Exploring Forecast Sensitivity through an Ensemble of Varying Land Surface Parameterizations, Soil Moisture, and Vegetation Characteristics

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Background and Motivation

The NASA Severe Thunderstorm Observations and Regional Modeling (NASA STORM) project included a component exploring the impact of land surface modeling and parameterizations on convection-driving允许global models.

- Here, we provide some highlights of case studies performed with a small ensemble of regional models focused on differences in land surface properties versus a control configuration.
- Efforts focused on whether additional land surface detail would provide additional information for the simulated events.
- Team also wanted to understand the time requirements for trying to produce a near real-time ensemble focused on land surface characteristics in response to predicted severe weather.

Ensemble Configuration

- 6 of the 20 member GEFS ensemble, randomly selected.
- 3 configurations for each GEFS ensemble member, varying the land surface, totaling 18 different model runs.
- Ensemble membership focused on changes in the land surface conditions and physics configurations.
- Land surface conditions derived exclusively from the GEFS initial and boundary conditions.
- GEFS land surface replaced with NASA Land Information System (LIS) but retaining the climatological vegetation fraction.
- GEFS land surface replaced with NASA LIS and near-real-time NOAA/NESDIS VIIRS Green Vegetation Fraction (GVF).
- 6 default GEFS, 6 GEFS + LIS, 6 GEFS + LIS + VIIRS.
- 3 km spatial resolution, 56 levels, 18 second time step.
- All simulations predict the evolution of storms with the Goddard 4-ice microphysics and radiation physics, MY9 PBL, and Noah LSM.

Simulated Events

- Simulations focused on a springtime event supporting classic supercells and a summertime northwest flow event, each producing severe weather across the forecast domain (Figure 1).

Variability in Land Surface Conditions

- Two cases were selected to examine forecast sensitivity to initial conditions, in land surface (Figure 2) and soil moisture (Figure 3).
- For the spring (supercell) case of March 2016, default GEFS land surface is greener than observed by VIIRS, by as much as 10-20% in Central Alabama (Figure 2).
- During the summer (northwest flow) case of July 2015, VIIRS observations are much greener than the GEFS, with observations 10-20% higher (Figure 2).

Linear Segments and Supercells: 31 March 2016

- Differences in the land surface contribution to each member were much smaller than differences in the GEFS initial and boundary conditions. Environment favored linear and bowing segments with embedded supercells (Figure 4).
- Relatively minor differences in ensemble members attributable to differences in soil moisture or vegetation and storm distributions common across GEFS members.


- Inclusion of the LIS soil moisture fields and VIIRS GVFS contribute to warmer and drier conditions (Figure 5) with overall reduction in SCAPE (not shown) in central Alabama.

Summary and Future Work

- A small regional ensemble was established over the southeastern United States to explore the impact of higher resolution soil moisture and vegetation information from the NASA LIS and NOAA/NESDIS VIIRS GVFS products.
- Two events were explored, a strongly forced springtime event where land surface parameters had minimal impact, and a northwest flow event in mid-summer, where warming and drying by LIS and GVFS contributed to differences in storm evolution.
- Future work will explore the feasibility of a similar, small ensemble system for near real-time events with a focus on the southeastern United States.