

Development of a Global Evaporative Stress Index Based on TIR and MW LST

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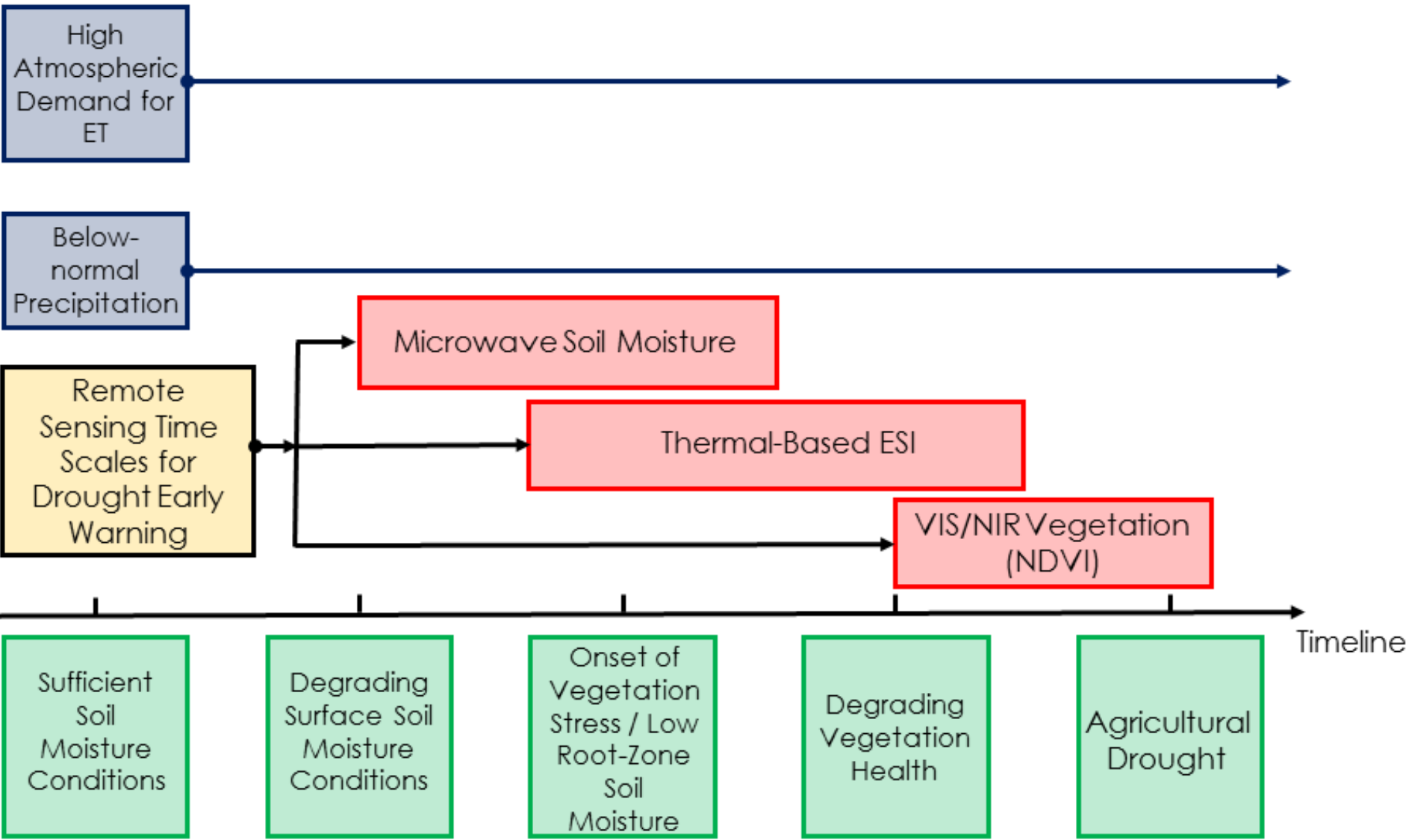
Thomas Holmes

NASA-GSFC

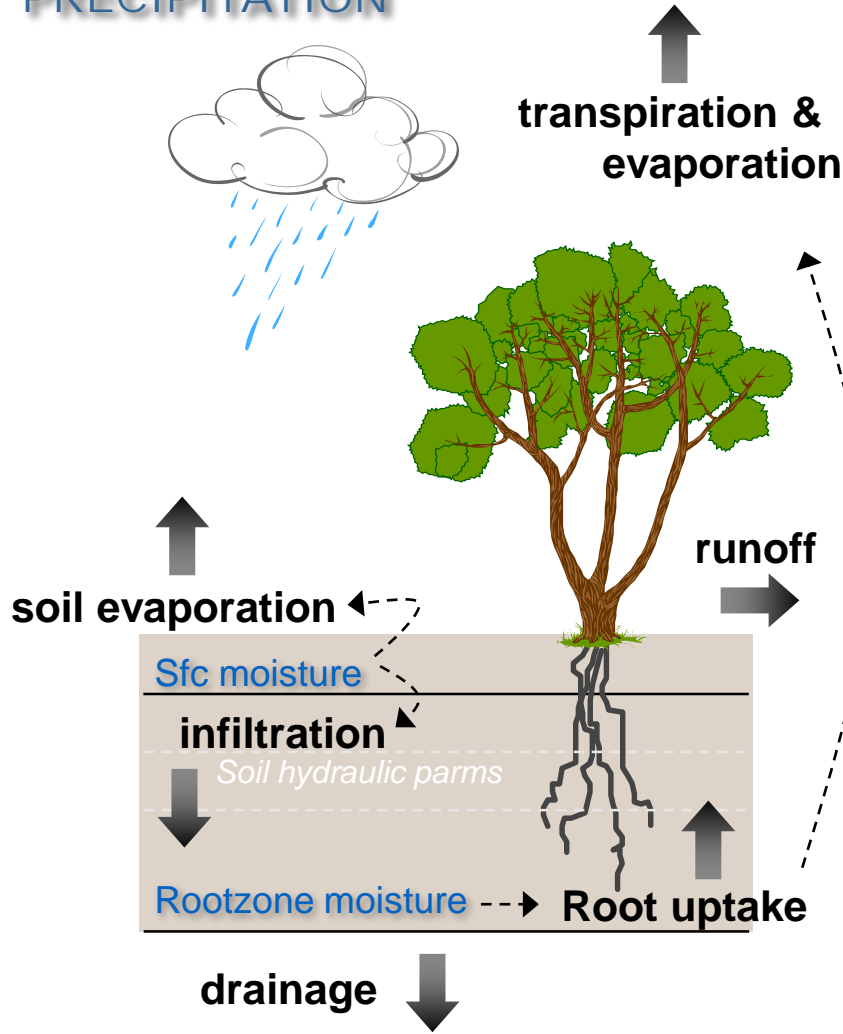
**Mark Svoboda,
Brian Wardlow**

U. Of Nebraska, NDMC

Example of the Evolution of Agricultural Drought

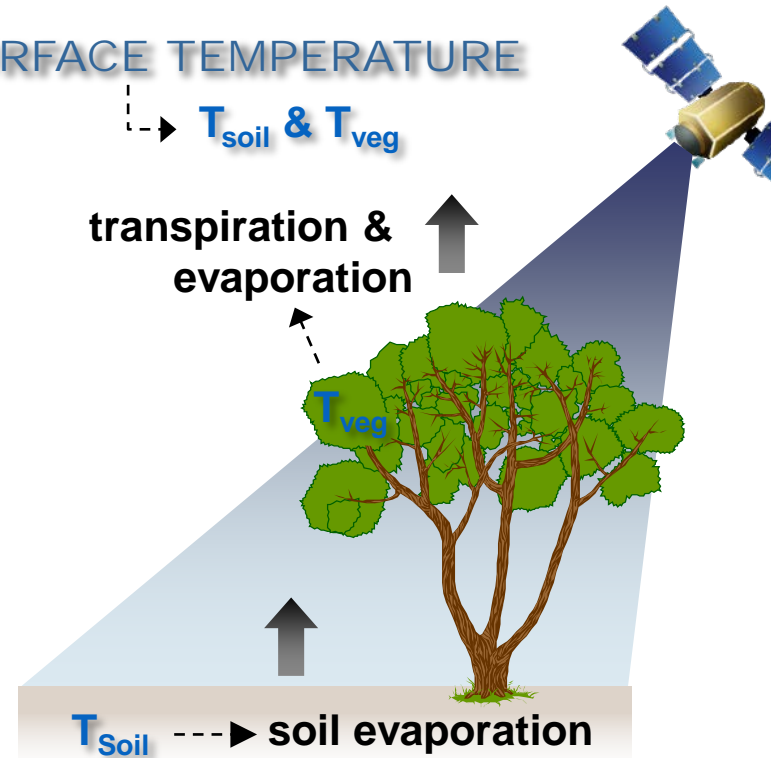


PRECIPITATION



WATER BALANCE APPROACH
(prognostic modeling)

SURFACE TEMPERATURE



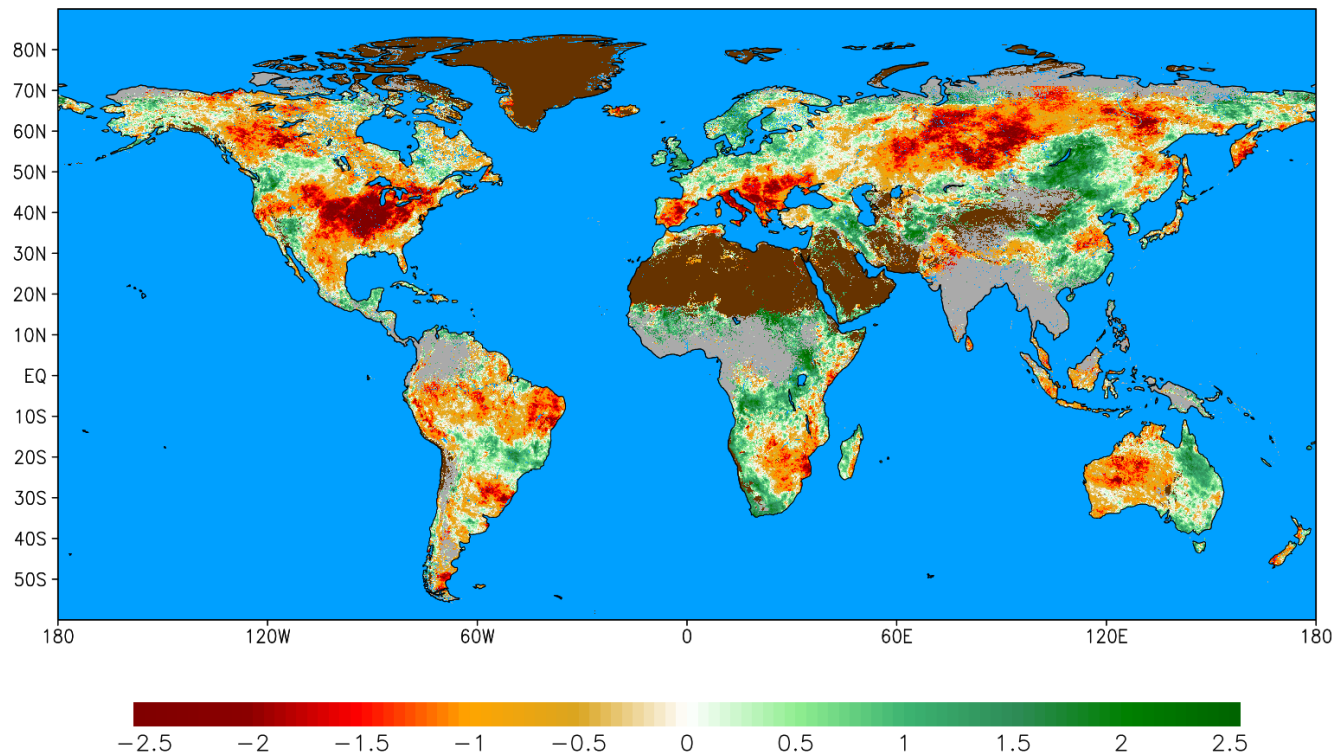
Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

ENERGY BALANCE APPROACH
(diagnostic modeling)

Global Evaporative Stress Index Methodology

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

- The current surface moisture state is deduced directly from the remotely sensed LST
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs
- Inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows)



1 August
2012

Project Stakeholders



Agriculture and Agri-Food Canada



NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION

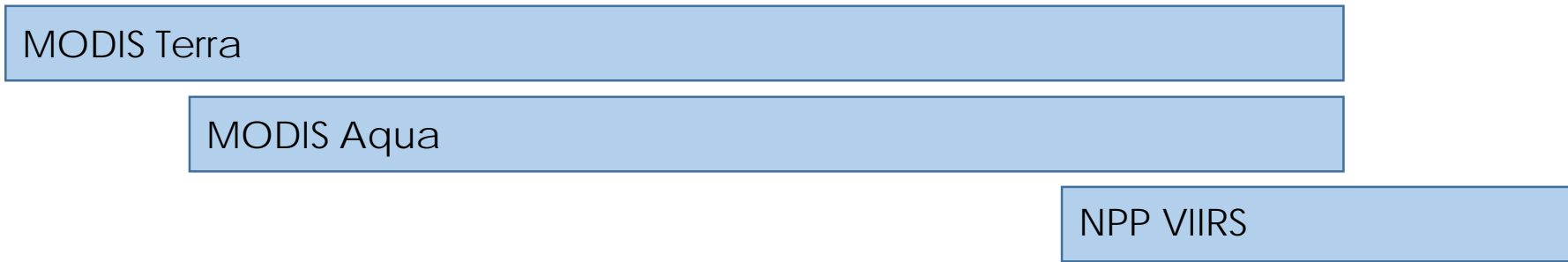


EARTH DATA FOR INFORMED AGRICULTURAL DECISIONS

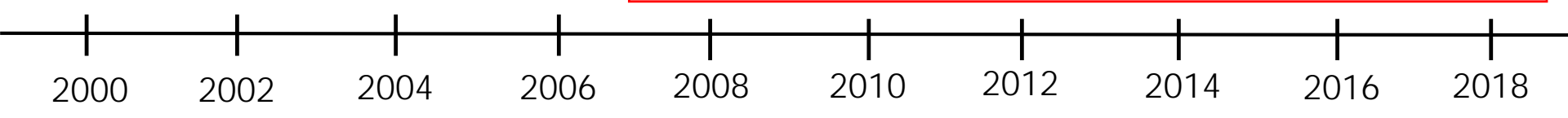
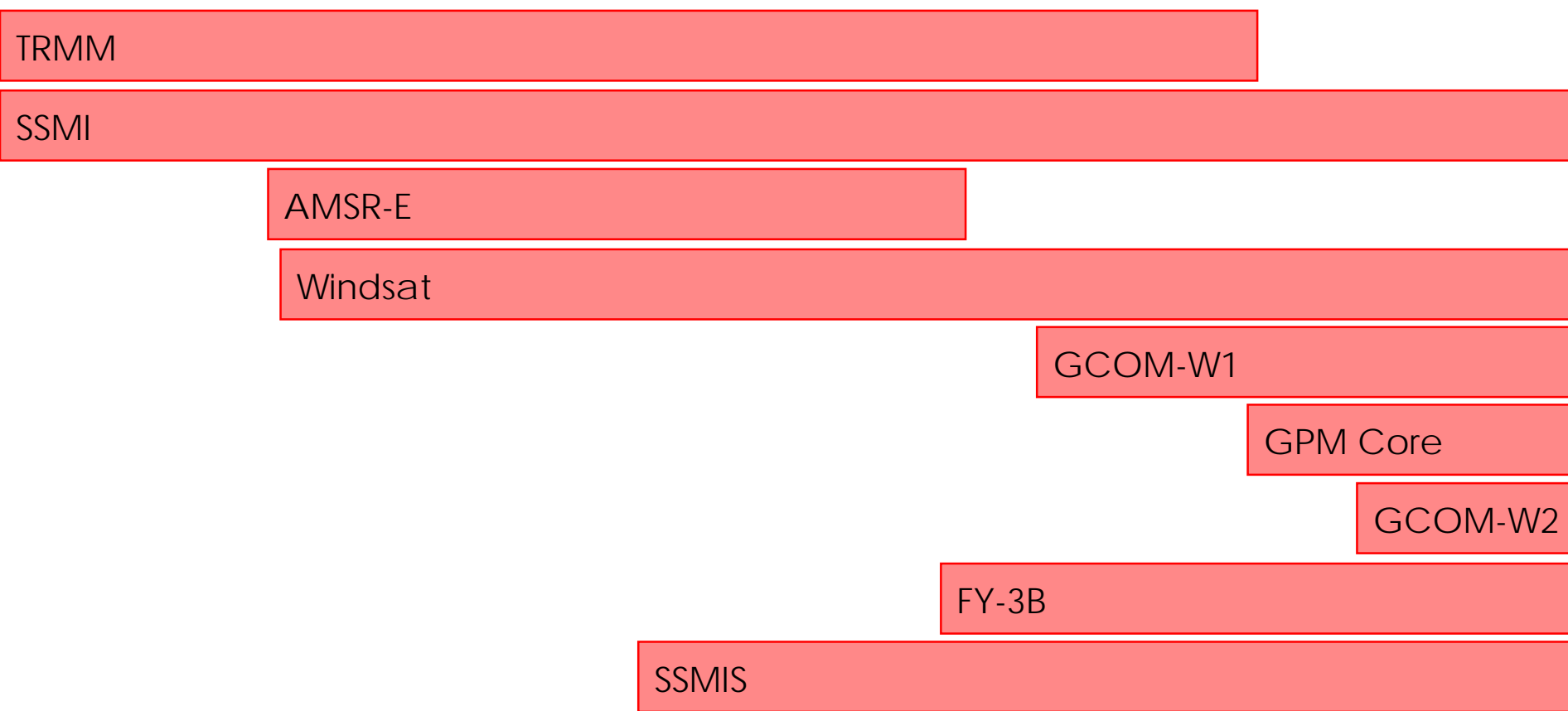
INTERSUCHO



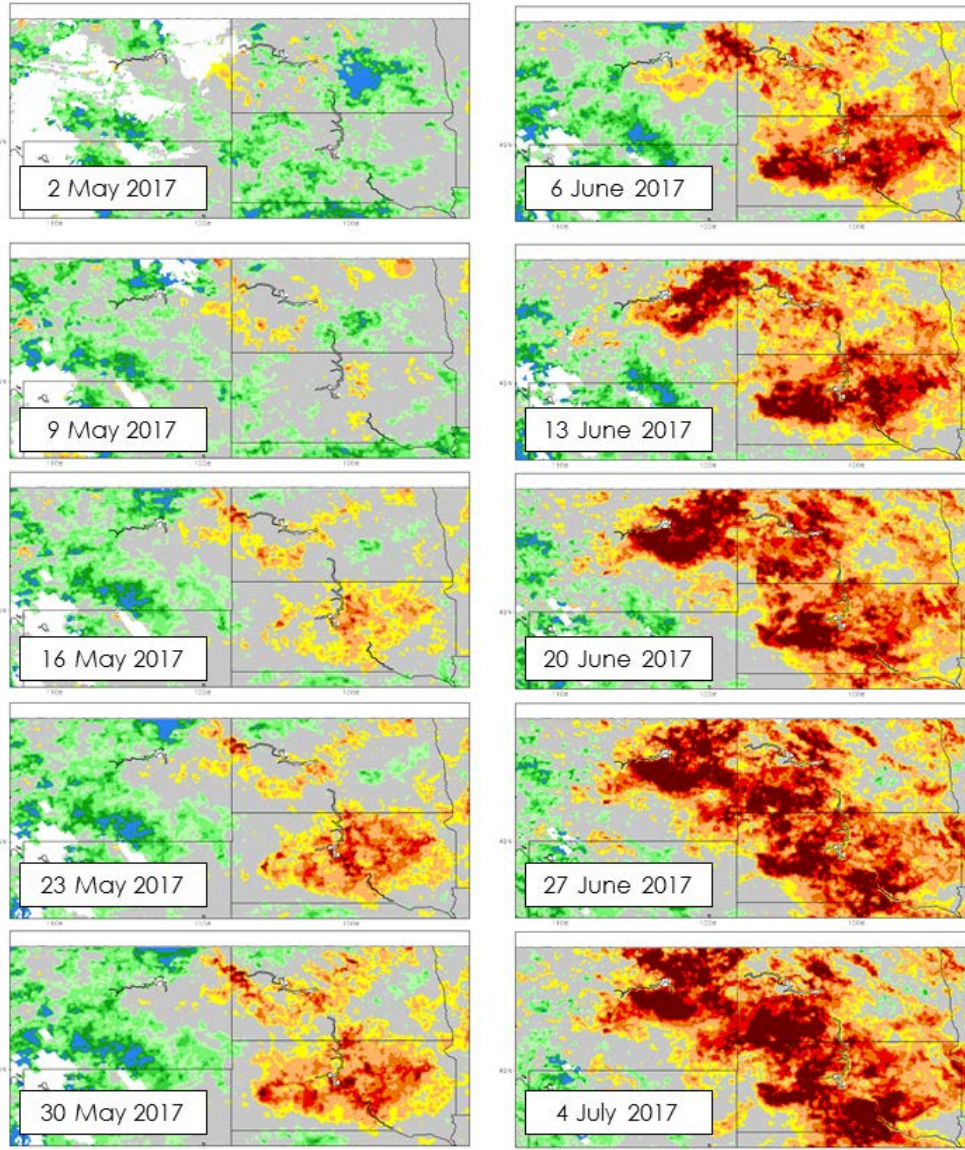
Thermal LST Observations



MW Ka-Band LST Observations



North Central US Flash Drought of 2017

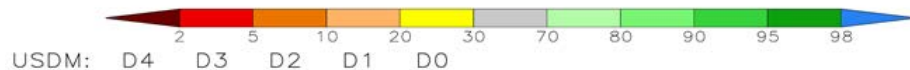


Flash drought are rapid onset events typically driven by:

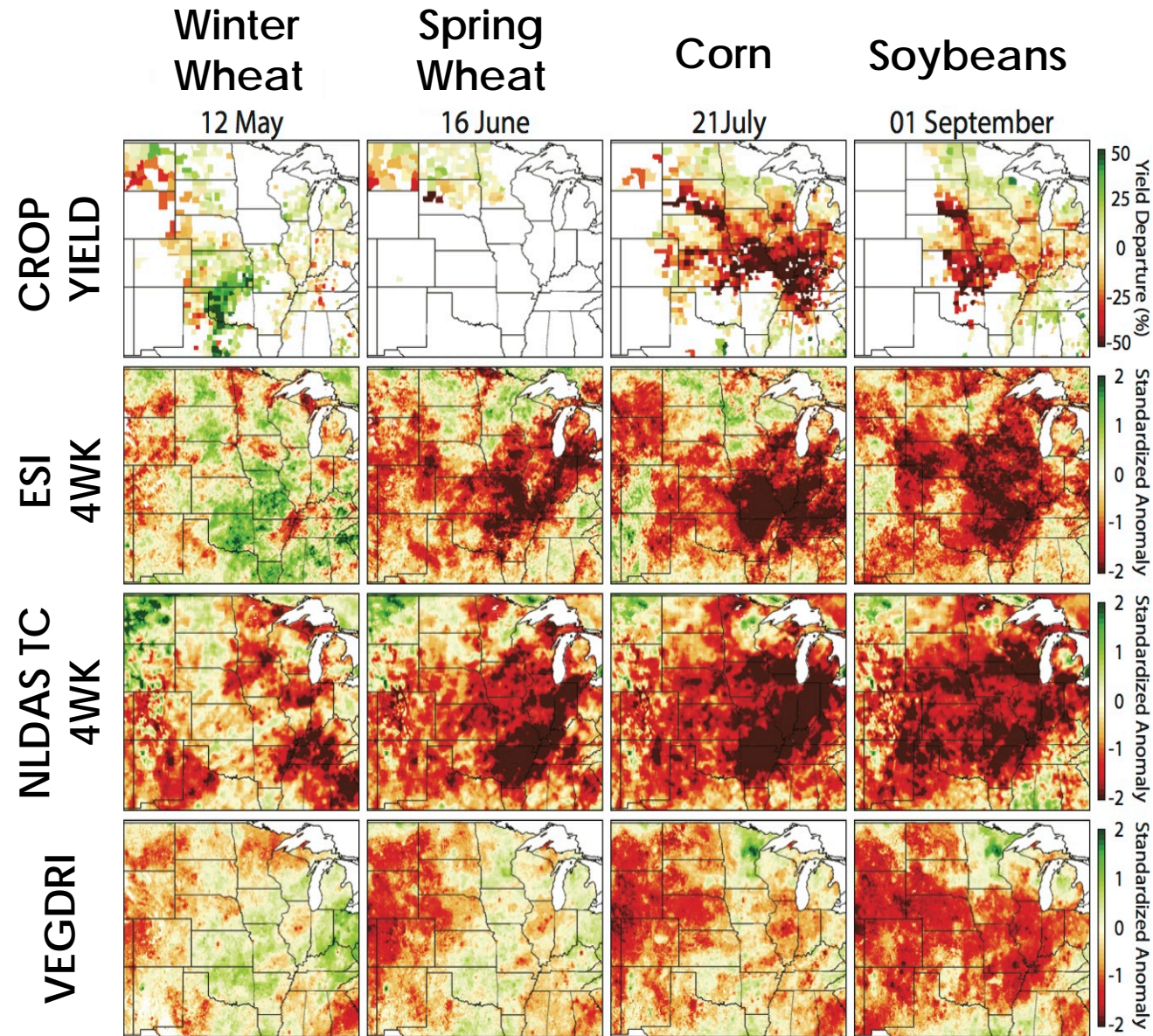
- 1) precipitation deficits,
- 2) high temperature anomalies;
- 3) strong winds;
- 4) Anomalous incoming solar radiation.

ESI provides early warning of the onset of vegetation stress.

Provides information physically related to "actual" stress.



Early Warning Metrics for Onset of Vegetation Stress



- Strong relationship between wheat yield and the ESI and VegDRI during critical crop stages

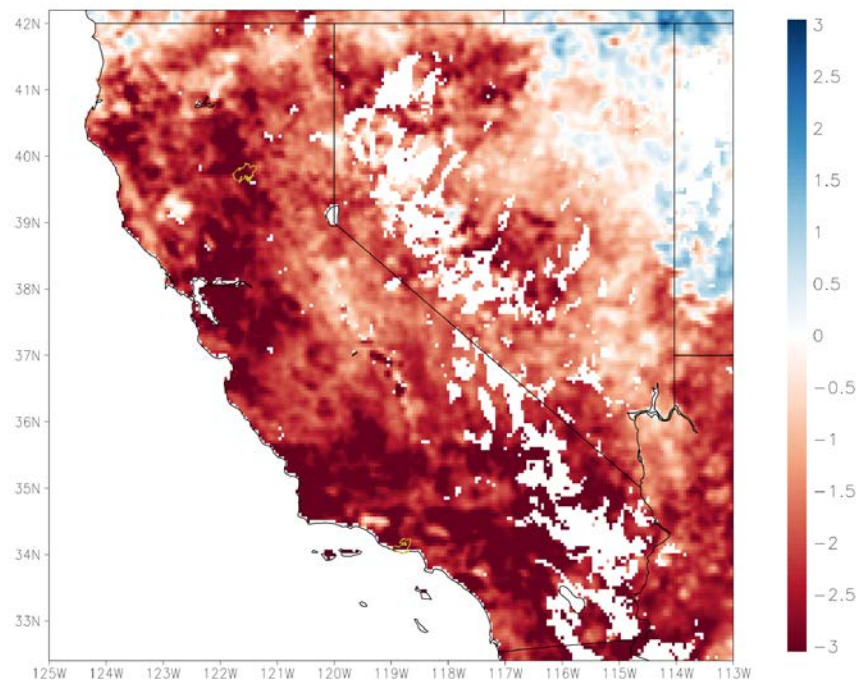
- NLDAS has strong (weak) relationship to corn/soybeans (wheat) yield

- ESI had strongest correlation to the wheat, corn, and soybean yield departures

Wildfire Applications

- ESI is strongly correlated with soil moisture, thus providing an independent assessment of current moisture conditions that can be compared to models that are driven by observations precipitation.
- ESI may better represent “dry fuel load” than remote sensing techniques such as NDVI which is focused on how “green” or “brown” vegetation is.
 - Stressed vegetation may susceptible to rapid fire growth before “brownness” is observed in a vegetation index such as NDVI.

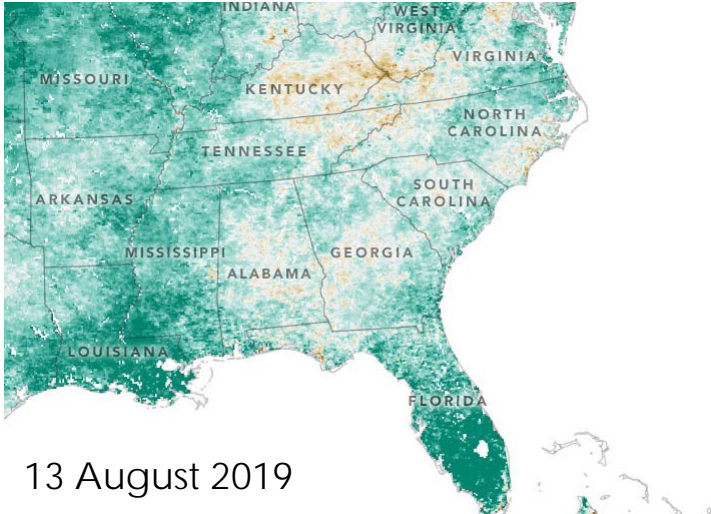
28-day change in ESI
(October 16 –
November 12)



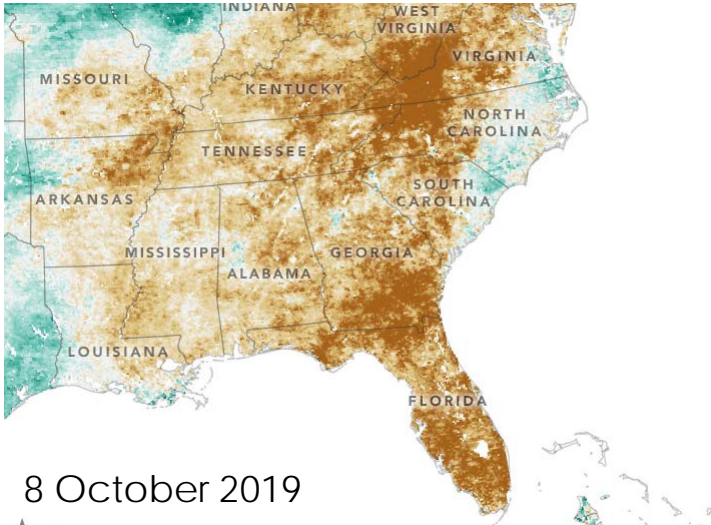
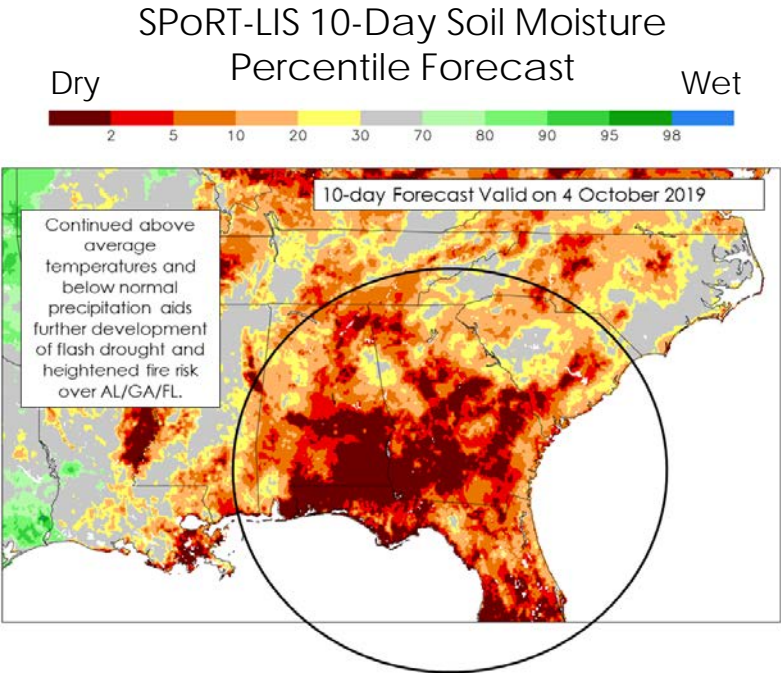
Rapid changes in ESI over California show significant increases in vegetation and moisture stress with the vegetation

ESI in Operational Situational Awareness

- Near-real-time ESI products are important for tracking rapidly changing drought conditions.
- For example, the evolution of the flash drought in the SE US (August – October) was accurately captured by ESI.



13 August 2019



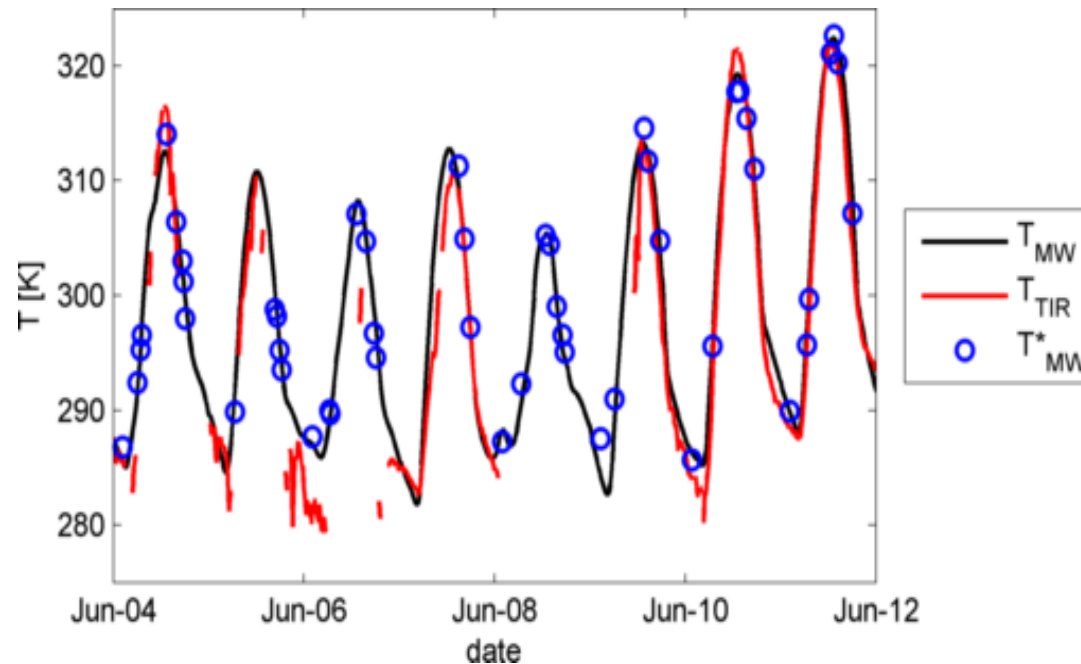
8 October 2019



The synergy between TIR and MW observations is further being exploited by the development of LST observations from MW observations(Ka-band).

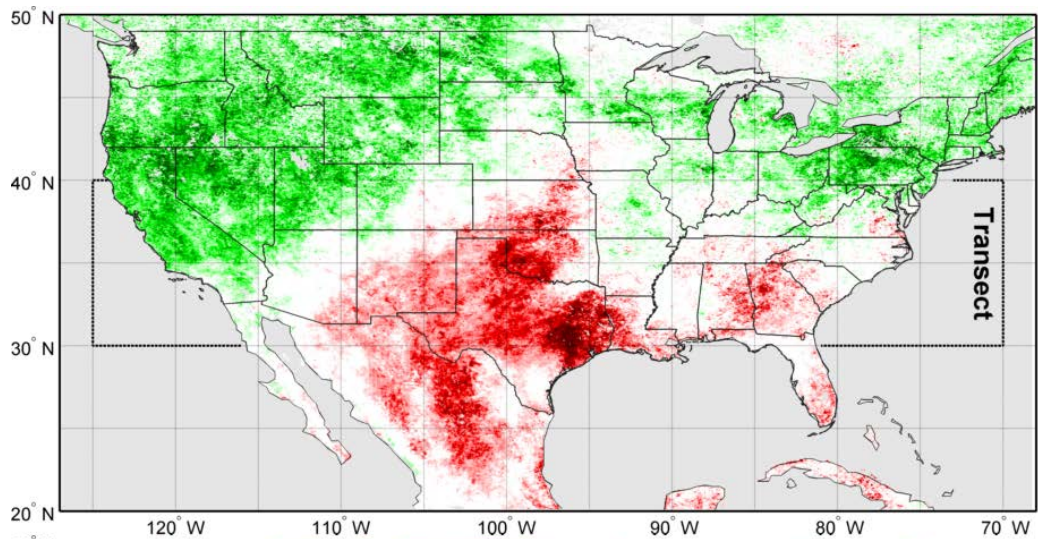
The integration of MW LST will allow for retrieval of surface fluxes under cloud cover.

This capability fills in a significant gap in a TIR-only system over tropical equatorial regions.

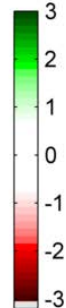


Anomaly analysis with MW-ALEXI

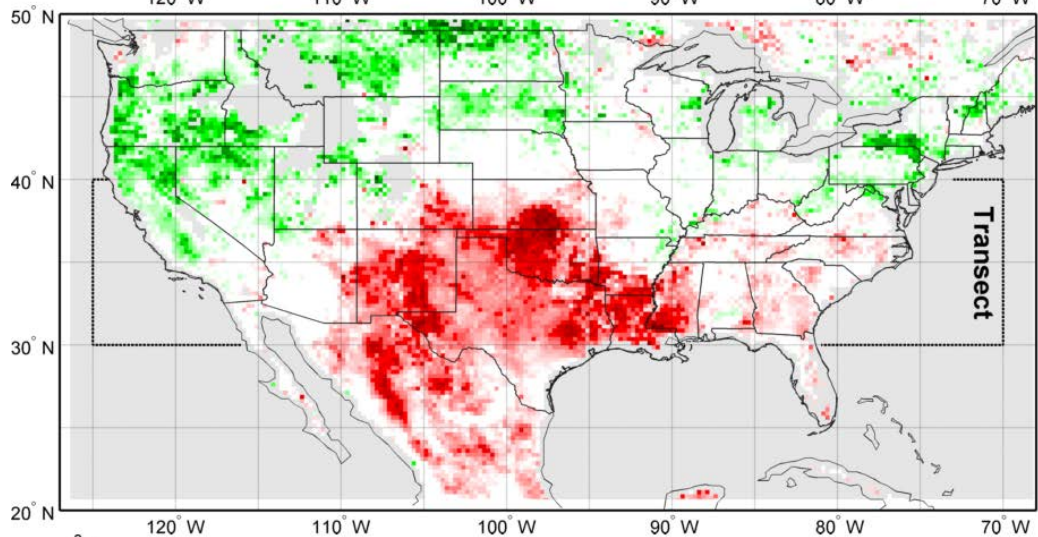
ESI 12week moving window



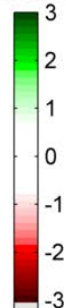
ALEXI
12WK ESI



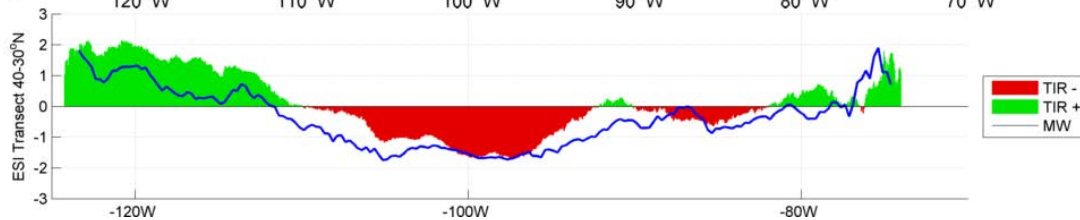
2011-155
LST: IR



ALEXI
12WK ESI

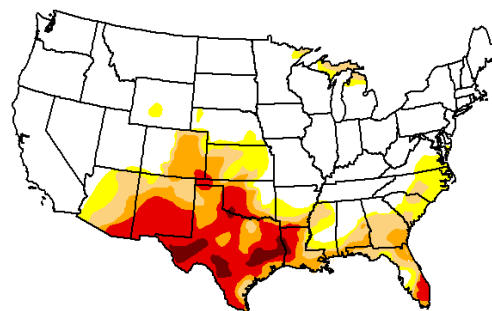


2011-155
LST: MW



TIR -
TIR +
MW

U.S. Drought Monitor
CONUS
June 7th, 2011



LST-Based Drought Indicators

- Diagnostically captures non-precipitation related moisture sources/sinks (irrigation, shallow groundwater, drainage)
- Provides early warning of on-set of actual vegetation stress
- Provides information about current soil moisture state without the need for knowledge of antecedent precipitation

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NRT data feed: <https://gis1.servirglobal.net/data/esi/>