A Methodological Framework to Combine Multiple Precipitation Datasets for Improving Streamflow Simulations: A test study in the Saskatchewan River basin, Canada

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Obtaining reliable precipitation measurements and accurate spatiotemporal distribution of precipitation remains as a challenging task for driving Hydrologic-Land Surface Models (H-LSMs) and better hydrological simulations and predictions. To further improve the accuracy of precipitation estimation for hydrological applications, the idea of generating a hybrid dataset by combining existing precipitation products has become a more appealing approach in recent years. The reliability of the hybrid dataset is evaluated against in-situ climate stations and error characteristics are calculated to compare to the existing products. However, the robustness of the hybrid dataset in representing spatial details could be problematic when evaluated only using a sparse network of in-situ observations at regional or basin scales. This study aims to develop a methodological framework that combines multiple precipitation products based on evaluation against not only climate stations but also streamflow stations that are spatially representative across large river basin. The framework is illustrated using a Canadian H-LSM named MESH (Modélisation Environnementale communautaire - Surface Hydrology) in the Saskatchewan River basin, Canada over the period of 2002 to 2012. Five existing precipitation datasets are considered as the candidates for generating the hybrid dataset. The framework consists of three components. The first component evaluates each precipitation candidate against the local gauge data for benchmarking, runs each candidate through MESH with 10 km spatial resolution and default parameterization, and calculates the overall streamflow performance in each sub-basins with equal weighting of three evaluation metrics. The second component generates the hybrid dataset by combining the best performing candidates (annual or seasonal) at sub-basin scale. The third component assesses the performance of the hybrid dataset at downstream gauge stations along the mainstream as a validation mechanism for comparison with the performance of the candidate datasets. Results shows that the hybrid dataset is able to perform equally well with the existing precipitation products in the headwater while improve the streamflow performance downstream. The successful application of the framework in this river basin could build the foundation and the confidence in applying the combination method to data-limited river basins in northern Canada.

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