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Assessment of high-resolution physical and AI-based precipitation forecasts in the Ecuadorian Tropics

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Accurate precipitation forecasting remains challenging, particularly in regions with complex terrain and sparse observational networks. This study evaluates precipitation forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF), the Integrated Forecasting System (IFS), and Artificial Intelligence/Integrated Forecasting System (AIFS) (ECMWF, 2024, 2025), including experimental models trained on the Integrated Multi-satellite Retrievals for GPM (IMERG) and Multi-Source Weighted-Ensemble Precipitation (MSWEP) datasets, the high-resolution (4km) model developed within the Destination Earth (DestinE) initiative (ECMWF et al., 2025)**,** and the GraphCast model (Lam et al., 2022). The evaluation is based on 2 years of observational data (2023–2024) from 30 Ecuadorian weather stations in coastal and Andean regions and considers forecast lead times of 1-10 days. Throughout the evaluation period, AIFS exhibits the highest overall predictive skill, whereas DestinE is most effective at identifying extreme precipitation events. Most models display a marked positive bias, particularly within the Andean region. AIFS models trained on IMERG and MSWEP demonstrate the lowest bias and highest skill, as indicated by the Stable Equitable Error in Probability Space (SEEPS) (Rodwell et al., 2010) and the Equitable Threat Score (ETS). The Frequency Bias Index (FBI) decreases across all models as thresholds increase from the 90th to the 99th percentile, with consistently elevated FBI values observed over mountainous terrain. AIFS (IMERG) achieves the best overall performance, while GraphCast demonstrates the lowest skill in both total and mountainous regions. Overall, in the Ecuadorian tropics, AI-based models generally outperform physical models, except during extreme precipitation events, when physical models remain more reliable. These results underscore the critical importance of training data for AI-based systems and the ongoing challenges of forecasting high-impact precipitation across both operational and experimental models.

Keywords: Precipitation forecasting, artificial intelligence, ECMWF, GraphCast, Ecuador, extreme rainfall

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