P162 Expansion of the Real-Time SPoRT-Land Information System for NOAA/National Weather Service Situational Awareness and Local Modeling Applications

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Background

SPoRT runs the NASA Land Information System (LIS) in real-time to support local modeling and diagnostics at NOAA/National Weather Service (NWS) weather forecast offices (WFOs)

- Current domain covers the Southeastern half of the Continental U.S. (CONUS) due to limitations in the Stage IV precipitation grids driving the Noah land surface model (LSM) integration in LIS
- This past year, SPoRT added a new real-time run over a full CONUS domain
  - ✓ Enables expansion of LIS applications to NOAA/NWS partners outside Southern Region
  - ✓ Sets stage for future soil moisture data assimilation activities

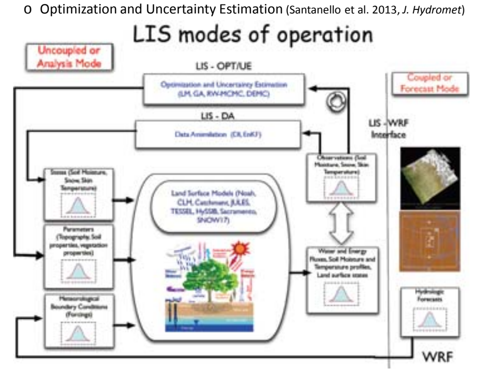
Poster objectives

- Provide summary of real-time LIS activities at SPoRT
- Compare/contrast real-time LIS over SE U.S. with full CONUS-LIS
- Map out future direction of LIS applications

Modeling System and Capabilities

NASA Land Information System (LIS)

- High-performance land surface modeling & data assimilation framework
- Can run a variety of LSMs (Noah, SLM, Catchment, etc.)
- Supports several static databases for land use and soil classification
- Able to run up to global domains at 1-km grid spacing
- Land surface data assimilation
  - ✓ Ensemble Kalman Filter (EnKF) or Direct Insertion (DI)
  - ✓ Soil moisture, skin temperature, snow fraction/depth/SWE
  - ✓ Kumar et al. 2009 (*J. Hydromet*; soil moisture); Liu et al. 2013 (*Adv. Water Res*; snow)
- Optimization and Uncertainty Estimation (Santanello et al. 2013, *J. Hydromet*)



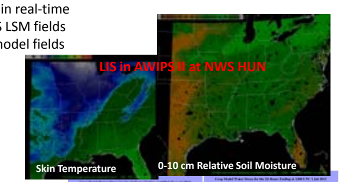
Current Applications of SPoRT-LIS

Initializing LSM fields in local modeling applications (i.e., WRF model)

- Supported option in the NWS SOO Science Training and Resource Center's Environmental Modeling System (EMS; http://strc.comet.ucar.edu/software/newrems)
- LIS GRIB output files uploaded to ftp server in real-time
- EMS users over SE U.S. can initialize with LIS LSM fields in place of coarser-resolution, large-scale model fields

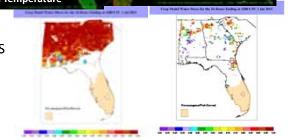
Situational Awareness

- Drought Monitoring
- Assessing flood potential
- LIS data ingested and displayed in AWIPS II at NWS Huntsville, AL
- Refer to training examples below



Vegetation Stress during Growing Season

- University of Alabama – Huntsville acquires SPoRT-LIS and MODIS vegetation products
- Manages in-house crop-stress model over SE U.S.
- Distributes reports to end-users



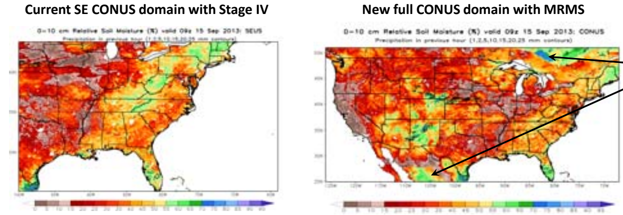
Comparison Between SE U.S. and CONUS SPoRT-LIS Configurations

Table 1. Summary of configuration details for the real-time SPoRT-LIS runs over the Southeastern U.S. domain and new CONUS domain.

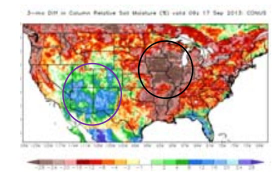
Configuration detail	Common to both domains	Southeastern U.S. domain	CONUS domain
Land surface model	Noah version 3.2		
Horizontal grid spacing	0.03 degrees		
Grid dimensions		1064 x 672	2200 x 934
Atmospheric Forcing	NLDAS-2, GDAS, GFS SW/LW Rad, sfc P, 2-m T, 2-m q, 10-m wind	Stage IV hourly Precipitation[1]	NSSL's Multi-Radar Multi-Sensor (MRMS) hourly gauge-adjusted radar QPE[2]
Static soil database	STATSGO		
Static land use database	MODIS/IGBP		
Green Vegetation Fraction	Daily SPoRT-MODIS[3]		
Cold start initialization	1 June 2010		
History restart interval	6 hours		

[1]Lin and Mitchell (2005), Lin et al. (2005); [2]Zhang et al. (2011); Zhang et al. (2014, this meeting, *28th Conf. Hydrology*), [3]Case et al. (2014)

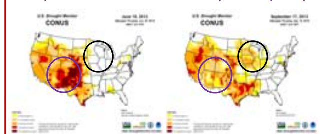
Current SE CONUS domain with Stage IV | **New full CONUS domain with MRMS**

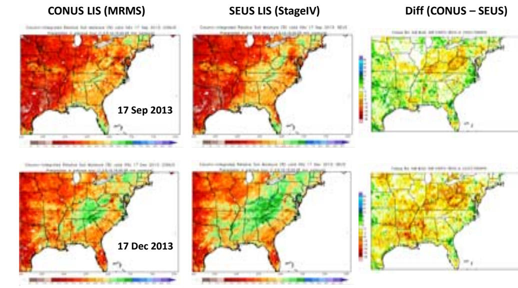


Sample Results / Comparison between SE U.S. LIS and CONUS LIS



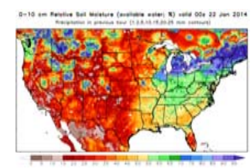
Summer 2013 had distinct dipole pattern in total column soil moisture change: SW U.S. moistening; Midwest drying (above)
Better/worse USDM classification over SW/Midwest (below)

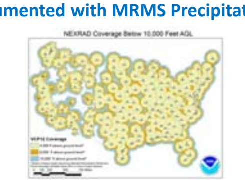




- MRMS-driven LIS soil moisture tends to be drier, esp. in Ohio Valley / Appalachians
- Drier tendency accentuated by late Autumn as precipitation increases across this region

Issues Documented with MRMS Precipitation Dataset





Comparison between sample soil moisture and WSR-88D radar coverage (left)

- Note similar patterns in soil moisture to radar coverage patterns in Western U.S.
- Moist soils within radar coverage; dry soils in radar coverage gaps
- MRMS product very dependent on available input radar data

Beam blockage due to terrain / physical impediments

- Not just a concern in Rocky Mountains
- Columbus, MS radar: Rapidly-growing trees have blocked beam over time at certain azimuths
  - Pattern particularly discernable in integrated soil moisture fields
  - LIS is a good tool to identify problems in QPE datasets through long-term integrations

Edge of radar networks and non-overlapping radars

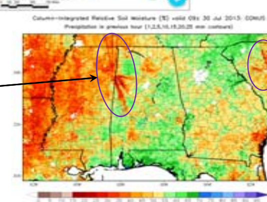
- Especially a problem in S. Canada / N. Mexico
- Recommend that end-users do not utilize CONUS-LIS output in these problem regions
- Better blending of precipitation forcing and/or soil data assimilation needed to improve spatial continuity

Periodic drop-outs of regional tiles (fixed Oct 2013)

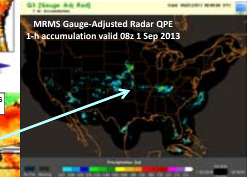
- Numerous days in late Summer / Autumn 2013
- Instead of precip assigned as missing, entire regional tile was filled with "0" values
- Led to artificial gradients in soil moisture in portions of domain when active precipitation occurs at tile boundary

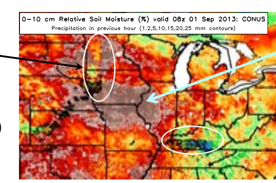
Points with no input data assigned "0" (fixed Feb 2013)

- Instead of a missing data flag, grid points with no input radar or gauge data were set to "0" (a legitimate value)
- Led to artificially dry soil, esp. in Canada and Mexico



(top-left) Examples of Beam Blockage problems in MRMS at Columbus, MS and Columbia, SC radars, manifested in locally drier soil moisture in distinct radial patterns

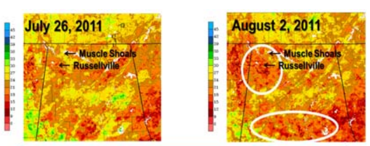




(bottom-left & above) Example of regional tile "drop-out" causing artificial soil moisture gradient at edge of missing MRMS tile

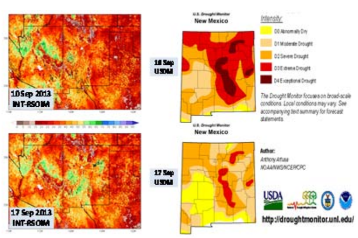
Development of LIS Training Module for Situational Awareness Applications

SPoRT-LIS for Drought Monitoring



Examining LIS volumetric soil moisture during a dry-down period can help quantify the amount of soil-moisture degradation on sub-county scales

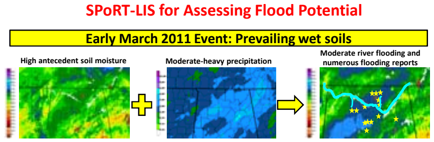
- Daily temperatures reached 95-100 F in Muscle Shoals and Russellville during this period with very little rainfall
- Highlighted regions had varying degrees of drying on local scales, which can help refine decisions about drought classification

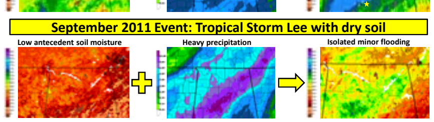


Example from 17 September 2013 over southwestern U.S.

- Heavy rainfall and flooding occurred in New Mexico during mid-September
- Dramatic moistening of Integrated Soil Moisture; state-wide relaxation in drought classification

SPoRT-LIS for Assessing Flood Potential





- Contrasting antecedent soil moisture conditions likely played a strong role in the different outcomes
- Local, subjective analysis of several events suggests typical moderate-heavy synoptic rainfall events over deep-layer relative soil moisture values exceeding 60% will lead to more substantial moderate or heavier flooding events

Poster References

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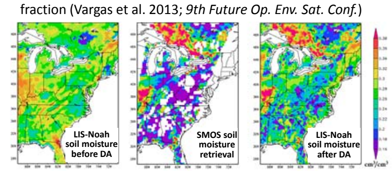
Future Direction

- Upgrade to LISv7 and utilize LIS Validation Toolkit
  - Validate LIS against soil moisture observations and field campaign data
  - Identify regional errors/biases, and causes of those errors
- Assimilate satellite-based soil moisture from SMOS and SMAP
- Incorporate NESDIS global real-time VIIRS green vegetation fraction (Vargas et al. 2013; *9th Future Op. Env. Sat. Conf.*)



SMOS DA in LIS: P53 (Blankenship et al.), *28th Hydro.*, 4 Feb 2014, this meeting