The Evaporative Stress Index as an agricultural drought indicator

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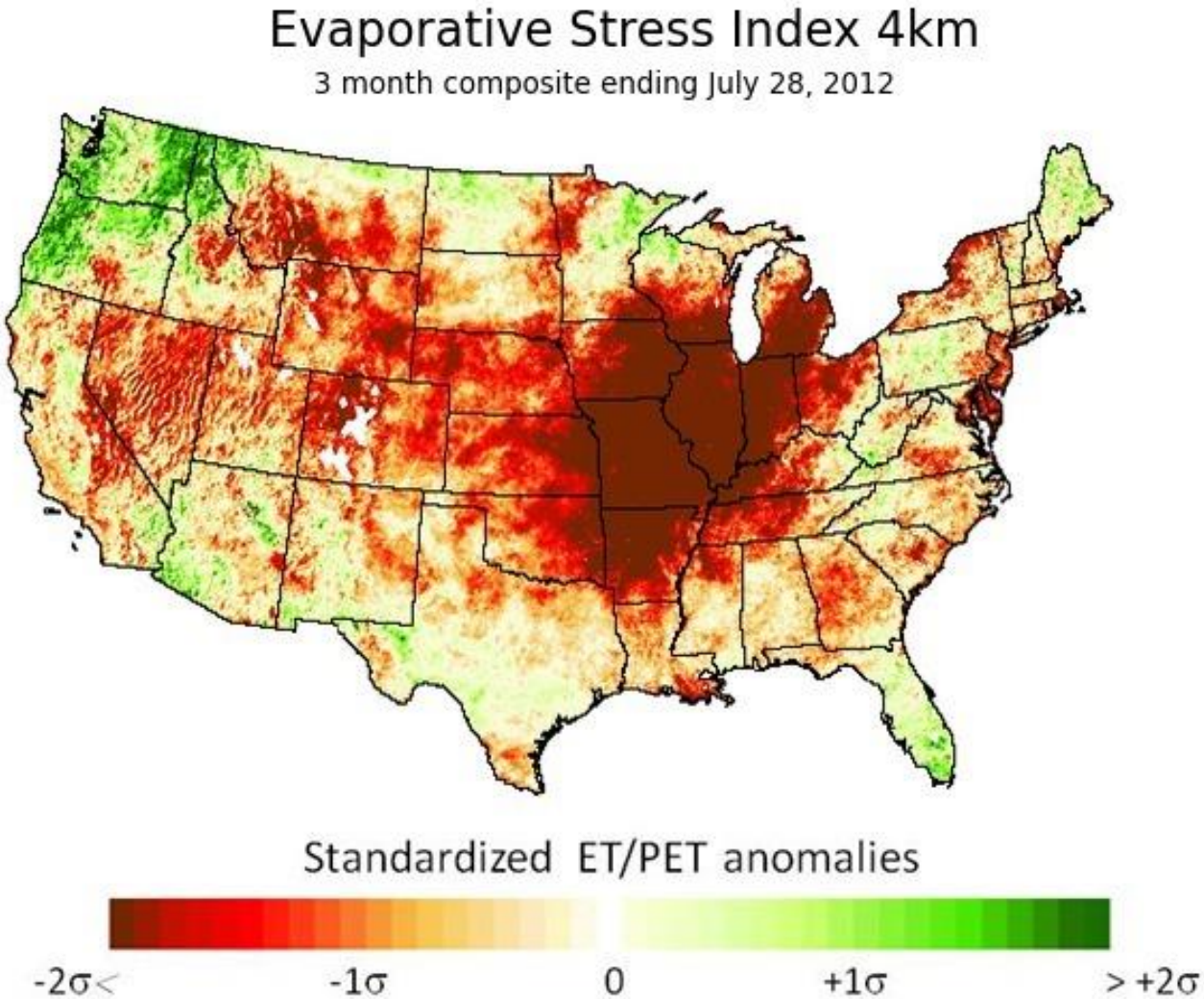
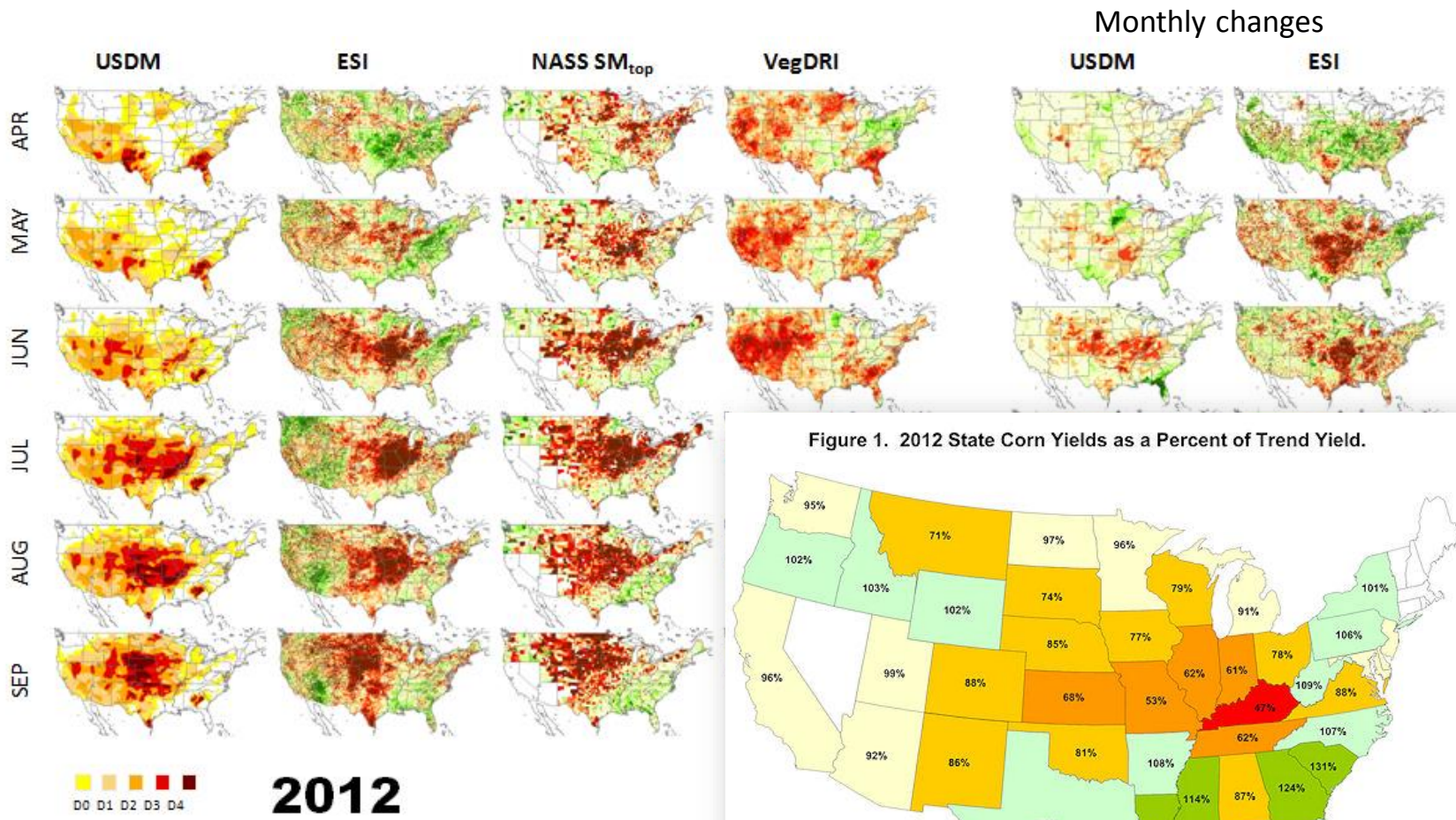
Satellite ET Drought Indicator

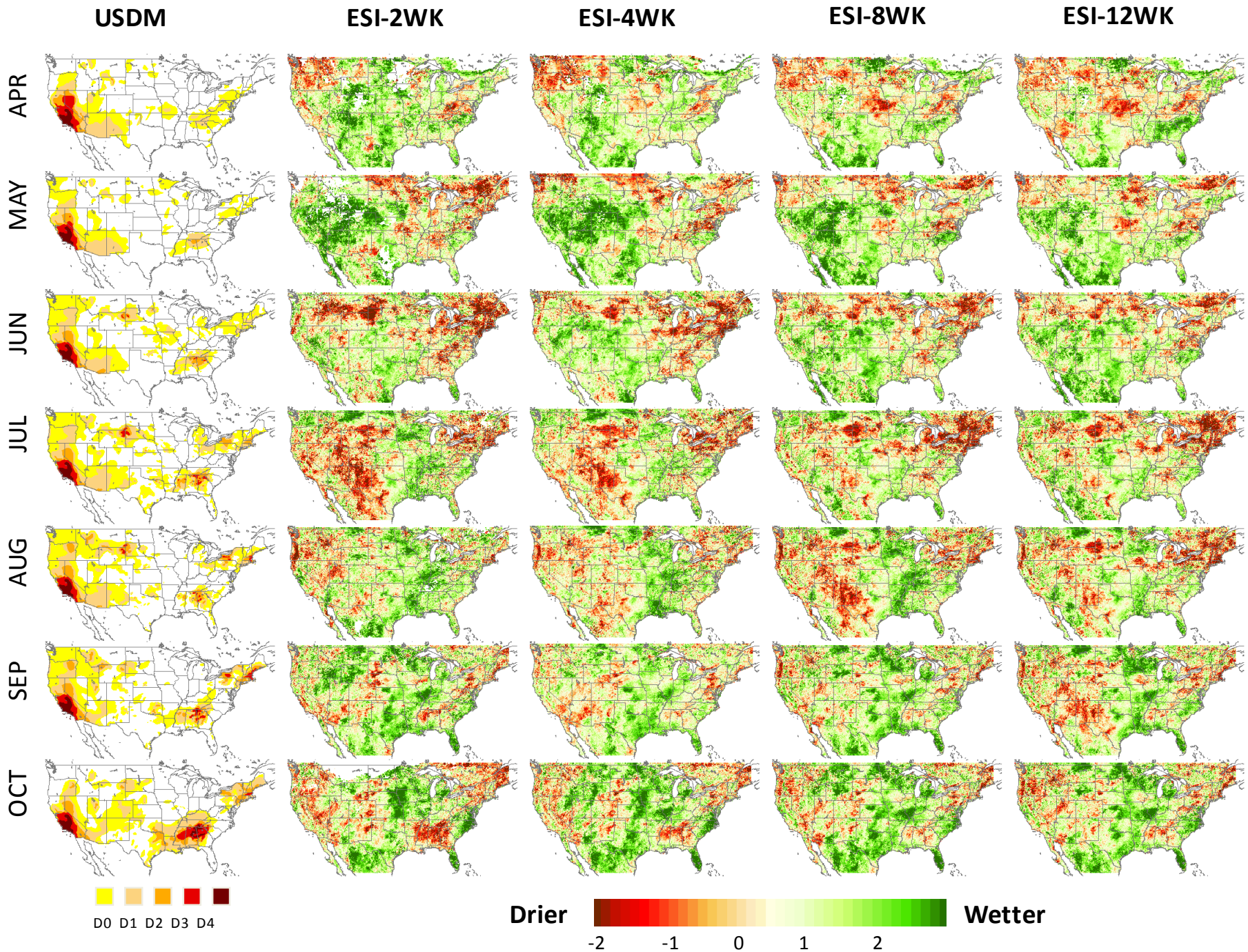


Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

2012 FLASH DROUGHT




USDM
ESI-2WK
ESI-4WK
ESI-8WK
ESI-12WK
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2
-1
0
1
2

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ESI Archive

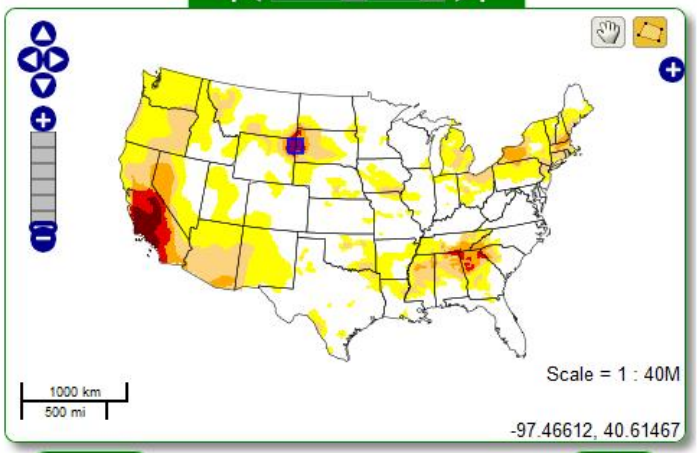
Region: CONUS | Index: USDM | Timescale: Weekly

Jul 21 | 2016

SPI 12 month:

SPI 9 month:

SPI 6 month:



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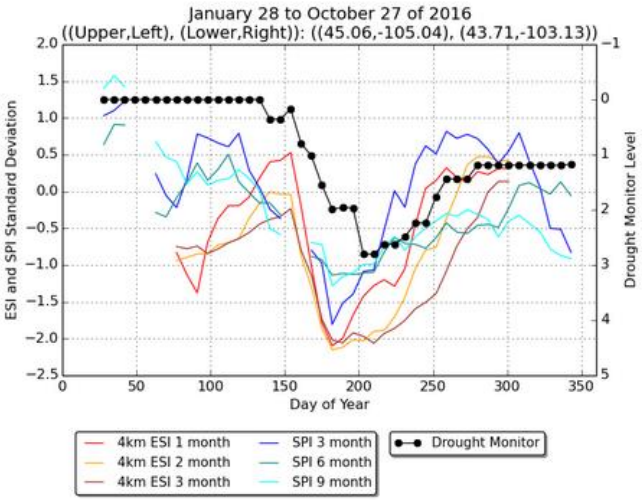
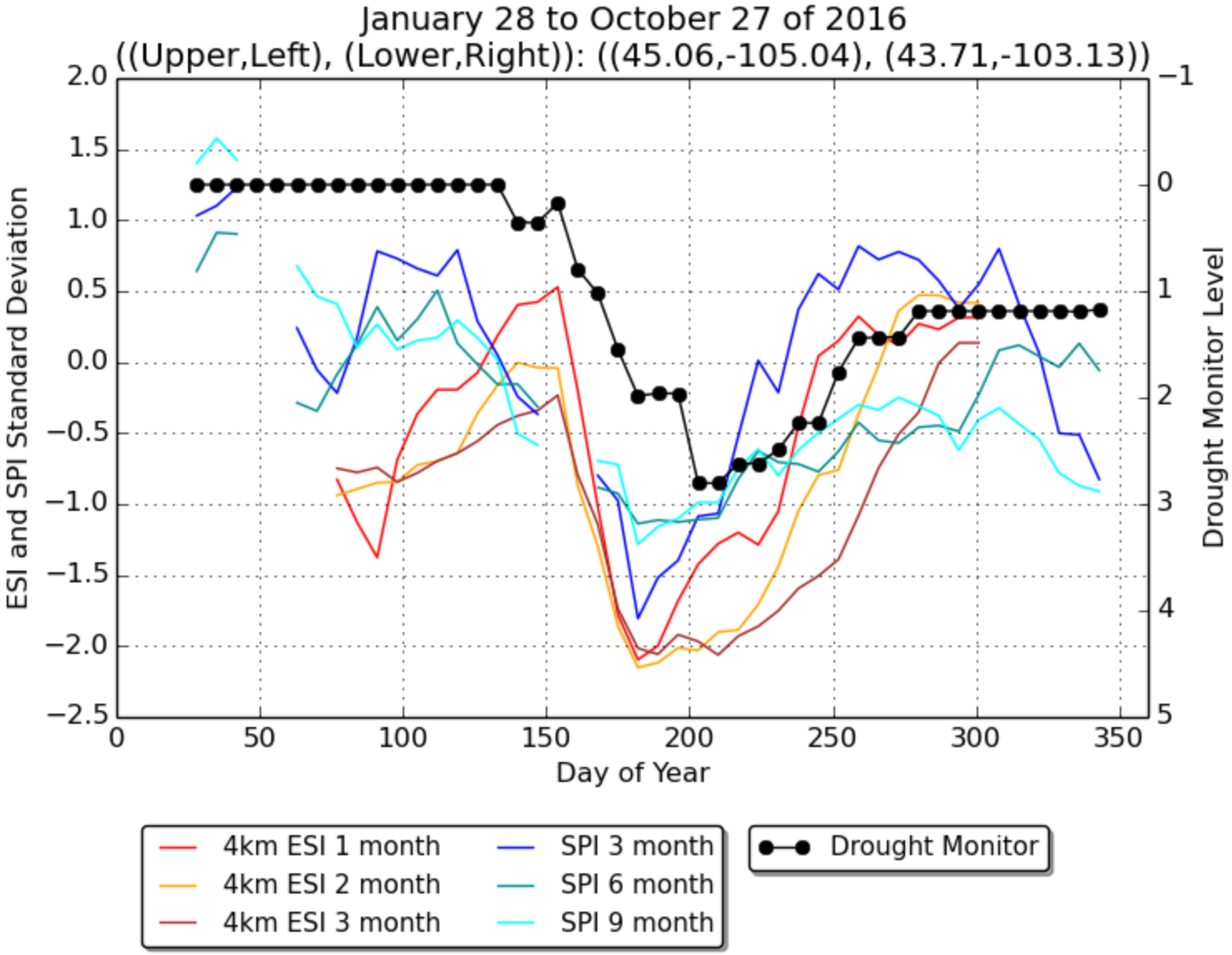
U.S. Drought Monitor Drought Severity

D0 D1 D2 D3 D4



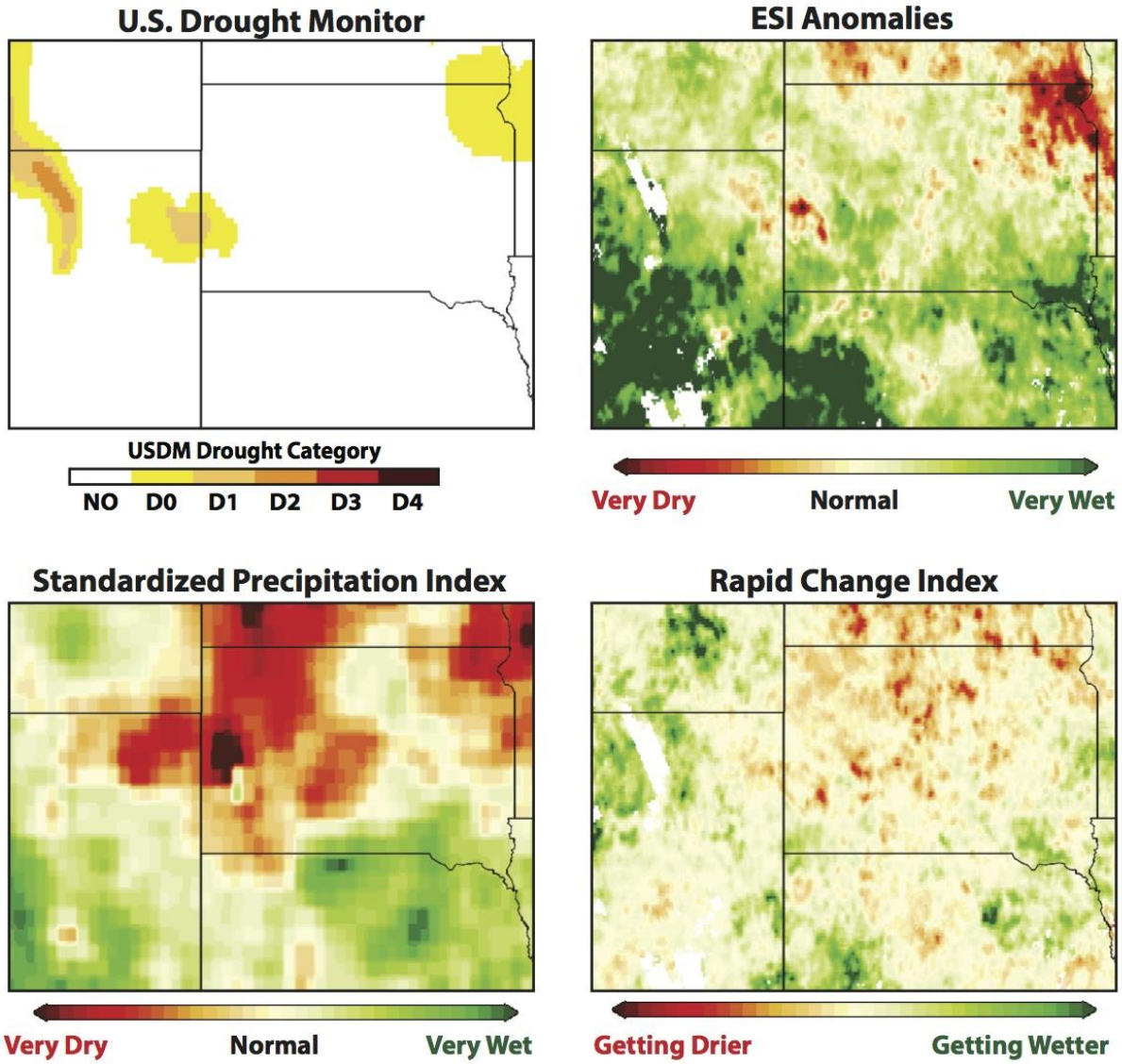
USDM -- Colors depict abnormal dryness (D0), moderate drought (D1), severe drought (D2), extreme drought (D3), and exceptional drought (D4)

Annual chart -- from map on left choose product and year; pan and zoom if desired; then select point or area to display chart of data for the year.


January 28 to October 27 of 2016
((Upper,Left), (Lower,Right)): ((45.06,-105.04), (43.71,-103.13))
ESI and SPI Standard Deviation
Drought Monitor Level
Day of Year
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−1
0
1
2
3
4
5
0
50
100
150
200
250
300
350
4km ESI 1 month
4km ESI 2 month
4km ESI 3 month
SPI 3 month
SPI 6 month
SPI 9 month
Drought Monitor

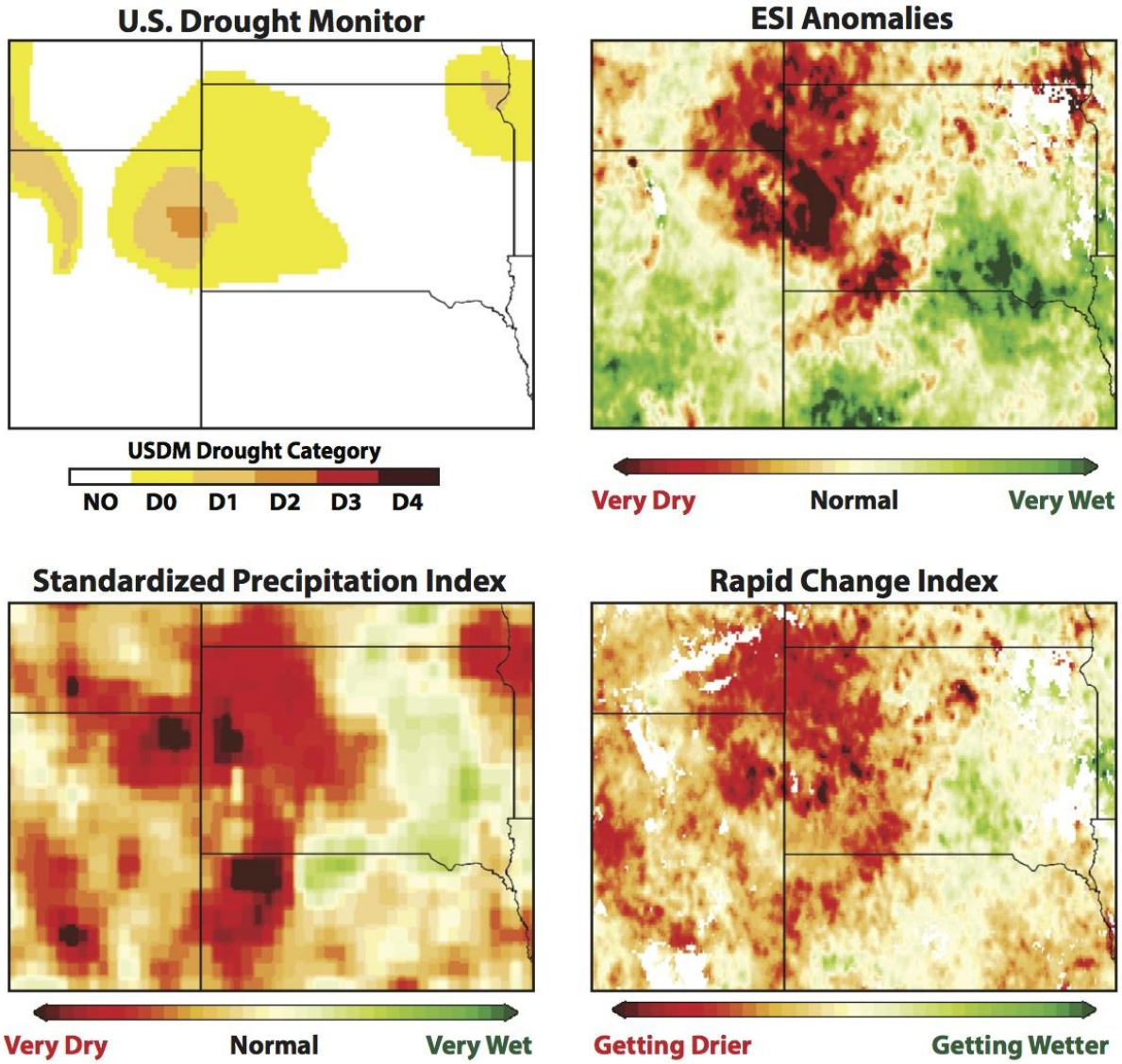
2016 Black Hills drought

May 26



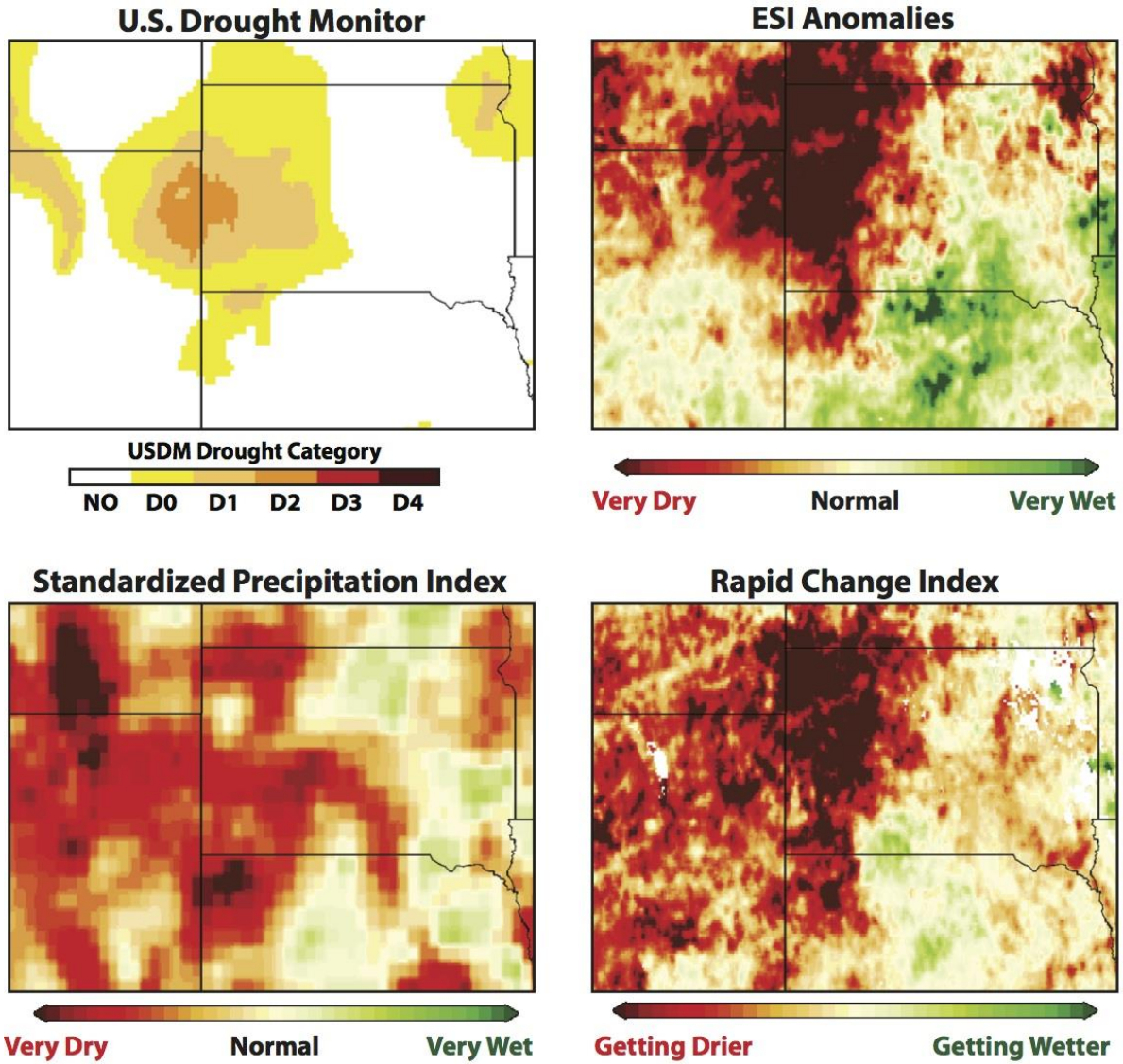
2016 Black Hills drought

June 9



2016 Black Hills drought

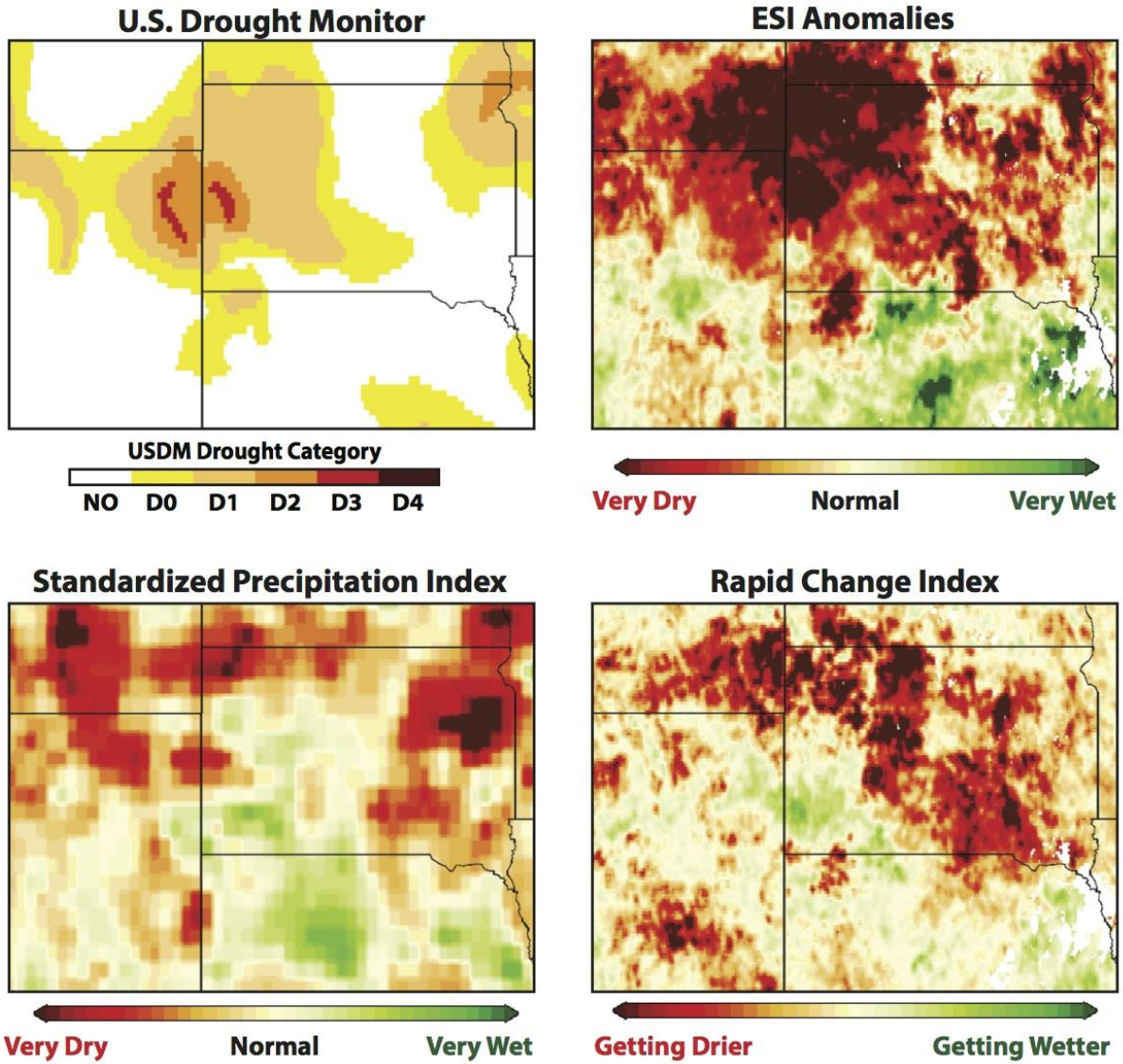
June 23



US Drought Monitor – April 2017

2016 Black Hills drought

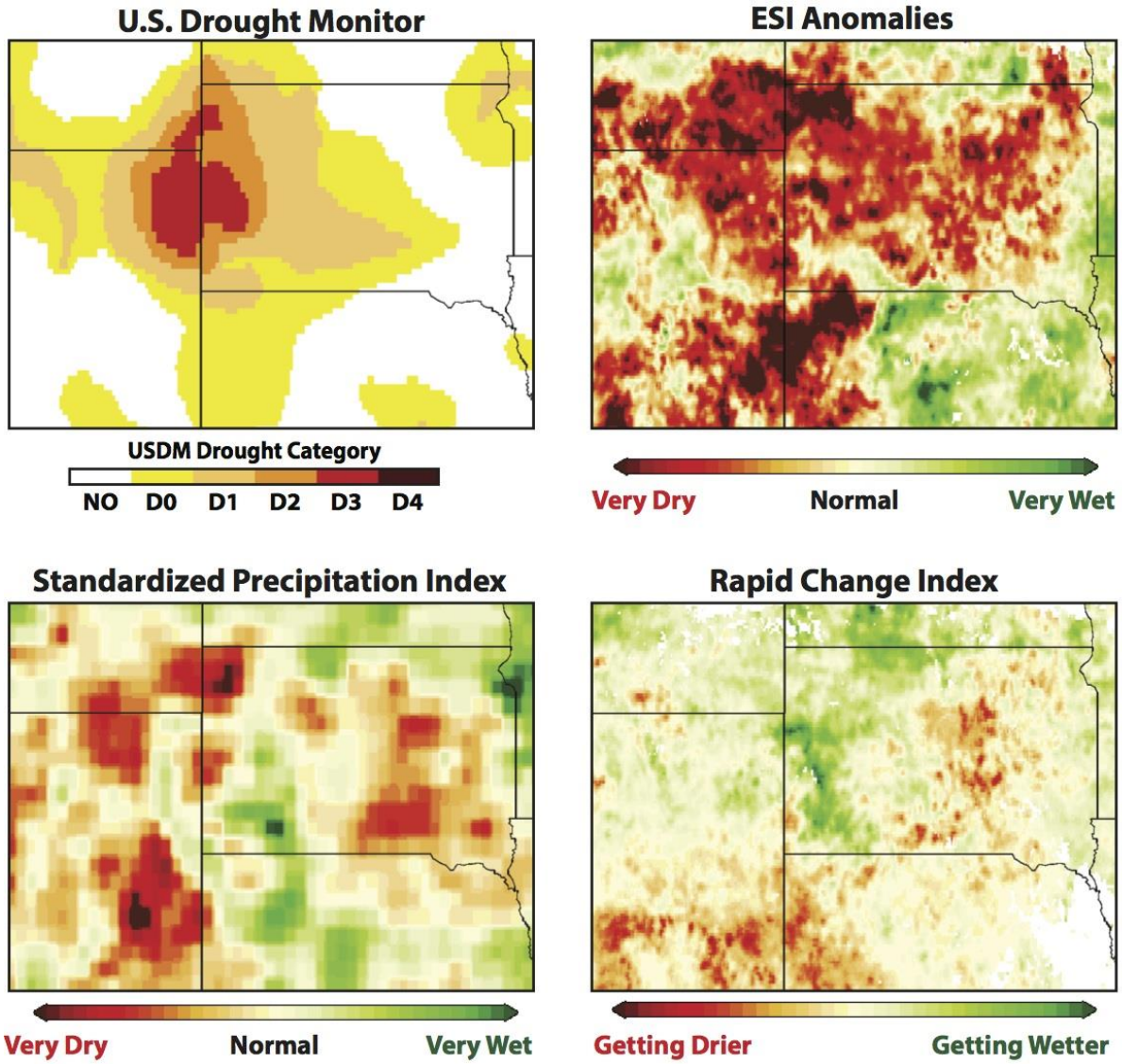
July 7



US Drought Monitor – April 2017

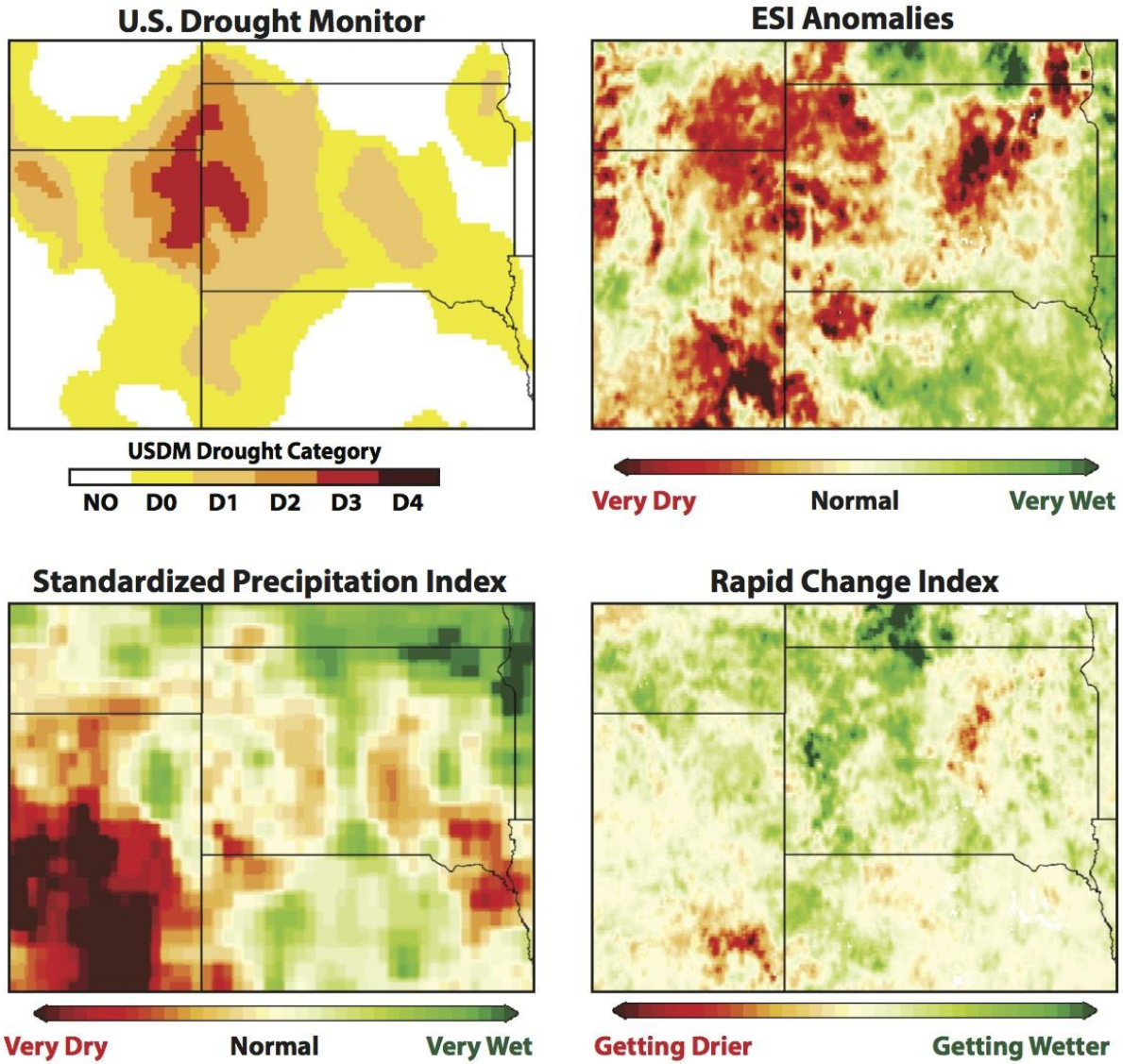
2016 Black Hills drought

July 21



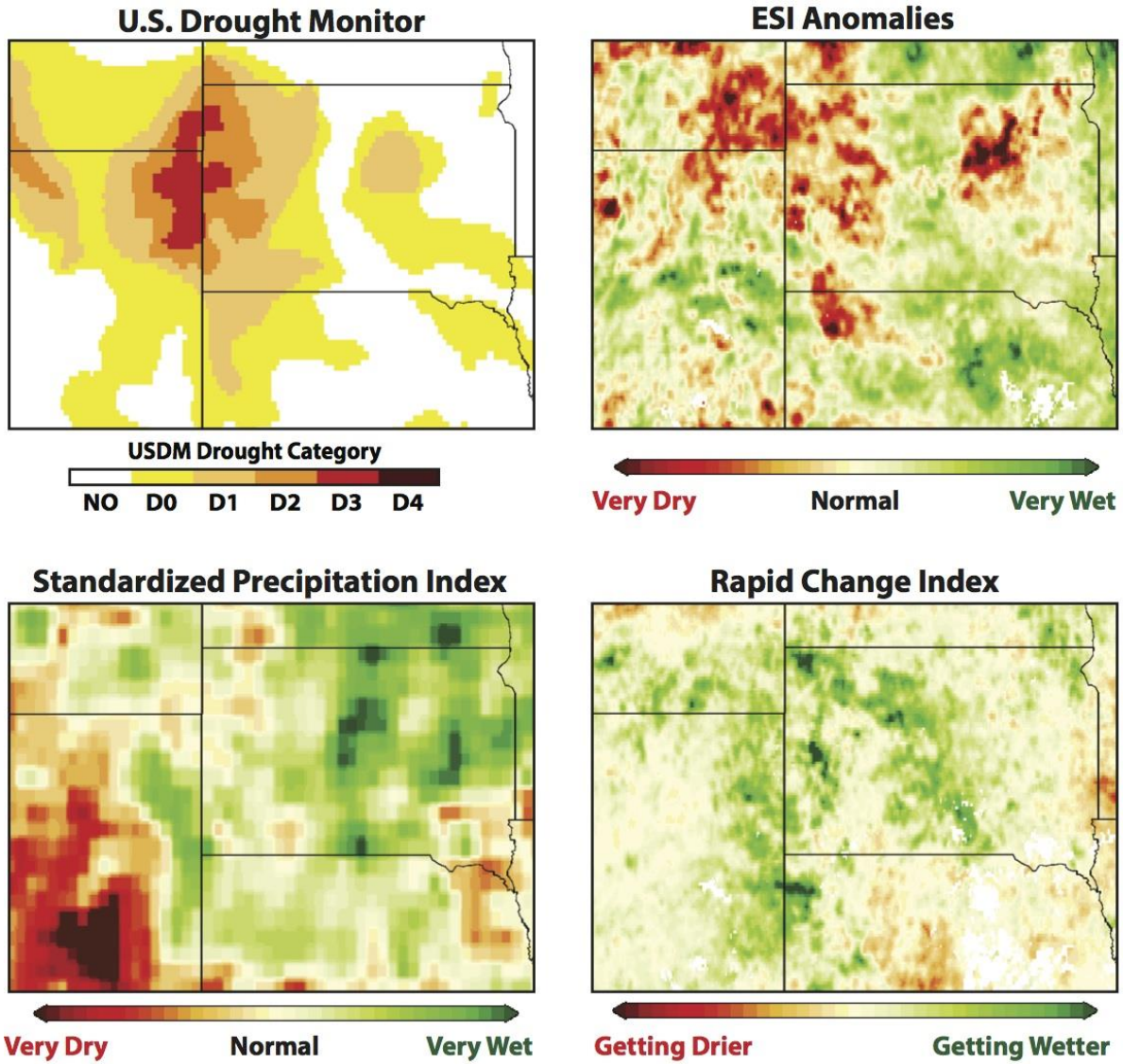
2016 Black Hills drought

Aug 4



2016 Black Hills drought

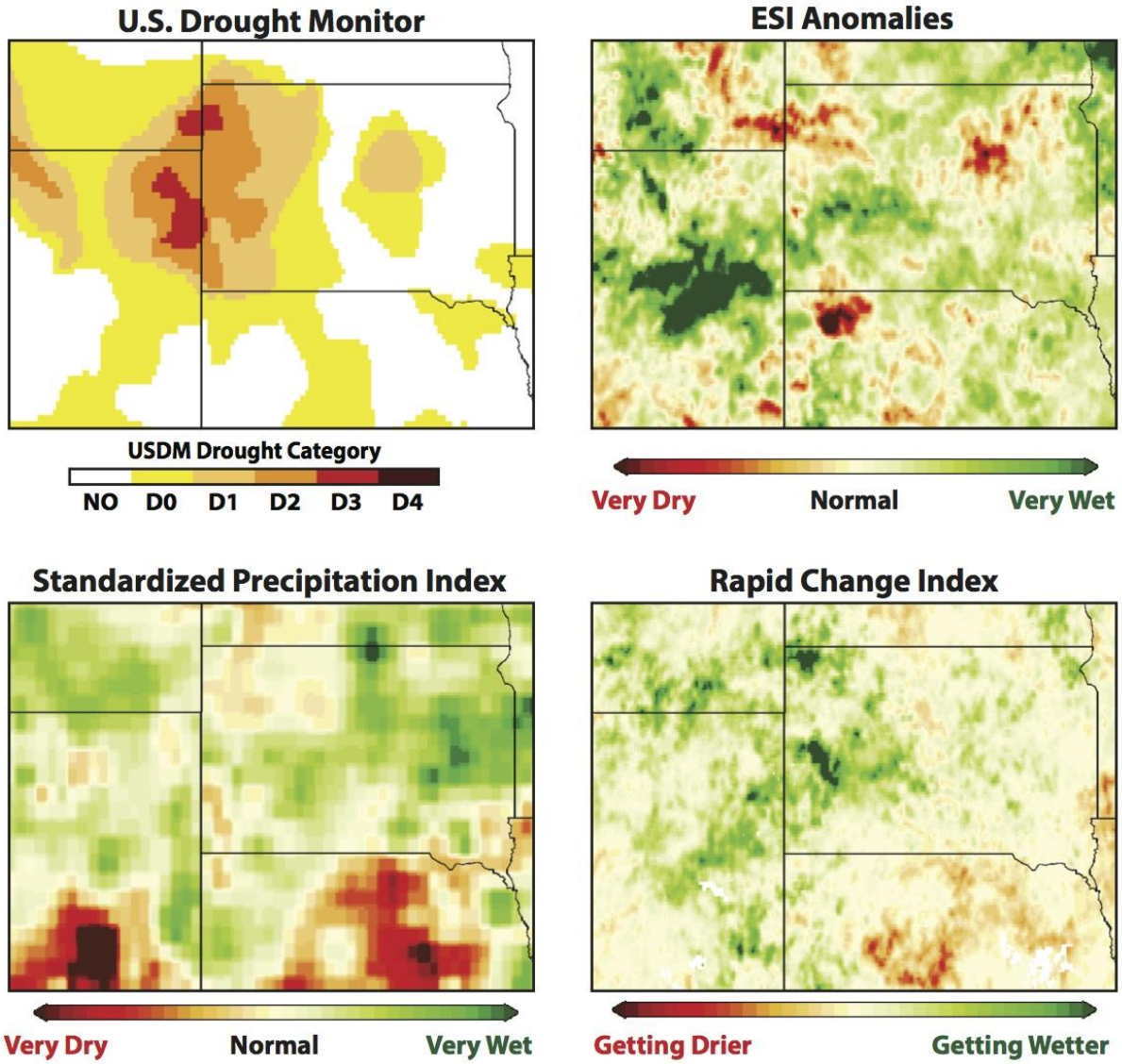
Aug 18



US Drought Monitor – April 2017

2016 Black Hills drought

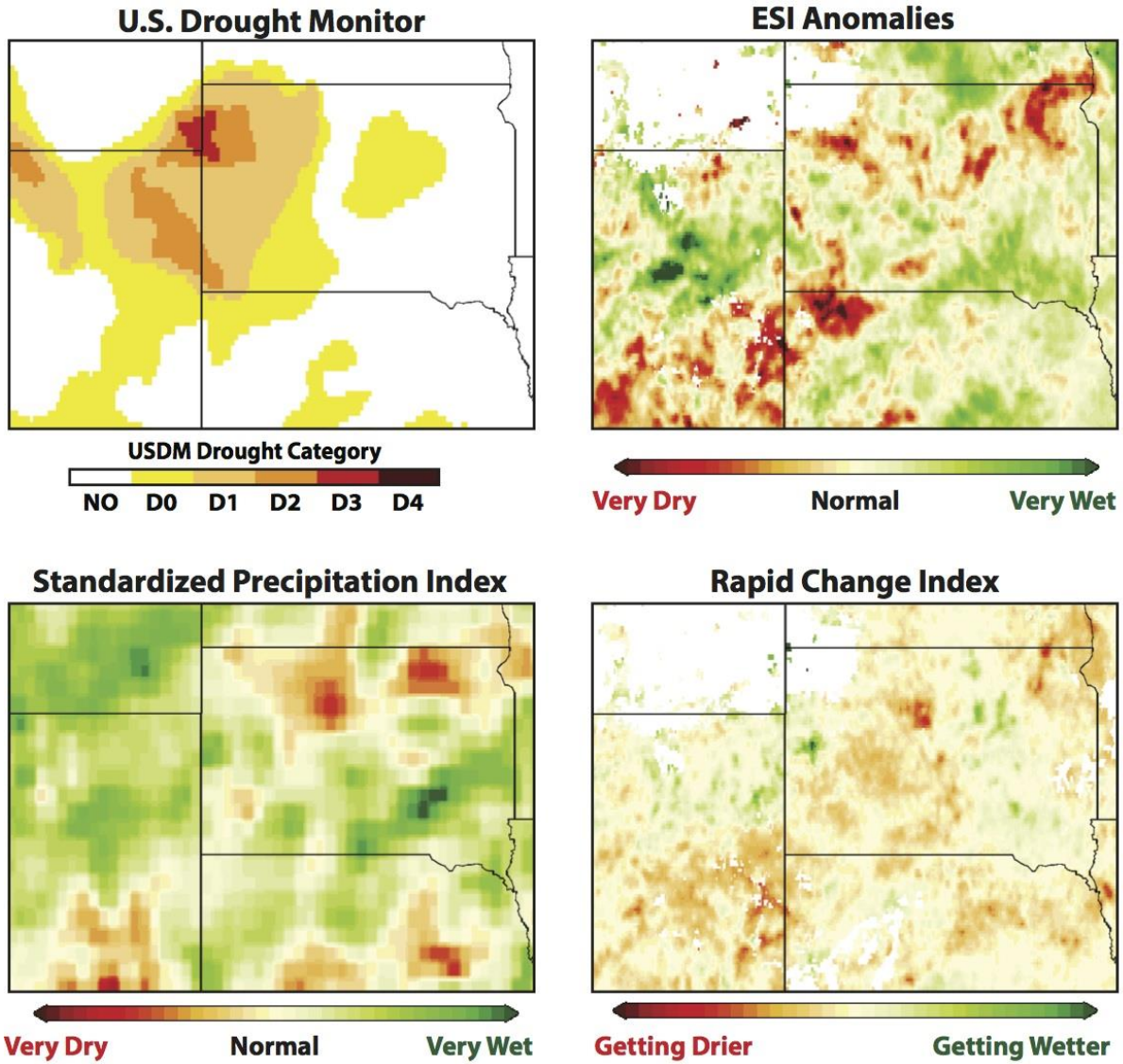
Sept 1



US Drought Monitor – April 2017

2016 Black Hills drought

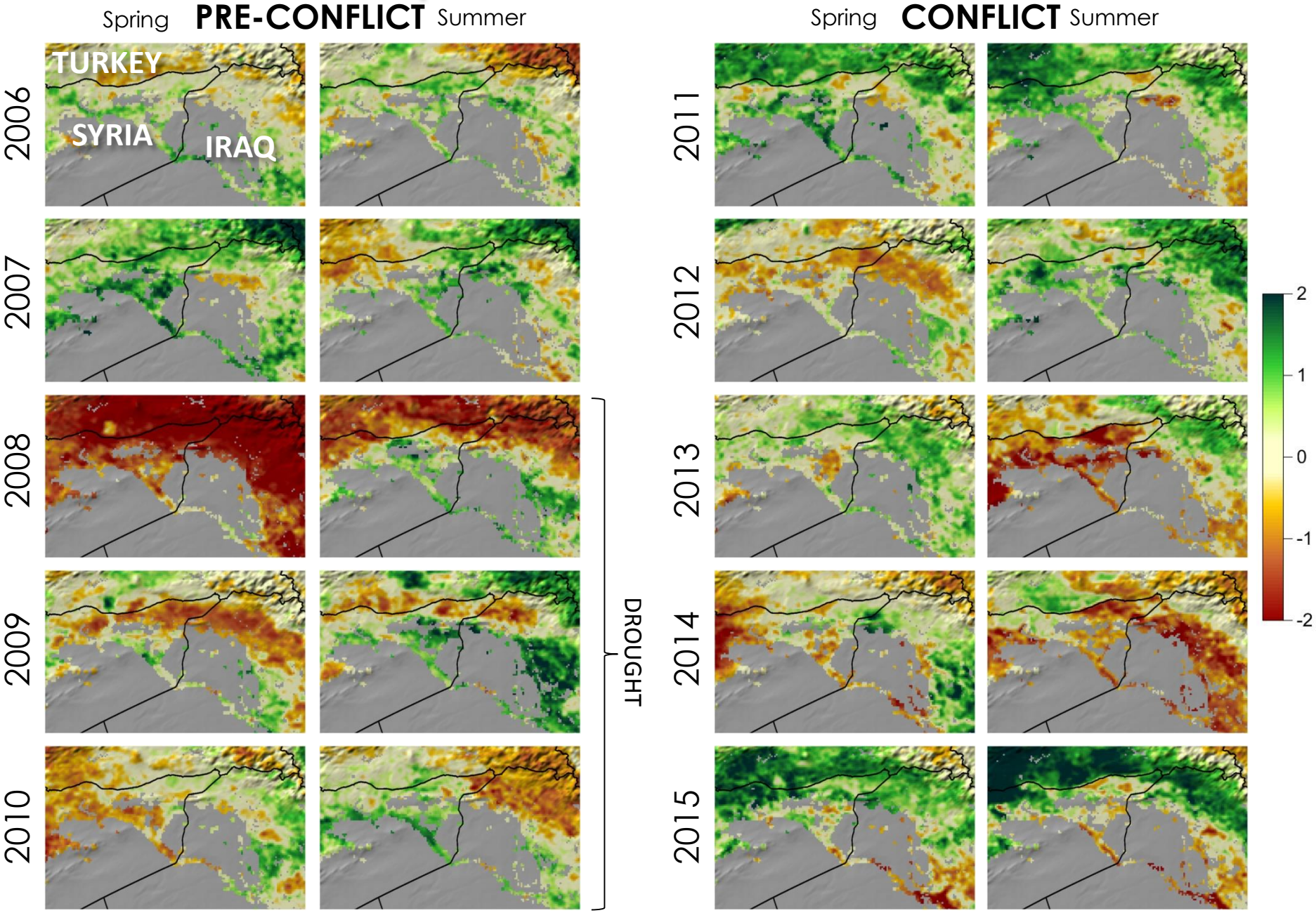
Sept 15



UNIQUE CHARACTERISTICS OF ESI

… reflects actual crop/vegetation stress conditions developing on the ground

Evaporative Stress Index

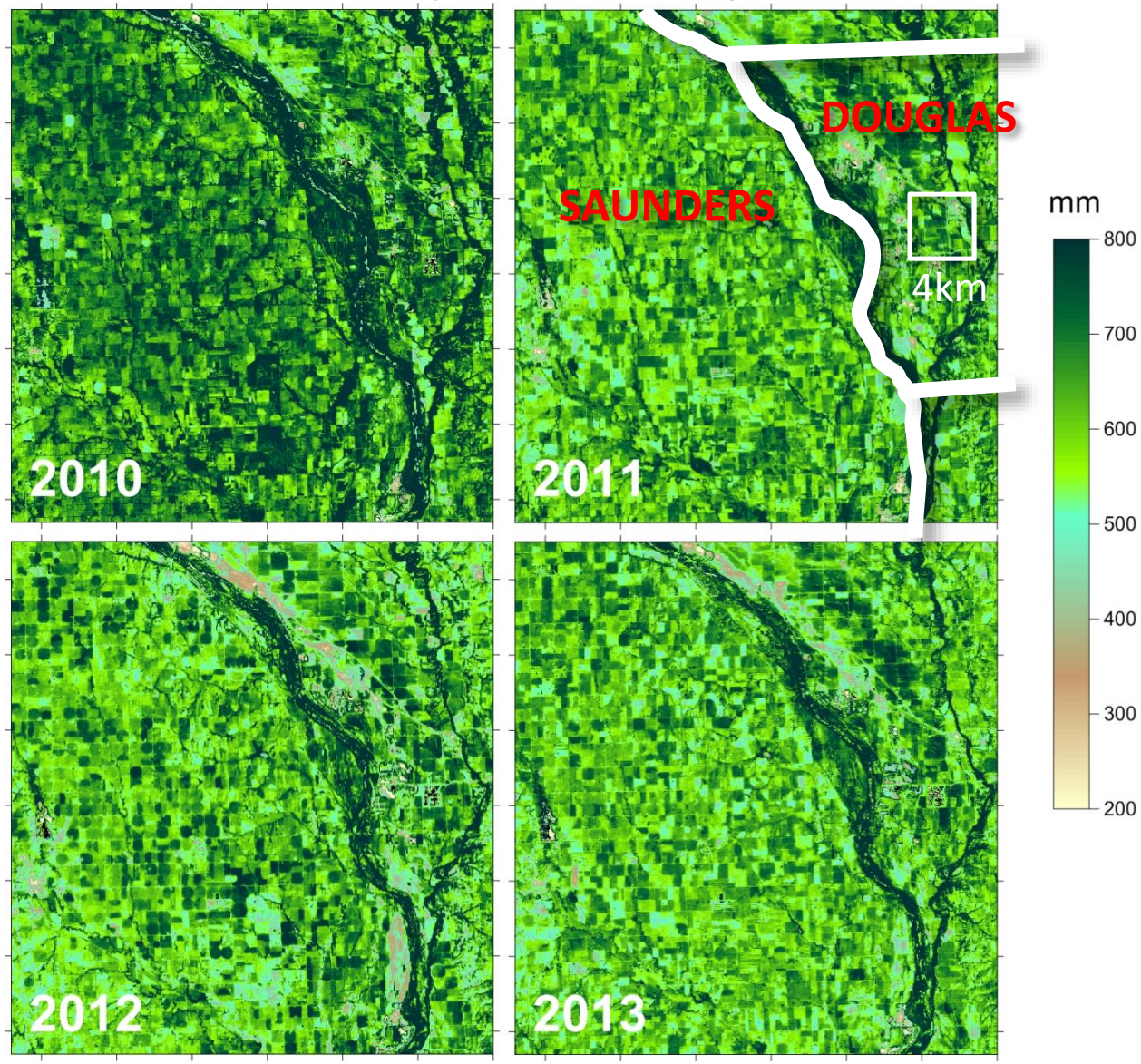


UNIQUE CHARACTERISTICS OF ESI

… can be developed at field scale
(Landsat/MODIS fusion, ECOSTRESS)

Landsat/MODIS ET datacubes

Mead, Nebraska (near Lincoln)

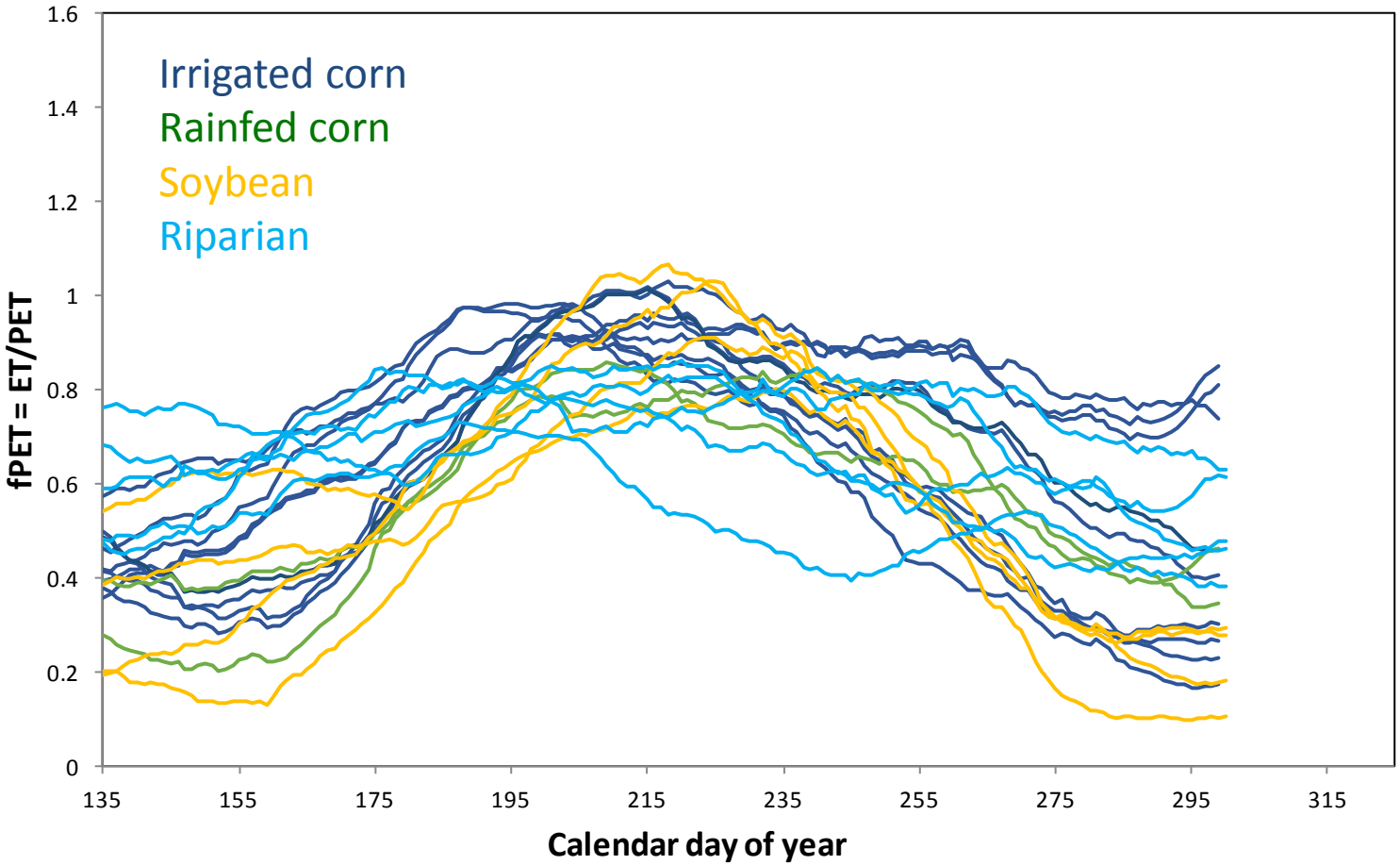


GROWING SEASON WATER USE

Yang Yang, 2017

Corn fields at Mead site

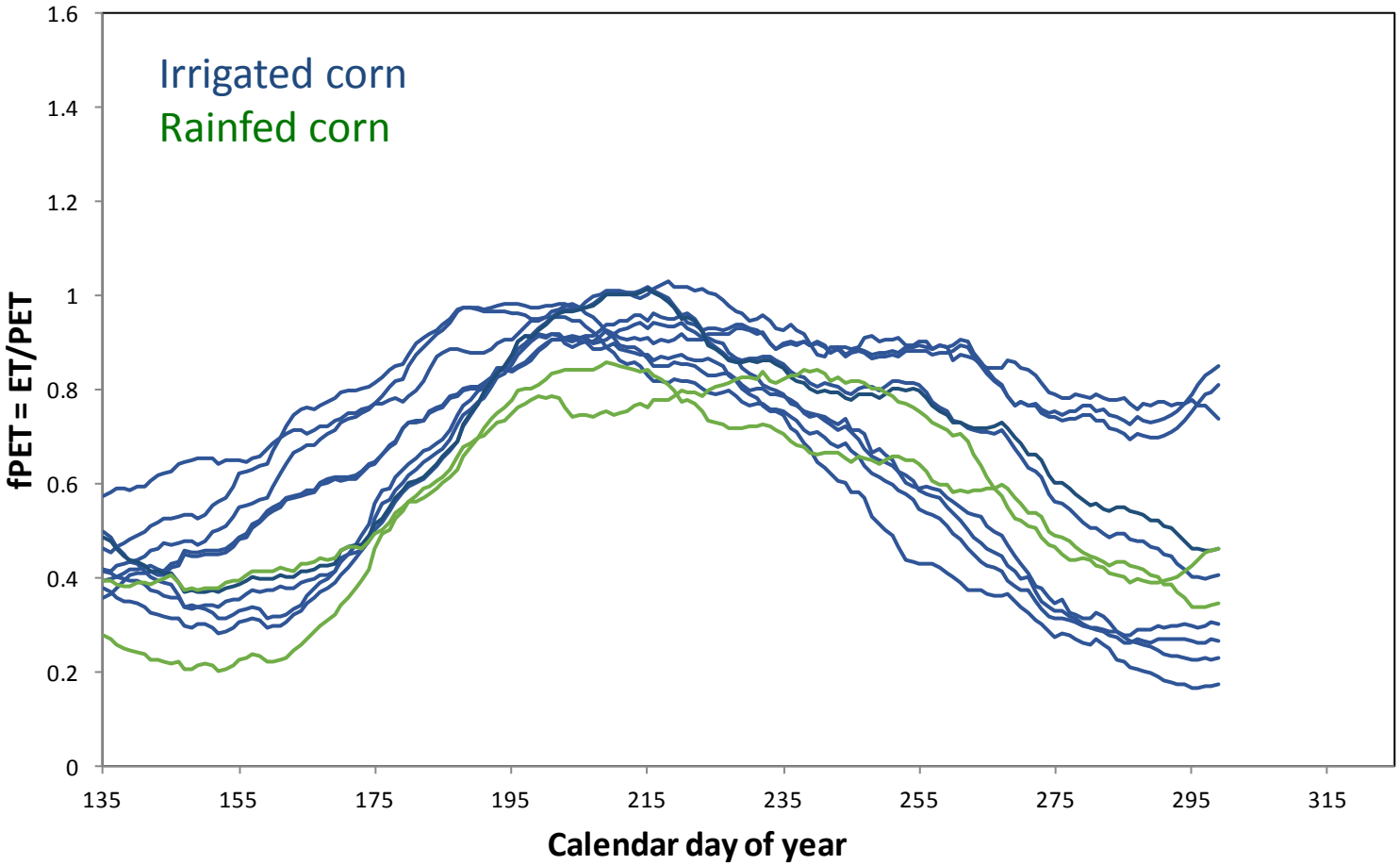
Aligned on calendar date



Yang Yang, 2017

Corn fields at Mead site

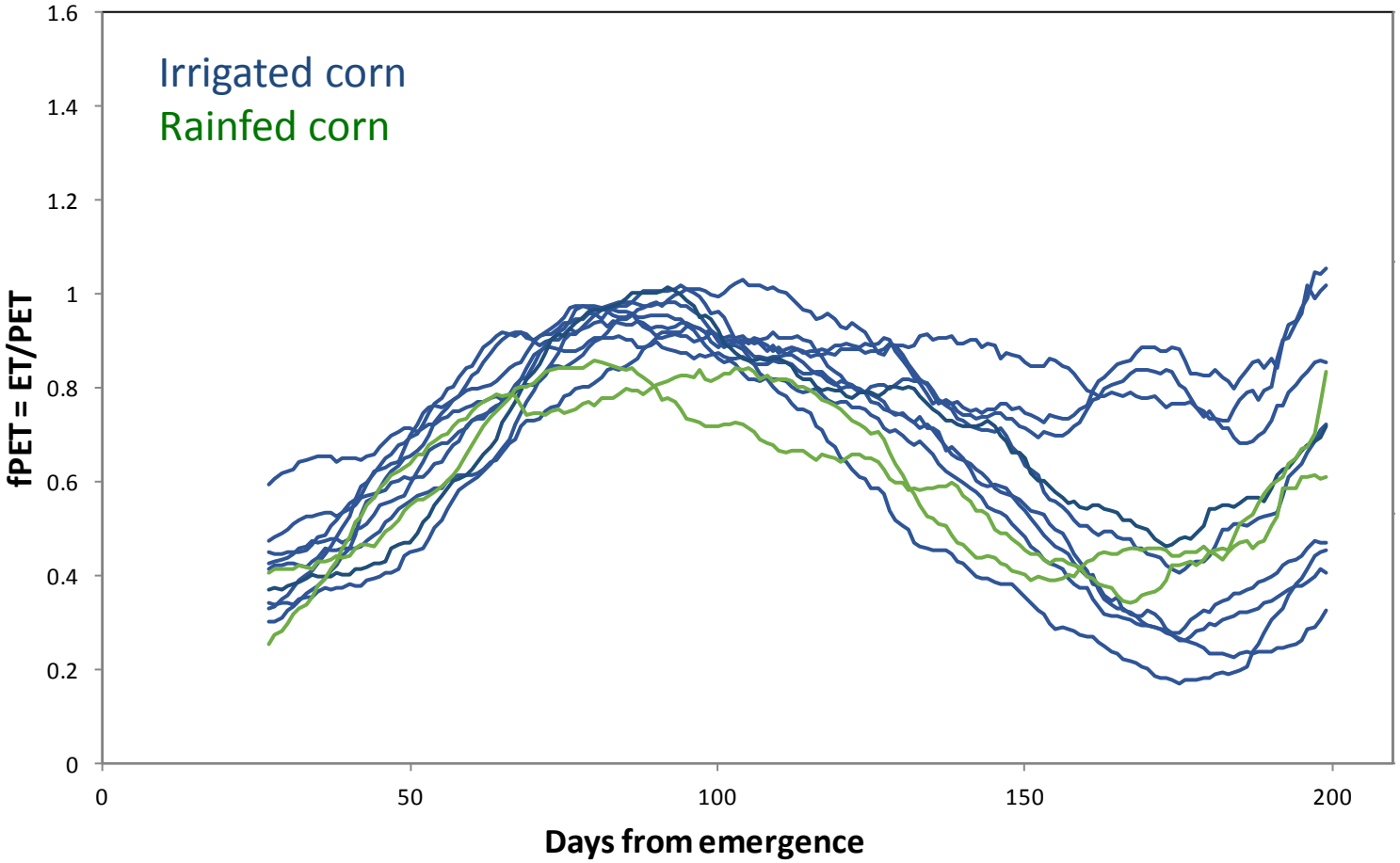
Aligned on calendar date



Yang Yang, 2017

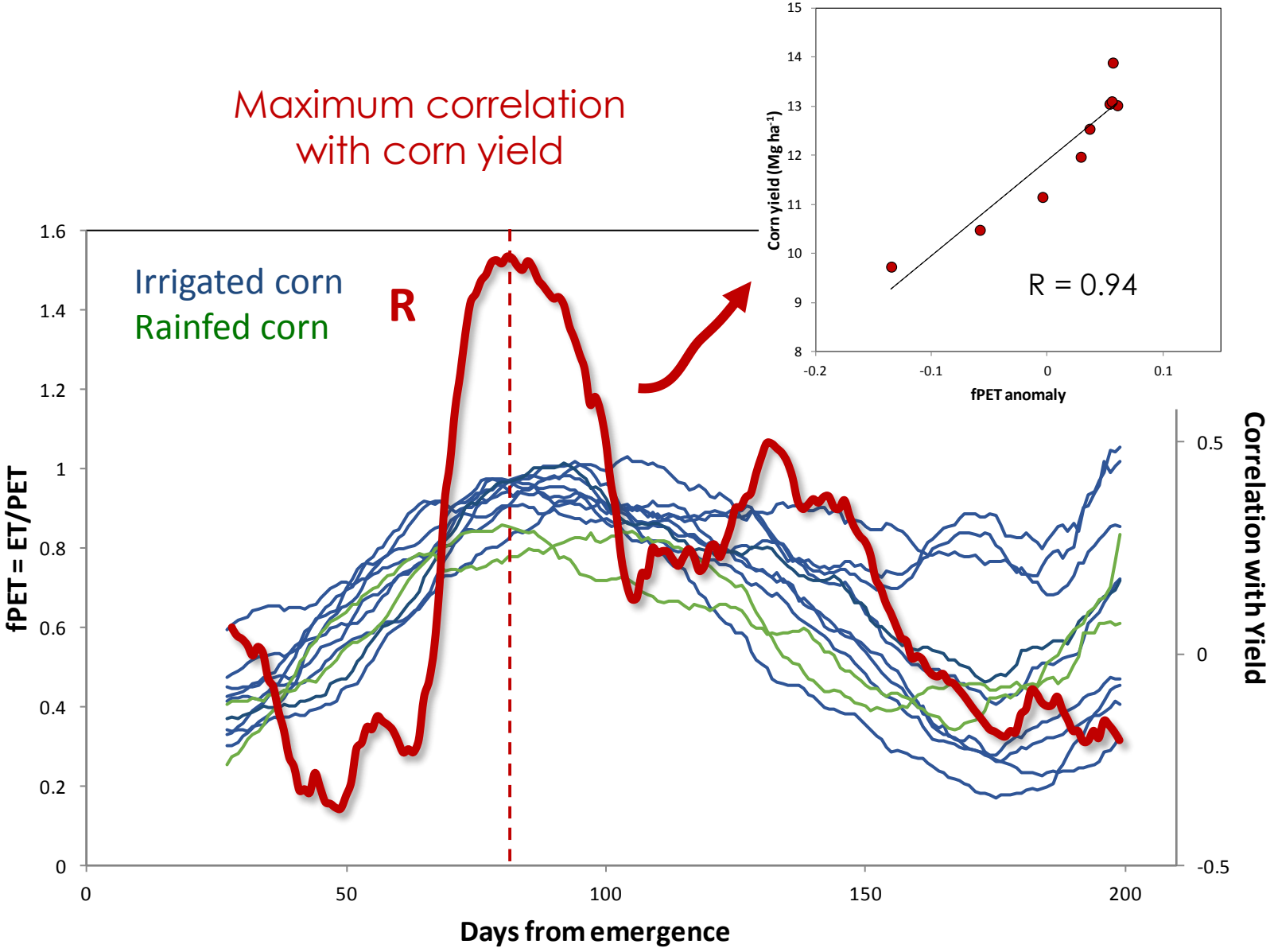
Corn fields at Mead site

Aligned on crop- (or field-) specific emergence date



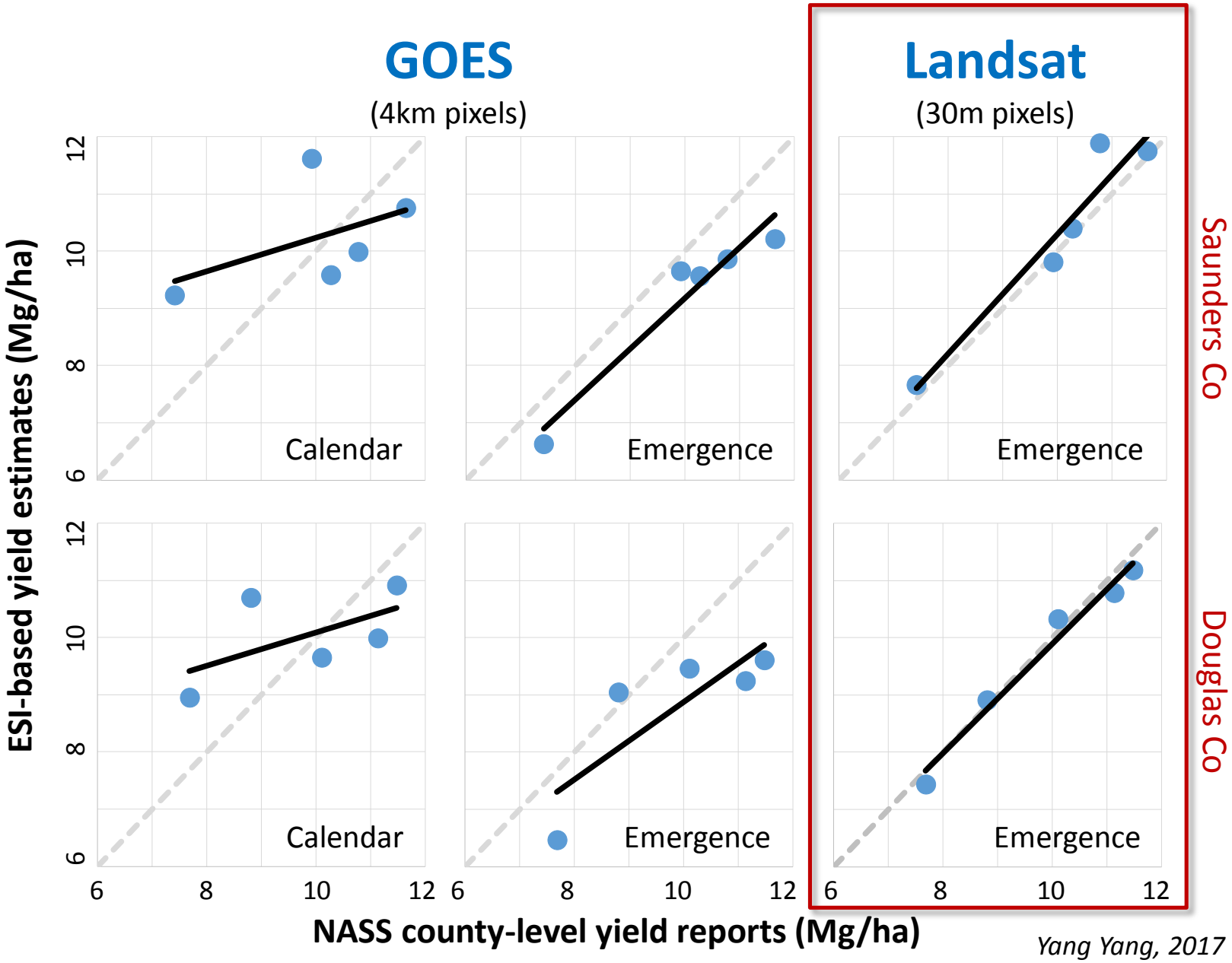
Yang Yang, 2017

Corn fields at Mead site



Yang Yang, 2017

Yield predictions improve at field scale



Yang Yang, 2017

Conclusions

Satellite Evapotranspiration

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

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ESI Archive

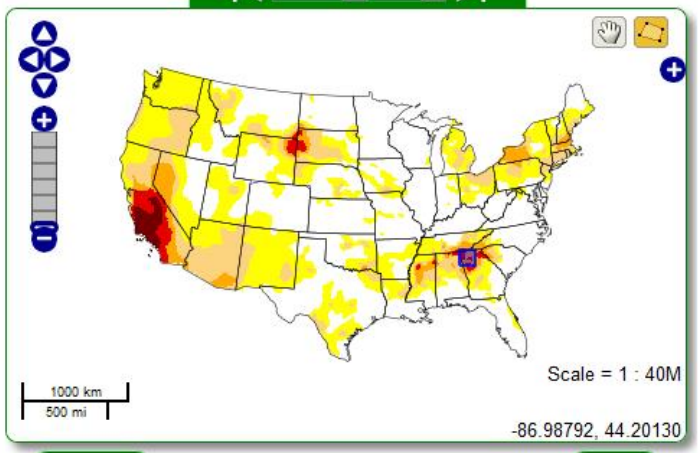
Region: CONUS | Index: USDM | Timescale: Weekly

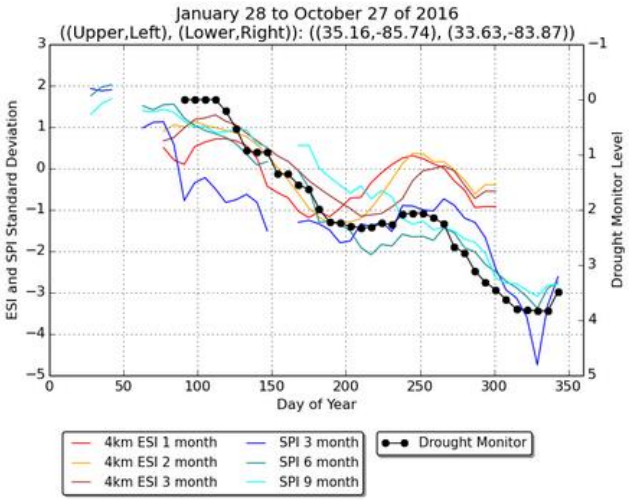
Jul 28 | 2016

SPI 12 month:

SPI 9 month:

SPI 6 month:





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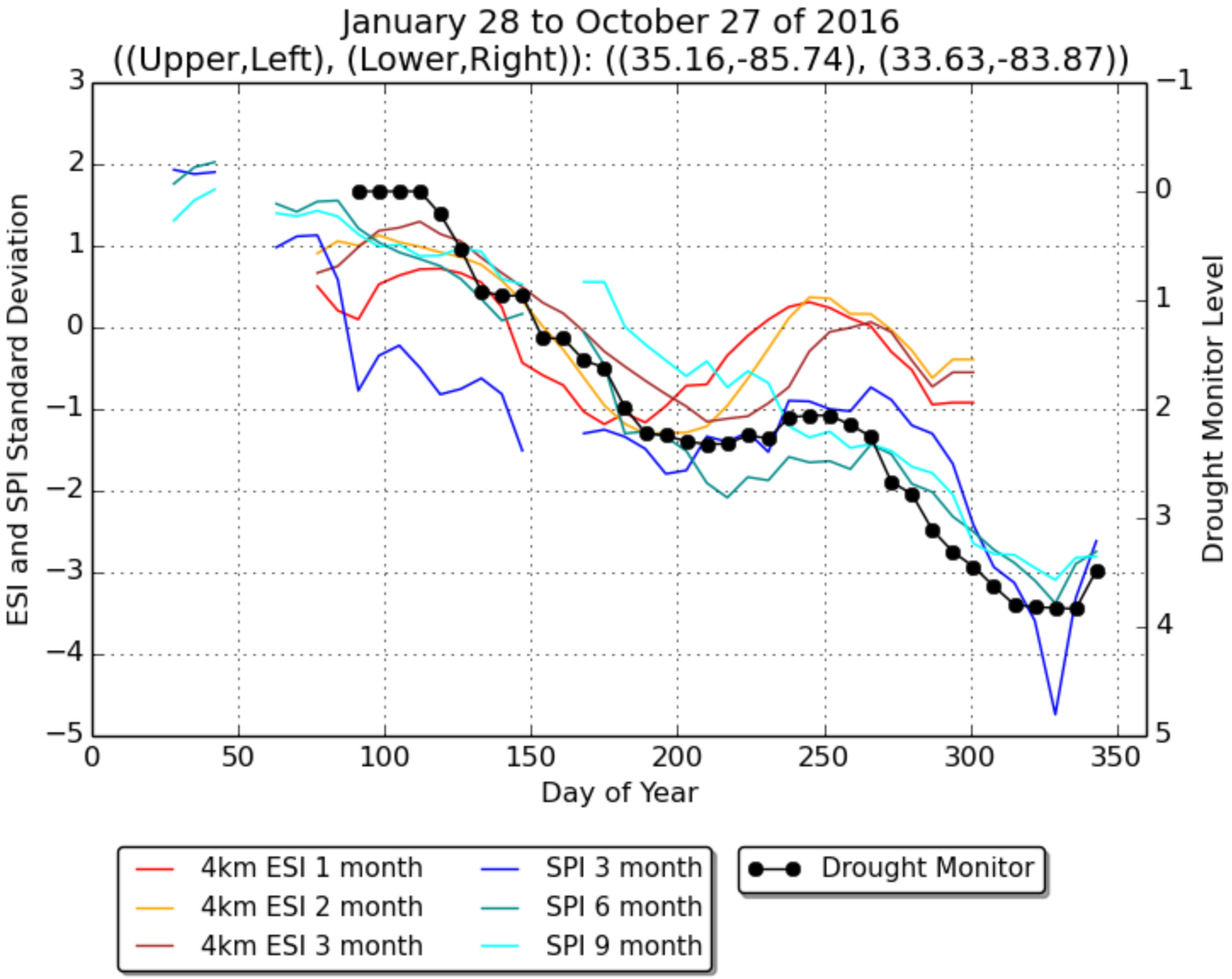
U.S. Drought Monitor Drought Severity

D0 D1 D2 D3 D4

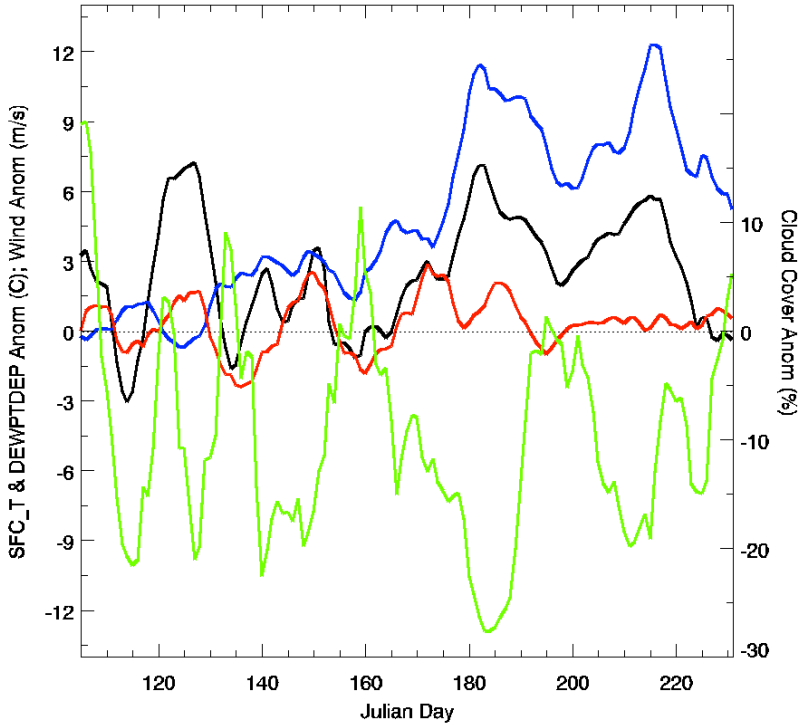
USDM -- Colors depict abnormal dryness (D0), moderate drought (D1), severe drought (D2), extreme drought (D3), and exceptional drought (D4)

Annual chart -- from map on left choose product and year; pan and zoom if desired; then select point or area to display chart of data for the year.


January 28 to October 27 of 2016
((Upper,Left), (Lower,Right)): ((35.16,-85.74), (33.63,-83.87))
ESI and SPI Standard Deviation
Drought Monitor Level
Day of Year
3
2
1
0
−1
−2
−3
−4
−5
−1
0
1
2
3
4
5
0
50
100
150
200
250
300
350
4km ESI 1 month
4km ESI 2 month
4km ESI 3 month
SPI 3 month
SPI 6 month
SPI 9 month
Drought Monitor

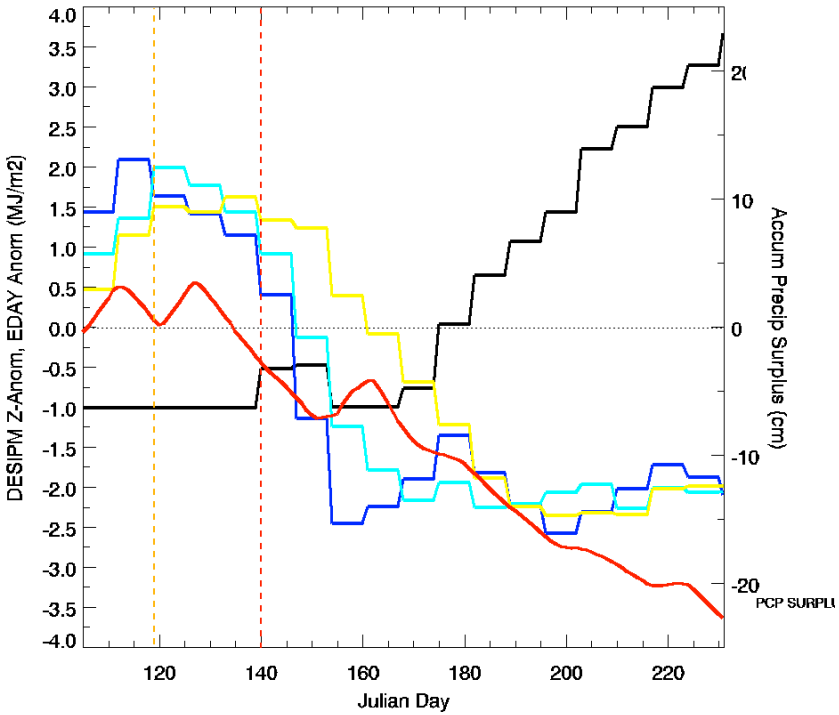
ESI Change over NE Oklahoma

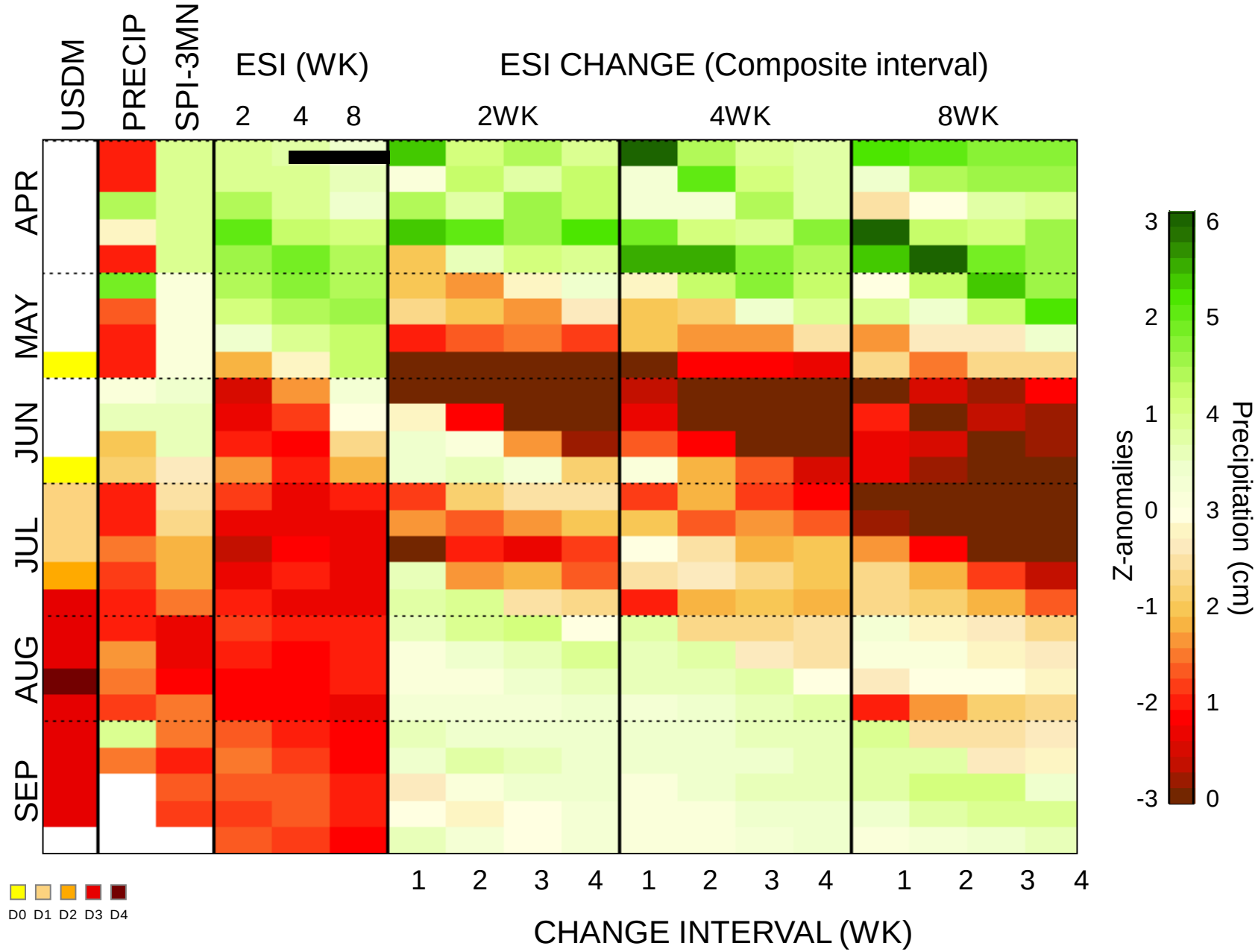
DRIVERS



Air temp
Dewpoint depression
Wind
Cloud cover

RESPONSES



USDM
ESI – 2WK
ESI – 4WK
ESI – 8WK
Accum precip anomaly

ESI Change over NE Oklahoma