New Operational Applications for the NASA Land Information System

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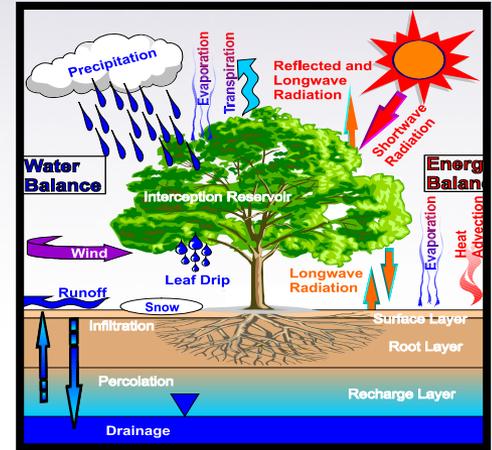
2011 SPoRT Partners Virtual Workshop

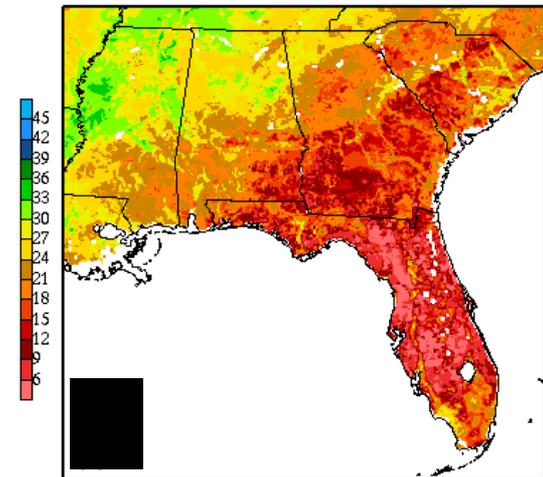August 31, 2011

Introduction to LIS

➢ High-performance land surface modeling and data assimilation system

- Runs a variety of Land Surface Models (LSMs)

- Integrates satellite, ground, and reanalysis data to integrate LSMs in offline mode

- Can run coupled to Advanced Research WRF

- Data assimilation capability (EnKF) built-in

- Modular framework enables easy substitution of datasets, LSMs, forcings, etc.

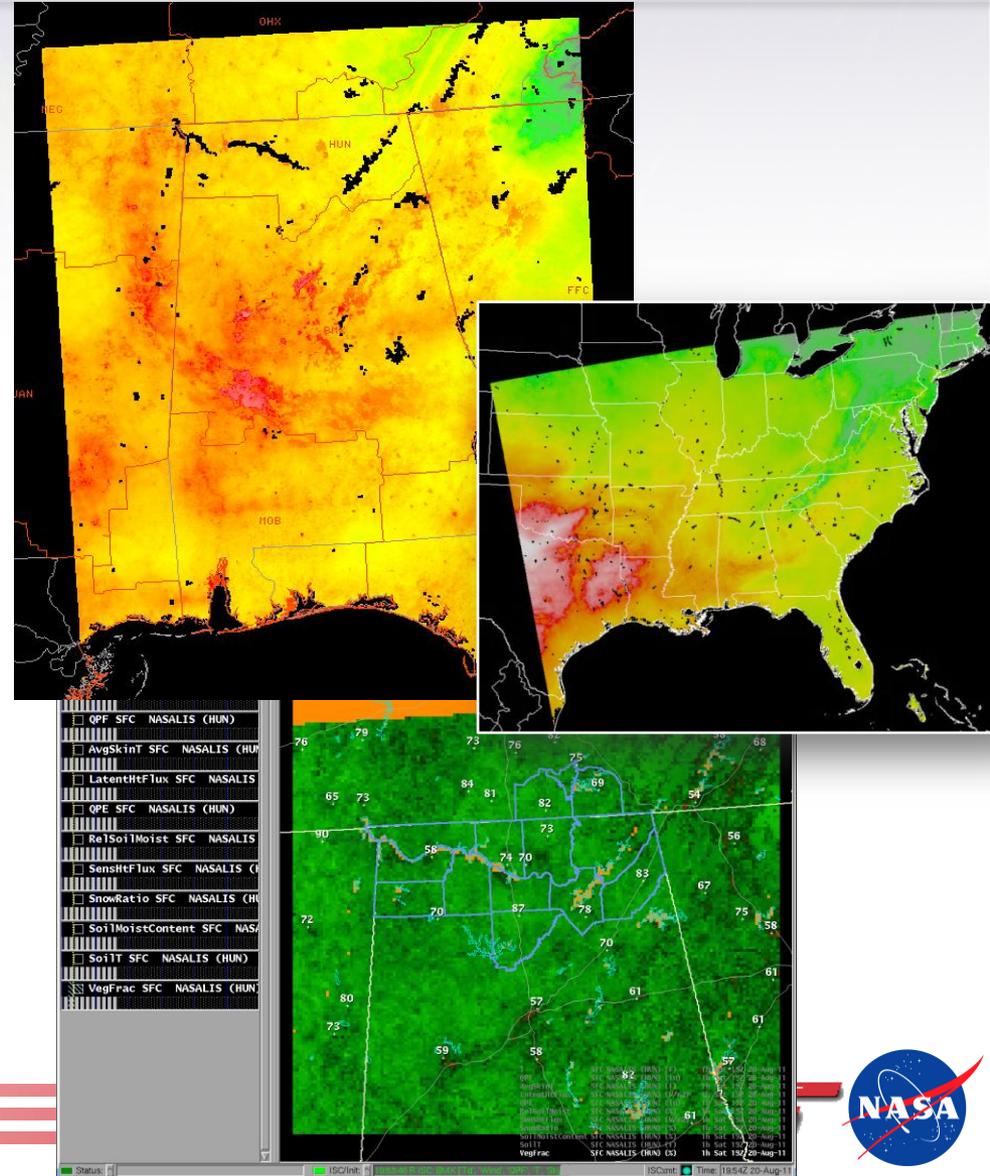- Adopted by AFWA for operational use in WRF

LISMOD 0-10 cm Soil Moist valid 080601/0300V000

Introducing LIS into WFO Operations

- SPoRT runs 1-kilometer LIS over Alabama, and 3 km LIS over the eastern United States
  - 3 km run can be easily incorporated within WRF-EMS
- AL domain recently ingested into D2D & GFE, and flowing through LDM, to support BMX summer convective initiation forecasting efforts
  - Some "subsurface" (below 10cm) soil data still not ingesting
  - Eastern CONUS domain to follow

Motivation

- It has traditionally been difficult for WFOs to integrate soil information into forecasting
  - Observations can be sparse, difficult to acquire, or unreliable
  - Analyses can be coarse or difficult to interpret
- Incorporating the LIS into AWIPS potentially marks a significant change to this paradigm
- In addition to the WFO BMX CI research, what other ways can soil information be useful to operations?
- Initial answer: drought monitoring, hydrology, snowfall forecasting
  - LIS has already been used for some drought monitoring in Alabama, but its utility is limited by lack of a climatology

Methodology

- Resources are currently too limited to perform a full climatology for the three focus areas
- Instead, run and examine the LIS over the HUN CWA for selected recent case studies where soil information is likely to have had a large impact
- Events selected to show variety
- **<u>Snowfall</u>**
  - Early January 2010 *(cold antecedent conditions)*
  - **White Christmas 2010** *(burst of heavy snow that partly melted later)*
  - 9 January 2011 *(3rd largest snowfall event on record)*
- **<u>Flooding</u>**
  - September 2009 *(Southeast flash flood)*
  - December 2009 *(widespread river flooding)*
  - **Late April 2011** *(significant flash/river flooding following tornado outbreak)*
- **<u>Drought</u>**
  - 2007-2008 *(worst drought on record)*
  - **Summer-Fall 2010** *(moderate-severe drought)*
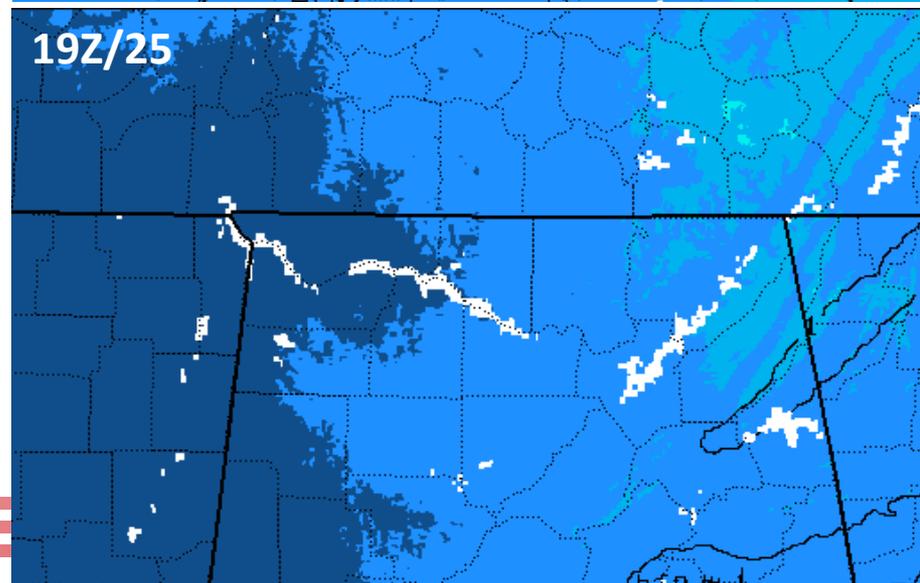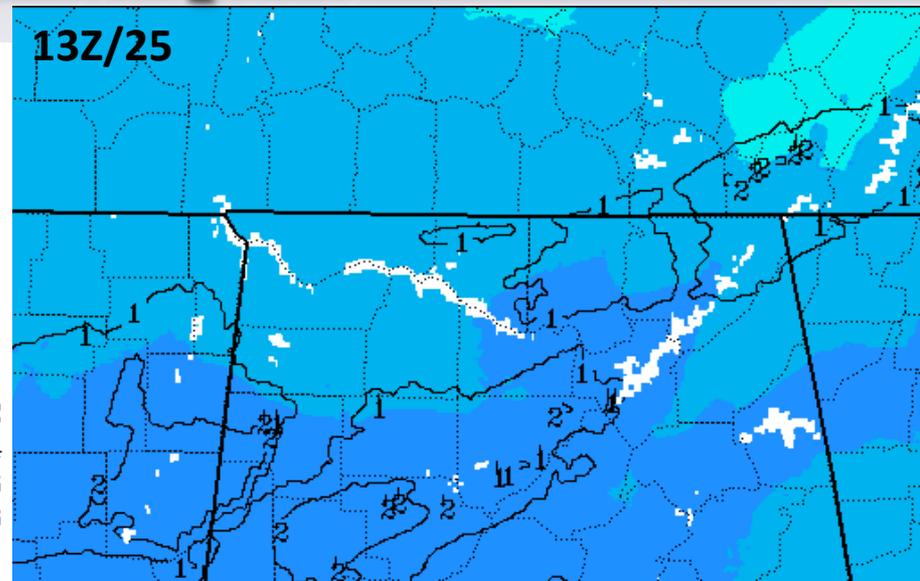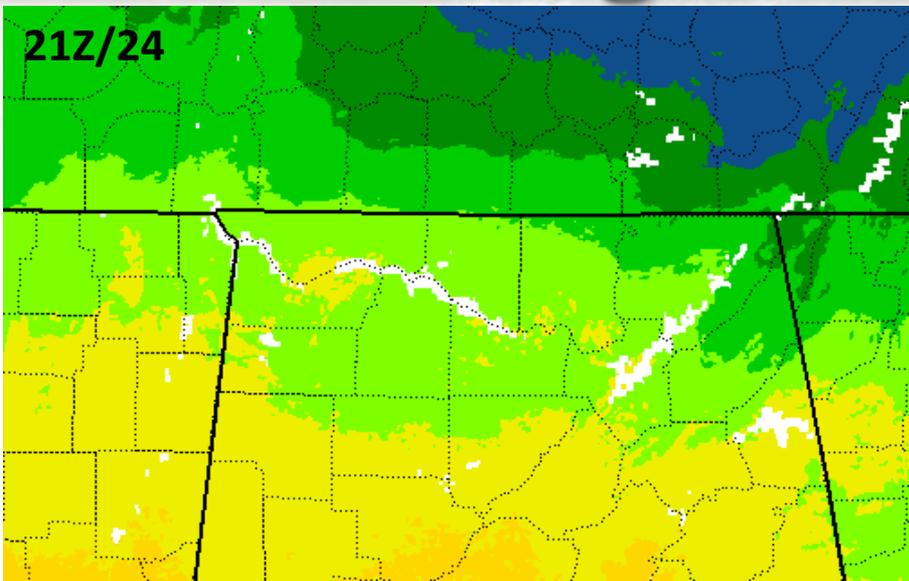
"White Christmas" 2010

7:45 AM

4:45 PM

"White Christmas" 2010:
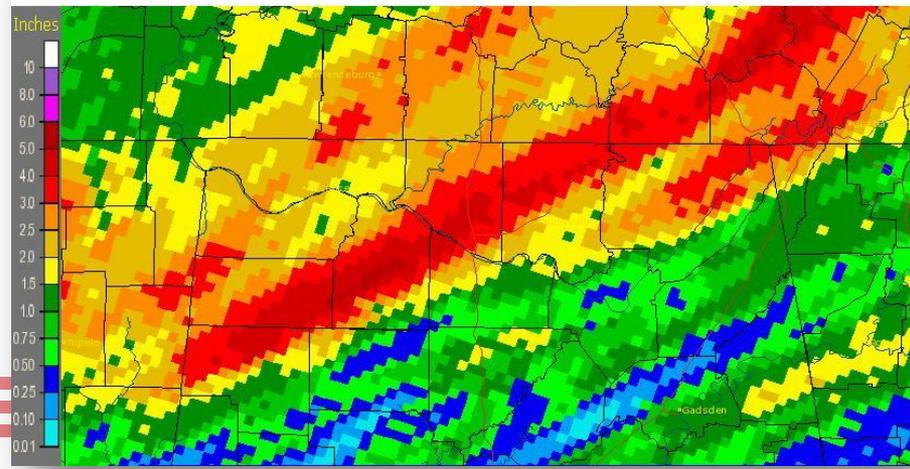# Average Skin Temperature

- Skin temperatures remained just above freezing through the event
- 1"/hour snowfall rates "overwhelmed" warm ground conditions
- Skin temperature data from 9-10 January 2011 are similar, but snowfall rates were higher for much longer
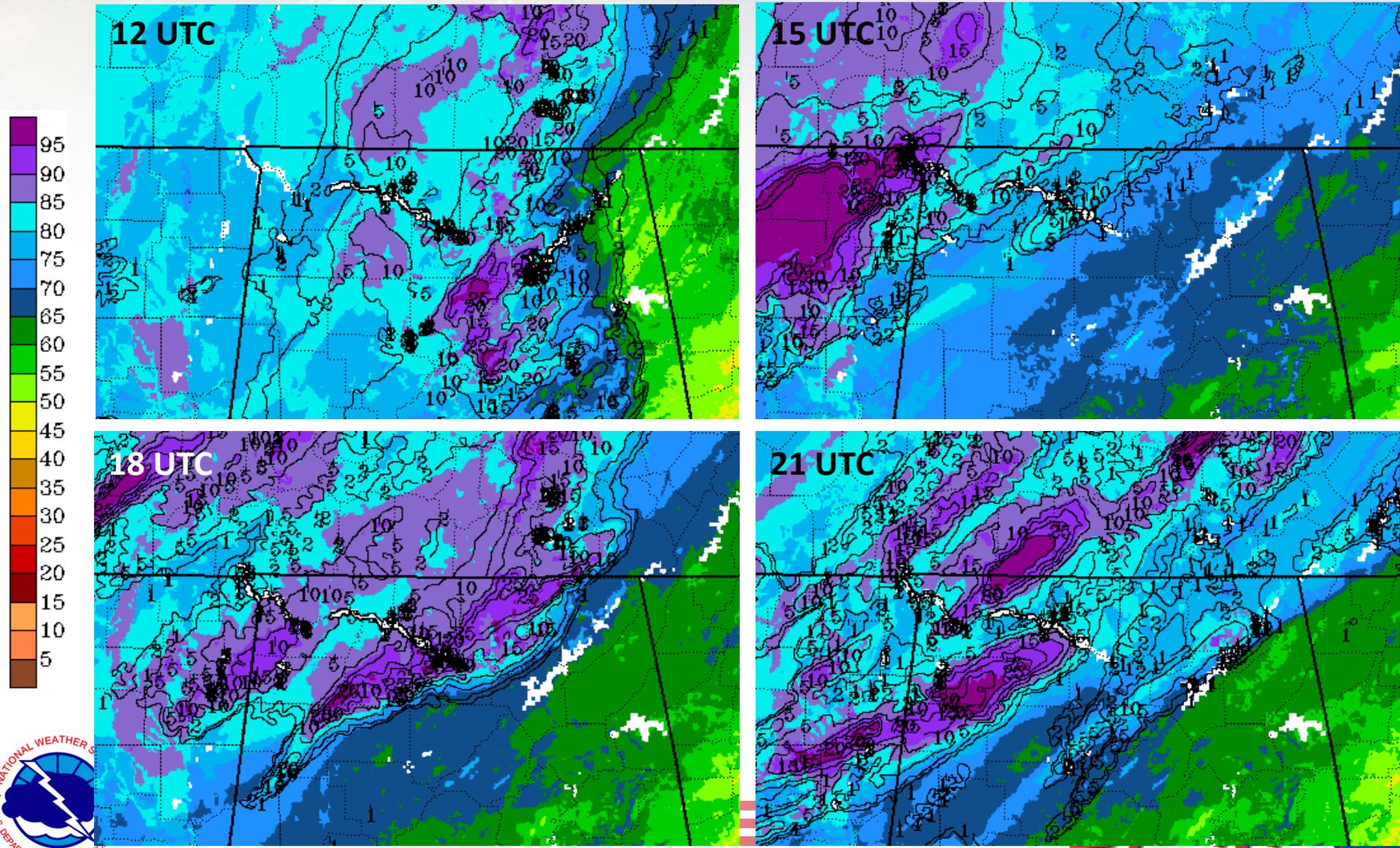
Late April 2011 Flooding

- 3 waves of storms (2 morning QLCSs & afternoon training supercells) produced 4-6 inches of rain

- Flash & river flooding in addition to the tornadoes

- 6 of 8 forecast points flooded (remaining 2 are on flood-controlled portions of Tennessee River); one point set a record crest, the other hit its third-highest crest

- Which products are best, and over which layers?

- Would heavy training rainfall in specific basins have been a factor regardless of soil moisture?

- Missing data during power outage is problematic

Huntsville, AL (HUN): 4/28/2011 1-Day Observed Precipitation
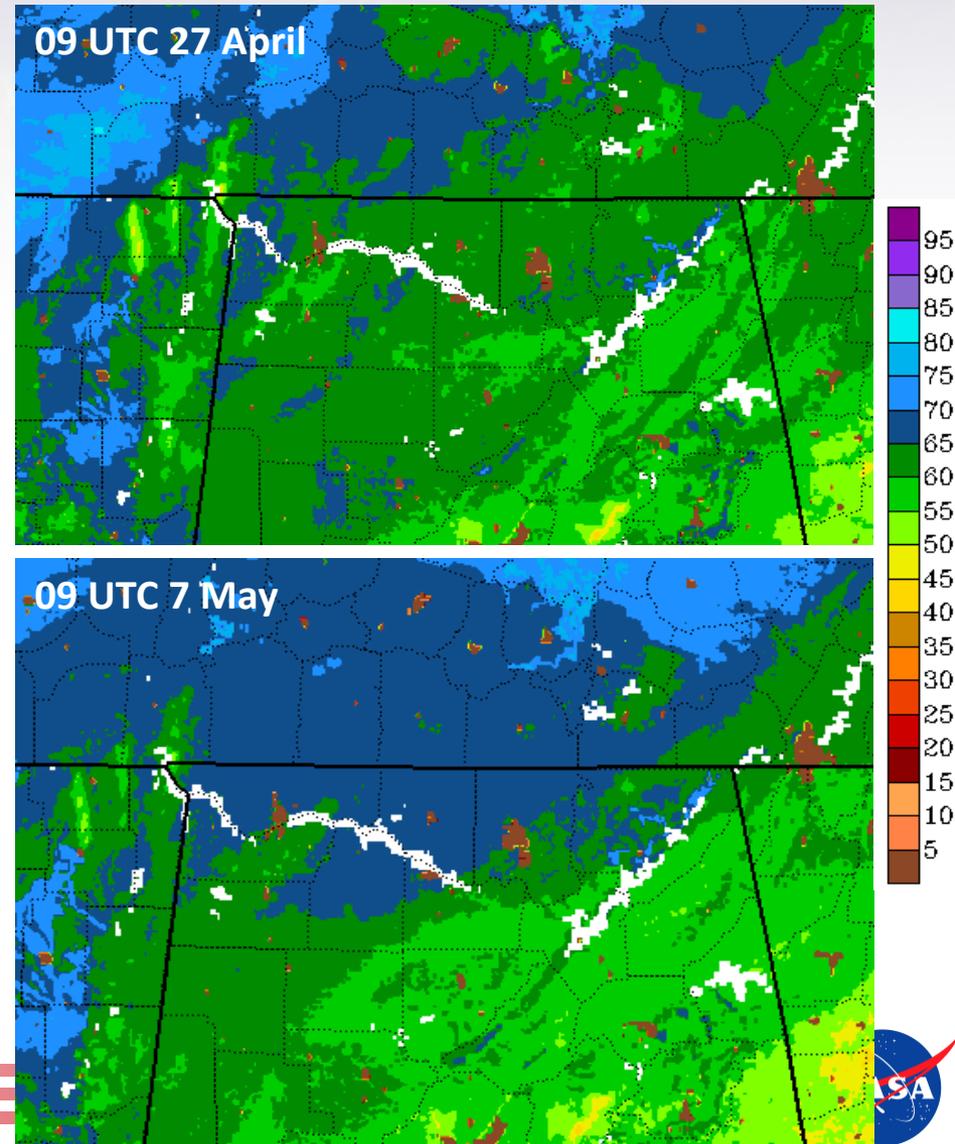Valid at 4/28/2011 1200 UTC- Created 7/2/11 2:58 UTC

Late April 2011 Flooding:
0-10 cm Relative Soil Moisture

Late April 2011 Flooding: Integrated Relative Soil Moisture

- Possibly 'infer' that integrated RSM > 75-80% is a red flag, but may be a consequence of existing flooding more than a predictor

- Data from 5-11 March 2011 heavy rains/flooding support this and may be a better case to examine
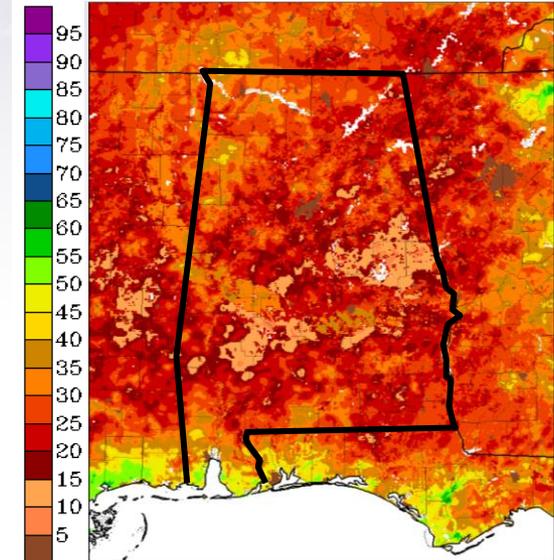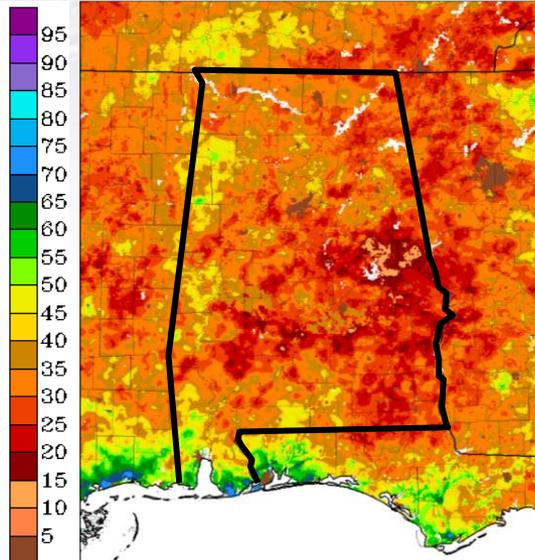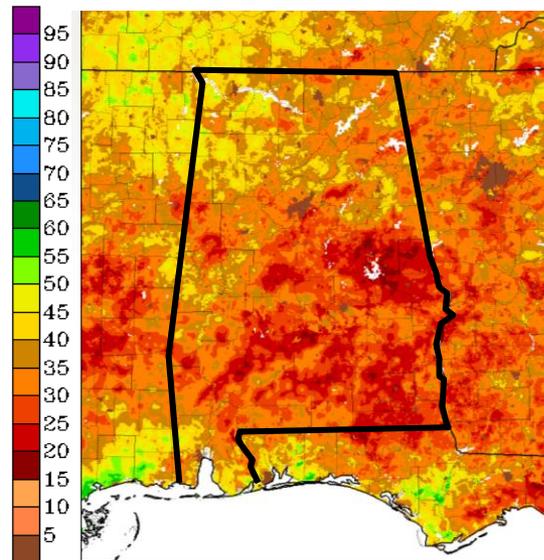

09 UTC 27 April

09 UTC 7 May

2010 Drought: Summer-Fall

LIS Relative Integrated Soil Moisture: 31 July

LIS Relative Integrated Soil Moisture: 31 Aug

LIS Relative Integrated Soil Moisture: 30 Sep
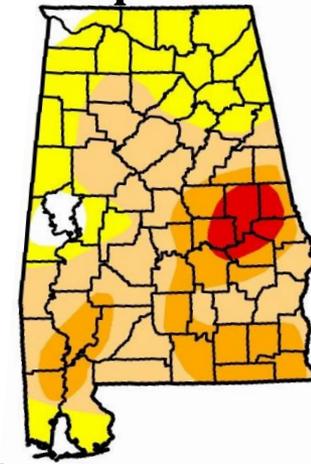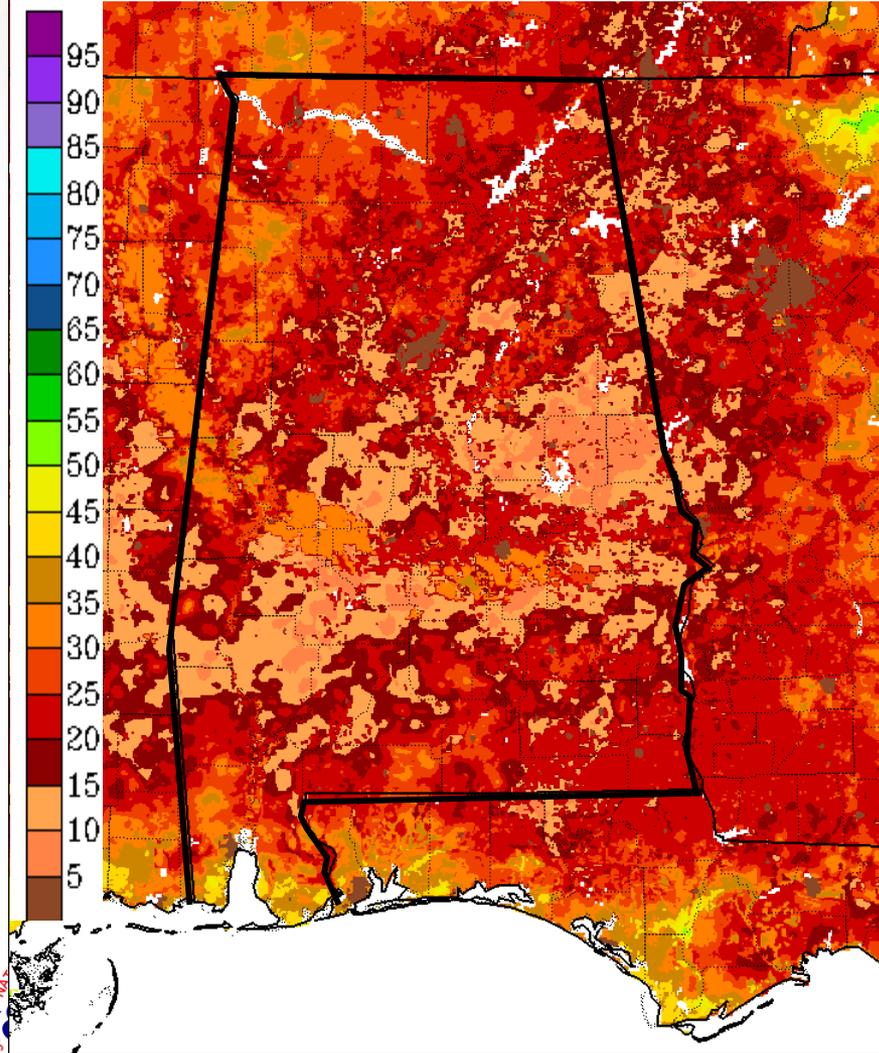
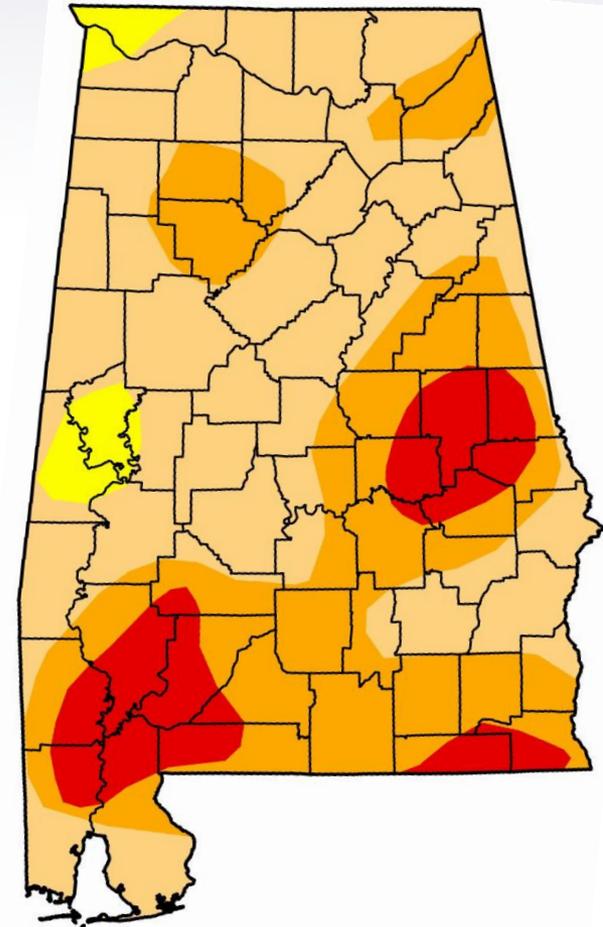**31 July**

31 August

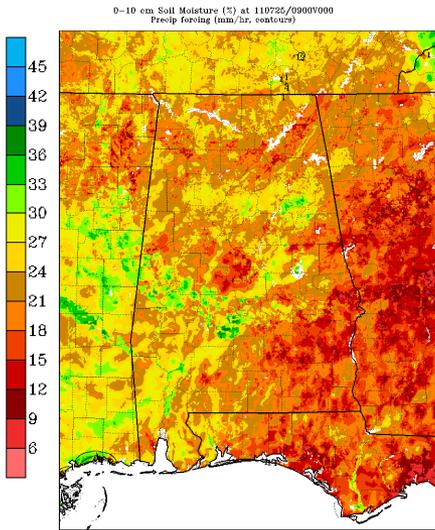**30 September**

2010 Drought: Peak
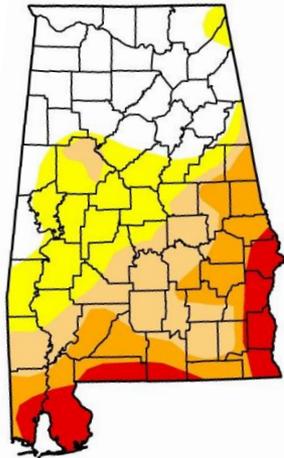
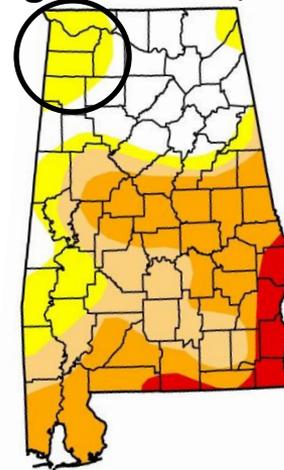LIS Relative Integrated Soil Moisture: 19 October

U.S. Drought Monitor: 19 October

Assessing Changes for the Drought Monitor

0-10 cm Soil Moisture (%) at 110725/0900V000
Precip forcing (mm/hr, contours)

July 25th-26th, 2011

0-10 cm Soil Moisture (%) at 110801/0900V000
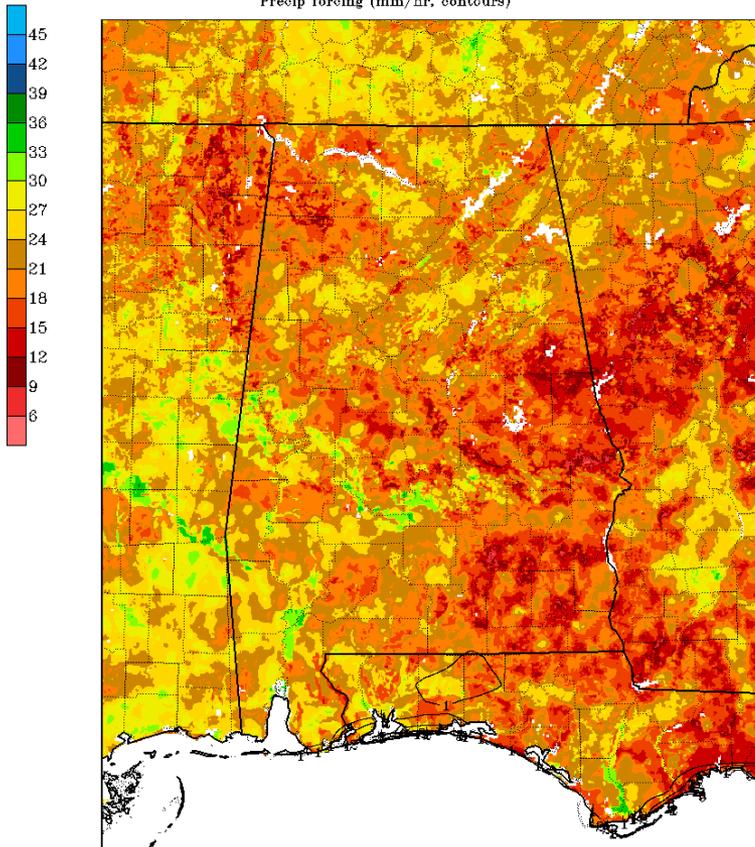Precip forcing (mm/hr, contours)

August 1st-2nd, 2011

Degradation of conditions evident in the 0-10 cm LIS soil moisture. This was utilized and expressed in response to the Drought Monitor valid For August 2nd.

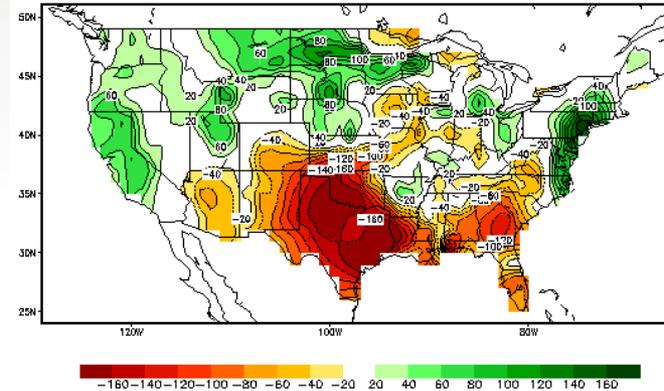Future work may entail Creating difference plots And anomaly plots.

Assessing Changes for the Drought Monitor

0–10 cm Soil Moisture (%) at 110801/0900V000
Precip forcing (mm/hr, contours)

August 1st-2nd, 2011

Calculated Soil Moisture Anomaly (mm)
AUG 28, 2011

The LIS plots, which are higher resolution and offer details on sub-county scales, can be potentially more useful than conventional plots of soil moisture and soil moisture anomalies.

Summary & Future Efforts

- The NASA LIS does show promise for assisting drought monitoring, and snowfall and flooding forecasts, but initial case studies provide a highly incomplete picture
  - Need more "marginal" cases to examine utility of LIS
- Future Efforts
  - NWA: Complete outlined case studies, examine these case studies in greater detail
  - Ingest 3 km eastern CONUS LIS into AWIPS
  - Additional case study work
  - Explore feasibility of constructing a climatology for soil moisture plots and difference images

Questions?

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