cisess
Cooperative Institute for Satellite Earth System Studies

LSTM-Based Forecasting and Anomaly Detection of LAI Satellite Image Time Series

LSTM

Alan Wang
Mentor: Heshun Wang

Objectives

Background:
- LAI represents the amount of leaf material in a canopy.
- LAI is key towards land surface and climate modeling research.

Problem: LAI SITS contains high-level noise and data gaps.

Purpose: Leverage LSTM models to address the mechanical and environmental factors impacting LAI SITS.
- Outlier Detection
- Data Reconstruction
- Forecasting

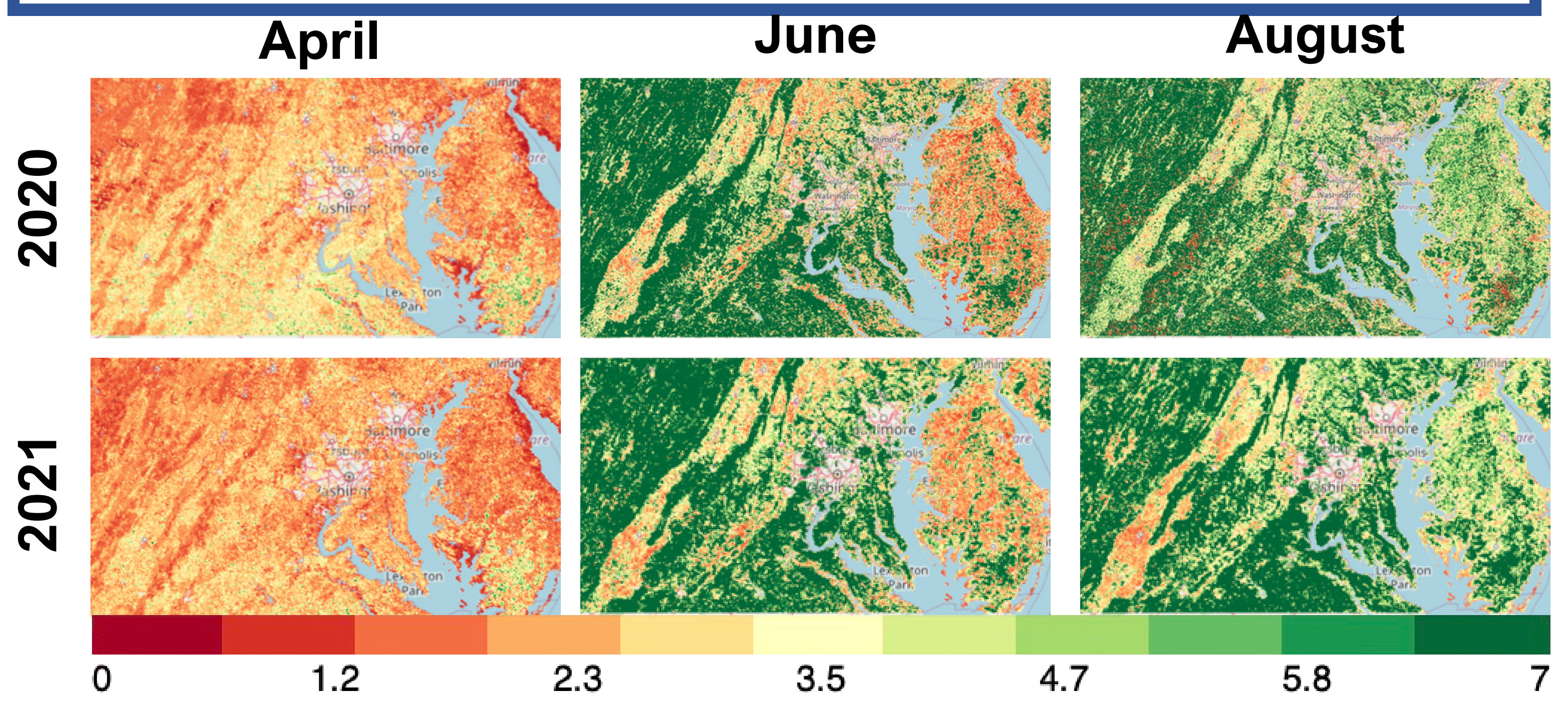

Figure 1. geepmap visualization of LAI values (2020-2021)

K-Means Clusters of LAI Time Series in Maryland (2020-2022)

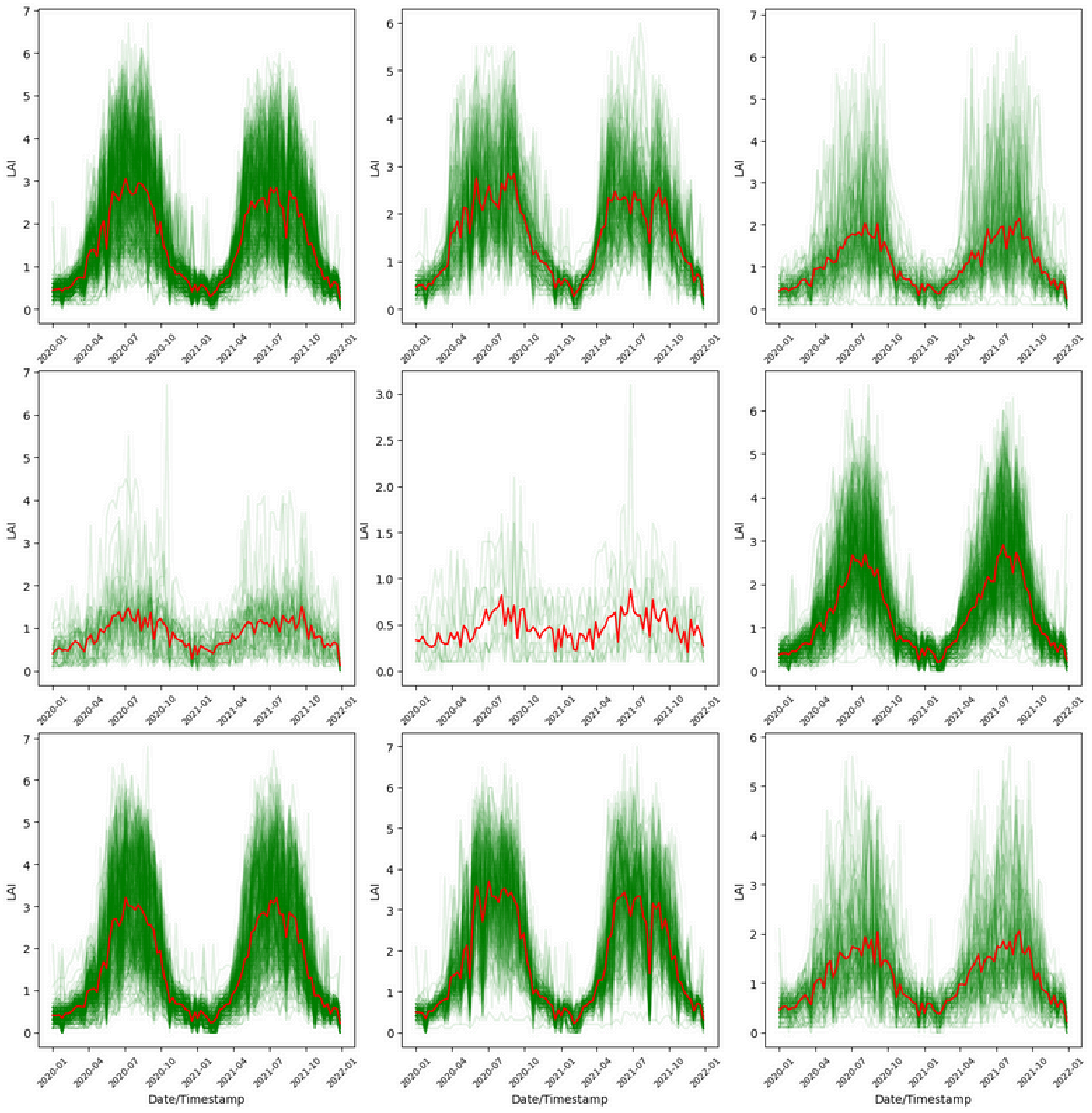

Figure 2. TimeSeriesKMeans clustering based on dynamic time warping.

Methodology/Data

Datasets:
- VNP15A2H: LAI/FPAR 8-Day L4 Global 500m SIN Grid
- SRTM Digital Elevation Model

Procedure:
- Extract features from LAI raster data.
- Apply feature engineering.
- Assess model performance using MAE and R-Squared
- Adjust feature engineering process and model parameters based on performance metrics.

Abbreviations:
- LAI - Leaf Area Index
- SITS - Satellite Image Time Series
- LSTM - Long Short Term Memory
- SRTM - Shuttle Radar Topography Mission
- DEM - Digital Elevation Model
- MAE - Mean Absolute Error

LSTM-Based Forecasting and Anomaly Detection of LAI Satellite Image Time Series

Alan Wang

Mentor: Heshun Wang

Cooperative Institute for Satellite Earth System Studies (CISESS)

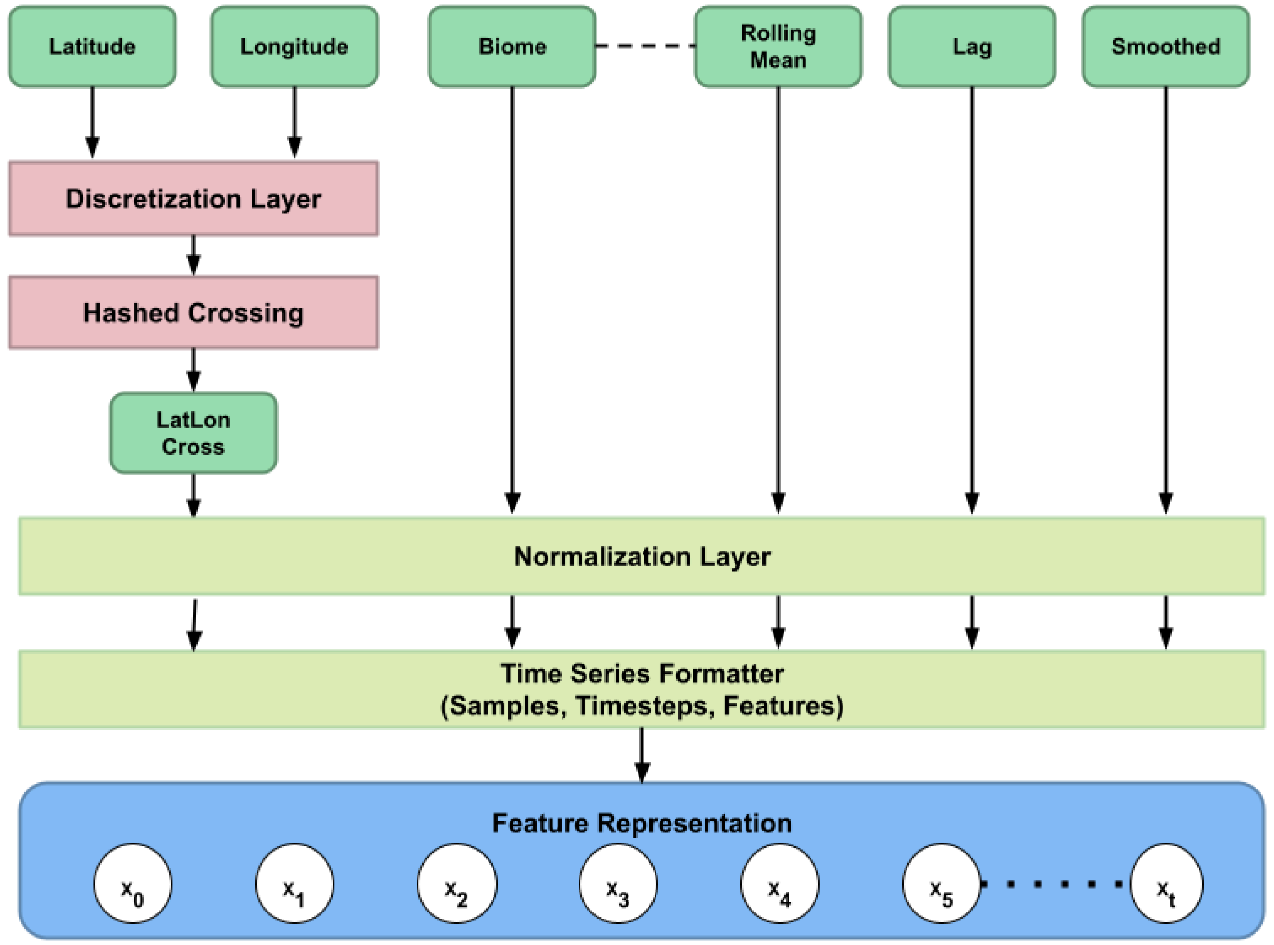

Fig 3. Pipeline for transforming feature data

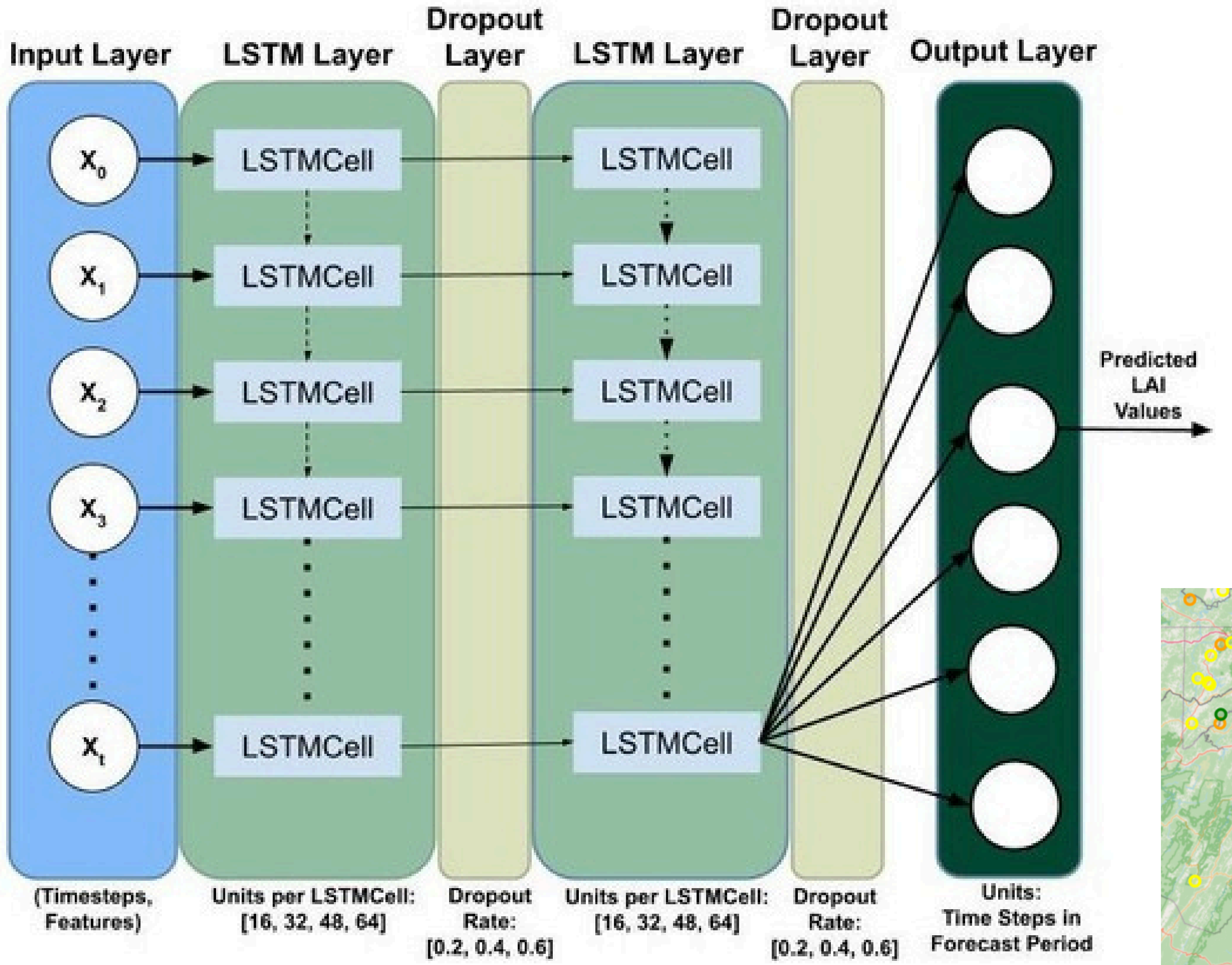

Fig 4. Architecture of LSTM model for forecasting.

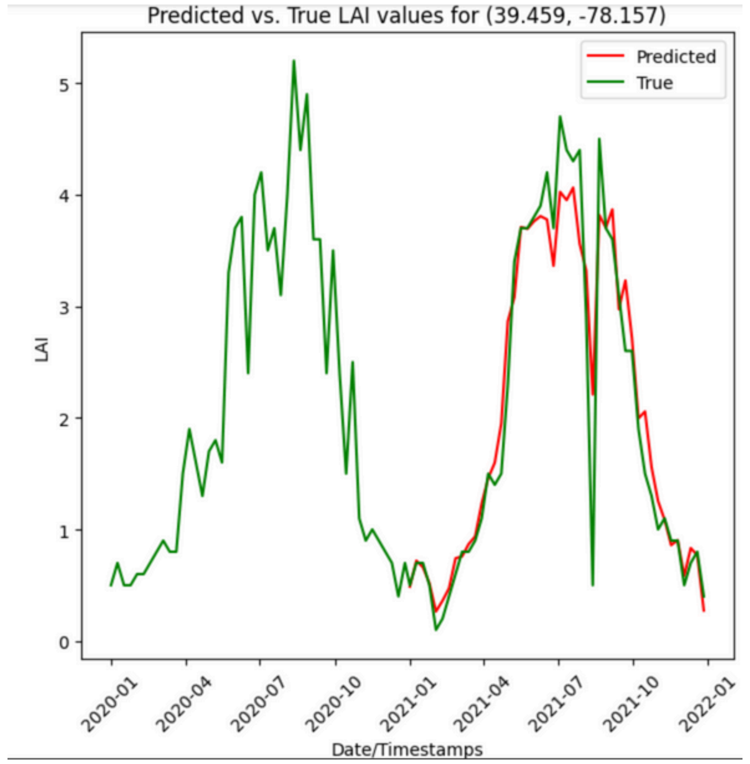

Fig 5. Output of LSTM forecasting model with forecast period of 1 year.

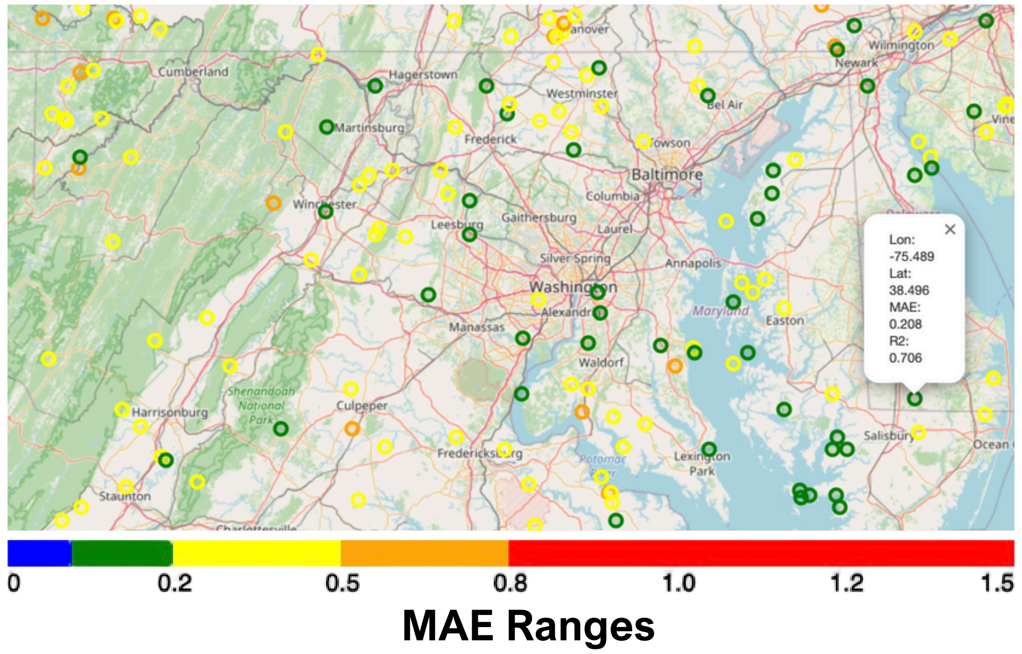

Fig 6. Folium map of model performance over validation dataset.

LSTM-Based Forecasting and Anomaly Detection of LAI Satellite Image Time Series

Alan Wang
Mentor: Heshun Wang

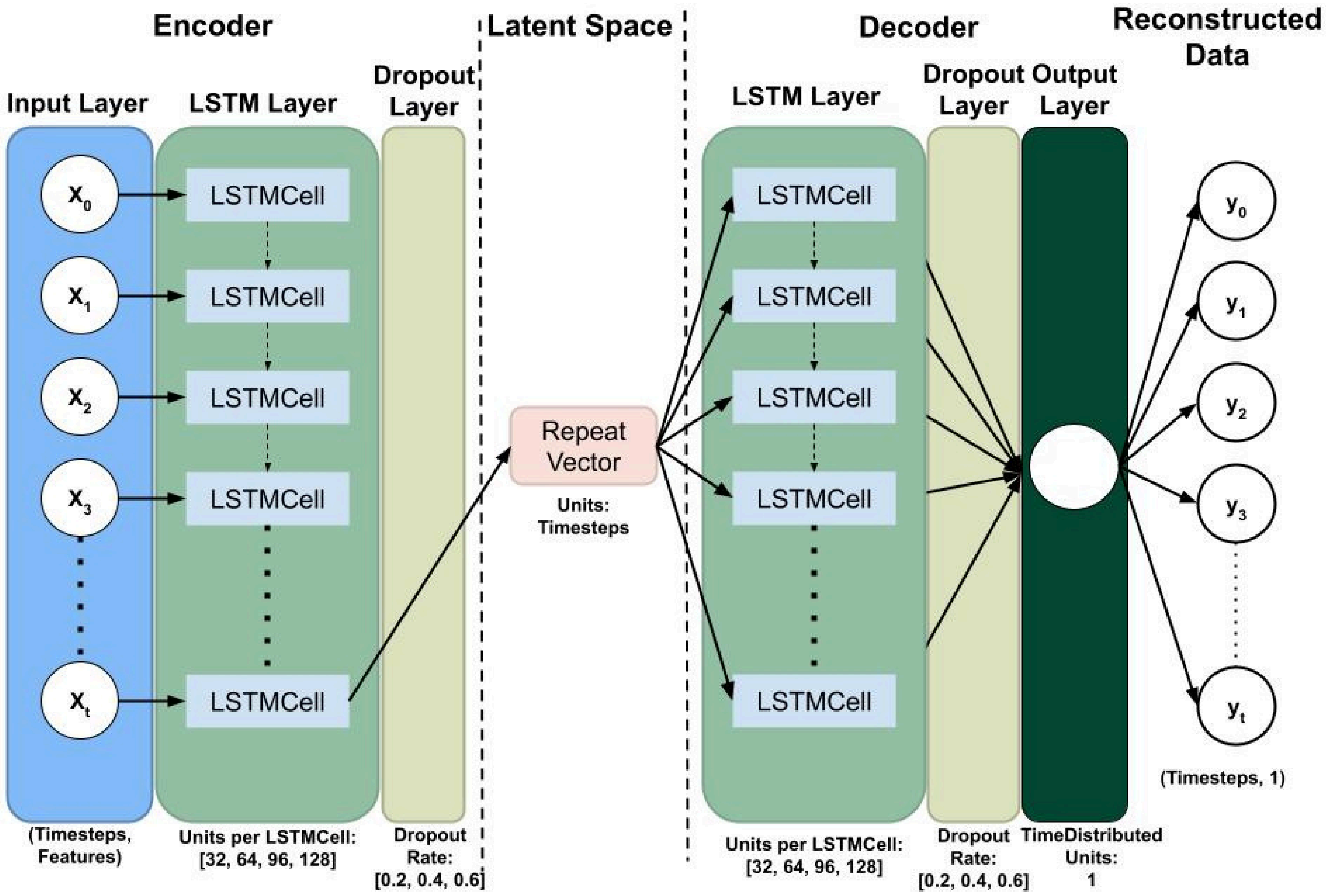

Fig 7. Autoencoder model architecture

Results

- Implemented pipeline for data transformation.
- Developed LSTM auto encoder for outlier detection and LSTM model for forecasting.
    - Forecasting model was outperformed by XGBoostRegressor.
- Outliers detected by the auto encoder were consistent with those detected by the Isolation Forest Algorithm.

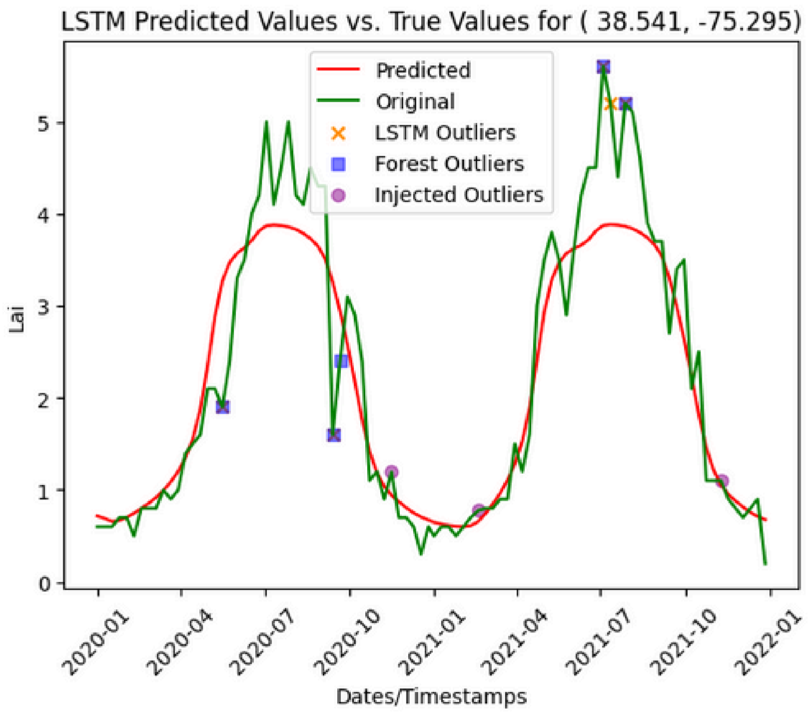

Fig 8. Autoencoder reconstruction of time series for specific latitude/longitude

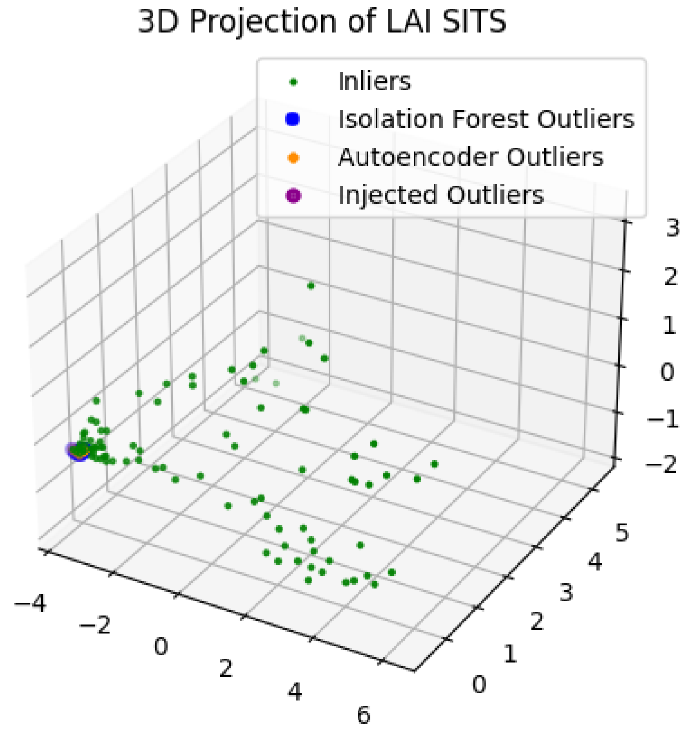

Fig 9. 3D Visualization of data points after applying Principal Component Analysis