Local-Time Aggregation of Satellite Precipitation (IMERG) and Its Daily Agreement with Georgian Hydrometeorological Station Data

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Satellite precipitation products, most notably NASA's Global Precipitation Measurement (GPM) mission's Integrated Multi-satellite Retrievals for GPM (IMERG), are widely used in hydrology and climate assessment. However, its standard "daily" product is accumulated over a Coordinated Universal Time (UTC) window (00:00–24:00 GMT), whereas the meteorological stations of Georgia's National Environmental Agency (NEA) record precipitation over a hydrological day window — 19:00 to 19:00 local time. Georgia's UTC offset is +4/+5 hours (winter/summer, accounting for Daylight Saving Time, DST), meaning the UTC calendar day begins at 04:00/05:00 local time — substantially offset from the starting point of the NEA's hydrological day (19:00 local). As a result of this mismatch, a single storm event may be split across two calendar days, obscuring its true date and magnitude.

This study presents a methodological demonstration for Georgia: half-hourly IMERG data (V07B Final Run, 0.1° resolution, year 2001) were re-aggregated using a local hydrological day window (19:00→19:00, Asia/Tbilisi, DST-aware) and compared against 72 stations of the National Environmental Agency. Results show that local-time aggregation systematically improves agreement: mean Pearson's r increases from 0.25 to 0.46 (explained variance rising from 6% to 21%, a 3.4-fold increase), mean RMSE decreases by 15% (8.15 → 6.90 mm/day), while the systematic bias remains unchanged (+0.14 mm/day) — indicating that only the temporal attribution of events is altered. Of the 72 stations, 67 (93%) show improvement; the Wilcoxon signed-rank test provides very strong evidence against the null hypothesis ($p < 10^{-12}$); Cohen's d = 1.79 indicates a very large effect size.

The effect is systematic across every stratification examined: climate zones (Köppen–Geiger; Kruskal–Wallis $p = 0.029$, maximum in the Cfa/Cfb group), seasons ($p < 10^{-7}$, maximum in summer, JJA), elevation ($r = -0.43$, $p < 0.001$ — the effect diminishes with altitude), and categorical skill scores (CSI at the 5 mm threshold improving by +47%). Q–Q analysis confirms that only the temporal attribution changed, not the magnitude calibration.

This study constitutes a one-year pilot demonstration for Georgia. Before generalizing these conclusions, further work is required: a multi-year extension, a pixel-extraction sensitivity analysis, and direct evidence of the diurnal cycle; in a subsequent stage, the methodology is intended to be applied to assessing the rainfall thresholds that trigger landslides in Georgia.