



SMAP Contributions to Drought Early Warning

**James Verdin
USGS/EROS
NIDIS Program Office,
NOAA/ESRL
Boulder, Colorado**

**Gabriel Senay
USGS/EROS
Land Sciences
Sioux Falls, South Dakota**

*“SMAP Applications Workshop”
Silver Spring, Maryland – September 9-10, 2009*

What is drought?

- A normal, recurrent feature of climate variability
- A deficiency of precipitation over an extended period of time, resulting in water shortage
- A temporary aberration relative to long term average balance between precipitation and evapotranspiration
- It occurs in virtually all climatic zones


What is drought?

- *Meteorological drought* based solely on departures of rainfall from expected amounts, e.g., days without rain above a certain threshold, and is region specific
- *Agricultural drought* is measured relative to crop water demand, and varies with crop type, stage of growth, and soil properties
- *Hydrological drought* occurs as shortage of surface or subsurface water supply, and lags the original deficiency of rainfall

What is drought?

- A slow-onset hazard
- Amorphous in extent, ambiguous in timing of onset and abatement
- Many early warning goals can be met through monitoring
- Remote sensing and modeling have important role to play in concert with surface observation networks
- Seasonal forecasting is increasingly important and effective

Drought Early Warning in the U.S.



National Integrated Drought Information System

U.S. Drought Portal

www.drought.gov

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LOCAL FORECAST: City/State or Zip

Area Drought Information

Select State...

Select Region...

Maps & Tools

- Map Viewer - **updated!**
- GIS Resources
- Geodata Portal

Events & Announcements

- Monitoring Gaps Assessment Workshop - December 2008
- Wildfire: National Seasonal Assessment Workshop - February 2009
- Climate Reference Network Soil Moisture Meeting - March 2009 (link coming soon)
- National Hydrologic Warning Council
- Remote Sensing Workshop - February 2008 (Updated Summary)

[View Archive](#) | [Portal Release Notes](#)

Drought In The News

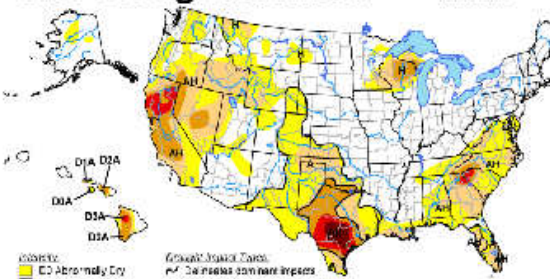
- California officials issue urgent call for immediate 20 percent cut in water use - [Sacramento News](#)
- FOXNews.com - Southern Governors Wage Water War Over Rights to Lake Lanier
- Rain: Saving it for a sunny day includes easy conservation measures - [Sacramento News](#)
- Drought may cut off federal water to Calif. farms - [USATODAY.com](#)

Featured Products

[Where are Drought Conditions Now?](#) |
 [How is the Drought Affecting Me?](#) |
 [Will the Drought Continue?](#)

U.S. Drought Monitor

February 24, 2009
Valid 6am EST



Legend:
 D0 Abnormally Dry
 D1 Drought - Moderate
 D2 Drought - Severe
 D3 Drought - Extreme
 D4 Drought - Exceptional

Legend:
 A - Agriculture, livestock, pasture, and range
 H - Hydrologic Impact

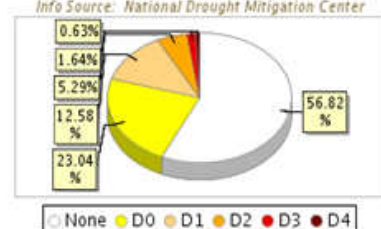
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for important statements.
<http://drought.unl.edu/dm>

Released Thursday, February 26, 2009
 Author: Bob Adler, Climate Prediction Center, NOAA

Drought Conditions

% Area for U.S., including AK, HI & PR (As of 2.24.2009)

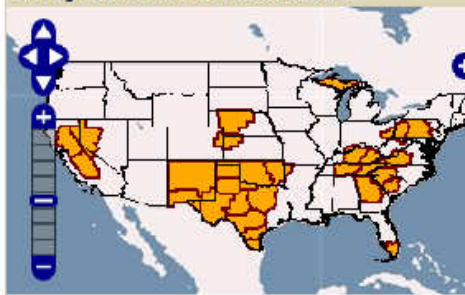
Info Source: National Drought Mitigation Center



Drought Classification	% Area
None	56.82%
D0	23.04%
D1	12.58%
D2	5.29%
D3	1.64%
D4	0.63%


[Drought Classifications](#) | [View Time Series](#)

Drought Information Statements







Click on a highlighted area to view the current NWS Drought Information Statement or [Click Here](#) to select from a list.

US Streamflow Drought Conditions




As of February 24, 2009

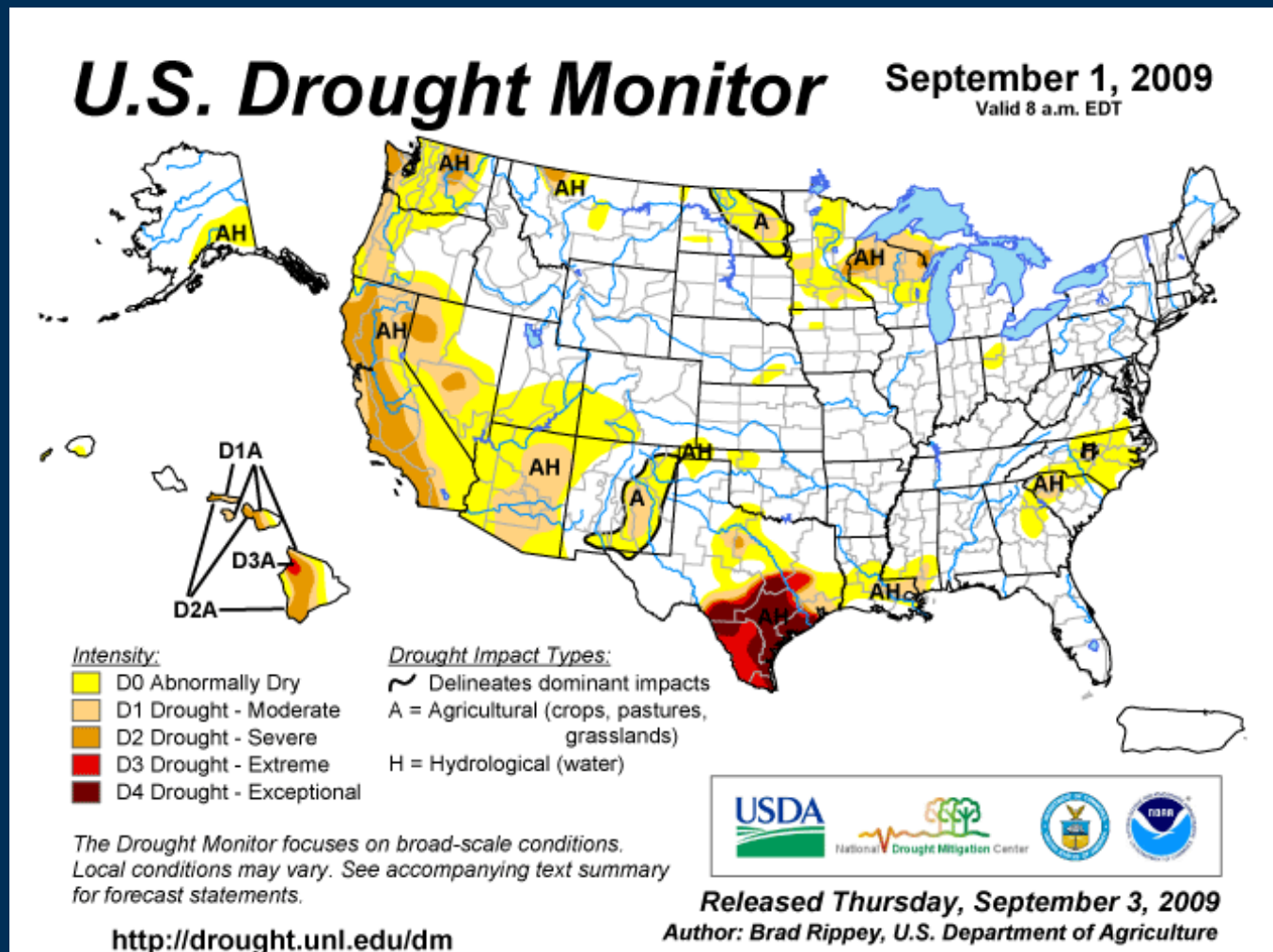
NIDIS Feature

Climate Change and Water Resources Management: A Federal Perspective



Drought Monitoring in the U.S.



"SMAP Applications Workshop"
Silver Spring, Maryland – September 9-10, 2009

The U.S. Drought Monitor

Integrates Key Drought Indicators:

- Palmer Drought Index
- SPI
- KBDI
- Modeled Soil Moisture
- 7-Day Avg. Streamflow
- Precip. Anomalies

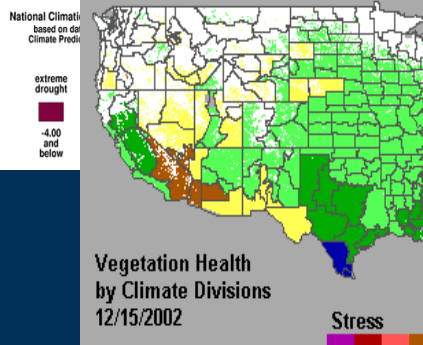
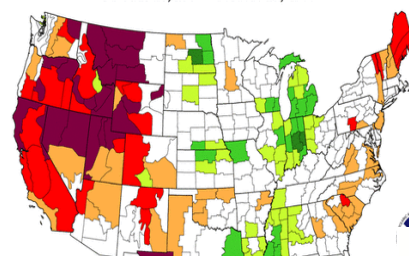
Growing Season:

- Crop Moisture Index
- Sat. Veg. Health Index
- USDA Soil Ratings
- Mesonet data

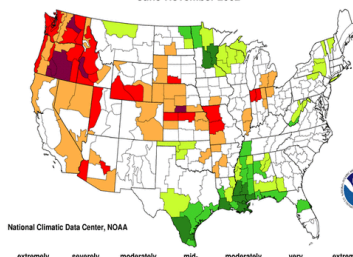
In The West:

- SWSI
- Reservoir levels
- Snowpack

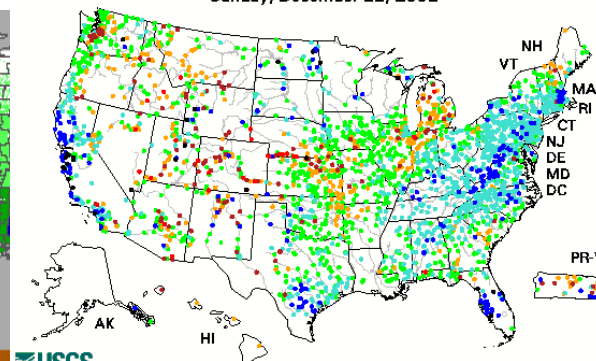
Palmer Drought Index
Long-Term (Meteorological) Conditions
October 21, 2001 - October 27, 2001



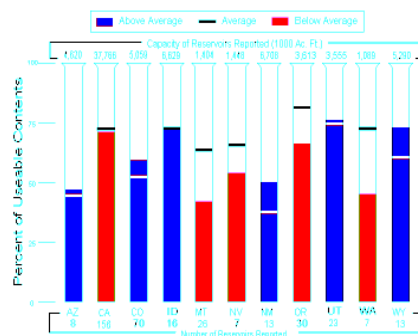
Standardized Precipitation Index
Six Months
June-November 2002



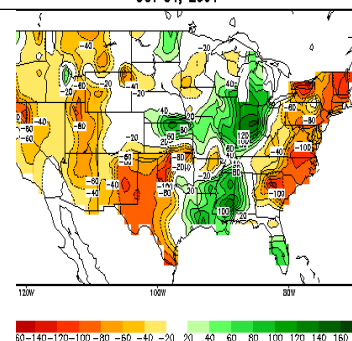
Sunday, December 22, 2002



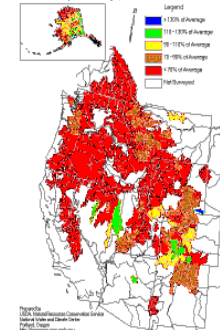
Reservoir Storage as of May 1, 2001



Calculated Soil Moisture Anomaly (mm)
OCT 31, 2001



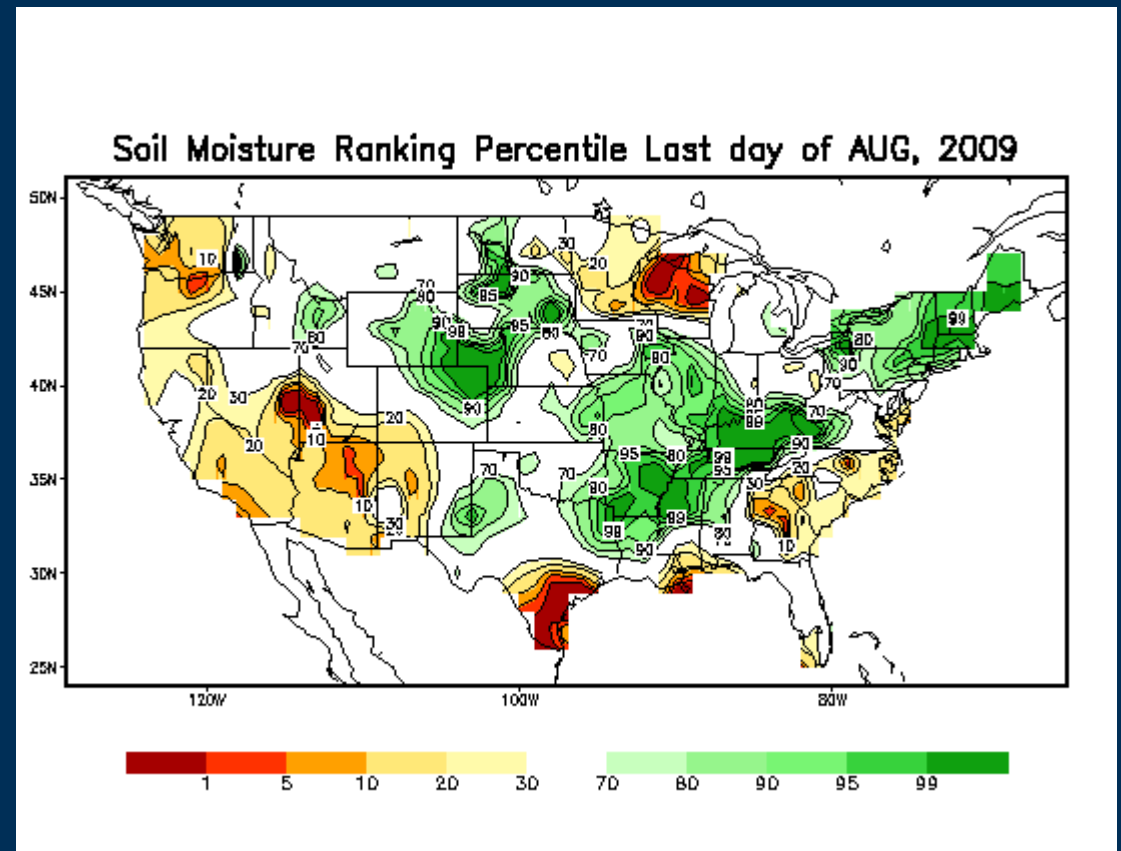
Mountain Snowpack as of May 1, 2001



Prepared by: USDA, Natural Resources Conservation Service, National Water and Climate Center, Portland, OR
http://www.nrcs.usda.gov

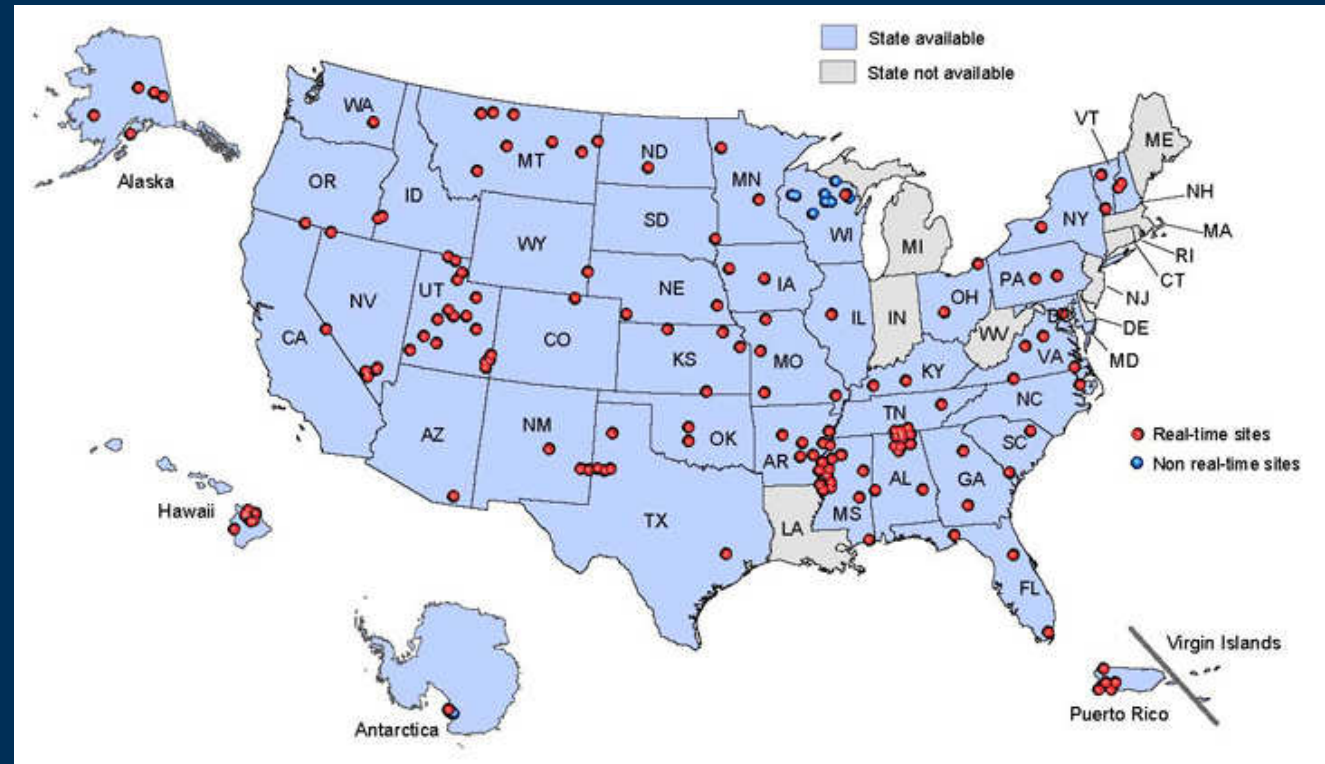
The U.S. Drought Monitor

- NOAA CPC
'Leaky Bucket'
Soil Moisture
Model



Drought Monitoring in the U.S.

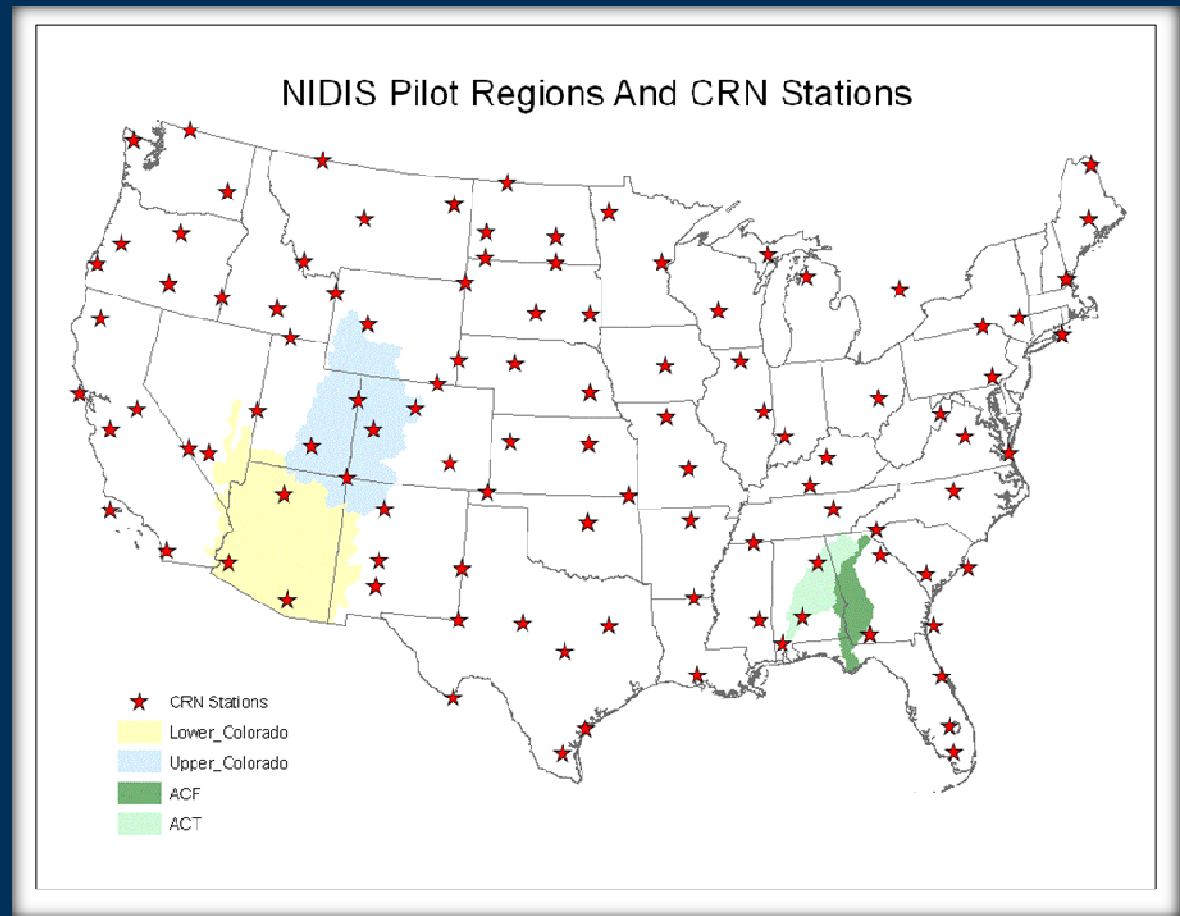
- **NRCS Soil Climate Analysis Network (SCAN)**



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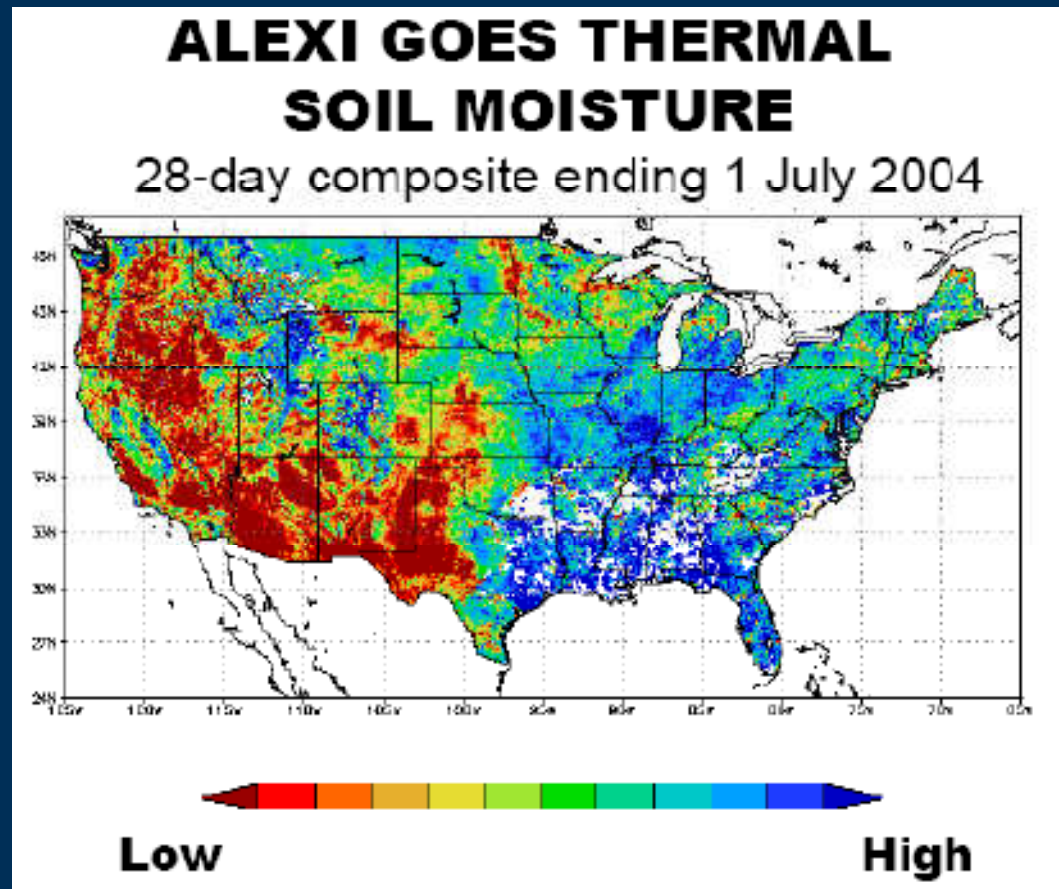
Drought Monitoring in the U.S.

- NIDIS is adding soil moisture sensors to the U.S. Climate Reference Network



Drought Monitoring in the U.S.

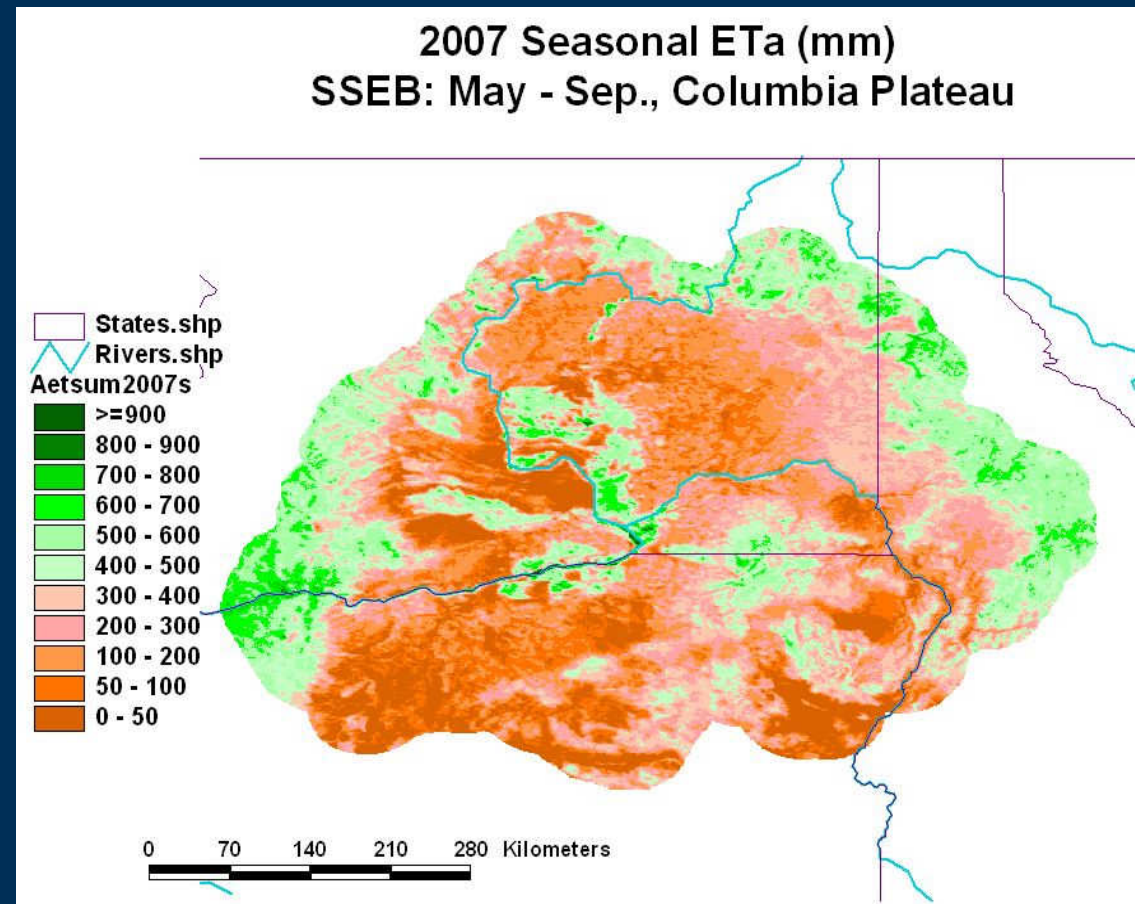
- Remote sensing, modeling required due to coverage, scale problems
- ALEXI TIR ET model, M. Anderson, USDA/ARS



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Drought Monitoring in the U.S.

- Remote sensing, modeling required due to coverage, scale problems
- MODIS LST estimates of ET, G. Senay, USGS/EROS



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Drought Forecasting in the U.S.

- NIDIS is supporting seasonal forecast modeling activities in the context of regional pilots
- In the Upper Colorado River Basin, linking CFS (NOAA/CPC), ESP (CBRFC), and reservoir operations model (USBR)
- In the Southeast U.S., linking CFS (NOAA/CPC) with Princeton multi-model hydrologic forecasting system

Drought Early Warning Outside the U.S.

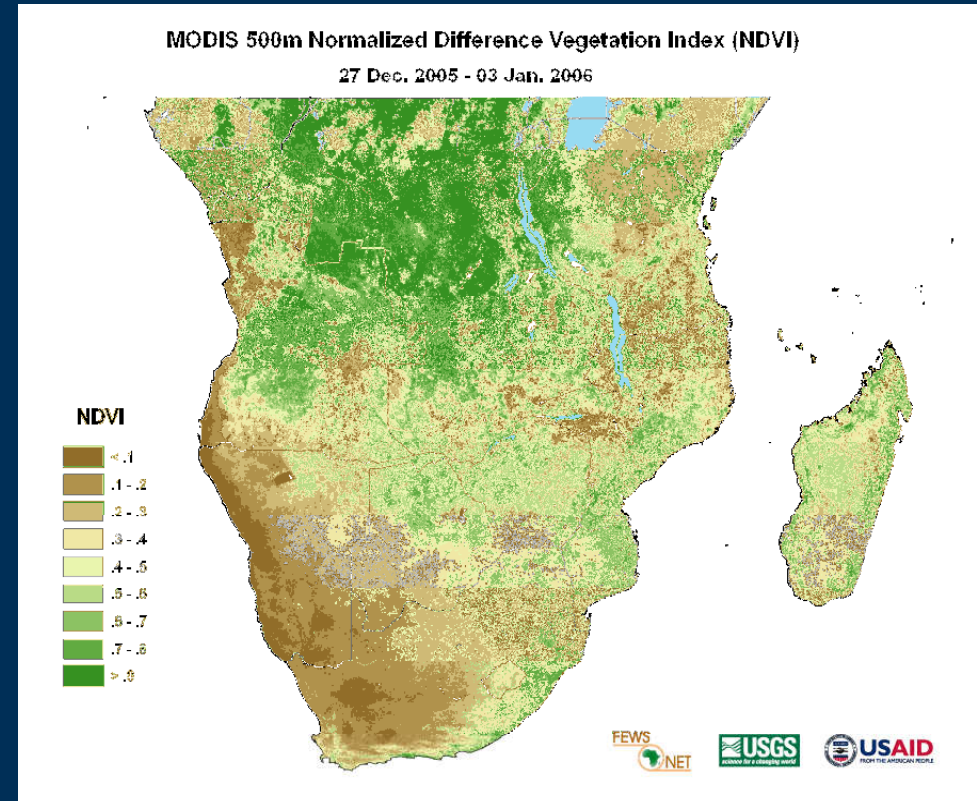
- Outside the U.S., agricultural drought is our biggest concern
- Drought can reduce crop production for export, impacting global markets
 - Role of USDA/FAS IPAD
- Drought can undermine food security in developing countries
 - Role of USAID FEWS NET
- Due to sparse ground networks, both rely on many of the same remote sensing systems

Monitoring Agricultural Drought for Famine Early Warning

- Primary motivation is early identification of potential *production anomalies* in regions of subsistence agriculture
- Subsistence agricultural systems are typically *water-limited*
- Consequently, early estimates of prospective food availability depend in large measure on *drought monitoring and forecasting*

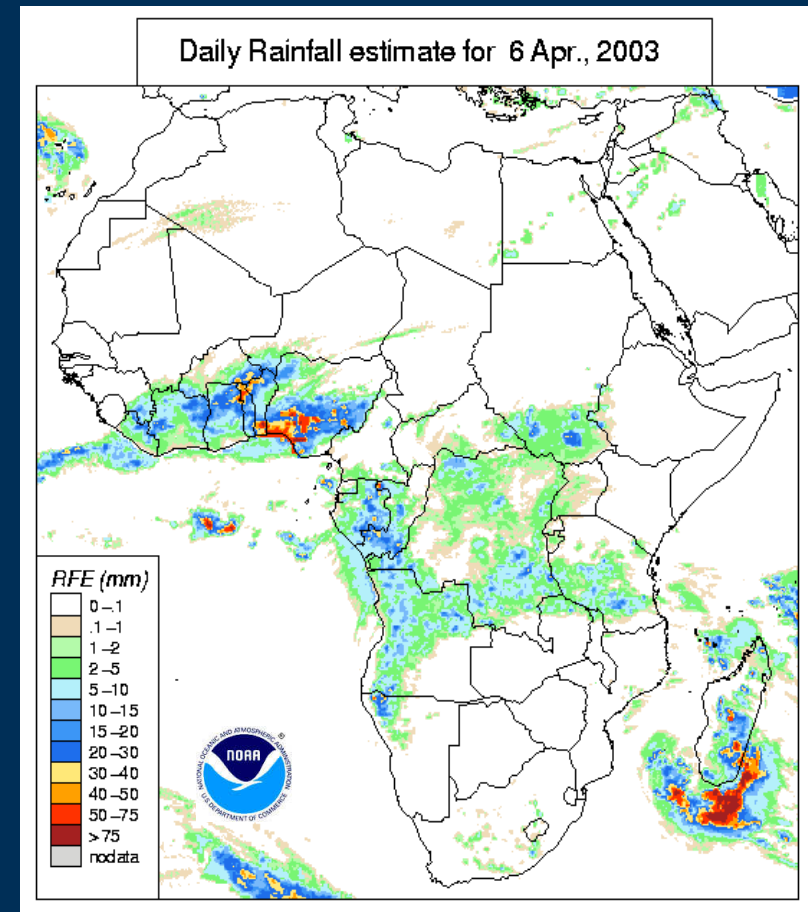
Monitoring Agricultural Drought for Famine Early Warning

- Tradition of NDVI use back to 1985
- MODIS NDVI data show strong correlation with USDA crop estimates
- Soil moisture status is implicit in the vigor of the plant canopy



Monitoring Agricultural Drought for Famine Early Warning

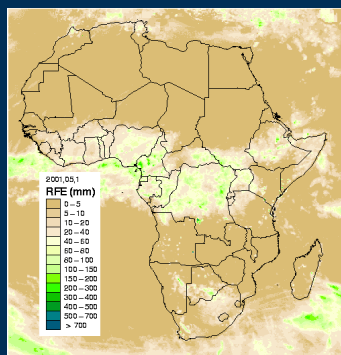
- Use of satellite RFE since mid-1990s
- Blend TIR, MW, and station observations
- Soil moisture status calculated in crop water balance model



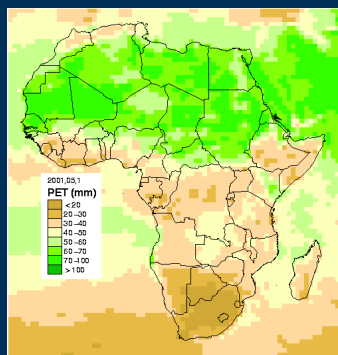
Water Requirement Satisfaction Index (WRSI)

$$\text{WRSI} = f(\text{ppt}, \text{pet}, \text{WHC}, \text{Crop Type}, \text{SOS}, \text{EOS}, \text{LGP})$$

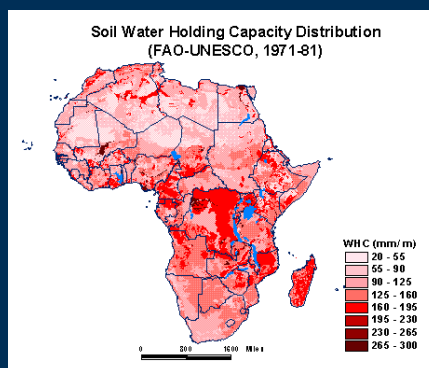
RFE
(NOAA)



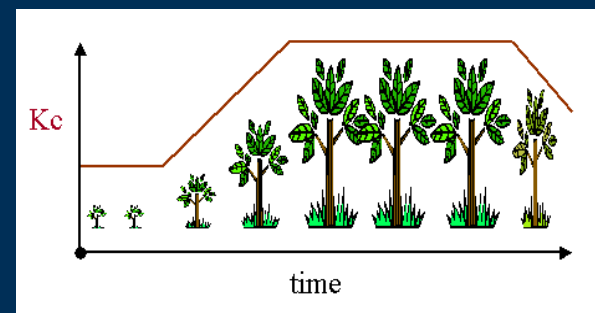
calculated from
NOAA GDAS
at EROS



FAO soils map
of the world

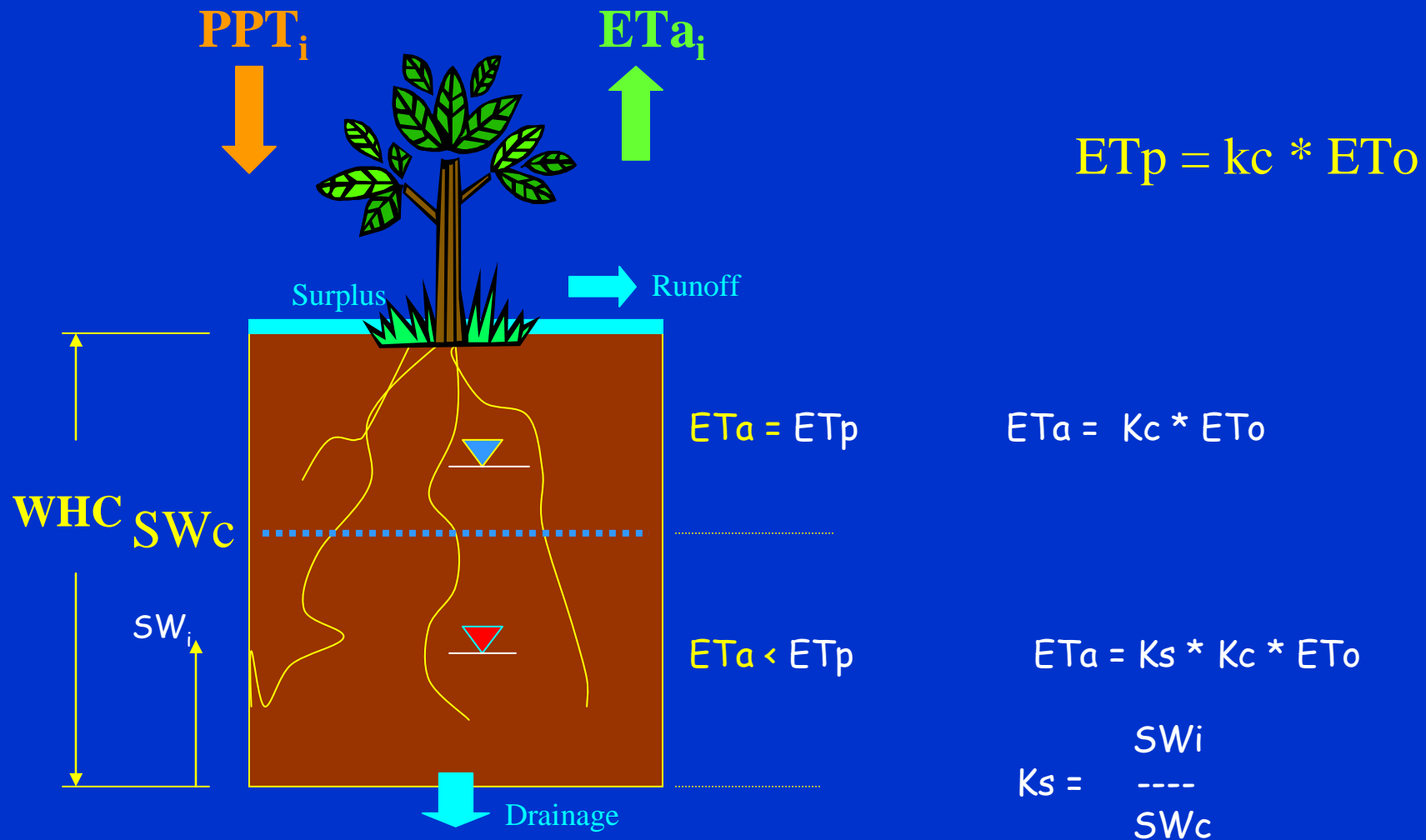


Kc (FAO)



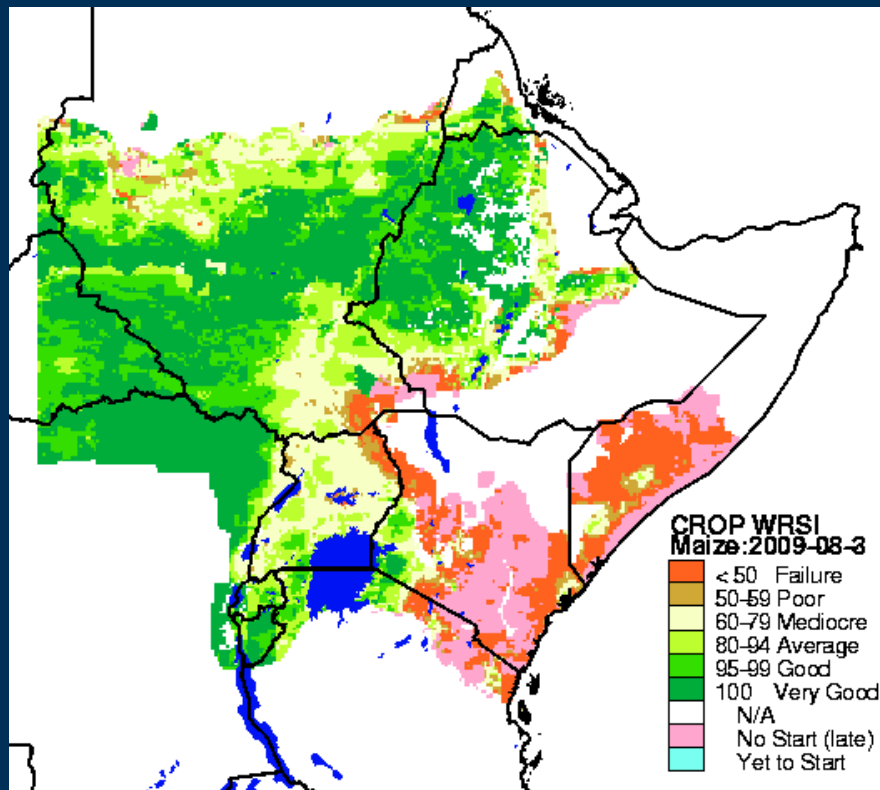
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Crop Water Balance

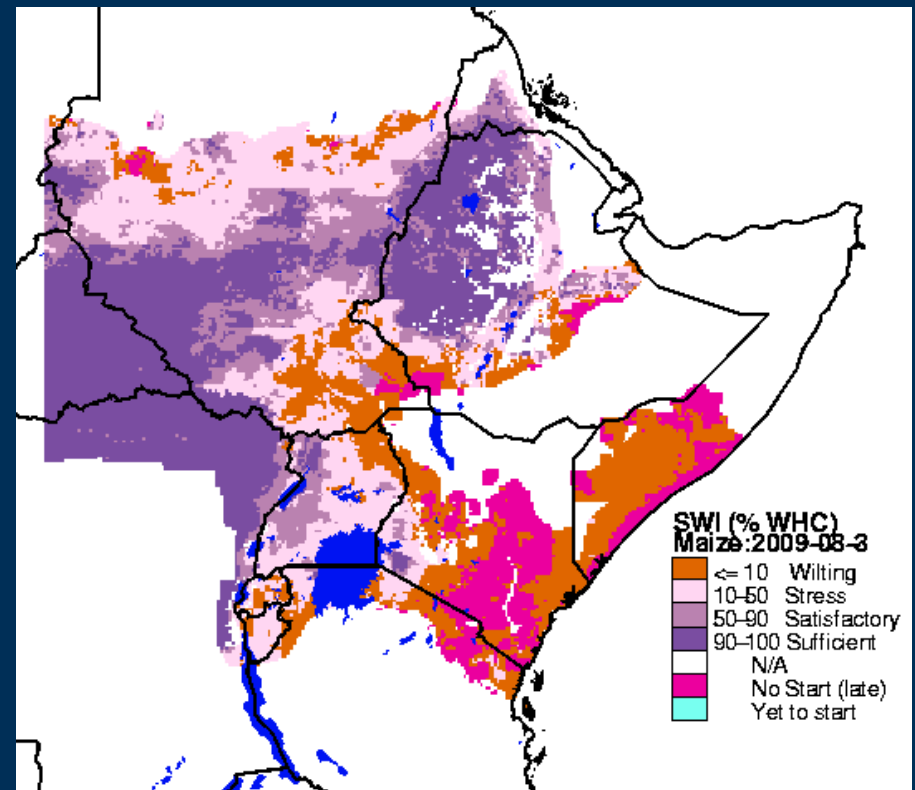


$$SW_i = SW_{i-1} + PPT_i - ET_{a_i} - RF_i - DD_i$$

Monitoring Agricultural Drought for Famine Early Warning



WRSI



Soil Water Index



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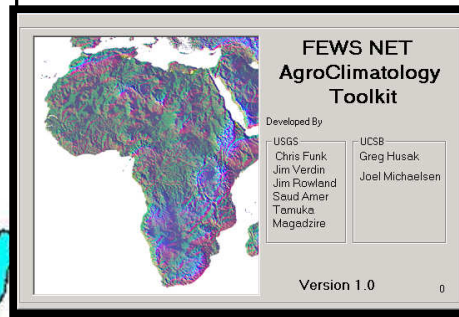
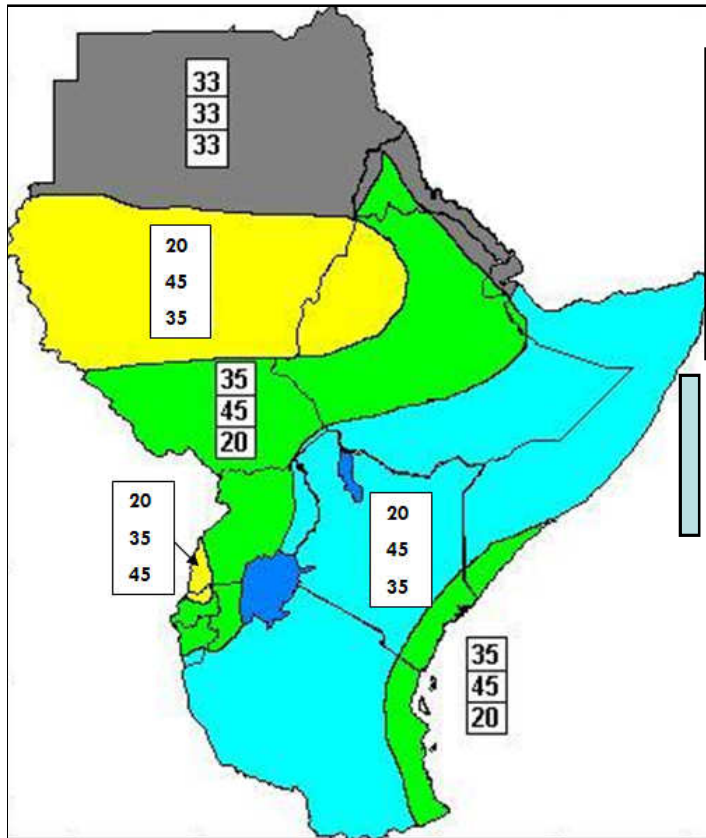
Monitoring Agricultural Drought for Famine Early Warning

- Many sources of uncertainty in Soil Water Index calculation:
 - *FAO Digital Soil Map of the World 1:5 M*
 - *Satellite RFE*
 - *Reference crop ET from atmospheric model analyses*
- No source of soil moisture data with which to verify/validate
- An early opportunity for SMAP

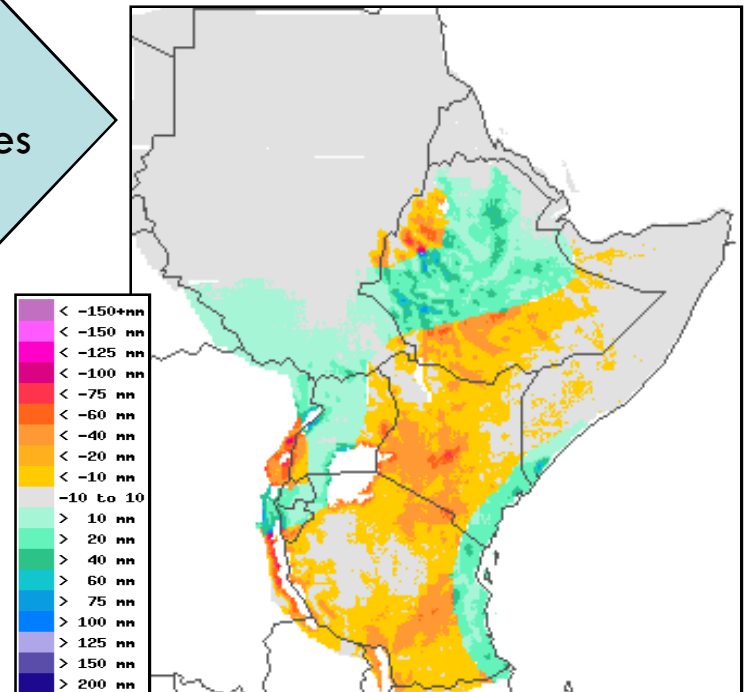
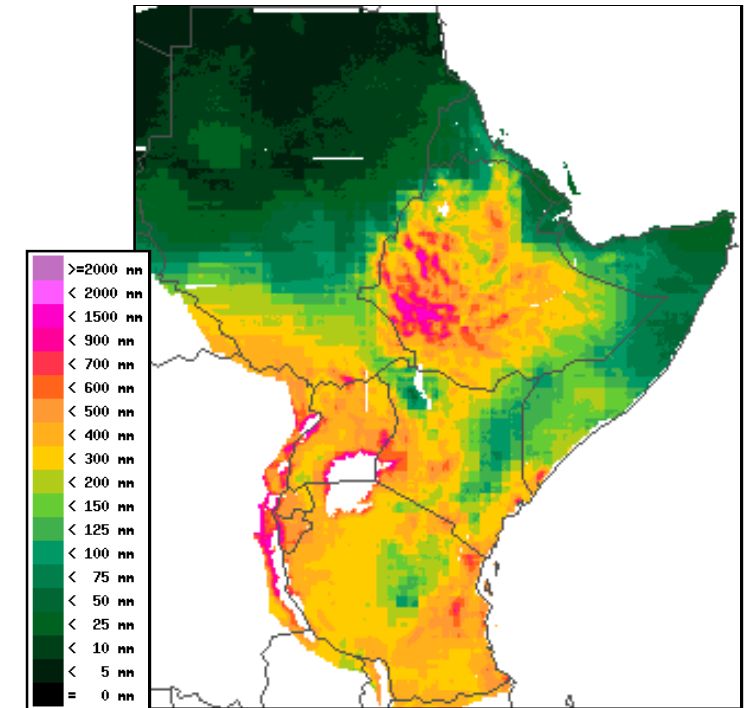


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Seasonal Rainfall Forecasting and Interpretation with the Forecast Interpretation Tool (FIT)



Translating prob.
Into rainfall anomalies



A LIS Instance for FEWS NET

Inputs

Topography,
Soils

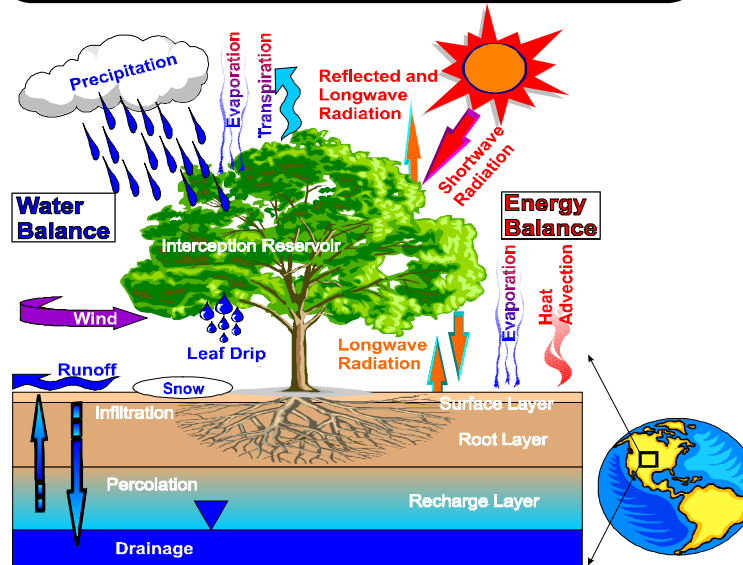
Land Cover,
Vegetation
Properties

Meteorological
Forecasts,
Analyses, and/or
Observations

Snow
Soil Moisture
Temperature

Physics

Land Surface Models
(CLM, Noah, VIC, etc)



Data Assimilation Modules

Outputs

Soil
Moisture &
Temperature

Evaporation
Sensible Heat
Flux

Runoff

Snowpack
Properties

Applications

Weather

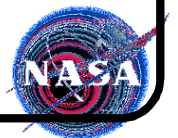
Climate

Water
Resources

Agriculture

Drought

Natural
Hazards



SMAP Applications – Initial Thoughts

Products with appeal for drought:

- **L3_SM_A/P Radar-Radiometer Soil Moisture on Earth Grid at 10 km with 24 hr latency**
- **L4_SM Surface and Root Zone Soil Moisture on Earth Grid at 10 km with 7 day latency**

SMAP Applications – Initial Thoughts

- Before launch, use findings of simulation field campaigns to provide a basis for mapping places and times of favorable/unfavorable vegetative cover
- Use within-season SMAP soil moisture spatial patterns, temporal evolution to check existing drought monitoring products

SMAP Applications – Initial Thoughts

- Explore use of SMAP products in conjunction with LST, NDVI products
- Assimilation of SMAP products by LSMs used to create hydrological re-analyses and seasonal forecasts of soil moisture and stream flow

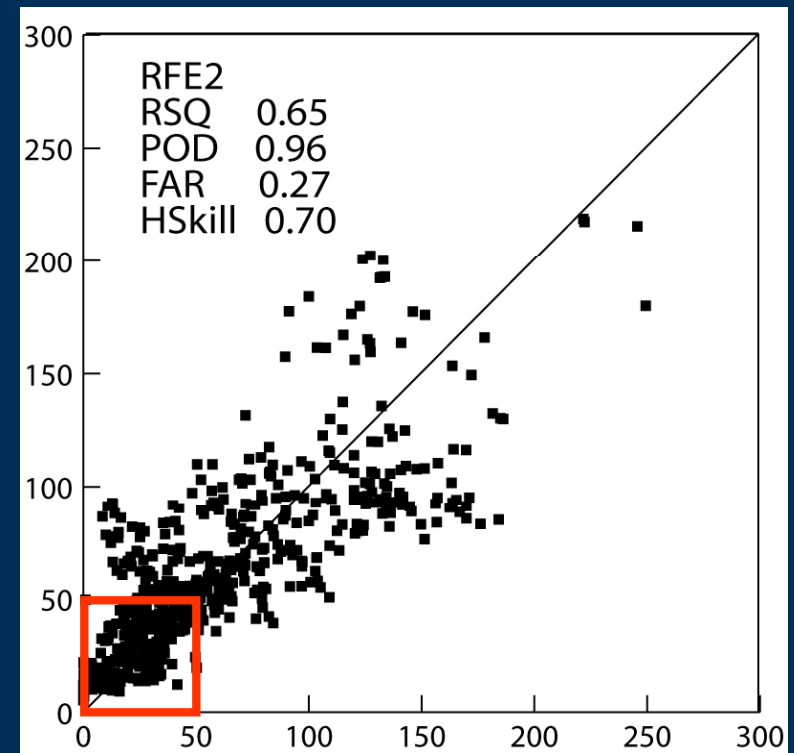
Thank you



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Importance of Precipitation Data

Satellite estimates are good at identifying low values (drought) because they are based on observed cloud properties



A GEO System of Systems for Agricultural Monitoring for Famine Early Warning

- Global trends: yield improvements not keeping pace with declining per capita cultivated area -> reduced availability
- Climate change: increased drought risk
- Global food crisis: unexpectedly rapid spikes in the price of food, fuel

A GEO System of Systems for Agricultural Monitoring for Famine Early Warning - Near Term Needs

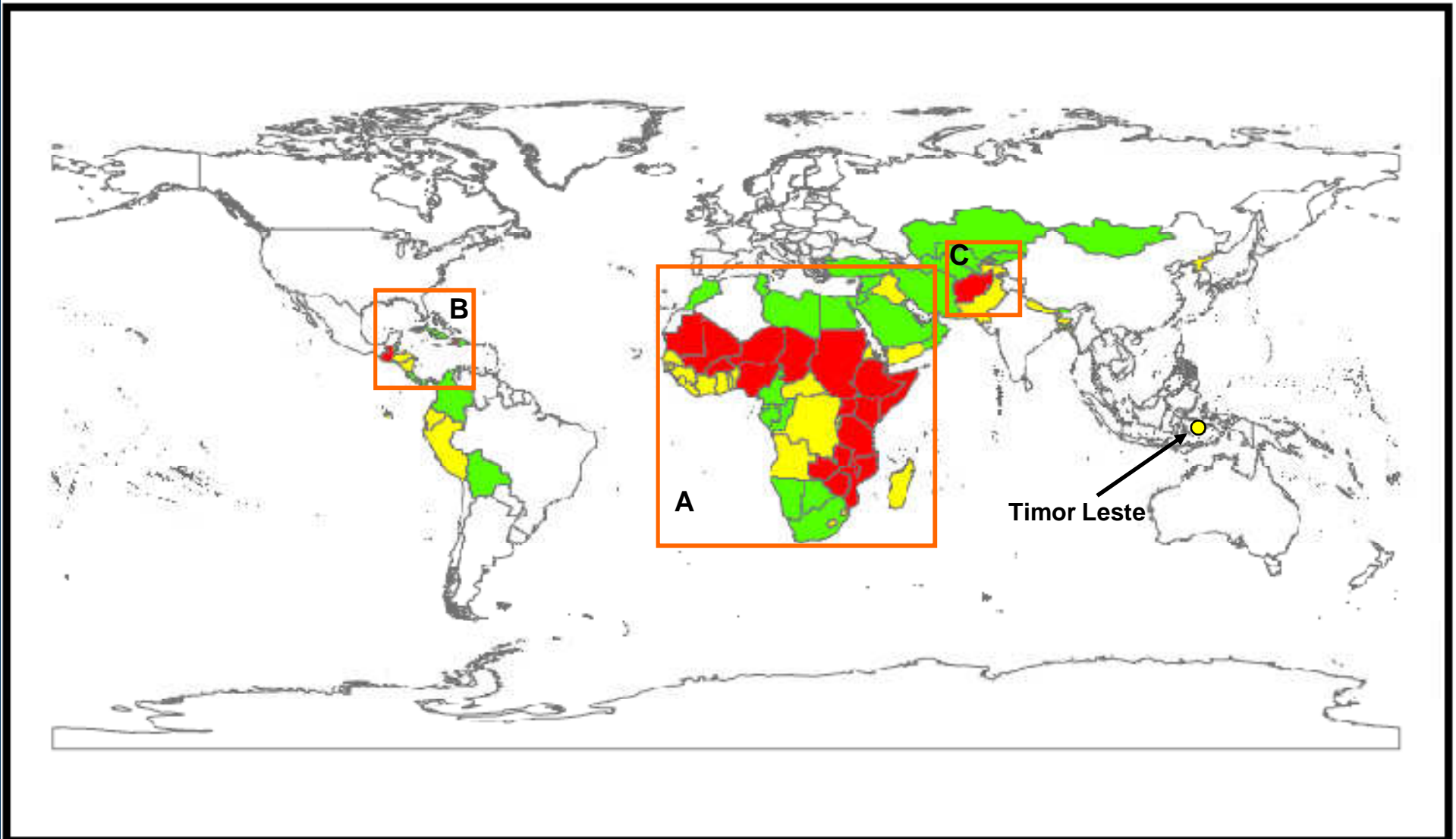
- **Application of Land Surface Modeling**
- **Specifically for EW domains, data streams, and monitoring/forecast needs**
- **Ready integration of satellite EO, atmospheric model forcings (reanalyses, NWP, seasonal forecasts, GCM scenarios)**
- **Multi-model ensembles, est. uncertainty**
- **Take greater advantage of the work of the climate science community**



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Proposed FEWS Operational Priority Countries



Red – Current countries

Yellow – Weather/ag outcomes AND availability/access monitoring

Green – Weather/agricultural outcomes