A Two-D Convolutional Neural Network (CNN) Short-term Probabilistic Forecast of Thunderstorms

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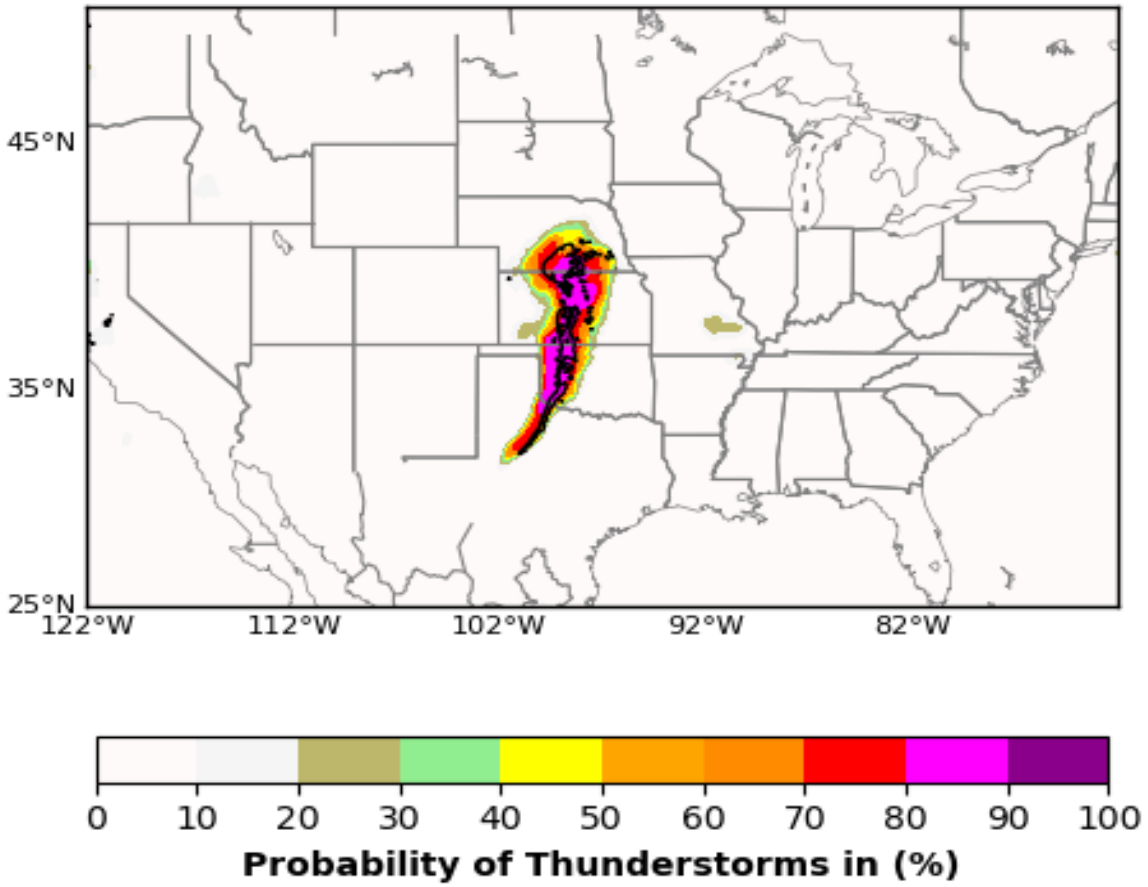
Abstract. Artificial Intelligence (AI) techniques such as Convolutional Neural Networks (CNN) can provide a powerful data integration tool for weather forecasting. A supervised Two-Dimensional (2-D) Convolutional Neural Network (CNN) model was developed by training the model with 5 years (September 28 – October 31, 2016 and March 1– October 31, 2017 - 2020) of predictors derived from the High-Resolution Rapid Refresh (HRRR) model to produce short range (1 - 8h) CNN Probability of Thunderstorm Forecasts (CNNPTFs) over the Conterminous United States (CONUS). An architecture of three hidden layers of 80 feature detection maps each is used. Of the 22 predictors used in the experimentation, thirteen that provided the most accurate predictions were selected. Multi-Radar/Multi-Sensor (MRMS) Composite Reflectivity (MRMSCRs) data were used as truth data to train the model. CNNPTFs and HRRR Simulated Composite Reflectivity Forecasts (HRRRSCRFs) were produced over our validation period (March to October 2021 and 2022) for each of the HRRR model initiation times. Qualitative validation was performed by comparing CNNPTFs to MRMSCRs for several case studies during the warm season during the validation period. Finally, traditional statistical metrics are computed to objectively verify the skill of CNNPTFs against that of HRRRSCRFs. Compared to the performance of the HRRRSCRFs over our validation period, the performance of the CNNPTFs generally exceeds that of HRRRSCRFs.

In this presentation, the CNN technique will be discussed, the methodology will be presented, and results showing the skill of the CNN will be shown. While this research is being undertaken with the goal of improving MDL's thunderstorm forecast guidance, the AI CNN technique has potential application to other post-processing work being done in MDL.



CNNPTFs for lead time 1 based on the HRRR model initialized at 0100 UTC Mar 27, 2023. Black contours correspond to observed MRMSCRs ≥ 35 dBZ at 0200 UTC.