Development of a 30-Year Soil Moisture Climatology for Situational Awareness and Public Health Applications

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Session on Computational and Data Advances: Land Data Assimilation Techniques and Systems II

Presentation Outline

- **Motivation: high-resolution, real-time soil moisture for**
  - Situational awareness (drought/flood potential)
  - Public health sector (vector borne illnesses)
- **Land Information System (LIS)**
  - LIS background and NASA/SPoRT-LIS real-time Noah LSM
  - LIS assessment at NOAA/NWS HUN, HGX, and RDU offices
- **30-year LIS-Noah soil moisture climatology**
- **Preliminary results compared to U.S. Drought Monitor**
- **Thinking ahead:**
  - Situational awareness and public health applications
  - Soil moisture data assimilation and verification

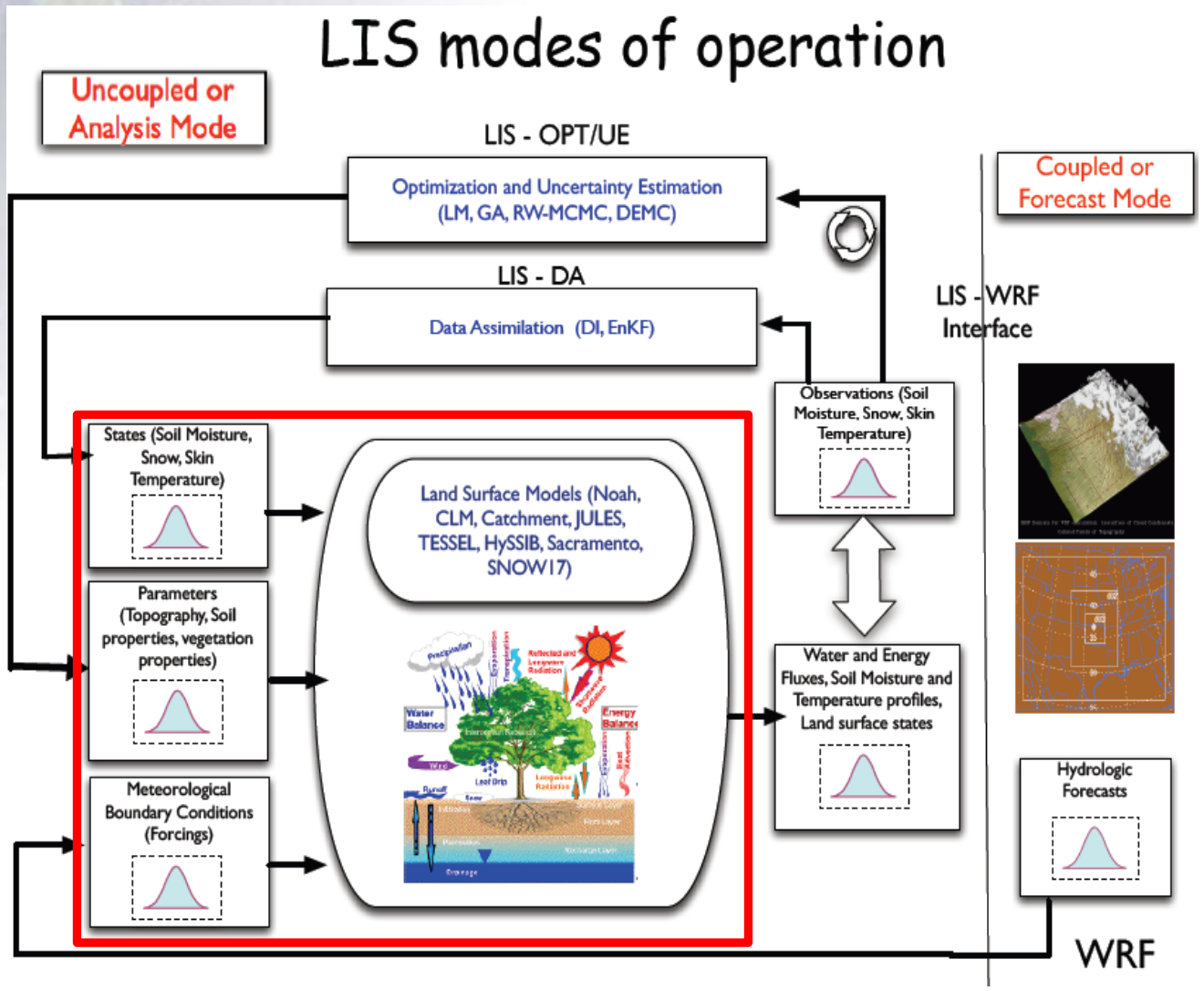
Land Information System (LIS)

High-performance land surface modeling & data assimilation system

Uncoupled/analysis mode

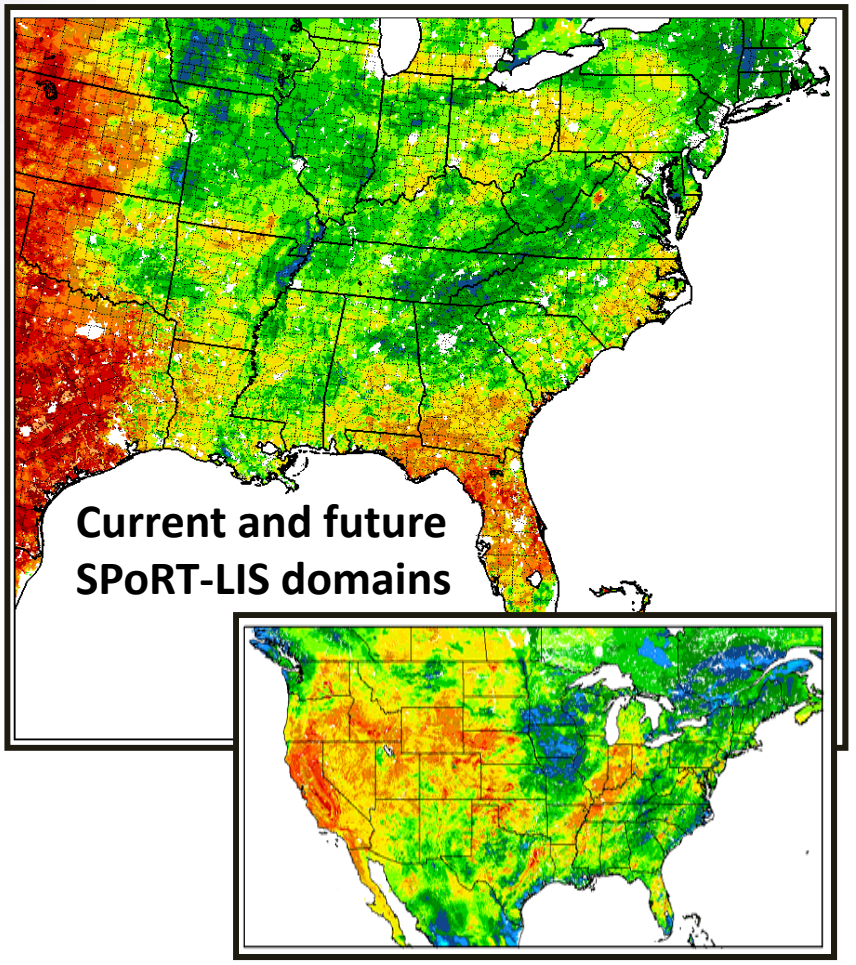
Forecast mode coupled to WRF model

We run Noah LSM in uncoupled/analysis mode



SPoRT Real-time LIS Running Noah LSM

- **Southeastern Continental U.S. (CONUS)**
- **Grid resolution 0.03° (lat/lon)**
- **Expanding to CONUS with climatology**
- **Unique characteristics of SPoRT-LIS:**
  - Real-time MODIS Green Vegetation Fraction
  - Albedo scaled to input MODIS vegetation
  - Simulation strategy to produce real-time output (timeline below)
  - Land surface variables available to initialize modeling applications (WRF and STRC/EMS)
  - SPoRT-LIS ingested and displayed in AWIPS II at select NOAA/NWS weather forecast offices

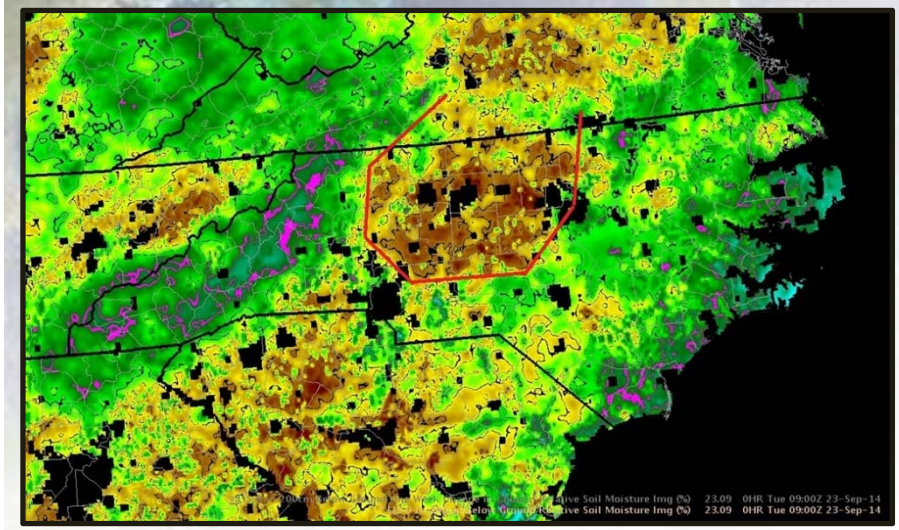


SPORT

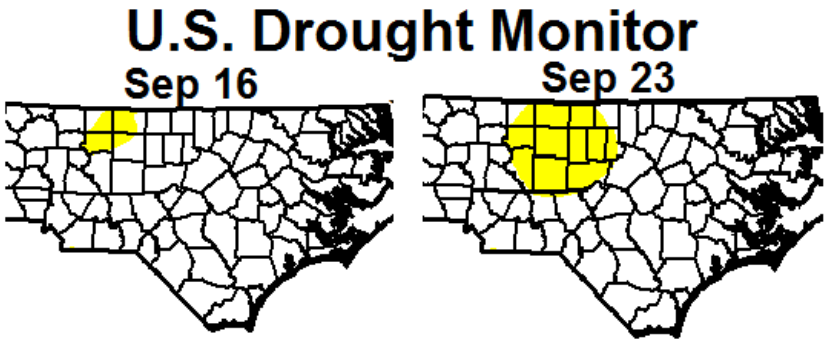
transitioning research data to the operational weather community

NASA

SPoRT-LIS Assessment: Aug-Oct 2014



LIS 0-2 m relative soil moisture in AWIPS II (above) for helping to expand USDM D0 area (below)



Assessing SPoRT-LIS for drought monitoring & area flood potential

- NWS forecast offices in Huntsville, AL; Houston, TX; and Raleigh, NC
- Disseminated select soil moisture grids
- Forecasters completed surveys to define product confidence and utility
  - Overall high confidence/reliability
  - SPoRT-LIS used experimentally to assist in U.S. Drought Monitor weekly classifications (example at left)
- Usage primarily qualitative in nature
- See Poster 520; *29th Hydrology*
- Climatology needed to place real-time soil moisture into historical context

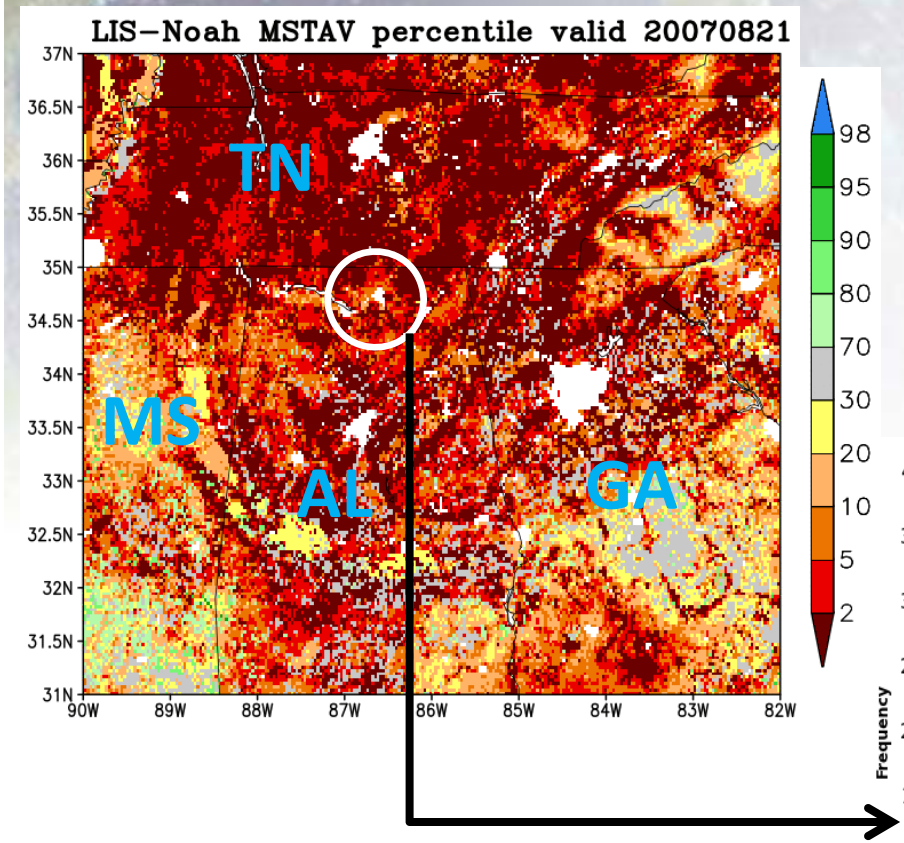
LIS-Noah 30-yr Climatology Development

- LIS-Noah run from Jan 1979 to Dec 2010
  - 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
  - 2-year spin-up (1979-1980)
  - Output once daily at 0000 UTC
  - Climatology spans 1 Jan 1981 to 31 Dec 2010, consistent with current NCDC averages

Daily Soil Moisture Climatology by County

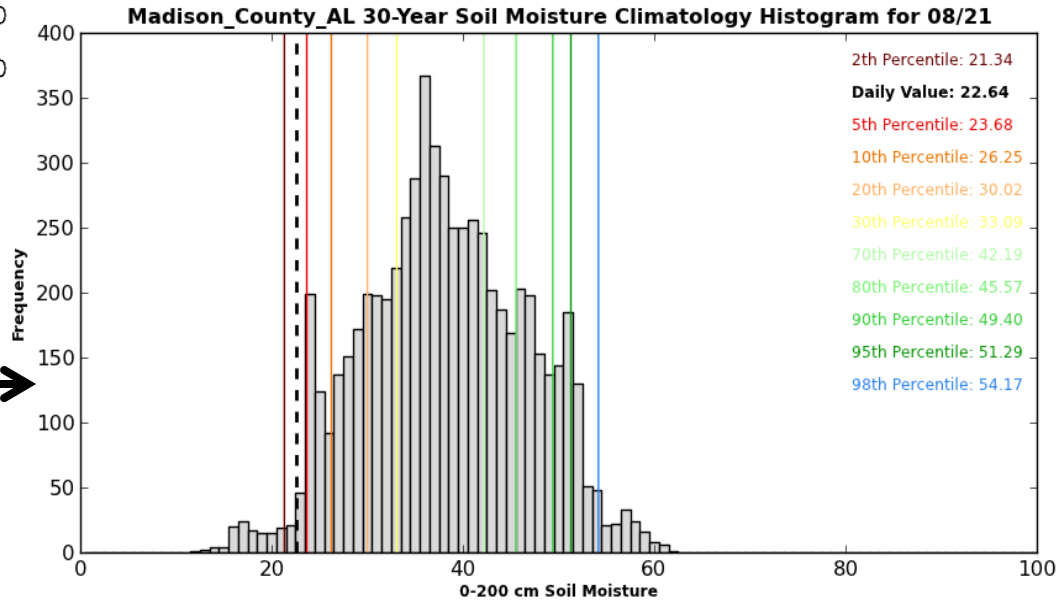
- Total column relative soil moisture (RSM; 0-2 m)
- Generate daily county histograms of 0-2 m RSM
  - U.S. county shapefiles read into Python script
  - Group all LIS-Noah grid points within specific county
  - Generate histogram of 0-2 m RSM from all 30 years
  - Repeat for each day of year and all CONUS counties
- Apply county-scale climatology to compute percentiles at all grid points for any given day

Sample County histogram & Percentile Map: 21 August 2007; SE U.S. Drought



Proxy percentiles of USDM categories

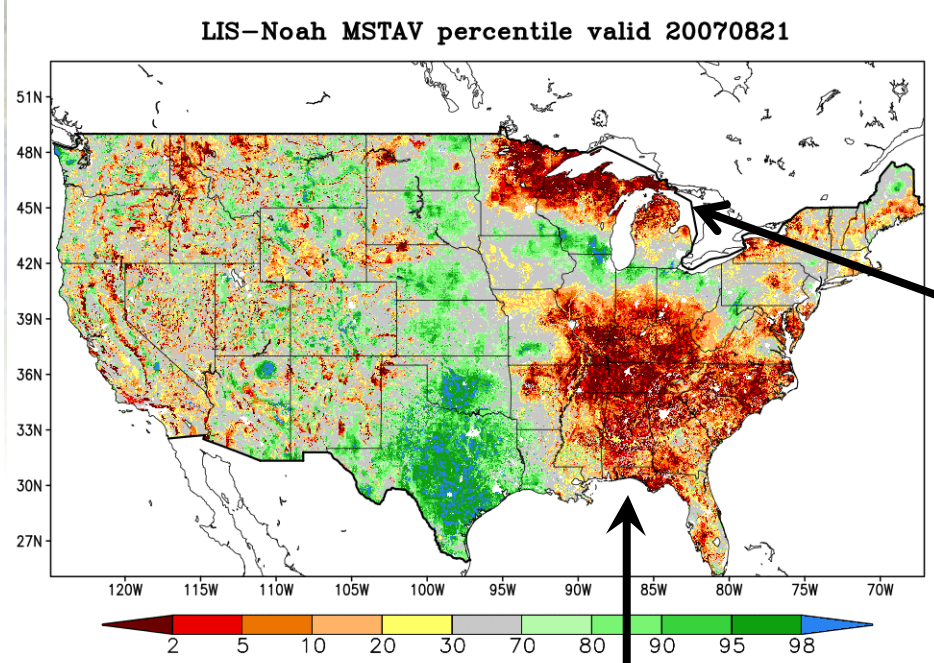
- Similar to NLDAS-2 drought index in Xia et al. (2014; *JHM*)
- Straight-up, uncalibrated 0-2 m relative soil moisture (i.e., available water)
- D4<2%; D3<5%; D2<10%; D1<20%; D0<30%

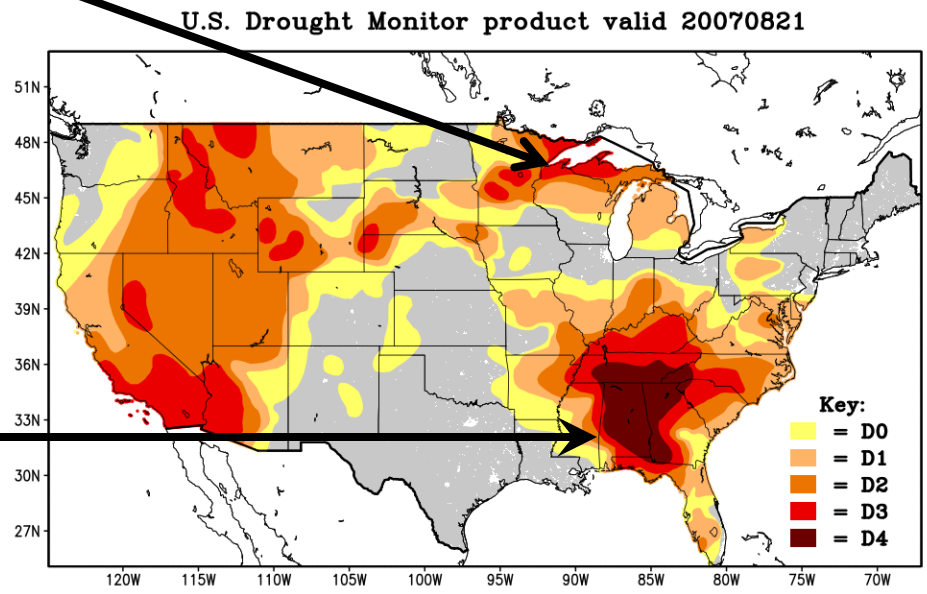


Soil Moisture Percentile vs. USDM

Good correspondence in East on sample day (21 Aug 2007)

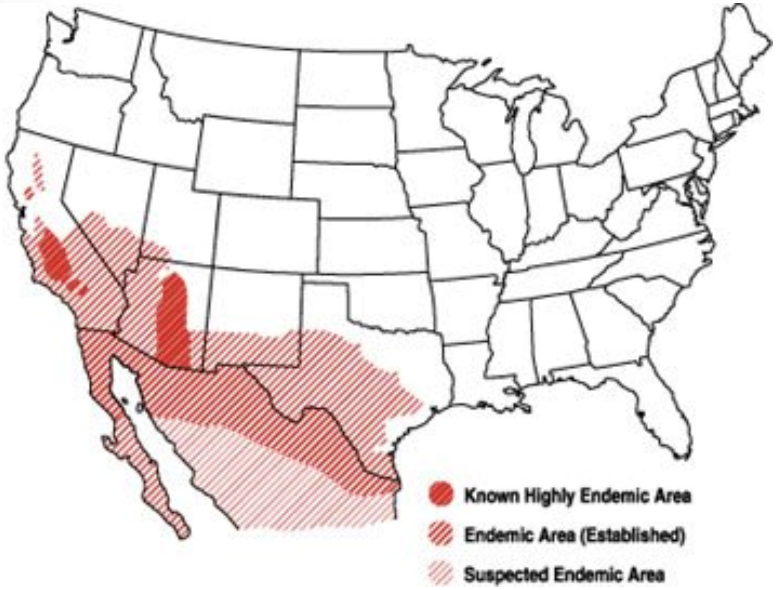
- LIS-Noah percentile suggests worst soil moisture deficits extend NW of USDM D4
- LIS shows D4 proxy percentiles over western Great Lakes as well

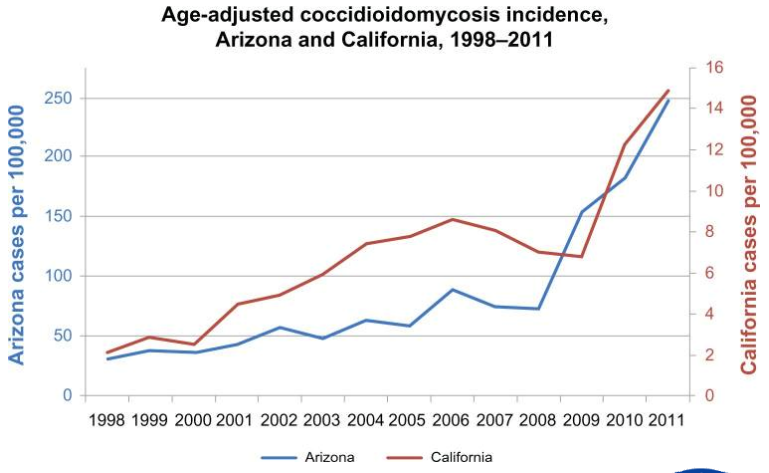




Index for CDC Public Health Tracking Tool

- *Coccidioides immitis* (valley fever) primarily dispersed by wind and dust storms
- *C. immitis* thrives during wet periods following droughts; infections occur during dry season
- Plan to integrate climatology product into CDC's online interface to aid health professionals in early identification of outbreaks





Thinking Ahead

- **Applications with NOAA/NWS and Public Health sector**
  - Drought monitoring/assessing flood potential
  - CDC's National Environmental Public Health Tracking Network
- **Coupling SPoRT-LIS soil moisture to regional NWP (i.e., NASA Unified-WRF) and/or hydrological models**
- **Future upgrade possibilities of SPoRT-LIS**
  - LIS data assimilation: SMOS and SMAP soil moisture, GRACE terrestrial water storage, satellite SWE, others?
  - Real-time NESDIS/VIIRS 4-km green vegetation fraction
- **Verification: Are we improving modeled soil moisture?**

Back-up Slides

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