Geophysical Research Abstracts
Vol. 21, EGU2019-3704-2, 2019
EGU General Assembly 2019

Using a Machine Learning Algorithm for Spatial Downscaling of Satellite Precipitation Products

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Precipitation measurements are traditionally performed using rain-gauges. Rain-gauges are the most reliable source of precipitation observations and are used in most studies as a reference to compare and validate satellite data. However, they have limited spatial coverage and are irregularly spaced. Satellite Precipitation Estimates (SPEs) have been widely used in various applications. However, when applied to small basins and regions, the spatial resolution of SPEs are too coarse. Since precipitation within a region may occur at finer scales compared with the pixel size of satellites, satellite data should be sufficiently accurate before used as inputs to the hydro-meteorological and water management models. In this study, a machine learning-based downscaling algorithm on the basis of the relationships between SPEs and cloud optical and microphysical properties is conducted in northeast Austria. The artificial neural networks (ANN) and spline interpolation were adopted for downscaling of Integrated Multi-satellitE Retrievals for GPM (IMERG-FR V05B) precipitation data. In this regard, a non-linear relationship among IMERG data and different cloud variables, such as cloud effective radius (CER), cloud optical thickness (COT), and cloud water path (CWP) were evaluated. Downscaled SPEs, as well as the original IMERG product, were subsequently validated using 62 rain-gauges in a daily time-scale according to five heavy precipitation events in 2015. The downscaled results before and after residual correction were also validated to assess the impact of residual correction. The residual maps indicate the areas where part of the precipitation cannot be solely explained by cloud variables.
According to the results, both downscaled products after the residual correction were more accurate than before the residual correction and the original IMERG data. In addition, the downscaled products captured the spatial patterns of precipitation reasonably well with more detailed information when compared with the original IMERG precipitation. Moreover, the presented method, which showed increased correlation and reduced mean absolute error and root mean square error for the average of all events, can more accurately produce downscaled precipitation data.

Reference:
Sharifi, E., Saghafian, B., & Steinacker, R. (2019). Downscaling Satellite Precipitation Estimates with Multiple Linear Regression, Artificial Neural Networks and Spline Interpolation Techniques. Journal of Geophysical Research: Atmospheres, 124. https://doi.org/10.1029/2018JD028795.