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The use of high-resolution atmospheric simulations over mountainous terrain for deriving error correction functions of satellite precipitation products

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Mountainous regions account for a significant part of the Earth's surface. Such areas are persistently affected by heavy precipitation episodes, which induce flash floods and landslides. The limitation of inadequate in-situ observations has put remote sensing rainfall estimates on a pedestal concerning the analyses of these events, as in many mountainous regions worldwide they serve as the only available data source. However, well-known issues of remote sensing techniques over mountainous areas, such as the strong underestimation of precipitation associated with low-level orographic enhancement, limit the way these estimates can accommodate operational needs. Even locations that fall within the range of weather radars suffer from strong biases in precipitation estimates due to terrain blockage and vertical rainfall profile issues.

A novel approach towards the reduction of error in quantitative precipitation estimates lies upon the utilization of high-resolution numerical simulations in order to derive error correction functions for corresponding satellite precipitation data. The correction functions examined consist of 1) mean field bias adjustment and 2) pdf matching, two procedures that are simple and have been widely used in gauge-based adjustment techniques. For the needs of this study, more than 15 selected storms over the mountainous Upper Adige region of Northern Italy were simulated at 1-km resolution from a state-of-the-art atmospheric model (RAMS/ICLAMS), benefiting from the explicit cloud microphysical scheme, prognostic treatment of natural pollutants such as dust and sea-salt and the detailed SRTM90 topography that are implemented in the model. The proposed error correction approach is applied on three quasi-global and widely used satellite precipitation datasets (CMORPH, TRMM 3B42 V7 and PERSIANN) and the evaluation of the error model is based on independent in situ precipitation measurements from a dense rain gauge network (1 gauge / 70 km2) available in the study area. Findings indicate that both correction functions are successful in characterizing the underestimation in the satellite precipitation estimates. Furthermore, it is shown that the correction functions exhibit dependence with synoptic atmospheric conditions, which reveals to a certain degree the predictability of error properties.