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Assimilation of soil moisture data for improving streamflow prediction: Is there a role for the hydrological model structure?

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Soil moisture data assimilation has found increased applicability in hydrology due to easily available remotely sensed soil moisture data. Numerous studies in the past have explored the possibility of assimilating soil moisture information for improving streamflow forecasting. The general understanding is that if better soil moisture data can provide better streamflow forecast. However, to our knowledge no study has so far focused on understanding if the hydrological model itself has a role in assimilation of soil moisture data. In this regard, here we use three different conceptual hydrological models for soil moisture assimilation: (1) Dynamic Budyko (DB), (2) GR4J, and (3) PDM model. Assimilation of GLDAS observed soil moisture is carried out for four MOPEX basins using Ensemble Kalman Filter. DB model's performance improved after soil moisture data assimilation for all the study basins. However, deterioration in performance was observed for GR4J and PDM for all the basins after the assimilation exercise. The performance of the assimilated models is evaluated in terms of Assimilation Efficiency (AE), which was found to be varying from 17.11 to 22.56%, from -20.98 to -41.29%, and from -8.4 to -38.23%, respectively, for DB, GR4J, and PDM. Overall, our results highlight the importance of the hydrological models structure in a soil moisture data assimilation exercise.