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Applying image morphing to precipitation data, a case study in Southern Ghana

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Estimating rainfall accurately is difficult because of its high spatial and temporal variability. This is especially true for localized events, such as the convective rainstorms that produce most of the rainfall in sub-Saharan Africa during the monsoon season. Many satellite-based rainfall estimates are available with ever increasing resolution. However, precipitation is not measured directly, it is derived from other variables measured by the satellites. This can lead to errors in the position and shape of the rain events in addition to errors in rainfall intensity. For some applications, such as hydrological modeling, flash flood warnings, or data assimilation in numerical weather model, detecting the correct position of the rain events is as important as their intensity.

Many satellite-based estimates use gauge information for bias correction. However, bias adjustment methods do not correct the position errors explicitly. We propose a method to gauge-adjust satellite-based estimates with regard to the position, based on morphing and registration techniques from image processing. Morphing uses warping and cross-dissolving to smoothly transform an image into another. Thus, both the intensity and the position are taken into account. The warping is based on a spatial mapping. This mapping is found through the registration method. We use an automatic registration that requires two images (in our case two rainfall fields) as inputs. The rain events do not need to be pre-defined manually.

We present the results of the morphing-adjustment applied to a rainfall event occurring during the monsoon season in the South of Ghana. We use the Trans-African Hydro-Meteorological Observatory (TAHMO) gauge network to gauge-adjust IMERG-Late (Integrated Multi-Satellite Retrievals for GPM) satellite-based estimates. The TAHMO measurements are interpolated on the same grid as IMERG, and then used in the automatic registration. The obtained mapping is applied to IMERG estimates to correct the positions error while preserving IMERG's spatial variability.