The Utility of the Real-Time NASA Land Information System for Drought Monitoring Applications

Kristopher D. White¹, Jonathan Case²
¹National Weather Service Huntsville and NASA Short-term Prediction Research and Transition (SPoRT) Center, Huntsville, AL
²NASA SPoRT/ENSCO Inc., Huntsville, AL

I. Background

The NASA Land Information System (LIS) is a global land surface modeling system that provides real-time information on land surface conditions, such as soil moisture, vegetation, and snow cover. The LIS is used to support drought monitoring, disaster response, and climate research.

II. Data/Imagery Output and Advantages

The Alabama 3-km Domain and associated soil moisture and GVF products

- **Inputs**
  - Topography, Soils
  - Land Cover, Vegetation Properties
  - Meteorology (Atmospheric Forcing)
  - Snow, Soil Moisture, Temperature

- **Outputs**
  - Soil Moisture & Temperature
  - Evaporation
  - Runoff
  - Snowpack Properties

- **LIS running Noah version 3.3 on SPoRT’s “weather-in-a-box” cluster:**
  - 910 x 800 dimensions with 3 km grid spacing (see figures below)
  - Restarted every 6 hours; originally initialized at 0000 UTC 1 June 2010

- **Static parameters:**
  - MOIS/ESMF 20-class land use; SRTM 18-class soil type
  - MOIS 5-km maximum snow albedo

- **Atmospheric forcing:**
  - Hourly NCEP-DA-2 and 4.8 km NCEP Stage IV precipitation from initialization to 1-4 days, based on 4 day latency of MODIS-L2 analyses in real-time
  - Global Data Assimilation System (GDAS) 0.205° analyses / short-term forecasts and NCEP Stage IV precipitation from 1-4 days to 12h, based on 6-9 hour latency of GDAS in real-time

- **LIS end-user applications**
  - Initialize LSM variables at resolution consistent with local models (typically ~3 km grid spacing)
  - Use hourly LIS output for diagnostic purposes:
    - Assessing drought/flood risk based on antecedent soil moisture,
    - Identifying differential heating zones that could contribute to warm-season convection initiation

- **SPoRT end-user applications**
  - Use LIS Noah output for diagnostic purposes:
    - Assessing drought/flood risk based on antecedent soil moisture,
    - Identifying differential heating zones that could contribute to warm-season convection initiation

III. Drought Monitoring Examples

**Mid Summer 2011**

- July 26, 2011
  - Hot and relatively dry weather (chart below) in mid summer 2011 lead to the rapid degradation of soil moisture conditions, as indicated by LIS 1 km 0-10 cm soil moisture analyses (above)

- August 2, 2011
  - Soil moisture (% in the 0-10 cm layer decreased about 10% from July 26 to August 2, 2011 in portions of northwest Alabama and central Alabama (above). Corresponding stress to agriculture was noted in the weekly USDA Crop Progress and Conditions report for the state of Alabama. As a result of these impacts, intervention was made to introduce D0 conditions in northwest Alabama.

- August 27, 2011
  - LIS data showed low relative soil moisture values in souther Dade County, AL by May 8th. Stage IV precipitation showed a similar result of rainfall during the previous week, but the main question is how does the lack of rainfall impact soil moisture and potential impacts to agriculture. The LIS allows for focus to drought analyses. Communications with USDA agricultural extension agents verified dry soils and impacts to corn crops, resulting in changes to the May 8th USDMD.

- August 11, 2011
  - U.S. Drought Monitor valid at 9 am EDT on the dates indicated.

**Early May 2012**

- May 8th, 2012
  - USDM valid May 8, 2012

- May 2012
  - USDM valid May 8, 2012

**November 2012**

- November 13, 2012
  - USDM valid May 8, 2012
  - USDM valid May 8, 2012

**Stage II precipitation totals for the 24 hours ending 1200Z November 8, 2012**

- Despite rainfall amounts around one to two inches in portions of southeastern Kentucky (above), deep layer relative soil moisture (0-200 cm) was still low, with values generally below 30%. The Kentucky Division of Water recommended keeping the existing severe (D2) drought designation based partly on LIS soil moisture evidence.

IV. Future Work

Work is ongoing to expand the LIS from its current SE CONUS domain (Section I) to a full CONUS domain. This presents some challenges, both with respect to quality of precipitation forcing data sets in the Intermountain West and adjacent portions of Canada and Mexico. The NASA SPoRT modeling team is working to incorporate other CONUS-scale precipitation data sets, which can be seen in poster 69 in the Tuesday morning Hydrology session. Additional work is ongoing to assimilate L-band soil moisture data from the European Soil Moisture Ocean Salinity mission. The upcoming NASA Soil Moisture Active-Passive mission will offer superior soil moisture retrievals as compared to the legacy AMSR-E mission. The SPoRT modeling team also plans to develop soil moisture climatology products with the standard LIS 3 km spatial resolution, which will better enable sub-county scale monitoring of drought conditions over the Southeast CONUS.