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# A Rapid Protoyping Approach for the Evaluation of Potential GPM-Era Precipitation Products for Water Resources Management Applications

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In order to facilitate the operational transition of satellite data, research products and advances in numerical modeling, the NASA Applied Sciences Program (ASP) had adopted a systems engineering approach to help identify and advanced and basic research capabilities that may be further developed for operational applications. This novel approach was envisioned to accelerate the harvesting of NASA's investment in research for societal benefits. International programs such as the Global Earth Observing System of Systems (GEOSS) could benefit from such systematic and integrated approaches to identify and extend the results of earth and environmental sciences for the benefits of global society. This new approach by the ASP was based on three phases of implementation, namely: (a) "Solutions Networks" for systematically examining data products, capabilities, and results from NASA Earth science research in order to find identify and prioritize candidate research activities that have the potential for societal benefits; (b) "Rapid Prototyping Capability (RPC)" experiments to further develop and tailor basic research and further evaluate and quantify their potential impacts for applications and decision support; and (c) "Integrated System Solutions (ISS)" to fully execute the transition the research to operational implementation and benchmark the performance resulting from integrating NASA Earth observations and science results. The RPC science experiments can be rapidly prototyped in order to evaluate the suitability of data, algorithms and models. They are designed to characterize uncertainties involved in the data, models, and decision making process while maintaining scientific rigor through the entire process. This approach helps identify scientific and logistical risks earlier in the process so that they can be appropriately addressed in a timely manner to minimize risk.

GPM is promoted as "a science mission with broad societal applications," that will address societal benefits related to human health (soil moisture, climate and disease outbreak), homeland security (removal of chemical/biological/nuclear agents), flooding potential and warning, water availability, water quality, and agriculture and food security. In 2006, the NASA ASP sponsored two RPC experiments to evaluate potential GPM-era high resolution satellite precipitation products for water management applications. One of the current uncertainties involved in the GPM missions is the nature of the exact configuration of the constellations of satellites and hence the potential for the dynamic error characteristics over time of the precipitation estimates. For the RPC evaluations, we needed a satellite precipitation product that would be analogous to the GPM-era products. Our solution was to develop a suite of high resolution precipitation products, based on the NRL-Blend algorithm. We created a set of 10 different satellite precipitation estimates (hereafter referred to as the "GPM-proxy data"), using the currently available IR and microwave sensors. However, in each product we systematically left out sets of observations and/or sensors, such as AM orbits. The geographical focus of our study was the operational domain of the Arkansas Basin River Forecast Center (ABRFC) of the U.S. National Weather Service. We have evaluated the GPM-proxy data against the operational product (radar and gauge based) used by ABRFC. Further, we also performed a set of soil water content (SWC) sensitivity experiments using the Noah and Mosaic Land Surface Models (LSM) to quantify the impacts on water management applications involving land surface hydrology. Both the LSMs were forced with the same set of GPM-proxy data. Though the overall spatial patterns for both the models were similar, there were subtle differences in the respective

model sensitivities to the different precipitation forcings. These experimental results illustrate the need for comprehensive pre-evaluations of applications, in order quantify and minimize the risks involved in applications with the introduction of new precipitation products, before making extensive investments in operational transitions.

Besides the SWC sensitivity experiments, we have also evaluated precipitation merging and downscaling techniques using various other precipitation products, including IR-based estimates, NRL-Blend and CMORPH. During the presentation, we will outline systems engineering approach used by ASP, summarize the results of the GPM RPC experiments, and discuss the lessons learned in prototyping applications for GPM-era high resolution precipitation products.