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Assesing the temporal and spatial performance of satellite-based rainfall estimates across the complex topographical and climatic gradients of Chile

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Accurate representation of the real spatio-temporal variability of catchment rainfall inputs is currently severely limited. Moreover, spatially interpolated catchment precipitation is subject to large uncertainties, particularly in developing countries and regions which are difficult to access. Recently, satellite-based rainfall estimates (SRE) provide an unprecedented opportunity for a wide range of hydrological applications, from water resources modelling to monitoring of extreme events such as droughts and floods.

This study attempts to exhaustively evaluate -for the first time- the suitability of seven state-of-the-art SRE products (TMPA 3B42v7, CHIRPSv2, CMORPH, PERSIANN-CDR, PERSIAN-CCS-adj, MSWEPv1.1 and PGFv3) over the complex topography and diverse climatic gradients of Chile. Different temporal scales (daily, monthly, seasonal, annual) are used in a point-to-pixel comparison between precipitation time series measured at 366 stations (from sea level to 4600 m a.s.l. in the Andean Plateau) and the corresponding grid cell of each SRE (rescaled to a 0.25° grid if necessary). The modified Kling-Gupta efficiency was used to identify possible sources of systematic errors in each SRE. In addition, five categorical indices (PC, POD, FAR, ETS, fBIAS) were used to assess the ability of each SRE to correctly identify different precipitation intensities.

Results revealed that most SRE products performed better for the humid South (36.4-43.7°S) and Central Chile (32.18-36.4°S), in particular at low- and mid-elevation zones (0-1000 m a.s.l.) compared to the arid northern regions and the Far South. Seasonally, all products performed best during the wet seasons autumn and winter (MAM-JJA) compared to summer (DJF) and spring (SON). In addition, all SREs were able to correctly identify the occurrence of no rain events, but they presented a low skill in classifying precipitation intensities during rainy days. Overall, PGFv3 exhibited the best performance everywhere and for all time scales, which can be clearly attributed to its bias-correction procedure using 217 stations from Chile. Good results were also obtained by the research products CHIRPSv2, TMPA 3B42v7 and MSWEPv1.1, while CMORPH, PERSIANN-CDR and the real-time PERSIANN-CCS-adj were less skillful in representing observed rainfall. While PGFv3 (currently available up to 2010) might be used in Chile for historical analyses and calibration of hydrological models, the high spatial resolution, low latency and long data records of CHIRPS and TMPA 3B42v7 (in transition to IMERG) show promising potential to be used in meteorological studies and water resources assessments. We finally conclude that despite improvements of most SRE products, a site-specific assessment is still needed before any use in catchment-scale hydrological studies.