Modelling the Extreme July 2023 Hudson Valley Precipitation Event Using WRF

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Record rainfall was observed in New York State's Hudson Valley on July 9, 2023, leading to flash flooding. This included totals over eight inches in several locations in less than 24 hours, resulting in damaged roads, water distribution systems, railbeds and buildings, and cessation of airport operations. The impacts were sufficiently extensive that repairs and rebuilding at the United States Military Academy at West Point alone were estimated to cost $100M.

While record rainfall totals for the most affected areas were over four inches, there were a few key factors that exacerbated the conditions leading to the flooding. First, the ground was relatively saturated given frequent summer rainfall over the previous few weeks. Since the Hudson Valley was formed from glacial retreat, the layer of topsoil is relatively shallow, further reducing its capacity to hold water. The amount of moisture in the atmosphere, primarily from tropical sources, was relatively high for that time of year. Simultaneously, that moisture was blocked by a high-pressure system leading to slow, training convection during that day.

Given the nature of this event, we want to characterize the highly localized rainfall across the region and its relative predictability. For example, the NOAA Weather Prediction Center showed moderate risk for the region during the day of the event and slight risk from the day before. The operational NCEP HRRR model captured some elements of the rainfall but only with a few hours of lead time. Therefore, we explore the predictability of the event with a customized version of the community WRF-ARW weather model configured for 1km resolution for all of New York State and the surrounding region. Observations from the New York State Mesonet are used for both data assimilation and to evaluate model skill as well as the overall precipitation characteristics of the event.

We will present an overview of this case study event and the approach to the modelling as well as an assessment of the model results. Since this is work in progress, we will outline the next step in this research and some of our current applications.