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Seasonal and long-term rainfall and cloud dynamics in the Mt. Kilimanjaro region as observed from local and remote sensing time series

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The melting glaciers of Mt. Kilimanjaro have become a synonym for global change. In contrast, the non-glaciated areas receive much less public attention. Aside from a brief examination of air-temperature, in-situ rainfall and remotely sensed cloud dynamics are analyzed to determine seasonal and long-term climate trends in the Mt. Kilimanjaro region in this study.

The in-situ air-temperature is based on NOAA'S GSOD datasets, the in-situ rainfall data is obtained from the Tanzania Meteorological Agency. Both datasets span from 1973 to 2013. Rainfall data was obtained from two in-situ stations at Moshi and Kilimanjaro Airport, both situated in the Kilimanjaro area, which were considered to be representative at least for the greater region after correlation analysis with in-situ station data from the southern slopes of Mt. Kilimanjaro.

While a temperature increase of about 0.29 K per decade can be identified, no long-term rainfall trends are observable. However, humid and dry decades are evident with so called "short" (with a peak around December) and "long" (March to May) rains. Seasonality has changed especially during the long rains between March and May.

As rainfall and cloud cover were analyzed with respect of the status of El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) some seasonal dynamics could be linked to these large-scale drivers. Characteristic seasonal patterns related to ENSO and IOD teleconnections show enhanced rainfall in the onset year and in the post-ENSO year for most El Niño events. During La Niña years, rainfall increases in the following year, while for the onset year scenarios must be regarded differentiated. Positive IOD events lead to enhanced rainfall amounts, highlighting the importance of IOD events in modifying ENSO related rainfall dynamics in the Kilimanjaro area

Additionally, cloud dynamics have been analyzed using daily Aqua-MODIS cloud products between 2002 and 2013. In contrast to the rainfall dynamics, cloud frequencies are much less influenced by ENSO and IOD. As cloud cover analysis were based on three sub-regions resulting from a spatial clustering model, different patterns appeared. The cloud cover in the northwestern area showed greatest similarity to rainfall patterns, especially during the rainy seasons. Regardless of ENSO, positive IOD events lead to distinctly enhanced cloud cover from May to August, emphasizing once more the pronounced influence of IOD events in the Kilimanjaro region.