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Rainfall estimation from commercial microwave links and METEOSAT SEVIRI cloud cover information in West Africa and Germany

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Flash floods and droughts cause major hazards to the population and economy of Sub-Saharan West African countries. Some of the impact could be eased by appropriate water management, which requires near-real time and accurate precipitation quantification. However, only very few radar systems exist in West Africa which can provide these data. At the same time, access to rain gauge data is declining worldwide, particularly in West Africa. A recent promising method is to derive rain rates from the attenuation of the microwave signal between mobile phone base stations, so called commercial microwave links (CMLs) due to rain drops falling between the antennas. With a rapidly increasing number of mobile phone users, also the CML network in West Africa is growing, thus providing a high potential for CML-derived precipitation measurements in the future.

To distinguish non-rain related CML signal fluctuations from actual attenuation due to rain, a temporal wet (rain event occurred)/dry (no rain event) classification is usually necessary. In this work, we investigate the use of information on cloud microphysical properties derived from the Spinning Enhanced Visible and Infrared Imager (SEVIRI) radiometer onboard the geostationary satellite METEOSAT for wet/dry-classification. For satellite pixels along the CMLs we test various ‘wet’ criteria based, e.g., on the SEVIRI derived cloud water path, effective radius and cloud phase. We apply these criteria to data from CMLs in Burkina Faso and Germany, which differ in technical aspects (CML frequencies, path lengths, signal level, signal-to-noise ratio) and meteorologically (rain rate and rain event duration, droplet size distributions). The CML-derived rain rates are compared to radar and gauge reference data in Germany and Burkina Faso, respectively.

For the German CMLs, which show a better signal-to-noise ratio and less non-rain-related attenuation, the satellite-based wet/dry classification methods yield similar results for rain event detection compared to a wet/dry classification method based on the signal’s variability. In case of the CMLs in Burkina Faso, where the signal is disturbed by several non-rain related factors, the rain event detection is improved by the satellite data compared to the statistical method. However, correlation of CML rain rates with gauge measurements is still low.

The results show that the geostationary satellite data can improve precipitation detection by CMLs when the signal-to-noise ratio is otherwise not sufficient and performs comparable to a method solely based on the signal variability for CMLs where non-rain-induced attenuation is low. Thus, in otherwise data scarce regions in West Africa, a combined CML-SEVIRI method may yield crucial precipitation information in a timely manner.