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Near Surface Ozone Predictions Based on Multiple Artificial Neural Network Architectures

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Artificial neural networks (ANNs) are well suited to solve complex and highly non-linear problems. Various machine learning architectures like convolutional neural networks (CNNs) and Long Short-Term Memory networks (LSTMs), both subclasses of ANNs, are applied to the prediction of near surface ozone concentrations (dma8eu) for a lead time of up to four days at 51 measurement sites in southern Germany. Only stations with at least 3500 days of valid data between 1997 and 2015 were used, while the first 80% of the data were used for training and the remaining 20% for testing and validation. Forecasts were evaluated with respect to other continuous predictions from climatological, persistence and ordinary least square (ols) models. Furthermore, the quality of threshold exceedance predictions for varying thresholds was analysed based on the joint distribution of forecasts and observations. Finally, it was examined which input variables are most important to generate skilful predictions. The results of all three analyses will be presented for all network architectures.
For example, experiments with a CNN architecture show that those networks outperform ols and persistence predictions on all four days. The climatological predictions, however, are outperformed at the first two days, only. On day three and four the CNN's skill score with respect to multivalued climatological forecasts decreased with time, indicating no added value on those days as the scores no longer differ substantially. The CNNs performed best for continuous ozone predictions between the 20% and the 80% percentile, but cannot generate skilful predictions for higher or lower concentrations due to imbalanced training data. The quality of forecasts was determined primarily by the previous day's ozone concentration. Of all other input variables, which were selected based on their importance for ozone formation and air mass transport, only temperature and the wind's v-component had a small impact on forecast quality.