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Towards innovative solutions for monitoring climate variables in observation poor regions: Rain Measurement based on cellular phone networks in Africa

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The pressure on water resources and water-related risks (floods and droughts) are increasing in the Tropics. Rainfall is the main source of water for the hydrological and agronomical system, and accurate rainfall monitoring is needed for many other applications. Many questions remain regarding the effect of climate on rainfall variability, a possible intensification of rainfall and increase in the occurrence of extreme events. The availability of high-resolution rainfall information over the continental tropics is essential to tackle these questions. Satellite remote sensing provides very useful information on rainfall, however the uncertainties of satellite rainfall products in the Tropics, and their performance at high resolution are still investigated. Accurate and robust ground- based rainfall measurement remains a crucial element, for satellite product evaluation or for urban applications. Confidence in future precipitation scenarios is currently subject to large uncertainties and can only be assured if there is a comprehensive understanding of the processes controlling rainfall variability, made possible through reliable rainfall records. Unfortunately in many part of the Tropics the ground based gauge networks are sparse, often degrading and accessing this data for process studies, climatological analysis or for validating satellite products is sometime difficult ; also weather radar networks are not as developed in the Tropics as they are in Europe or North America.

Here a novel approach is presented. It is based on using commercial microwave links from cellular telephone networks to detect and quantify rainfall. The technique can provide accurate rainfall mapping in areas with poor rain gauge or weather radar coverage. The technique is based on measuring microwave signal attenuation by rainfall. A key advantage of using cellular communication networks for weather observations is that the infrastructure, i.e. the MW-link network, is already in place and is maintained to the highest standards by the telecom companies.

Rainfall monitoring based on commercial terrestrial microwave links has been tested for the first time in Burkina Faso, in Sahelian West-Africa (Doumounia et al., 2014 ; GRL). In collaboration with one national cellular phone operator, Telecel Faso, the attenuation on a 29 km long microwave link operating at 7 GHz was monitored at 1s time rate for the monsoon season 2012. The time series of attenuation is transformed into rain rates and compared with rain gauge data. The method is successful in quantifying rainfall: 95% of the rainy days are detected. The correlation with the daily raingauge series is 0.8 and the season bias is 5%. The correlation at the 5 min time step within each event is also high.

These results demonstrate the potential interest of exploiting national and regional wireless telecommunication networks for monitoring rainfall in the Tropics, where operational rain gauge networks are degrading, the hydro-meteorological risk is increasing and cellular communication networks developing rapidly.