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Validation of SMAP and AMSR2 satellite soil moisture data over the Critical Zone Observatory in central Ganga plains, North India using ground-based observations

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Soil moisture (SM) products derived from the passive satellite missions have been extensively used in various hydrological and environmental processes. However, validation of the satellite derived product is crucial for its reliability in several applications. In this study, we present a comprehensive validation of the descending SM product from Soil Moisture Active Passive (SMAP) Enhanced Level-3 (L3) radiometer (SMAP L3-Version 3) and the Advanced Microwave Scanning Radiometer 2 (AMSR2) Level-3 (Version 1), over the newly established Critical Zone Observatory (CZO) within the Ganga basin, North India. The AMSR2 soil moisture product used here, has been derived using the Land Parameter Retrieval Model (LPRM) algorithm. Four SM derived products from SMAP (L-band) and AMSR2 (C1- and C2- and X-band) are validated against the in-situ observations collected from 21 SM monitoring locations distributed over the CZO within a period from September 2017 to December 2019, for a total of 62 days. Since the remotely sensed SM product has a coarser spatial resolution (here 9 km for SMAP and 10 km for AMSR2), the assessment has been carried out for the temporal variation of the measured values. Four statistical metrics such as bias, root mean square error (RMSE), unbiased root-mean-square error (ubRMSE) and the correlation coefficient (R) have been used here for the evaluation. The SMAP Level-3 products are found to show a satisfactory correlation (R>0.6) compared to the other three SM product. Both the SMAP L3 and the AMSR2 C2 SM shows a negative bias, -0.05 m^3/m^3 and -0.04 m^3/m^3 respectively whereas these values are found to be 0.04 m^3/m^3 and 0.06 m^3/m^3 for C1 and X bands of AMSR2, respectively. Furthermore, the RMSE between the SMAP L3 and in-situ data is 0.07 m^3/m^3, which is slightly underperformed when considering the required accuracy of SMAP. This is possibly due to variation in the sampling depth along with the sampling day distribution over CZO. The AMSR2 SM products (C1-, C2- and X-bands) are found to have a higher RMSE than SMAP L3, ranging from 0.08-0.1 m^3/m^3. In addition, the ubRMSE for all remotely sensed soil moisture product range from 0.06-0.08 m^3/m^3 with the lowest value for the SMAP L3 and AMSR2 C1. The results in this study can be used further for relevant hydrological modelling along with evaluating various downscaling strategies towards improving the coarser resolution satellite soil moisture.