



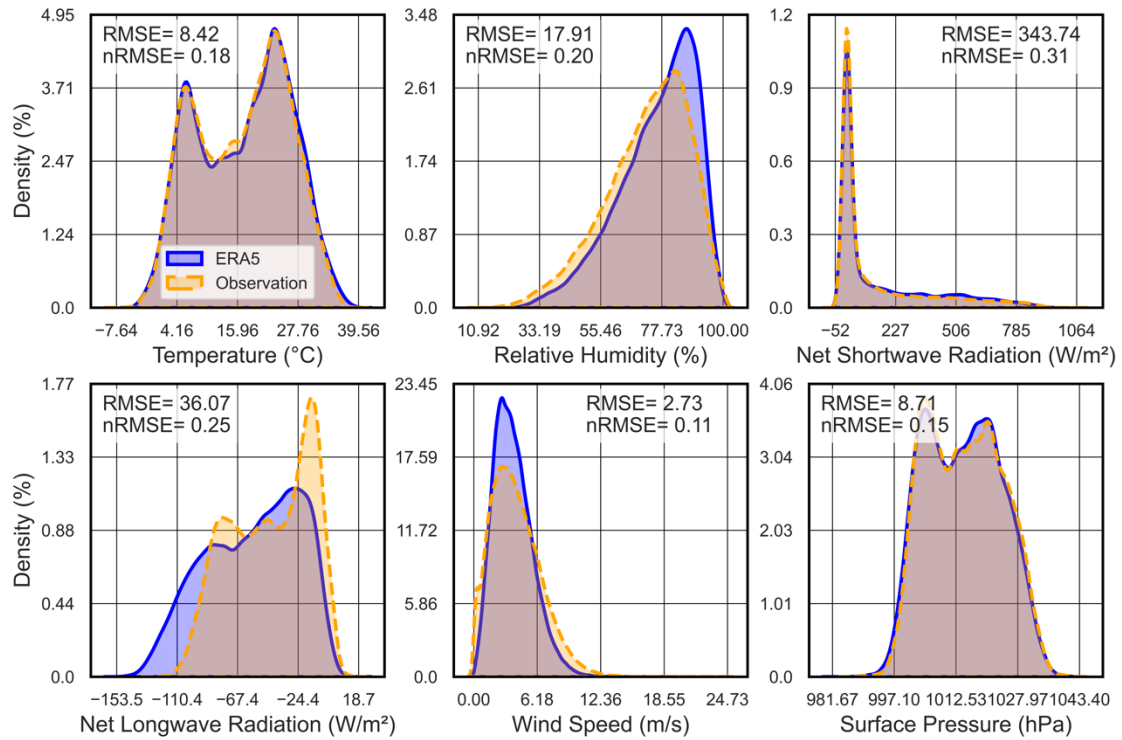
*Supplement of*

## **Hybrid Lake Model (HyLake) v1.0: unifying deep learning and physical principles for simulating lake-atmosphere interactions**

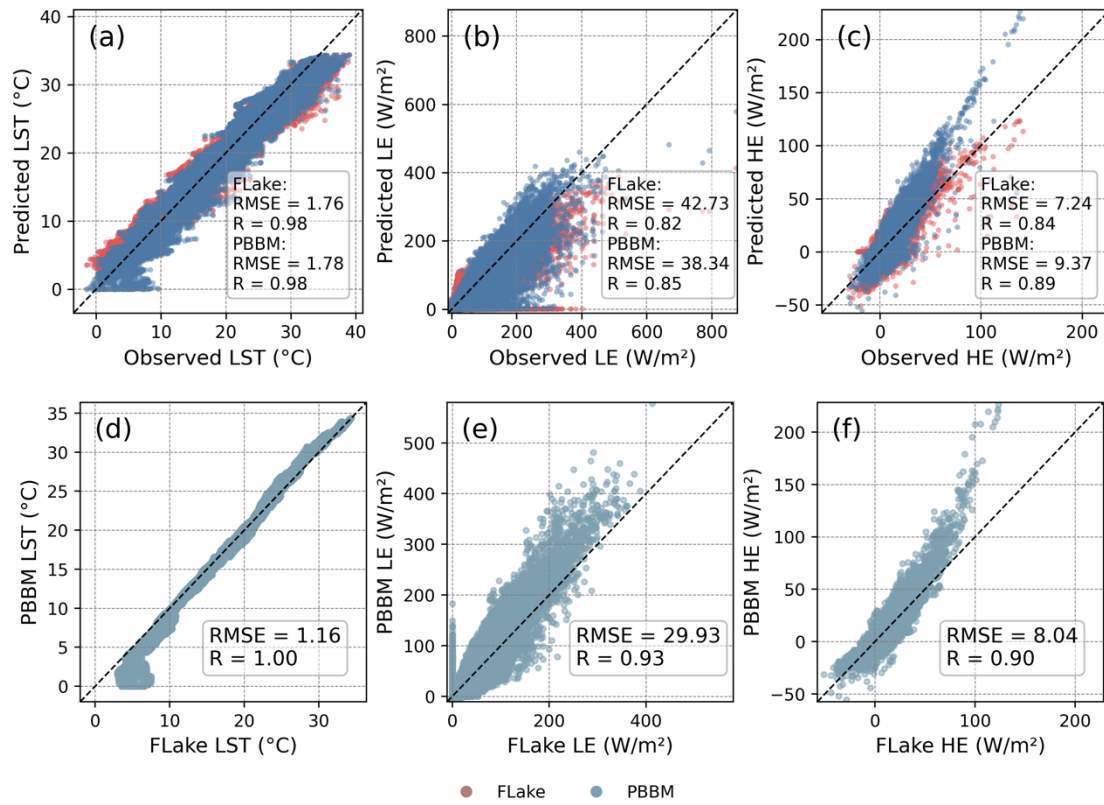
**Yuan He and Xiaofan Yang**

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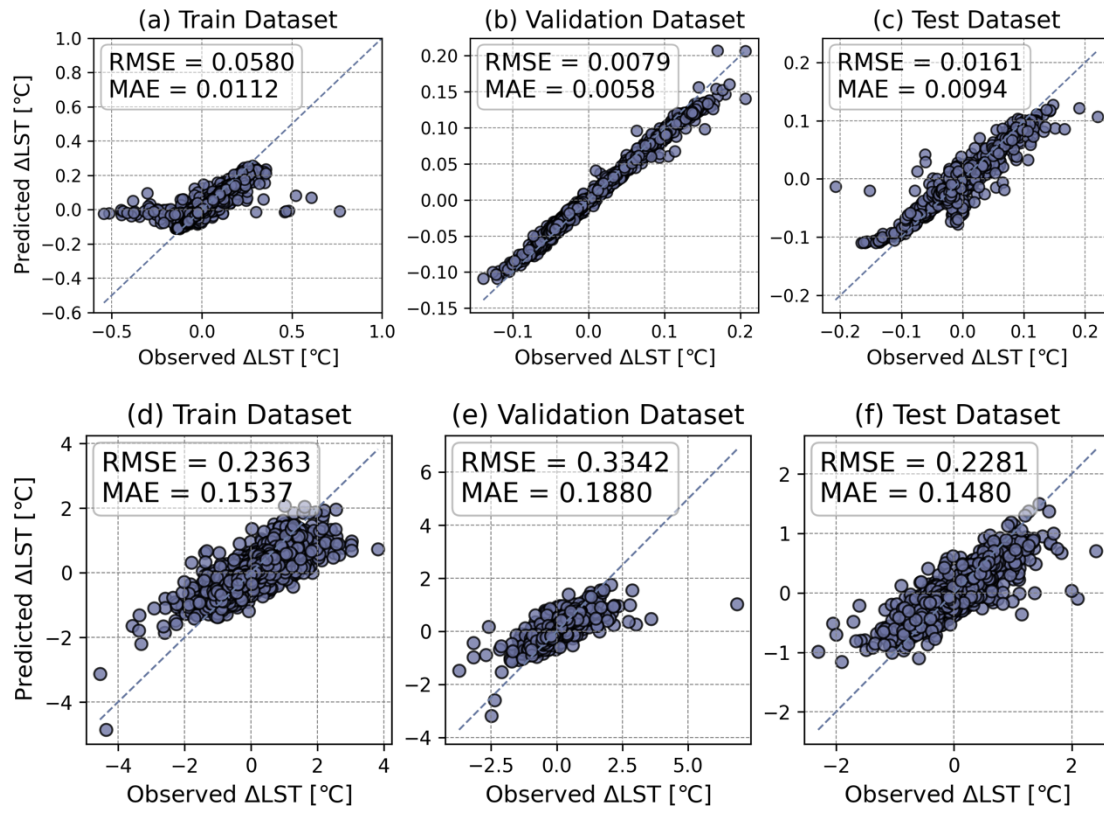
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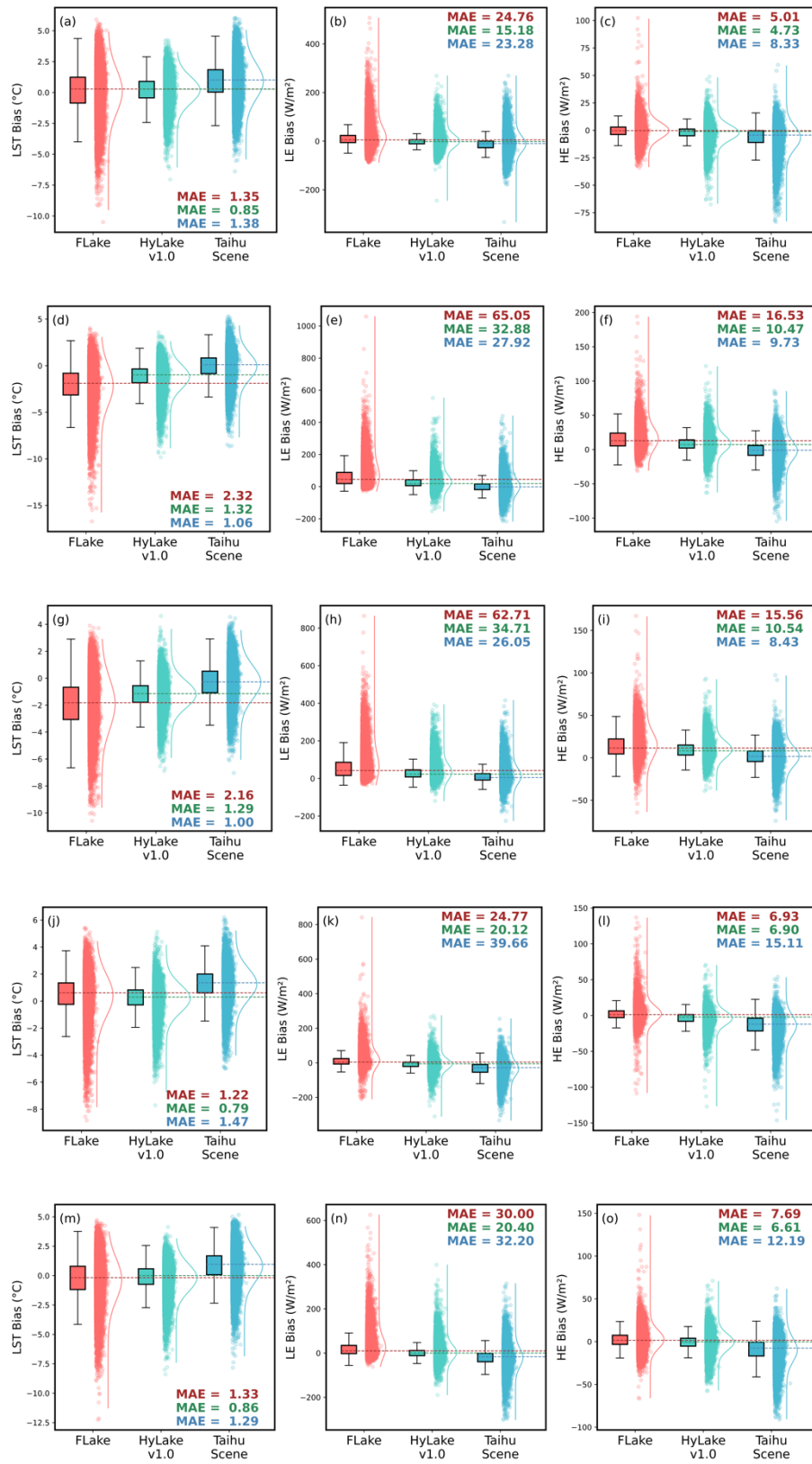
**Figure S1: The probability density distribution of meteorological variables from observation and ERA5 reanalysis datasets in MLW, BFG, DPK, PTS, and XLS site during 2012 to 2015. A normalized RMSE (nRMSE) was assigned to assess the error between observation and ERA5 reanalysis datasets.**



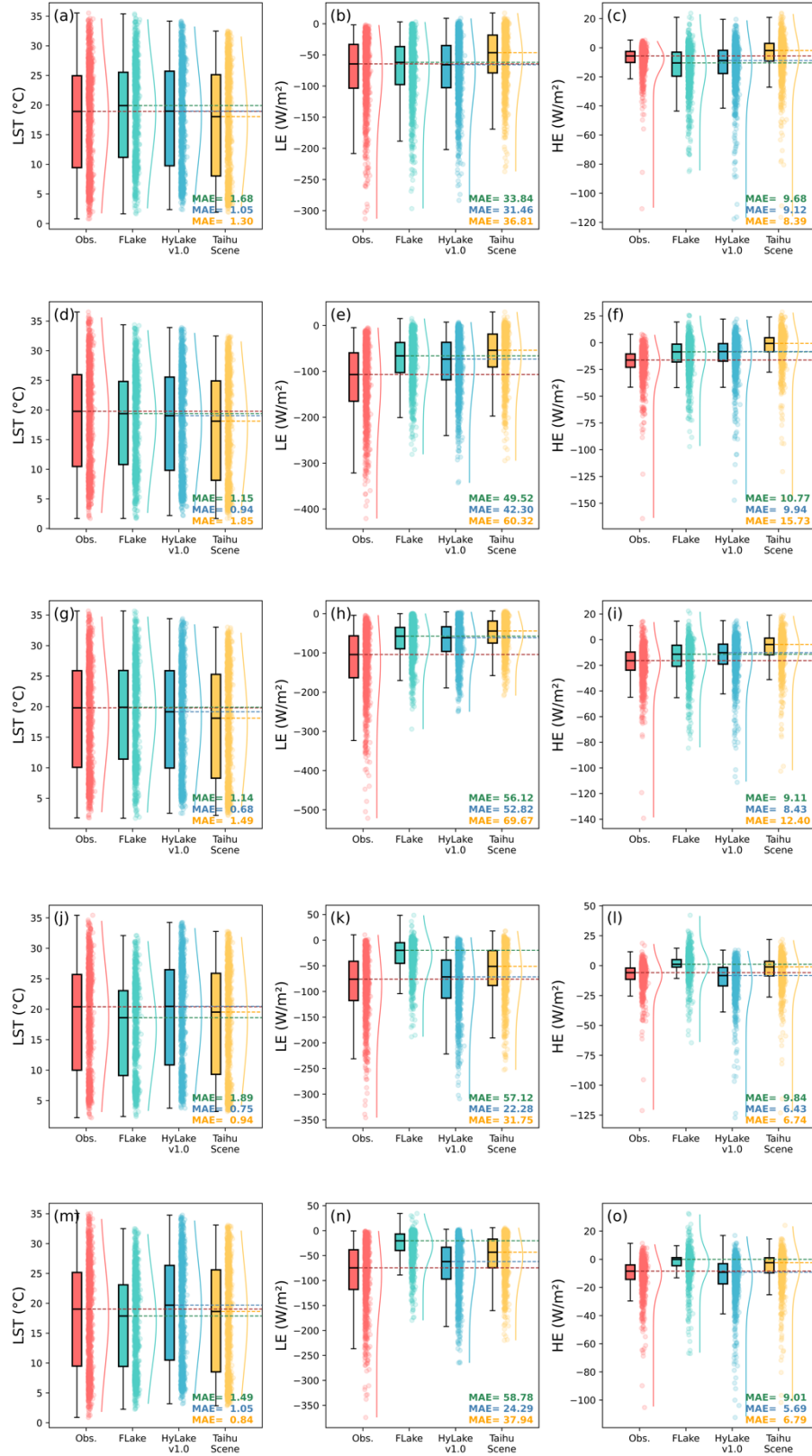
**Figure S2: The comparison between FLake, PBBM and observations in LST, LE, and HE. (a-c) present the comparison of model performance between FLake, PBBM, and observations. (d-f) present the scatterplots between FLake and PBBM.**



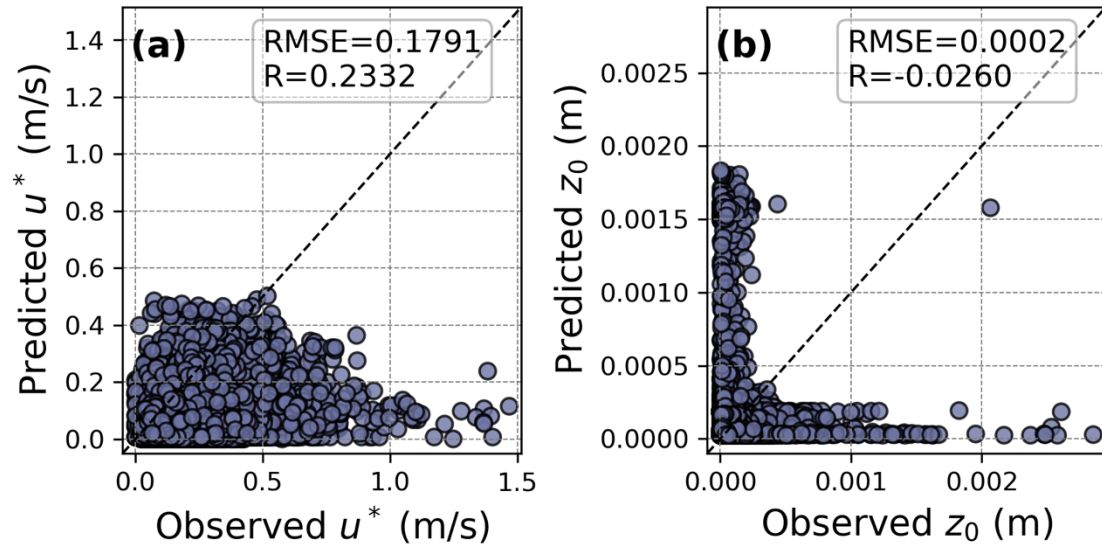
**Figure S3: The separate performance of LSTM-based surrogates for Baseline (a-c) and TaihuScene (e-f) in train, validation, and test datasets, respectively.**



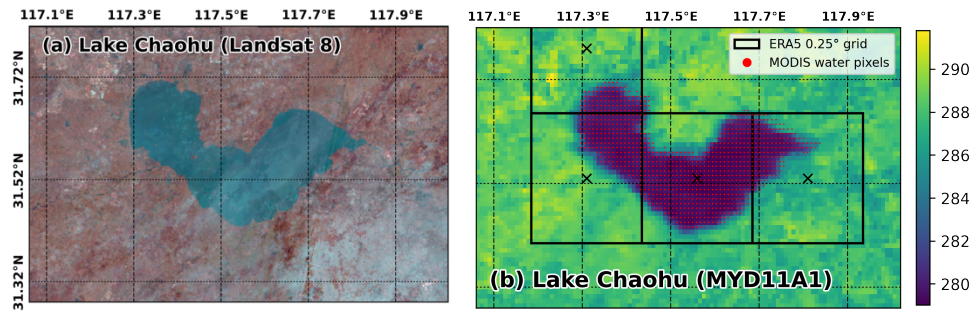
**Figure S4: The intercomparison of LST, HE, and LE for each lake site between FLake, HyLake v1.0 and TaihuScene. MLW, BFG, DPK, PTS, and XLS site are (a-c), (d-f), (g-i), (j-l), and (m-n) in this Figure, respectively.**



**Figure S5: The comparison of LST, HE, and LE for each lake site between observations, FLake, HyLake v1.0 and TaihuScene under ERA5 reanalysis datasets. MLW, BFG, DPK, PTS, and XLS site are (a-c), (d-f), (g-i), (j-l), and (m-n) in this Figure, respectively.**

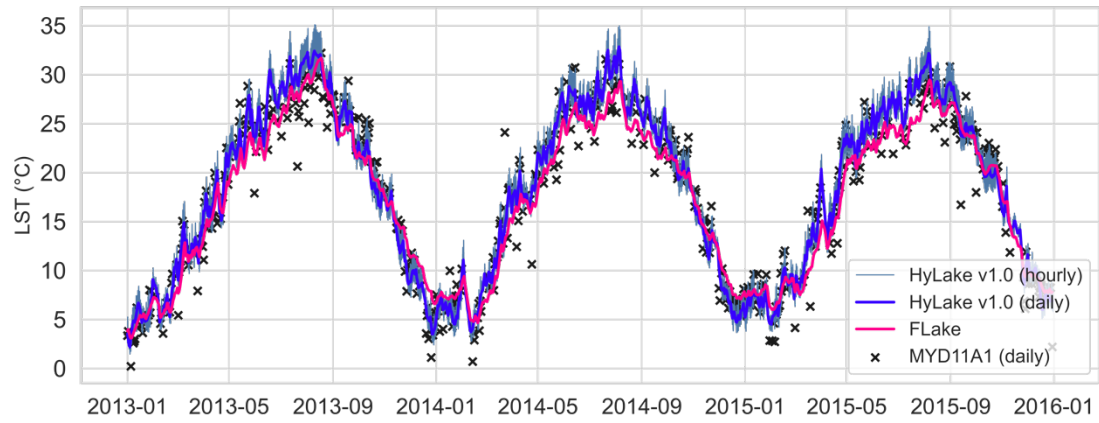


**Figure S6: The comparison of friction velocity ( $u^*$ ) and surface roughness length ( $z_{0m}$ , m) in MLW lake site between simulation derived from PBBM and HyLake v1.0 and observations.**

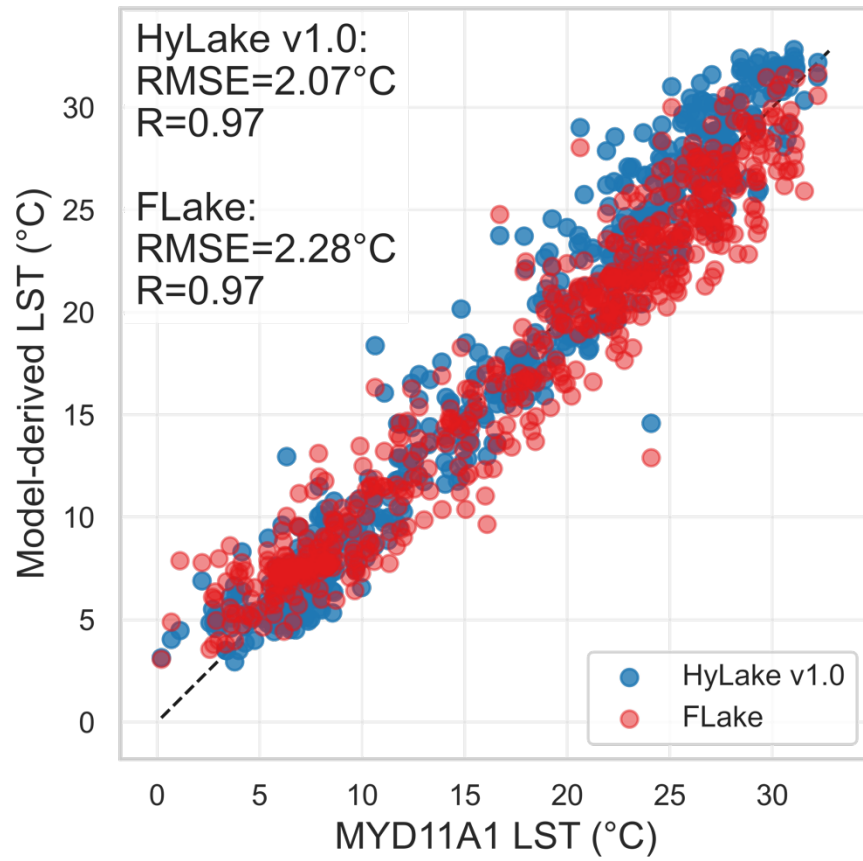


**Figure S7: The locations of Lake Chaohu overlaid on a true-color image from (a) Landsat 8 and daily land surface temperature from (b) MYD11A1 product.**

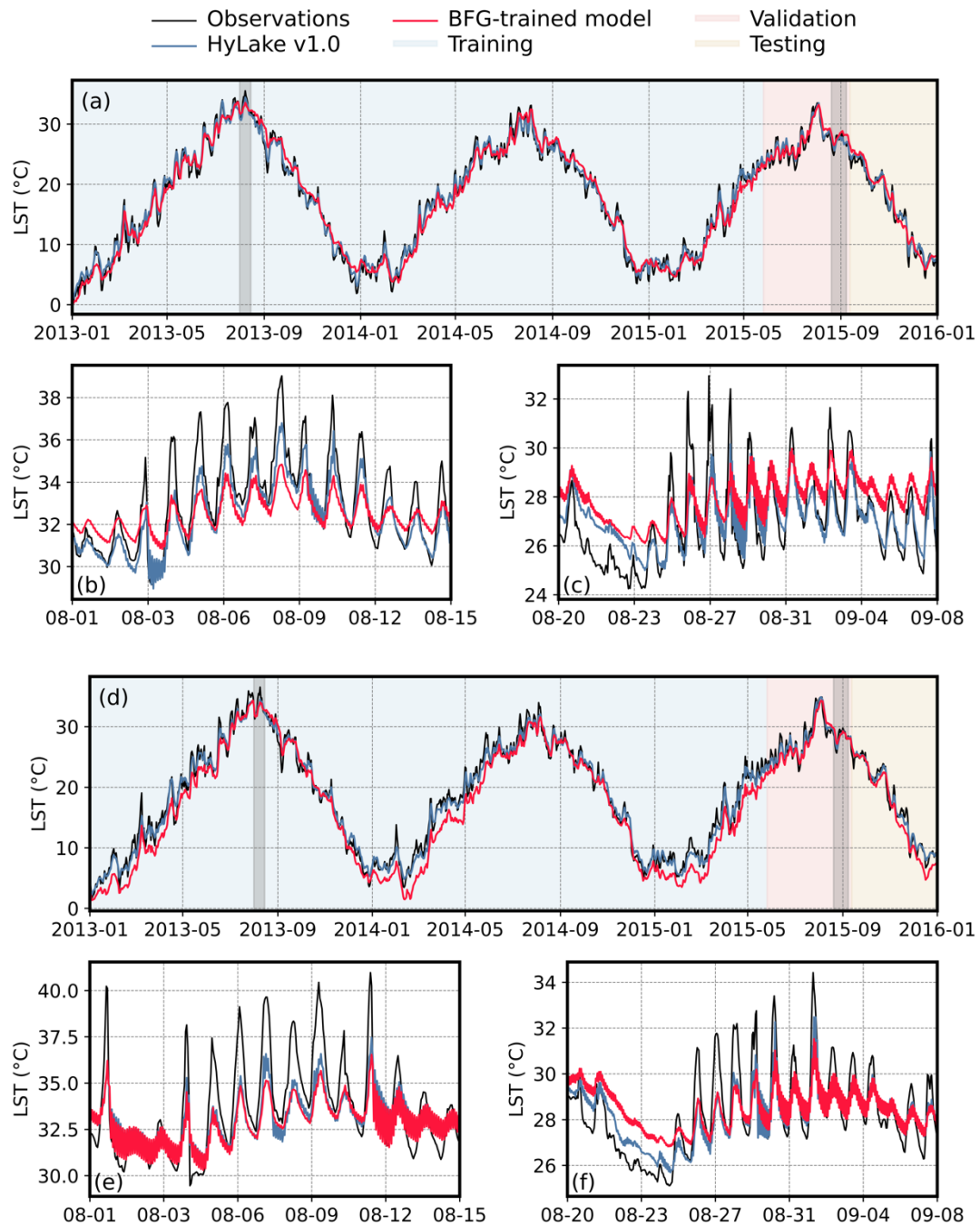




**Figure S8: Time series of daily grid-average LST on Lake Chaohu derived from MYD11A1, FLake simulation, and HyLake v1.0 from 2013 to 2015. HyLake v1.0 provides daily and hourly simulations.**



**Figure S9: The intercomparison of daily LST between model simulations (FLake and HyLake v1.0) and MYD11A1 observations on Lake Chaohu from 2013 to 2015.**



**Figure S10: Comparison between HyLake v1.0 used MLW-train surrogate and BFG-trained surrogate in temporal trends of LST. (a-c) and (d-f) present the time series comparison at MLW and BFG site, respectively. Comparison of (a, and d) the full time series and (b-c, and e-f) partial time series of models derived LST and observations from 2013 to 2015. Blue, red, and yellow regions represent the period for the training, validation, and test datasets, respectively.**

**Table S1: Model specifications of BO-BLSTM-based surrogates that trained with BFG, DPK, PTS, and XLS observations and performance in training sets, validation sets, and test sets of MLW. The RMSE for each surrogate was calculated from the difference between their training datasets.**

NO.	Training dataset	Model specifications				RMSE (°C)		
		Number of layers	Neurons per layer	Batch size	Learning rate	Train	Validation	Test
1	MLW	4	467	64	9.6E-4	0.19	0.34	0.23
2	BFG	5	30	94	2.5E-3	0.20	0.26	0.18
3	DPK	5	94	124	3.0E-3	0.21	0.24	0.23
4	PTS	6	143	124	7.5E-4	0.20	0.22	0.23
5	XLS	5	170	29	1.0E-2	0.40	0.45	0.33
6	Whole	7	836	145	2.5E-2	0.24	0.33	0.23