NASA Science Mission Directorate
Earth Science Division
Applied Sciences Program

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

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NASA Water Resources PI Meeting

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Project Title: *Development of a Remote-Sensing Based Framework for Mapping Drought over North America*

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Project Partners:

National Drought Mitigation Center

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

Agriculture Counts NASS

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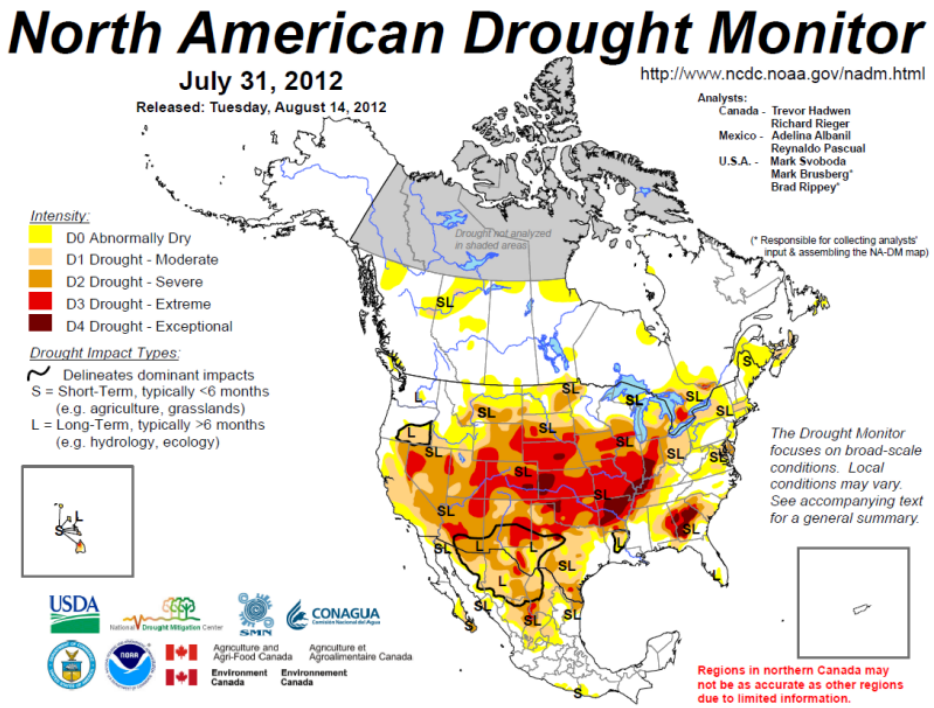
The impacts of drought do not adhere to political boundaries and can have profound impacts on water compacts between countries, food security, commodity prices and geopolitics.

Expected Project Outcome:

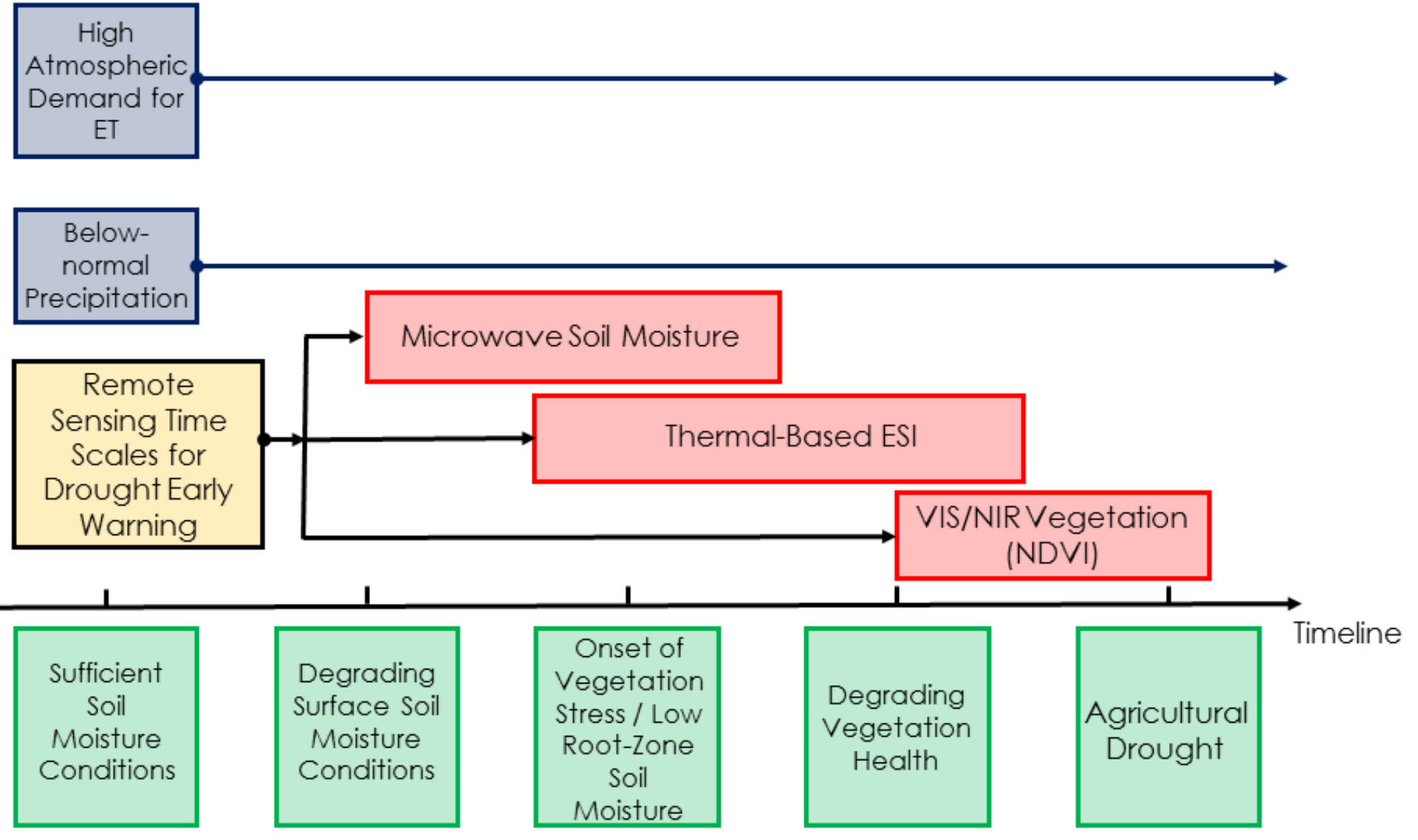
- The ALEXI Evaporative Stress Index (ESI) has been shown to be an effective, fast-response indicator for monitoring agricultural drought over CONUS.

- 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.



Example of the Evolution of Agricultural Drought



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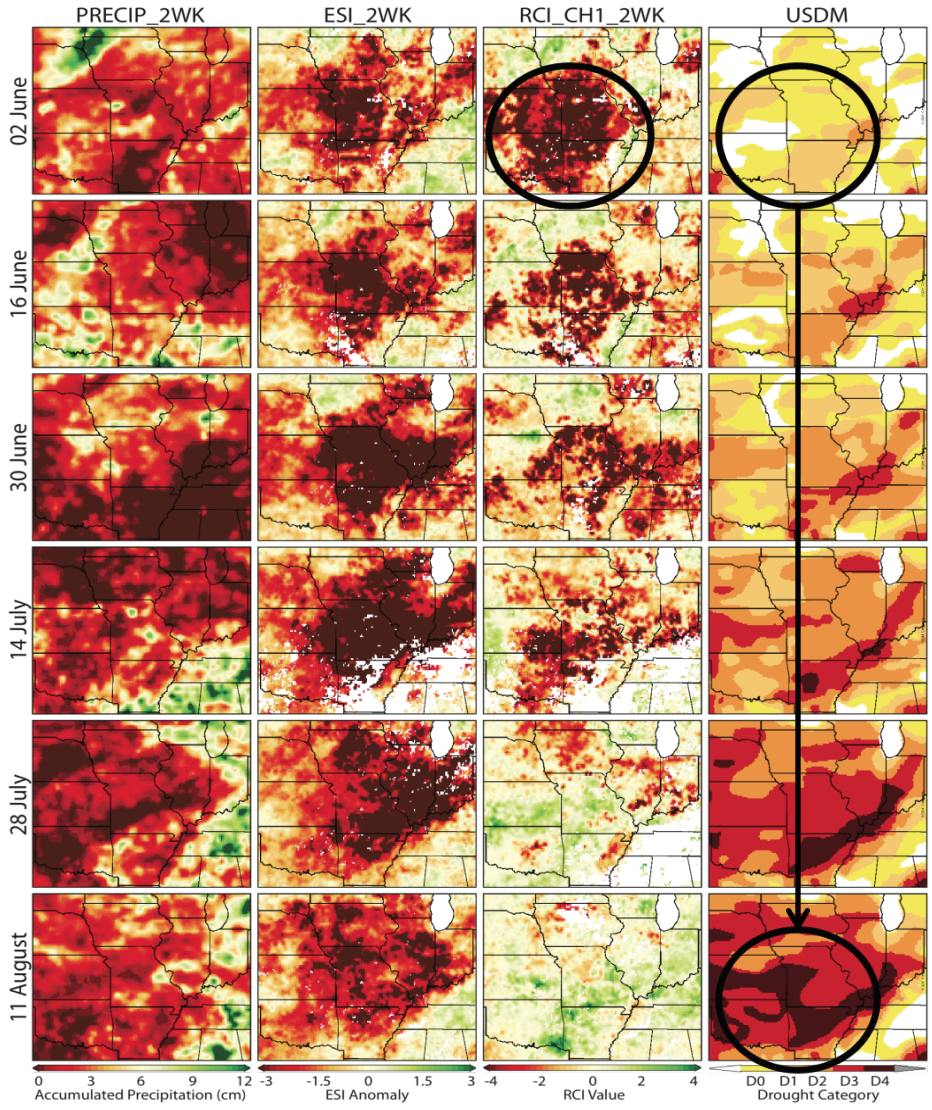
Detecting Rapid Onset of Vegetation and/or Water Stress:



- 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

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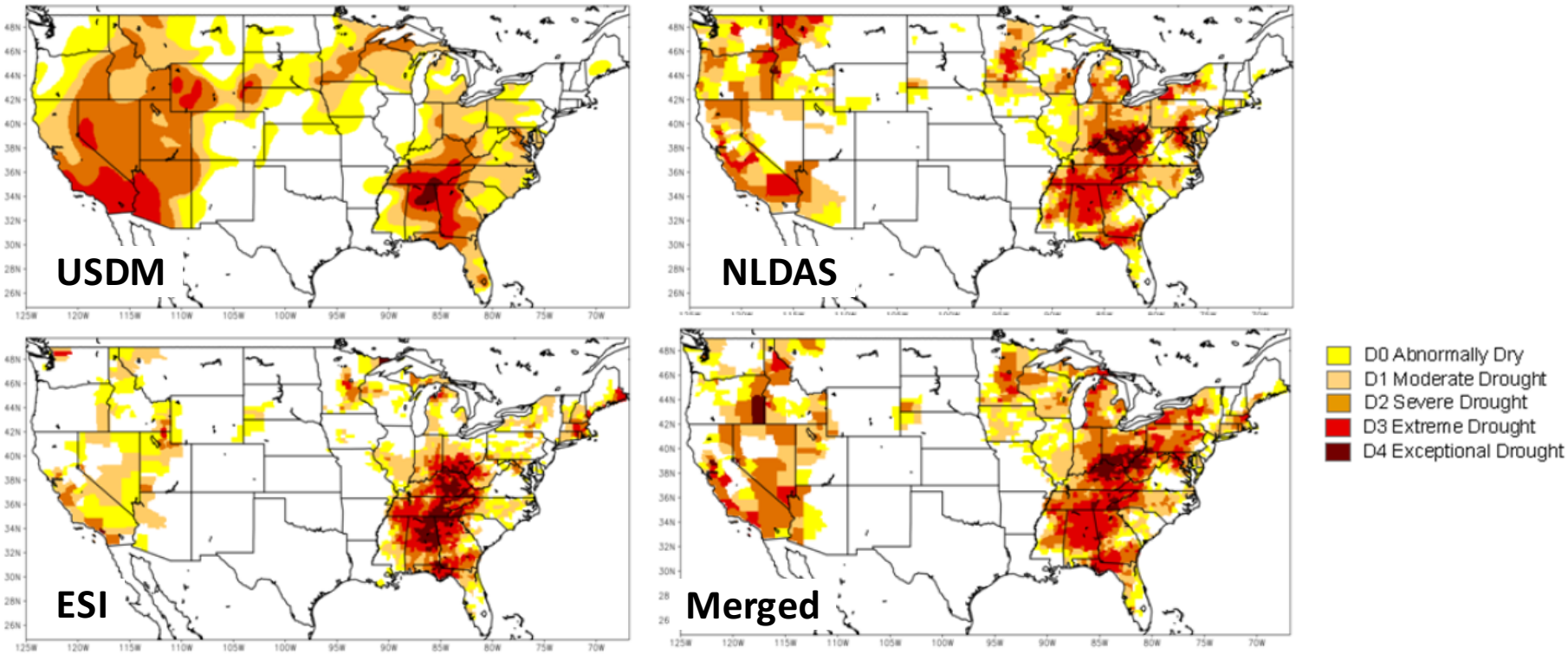
- Remote sensing product have much shorter periods of records than "climate" indicators predominantly used by the USDM.

- 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).



Example of percentile ranking method on 7 August 2007 for USDM, NLDAS Soil Moisture, ESI and Merged ESI/NLDAS product.

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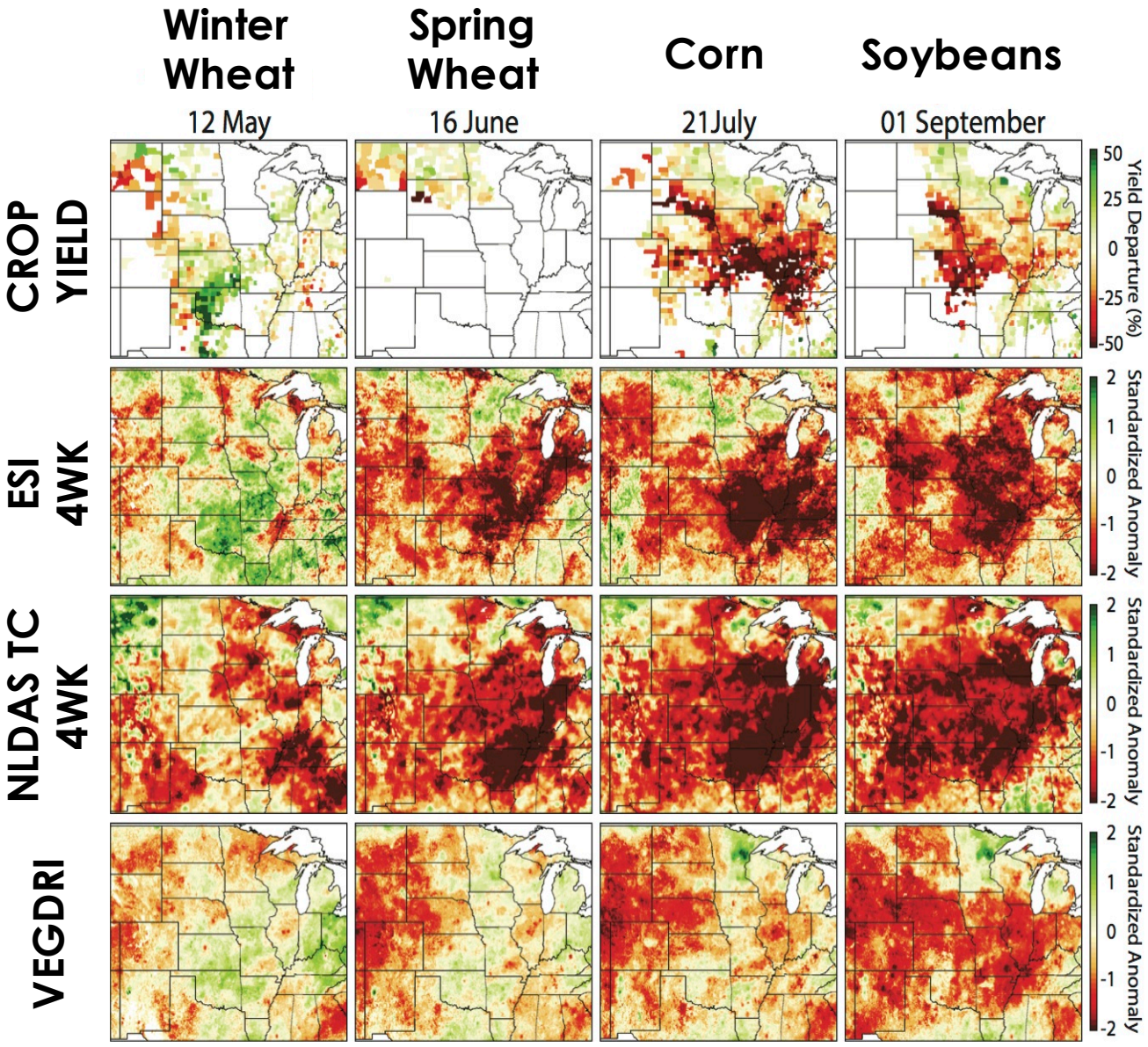

- Examine drought conditions during critical crop stages
- Strong relationship between wheat yield and the ESI and VegDRI during critical crop stages
- NLDAS has strong (weak) relationship to corn/soybeans (wheat) yield
- ESI had strongest correlation to the wheat, corn, and soybean yield departures

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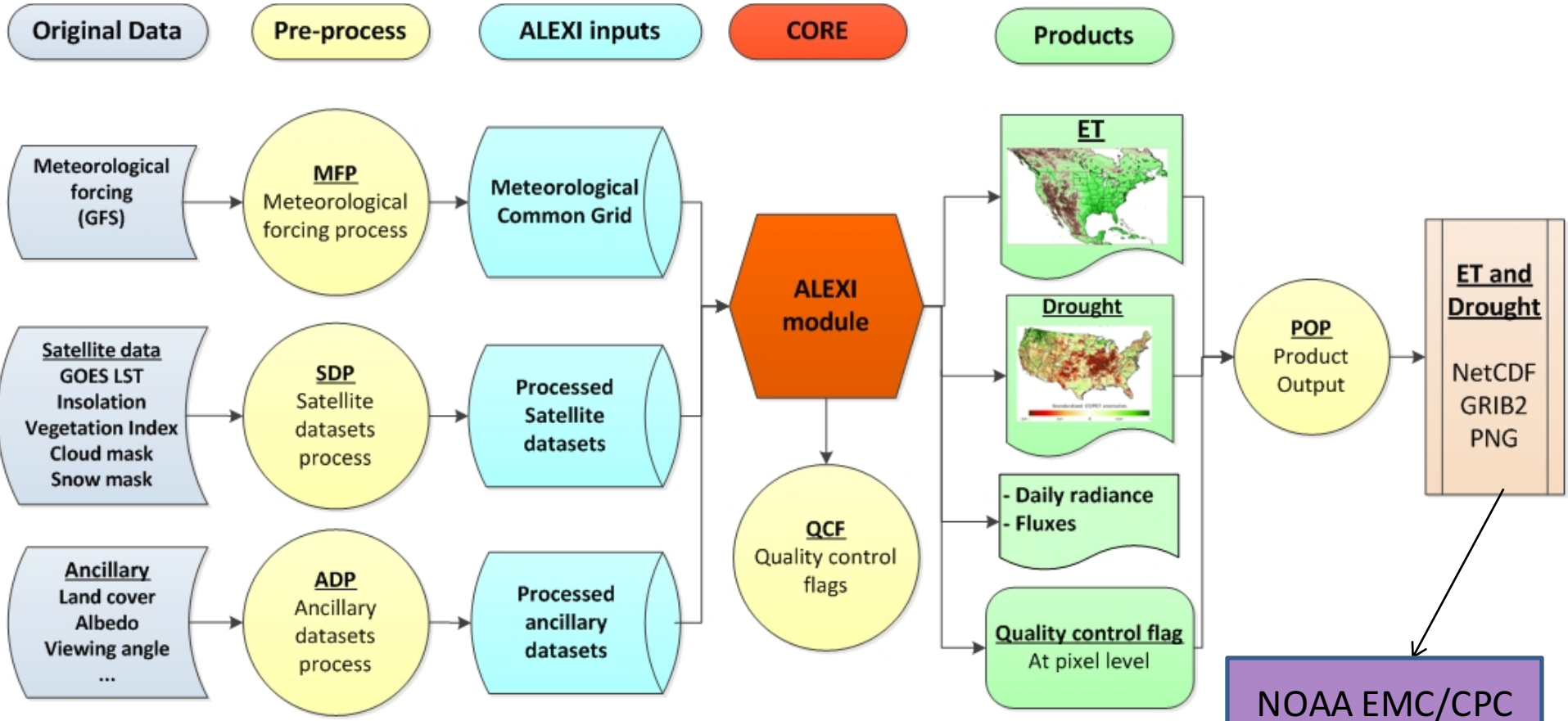
NOAA OSPO Operational GET-D System Workflow



*** All NOAA operational transition reviews have been completed and system will be deemed operational at OSPO in May/June 2016.*

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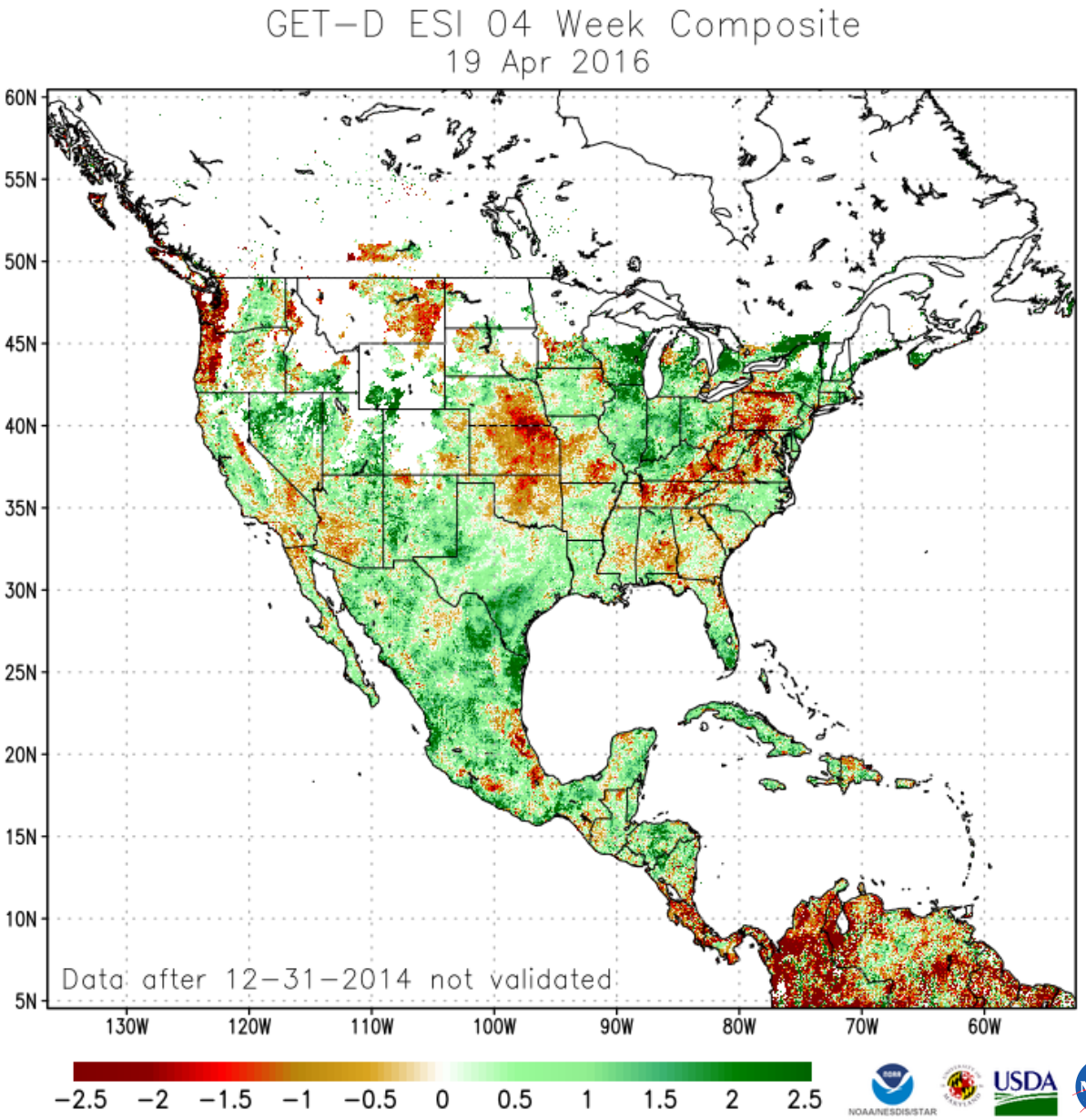
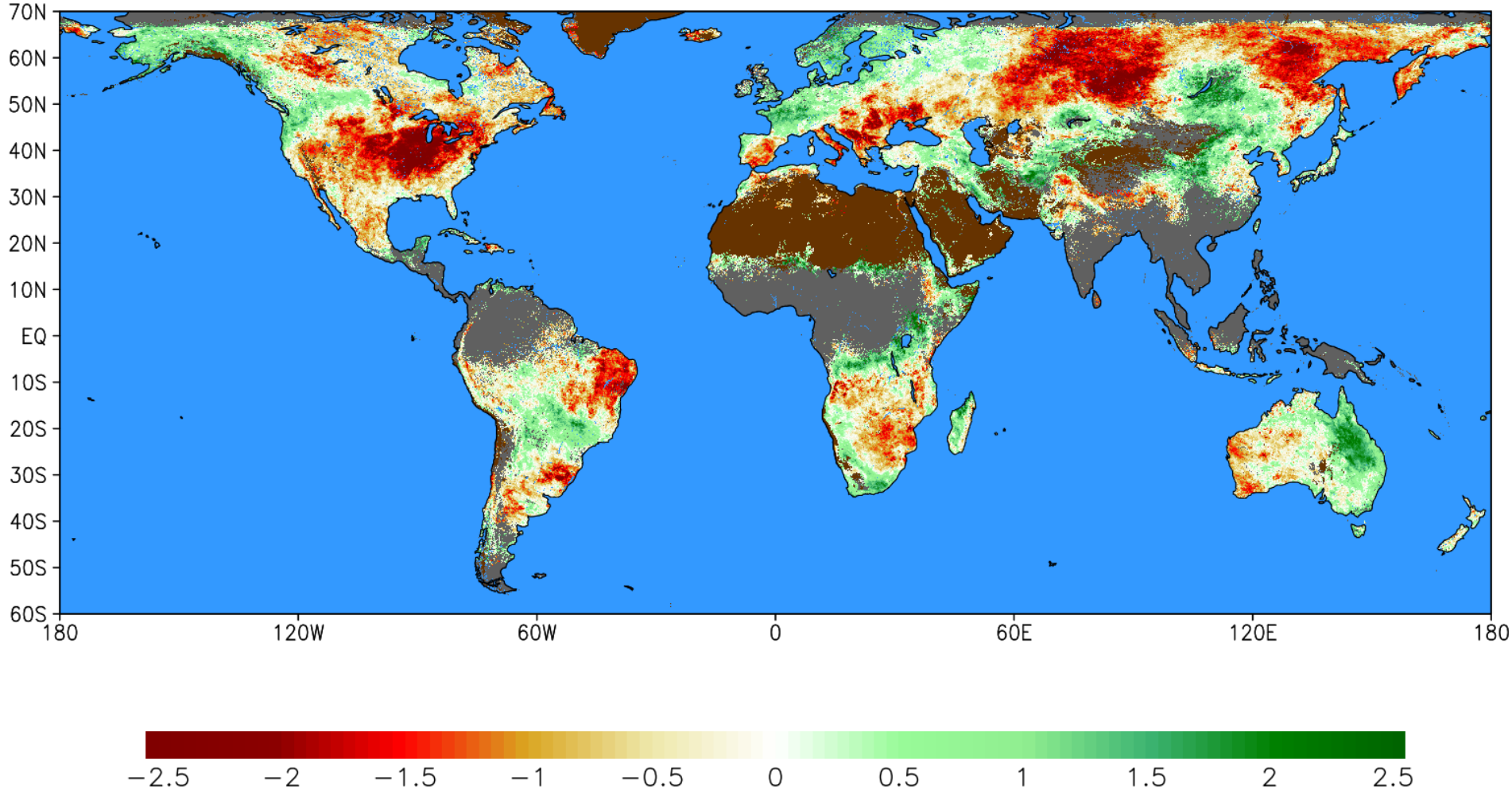


Proposed Stage II Enhancements: 4-km ESI Prototype

Actual Stage II Enhancements: 5-km Global ESI Prototype



The prototype global ESI (5-km spatial resolution) has been generated retrospectively from Apr 2000 to current based on MODIS Aqua/Terra Day-Night LST to drive ALEXI.

Global ESI

In the past 12 months, we've had tremendous interest in the dataset – with users ultimately needing an operational option for global ESI in the near-future

USDA FAS – currently evaluating global ESI to address feasibility of ingesting into their operations

Regional Drought Management System for MENA --
currently evaluating global ESI for use in the MENA composite drought index – plans to use when operational product becomes available

GeoGLAM Crop Monitor – currently evaluating monthly global ESI for use in their operational crop monitor activities

Researchers in Brazil / Czech Republic / Canada / Tunisia – applications related to predicting agricultural yields based on intra-seasonal ESI correlations

Crop Insurance Stakeholders (IRI / Syngenta Foundation) – evaluating using ESI as a potential index for crop insurance policies

Global ALEXI ESI

In the past 12 months, we've had tremendous interest in the dataset – with most users ultimately needing an operational option for global ESI:

UNESCO-IHE -- currently using global ALEXI ET for global water accounting activities (several basins have already used the prototype global ALEXI system

NOAA / CDC -- using global ESI in a pilot study in Niger to evaluate the use of ESI in outbreaks of meningitis (e.g., outbreaks associated with anomalous dry soils)

GET-D Framework:

At least in this case – shows the benefit of a centralized system addressing the needs of numerous stakeholders – where the focus can be on the use of data products and the not on running a redundant operational product system at each stakeholder institution.

Lessons Learned:

- Education of end-user; "trust"; needed better mechanism for training activities
- NOAA operational apparatus is slow to adapt to new observations; "risk-averse";
    - Example: wouldn't allow for ingest of MODIS products due to projected end of life
    - Development of "research" node at UMD, to complement "operational node" at NOAA to serve out additional products – test new derivative ESI products with established users
- Be willing to adapt to changing user needs – motivated the development of prototype global ESI built on foundational framework developed for N. America

Presentations:

Hain, C.R., M. Anderson, J. Otkin, X. Zhan, L. Fang and Z. Li, "Evaporative stress and soil moisture as early warning drought indicators, Midwest Drought Early Warning System Kickoff Meeting, St. Louis, 9-11 February, 2016.

Hain, C.R., M. Anderson, Y. Yang, J. Otkin, Monitoring evapotranspiration and drought using thermal remote sensing (invited), EUMETSAT Land Surface Analysis Satellite Application Facility 2015 User Workshop, Reading, United Kingdom, 6/8/2015 to 6/10/2015.

Hain, C.R. and M. Anderson, Monitoring Water Use and Drought using Multi-scale Imaging (invited), Daughtery Water for Food Institute Seminar Series, Lincoln, Nebraska, 7/9/2015.

Hain, C.R., Monitoring Evapotranspiration and Drought using Thermal Remote Sensing (invited), UN-FAO: Operational Meeting on Remote Sensing Monitoring of Key Agricultural Water Parameters, Cairo, Egypt, 3/11/2015 to 3/12/2015.

Hain, C.R., M. Anderson, J. Otkin, T. Holmes and W. Crow, "Implementing the remotely sensed Evaporative Stress Index globally using MODIS Day/Night land surface temperature, 2016 Annual Meeting of the American Meteorological Society, New Orleans, LA, 10-14 January, 2016.

Hain, C. R., M. Anderson, L. Fang, X. Zhan, Z. Li and J. Otkin, "Development of a Remote-Sensing Based Framework for Mapping Drought over North America", International Symposium on Weather and Climate Extremes, Food Security and Biodiversity in Fairfax, VA, 20-24 October 2014.