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Predicting spatial precipitation extremes with deep learning models. A comparison of existing model architectures.

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The rapid development of deep learning approaches has conquered many fields, and precipitation prediction is one of them. Precipitation modeling remains a challenge for numerical weather prediction or climate models, and parameterization is required for low spatial resolution models, such as those used in climate change impact studies. Machine learning models have been shown to be capable of learning the relationships between other meteorological variables and precipitation. Such models are much less computationally intensive than explicit modeling of precipitation processes and are becoming more accurate than parametrization schemes.

Most existing applications focus either on precipitation extremes aggregated over a domain of interest or on average precipitation fields. Here, we are interested in spatial extremes and focus on the prediction of heavy precipitation events (>95th percentile) and extreme events (>99th percentile) over the European domain. Meteorological variables from ERA5 are used as input, and E-OBS data as target. Different architectures from the literature are compared in terms of predictive skill for average precipitation fields as well as for the occurrence of heavy or extreme precipitation events (threshold exceedance). U-Net architectures show higher skills than other variants of convolutional neural networks (CNN). We also show that a shallower U-Net architecture performs as well as the original network for this application, thus reducing the model complexity and, consequently, the computational resources. In addition, we analyze the number of inputs based on the importance of the predictors provided by a layer-wise relevance propagation procedure.