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INTRODUCTION

(LATEST PARAGRAPHS: From p.3, l.19 – p.4, l.5 IN ORIGINAL MANUSCRIPT VERSION)

Before launch, in the preparatory phase, Observing System Simulation Experiments (OSSE) can be done to assess the benefits from assimilating SWOT data into a hydrological model and to evaluate the most adapted methodologies to assimilate this data into models. Several studies assimilating synthetic and/or simplified SWOT like data have been published to evaluate the correction of river model state, namely river depth (Andreadis et al., 2007; Biancamaria et al., 2011), river storages (Munier et al., 2015) and river discharges (Andreadis and Schumann, 2014) at various scales **[R#1-M#1]**. But also, several studies focused on the possibility of using SWOT data to retrieve critical river parameters such as river bathymetry (Durand et al., 2008; Yoon et al., 2012; Mersel et al., 2013) and/or riverbed roughness/friction coefficient (Pedinotti et al., 2014; Oubanas et al., 2018; Hafliger et al., 2019). Indeed, SWOT is a scientific mission with a three years nominal lifetime. Therefore, SWOT observations will help to better calibrate hydrological models and improve their performances even over time periods beyond its lifetime. Moreover, other studies using real remote-sensing data have also been published and give insight in the challenges related to the assimilation of space-borne products such as Michailovsky et al. (2013), Michailovsky and Bauer- Gottwein (2014), and Emery et al. (2018) that assimilate nadir radar altimetry data **[R#1-M#1].**

In the present study, a data assimilation framework is used to correct input parameters of the large-scale ISBA-CTRIP model. More specifically, synthetic SWOT observations of water surface depths and anomalies **[R#2-M#1]** are assimilated in order to correct the spatially-distributed riverbed friction coefficients (or Manning coefficients). As SWOT will not measure directly water depths (it provides water elevation and the bathymetry is required to derive water depth) **[R#2-m#11]**, the purpose of this study is to evaluate the possibility to assimilate water elevation anomalies to correct model's parameters and assess how the assimilation performances are impacted, compared to the direct assimilation of water depths **[R#3-M#1].** Assimilating water elevation anomalies is done to overcome potential lack of bathymetry data **[R#2-M#1].**

This study is presented as a complementary study of Emery et al. (2018) dedicated to the state estimation (river storage and discharge) of the same ISBA-CTRIP model, using real satellite-based discharge products **[R#1-M#1]**. The choice of the roughness coefficient as control variable was made following the results from the ISBA-CTRIP sensitivity analysis in Emery et al. (2016). In this preliminary study, the sensitivity of the simulated water depths and also anomalies to several river input parameters (such as riverbed width, depth, slope and also friction coefficient) was evaluated. The results showed that the highest sensitivity was to the Manning coefficient.

Furthermore, this study is also built on the conclusions from Pedinotti et al. (2014)'s work. In our study, an Ensemble Kalman Filter (EnKF) is used (instead of the Extended Kalman Filter in Pedinotti et al., 2014) to better account for nonlinearities of the system and better estimate model errors. Also, Pedinotti et al. (2014) chose to update the Manning coefficients distribution at the grid cell scale and rose the question of equifinality (Beven and Freer, 2001) in their results. For the current study, it was decided to update the Manning coefficient distribution not at the grid-cell resolution, but at a coarser zonal resolution, by applying multiplying correcting factors uniformly over each zone **[R#1-m#2]**, identical to the one used in Emery et al. (2016). Finally, Pedinotti et al. (2014) used an assimilation window of 2 days. This configuration resulted in updated Manning coefficient time series displaying "unrealistic jumps" with a frequency of about 20 days that were associated to the orbit repeat cycle (longer than the 2-day window). To avoid this phenomenon, the present study uses an assimilation window of 21 days, corresponding to the current SWOT orbit repeat cycle.

Section 2 will first give a description of the ISBA-CTRIP model used for this study. Section 3 will present the particular data assimilation method developed for this study and finally, after presenting the assimilation strategy in Section 4, Sections 5 and 6 will give the data assimilation results.

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