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Potential of the EUMETSAT snow covered area and snow water equivalent satellite products in hydrologic modeling

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Snow is one of the main water resources, therefore monitoring and estimating the snow water equivalent play important role in predicting discharges during melting seasons. Spatial ground-based observations of snow are often limited at the watershed-scale, therefore satellite snow products besides the ground data can be useful for hydrological modeling. The snow modeling component of a hydrologic modeling system is often calibrated along the rainfall-runoff model using watershed discharge observations. The objective of this study is to evaluate the potential of EUMETSAT snow covered area and snow water equivalent products for improving hydrological simulations in gauged basins. The satellite products have been developed in the framework of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), Satellite Application Facility on Support to Operational Hydrology and Water Management (H-SAF) Project. Snow covered area (SCA) product is generated by using data from Spinning Enhanced Visible and InfraRed Imager (SEVIRI) instrument mounted on the geostationary Meteosat Second Generation (MSG) satellite. The SCA product merges snow cover satellite observations at very high (15 minutes) temporal resolution for the whole northern hemisphere. Snow water equivalent product is generated from microwave data from special sensor microwave imager and sounder (SSMI/S). The accuracy of both snow products is evaluated at 178 meteorological stations in Austria. The assimilation of SCA product to hydrological modeling is performed in the upper Euphrates basin in Turkey and 144 basins in Austria. The results indicate that the 15-minute temporal sampling allows a significant reduction of clouds in the SCA product. The mean annual cloud coverage is less than 30% in Austria, as compared to 52% for the combined MODIS product. The mapping accuracy for cloud-free days is 89% as compared to 94% for MODIS. The largest mapping errors are found in regions with large topographical variability. The assessment of microwave product accuracy indicates a significant underestimation of snow cover at meteorological stations, particularly at locations, which are situated above the mean pixel elevation.
The assimilation of SCA product in multiple objective calibration of a conceptual hydrologic model improved snow and runoff simulation in Euphrates basin. The runoff model efficiency in the validation period is larger (ME=0.74) for multiple objective calibration to MSG-SEVIRI and runoff than to runoff only (ME=0.68). The results for Austrian basins indicate improvement in snow simulations in both the calibration and validation periods. The largest improvement is found in hilly regions of Austria.