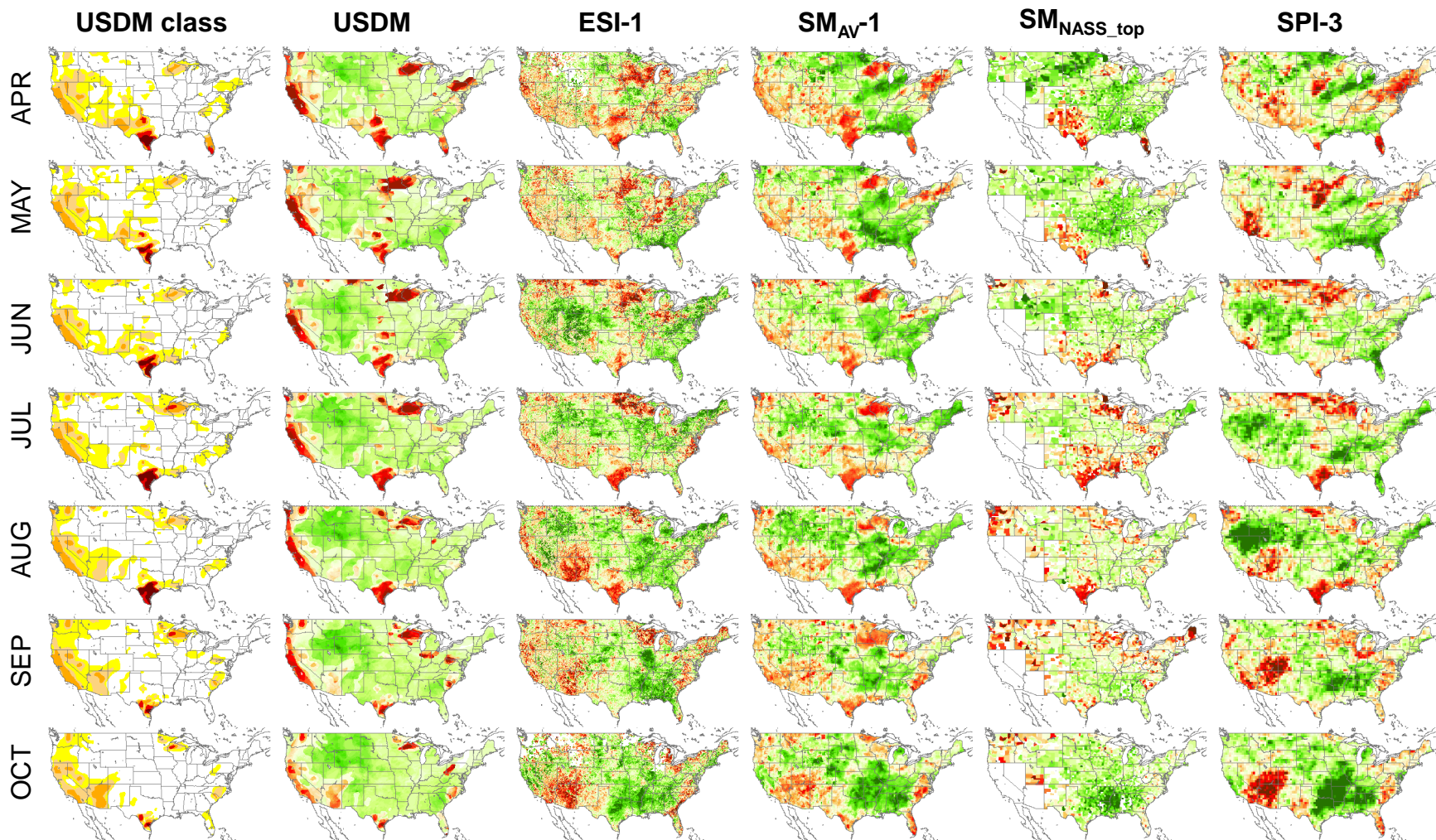
Drier



Anomalies

Wetter

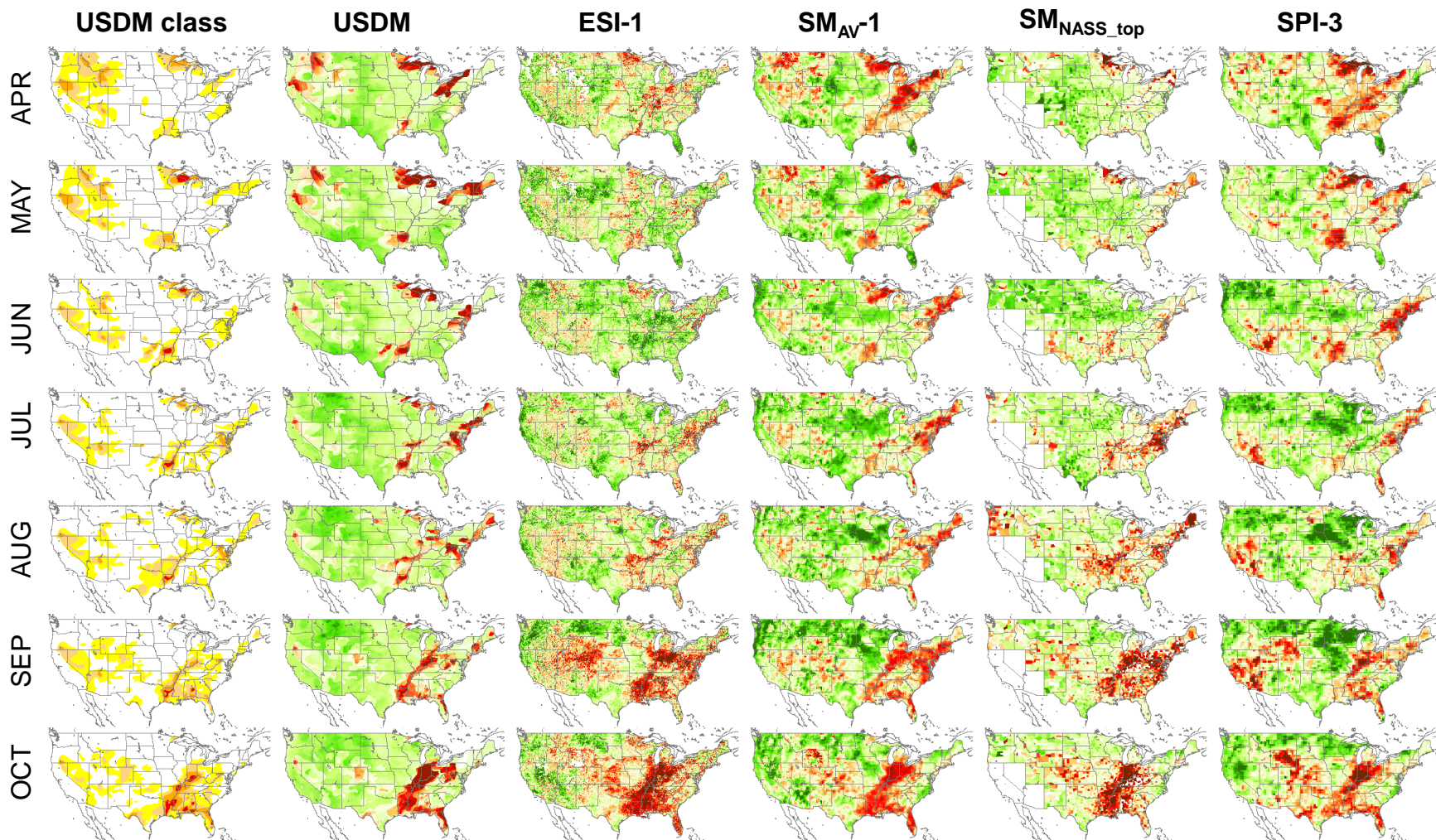
2008



D0 D1 D2 D3 D4

Drier **Wetter**
 -2 -1 0 1 2
Anomalies

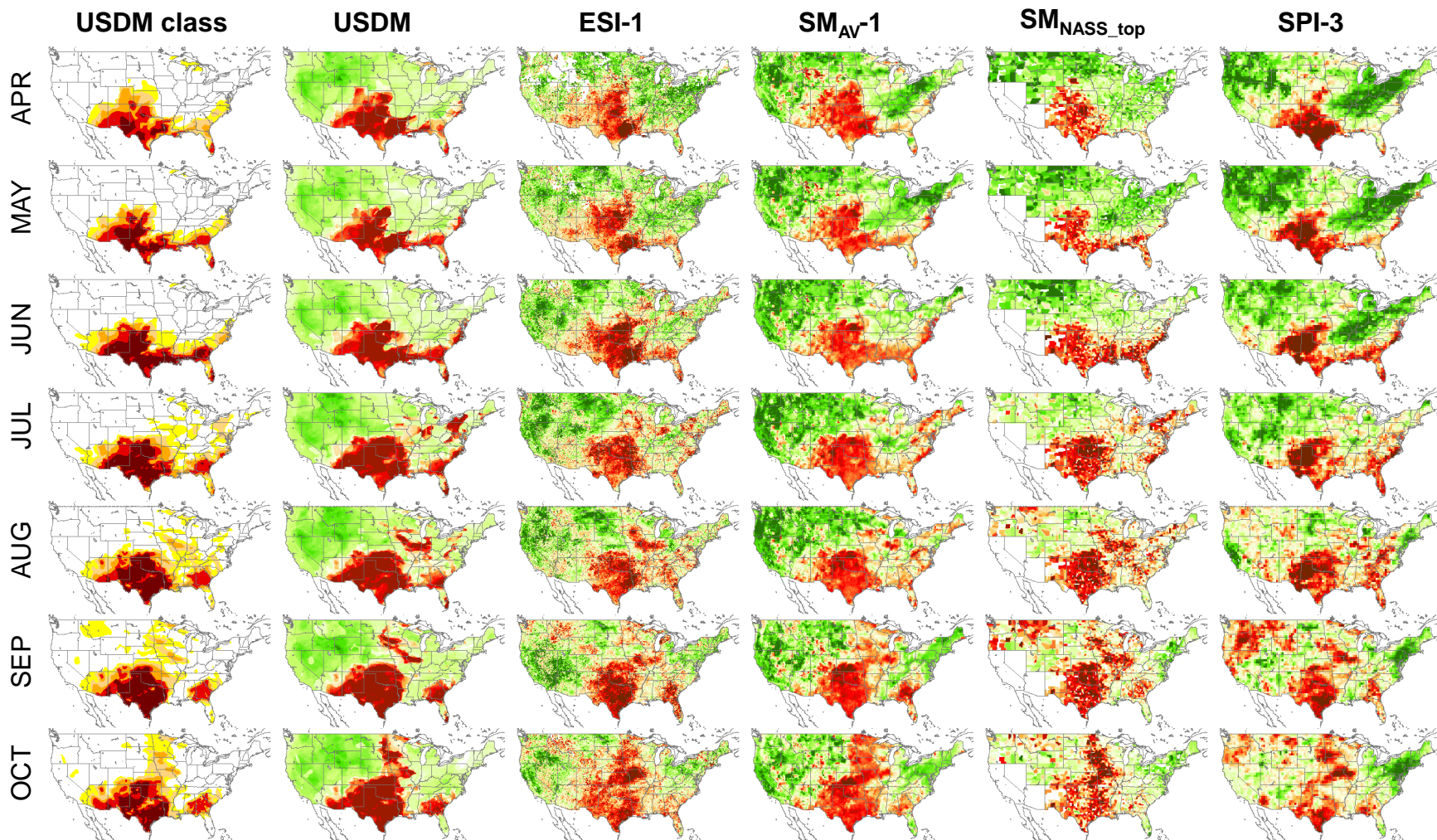
2009



D0 D1 D2 D3 D4

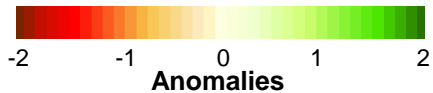
Drier **Wetter**
 -2 -1 0 1 2
Anomalies

2010



D0 D1 D2 D3 D4

Drier



Wetter

2011