

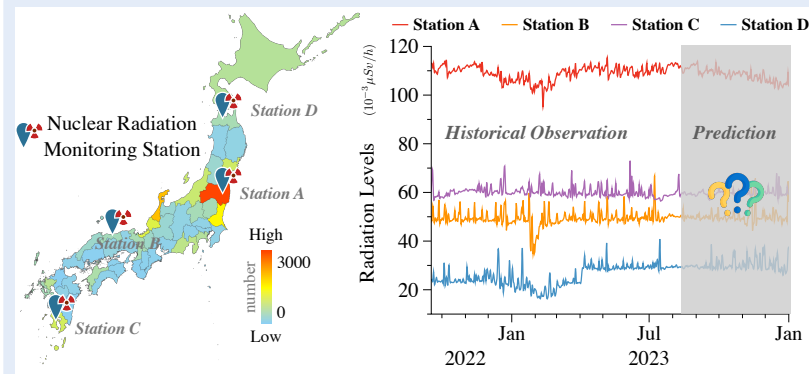
NRFormer: Nationwide Nuclear Radiation Forecasting with Spatio-Temporal Transformer

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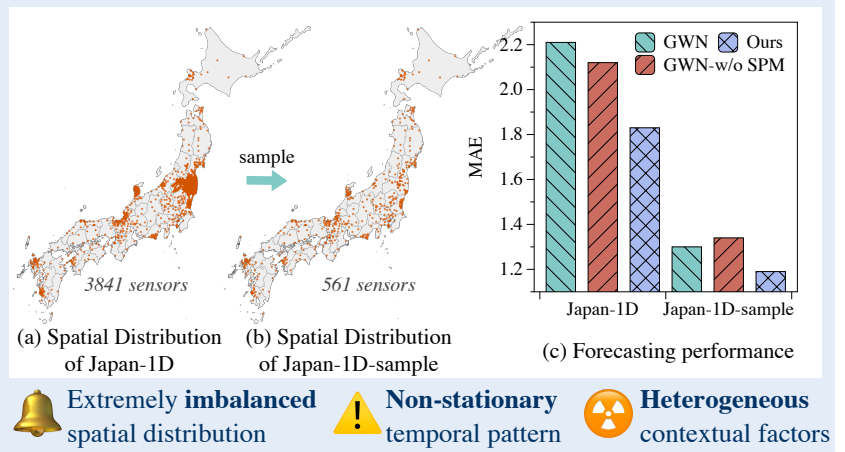
Introduction

Nuclear Radiation Forecasting

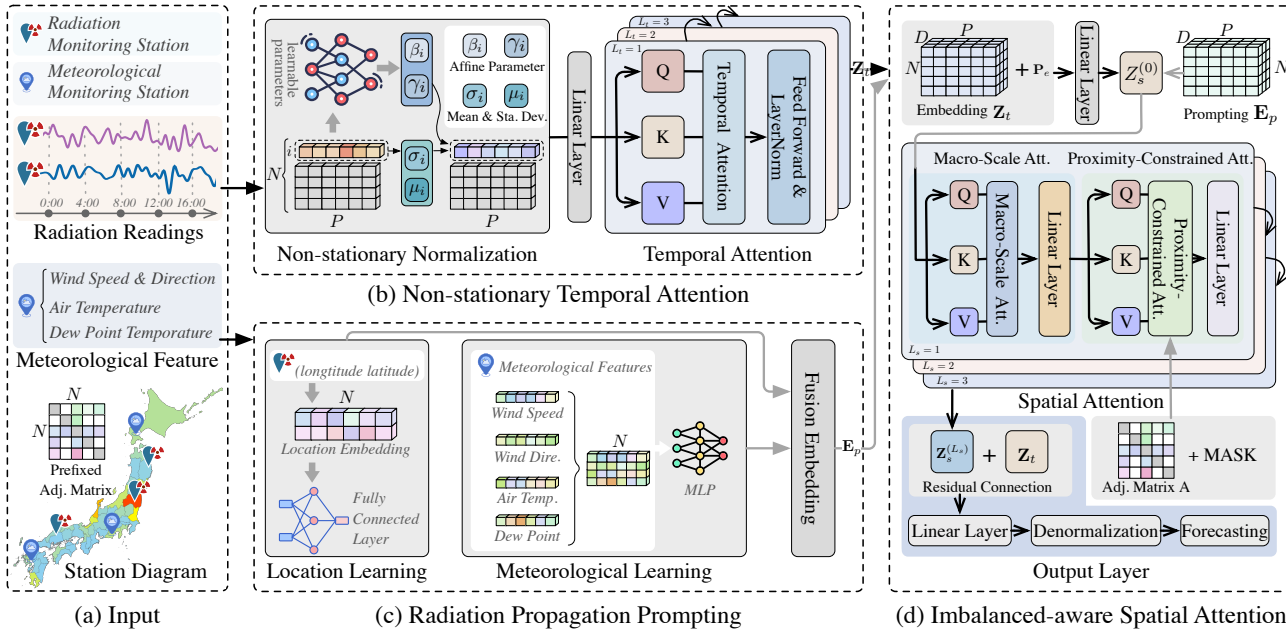


Given the historical observation, we aim to **predict the radiation level** 1-24 days ahead across all monitoring stations.

Motivation & Challenges



NRFormer Framework



Highlight

Non-stationary Temporal Attention

Effectively **extract stable knowledge** from radiation sequence inputs, using this two parts: **nonstationary normalization** and **point-wise temporal attention**.

Radiation Propagation Prompting

Encode **context-specific knowledge** (e.g., location, meteorological data) as **prompts** to guide model forecasting.

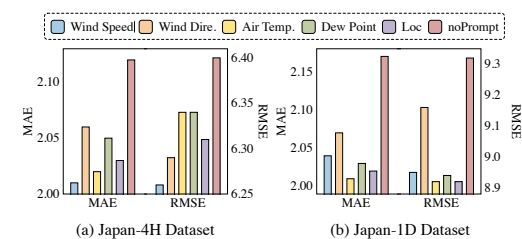
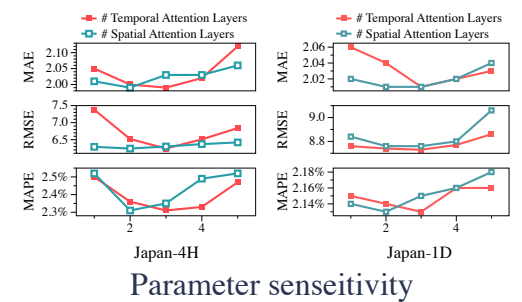
Imbalance-aware Spatial Attention

Adaptively balance information flow: **enriching spatial context** for isolated stations while **preventing information overload** in dense regions.

Experimental Results

Data	Models	6th (24 hours / 6 days)			9th (36 hours / 9 days)			12th (48 hours / 12 days)			24th (96 hours / 24 days)			sudden change		
		MAE	RMSE	MAPE	MAE	RMSE	MAPE	MAE	RMSE	MAPE	MAE	RMSE	MAPE	MAE	RMSE	MAPE
Japan-4H	HA	3.20	19.73	3.18%	3.57	20.16	3.58%	3.51	20.20	3.48%	3.74	20.78	3.64%	3.83	21.91	3.67%
	LR	2.80	11.17	2.58%	2.96	11.50	2.75%	2.94	11.75	2.64%	3.04	12.43	2.65%	3.44	14.19	2.88%
	XGBoost	2.38	12.47	2.53%	2.49	12.92	2.61%	2.58	13.10	2.67%	2.80	14.38	2.83%	3.64	16.46	2.97%
	DCRNN	2.15	6.32	2.52%	2.30	7.22	2.64%	2.42	8.01	2.73%	2.79	10.49	2.97%	3.09	12.12	2.81%
	STID	2.04	5.72	2.47%	2.15	6.18	2.56%	2.19	6.50	2.59%	2.30	7.51	2.63%	2.56	9.63	2.79%
	DLinear	2.12	6.16	2.57%	2.20	6.15	2.66%	2.22	6.51	2.60%	2.31	7.47	2.66%	2.35	8.99	2.62%
	PatchTST	1.89	5.61	2.24%	2.01	6.06	2.35%	2.05	6.36	2.36%	2.23	7.57	2.48%	2.32	7.84	2.47%
	Koopa	1.92	5.69	2.28%	2.01	6.08	2.35%	2.06	6.42	2.38%	2.23	7.64	2.55%	2.31	7.89	2.49%
	StemGNN	2.01	6.11	2.72%	2.22	6.19	2.52%	2.29	6.47	2.55%	2.38	7.53	2.59%	2.41	8.71	2.71%
	GWN	2.25	5.99	2.78%	2.26	6.30	2.72%	2.27	6.48	2.70%	2.40	7.33	2.80%	2.69	9.86	2.72%
	LightCTS	1.87	5.73	2.34%	2.01	6.35	2.44%	2.15	6.54	2.49%	2.29	7.51	2.50%	2.40	8.69	2.68%
	NRFormer	1.72	4.82	2.07%	1.79	5.15	2.14%	1.85	5.39	2.18%	1.99	6.24	2.31%	2.05	6.76	2.31%
Japan-1D	HA	2.86	17.83	2.73%	2.97	18.22	2.86%	3.08	18.58	2.98%	3.46	20.01	3.45%	4.11	22.41	3.49%
	LR	2.46	11.08	2.07%	2.55	11.76	2.14%	2.67	12.27	2.25%	2.95	14.21	2.50%	3.79	13.92	3.01%
	XGBoost	2.51	13.71	2.66%	2.64	14.97	2.76%	2.73	15.36	2.85%	2.95	16.10	3.07%	3.82	15.14	3.15%
	DCRNN	1.97	10.51	2.00%	2.14	11.44	2.09%	2.78	12.43	2.17%	2.64	14.53	2.42%	3.46	13.63	3.02%
	STID	2.44	7.42	3.41%	2.57	7.93	3.58%	2.68	8.38	3.72%	3.06	9.99	4.23%	3.26	12.62	3.12%
	DLinear	1.89	7.85	2.03%	2.11	8.75	2.25%	2.19	8.42	2.42%	2.33	9.19	2.46%	2.48	10.54	2.60%
	PatchTST	1.84	6.37	1.95%	1.97	6.98	2.05%	2.03	7.90	2.10%	2.17	9.02	2.44%	2.44	9.92	2.53%
	Koopa	1.74	7.03	2.00%	1.83	7.68	2.10%	1.91	8.17	2.15%	2.11	9.77	2.49%	2.46	9.95	2.50%
	StemGNN	1.83	7.79	2.11%	2.14	8.63	2.23%	2.16	8.39	2.42%	2.32	9.13	2.43%	2.42	10.25	2.56%
	GWN	1.90	7.31	2.16%	1.97	7.77	2.19%	2.04	8.15	2.26%	2.20	9.19	2.43%	2.94	11.35	2.86%
	LightCTS	1.85	8.02	2.13%	1.93	7.17	2.17%	2.00	7.74	2.15%	2.15	9.19	2.36%	2.39	9.97	2.51%
	NRFormer	1.71	6.25	1.90%	1.78	6.82	1.94%	1.83	7.28	1.98%	2.01	8.76	2.13%	2.06	8.97	2.21%

Overall results on two real-world datasets



Ablation study of contextual feature



Code &
Datasets



Deployed
Forecasting System