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Deep Learning for Multimodal Precipitation Estimation: From Research to Operationalization

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Deep Learning (DL) has seen multiple successes in Artificial Intelligence (AI) applications, such as image and text generation, visual recognition, and speech recognition. Its popularity has grown beyond AI, with wide usage in geoscience applications like meteorology, where large datasets are available for training DL models.

At the Royal Meteorological Institute of Belgium (RMIB), we studied the application of DL for precipitation estimation, particularly to merge multiple data modalities like rain gauges, weather radars, and satellite radiometer images. A model combining these modalities offers improved coverage compared to traditional methods that rely on radar scans corrected by rain gauges. Additionally, a well-trained DL model could provide more accurate precipitation estimates.

We developed a Convolutional Neural Network (CNN) at RMIB that uses automatic rain gauge measurements, the OPERA radar composite, and infrared satellite channels of SEVIRI as inputs. The CNN employs an encoder-decoder architecture to perform a multiscale analysis of these inputs, simultaneously estimating rainfall probability and precipitation rate. The model was trained and evaluated on a dataset spanning five years (2015-2019) and covering Belgium, the Netherlands, and Germany. Our DL method was validated using an independent rain gauge dataset for both instantaneous rain detection and rain rate estimation, as well as for daily precipitation accumulation. The results showed a significant improvement over the OPERA radar composite product.

Our method is currently being developed for operationalization at RMIB and will run in near real-time. Encouraged by these results, we are also studying the application of this method to dual polarization radar variables to further enhance the accuracy of precipitation estimation.

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