Contribution ID: **86** Type: **not specified**

Application of a predictive recurrent neural network for quantitative precipitation nowcasting

Tuesday 18 March 2025 14:30 (15 minutes)

Deep learning has recently become a very effective tool in radar meteorology for precipitation nowcasting. Predictive deep learning aims to learn time series and sequential data to predict future sequences, where the data is assumed to have modular structures. A predictive recurrent neural network (PredRNN) has been implemented with spatiotemporal long and short-term memory (ST-LSTM) units and additional connections between time steps and forces memory states to flow throughout the network. The model is further extended with a decoupling and reverse sampling mechanism to learn long and short-term dynamics to model the shape deformation and motion trajectories more efficiently. Polarimetric rainfall retrievals based on specific attenuation AH and specific differential phase KDP (R(AH, KDP)) are developed within the research unit RealPEP by using the Polara C++ platform from the German Weather Service (DWD). The generated rainfall maps with 5-minute temporal resolution covering the whole of Germany are fed into the PredRNN model. We investigated daily precipitation events and resized composite images for efficient data management. So far a total of 192 sequences (18 images per sequence) have been used to train, while 48 sequences are used to test the model. For the model evaluation, 6 sequential input images are used to predict the future 12 images. The PredRNN model is also opposed to an extended version of the spectral prognosis model (SPROG-LOC), which estimates spatially localized parameters of the inherent auto-regressive (AR) process. A primary comparison with SPROG-LOC showed that PredRNN outperforms. However, the experiment is still preliminary, and the best hyperparameter set has yet to be found. We will also train the model with the polarimetric radar variables to investigate further improvements. Furthermore, we aim to exploit the PredRNN to combine the predictive information content of radar measurements with satellite-based retrievals, e.g. MTG-FCI satellite-based cloud products and probability index fields for convective initiation, to further improve the lead time.

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Session

Prediction Scales and Model Development: Modeling elements in nowcasting

Preferred Contribution Type

Oral Presentation

VAT

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