Long-term country-wide rainfall mapping employing cellular communication networks

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Accurate rainfall observations with high spatial and temporal resolutions are needed for hydrological applications, agriculture, meteorology, and climate monitoring. However, the majority of the land surface of the earth lacks accurate rainfall information and the number of rain gauges is even severely declining in Europe, South-America, and Africa. This calls for alternative sources of rainfall information. Various studies have shown that microwave links from operational cellular telecommunication networks may be employed for rainfall monitoring. Such networks cover 20% of the land surface of the earth and have a high density, especially in urban areas.

The basic principle of rainfall monitoring using microwave links is as follows. Rainfall attenuates the electromagnetic signals transmitted from one telephone tower to another. By measuring the received power at one end of a microwave link as a function of time, the path-integrated attenuation due to rainfall can be calculated. Previous studies have shown that average rainfall intensities over the length of a link can be derived from the path-integrated attenuation. This is particularly interesting for those countries where few surface rainfall observations are available. Here we present almost two years of country-wide rainfall maps employing cellular communication networks.

A data set from a commercial microwave link network over the Netherlands is analyzed, containing data from an unprecedented number of links (~ 2000) covering the land surface of the Netherlands (35500 square kilometers). This data set almost completely covers the years 2011 and 2012. Fifteen-minute and daily rainfall maps (1 km spatial resolution) are derived from the microwave link data and compared to maps from a gauge-adjusted radar data set. The performance of the rainfall retrieval algorithm is studied, particularly differences in time and space. Time series of air temperature from automatic weather stations, operated by the Royal Netherlands Meteorological Institute, are used to systematically study the performance of the algorithm during the two-year period for different temperature classes. Moreover, we present case studies to investigate the performance of the algorithm during snow and sleet and to show the influence of dew formation on the antennas on the received signal levels.