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Estimation of terrestrial latent heat flux over Qilian Mountains by the fusion of five satellite-derived products using Extremely Randomized Trees

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The latent heat flux (LE) governs the associated heat flux from the interactions between the land surface and its atmosphere and plays an important role in the surface water and energy balance. The Qilian Mountains is the largest marginal mountain system in the northeast of the Qinghai-Tibet Plateau. An accurate representation of spatio-temporal patterns of LE over Qilian Mountains is essential in many terrestrial biosphere, hydrosphere, and atmosphere applications. Various satellite-derived LE products have been widely used to estimate terrestrial LE, yet each individual LE product exhibits large discrepancies. To reduce uncertainties from individual product and improve terrestrial LE estimation over Qilian Mountains, we produced five satellite-derived LE products using traditional algorithms based on Moderate Resolution Imaging Spectroradiometer (MODIS) NDVI, LAI products and China Meteorological Forcing Dataset (CMFD), and implemented the fusion of these five LE products using Extremely Randomized Trees (Extra-Trees) combining information from ground-based measurements. A validation using ground-based measurements was applied at different plant function types and the validation results demonstrate that the fusion product using Extra-Trees outperformed all the LE products used in the fusion method. Comparing with three other machine learning fusion models such as Gradient Boosting Regression Tree (GBRT), Random Forest (RF) and Gaussian Process Regression (GPR), Extra-Trees exhibits the best performance in terms of both training and validation accuracy. This fusion LE product also outperformed when compared against two state-of-the-art global LE products such as Global Land Surface Satellite (GLASS) and Moderate Resolution Imaging Spectroradiometer (MODIS). The fusion LE product showed improvements in the linear correlation, bias and RMSE at different plant function types. Our results suggest that the fusion method using Extra-Trees could be successfully applied to other region and to enhance the estimation of other hydrometeorological variables.