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The University of Colorado Space Weather Technology, Research, and Education Center (SWx TREC) Deep Learning Laboratory: progress in solar eruption and ionospheric scintillation prediction

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The University of Colorado at Boulder Space Weather Technology, Research, and Education Center (SWx TREC) is a national center of excellence in cross-disciplinary research, technological innovation, and education enabling federal agencies, academia, commercial partners and industry to collaboratively address evolving space weather forecasting needs. Working with the Laboratory for Atmospheric and Space Physics (LASP), we have established the Space Weather Deep Learning Laboratory (DLL) to explore the application of modern machine learning techniques to problems of environmental prediction in the Sun-Earth system. This talk reviews our progress in applying deep convolutional neural networks (CNNs), Long Short-Term Memory (LSTM) networks, and feature engineering to the specific problem of solar magnetic eruption prediction. Using NASA's petabyte-scale Solar Dynamics Observatory (SDO) database of multiwavelength solar images and other sources of solar flare data for training, validation, and testing, performance metrics are achieved that outperform current heuristic methods used in operational forecasting. Feature engineering in the form of topological data analysis is applied to solar magnetic field data to improve prediction of eruption onset times. We also review the application of machine learning to the prediction of ionospheric scintillation events that can adversely affect Global Navigation Satellite System (GNSS) reception and positional accuracy. We review this work as well and outline future plans for further progress in the application of deep learning to space weather prediction.