Geophysical Research Abstracts
Vol. 16, EGU2014-1167, 2014
EGU General Assembly 2014

Preparing for the SWOT mission by evaluating the simulations of river water levels within a regional-scale hydrometeorological modeling framework

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The upcoming Surface Water Ocean Topography (SWOT) mission will provide unprecedented observations of water elevation in rivers and lakes. The vertical accuracy of SWOT measurements is expected to be around 10 cm for rivers of width greater than 50-100m. Over France, new observations will be available every 5 days. Such observations will allow new opportunities for validation of hydrological models and for data assimilation within these models.

The objective of the proposed work is to evaluate the quality of simulated river water levels in the Garonne River Basin (55,000 km^2) located in Southwestern France. The simulations are produced using a distributed regional-scale hydrometeorological modeling framework composed of a land surface model (ISBA), a hydrogeological model (MODCOU) and a river network model (RAPID). The modeling framework had been initially calibrated over France although this study focuses on the smaller Garonne Basin and the proposed research emphasizes on modifications made to RAPID. First, the existing RAPID parameters (i.e. temporally-constant but spatially-variable Muskingum parameters) were updated in the Garonne River Basin based on estimations made using a lagged cross correlation method applied to observed hydrographs. Second, the model code was modified to allow for the use of a kinematic or a kinematic-diffusive wave equation for routing, both allowing for temporally and spatially variables wave celerities. Such modification required prescribing the values of hydraulic parameters of the river-channel.

Initial results show that the variable flow velocity scheme is advantageous for discharge computations when compared to the original Muskingum method in RAPID. Additionally, water level computations led to root mean square errors of 50-60 cm in the improved Muskingum method and 40-50 cm in the kinematic-diffusive wave method. Discharge computations were also shown to be comparable to those obtained with high-resolution models solving the full 1D Saint-Venant equations. Similar comparisons are more challenging for water levels because of their strong dependence on the choice of hydraulic parameters and their spatial variability, but spatial-averaging leads to satisfactory results.

The improved model will be used in the future to perform sensitivity studies and implement data assimilation strategies that are adapted to the most significant sources of uncertainty in the modeling framework.