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Exploring a machine learning model as radar rainfall retrieval of the highest X-band radar in the world

Johanna Orellana-Alvear (1,2), Rolando Célleri (2), Rütger Rollenbeck (1), and Jörg Bendix (1)

(1) Laboratory for Climatology and Remote Sensing, Faculty of Geography, University of Marburg, Marburg, Germany, (2) Departamento de Recursos Hídricos y Ciencias Ambientales, Universidad de Cuenca, Cuenca, Ecuador (johanna.orellana@ucuenca.edu.ec)

Quantitative precipitation estimation (QPE) from weather radar data is crucial for hydrological applications, which benefit of the high spatio-temporal resolution of X-band radar imagery. Nonetheless, radar rainfall retrieval process involves a challenging correction of reflectivity, which is particularly difficult for single polarized technology. In addition, high mountain topography as the Andean cordillera deeply increases the complexity of radar QPE. This study explores a Random Forest (RF), state-of-the-art data-driven model, for optimizing the radar rainfall derivation of the highest X-band radar in the world (4450 m a.s.l.) by means of single Plan Position Indicator (PPI) scans. Several features were derived from raw reflectivity to account for the evolution of rainfall along the beam. Performance of the RF model was evaluated in comparison with the well-known step-wise approach. For this, the Marshall-Palmer and a site-specific Z-R relationship were used. The bias adjustment step was omitted from the step-wise correction chain due to the lack of evenly distributed gauge networks in mountain regions. Results showed that the step-wise approach slightly improved when using the site-specific instead of the Marshall-Palmer Z-R relationship. However, both models performed poorly for radar QPE ($R^2 < 0.1$). Conversely, the RF model remarkably outperformed the other models in all different testing locations and rainfall events (R^2 up to 0.85). This is the first time a QPE random forest model is applied on single polarized X-band radar imagery. The results are outstanding and provide a simplified model to overcome the complexity of deriving QPE from single polarized radars. Further work will focus on blending techniques to enhance the radar rainfall maps obtained using this RF model.