P14 The sensitivity of a coupled hydrometeorological flash flood forecast to model physics and initial state perturbations: A WRF-Hydro demonstration

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Successful flash flood prediction requires forecast skill in both the atmospheric driving fields (i.e., precipitation) as well as the hydrologic processes responsible for transporting water across the land surface. While land and atmosphere components of the flash flood forecast process have historically been treated as separate entities, emerging coupled hydrometeorological prediction tools such as the WRF-Hydro modeling framework allow more fully coupled systems to be used toward integrated forecast improvement.

Studies have shown that many severe weather events are impacted by the spatial patterns and magnitudes of land surface fluxes. In turn, the severity of flood responses to heavy precipitation are often influenced by antecedent soil moisture, groundwater and channel flow conditions. Specifically, uncertainty in initial land-surface model states can affect both convective storm triggering (and thus the amount and spatial distribution of precipitation) as well as surface runoff generation critical to determining the actual impact of a potential flash flood. This work examines land-surface initial state sensitivity through the evaluation of ensemble hydrometeorological forecasts for a large flash flood event that occurred in western North Carolina on 27 July 2013. Nearly a foot of rainfall falling in less than 24 hours drove flash flooding that was responsible for over 50 road closures, at least 4 destroyed homes, and over 700 damaged properties in western North Carolina. The flash flooding was also blamed for two deaths when swimmers were swept away in a fast-moving rural creek. The event occurred at the end of an already-record-setting month for rainfall in the region: most of western North Carolina received monthly precipitation amounts exceeding 500% of normal in many locations thereby exacerbating the ultimate flood response.

Initial work has already demonstrated that the coupled WRF/WRF-Hydro system is capable of producing a reasonably skillful hindcast of the 27 July precipitation event and its streamflow event using a default configuration of model physics and initial land surface conditions. Building on that success, we attempt to quantify the probabilistic skill of quantitative precipitation forecasts and streamflow forecasts using a combination of physics and initial state perturbations. The modular, multi-physics structure of the WRF and WRF-Hydro architectures readily facilitate generation of physics ensembles through the selection of different physics parameterizations. Initial state perturbations in both land surface conditions will be derived from regional measurements of soil moisture and soil temperature from the region. Lower atmospheric initial state perturbations of temperature and humidity will also be constructed. In addition to quantifying the probabilistic skill of precipitation and streamflow conditions, we will also diagnose the relative importance of the various initial states on final forecast fidelity.