High Performance Computing and Algorithms for Hurricane Storm Surge Modeling: Current State and Future Outlook

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Abstract: Hurricane storm surge modeling, especially in forecast mode as hurricanes approach land, is critical for emergency management, evacuation or shelter-in-place planning, and deployment of first responders. After the event, storm surge models are used in forensic studies, validation exercises, and for planning future response to potential hurricanes. Over the past 20 years, storm surge models, particularly the Advanced Circulation Model (ADCIRC), have advanced to the point that they can be used reliably to predict maximum surge in both forecast and hindcast mode. We will highlight some of these achievements and show how HPC was critical to these efforts. We will then demonstrate the performance of such models on recent events, such as Hurricanes Harvey and Irma, and show how the model is used to evaluate proposed mitigitation systems, focusing particularly on the Texas coast.

Even with these advances, there are still critical physical processes that are missing in these models. Moreover, efficient performance on future HPC architectures that utilize GPU or KNL chips must be addressed for these models to retain their relevance. We will outline research on new algorithms based on discontinuous Galerkin methods and HPX which may serve as the basis for future simulation technology. We will also discuss missing components in these modeling systems, including coupling with rainfall/runoff, sediment transport, etc., and the research needed to realize a more fully complete modeling system.

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