Multi-variate data assimilation into a large scale hydrological system: a study over the Niger basin

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The advent of new satellite missions dedicated to hydrology, such as SWOT launched in December 2022, brings fresh perspectives for monitoring and forecasting continental water resources. But it also requires the set up of fully automated hydrological forecasting systems able to take advantage of these new types of products. It is in this perspective that a platform named HYdrological Forecasting system with Altimetry Assimilation (HYFAA) was implemented, which encompasses the MGB large-scale hydrological model developed within the large-scale hydrology research group of the University of Rio Grande do Sul (Brazil), and an Ensemble Kalman Filter (EnKF) module that corrects model states and parameters whenever discharge observations are available. While discharge is the most classically used variable for data assimilation into hydrological models, it does however have some limitations: i) it only provides 1D information about the hydrological flow and cannot capture lateral processes which are essential in flooded areas; ii) it must be derived from nadir altimetry data, which has limitations in terms of spatial sampling, via rating curves. Combining discharge observations with other types of data can therefore improve models' representation of the complex processes governing the hydrological regime of large basins. The current work is part of a CNES-funded project aiming to implement and evaluate multivariate data assimilation on the Niger river basin based on the HYFAA modeling platform. Three types of observations will be assimilated: water levels and discharge from the Hydroweb database, and surface water bodies from Sentinel-1 and Sentinel-2 data processing. This study presents the preliminary results obtained within the framework of this project. First, we evaluate and compare the performance of the EnKF when assimilating each variable separately. For validation, we use in-situ or independent datasets when they exist. Otherwise, we use a random sample of the assimilated datasets. We then discuss the approach to be taken and the risks to be anticipated for their combined assimilation. This study allows preparing the use of SWOT data as soon as they are available in the course 2023.