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Recent advances in forecasting severe precipitation events & consequent flooding: advantages & limitations of CRMs as the forecast platform

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Progress in the accuracy of forecasting precipitation, particularly severe precipitation, since the advent of nonhydrostatic cloud resolving models (CRMs), has largely been driven by the increase in CRM spatial resolution – in which higher spatial resolution leads to greater precipitation magnitudes presuming resolution-dependent empirical enhancements have not been introduced. Since the horizontal and vertical circulation scales producing severe precipitation are almost always below 10 km – in essence some 1-2 km – it is computational challenging to operate CRMs in an operational forecast environment at the preferred very high resolution scales, while at the same time gaining sufficient lead time against actual time into the future to be able to actually make useful forecasts. Moreover, this is the situation for deterministic forecasting. When considering ensemble forecasting, which would be virtually essential for an operational system designed for warning an actual human population, the computational challenge becomes much more severe.

Therefore, much of what is currently understood about severe precipitation forecasting, has been accomplished in a research mode addressing past events without concern about the ratio between computational time and real time. Nonetheless, what has been accomplished in a research environment, and in the past few years with the NCEP and NCAR versions of the WRF model over the continental U.S., suggests that under conditions in which precipitation bearing flows are focused onto topographically uneven surfaces, reasonable to at times accurate forecasting skills can be obtained. Since flood forecasting is totally dependent on placing precipitation events over the correct catchments with correct timings and with relatively accurate accumulations, CRM-based precipitation forecasting, which can also be referred to as quantitative precipitation forecasting (QPF), is slowly becoming recognized as the essential underpinning to flood hazard forecasting. This was not always the case.

In this talk, we focus on the strengths and weaknesses of severe precipitation forecasting and concomitant flooding through use of CRMs in four regions embodying four types of precipitation events: (1) the Mediterranean basin experiencing late year severe mesoscale storms, (2) the U.S. Gulf coast experiencing late-summer hurricanes, (3) northwestern India experiencing repeated mesoscale convective systems (MCSs) during the summer monsoon; and (4) the Korean Peninsula experiencing late summer supertyphoons. The cases and results that we examine can be used to gain a perspective on current advances in severe precipitation forecasting, and to understand some of factors that affect the implementation of an operational forecasting system.