

1 NH3 vs NH3+colour forecasting NH3

1.1 NH₃N vs NH3+colour

Table 1: Evaluation of multivariate models in forecasting NH₃N.

Rank	Model-Dataset	Test loss	Improvement
1	LSTM-ew3	0.0379 ±0.0009	3.32%
2	LSTM-sg7	0.0379 ±0.0004	4.77%
3	LSTM-ew4	0.0380 ±0.0003	2.06%
4	GRU-ew3	0.0386 ±0.0004	1.53%
5	LSTM-sg5	0.0387 ±0.0004	4.44%
6	LSTM-ew2	0.0389 ±0.0004	1.77%
7	GRU-sg7	0.0390 ±0.0009	-1.30%
8	GRU-sg5	0.0392 ±0.0008	3.21%
9	GRU-ew4	0.0394 ±0.0004	-0.77%
10	GRU-sg9	0.0400 ±0.0010	-4.44%
11	GRU-ew2	0.0402 ±0.0012	-3.34%
12	LSTM-sg9	0.0409 ±0.0006	-5.41%
13	LSTM-obs	0.0411 ±0.0007	-4.05%
14	RNN-sg5	0.0413 ±0.0009	0.48%
15	RNN-sg7	0.0417 ±0.0007	1.42%
16	GRU-obs	0.0420 ±0.0006	-1.45%
17	RNN-ew2	0.0424 ±0.0006	-9.28%
18	RNN-ew3	0.0426 ±0.0003	-3.90%
19	RNN-ew4	0.0427 ±0.0005	-1.43%
20	RNN-obs	0.0437 ±0.0012	-1.16%

1.2 NH_3N + pos vs NH_3 + colour + pos

Table 2: Comparison of univariate and multivariate models trained with positional encoding in forecasting NH_3N .

Rank	LSTM-3	Test loss	LSTM-4	Test loss	Improvement
1	sg7	0.0373 ± 0.0002	sg7	0.0369 ± 0.0003	1.07%
2	sg9	0.0391 ± 0.0004	sg9	0.0384 ± 0.0001	1.79%
3	sg5	0.0392 ± 0.0009	ew3	0.0392 ± 0.0007	1.26%
4	ew3	0.0397 ± 0.0007	sg5	0.0397 ± 0.0002	-1.28%
5	ew4	0.0400 ± 0.0001	ew4	0.0399 ± 0.0007	0.25%
6	ew2	0.0403 ± 0.0008	ew2	0.0404 ± 0.0007	-0.25%
7	obs	0.0426 ± 0.0005	obs	0.0432 ± 0.0009	-1.41%

2 NH3 vs NH3+colour forecasting colour

2.1 Colour vs colour + nh3

Table 3: Evaluation of multivariate models in forecasting colour.

Rank	Model-Dataset	Test loss	Improvement
1	LSTM-ew3	0.0132±0.0001	4.35%
2	LSTM-ew4	0.0135±0.0002	2.17%
3	LSTM-ew2	0.0139±0.0002	7.95%
4	GRU-ew4	0.0140±0.0001	2.10%
5	GRU-ew3	0.0142±0.0003	-1.43%
6	GRU-ew2	0.0143±0.0002	-0.70%
7	GRU-sg9	0.0145±0.0002	8.81%
8	LSTM-sg9	0.0146±0.0001	-2.10%
9	RNN-ew4	0.0147±0.0002	0.00%
10	RNN-ew3	0.0149±0.0001	0.00%
11	GRU-obs	0.0149±0.0002	-3.47%
12	RNN-sg9	0.0151±0.0002	-0.67%
13	RNN-ew2	0.0151±0.0002	-2.72%
14	LSTM-obs	0.0152±0.0001	-11.76%
15	LSTM-sg7	0.0154±0.0007	4.35%
16	GRU-sg5	0.0158±0.0004	1.25%
17	RNN-sg7	0.0159±0.0005	-7.43%
18	LSTM-sg5	0.0159±0.0006	0.62%
19	RNN-obs	0.0159±0.0002	-0.63%
20	RNN-sg5	0.0163±0.0003	-3.16%

2.2 colour + pos vs NH3 + colour + pos

Table 4: Comparison of univariate and multivariate models trained with positional encoding in forecasting colour.

Rank	LSTM-3	Test loss	LSTM-4	Test loss	Improvement
1	sg9	0.0120 \pm 0.0007	sg9	0.0129 \pm 0.0007	-7.50%
2	ew2	0.0132 \pm 0.0004	ew3	0.0136 \pm 0.0005	-1.49%
3	ew3	0.0134 \pm 0.0004	sg7	0.0136 \pm 0.0005	4.90%
4	ew4	0.0135 \pm 0.0003	ew4	0.0137 \pm 0.0003	-1.48%
5	obs	0.0135 \pm 0.0001	obs	0.0140 \pm 0.0001	-3.70%
6	sg7	0.0143 \pm 0.0003	ew2	0.0141 \pm 0.0001	-6.82%
7	sg5	0.0144 \pm 0.0002	sg5	0.0155 \pm 0.0003	-7.64%

3 NH3/colour forecasting NH3

3.1 Multivariate NH₃N forecasting model, baseline performance

Table 5: Evaluation of multivariate models of each NH₃N forecasting approach.

Rank	Model-Dataset	Test loss	Valid loss
1	LSTM-ew3	0.0379 \pm 0.0009	1.0702 \pm 0.0067
2	LSTM-sg7	0.0379 \pm 0.0004	1.1582 \pm 0.0159
3	LSTM-ew4	0.0380 \pm 0.0003	1.0641 \pm 0.0087
4	GRU-ew3	0.0386 \pm 0.0004	1.1137 \pm 0.0268
5	LSTM-sg5	0.0387 \pm 0.0004	1.1531 \pm 0.0323
6	LSTM-ew2	0.0389 \pm 0.0004	1.0909 \pm 0.0241
7	GRU-sg7	0.0390 \pm 0.0009	1.3082 \pm 0.0383
8	GRU-sg5	0.0392 \pm 0.0008	1.1839 \pm 0.0114
9	GRU-ew4	0.0394 \pm 0.0004	1.2183 \pm 0.0324
10	GRU-sg9	0.0400 \pm 0.0010	1.2075 \pm 0.0283
11	GRU-ew2	0.0402 \pm 0.0012	1.1545 \pm 0.0292
12	LSTM-sg9	0.0409 \pm 0.0006	1.2460 \pm 0.0058
13	LSTM-obs	0.0411 \pm 0.0007	1.1552 \pm 0.0109
14	RNN-sg5	0.0413 \pm 0.0009	1.4160 \pm 0.0397
15	RNN-sg7	0.0417 \pm 0.0007	1.4258 \pm 0.0365
16	GRU-obs	0.0420 \pm 0.0006	1.2439 \pm 0.0131
17	RNN-ew2	0.0424 \pm 0.0006	1.3500 \pm 0.0644
18	RNN-ew3	0.0426 \pm 0.0003	1.4554 \pm 0.0408
19	RNN-ew4	0.0427 \pm 0.0005	1.5066 \pm 0.0359
20	RNN-obs	0.0437 \pm 0.0012	1.4610 \pm 0.0628

3.2 NH₃N forecasting, LSTM LSTM-4 comparison

Table 6: Evaluation of NH₃N forecasting models trained with positional encoding.

LSTM	Test loss	LSTM-4 ¹	Test loss
sg7	0.0379 ±0.0009	sg7	0.0369 ±0.0003
ew3	0.0379 ±0.0004	sg9	0.0384 ±0.0001
ew4	0.0380 ±0.0003	ew3	0.0392 ±0.0007
sg5	0.0387 ±0.0004	sg5	0.0397 ±0.0002
ew2	0.0389 ±0.0004	ew4	0.0399 ±0.0007
sg9	0.0409 ±0.0006	ew2	0.0404 ±0.0007
obs	0.0411 ±0.0007	obs	0.0432 ±0.0009

¹Number 4 stands for the number of features.

4 NH3/colour forecasting colour

4.1 Multivariate colour forecasting model, baseline performance

Table 7: Evaluation of multivariate models of each colour forecasting approach.

Rank	Model-Dataset	Test loss	Valid loss
1	LSTM-sg9	1.5358 \pm 0.0001	0.7016 \pm 0.0129
2	GRU-sg9	1.7454 \pm 0.0002	0.7415 \pm 0.0153
3	LSTM-sg7	1.8177 \pm 0.0002	0.7633 \pm 0.0236
4	GRU-sg7	1.9366 \pm 0.0001	0.7463 \pm 0.0333
5	RNN-sg9	2.0959 \pm 0.0003	0.8345 \pm 0.0088
6	RNN-sg7	2.4952 \pm 0.0002	0.8160 \pm 0.0256
7	LSTM-ew4	2.9674 \pm 0.0002	0.7590 \pm 0.0275
8	GRU-ew4	3.0119 \pm 0.0001	0.7475 \pm 0.0152
9	RNN-ew4	3.3010 \pm 0.0002	0.8599 \pm 0.0021
10	LSTM-sg5	3.3376 \pm 0.0001	0.8231 \pm 0.0351
11	LSTM-ew3	3.4504 \pm 0.0002	0.7473 \pm 0.0236
12	GRU-sg5	3.5714 \pm 0.0002	0.7687 \pm 0.0112
13	GRU-ew3	3.8090 \pm 0.0002	0.7899 \pm 0.0184
14	RNN-sg5	3.8777 \pm 0.0001	0.8963 \pm 0.0192
15	RNN-ew3	3.9121 \pm 0.0007	0.8344 \pm 0.0111
16	DNN-sg9	4.6878 \pm 0.0004	1.4568 \pm 0.0132
17	LSTM-ew2	4.7100 \pm 0.0005	0.7855 \pm 0.0316
18	GRU-ew2	4.8043 \pm 0.0006	0.8067 \pm 0.0070
19	RNN-ew2	4.9021 \pm 0.0002	0.8804 \pm 0.0285
20	DNN-sg7	5.1713 \pm 0.0003	1.4630 \pm 0.0244

4.2 LSTM LSTM-4 comparison

Table 8: Evaluation of colour forecasting models trained with positional encoding.

LSTM	Test loss	LSTM-4 ²	Test loss
ew3	0.0132 \pm 0.0001	sg9	0.0129 \pm 0.0007
ew4	0.0135 \pm 0.0002	sg7	0.0136 \pm 0.0005
ew2	0.0139 \pm 0.0002	ew3	0.0136 \pm 0.0005
sg9	0.0146 \pm 0.0001	ew4	0.0137 \pm 0.0003
obs	0.0152 \pm 0.0001	obs	0.0140 \pm 0.0001
sg7	0.0154 \pm 0.0007	ew2	0.0141 \pm 0.0001
sg5	0.0159 \pm 0.0006	sg5	0.0155 \pm 0.0003

²Number 4 stands for the number of features.

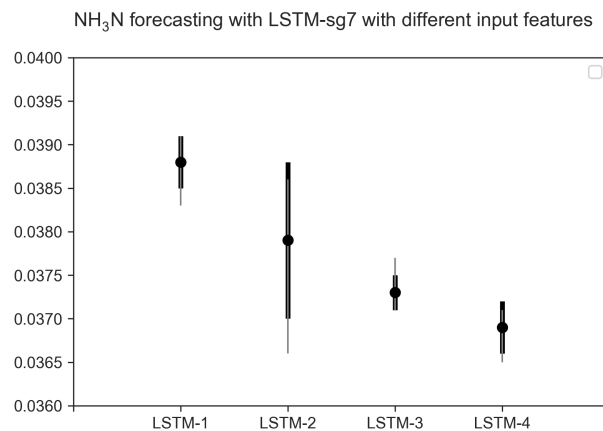


Figure 1: Ammonia forecasting models trained with different input features. LSTM-1 and LSTM-3 represent models trained with NH₃N only and NH₃N with positional encoding. LSTM-2 and LSTM-4 represent models trained with colour/NH₃N, colour/NH₃N and positional encoding.