Contribution ID: **345** Type: **Oral Presentation**

Application of Data-Driven Deep Learning Hybrid Models for Forecasting of Semidiurnal and Diurnal Tides Measured by a SuperDARN HF Radar

Tuesday, 4 July 2023 15:00 (20 minutes)

Semidiurnal and diurnal tides are known to have a significant impact upon the momentum balance in the mesosphere-lower thermosphere (MLT) region, and on the distribution of atmospheric constituents. In general, tidal structures in the middle atmosphere are exceptionally complex, and thus their successful modelling requires consideration of a wide range of atmospheric phenomena, such as radiational, chemical, and dynamical processes. The recent developments in the field of machine learning and deep learning data-driven time series forecasting models have opened an opportunity to forecast complex time series such as atmospheric tide. Therefore, the main aim of this study is to extract and analyze tidal wave information from Kerguelen SuperDARN High-Frequency (HF) radar zonal and meridional wind components using Short-Time Fourier Transform (STFT), and to forecast the tidal waves amplitude time series using hybrid deep learning neural networks models. The model used here is the long short-term memory networks (LSTM) recurrent neural networks (RNNs), a robust data-driven hybrid time series-forecasting model which is based on signal decomposition techniques such as Ensemble Empirical Mode Decomposition (EEMD), and Empirical Wavelet Transforms (EWT). To compare the modelled data to the ground truth, the tidal wave data is divided into 80% training time series and 20% testing time series. In general, the results highlight that the EWT-LSTM model outperforms the other models in terms of accuracy and error reduction in the forecasting of both semidiurnal and diurnal tides. Signal decomposition seems to enhance the performance of the model when compared to the use of the LSTM model as a standalone.

Keywords: Tides, LSTM, forecasting, Middle Atmosphere, neural networks
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Apply to be considered for a student ; award (Yes / No)?

N/A

Level for award;(Hons, MSc, PhD, N/A)?

N/A

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Session Classification: Astrophysics & Space Science

Track Classification: Track D2 - Space Science