H51H-1618

Impacts of Real-time Satellite-derived Vegetation on WRF-Hydro Simulated Streamflow

Nicholas Elmer[1,5], Bradley Zavodsky[2,5], Andrew Molthan[2,5], Jonathan Case[3,5], Clay Blankenship[4,5]

[1]Dept. of Atmospheric Science, Univ. of Alabama in Huntsville, Huntsville, AL [2]Earth Science Office, NASA Marshall Space Flight Center, Huntsville, AL
[3]ENSCO, Inc., Huntsville, AL [4]Universities Space Research Association (USRA), Huntsville, AL
[5]NASA Short-term Prediction Research and Transition (SPoRT) Center, Huntsville, AL

1. Introduction

- National Water Center implemented operational National Water Model (NWM) to improve hydrological prediction (Figure 1)

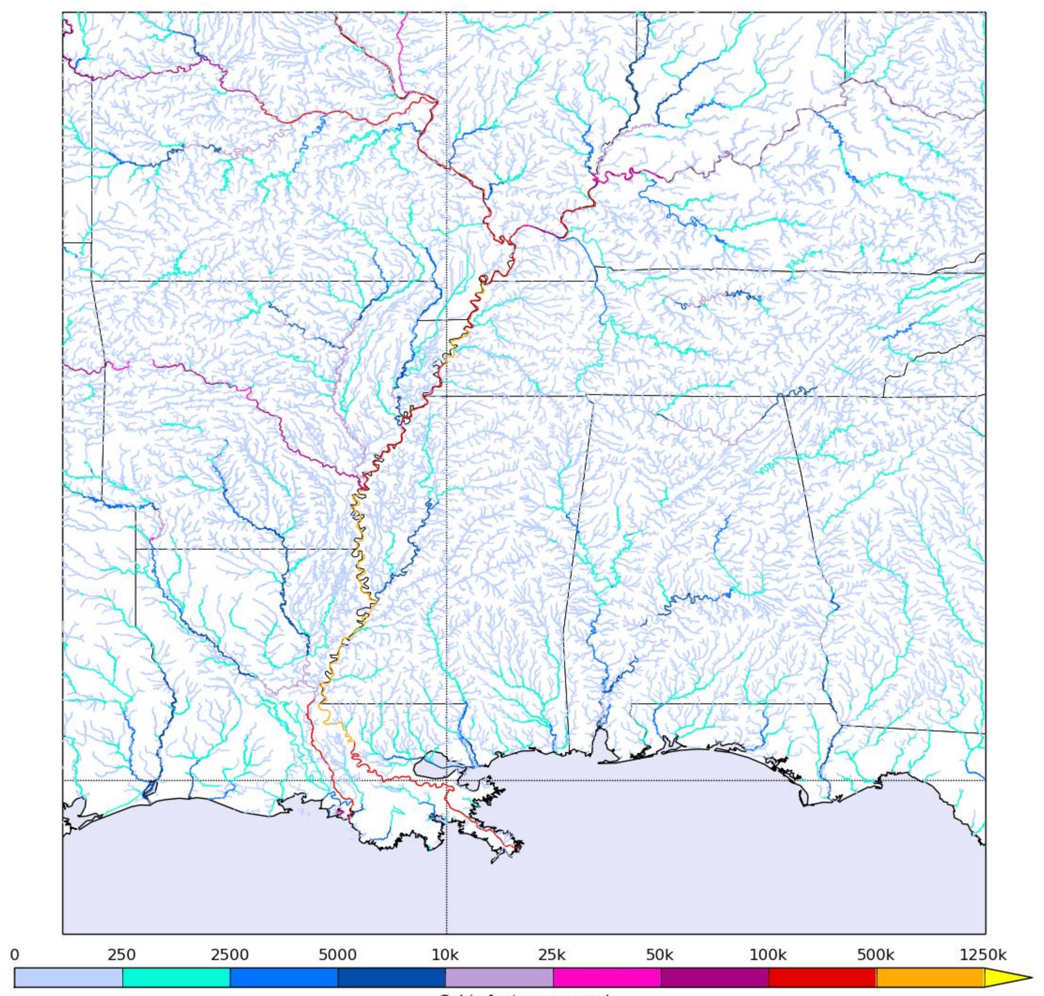

Figure 1. Example of streamflow product generated by the National Water Model.

- NWM is instantiation of Weather Research and Forecasting model hydrological extension package (WRF-Hydro) [Gochis et al., 2013] coupled with Noah Land Surface Model with Multi-Parameterization options (Noah-MP) [Niu et al., 2011]
- Noah-MP includes vegetation parameterizations which use monthly climatological tables to define leaf area index (LAI) and green vegetation fraction (GVF) within the model
- However, LAI and GVF can deviate greatly from climatology as result of anomalous meteorological conditions or changes in land use-land cover due to agriculture, forest fires, etc.
- Changes in vegetation influence soil moisture and surface runoff, which are intrinsically linked to streamflow
- This study investigates the impact of replacing climatological vegetation in Noah-MP with real-time vegetation

Nicholas Elmer
University of Alabama in Huntsville
320 Sparkman Drive
Huntsville, AL 35805
nicholas.j.elmer@nasa.gov
256-961-7356

2. 2015 December North Alabama Flood

- Warmer than average temperatures leading up to event
- LAI higher than climatological values (Figure 2)
- Heavy rainfall over multiple days in excess of 100 mm (4 in.) across much of northern Alabama and over 250 mm (10 in.) in some locations (Figure 3)
- Moderate to major flooding along several rivers in North Alabama, including Flint River and Paint Rock River (Figure 5)

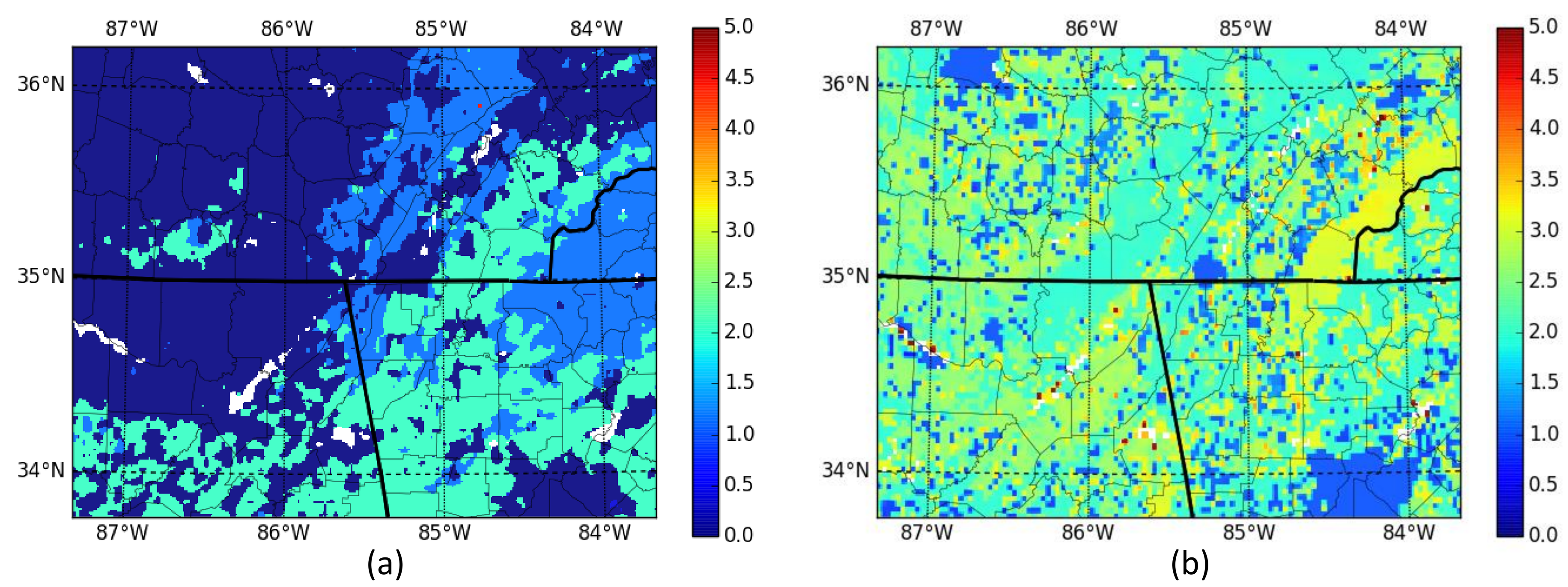

Figure 2. Leaf area index. (a) Noah-MP mean LAI for December. (b) VIIRS-derived LAI for 23 December 2015.

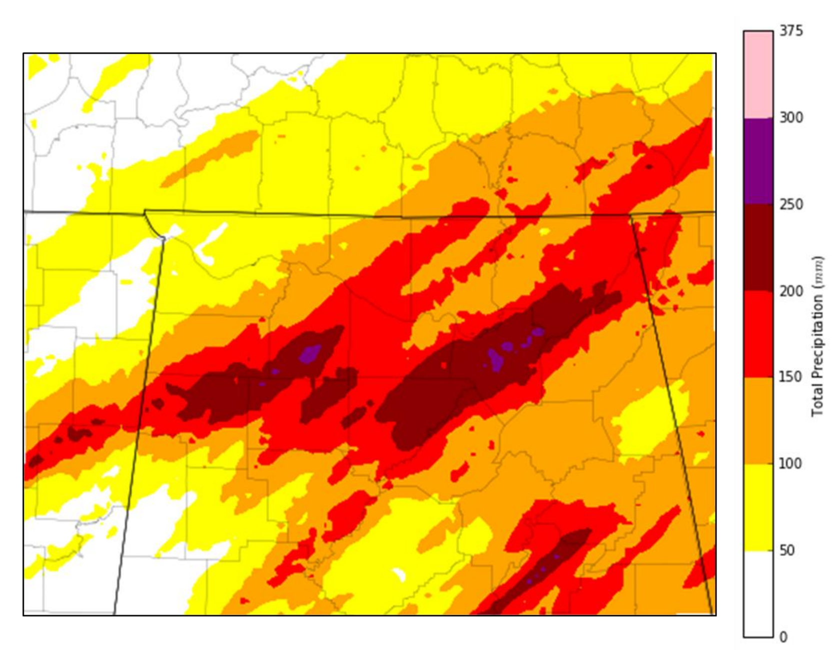

Figure 3. Multi-Radar Multi-Sensor (MRMS) gauge corrected total precipitation (mm) for 72-hour period beginning 1200 UTC 23 December 2015.

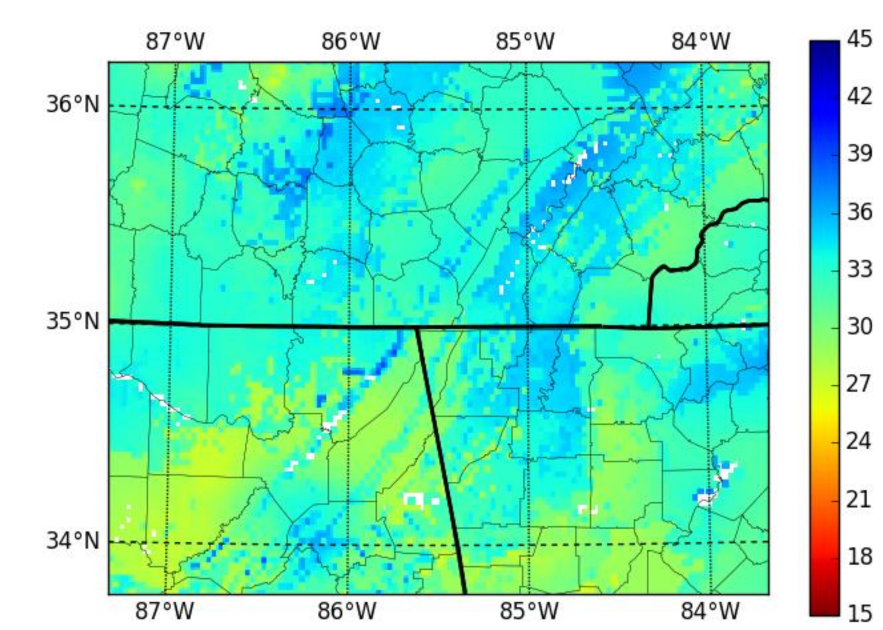

Figure 4. 1200 UTC 23 December 2015 SPoRT-LIS 0-10 cm volumetric soil moisture (%).

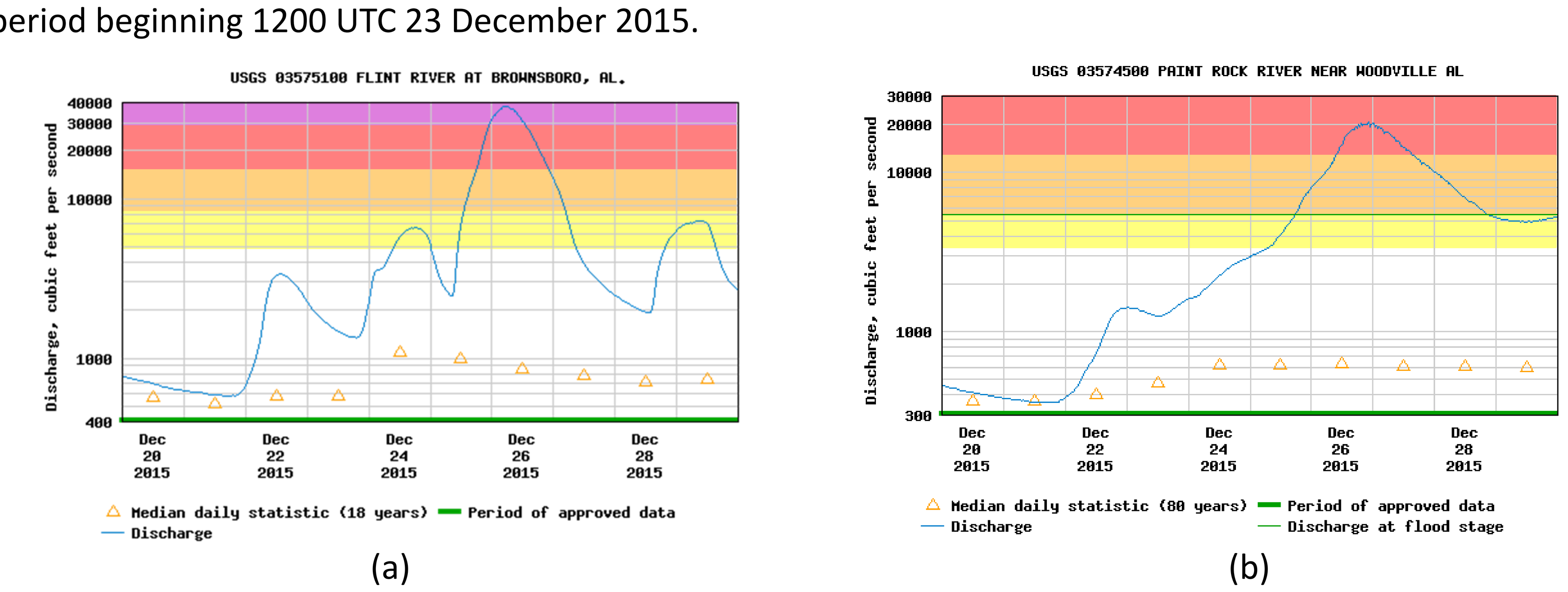

Figure 5. 20-29 December 2015 observed discharge for the (a) Flint River and (b) Paint Rock River. National Weather Service flood categories (action, flood, moderate, major) are indicated by the colored shading (yellow, orange, red, and purple, respectively). Gauge locations shown in Fig. 7. Hydrographs generated by http://nwis.waterdata.usgs.gov/.

References

Gochis, D. J., W. Yu, and D. N. Yates (2013), The WRF-Hydro Model Technical Description and User's Guide, Version 1.0, NCAR Technical Document, 120 pp., NCAR, Boulder, Colo. [Available at http://www.ral.ucar.edu/projects/wrf_hydro/.]

Niu, G.-Y., et al. (2011), The community Noah land surface model with multiparameterization options (Noah-MP): 1. Model description and evaluation with local-scale measurements, J. Geophys. Res., 116, D12109, doi:10.1029/2010JD015139.

Xia, Y., et al. (2012), Continental-scale water and energy flux analysis and validation for the North American Land Data Assimilation System project phase 2 (NLDAS-2): 1. Intercomparison and application of model products, J. Geophys. Res., 117, D03109, doi:10.1029/2011JD016048.

3. Methodology

- Coupled WRF-Hydro (version 3.0) with Noah-MP
- Real-time Suomi National Polar-orbiting Partnership (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) Green Vegetation Fraction (GVF) and SPoRT Land Information System (LIS) LAI replace climatological vegetation in Noah-MP
- Case study of 2015 December North Alabama Flood
- 2-year model spin-up, manual calibration

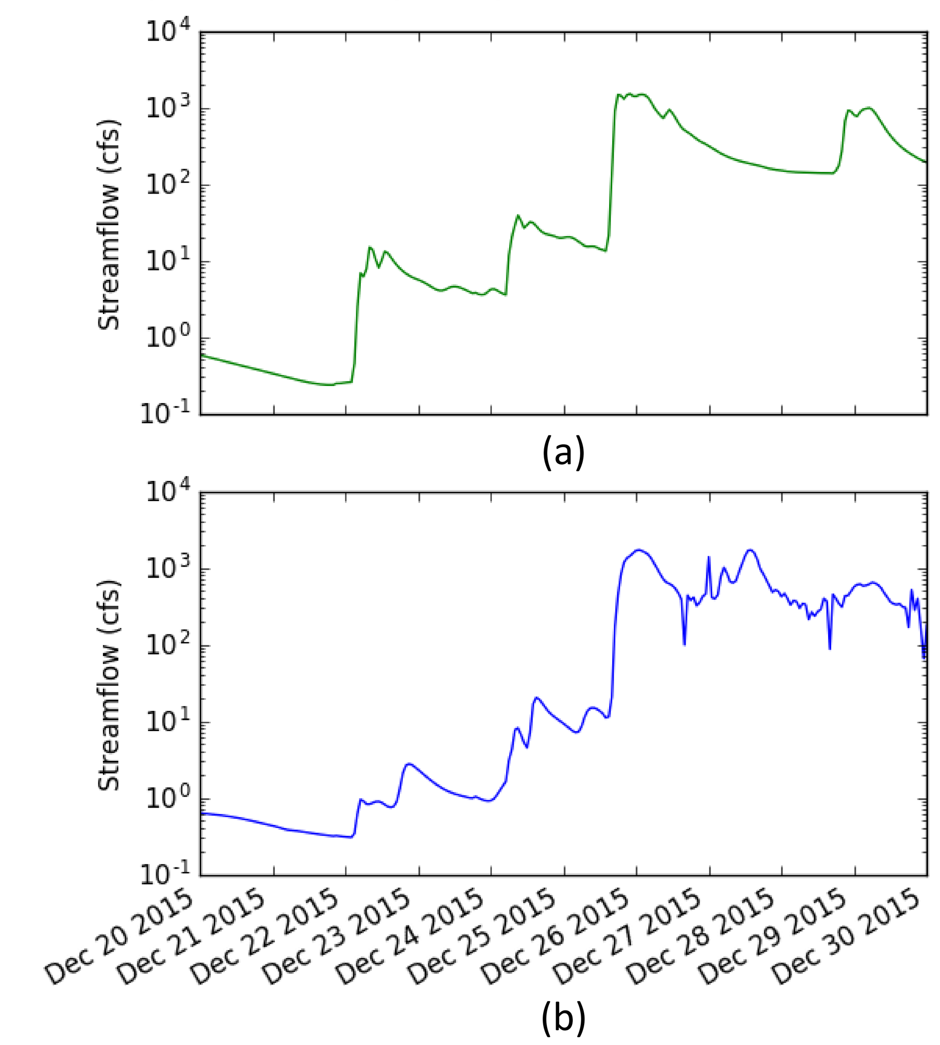

Figure 6. 20-29 December 2015 modeled streamflow for the (a) Flint River and (b) Paint Rock River.

4. Preliminary Results

- Model hydrographs follow observations trend, but magnitude is lower than observed
- Replacing climatological vegetation with real-time vegetation in Noah-MP noticeably changes WRF-Hydro streamflow
- 10-40 cm volumetric soil moisture is relatively unchanged when using real-time vegetation

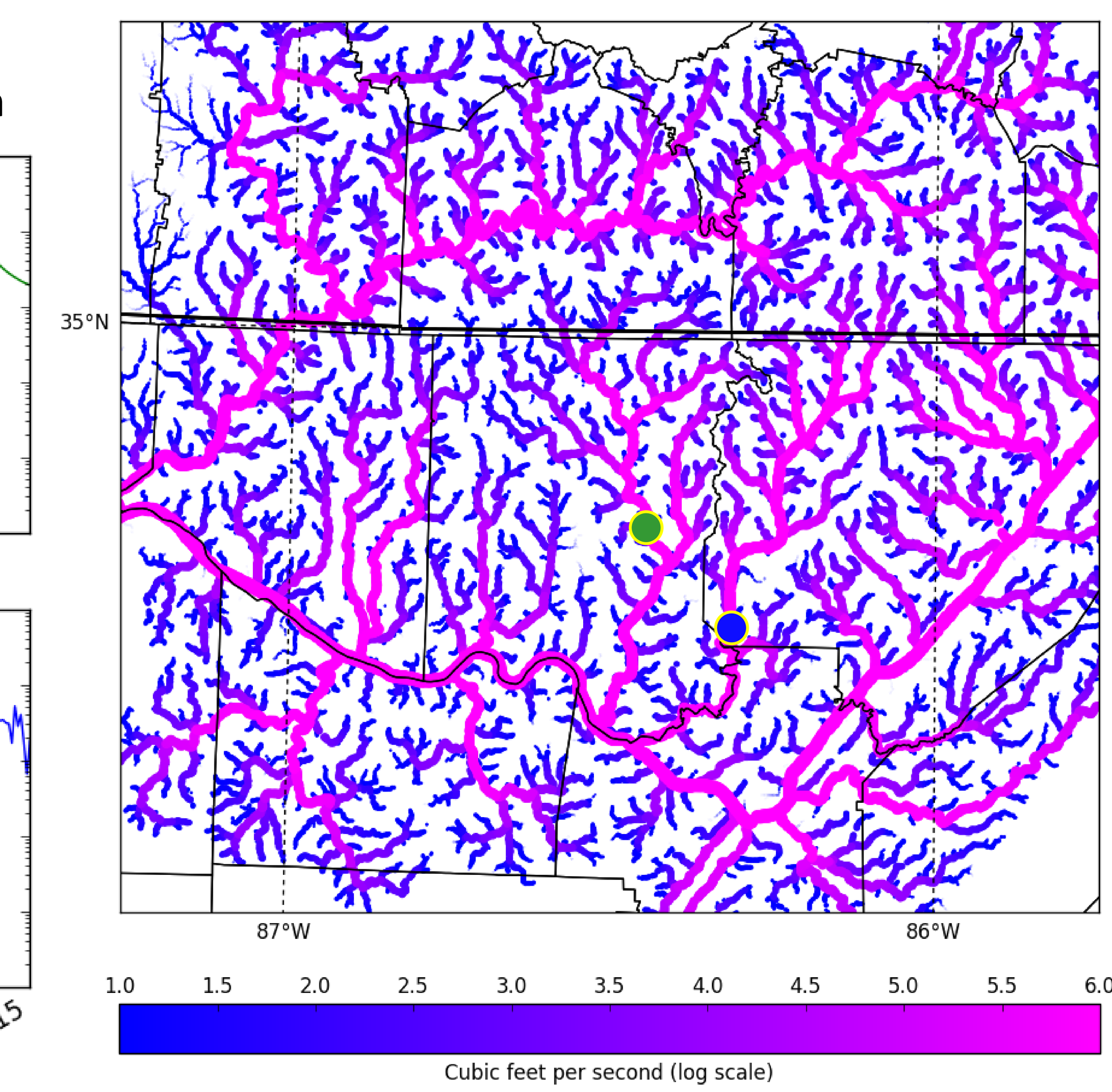

Figure 7. 1200 UTC 28 December 2015 WRF-Hydro streamflow (cubic feet per second) for the simulation using real-time vegetation.

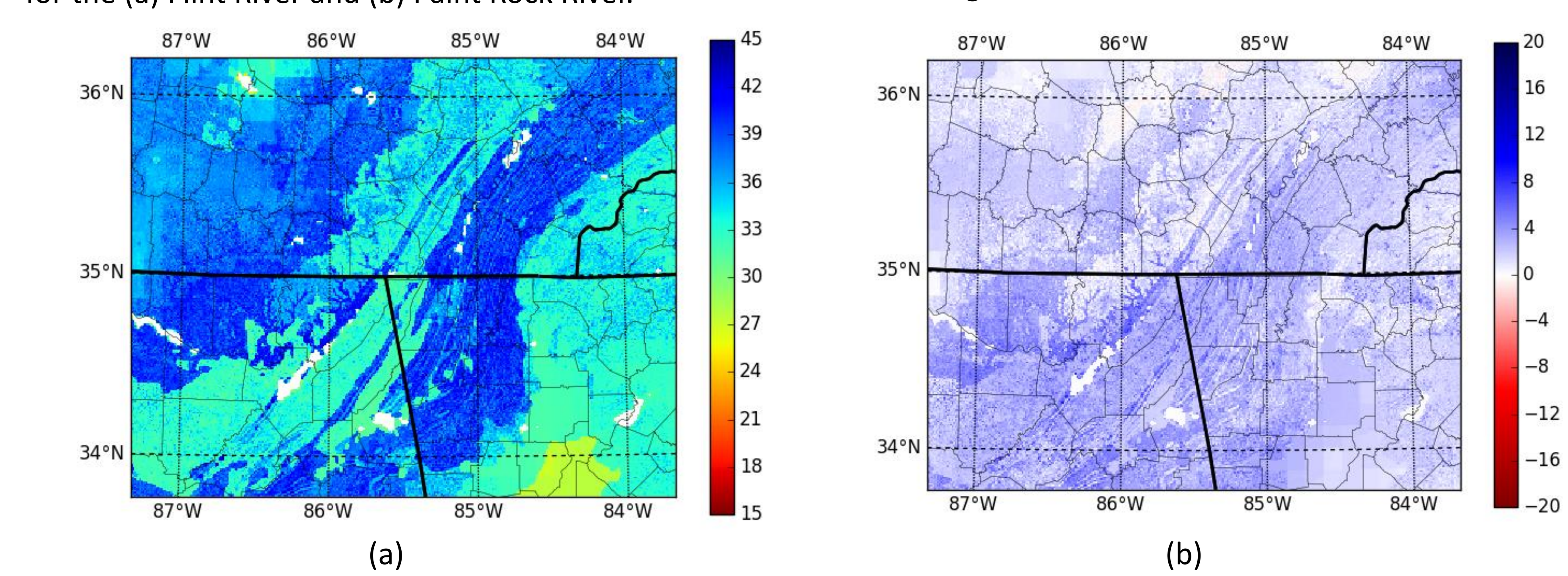

Figure 8. 0000 UTC 30 December 2015 (a) 10-40 cm volumetric soil moisture (%) for simulation using Noah-MP mean LAI and (b) the 10-40 cm volumetric soil moisture difference between (a) and the simulation using real-time VIIRS vegetation.

5. Conclusions and Future Work

- Accurate depiction of vegetation is needed for hydrological modeling applications
- Further calibration of WRF-Hydro against stream gauge observations using PEST parameter estimation tool (http://www.pesthomepage.org/)
- Investigate impacts of assimilating other NASA satellite datasets (e.g., SMAP, SWOT) into WRF-Hydro on simulated streamflow