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Multivariate forecasting of tropical cyclones using combined neural networks

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Tropical cyclones (TCs) are hazardous and destructive events that pose a threat to human life every year. Since the beginning of the meteorological observation era, predicting the behavior of cyclones has always been an issue. It has been proven that with climate change due to global warming, the proportion of stronger TCs increases, increasing the danger and potential harm of TCs.
Numerous techniques have been developed over the years and are used in ensembles to detect, predict, and classify TCs. Nevertheless, the tasks in the field of TC prediction are considered challenging because the development of TC systems exhibits nonlinear behavior and depends on many environmental factors.
Conventional TC forecasting methods are computationally intensive and require a relatively large amount of energy and time. Due to ongoing global warming, the behavior of TCs may constantly change and therefore requires the use of modern, environmentally friendly and more flexible learning methods for estimating and predicting the future behavior of TCs.
In recent years, the study of the application of Deep Learning (DL) in this area proved to be highly effective. These methods are designed to facilitate the prediction process, as well as automatically detect possible trends that may occur over time. DL methods provide the most modern statistical analysis and can thus exert their influence on research.
In our research, we have applied a novel approach of incorporating two-dimensional meteorological data to forecast the track and intensity of TCs together with scalar data of location, intensity, and temporal information. We have built and tested numerous sequence-to-sequence forecasting models based on ConvLSTM2D neural network layers and tested two-dimensional data compression using autoencoders as a data preparation technique. Our experiments have shown that the multivariate forecast yields perspective results. We have also succeeded in detecting the influence of recent trends in changes of TC behaviour in recent years and proved the ability of neural networks to fit themselves to those trends.