

Real-time Land Information System over the Continental U.S. for Situational Awareness and Local Numerical Weather Prediction Applications

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Session on Hydrometeorological applications, products and services in service to society

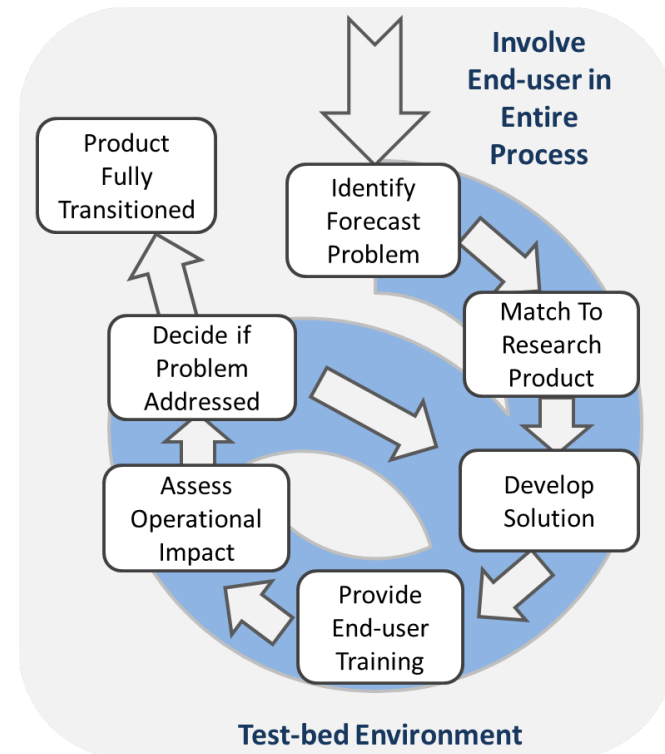
Motivation and Presentation Outline

- **Motivation: high-resolution, real-time soil moisture for**
 - Situational awareness (assessing drought/flood potential)
 - Local modeling applications (to improve sfc-PBL exchanges)
- **Land Information System (LIS)**
 - 30+ year soil moisture climatology & percentile product
 - LIS background and NASA/SPoRT-LIS real-time Noah LSM
 - Evaluation at NOAA/NWS forecast offices
- **Examples from 2015 summer evaluation**
- **Future work:**
 - Real-time soil moisture data assimilation with SMAP / SMOS
 - National Water Center collaborations

NASA/SPoRT Center

Short-term Prediction Research and Transition (SPoRT)

- Transitions unique NASA and NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- ***Proven paradigm for transition of research and experimental data to operations***
- Close collaboration with numerous NWS WFOs across the U.S.
- Began in 2002; co-funded by NOAA since 2009 through “proving ground” activities



Land Information System (LIS)

LIS modes of operation

Uncoupled or Analysis Mode

LIS - OPT/UE

Optimization and Uncertainty Estimation
(LM, GA, RW-MCMC, DEMC)

LIS - DA

Data Assimilation (DI, EnKF)

Coupled or Forecast Mode

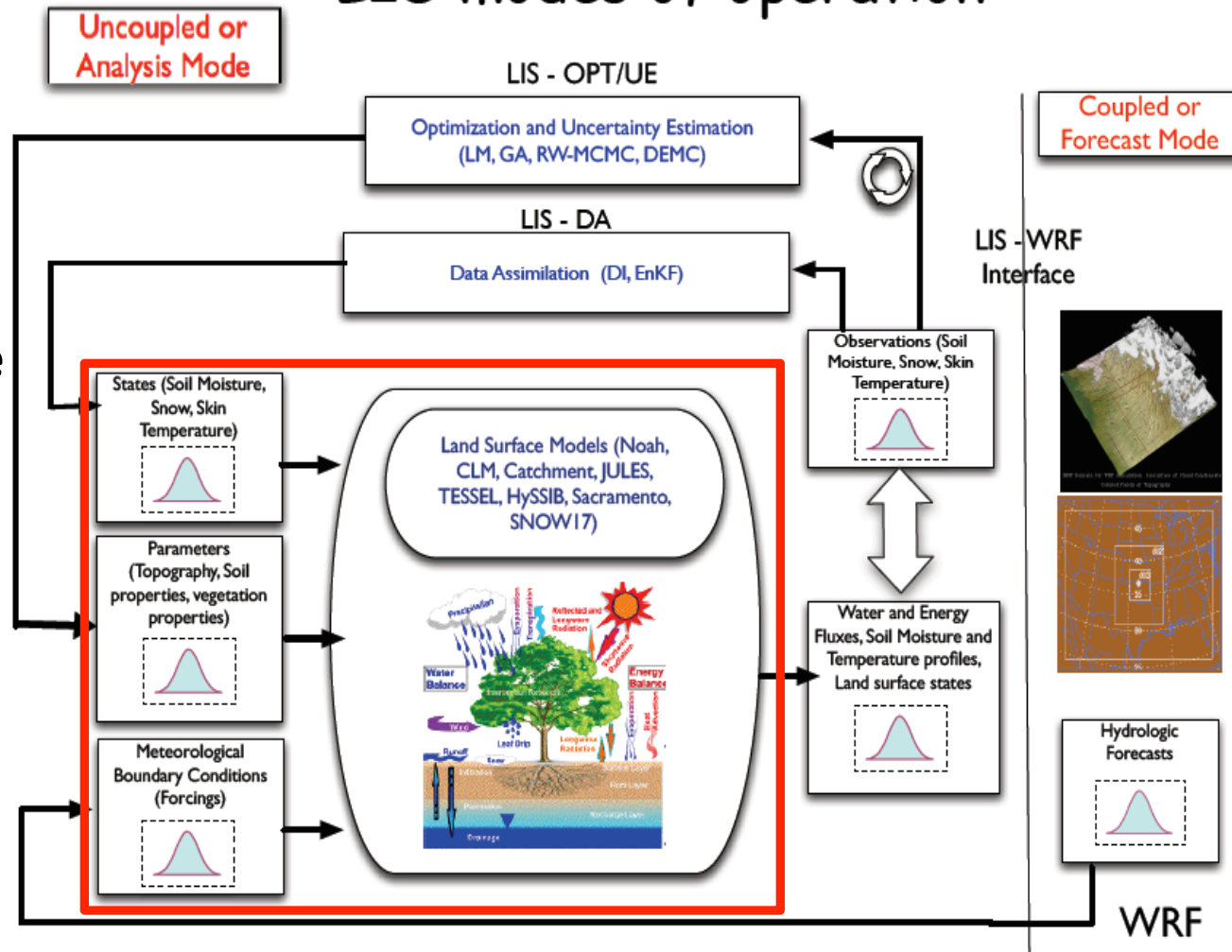
LIS - WRF Interface

Observations (Soil Moisture, Snow, Skin Temperature)

Water and Energy Fluxes, Soil Moisture and Temperature profiles, Land surface states

Hydrologic Forecasts

WRF



High-performance land surface modeling & data assimilation system

Uncoupled/analysis mode

Forecast mode coupled to WRF model

We run Noah LSM v3.3 in uncoupled/analysis mode

LIS-Noah 33-yr Soil Moisture Climatology

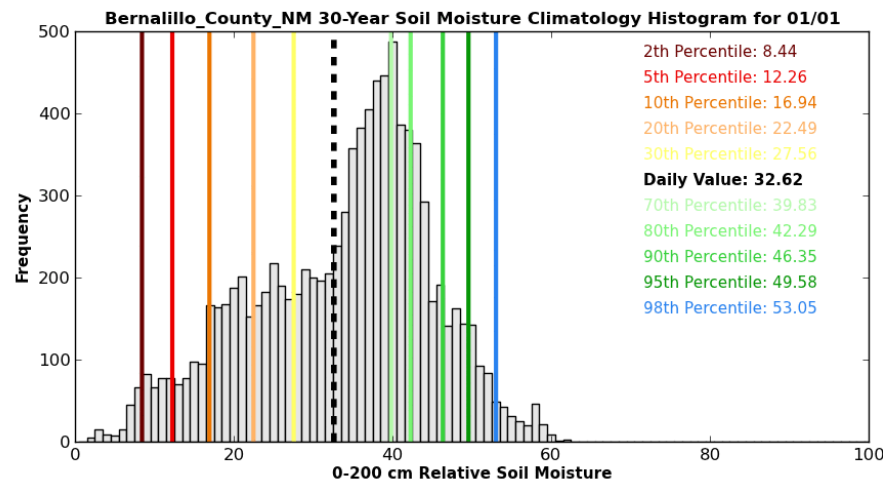
LIS-Noah run from 1981 to 2013

- CONUS+ domain at 0.03-deg resolution (~3 km)
- IGBP/MODIS 20-class land use, STATSGO 16-class soil
- MODIS/FPAR 30-sec resolution monthly GVF climatology (Barlage; from community WRF v3.5.1+)
- Atmos. forcing: NARR-based NLDAS-2 hourly data
- 35-year spin-up (1979-2013, back to 1979-1980)
- Output total column relative soil moisture (RSM) once daily

Daily climatology for every CONUS county

- Basis of RSM percentile product
- Poster 88 in *30th Hydro*; Zavodsky et al.; Mon PM session

(right) Animation of daily total column relative soil moisture distribution for Bernalillo county, NM (Albuquerque), with 2014 values in bold dash line.



SPoRT Real-time LIS Running Noah LSM

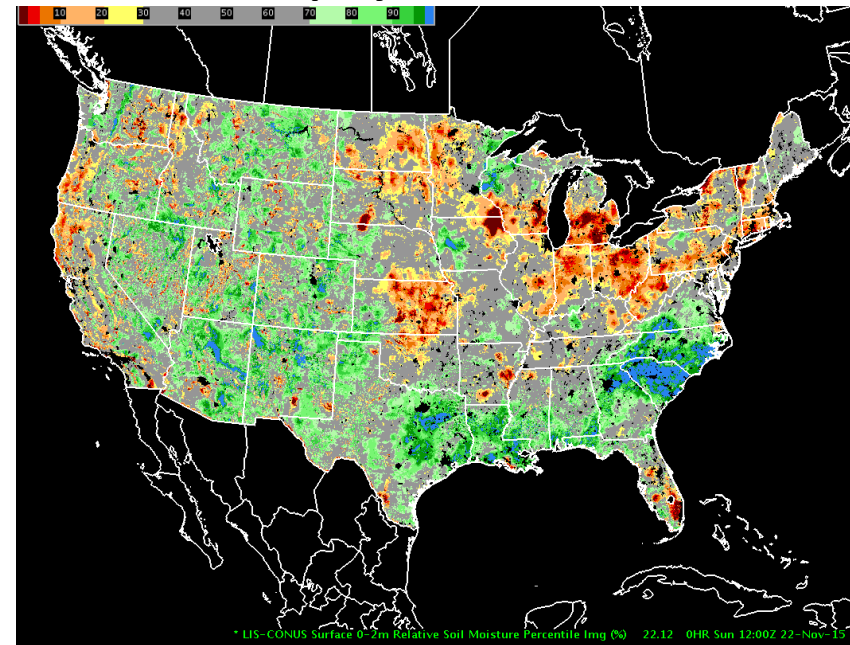
Full Continental U.S. (CONUS) domain with
0.03° (lat/lon) grid resolution

Restarted from soil moisture climatology

Unique characteristics of SPoRT-LIS:

- Real-time S-NPP/VIIRS Green Vegetation Fraction
- Albedo scaled to input vegetation
- Restart simulation strategy to produce real-time output (timeline below)
- SPoRT-LIS ingested and displayed in AWIPS II at select NOAA/NWS weather forecast offices
- Land surface variables available to initialize modeling applications (WRF and STRC/EMS/UEMS)

Current SPoRT-LIS CONUS domain,
as displayed in AWIPS II



transitioning research data to the operational weather community



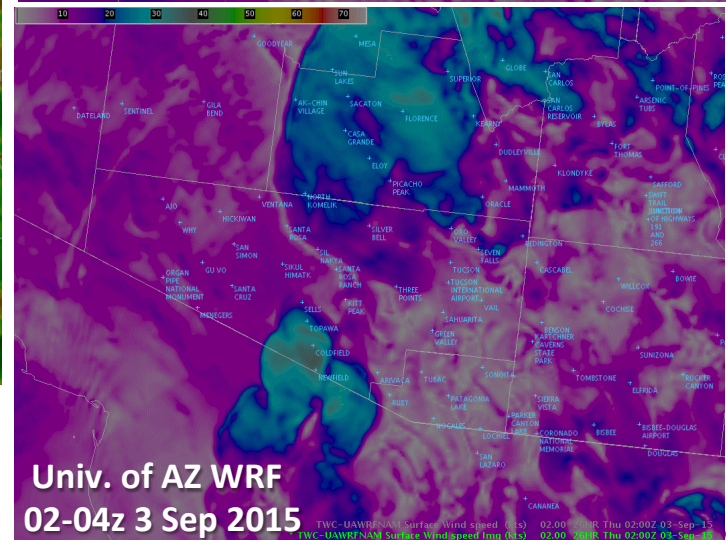
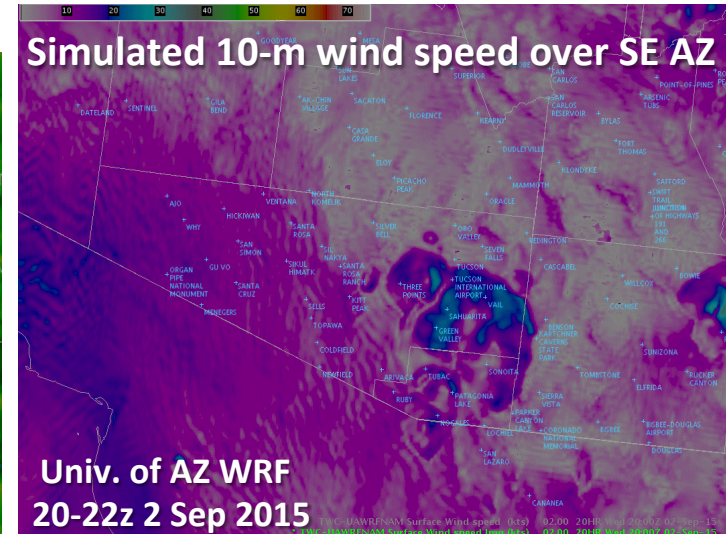
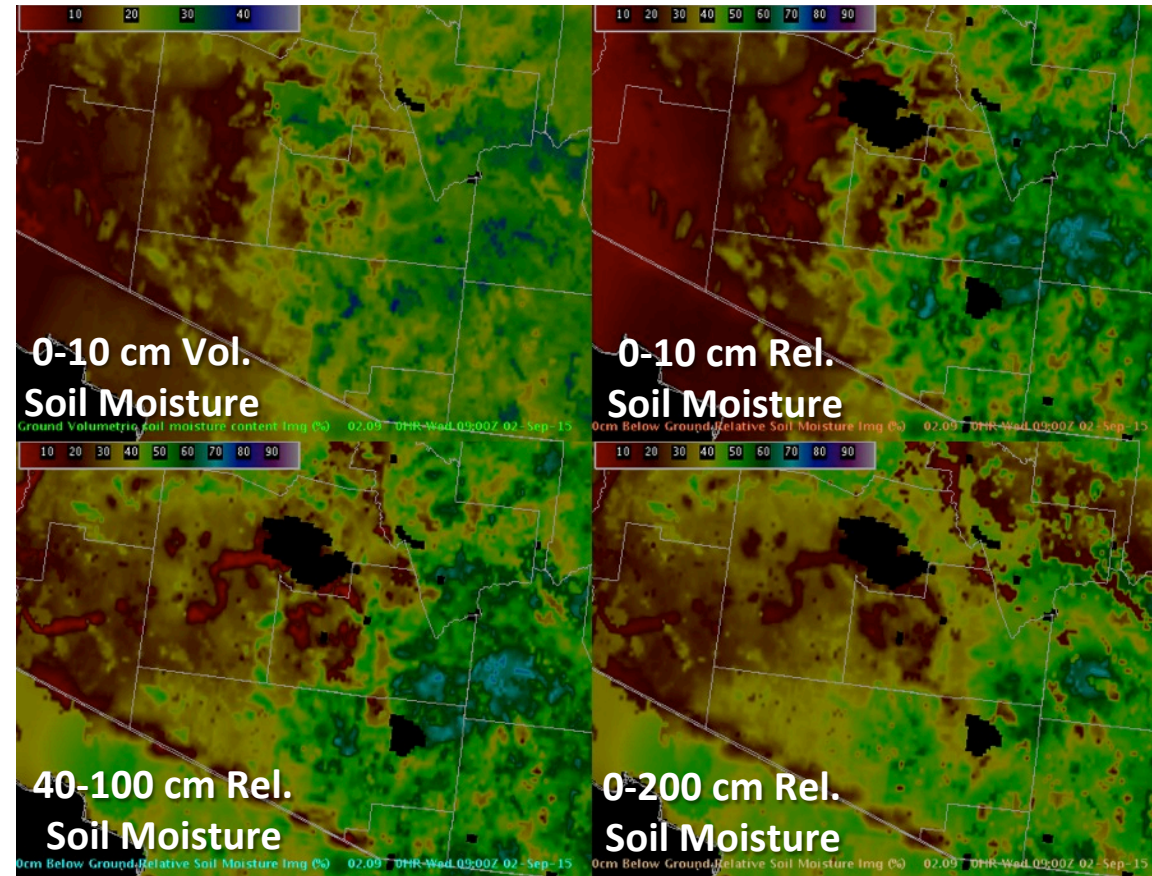
SPoRT-LIS Evaluation: Jun-Aug 2015

SPoRT-LIS for improving situational awareness

- NWS forecast offices at Tucson, Albuquerque, and Huntsville
- Part of Summer 2015 evaluation focused on GPM/IMERG precipitation products (see Smith et al. talk 9.6, *30th Hydro*, Thursday 2:45pm)
- Disseminated select soil moisture grids and change fields
- Forecaster surveys and blog posts to highlight product utility
- Applications included:
 - Assessing drought and USDM drought categories
 - Monitoring soil moisture to help evaluate flooding concerns
 - Examining soil moisture around wildfires
 - Evaluating risk for blowing dust from convective outflows

SPoRT-LIS Evaluation:

Flooding and Blowing Dust Outlooks (NWS TWC)



(above) SPoRT-LIS at 09z 2 Sep 2015, as displayed in NWS Tucson, AZ operational AWIPS II

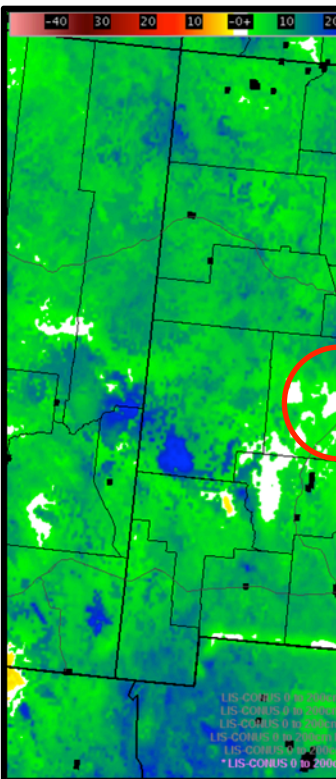


transitioning research data to the operational weather community

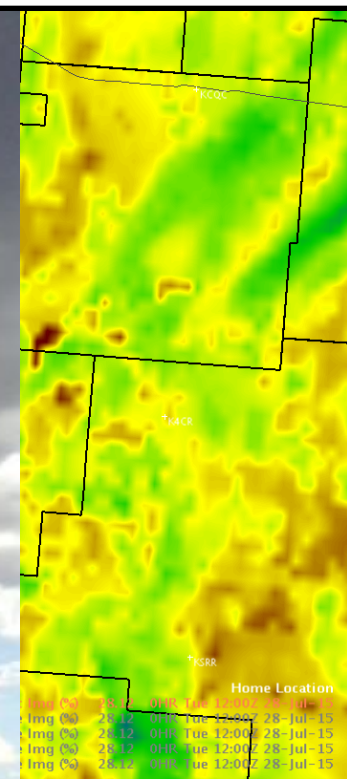


SPoRT-LIS Evaluation:

Soil Moisture Associated with Wildfire (NWS ABQ)



Fort Craig, NM wildfire at 830am 27 July 2015. Wildfire grew to ~700 acres over 2 days.



(left) 1-yr change in soil moisture, valid NWS Albuquerque, NWS operational AvVIPS II.

[Photo credit: Dave DuBois, NM state climatologist]

electric soil moisture



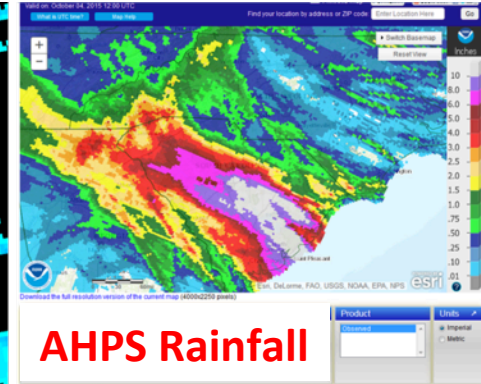
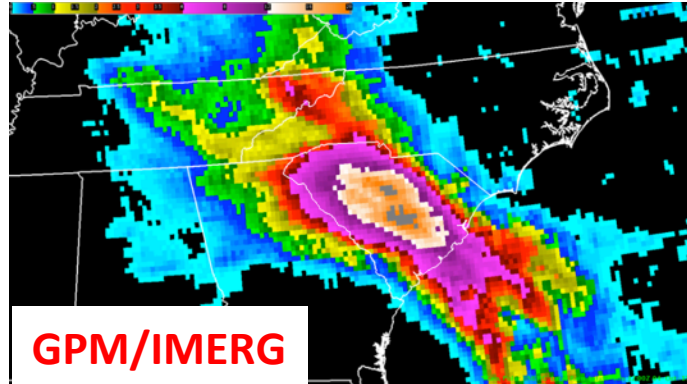
transitioning research data to the operational weather community



SPoRT-LIS Evaluation:

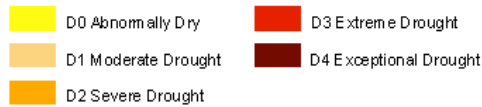
Soil Moisture Change in South Carolina Flooding

NASA's GPM satellite precipitation estimate captured 10-20"+ rainfall with some over-estimation (right)

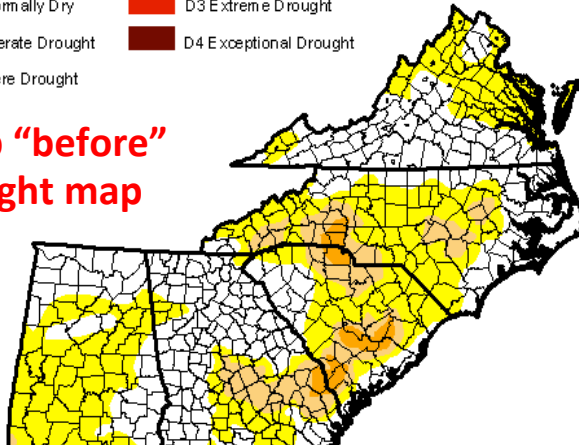


U.S. Drought Monitor Southeast

Intensity:

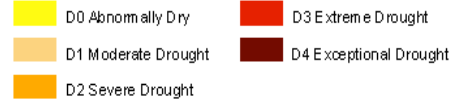


**29 Sep "before"
drought map**

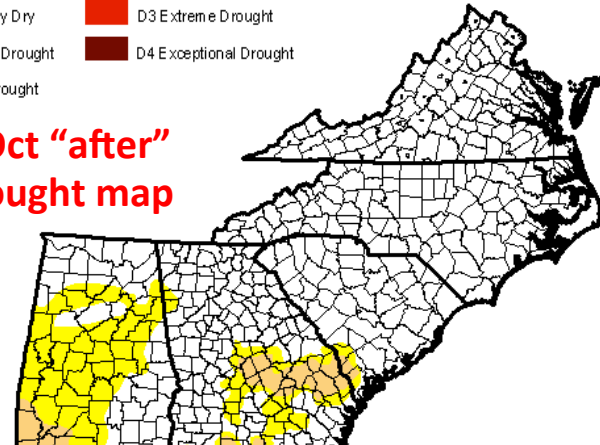


U.S. Drought Monitor Southeast

Intensity:



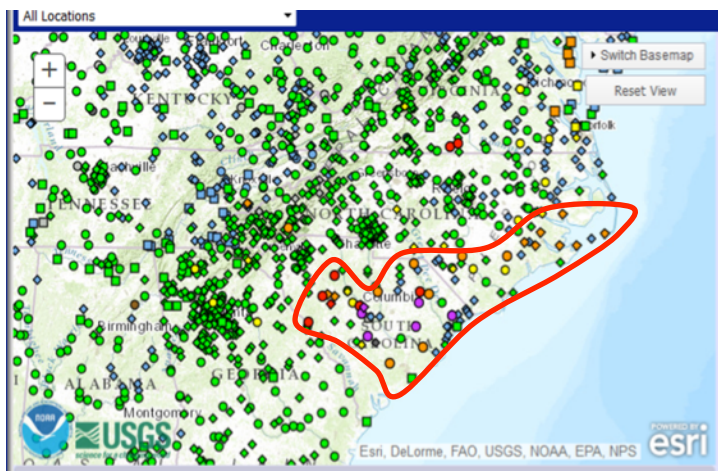
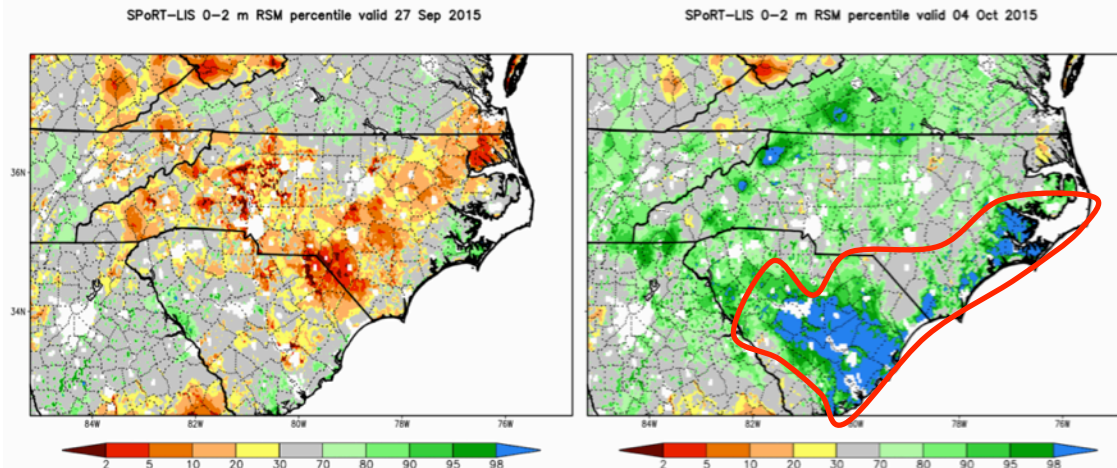
**6 Oct "after"
drought map**



SPoRT-LIS Evaluation:

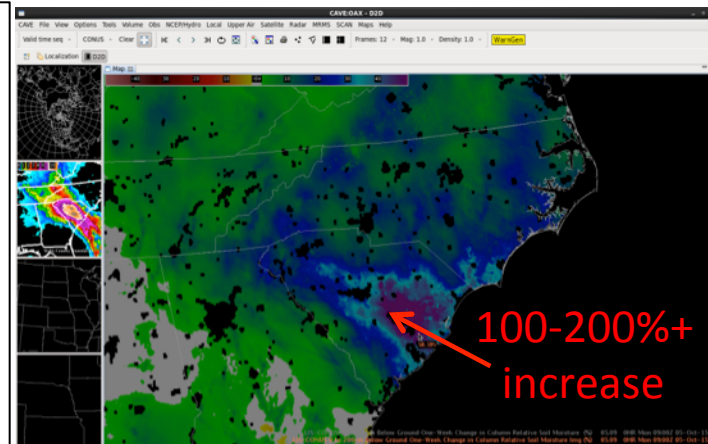
Soil Moisture Change in South Carolina Flooding, cont.

Total column relative soil moisture percentile before and after event (right images)



USGS river gauges indicating minor to major flooding (left);

One-week change in total column relative soil moisture displayed in NWS Huntsville AWIPS II (right)



Future Direction and Ideas

- **Future upgrades of SPoRT-LIS**
 - SMAP data assimilation: (See Blankenship et al. talk J11.2, 30th Hydro, Tue 11:15 am)
 - GRACE terrestrial water storage, SMOPS, others?
- **Collaborate with National Water Center and RFCs**
- **Run SPoRT-LIS coupled to regional NWP (i.e., NASA Unified-WRF) and/or hydrological models (WRF-Hydro)**
- **Verification:**
 - Use Land surface Verification Toolkit with available near-real time soil moisture observations
 - Monitor impacts of data assimilation and regional NWP