Development of a Remote-Sensing Based Framework for Mapping Drought over North America

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Project Team

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Project Partners:

National Drought Mitigation Center

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

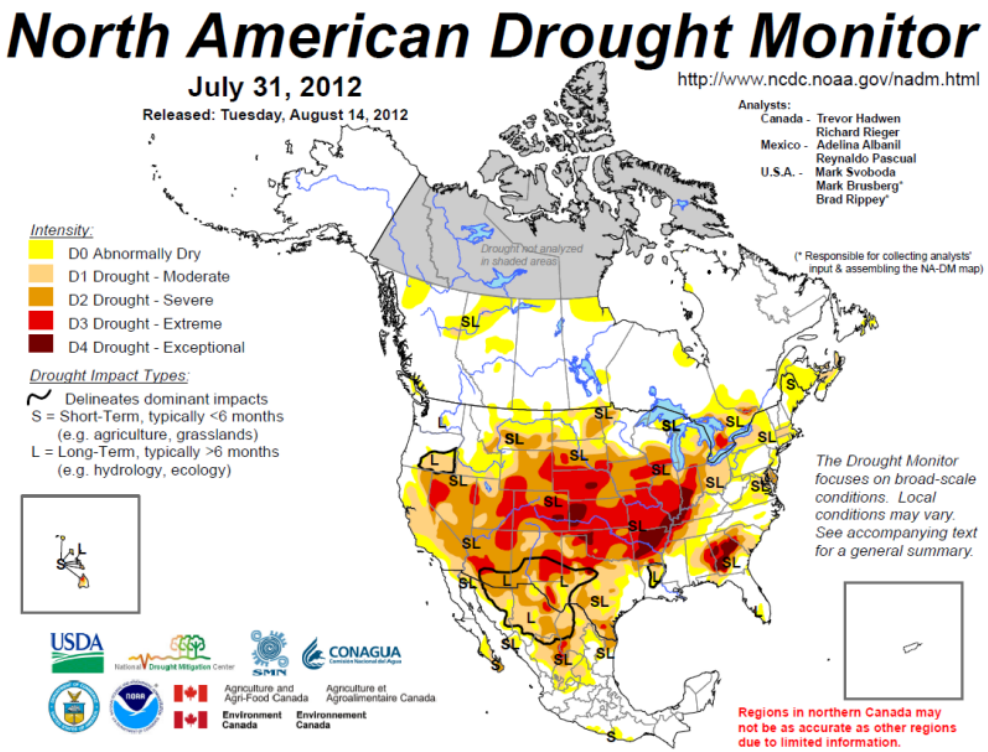
Agriculture Counts — NASS

Project Objective: North American Drought Monitoring

The impacts of drought do not adhere to political boundaries and can have profound impacts on water compacts between countries, food security, commodity prices and geopolitics.

Expected Project Outcome:

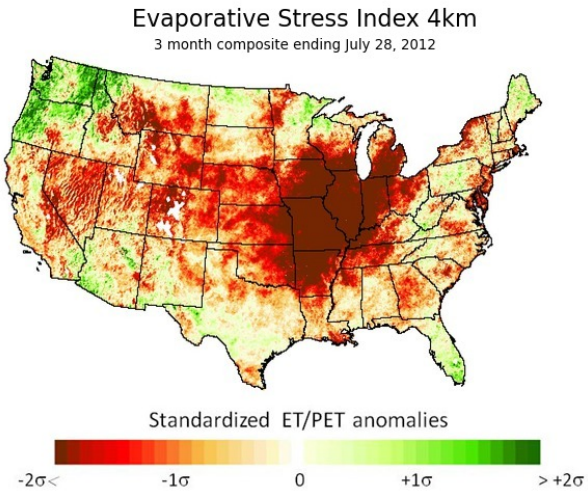
- The ALEXI Evaporative Stress Index (ESI) has been shown to be an effective, fast-response indicator for monitoring agricultural drought over CONUS.
- The ESI uses GOES-derived land-surface temperature data to assess crop and soil moisture stress, and is an independent check on precipitation-based indices.
- To address the need for additional remote sensing-based drought monitoring tools covering North America, the current ESI domain will be expanded to include Canada, Mexico and Central America.
- The expanded ESI dataset will be evaluated with standard drought indices and available crop condition data and delivered to end-users at NOAA/CPC, NDMC and NASS by the end of Stage I.



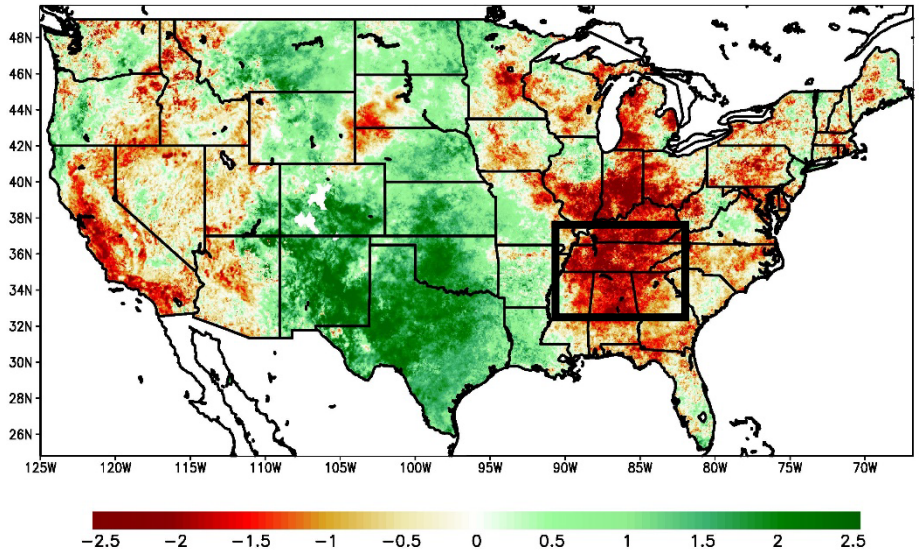
ESI Methodology

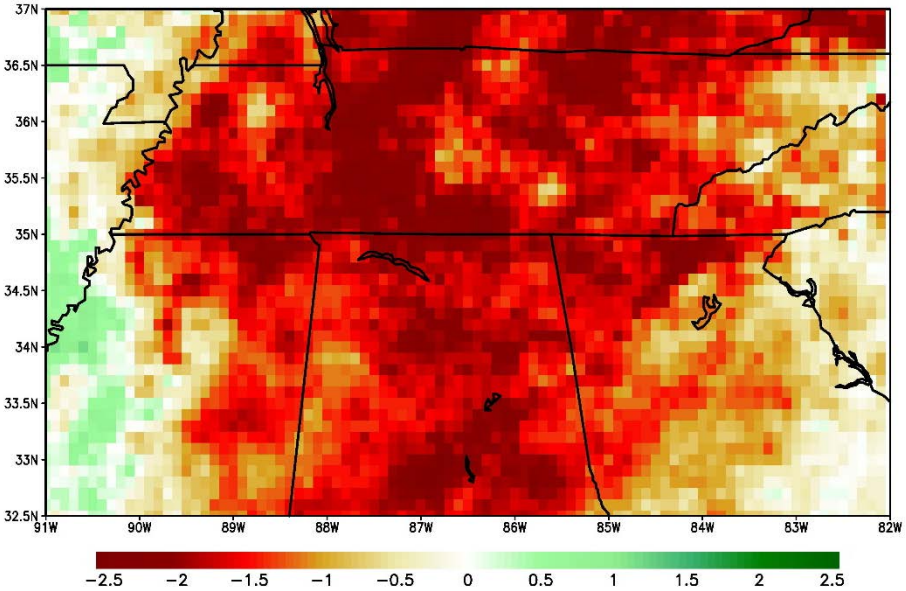
ALEXI ESI represents temporal anomalies in the ratio of actual ET to potential ET.

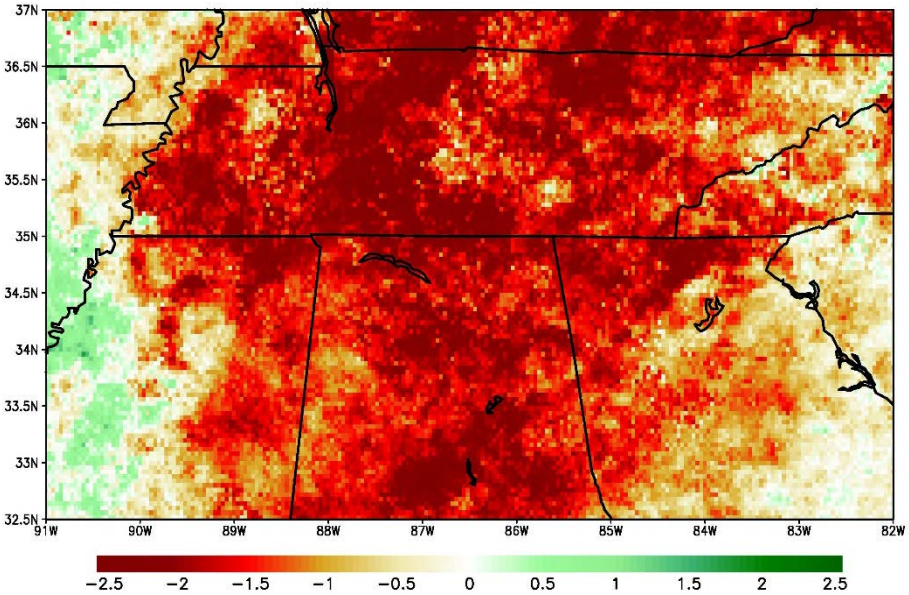
- ESI does not require precipitation data, ***the current surface moisture state is deduced directly from the remotely sensed LST*** , therefore it may be more robust in regions with minimal in-situ precipitation monitoring.
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs, for as example as indicated in NDVI, so TIR-based indices such as ESI can provide an effective early warning signal of impending agricultural drought.
- ALEXI ESI inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows) that need to be modeled a priori in prognostic LSM schemes.
- ALEXI ESI provides an independent assessment of current drought conditions, supplementing precipitation and modeling-based indices – an invaluable resource to decision-makers who usually depend on a convergence of information in the decision making process.



Accomplishments: Transition to 4-km CONUS ESI in 2014

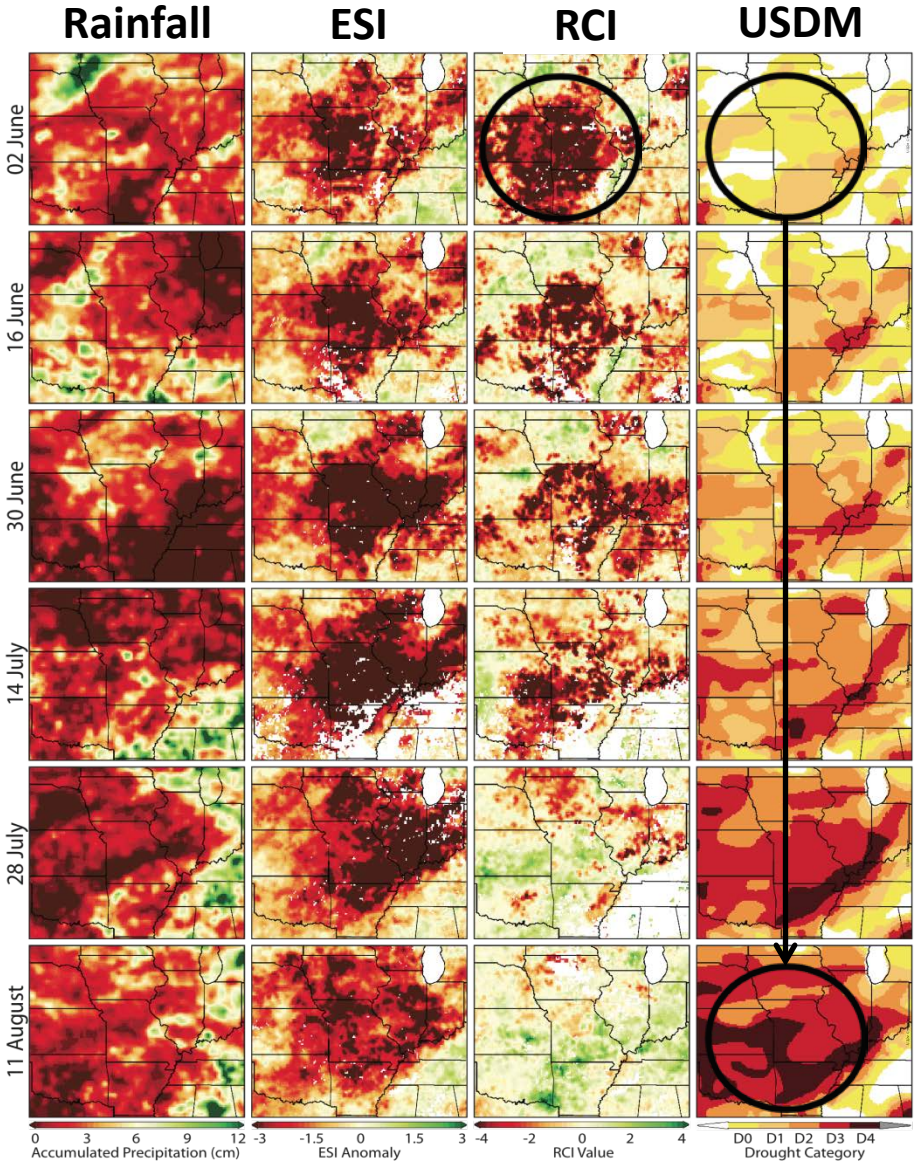






Accomplishments: ESI Rapid Change Indices -- 2012 Central US Example

Flash drought are rapid onset events typically driven by precipitation deficits, high temperature anomalies and often strong winds. ESI has the potential to provide an early warning component during such events as water stress is able to be detected in the LST signal before degradation in the vegetation health occurs.



- Large negative RCI values in the top row indicate that moisture stress was rapidly increasing at the beginning of summer
- Impressive scope of the unusually rapid decrease in the ESI anomalies is clearly depicted by the large area of negative RCI values
- Initial appearance of negative RCI values led the introduction of severe drought in the USDM by more than 4 weeks

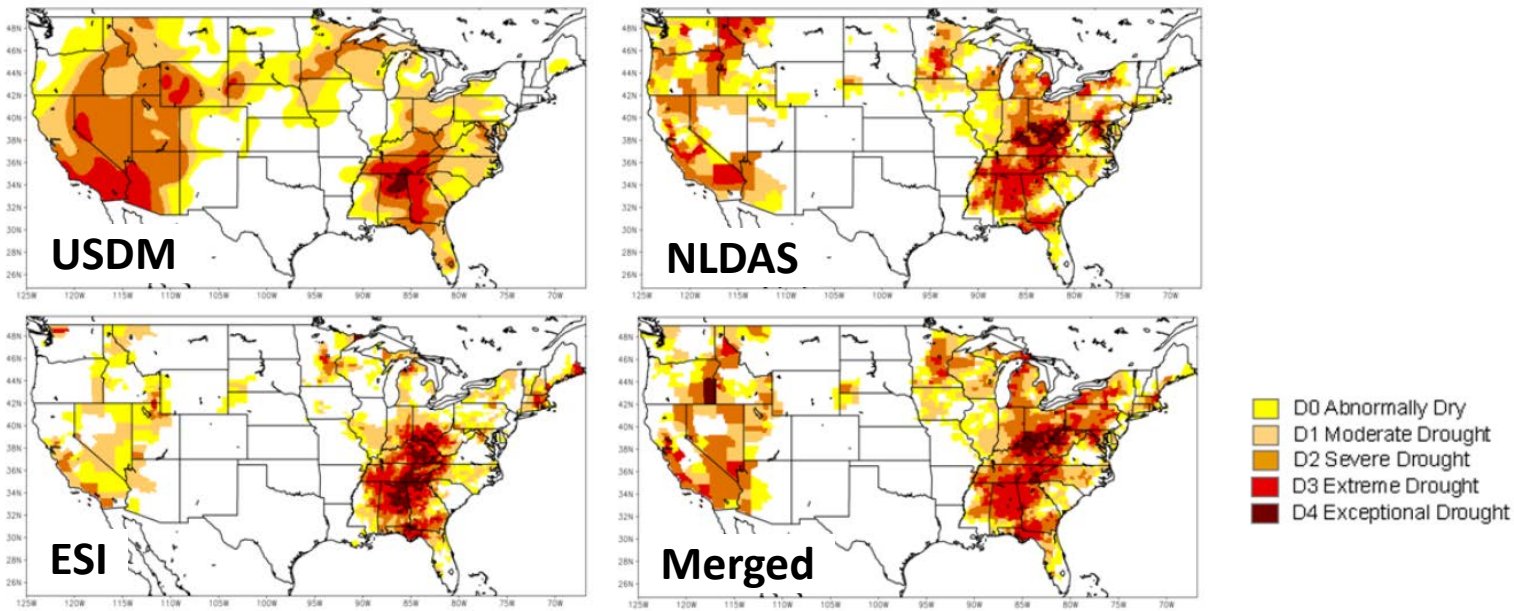
NOAA SARP Project: ESI Workshops for Agricultural Stakeholders in Central US

- Co-I Jason Otkin held two ESI training workshops this summer with agricultural stakeholders in Oklahoma and Nebraska.
- The workshop focused on the introduction of ESI as a drought monitoring tool.
- All attendees were invited based on their prior interest in drought mitigation: 70% were from university, federal, and non-profit scientific organizations, 20% were from state and local government and 10% were full-time farmers or ranchers.
- <u>Key findings from the workshops</u> :
  - Confusion on ESI units (standardized ET/PET anomaly)
  - Change indicator variable name – some attendees didn't know that DESI meant a "change in ESI"
  - Confusion over products available at different spatial resolutions (10 km vs. 4 km)
  - Make it clear that our period of record (2000-2013) differs from that of most climate products produced by the National Weather Service (1981-2010)
  - More details to help end-users better interpret each of our drought products
  - Produce a product that is consistent with percentile ranking method used by USDM (D0-D4)

Percentile Ranking (USDM method)

- Remote sensing product have much shorter periods of records than “climate” indicators predominantly used by the USDM.

- Drought Monitor authors have requested we attempt to use percentile-ranking to produce ESI maps represented in terms of the USDM drought classifications (D0-D4).



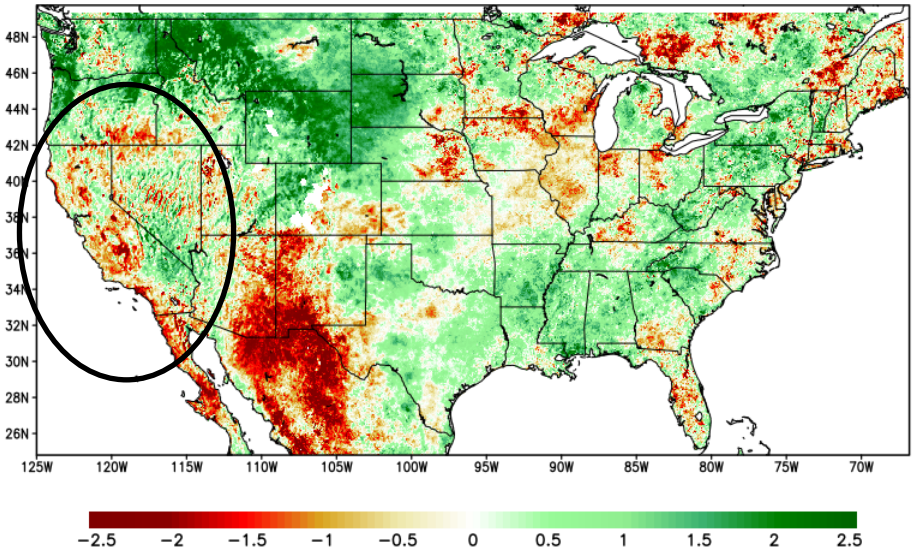
1 August 2007

Long-term ESI Composites to Better Capture Long-Term Drought

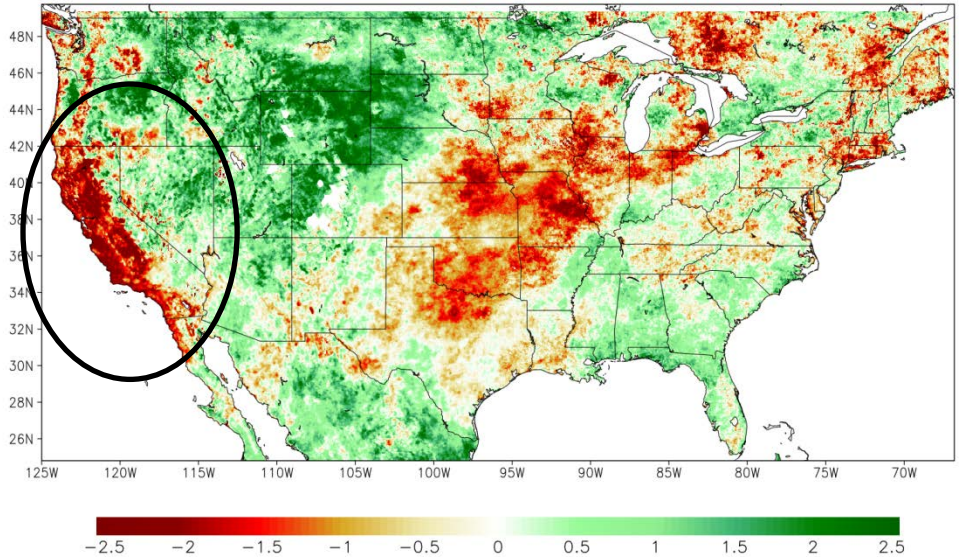
ALEXI ESI has mainly focused on 1-3 month composites which better represent time scales of agricultural and meteorological drought in the central and eastern US.

Longer term drought signals operate on time scales that are longer, thus we've added a 52-week ESI composite product to our suite of drought indicators.

3-month ESI – 31 August 2014



12-month ESI – 31 August 2014



Transition to Operations at NOAA -- Overview

NOAA has identified independent satellite-based estimates of evaportranspiration and drought as a critical requirement and is providing direct partner funding to develop the "GOES Evapotranspiration and Drought Product System (GET-D)".

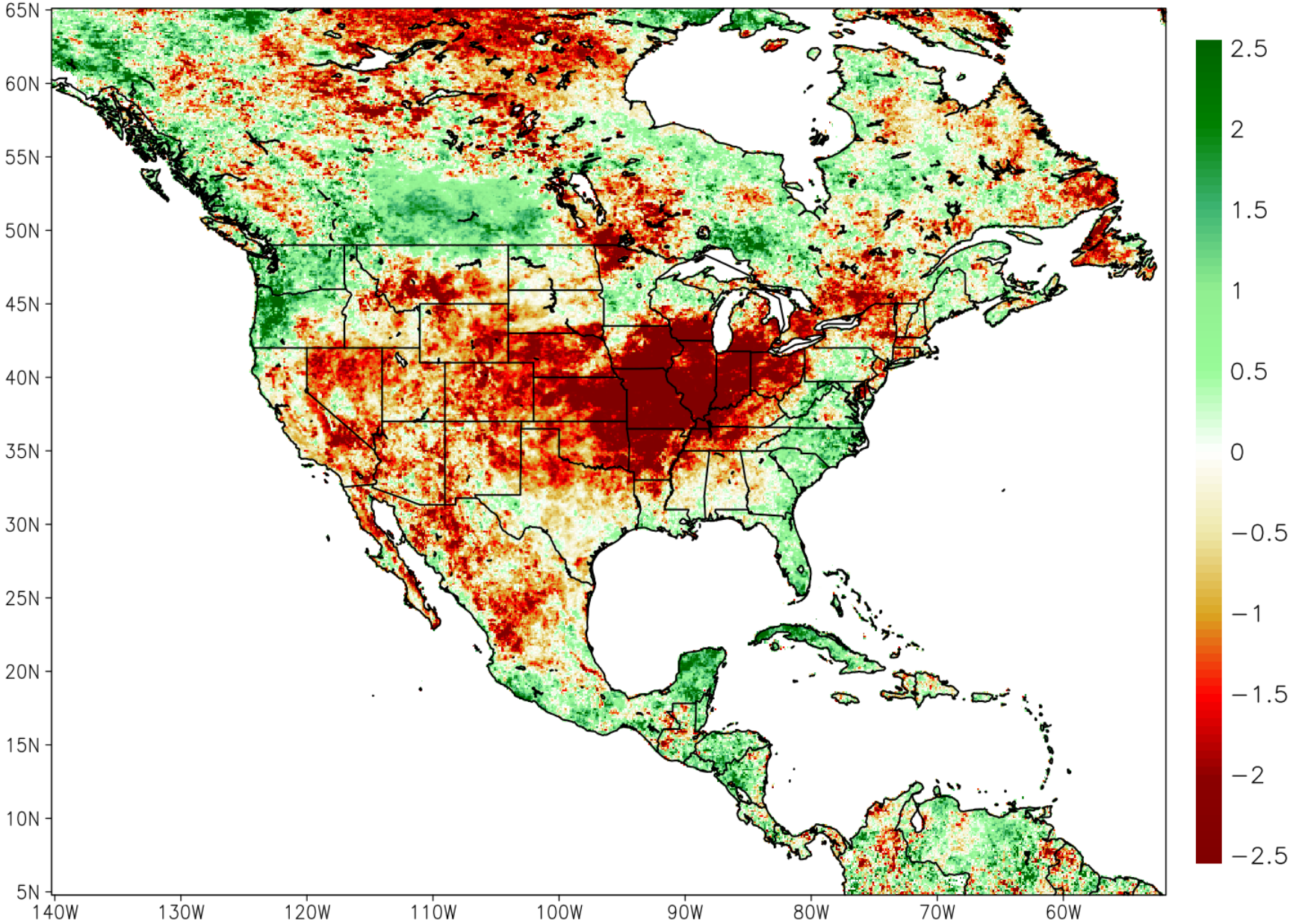
We have begun work to transition the core ALEXI/ESI modeling system over North America (as developed during Stage I of this project) to operations by 2015, with continuing operational maintenance support beyond 2015 provide by NOAA OSPO base funding.

Timeline:

Critical Design Review	Completed October 2014
Code Delivery	March 2015
Code Review	April 2015
Algorithm Review	May 2015
Operational Readiness Review	June 2015
SPSRB Operation Briefing	July 2015
Start of Operations	Mid-August 2015

ALEXI Evaporative Stress Index: 12-week Composite

Initialized : 5 August 2012



Transition to Operations at NOAA – Phase II (FY16)

NOAA provides funding opportunities to add enhancements to the initial implementation of the GET-D system currently being developed in the project.

Potential Additions in Phase II:

- Extension to cover all of South America (currently working with stakeholders in Brazil)
- ESI Rapid Change Indices
- Probabilistic Forecasts of Drought Change from ESI
- 1-km Target Regions (MODIS/VIIRS)
- Transition to 4-km resolution over North America
- TSEBS (Two-source Energy Balance over Snow) – Provides fluxes over snow covered pixels (currently masked in ALEXI)
- Operational Soil Moisture Composite Drought Index (interface with SMOPS [NOAA operational microwave soil moisture system] and NLDAS [operational])