CatBoost Forecasting Report - 西条

CatBoost builds oblivious decision trees using Ordered Boosting.

Each tree uses symmetric (oblivious) splits.
Ordered Boosting avoids prediction shift and reduces overfitting.
CatBoost handles categorical and numerical features efficiently.
Multi-output regression uses one independent CatBoost model per horizon.

CatBoost builds symmetric trees using Ordered Boosting.
Each output horizon is predicted by an independent CatBoost model.
Feature importances show the contribution of each variable to prediction accuracy.

Prefecture code	38
Station code	38206050
Station name	西条
Target item	Ox(ppm)
Forecast horizon (hours)	24
Training samples	15735
Test samples	6744
Features used	140
Model	CatBoost (MultiOutput)
Elapsed time	7 min 22 sec
Iterations	500
Depth	8
Learning rate	0.05
L2 leaf reg	1
Bagging temperature	0

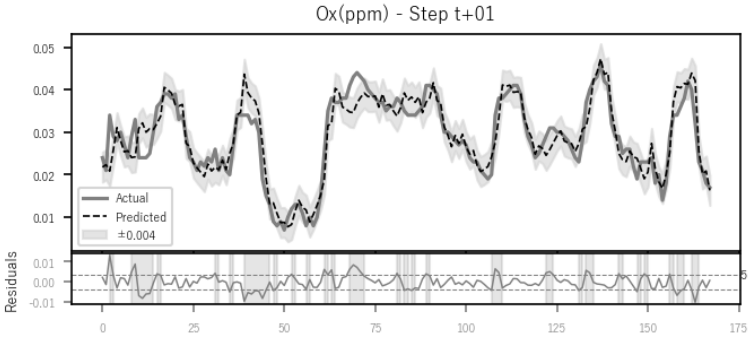
Features used for prediction

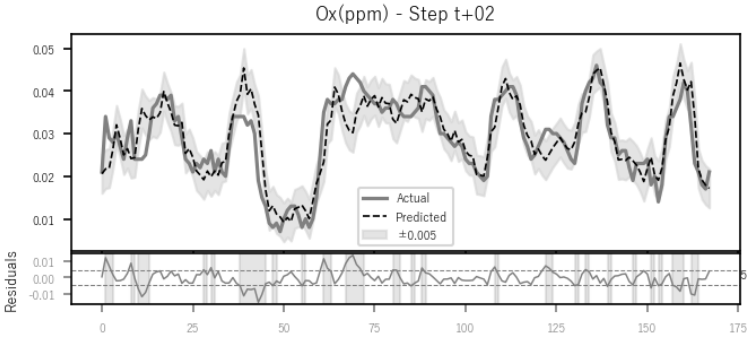
NO(ppm)	NO2(ppm)	U	V	Ox(ppm)_lag1
Ox(ppm)_lag2	Ox(ppm)_lag3	Ox(ppm)_lag4	Ox(ppm)_lag5	Ox(ppm)_lag6
Ox(ppm)_lag7	Ox(ppm)_lag8	Ox(ppm)_lag9	Ox(ppm)_lag10	Ox(ppm)_lag11
Ox(ppm)_lag12	Ox(ppm)_lag13	Ox(ppm)_lag14	Ox(ppm)_lag15	Ox(ppm)_lag16
Ox(ppm)_lag17	Ox(ppm)_lag18	Ox(ppm)_lag19	Ox(ppm)_lag20	Ox(ppm)_lag21
Ox(ppm)_lag22	Ox(ppm)_lag23	NO(ppm)_lag1	NO(ppm)_lag2	NO(ppm)_lag3
NO(ppm)_lag4	NO(ppm)_lag5	NO(ppm)_lag6	NO(ppm)_lag7	NO(ppm)_lag8
NO(ppm)_lag9	NO(ppm)_lag10	NO(ppm)_lag11	NO(ppm)_lag12	NO(ppm)_lag13
NO(ppm)_lag14	NO(ppm)_lag15	NO(ppm)_lag16	NO(ppm)_lag17	NO(ppm)_lag18
NO(ppm)_lag19	NO(ppm)_lag20	NO(ppm)_lag21	NO(ppm)_lag22	NO(ppm)_lag23
NO2(ppm)_lag1	NO2(ppm)_lag2	NO2(ppm)_lag3	NO2(ppm)_lag4	NO2(ppm)_lag5
NO2(ppm)_lag6	NO2(ppm)_lag7	NO2(ppm)_lag8	NO2(ppm)_lag9	NO2(ppm)_lag10
NO2(ppm)_lag11	NO2(ppm)_lag12	NO2(ppm)_lag13	NO2(ppm)_lag14	NO2(ppm)_lag15
NO2(ppm)_lag16	NO2(ppm)_lag17	NO2(ppm)_lag18	NO2(ppm)_lag19	NO2(ppm)_lag20
NO2(ppm)_lag21	NO2(ppm)_lag22	NO2(ppm)_lag23	U_lag1	U_lag2
U_lag3	U_lag4	U_lag5	U_lag6	U_lag7
U_lag8	U_lag9	U_lag10	U_lag11	U_lag12
U_lag13	U_lag14	U_lag15	U_lag16	U_lag17
U_lag18	U_lag19	U_lag20	U_lag21	U_lag22
U_lag23	V_lag1	V_lag2	V_lag3	V_lag4
V_lag5	V_lag6	V_lag7	V_lag8	V_lag9
V_lag10	V_lag11	V_lag12	V_lag13	V_lag14
V_lag15	V_lag16	V_lag17	V_lag18	V_lag19
V_lag20	V_lag21	V_lag22	V_lag23	Ox(ppm)_roll_mean_3
Ox(ppm)_roll_std_6	NO(ppm)_roll_mean_3	NO(ppm)_roll_std_6	NO2(ppm)_roll_mean_3	NO2(ppm)_roll_std_6
U_roll_mean_3	U_roll_std_6	V_roll_mean_3	V_roll_std_6	Ox(ppm)_diff_1
Ox(ppm)_diff_2	Ox(ppm)_diff_3	NO(ppm)_diff_3	NO2(ppm)_diff_3	U_diff_3
V_diff_3	hour_sin	hour_cos	dayofweek	is_weekend

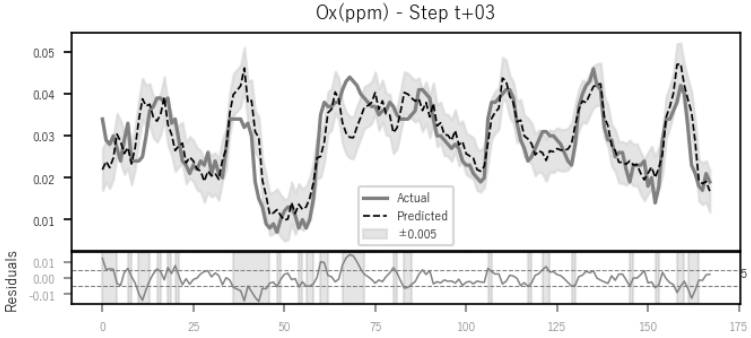
Model accuracy

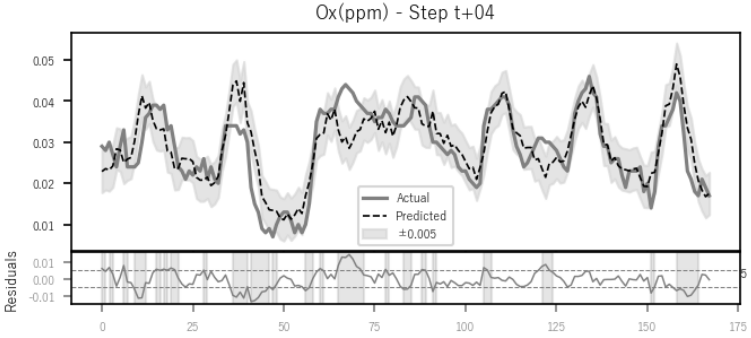
Target	R^2	MAE	RMSE
Ox(ppm)_t+01	0.8961	0.0042	0.0059
Ox(ppm)_t+02	0.8409	0.0053	0.0073
Ox(ppm)_t+03	0.7915	0.0061	0.0083
Ox(ppm)_t+04	0.7490	0.0067	0.0091
Ox(ppm)_t+05	0.7097	0.0073	0.0098
Ox(ppm)_t+06	0.6752	0.0077	0.0104
Ox(ppm)_t+07	0.6529	0.0080	0.0108
Ox(ppm)_t+08	0.6301	0.0083	0.0111
Ox(ppm)_t+09	0.6151	0.0085	0.0113
Ox(ppm)_t+10	0.5981	0.0086	0.0116
Ox(ppm)_t+11	0.5838	0.0088	0.0118
Ox(ppm)_t+12	0.5646	0.0090	0.0120
Ox(ppm)_t+13	0.5529	0.0091	0.0122
Ox(ppm)_t+14	0.5440	0.0092	0.0123
Ox(ppm)_t+15	0.5382	0.0092	0.0124
Ox(ppm)_t+16	0.5332	0.0093	0.0125
Ox(ppm)_t+17	0.5327	0.0093	0.0125
Ox(ppm)_t+18	0.5189	0.0094	0.0127
Ox(ppm)_t+19	0.5167	0.0094	0.0127
Ox(ppm)_t+20	0.5179	0.0094	0.0127
Ox(ppm)_t+21	0.5051	0.0095	0.0128
Ox(ppm)_t+22	0.5150	0.0095	0.0127
Ox(ppm)_t+23	0.5129	0.0095	0.0127
Ox(ppm)_t+24	0.5091	0.0096	0.0128

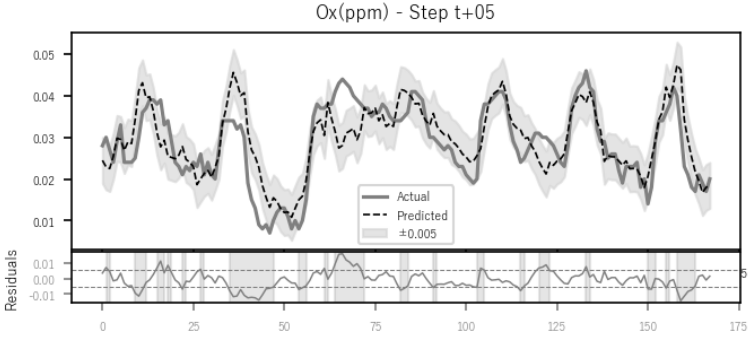
Comparison between actual and predicted values
with ± Standard Deviation Bands

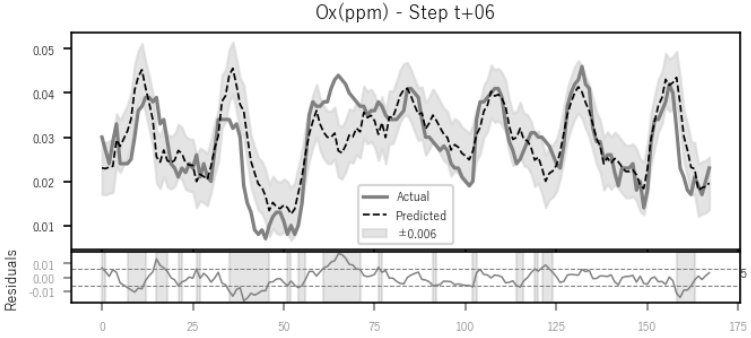












Comparison between actual and predicted values
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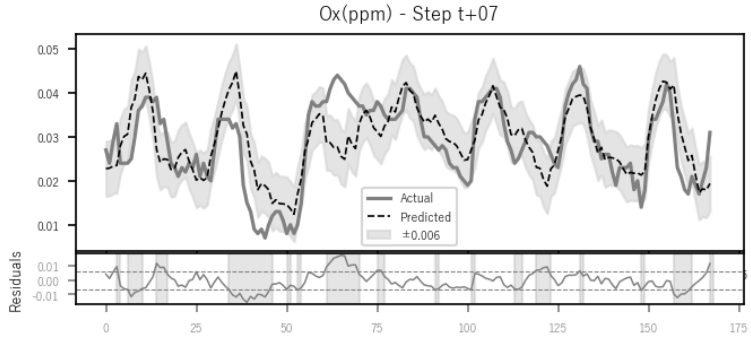
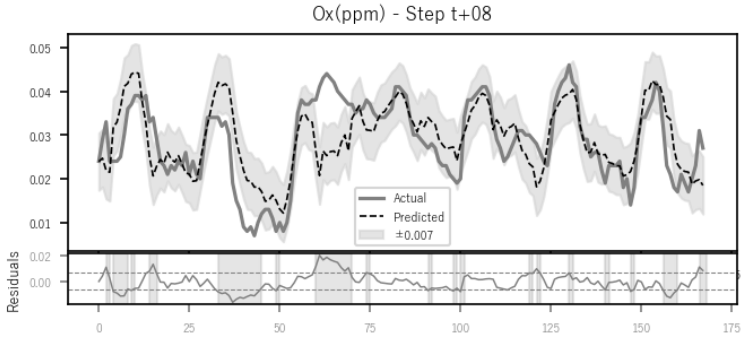
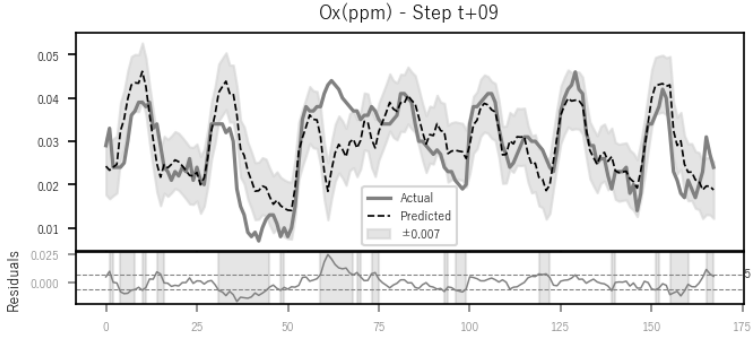
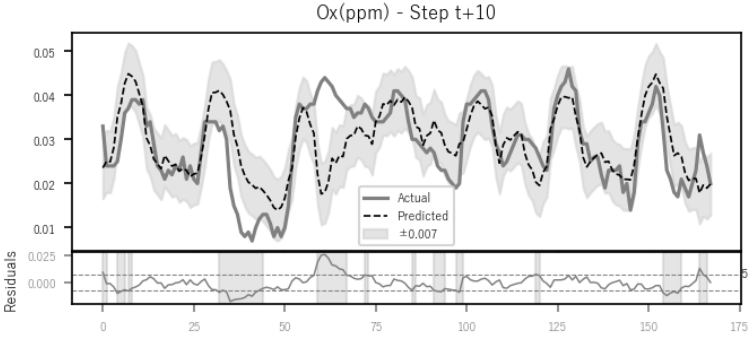
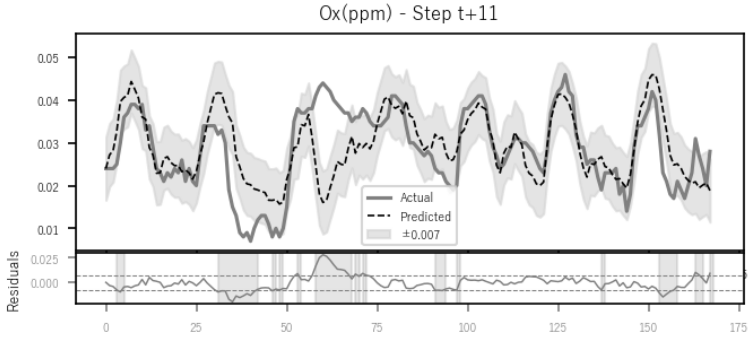
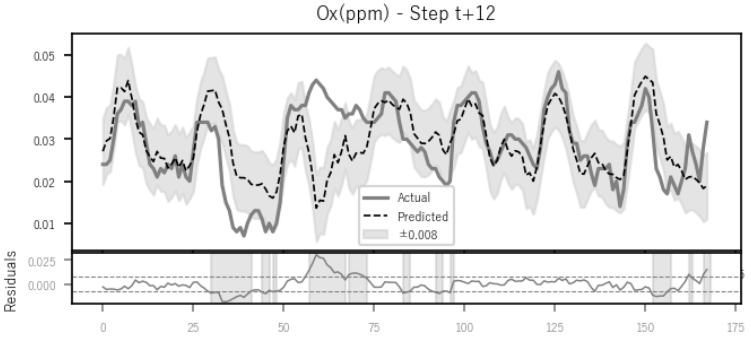




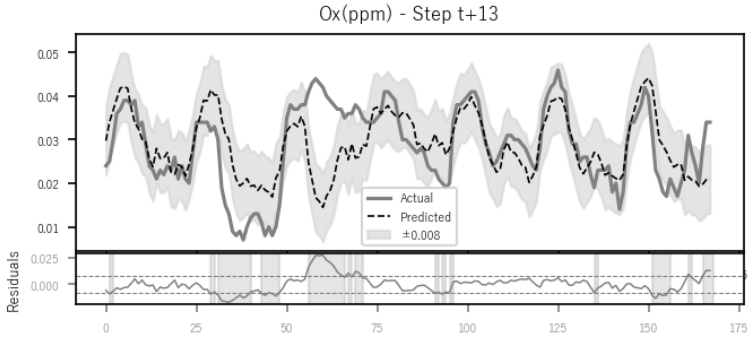


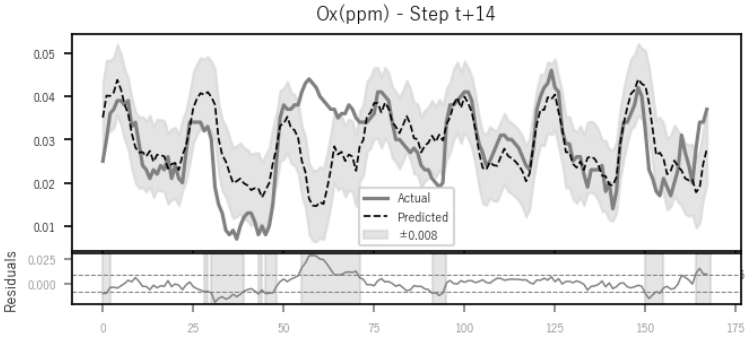


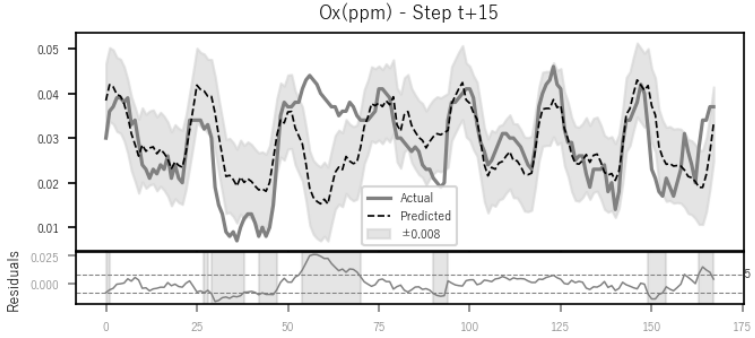


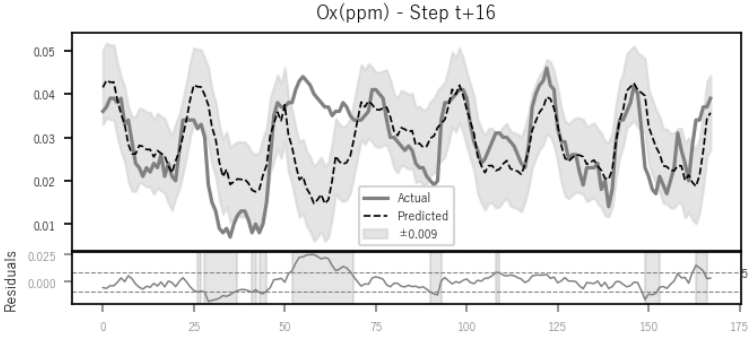


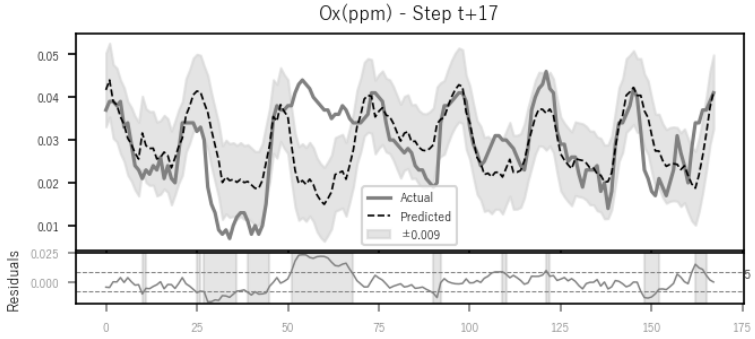
Comparison between actual and predicted values
with ± Standard Deviation Bands

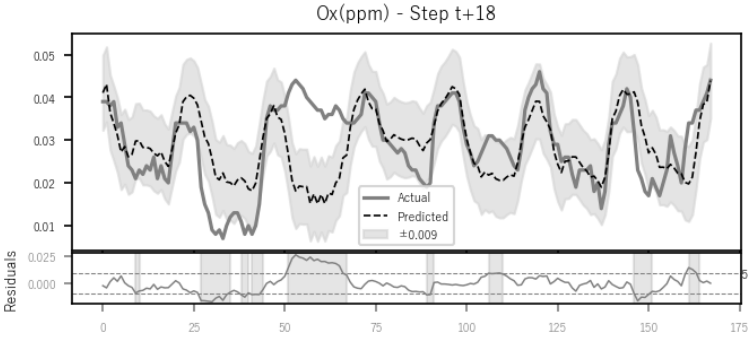




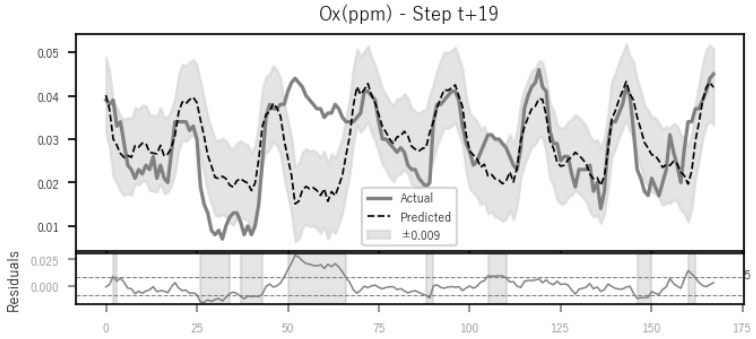


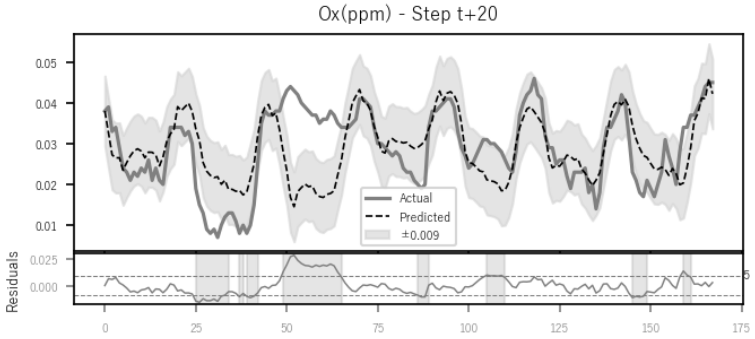


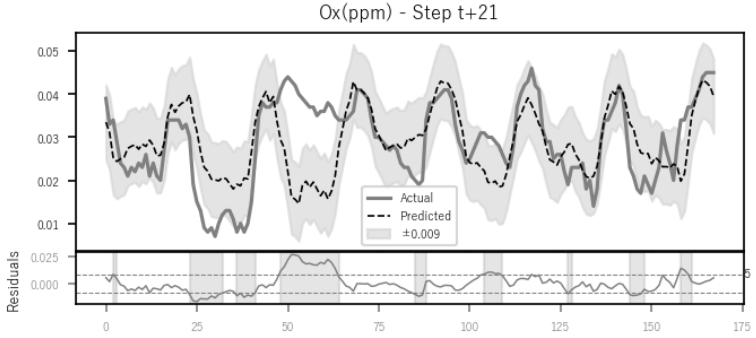


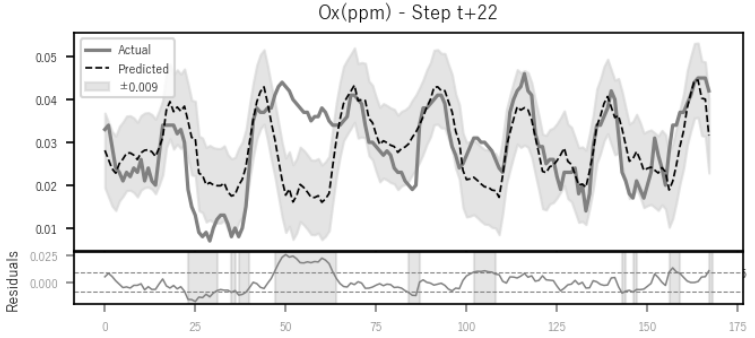


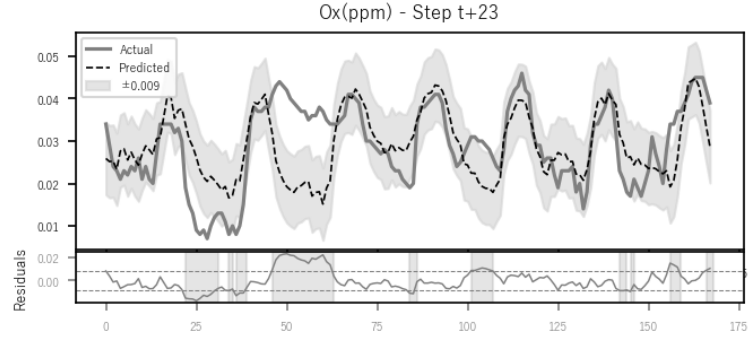
Comparison between actual and predicted values
with ± Standard Deviation Bands

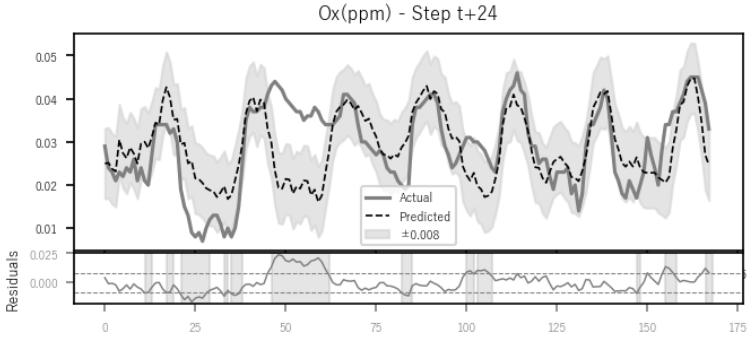


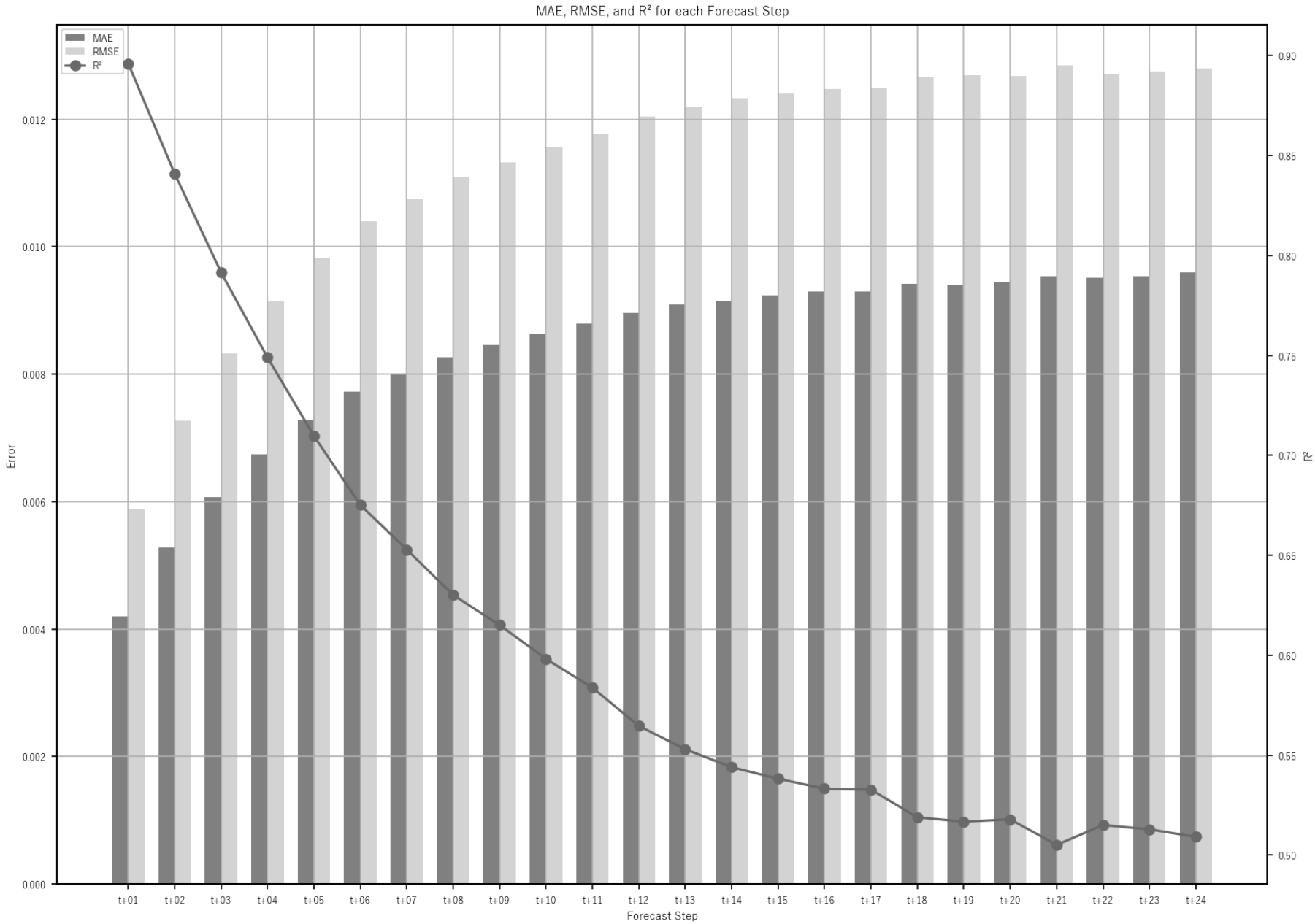


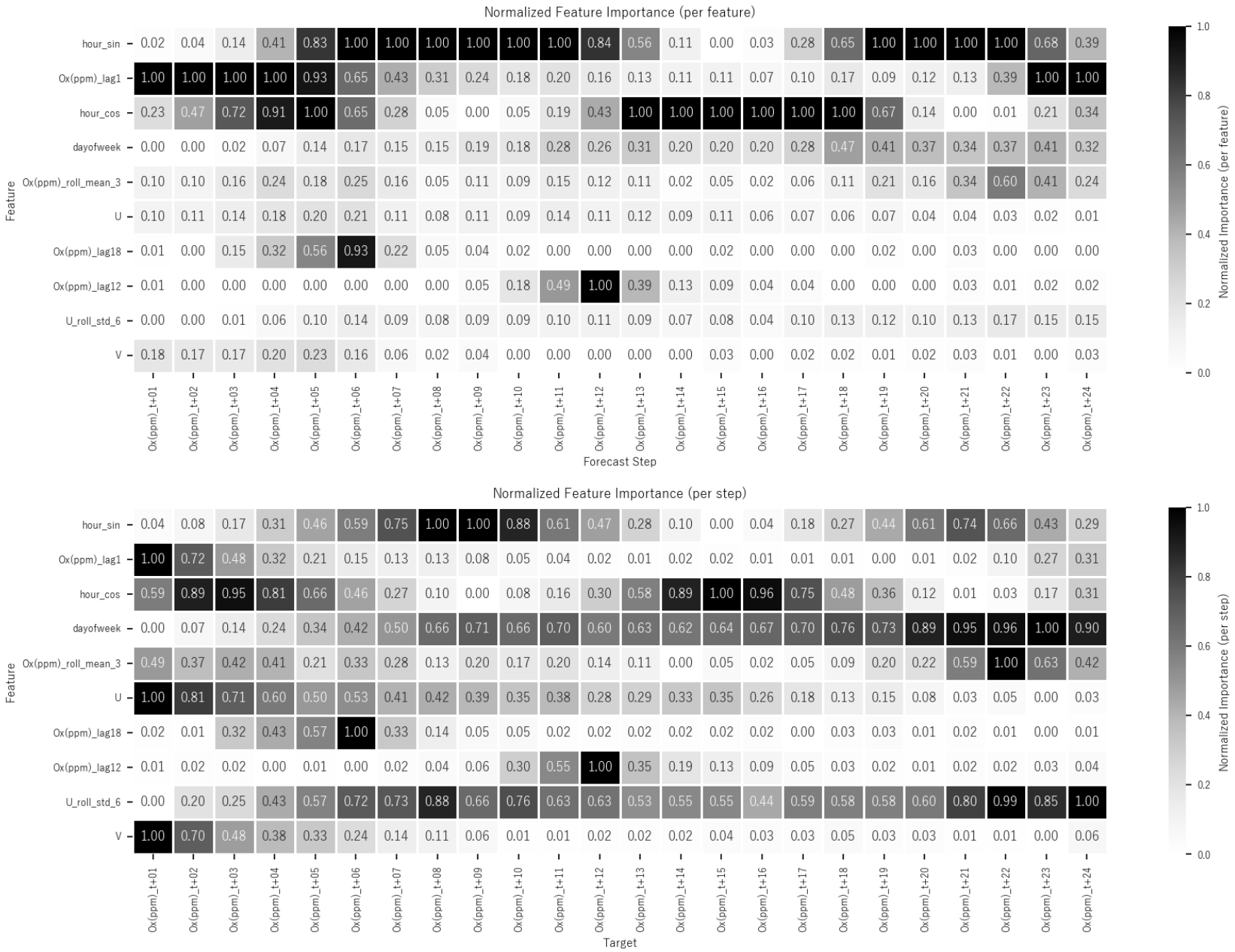









MAE, RMSE, and R² for each Forecast Step
MAE
RMSE
R²
Error
R²
Forecast Step
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
t+01
t+02
t+03
t+04
t+05
t+06
t+07
t+08
t+09
t+10
t+11
t+12
t+13
t+14
t+15
t+16
t+17
t+18
t+19
t+20
t+21
t+22
t+23
t+24


Normalized Feature Importance (per feature)
Feature
hour_sin 0.02 0.04 0.14 0.41 0.83 1.00 1.00 1.00 1.00 1.00 1.00 0.84 0.56 0.11 0.00 0.03 0.28 0.65 1.00 1.00 1.00 1.00 0.68 0.39
Ox(ppm)_lag1 1.00 1.00 1.00 1.00 0.93 0.65 0.43 0.31 0.24 0.18 0.20 0.16 0.13 0.11 0.11 0.07 0.10 0.17 0.09 0.12 0.13 0.39 1.00 1.00
hour_cos 0.23 0.47 0.72 0.91 1.00 0.65 0.28 0.05 0.00 0.05 0.19 0.43 1.00 1.00 1.00 1.00 1.00 1.00 0.67 0.14 0.00 0.01 0.21 0.34
dayofweek 0.00 0.00 0.02 0.07 0.14 0.17 0.15 0.15 0.19 0.18 0.28 0.26 0.31 0.20 0.20 0.20 0.28 0.47 0.41 0.37 0.34 0.37 0.41 0.32
Ox(ppm)_roll_mean_3 0.10 0.10 0.16 0.24 0.18 0.25 0.16 0.05 0.11 0.09 0.15 0.12 0.11 0.02 0.05 0.02 0.06 0.11 0.21 0.16 0.34 0.60 0.41 0.24
U 0.10 0.11 0.14 0.18 0.20 0.21 0.11 0.08 0.11 0.09 0.14 0.11 0.12 0.09 0.11 0.06 0.07 0.06 0.07 0.04 0.04 0.03 0.02 0.01
Ox(ppm)_lag18 0.01 0.00 0.15 0.32 0.56 0.93 0.22 0.05 0.04 0.02 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.02 0.00 0.03 0.00 0.00 0.00
Ox(ppm)_lag12 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.05 0.18 0.49 1.00 0.39 0.13 0.09 0.04 0.04 0.00 0.00 0.00 0.03 0.01 0.02 0.02
U_roll_std_6 0.00 0.00 0.01 0.06 0.10 0.14 0.09 0.08 0.09 0.09 0.10 0.11 0.09 0.07 0.08 0.04 0.10 0.13 0.12 0.10 0.13 0.17 0.15 0.15
V 0.18 0.17 0.17 0.20 0.23 0.16 0.06 0.02 0.04 0.00 0.00 0.00 0.00 0.00 0.03 0.00 0.02 0.02 0.01 0.02 0.03 0.01 0.00 0.03
Ox(ppm)_t+01 Ox(ppm)_t+02 Ox(ppm)_t+03 Ox(ppm)_t+04 Ox(ppm)_t+05 Ox(ppm)_t+06 Ox(ppm)_t+07 Ox(ppm)_t+08 Ox(ppm)_t+09 Ox(ppm)_t+10 Ox(ppm)_t+11 Ox(ppm)_t+12 Ox(ppm)_t+13 Ox(ppm)_t+14 Ox(ppm)_t+15 Ox(ppm)_t+16 Ox(ppm)_t+17 Ox(ppm)_t+18 Ox(ppm)_t+19 Ox(ppm)_t+20 Ox(ppm)_t+21 Ox(ppm)_t+22 Ox(ppm)_t+23 Ox(ppm)_t+24
Forecast Step
Normalized Importance (per feature)
1.0
0.8
0.6
0.4
0.2
0.0
Normalized Feature Importance (per step)
Feature
hour_sin 0.04 0.08 0.17 0.31 0.46 0.59 0.75 1.00 1.00 0.88 0.61 0.47 0.28 0.10 0.00 0.04 0.18 0.27 0.44 0.61 0.74 0.66 0.43 0.29
Ox(ppm)_lag1 1.00 0.72 0.48 0.32 0.21 0.15 0.13 0.13 0.08 0.05 0.04 0.02 0.01 0.02 0.02 0.01 0.01 0.01 0.00 0.01 0.02 0.10 0.27 0.31
hour_cos 0.59 0.89 0.95 0.81 0.66 0.46 0.27 0.10 0.00 0.08 0.16 0.30 0.58 0.89 1.00 0.96 0.75 0.48 0.36 0.12 0.01 0.03 0.17 0.31
dayofweek 0.00 0.07 0.14 0.24 0.34 0.42 0.50 0.66 0.71 0.66 0.70 0.60 0.63 0.62 0.64 0.67 0.70 0.76 0.73 0.89 0.95 0.96 1.00 0.90
Ox(ppm)_roll_mean_3 0.49 0.37 0.42 0.41 0.21 0.33 0.28 0.13 0.20 0.17 0.20 0.14 0.11 0.00 0.05 0.02 0.05 0.09 0.20 0.22 0.59 1.00 0.63 0.42
U 1.00 0.81 0.71 0.60 0.50 0.53 0.41 0.42 0.39 0.35 0.38 0.28 0.29 0.33 0.35 0.26 0.18 0.13 0.15 0.08 0.03 0.05 0.00 0.03
Ox(ppm)_lag18 0.02 0.01 0.32 0.43 0.57 1.00 0.33 0.14 0.05 0.05 0.02 0.02 0.02 0.02 0.02 0.02 0.00 0.03 0.03 0.01 0.02 0.01 0.00 0.01
Ox(ppm)_lag12 0.01 0.02 0.02 0.00 0.01 0.00 0.02 0.04 0.06 0.30 0.55 1.00 0.35 0.19 0.13 0.09 0.05 0.03 0.02 0.01 0.02 0.02 0.03 0.04
U_roll_std_6 0.00 0.20 0.25 0.43 0.57 0.72 0.73 0.88 0.66 0.76 0.63 0.63 0.53 0.55 0.55 0.44 0.59 0.58 0.58 0.60 0.80 0.99 0.85 1.00
V 1.00 0.70 0.48 0.38 0.33 0.24 0.14 0.11 0.06 0.01 0.01 0.02 0.02 0.02 0.04 0.03 0.03 0.05 0.03 0.03 0.01 0.01 0.00 0.06
Ox(ppm)_t+01 Ox(ppm)_t+02 Ox(ppm)_t+03 Ox(ppm)_t+04 Ox(ppm)_t+05 Ox(ppm)_t+06 Ox(ppm)_t+07 Ox(ppm)_t+08 Ox(ppm)_t+09 Ox(ppm)_t+10 Ox(ppm)_t+11 Ox(ppm)_t+12 Ox(ppm)_t+13 Ox(ppm)_t+14 Ox(ppm)_t+15 Ox(ppm)_t+16 Ox(ppm)_t+17 Ox(ppm)_t+18 Ox(ppm)_t+19 Ox(ppm)_t+20 Ox(ppm)_t+21 Ox(ppm)_t+22 Ox(ppm)_t+23 Ox(ppm)_t+24
Target
Normalized Importance (per step)
1.0
0.8
0.6
0.4
0.2
0.0