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Big commercial microwave link data: Detecting rain events with deep learning

Julius Polz[1], Christian Chwala[1,2], Maximilian Graf[1], and Harald Kunstmann[1,2]
[1]Karlsruhe Institute of Technology (KIT), Campus Alpin, Institute of Meteorology and Climate Research - Atmospheric Environmental Research (IMK-IFU), Garmisch-Partenkirchen, Germany (julius.polz@kit.edu)
[2]Institute of Geography, Regional Climate and Hydrology, University of Augsburg, Augsburg, Germany

Commercial microwave links (CMLs) can be used for quantitative precipitation estimation. The measurement technique is based on the exploitation of the close to linear relationship between the attenuation of the signal level by rainfall and the path averaged rain rate. At a temporal resolution of one minute, the signal level of almost 4000 CMLs distributed all over Germany is being recorded since August 2017, resulting in one of the biggest CML data sets available for scientific purposes. A crucial step for retrieving rainfall information from this large CML data set is to accurately detect rainy periods in the time-series, a process which is hampered by strong signal fluctuations, occasionally occurring even when there is no rain. In our study, we evaluate the performance of convolutional neural networks (CNNs) to distinguish between rainy and non-rainy signal fluctuations by recognizing their specific patterns. CNNs make use of many layers and local connections of neurons to recognize patterns independent of their location in the time-series. We designed a custom CNN architecture consisting of a feature extraction and classification part with 20 layers of neurons and 1.4×10^5 trainable parameters. To train the model and validate the results we refer to the gauge-adjusted radar product RADOLAN-RW, provided by the German meteorological service. Despite not being an absolute truth, it provides robust information about rain events at the CML locations at an hourly time resolution. With only 400 CMLs used for training and 3504 for validation, we find that CNNs can learn to recognize different signal fluctuation patterns and generalize well to sensors and time periods not used for training. Overall we find a good agreement between the CML and weather radar derived rainfall information by detecting on average 87 % of all rainy and 91 % of all non-rainy periods.