An Uncertainty Quantification and Data Assimilation Framework for Shallow Water Equations: Application to Flood Forecasting

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Two-dimensional Shallow Water Equations (SWEs) are extensively used to model the physical phenomena of water flows such as dam-breaks, flood waves and tidal flows in coastal regions where the vertical fluid depth is much smaller than the horizontal scale of motion. A significant uncertainty exists in modeling such phenomena due to approximate nature of the mathematical model, and insufficient and inaccurate information on the spatio-temporal variability of the associated atmospheric and geological parameters (e.g. bed friction, wind drag and bathymetry). Conventional approach of treating such natural systems as deterministic entities may therefore be unacceptable. Due to inherent uncertainty associated with these complex systems, it is necessary to quantify confidence in numerical models in order to accept them as reliable alternatives to expensive field experiments. Furthermore, recent availability of modern sensing technology has opened up the possibility of obtaining more reliable predictions by dynamically incorporating sensor data into executing computer models. It is therefore of interest to develop mathematical tools that blend field measurements in order to reduce uncertainty and thereby improving accuracy of the predictive models. This presentation describes an uncertainty quantification and data assimilation framework for shallow water equations which can exploit sensor data to enhance confidence in predicting flood waves due to dam break in a basin with uncertain bed friction.

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