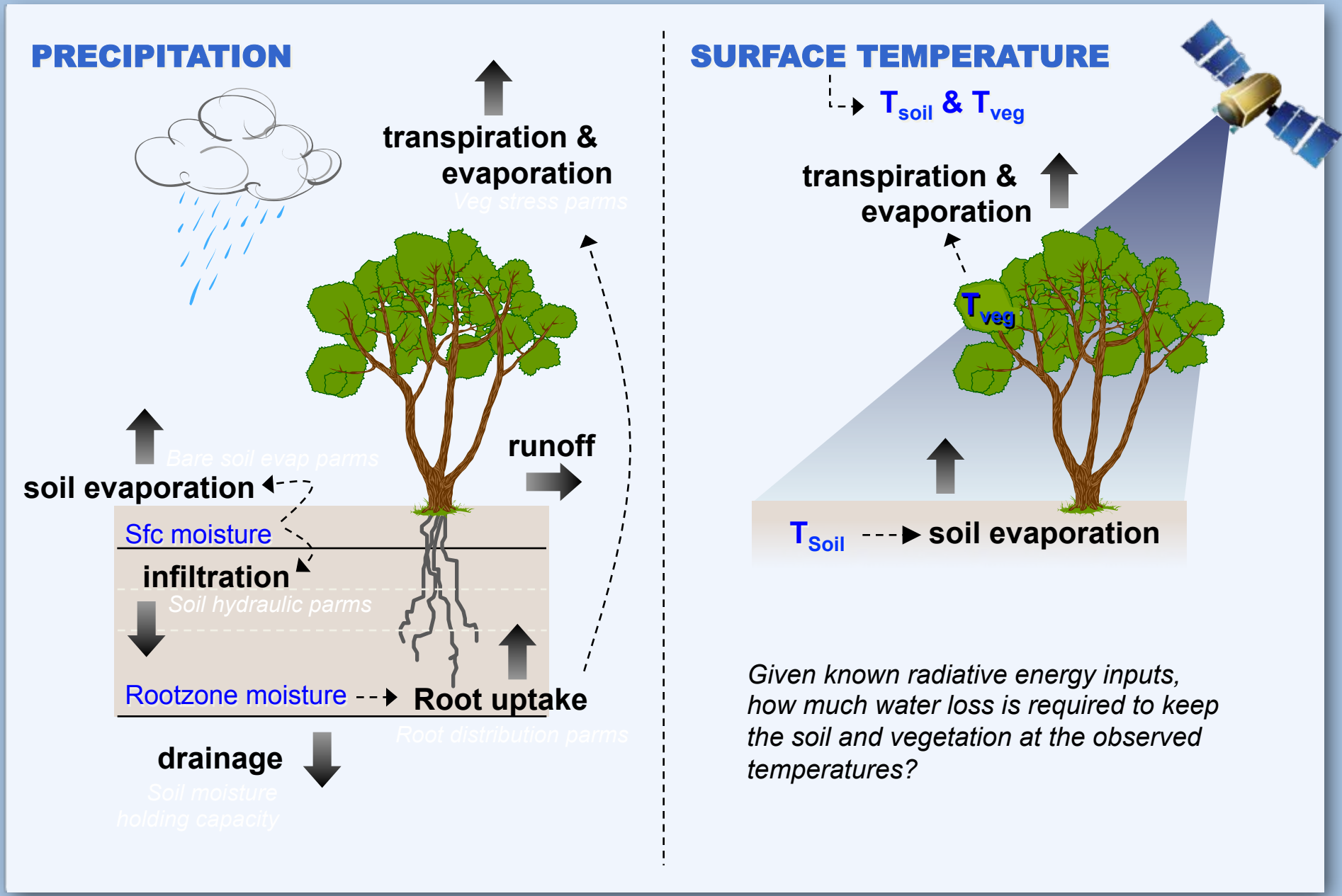
"A GOES Thermal-based Drought Early Warning Index for NIDIS"

Christopher Hain (ESSIC/UMD)
Martha Anderson (USDA)
Xiwu Zhan (NESDIS STAR)
Kingtse Mo (CPC)
Mark Svoboda (NDMC)
Brian Wardlow (NDMC)
John Mecikalski (UAH)
William Kustas (USDA)



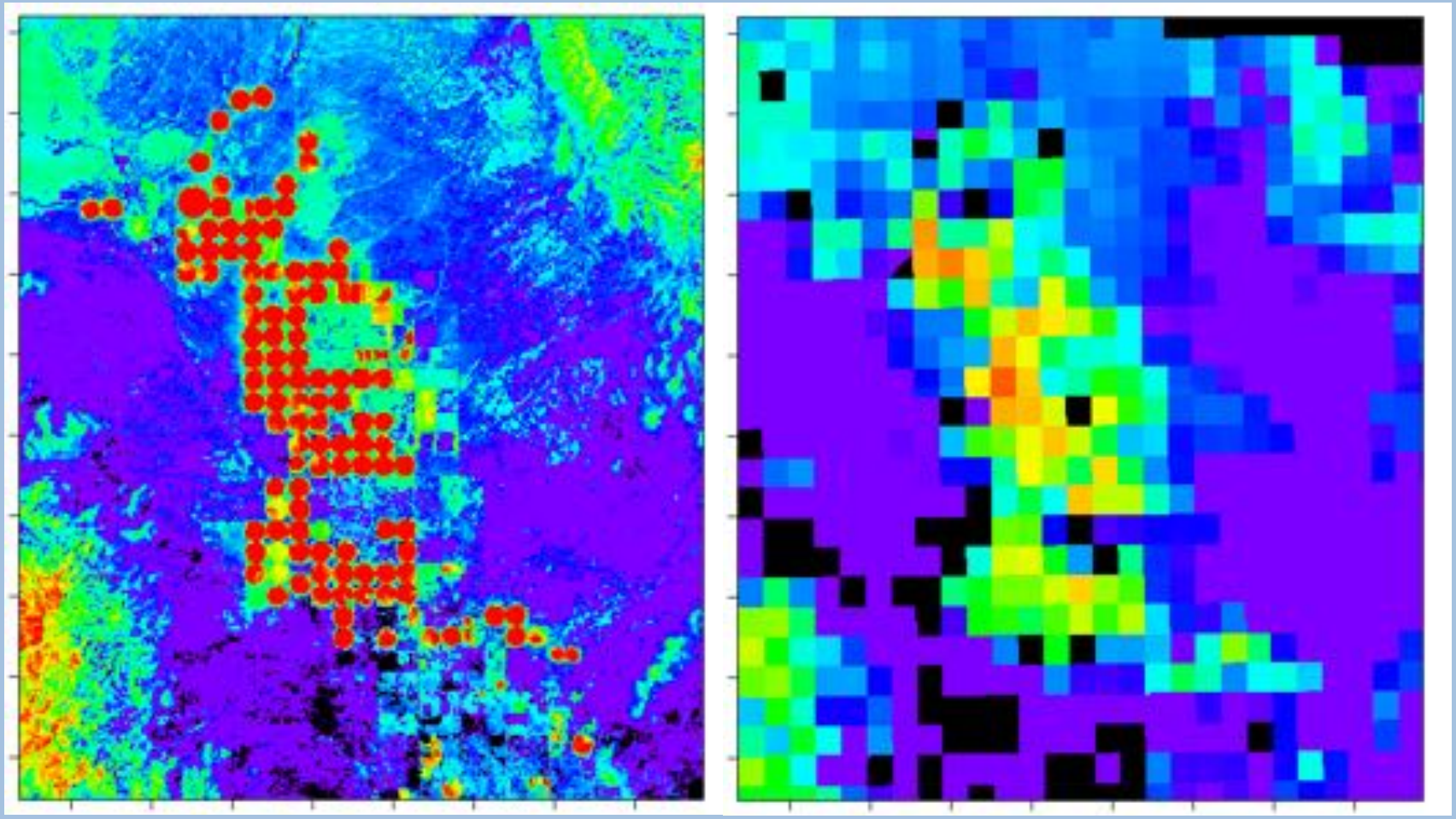
WATER BALANCE APPROACH
("forward modeling")

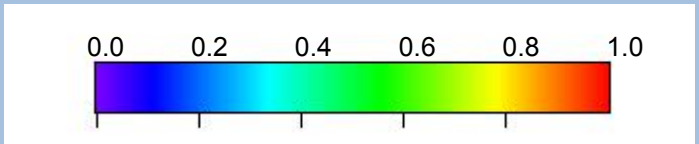
REMOTE SENSING APPROACH
("inverse modeling")

Sensitivity to irrigation

Landsat 7 – 60m

MODIS – 1km



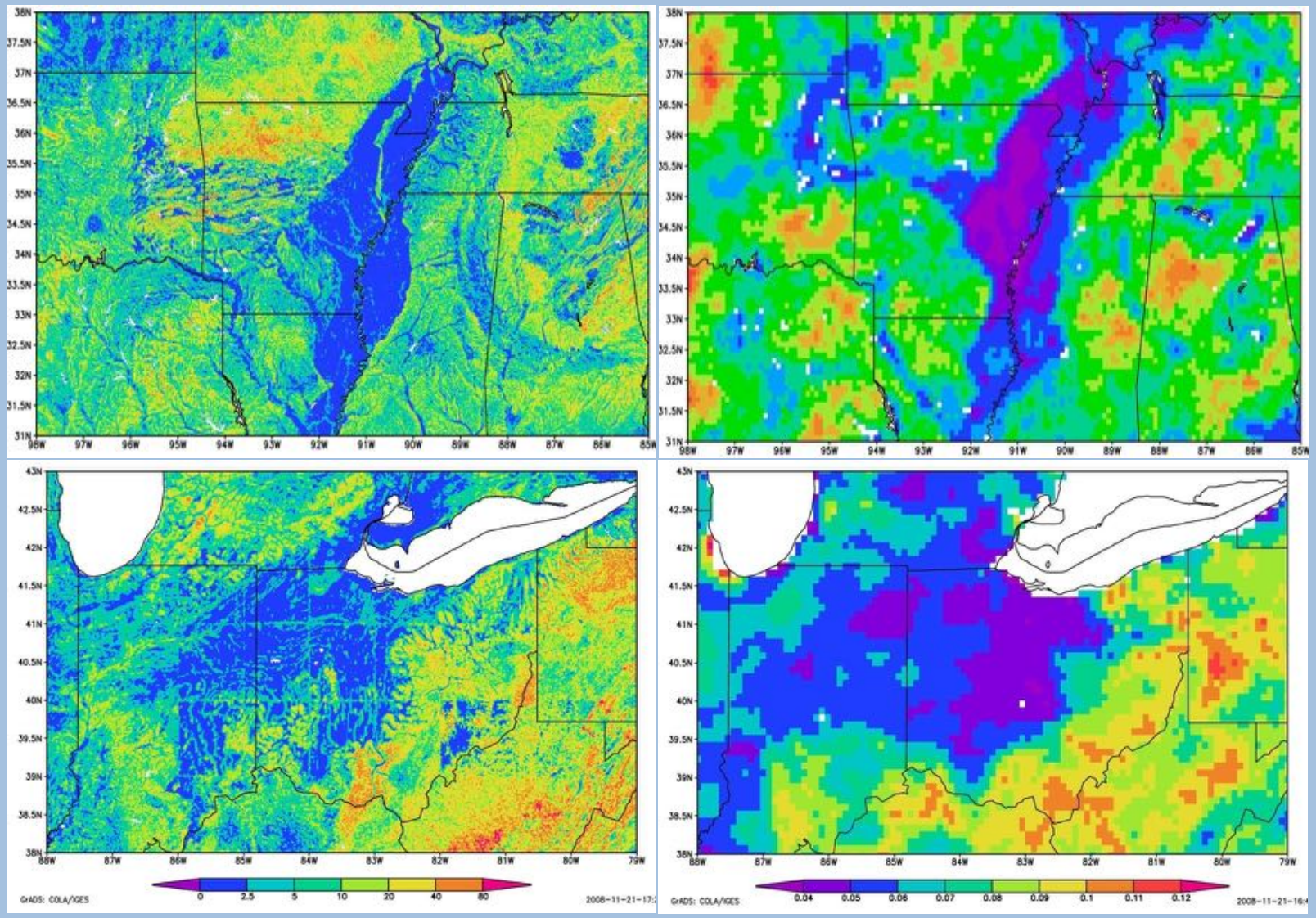


$\frac{ET}{PET}$

Sensitivity to shallow water tables

Simulated climatological water table*

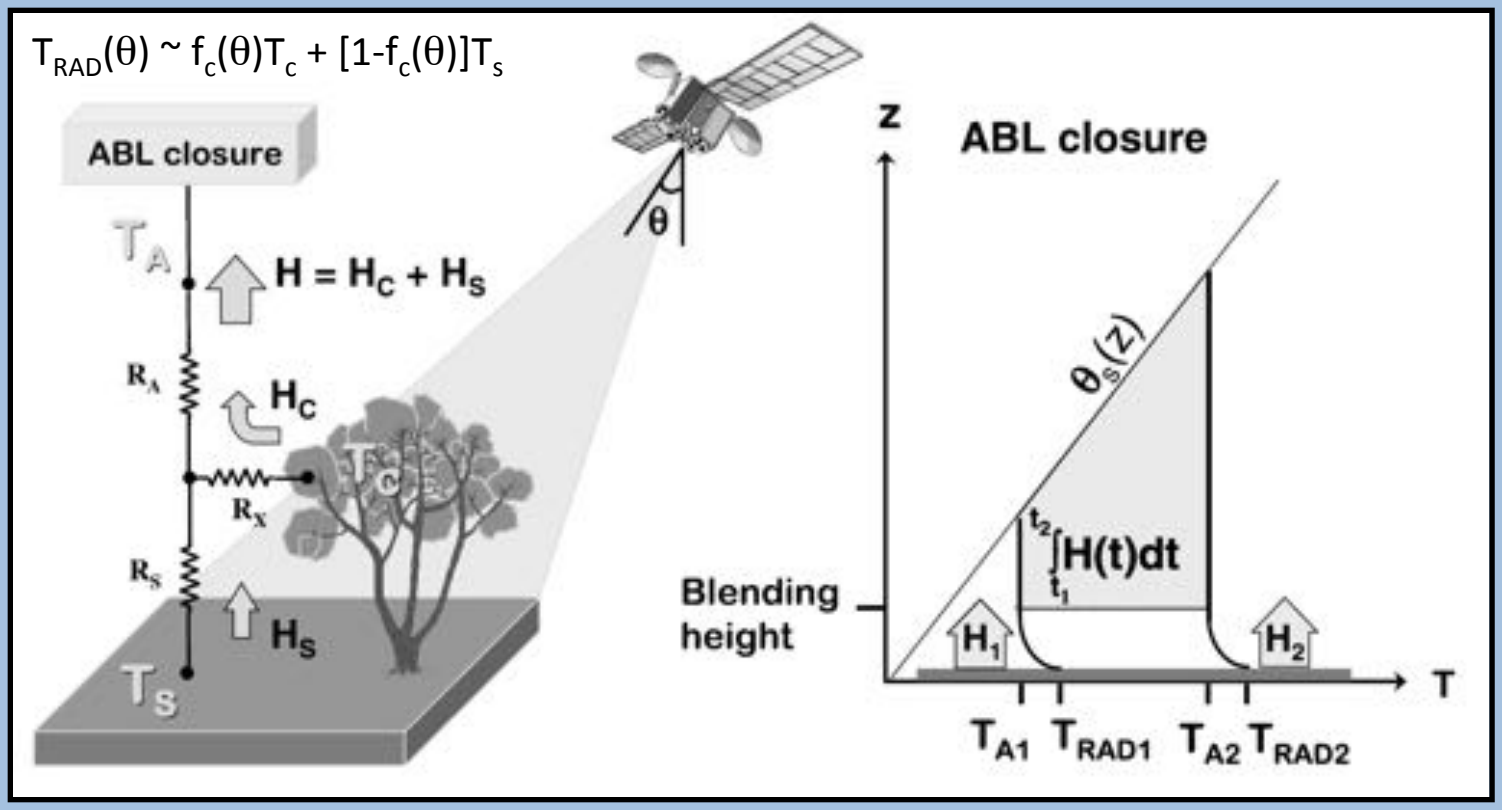
Temporal variability in ET/PET



shallow deep low high

* Miquez-Macho et al, BAMS, 90, 663-672

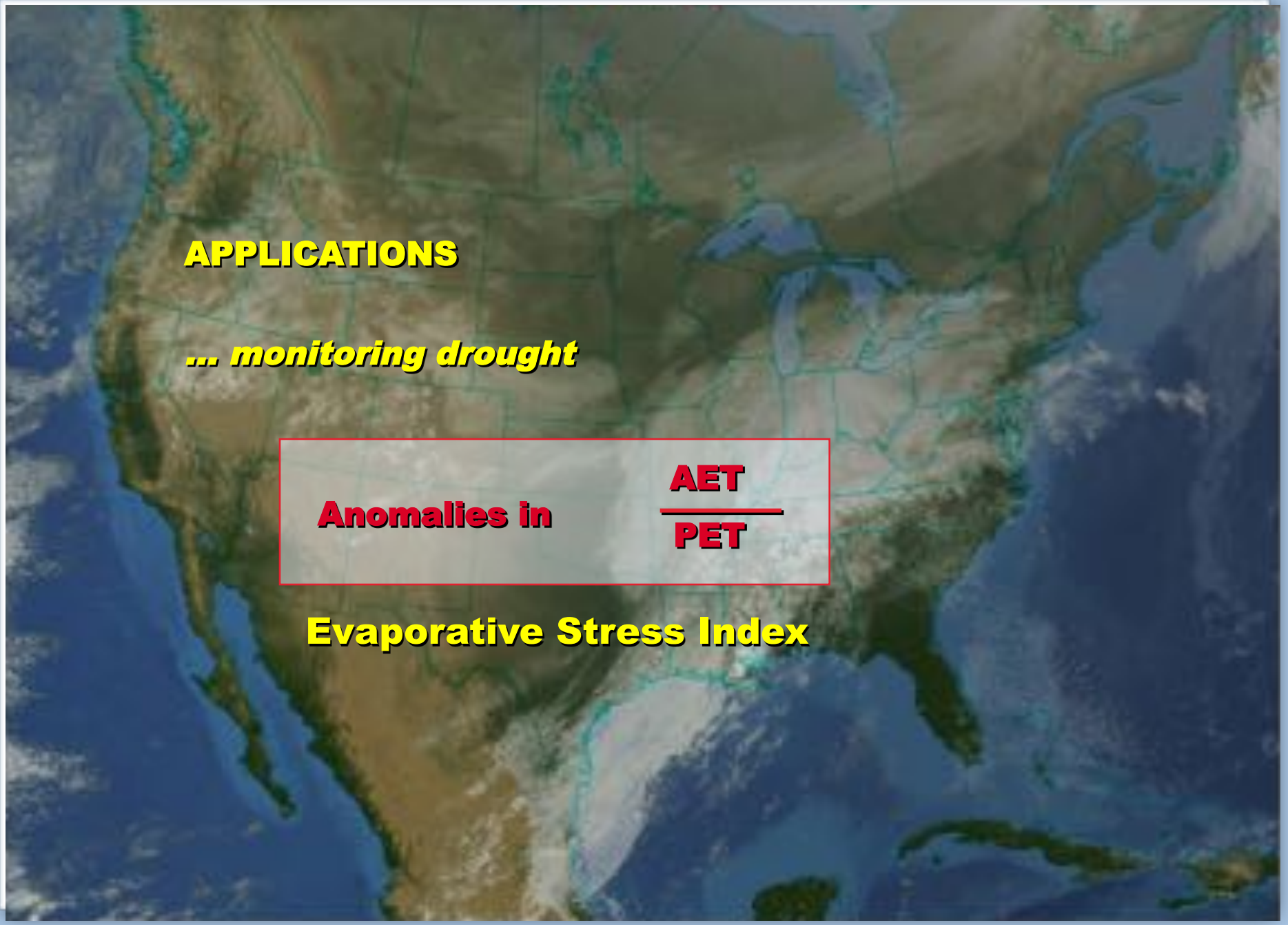
Atmosphere Land Exchange Inverse (ALEXI) Model

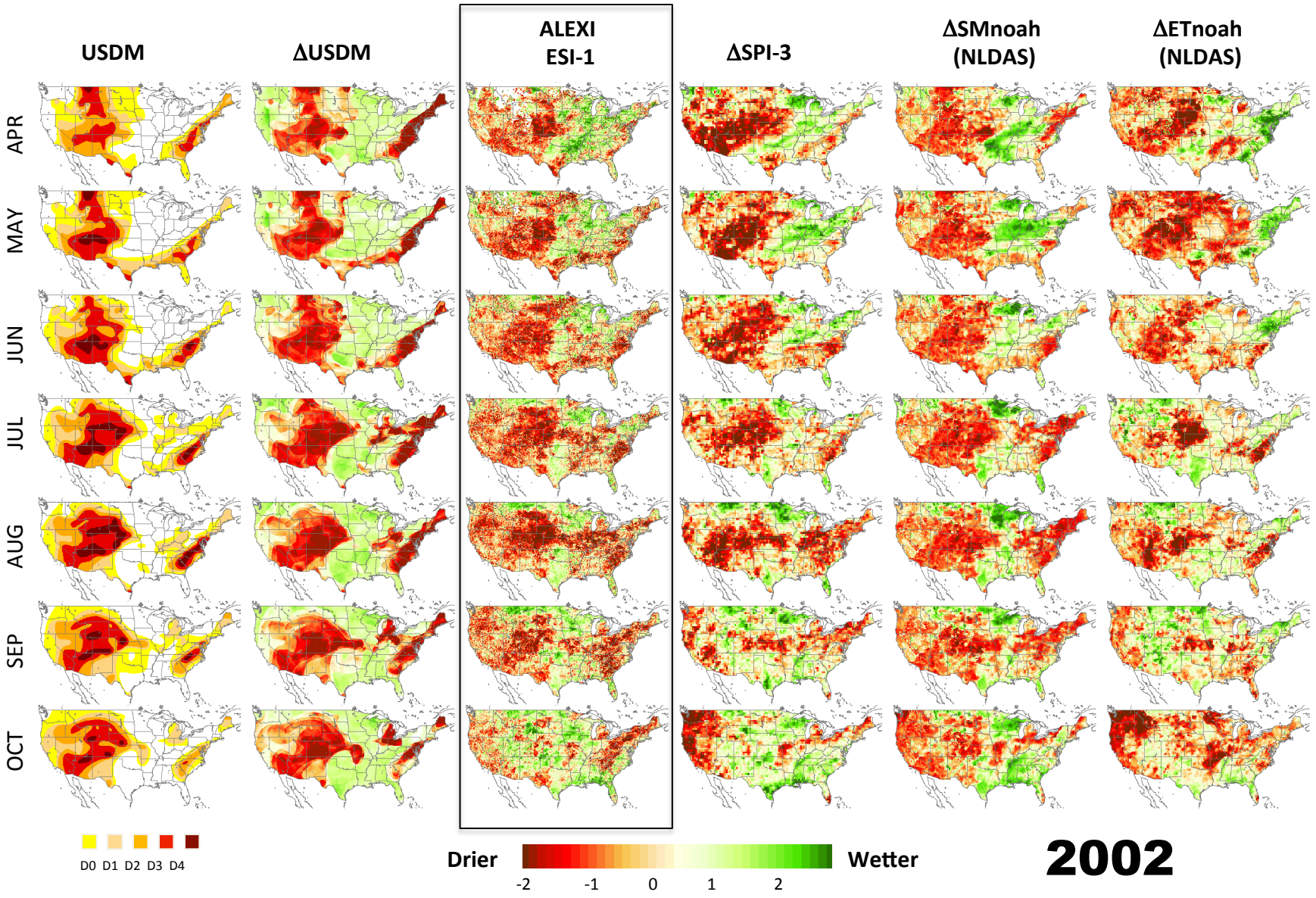


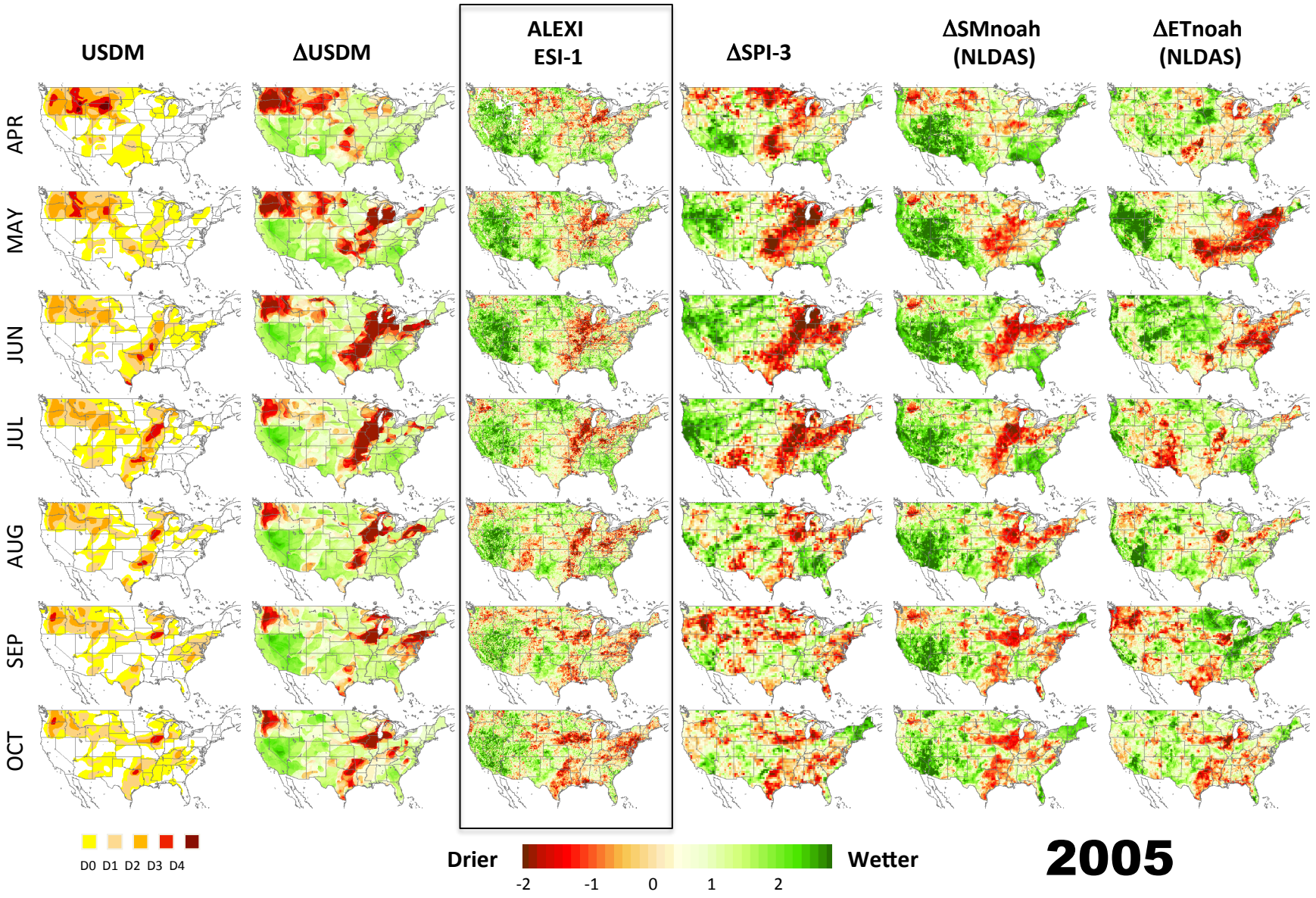
Strengths of ALEXI in ET and Drought Monitoring

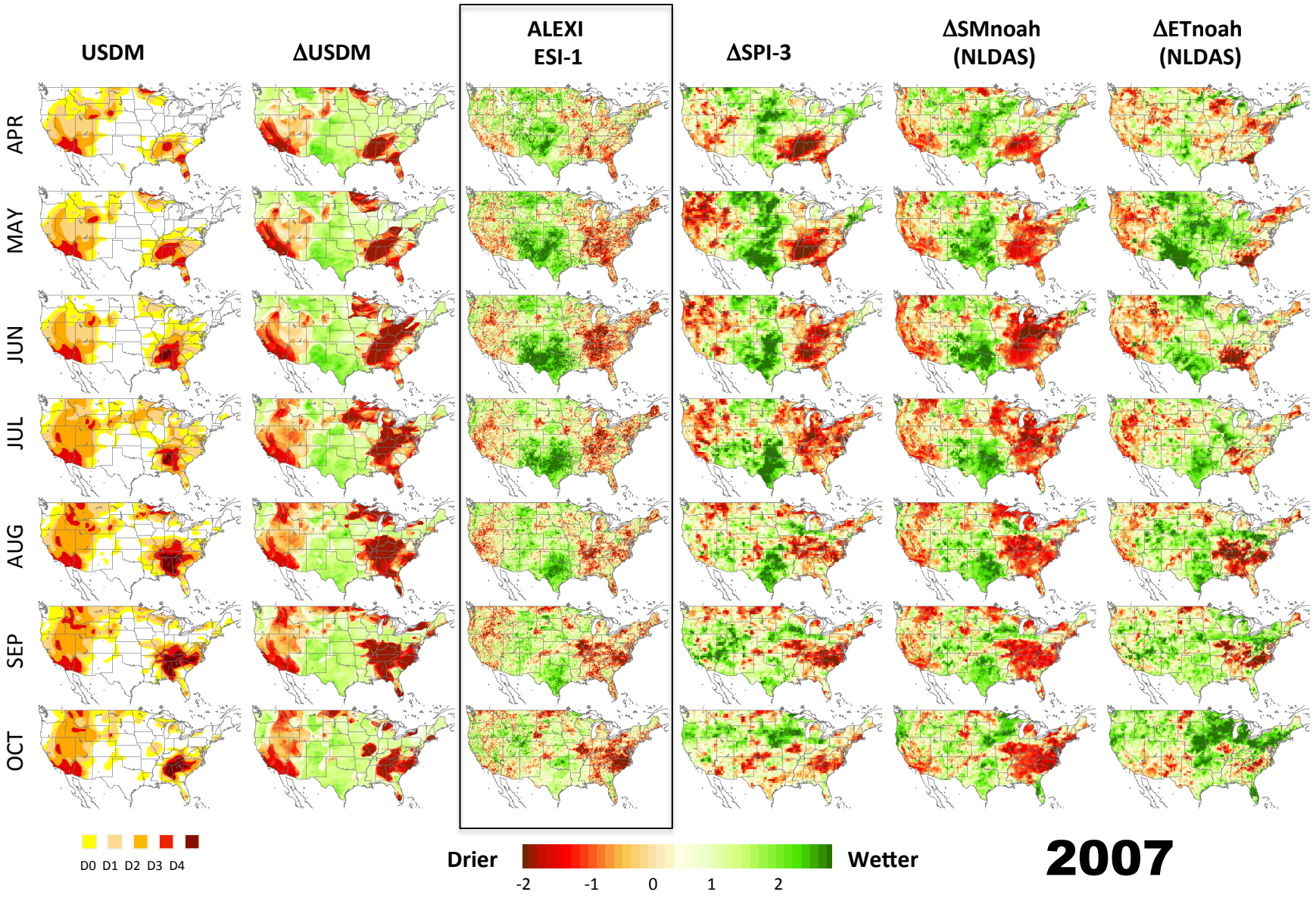
Diagnostic LSMs based on TIR remote sensing like ALEXI, **require no information regarding antecedent precipitation or soil moisture storage capacity** – *the current surface moisture status is deduced directly from the remotely sensed radiometric temperature signal.*

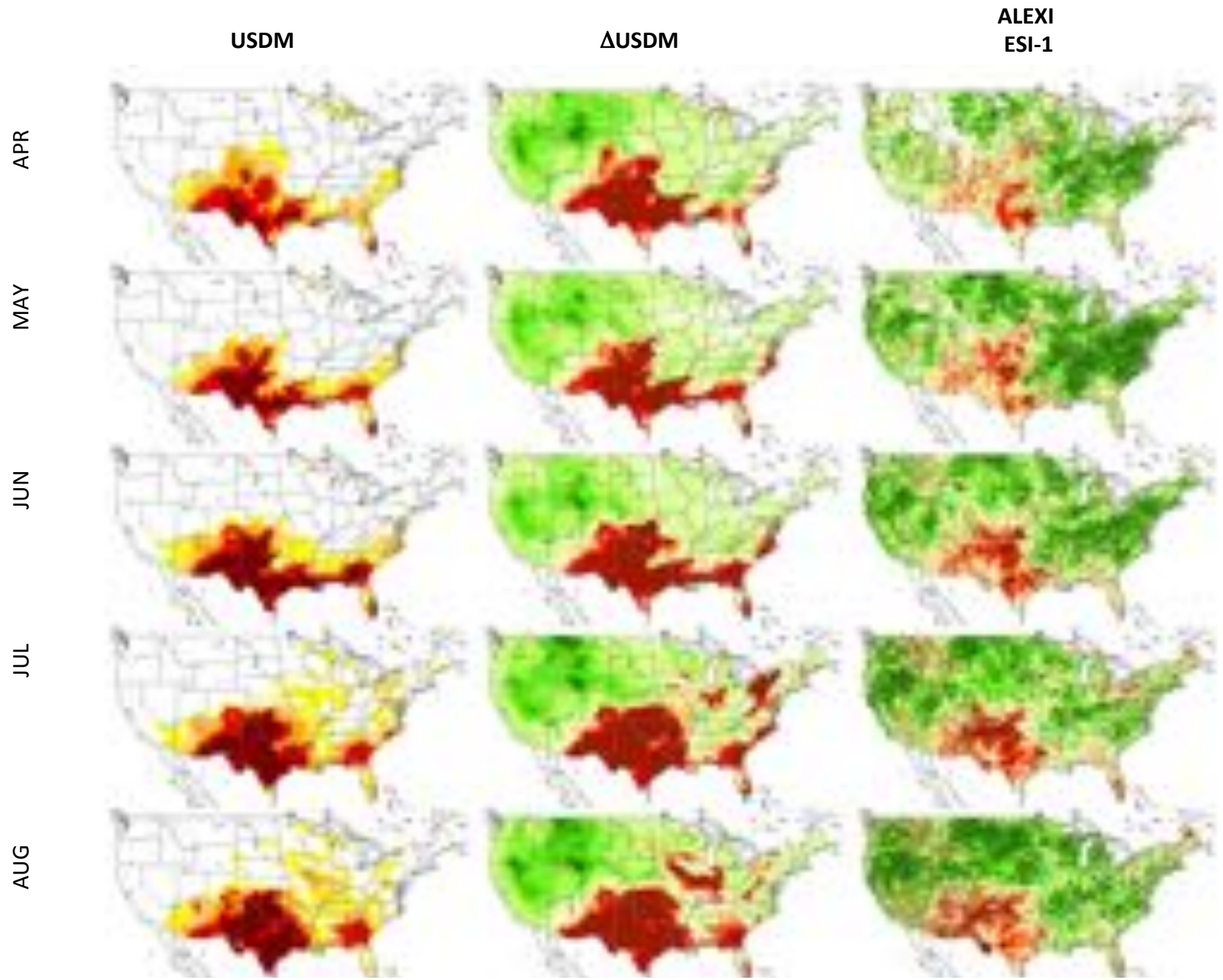
Vegetation-based indices (such as NDVI and VHI) are relatively slow response variables to moisture deficits, showing decline only after damage has been done, while **ALEXI is able to determine potential vegetation stress** and potentially provide early warning preceding detectable degradation in vegetation indices.


APPLICATIONS
... monitoring drought
Anomalies in
AET
PET
Evaporative Stress Index


USDM
ΔUSDM
ALEXI
ESI-1
ΔSPI-3
ΔSMnoah
(NLDAS)
ΔETnoah
(NLDAS)
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
2002


USDM
ΔUSDM
ALEXI
ESI-1
ΔSPI-3
ΔSMnoah
(NLDAS)
ΔETnoah
(NLDAS)
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2
-1
0
1
2
2005


USDM
ΔUSDM
ALEXI
ESI-1
ΔSPI-3
ΔSMnoah
(NLDAS)
ΔETnoah
(NLDAS)
APR
MAY
JUN
JUL
AUG
SEP
OCT
D0 D1 D2 D3 D4
Drier
Wetter
-2 -1 0 1 2
2007



2011

Drought Index Intercomparison Accomplishments

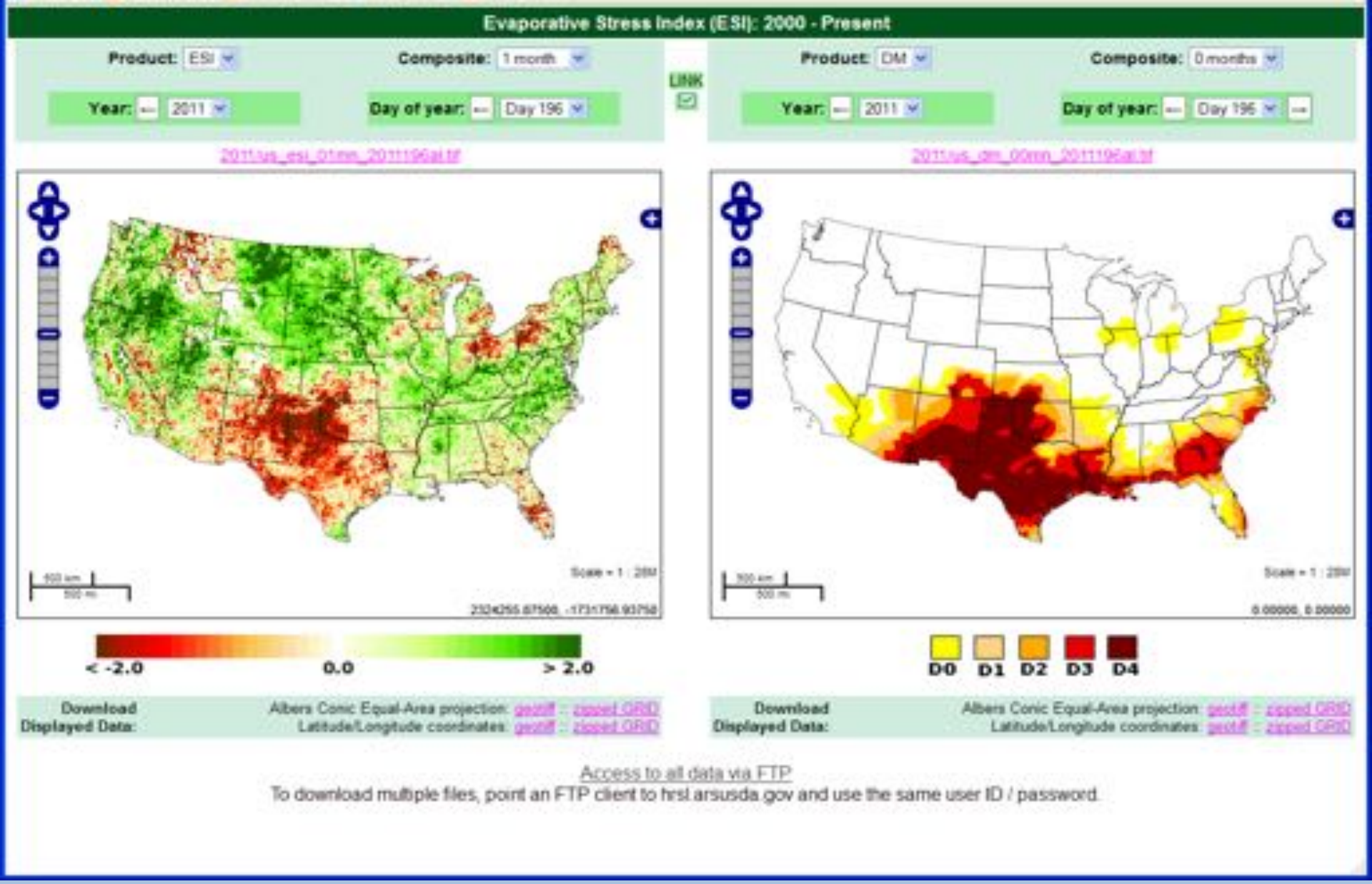
Spatial distributions in ESI, representing anomalies in the radio of actual to potential ET, were found to correlate well with patterns in precipitation-based indices, NLDAS SM/ET and in the USDM, responding to rainfall events at monthly timescales.

Because the USDM cannot be considered a metric of absolute truth in drought monitoring, this study is not intended as an assessment of index performance, but rather a study of what types and timescales of information appear to be most correlated with subjective expert-interpreted drought severity delineations.

In some cases, low correlations might in fact identify regions of unique contribution by a particular indicator, highlighting information not currently conveyed in the USDM. For example, lower ESI correlations are found in areas where groundwater is contributing (naturally or through irrigation) to the surface moisture supply.

Future work will be completed in Year 3, focusing on an expanded intercomparison between ALEXI ESI (and surface flux estimates) and NLDAS.


ESI Product Delivery



Website is currently password-protected to the general public as we roll out these current capabilities and future features to end-users at CPC and NDMC for initial testing.

Year 3 Priorities

1. Expand CONUS intercomparison between ALEXI and NLDAS surface fluxes (ET; H; G; R_n); ALEXI provides an independent assessment of NLDAS surface fluxes.

2. Further refinements of the realtime execution of ALEXI at STAR.

3. ESI website will be expanded to include additional features such as NLDAS SM/ET anomalies; change maps for all drought products; additional features suggested from end-user feedback.

4. ESI products will begin be available through the NIDIS Drought Portal (http://www.drought.gov) (ETA: early 2012).

5. Gather feedback from end-users at CPC and NDMC regarding index performance, data preferences and supplementary model output variables that may be used in the creation of regional drought outlooks.

Publications:

M. C. Anderson, C. Hain, B. Wardlow, A. Pimstein, J. R. Mecikalski, W. P. Kustas, 2011: Evaluation of Drought Indices Based on Thermal Remote Sensing of Evapotranspiration over the Continental United States. *J. Climate*, **24**, 2025–2044. doi: 10.1175/2010JCLI3812.1

C. R. Hain, W. T. Crow, J. R. Mecikalski, M. C. Anderson, and T. Holmes (2011), An intercomparison of available soil moisture estimates from thermal infrared and passive microwave remote sensing and land surface modeling, *J. Geophys. Res.*, *116*, D15107, doi:10.1029/2011JD015633.