System identification models for waves in the inner magnetosphere

Richard Boynton\(^1\), Homayon Aryan\(^{1,2}\), Walker Simon\(^1\), and Michael Balikhin\(^1\)
\(^1\)University of Sheffield, Sheffield, United Kingdom of Great Britain and Northern Ireland (r.boynton@sheffield.ac.uk)
\(^2\)UCLA, CA, USA

This research develops forecast models of the spatiotemporal evolution of emissions throughout the inner magnetosphere between L=2-6 and at all MLT. The system identification, or machine learning, technique based on Nonlinear AutoRegressive Moving Average eXogenous (NARMAX) models is employed to deduce the forecasting models of the lower band chorus, Hiss, and magnetosonic waves using solar wind and geomagnetic indices as inputs. It is difficult to develop machine learning based spatiotemporal models of the waves in the inner magnetosphere as the data is sparse and machine learning techniques require large amounts of data to deduce a model. To solve this problem, the spatial co-ordinates at the time of the measurements are included as inputs to the model along with time lags of the solar wind and geomagnetic indices, while the measurement of the waves by the Van Allen Probes are used as the output to train the models. The estimates of the resultant models are compared with separate data to the training data to assess the performance of the models. The models are then used to reconstruct the spatiotemporal waves over the inner magnetosphere, as the waves respond to changes in the solar wind and geomagnetic indices.