



Comparison of Deep Learning Models' Performance for 24-Hour Forecast of Particulate Matter Using ERA5 Meteorological Data



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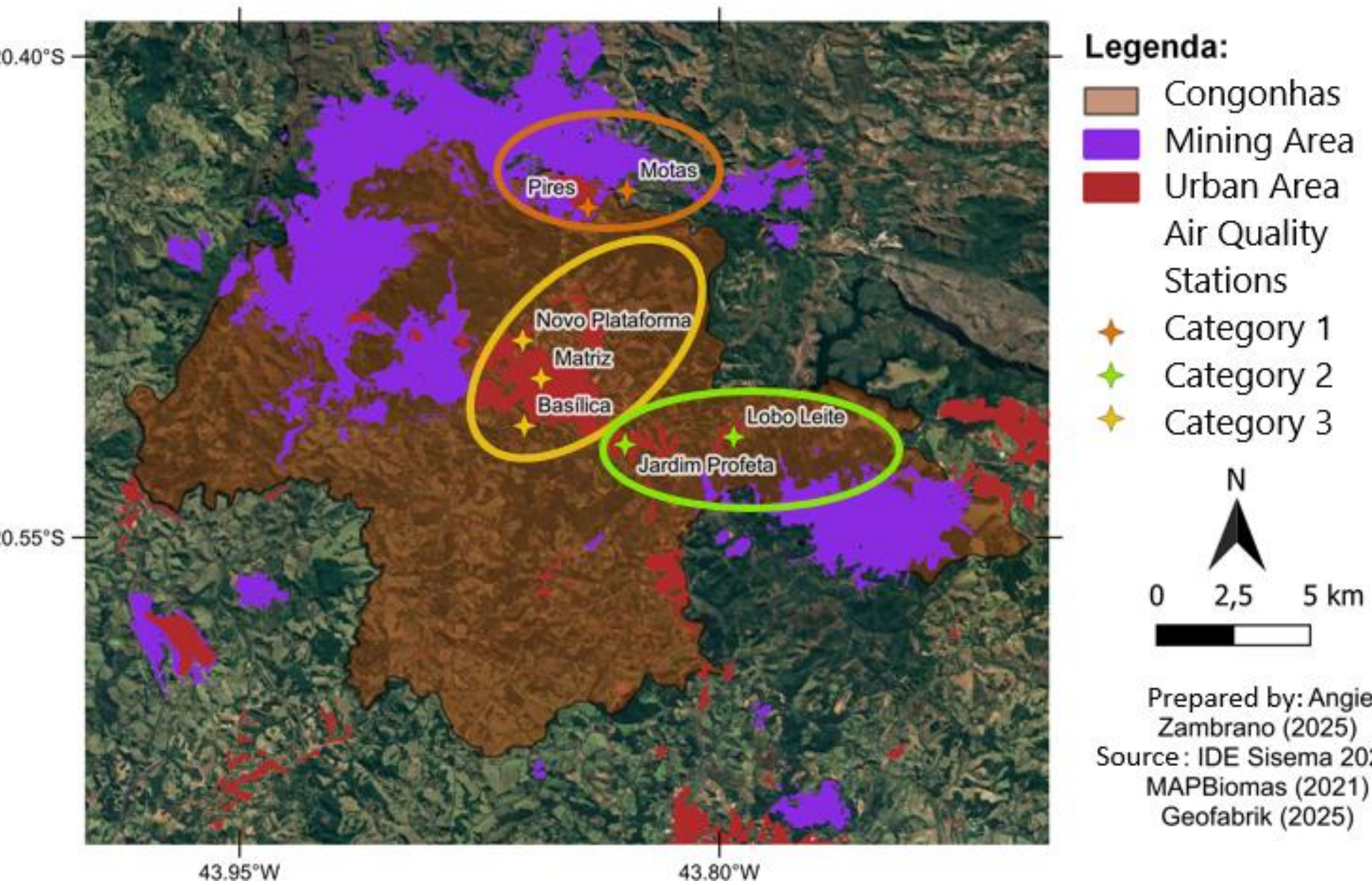
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INTRODUCTION

This study aimed to develop and evaluate deep learning models to forecast inhalable particulate matter (PM10) concentrations 24 hours ahead in the municipality of Congonhas, Minas Gerais, a region affected by mining activity.

METHODS

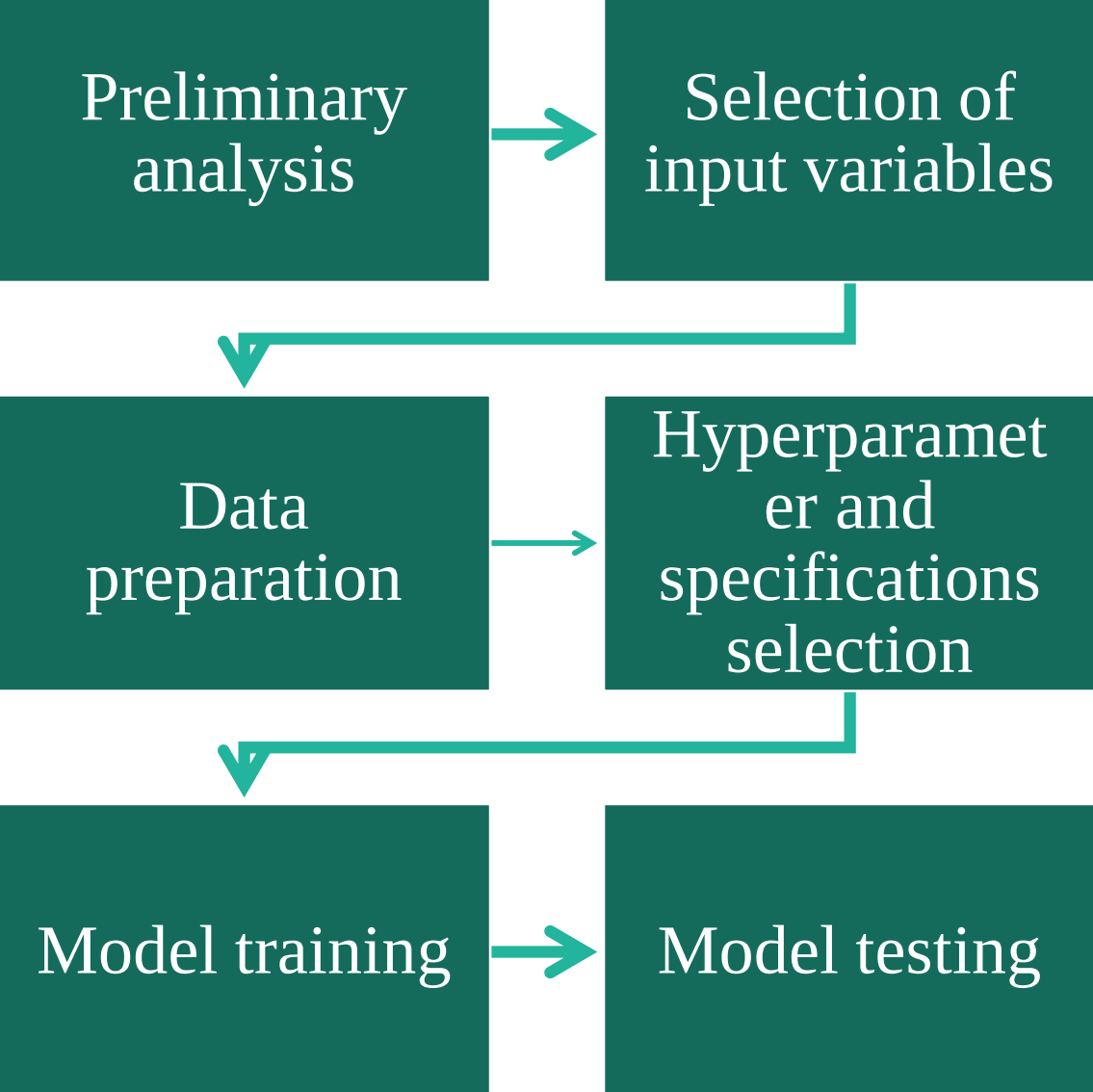
Air quality and meteorological reanalysis ERA5 data



2017 -2023

Categories:

- 1: Strongly influenced by mining activities.
- 2: Influenced by the BR-040 highway and the steel industry.
- 3: Historic center.



RESULTS

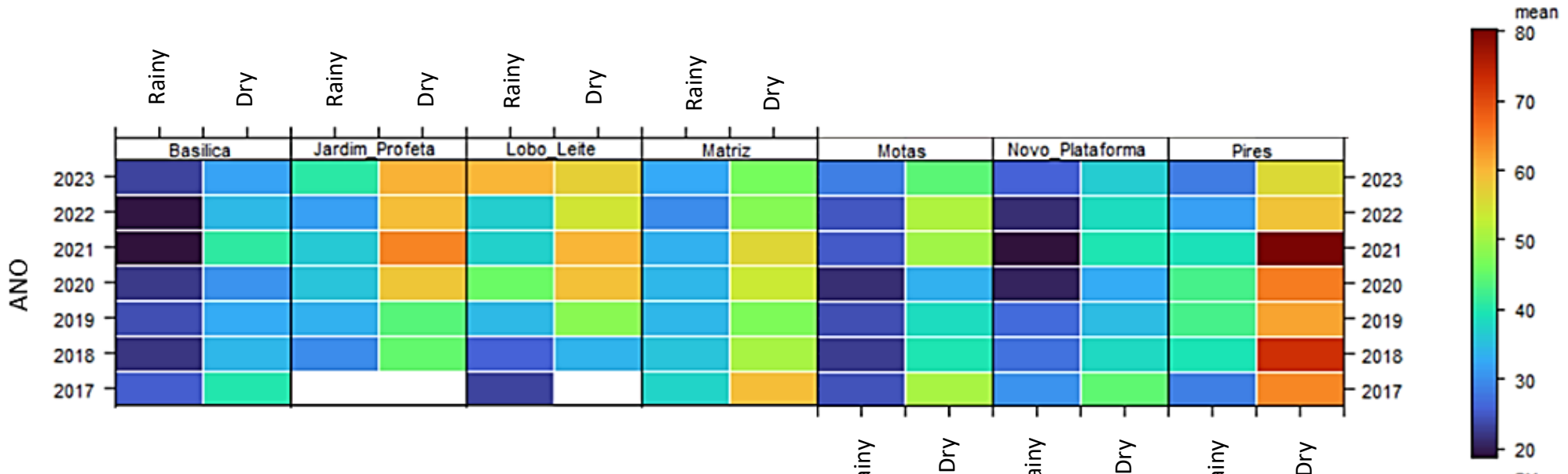


Figure 1 – PM10 dynamics across varying temporal intervals. Source: Author (2024)

Table 1 – Performance metrics of the trained models

Modelo	RMSE	MAE	NRMSE	R ²	r Spearman
LSTM	32,25	19,09	0,03	0,12	0,54
GRU	32,07	18,17	0,03	0,13	0,52
Conv1D	30,73	19,20	0,03	0,21	0,56
LSTM	32,51	17,97	0,03	0,11	0,55
GRU	30,59	19,65	0,03	0,21	0,56
Conv1D					

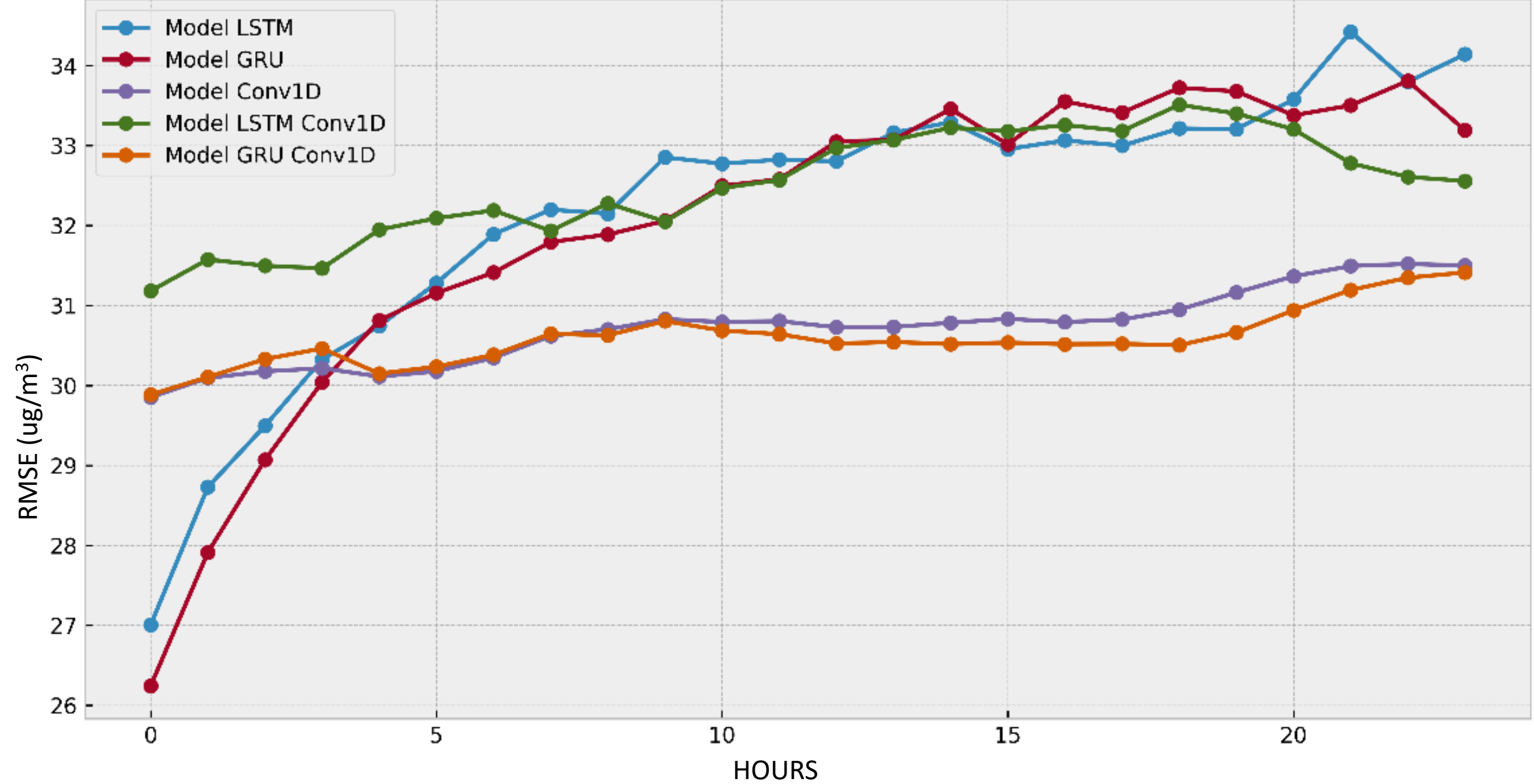


Figure 2 – RMSE by forecast horizons for the trained models. Source: Author (2024)

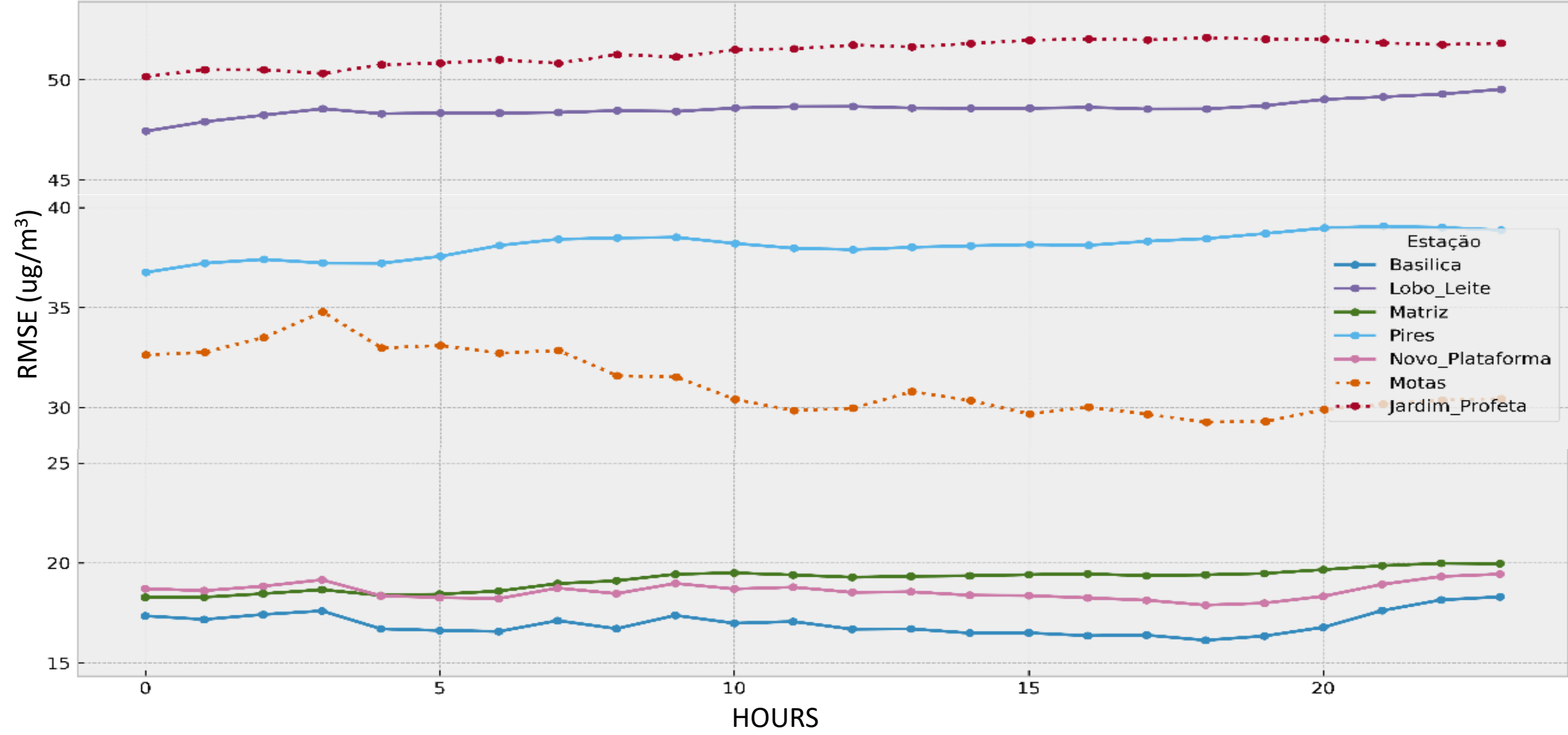


Figure 3 – RMSE by forecast horizons for each station. Source: Author (2024)

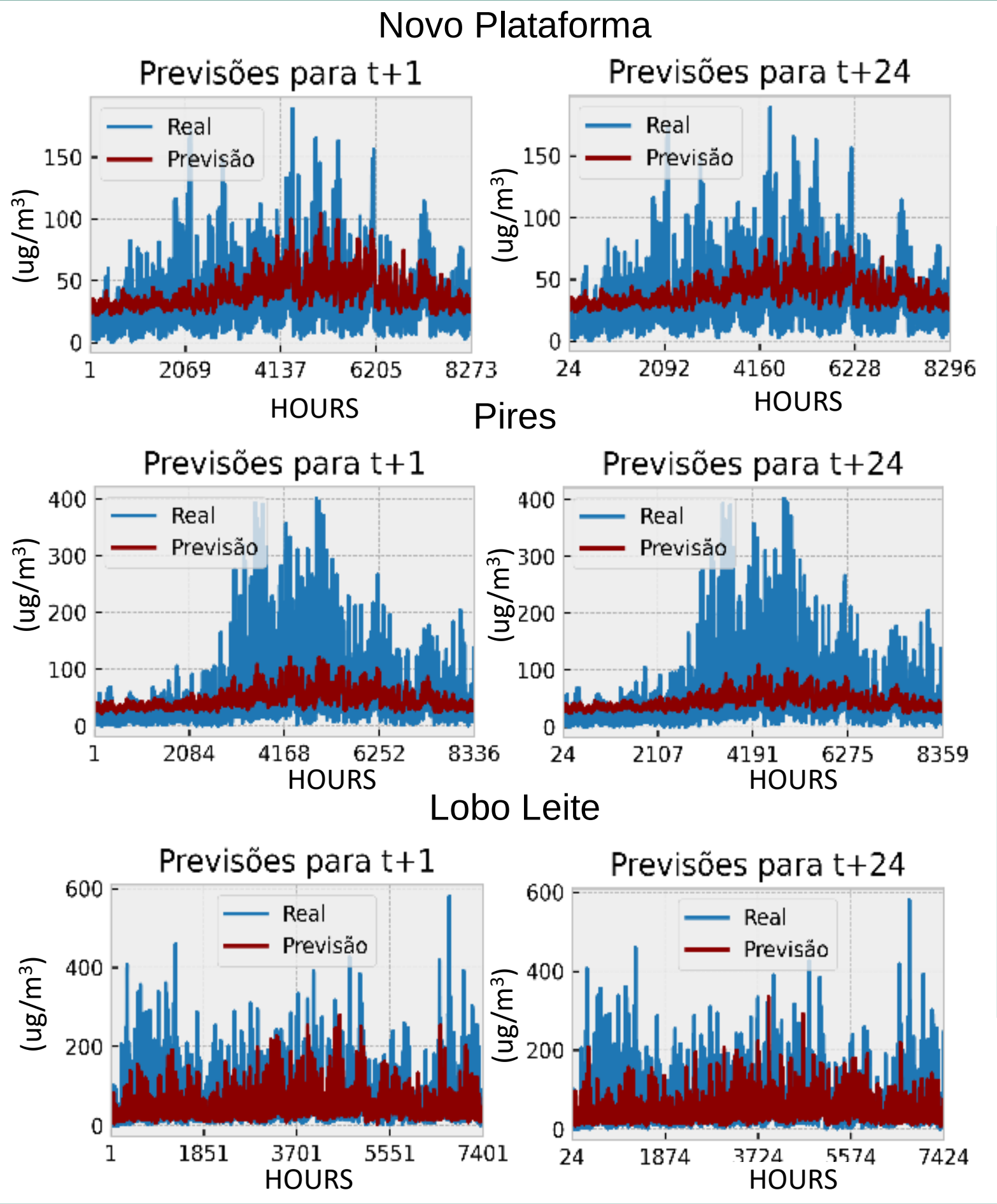


Figure 4 – Actual and predicted values at 1-hour and 24-hour horizons for the stations used in model training and validation. Source: Author (2024)

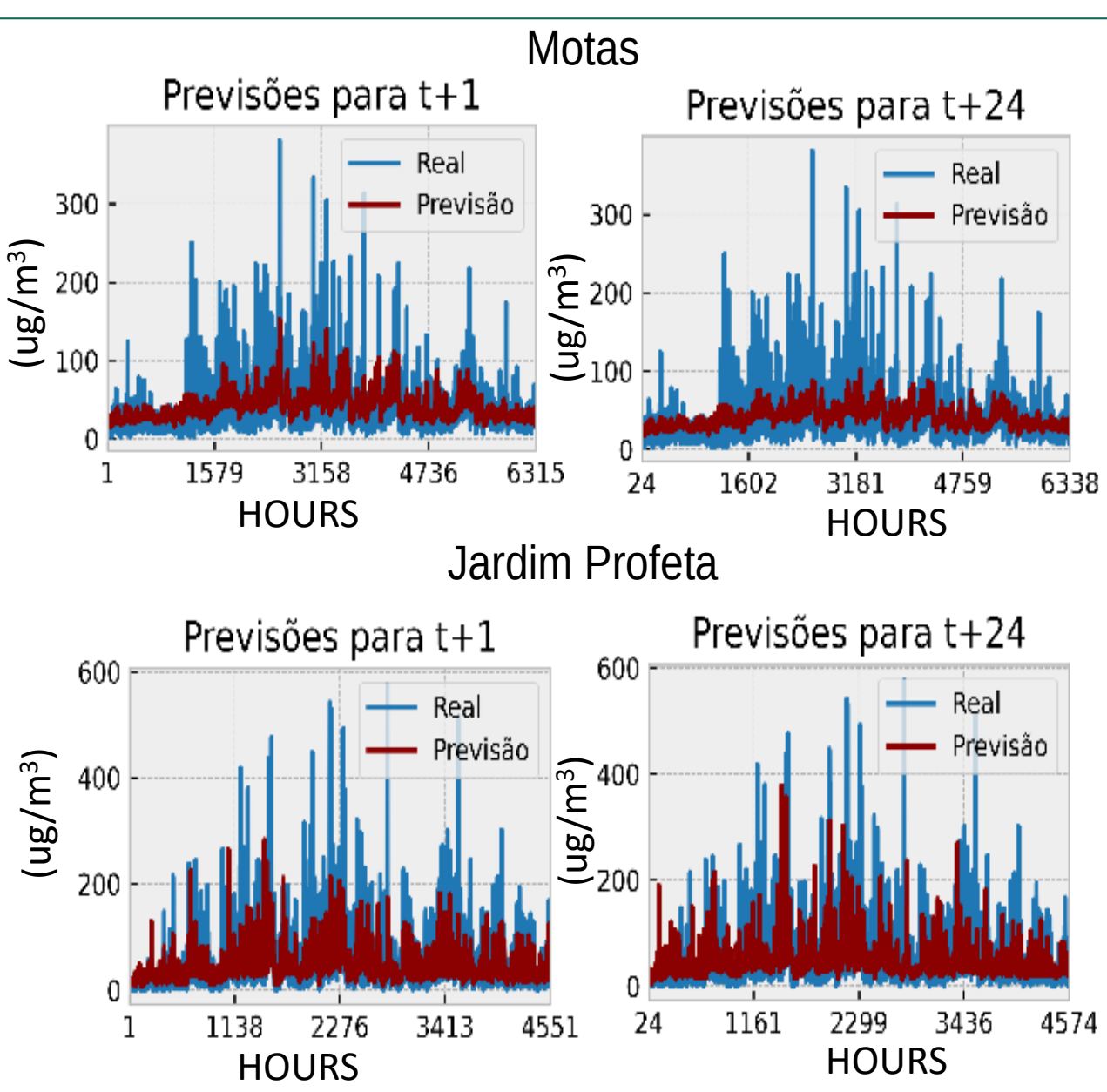


Figure 5 – Actual and predicted values at 1-hour and 24-hour horizons for the stations used exclusively for model testing. Source: Author (2024)

IMPLICATIONS

- The project shows how deep learning models can predict air particulate matter concentrations, providing a valuable tool for environmental management and public policy.
- In Congonhas, this technology has enhanced air quality monitoring and enabled more effective resource allocation in high-risk areas.
- Furthermore, the approach is scalable and can be replicated in other municipalities facing similar environmental challenges.

References and acknowledgements

