

# Appendix 18. Model Archival Summary for Total Nitrogen Concentration at U.S. Geological Survey Site 06892350, Kansas River at De Soto, Kansas, during June 2014 through September 2019

This model archival summary summarizes the total nitrogen (TN; U.S. Geological Survey [USGS] parameter codes 49570 + 62854) concentration model developed to compute 15-minute TN concentrations from June 2014 onward. This model supersedes all previous models.

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## Site and Model Information

Site number: 06892350

Site name: Kansas River at De Soto, Kansas

Location: Lat 38°59'00", long 94°57'52" referenced to North American Datum of 1927, in NE 1/4 SE 1/4 SE 1/4 sec.28, T.12 S., R.22 E., Leavenworth County, Kans., hydrologic unit 10270104.

Equipment: A YSI 6600 water-quality monitor equipped with sensors for water temperature, specific conductance, dissolved oxygen, pH, and turbidity (TBY) was installed from August 2012 through June 2014. A Xylem YSI EXO2 water-quality monitor equipped with sensors for water temperature, specific conductance, dissolved oxygen, pH, TBY, and chlorophyll (fCHL) and phycocyanin fluorescence was installed during June 2014 through September 2019. A Hach Nitratax plus sc sensor (5-millimeter path length) that monitors ultraviolet (UV) nitrate concentrations was installed from June 2013 through September 2019. The monitors were housed in side-by-side 4-inch-diameter galvanized steel pipes. Readings from the water-quality and nitrate plus nitrite monitors were recorded every 15 minutes and transmitted by way of satellite, hourly.

Date model was created: April 15, 2020

Model calibration data period: June 30, 2014, through September 24, 2019

Model application date: June 30, 2014, onward

## Model-Calibration Dataset

All data were collected using USGS protocols (Wagner and others, 2006; U.S. Geological Survey, variously dated) and are stored in the National Water Information System (U.S. Geological Survey, 2020) database and available to the public. Ordinary least squares analysis was used to develop regression models using R programming language (R Core Team, 2020). Potential explanatory variables that were evaluated individually and in combination included streamflow, water temperature, specific conductance, dissolved oxygen, pH, TBY, fCHL, phycocyanin fluorescence, and UV nitrate sensor data. The maximum time span between two continuous data points used for interpolation was 2 hours (in order to preserve the sample dataset, field monitor averages obtained during sample collection were used for model development data if no continuous data were available or if gaps larger than 1 hour in the continuous data record resulted in missing interpolated data). Seasonal components (sine and cosine variables) were also evaluated as potential explanatory variables.

The final selected regression model was based on 94 concurrent measurements of TN concentration, sensor-measured TBY, fCHL, and seasonal components (sine and cosine variables) during June 30, 2014, through September 24, 2019. Samples were collected throughout the range of continuously observed hydrologic conditions. Total nitrogen results were calculated by combining total particulate nitrogen (USGS parameter code 49570) and total dissolved nitrogen (USGS parameter code 62854). One total particulate nitrogen sample (USGS parameter code 49570) had a concentration below the laboratory detection limit and was halved to preserve the full dataset. Summary statistics and the complete model-calibration dataset are provided below. Potential outliers were identified using the methods described in Rasmussen and others (2009). Additionally, studentized residuals from the final model were inspected for values greater than three or less than negative three. Values outside of that range were considered potential outliers and were investigated. All potential outliers were not found to have errors associated with collection, processing, or analysis and were therefore considered valid.

This model is specific to the Kansas River at De Soto, Kans., during this study period and cannot be applied to data collected from other sites on the Kansas River or data collected from other waterbodies.

## Total Nitrogen Sampling Details

Cross-section samples typically were collected either from the downstream side of the bridge or instream within 100 feet of the bridge. The equal-width-increment collection method was used (although multiple vertical, single vertical, and grab samples were

occasionally collected), and samples typically were composited for analysis (U.S. Geological Survey, variously dated). During July 2012 through June 2017, cross-section samples were collected every 2 weeks during March through October, once a month during November through February, and during selected reservoir release and runoff events. During July 2017 through September 2019, cross-section samples were collected on a monthly to bimonthly basis, depending on flow conditions. A FISP US DH-81, DH-95, D-95, D-96a, or D-96 depth integrating sampler was used. Additional detail on sample collection is available in Foster and Graham (2016) and Graham and others (2018). Samples were analyzed for TN concentration at the USGS National Water Quality Laboratory in Lakewood, Colorado.

## Model Development

Ordinary least squares regression analysis was done using R programming language (R Core Team, 2020) to relate discretely collected TN concentration to sensor-measured TBY, fCHL, and seasonal components (sine and cosine variables). The distribution of residuals was examined for normality, and the plots of residuals (the difference between the measured and computed values) were examined for homoscedasticity (departures from zero did not change substantially over the range of computed values). Previously published explanatory variables were also strongly considered for continuity.

TBY, fCHL, and seasonal components (sine and cosine variables) were selected as good surrogates for TN based on residual plots, coefficient of determination ( $R^2$ ), and model standard percentage error. Values for all the aforementioned statistics were computed and are included below along with all relevant sample data and additional statistical information.

## Model Summary

The following is a summary of final regression analysis for TN concentration at USGS site 06892350:

TN concentration-based model:

$$\log TN = 0.327 \times \log TBY - 0.0994 \times \log fCHL + 0.0758 \times \sin(2\pi D) + 0.0306 \times \cos(2\pi D) - 0.275$$

where

$\log$  = logarithm base 10;

$TN$  = total nitrogen concentration (USGS parameter codes 49570 + 62854), in milligrams per liter;

$TBY$  = turbidity, in formazin nephelometric units;

$fCHL$  = chlorophyll fluorescence, in relative fluorescence units;

$\sin$  = sine;

$D$  = date, in decimal years; and

$\cos$  = cosine.

TBY and seasonal components (sine and cosine variables) make physical and statistical sense as explanatory variables for TN because increases in TN can be associated with precipitation runoff events which can exhibit a seasonal pattern and cause increases in TBY. fCHL also was used as an explanatory variable in the model previously published by Foster and Graham (2016).

The logarithmically ( $\log$ ) transformed model may be retransformed to the original units so that TN can be calculated directly. The retransformation introduces a bias in the calculated constituent. This bias may be corrected using Duan's bias correction factor (BCF; Duan, 1983). For this model, the calculated BCF is 1.02. The retransformed model, accounting for BCF is as follows:

$$TN = 1.02 \times (TBY^{0.327} \times fCHL^{-0.0994} \times 10^{[0.0758 \times \sin(2\pi D)]} \times 10^{[0.0306 \times \cos(2\pi D)]} \times 10^{-0.275})$$

## Previous Models

Start Year	End Year	Model Equation	Reference
2012	2019	$\log TN = -0.0362WT + 1.93 \log TBY - 0.735$  where, WT = water temperature in degrees Celsius	Foster and Graham (2016)
1999	2003	$\log TN = 0.239 \log TBY - 0.263$	Rasmussen and others (2005)

# Model Statistics, Data, and Plots

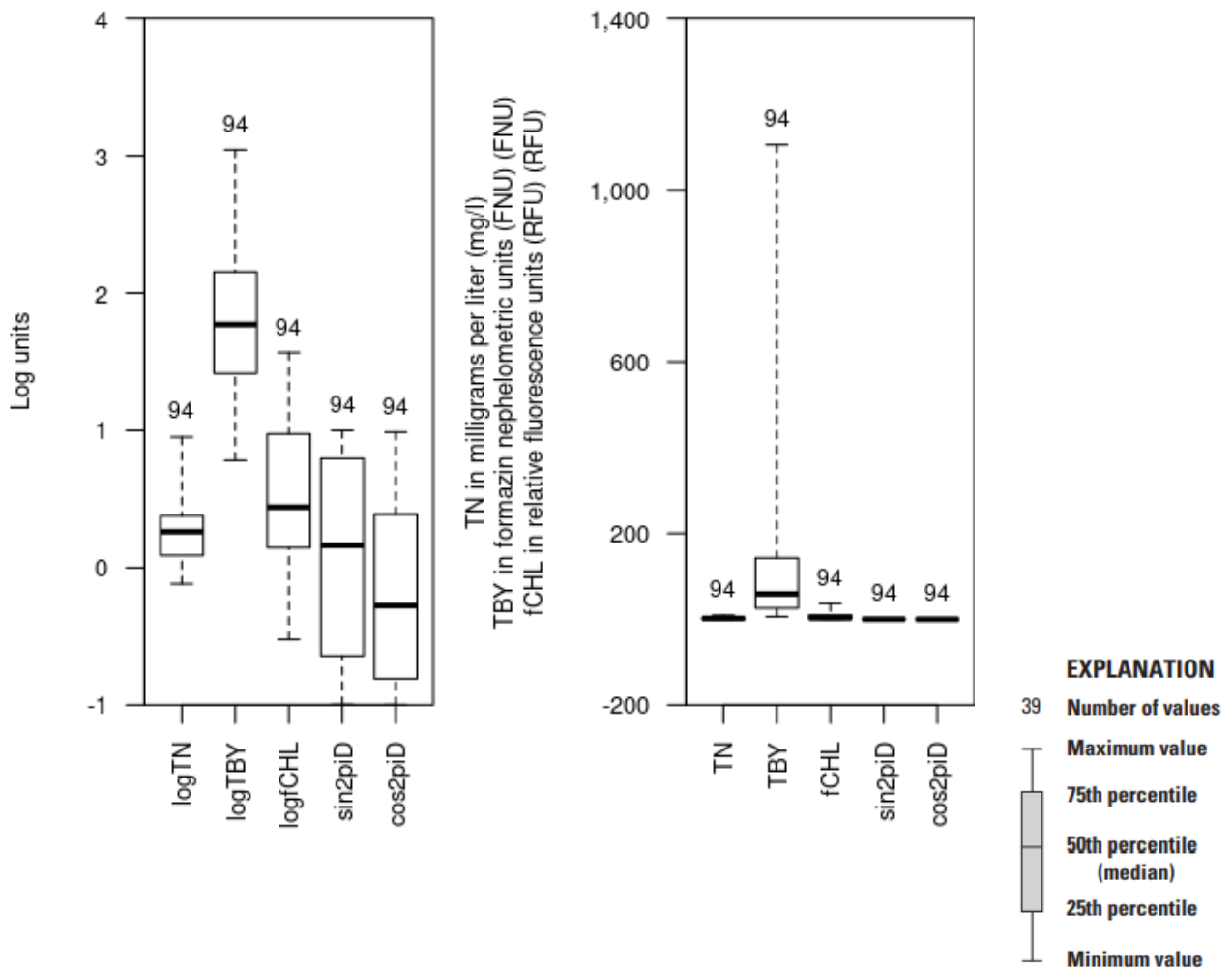
## Model

$$\log\text{TN} = + 0.327 * \log\text{TBY} - 0.0994 * \log\text{fCHL} + 0.0758 * \sin 2\pi\text{iD} + 0.0306 * \cos 2\pi\text{iD} - 0.275$$

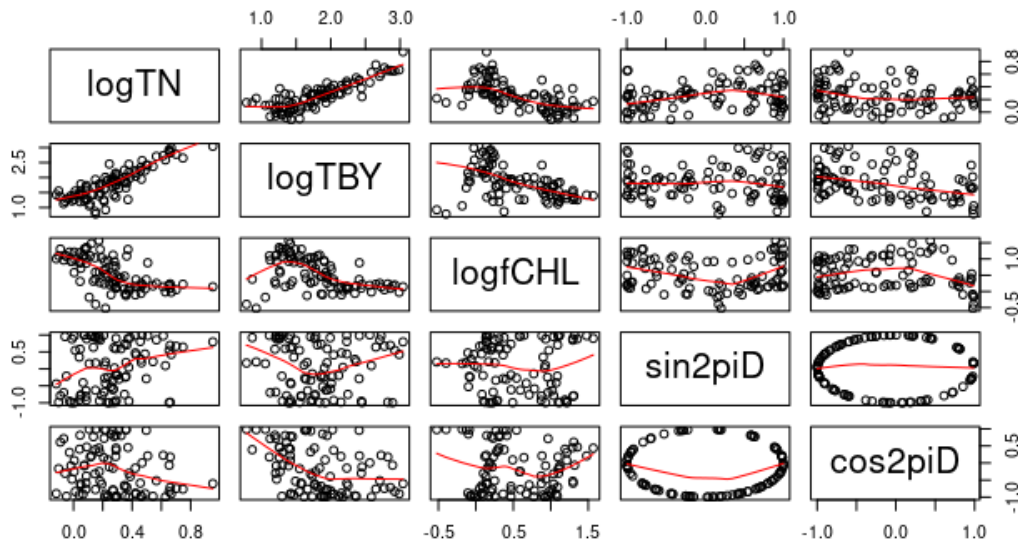
## Variable Summary Statistics

	logTN	TN	logTBY	logfCHL	sin2piD	cos2piD	TBY	fCHL
Minimum	-0.1170	0.763	0.782	-0.523	-0.9980	-1.000	6.06	0.30
1st Quartile	0.0896	1.230	1.410	0.146	-0.6420	-0.809	26.00	1.40
Median	0.2620	1.830	1.770	0.440	0.1630	-0.276	59.00	2.76
Mean	0.2670	2.120	1.830	0.544	0.0648	-0.177	147.00	6.32
3rd Quartile	0.3780	2.390	2.150	0.975	0.7960	0.390	143.00	9.44
Maximum	0.9510	8.940	3.040	1.570	1.0000	0.988	1110.00	36.90

## Box Plots



## Exploratory Plots



Red line shows the locally weighted scatterplot smoothing (LOWESS).

The x- and y-axis labels for a given bivariate plot are defined by the intersecting row and column labels.

## Basic Model Statistics

Number of Observations	94
Standard error (RMSE)	0.086
Average Model standard percentage error (MSPE)	19.9
Coefficient of determination ( $R^2$ )	0.851
Adjusted Coefficient of Determination (Adj. $R^2$ )	0.845
Bias Correction Factor (BCF)	1.02

### Variance Inflation Factors (VIF)

logTBY	logfCHL	sin2piD	cos2piD
1.67	1.44	1.01	1.34

## Explanatory Variables

	Coefficients	Standard Error	t value	Pr(> t )
(Intercept)	-0.2750	0.0468	-5.86	7.62e-08
logTBY	0.3270	0.0217	15.00	3.83e-26
logfCHL	-0.0994	0.0220	-4.52	1.90e-05
sin2piD	0.0758	0.0124	6.10	2.68e-08
cos2piD	0.0306	0.0153	2.00	4.85e-02

## Correlation Matrix

	Intercept	logTBY	logfCHL	sin2piD	cos2piD
Intercept	1.0000	-0.9580	-0.695	-0.0811	-0.4530
logTBY	-0.9580	1.0000	0.542	0.0576	0.4970
logfCHL	-0.6950	0.5420	1.000	0.0680	0.3490
sin2piD	-0.0811	0.0576	0.068	1.0000	0.0385
cos2piD	-0.4530	0.4970	0.349	0.0385	1.0000

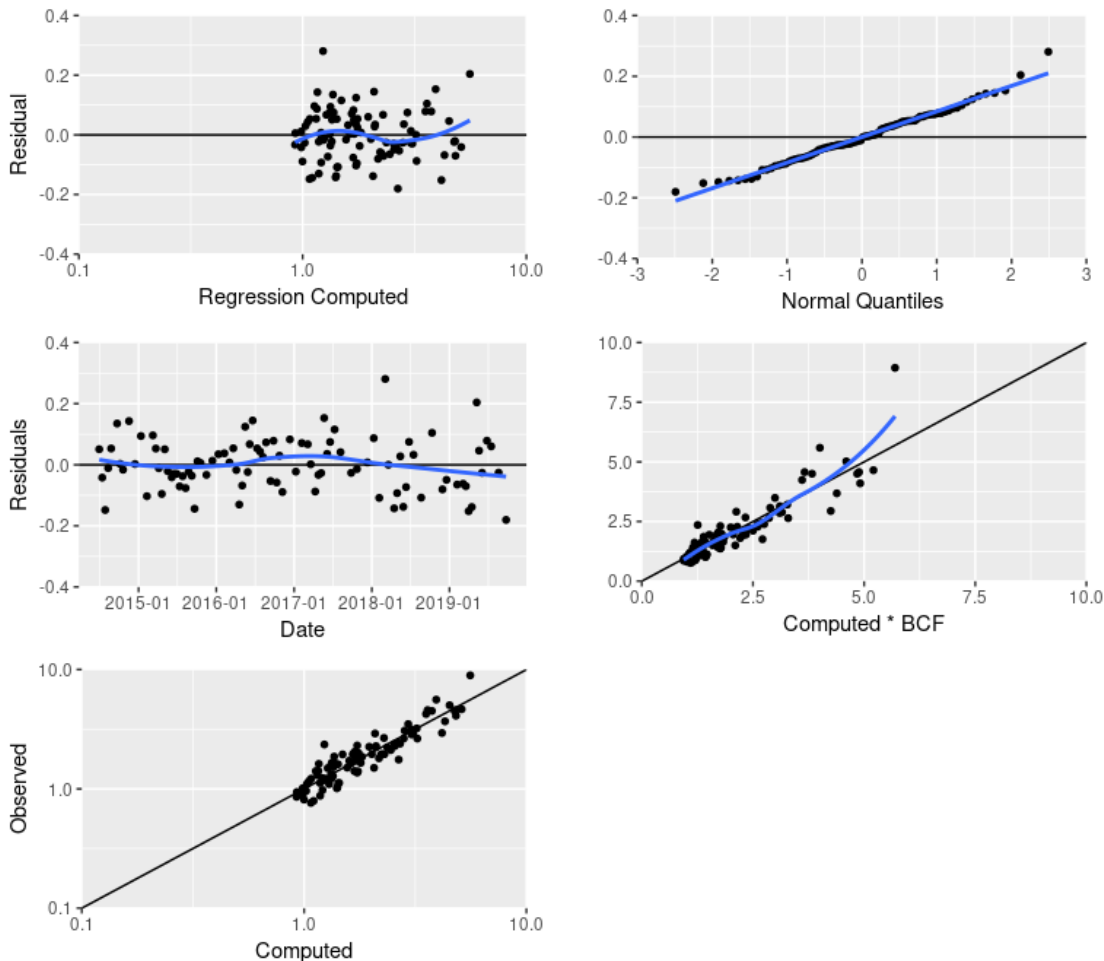
## Outlier Test Criteria

Leverage	Cook's D	DFFITS
0.160	0.364	0.461

## Flagged Observations

	logTN	Estimate	Residual	Standard Residual	Residual Studentized	Residual Leverage	Cook's D	DFFITS
201501121130	0.218	0.1240	0.094	1.19	1.20	0.1600	0.0544	0.523
201801101030	0.151	0.0637	0.087	1.10	1.11	0.1600	0.0466	0.483
201803051010	0.372	0.0911	0.281	3.38	3.60	0.0662	0.1620	0.958
201904011200	0.468	0.6200	-0.152	-1.82	-1.85	0.0602	0.0425	-0.467
201905091110	0.951	0.7470	0.204	2.48	2.55	0.0826	0.1110	0.766
201909240950	0.245	0.4250	-0.180	-2.15	-2.20	0.0517	0.0506	-0.514

## Statistical Plots

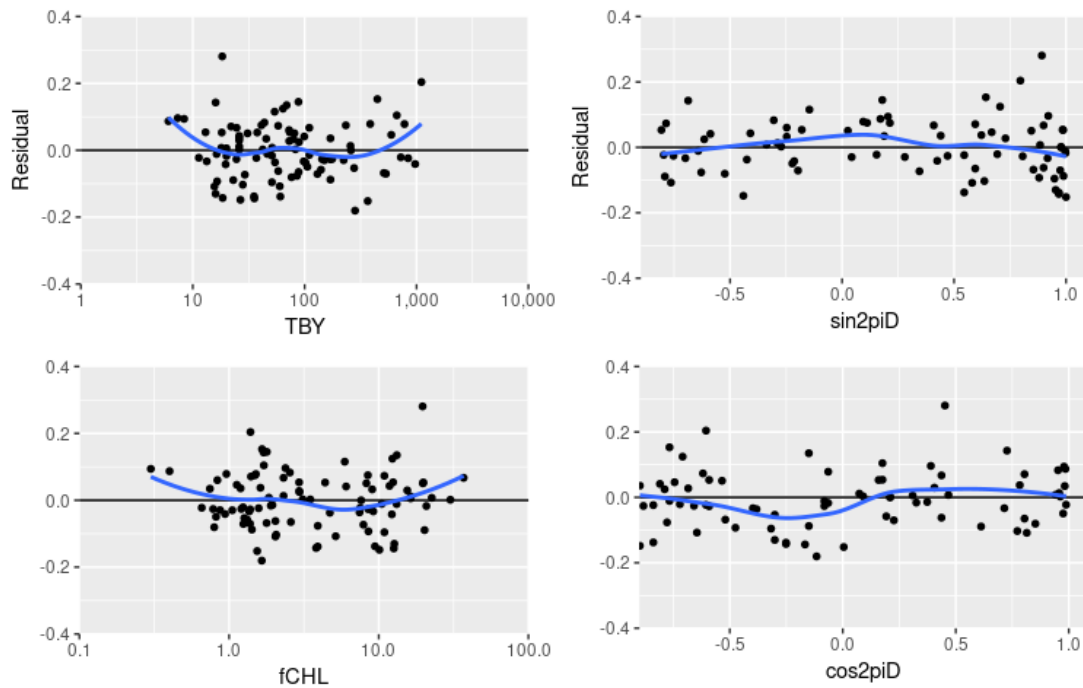


**First row (left):** Residual TN related to regression computed TN with local polynomial regression fitting, or locally estimated scatterplot smoothing (LOESS), indicated by the blue line.

**First row (right):** Residual TN related to the corresponding normal quantile of the residual with simple linear regression, indicated by the blue line.

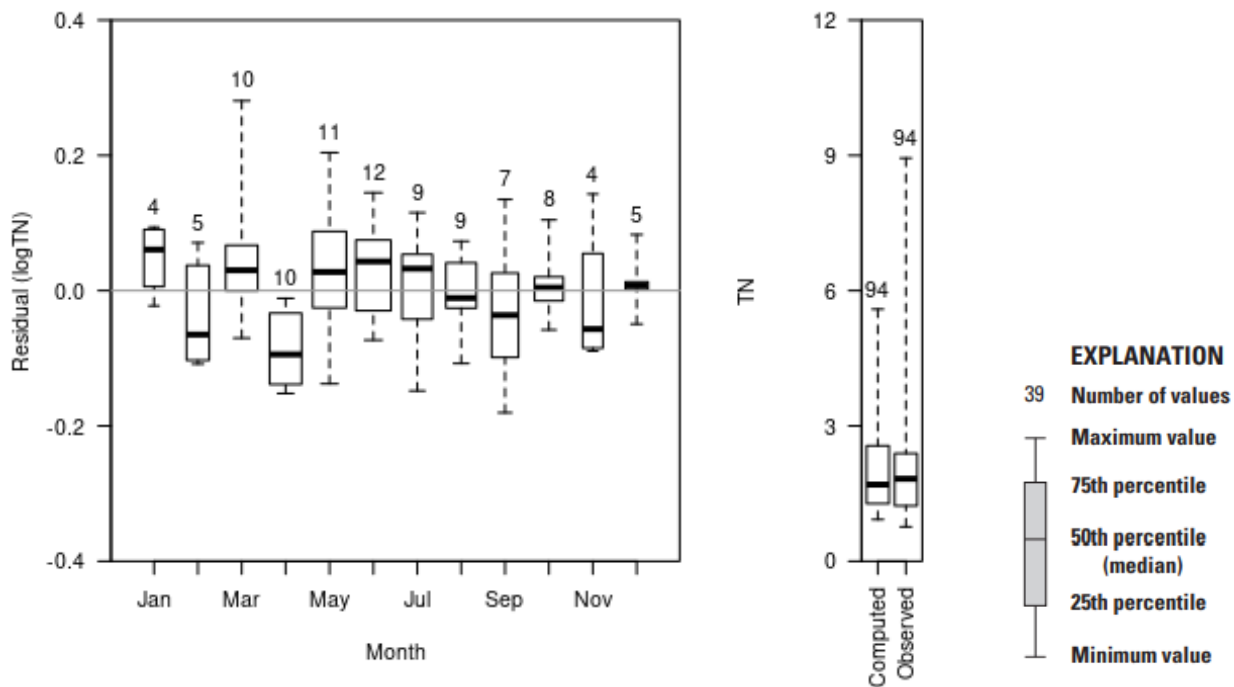
**Second row:** Residual TN related to date (left) and regression computed TN multiplied by the BCF (right) with LOESS, indicated by the blue line.

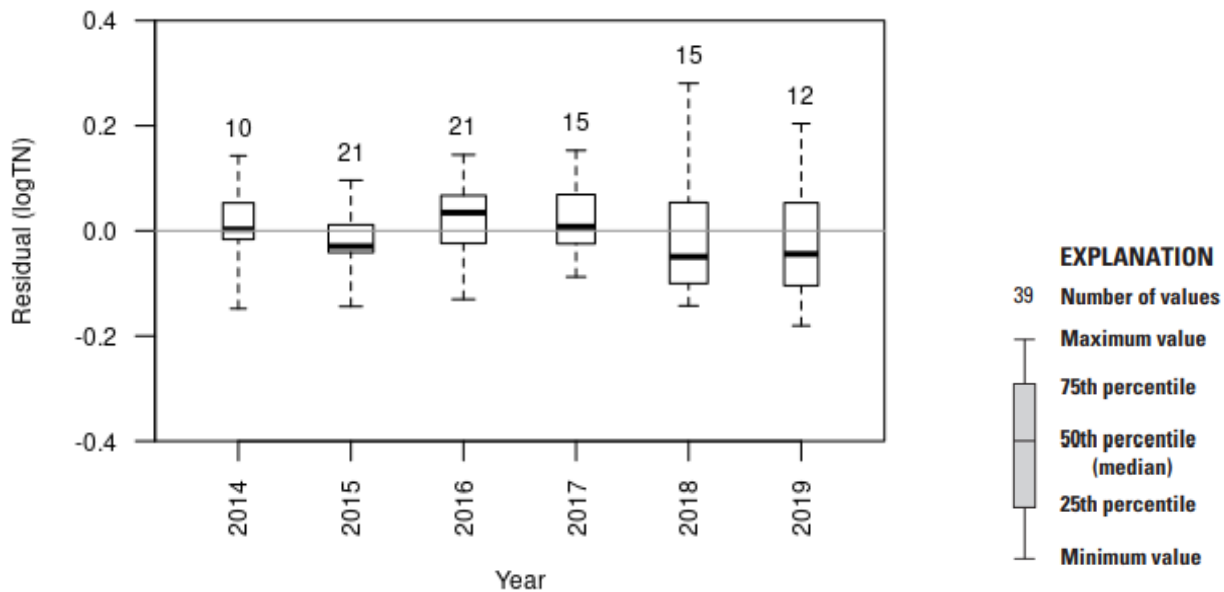
**Third row:** Observed TN related to regression computed TN.



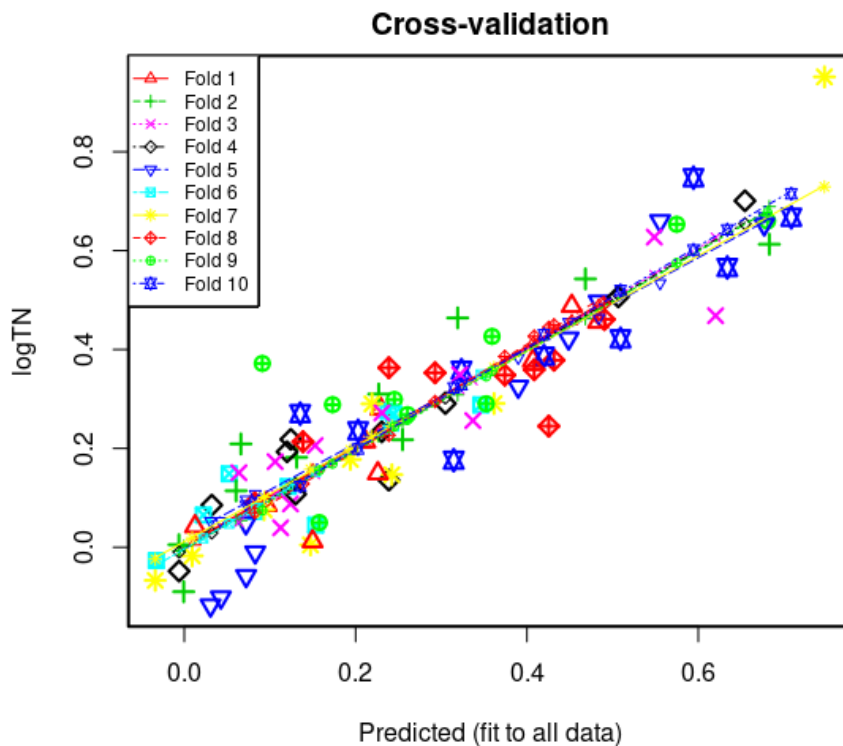
**First row:** Residual TN related to TBY (left) and sin2piD (right) with LOESS, indicated by the blue line.

**Second row:** Residual TN related to fCHL (left) and cos2piD (right) with LOESS, indicated by the blue line.





## Cross-Validation



Fold - equal partition of the data (10 percent of the data).

Large symbols - observed value of a data point removed in a fold.

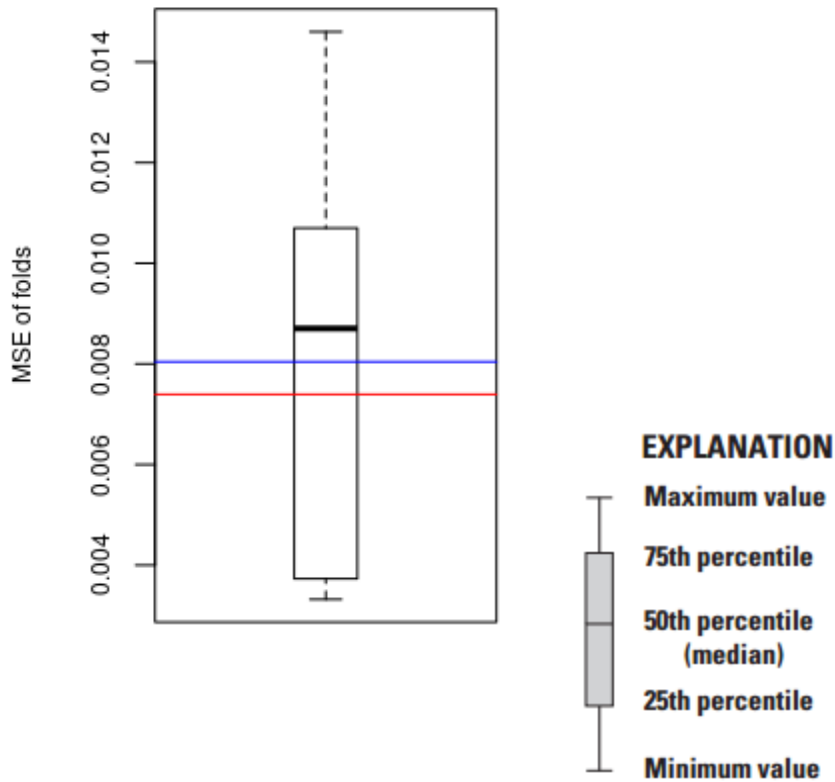
Small symbols - recomputed value of a data point removed in a fold.

Recomputed regression lines - adjusted regression line with one fold removed.

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Minimum MSE of folds: 0.00332
Mean MSE of folds: 0.00804
Median MSE of folds: 0.00871
Maximum MSE of folds: 0.01460
(Mean MSE of folds) / (Model MSE): 1.09000

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Red line - Model MSE

Blue line - Mean MSE of folds

### Model-Calibration Dataset

	Date	logTN	logTBY	logfCHL	sin2piD	cos2piD	TN	TBY	fCHL	Computed logTN	Computed TN	Residual	Normal Quantiles	Censored Values
0														
1	2014-06-30	0.28	1.91	0.917	0.0258	-1	1.9	81	8.27	0.229	1.73	0.0508	0.576	--
2	2014-07-14	-0.0482	1.29	1.09	-0.214	-0.977	0.895	19.7	12.2	-0.00608	1.01	-0.0421	-0.576	--
3	2014-07-28	-0.117	1.43	1	-0.441	-0.898	0.763	26.7	10.1	0.0306	1.09	-0.148	-1.92	--
4	2014-08-11	0.0853	1.67	1.02	-0.642	-0.767	1.22	46.3	10.5	0.0962	1.27	-0.0109	-0.0133	--
5	2014-08-25	0.0853	1.58	1.3	-0.806	-0.591	1.22	37.7	19.9	0.0321	1.1	0.0532	0.64	--
6	2014-09-22	0.27	1.84	1.12	-0.989	-0.15	1.86	69	13.2	0.135	1.39	0.135	1.56	--
7	2014-10-06	0.234	1.92	0.491	-0.996	0.0903	1.71	82.8	3.1	0.23	1.73	0.00304	0.0933	--
8	2014-10-20	0.178	1.71	0.279	-0.946	0.325	1.51	51	1.9	0.194	1.59	-0.016	-0.0933	--
9	2014-11-17	0.209	1.2	0.23	-0.687	0.727	1.62	16	1.7	0.0661	1.19	0.143	1.66	--
10	2014-12-15	0.214	1.63	0.543	-0.272	0.962	1.64	42.2	3.49	0.211	1.66	0.00249	0.0666	--
11	2015-01-12	0.218	0.923	-0.523	0.205	0.979	1.65	8.37	0.3	0.124	1.36	0.094	1.21	--
12	2015-02-09	0.136	1.45	0.315	0.635	0.772	1.37	28	2.06	0.239	1.77	-0.103	-1.21	--
13	2015-03-09	0.149	0.865	0.377	0.921	0.39	1.41	7.33	2.38	0.0524	1.15	0.0962	1.27	--
14	2015-03-23	0.206	1.26	0.641	0.987	0.159	1.61	18.2	4.38	0.153	1.45	0.0531	0.607	--
15	2015-04-06	0.0722	1.21	1.12	0.997	-0.0817	1.18	16.3	13.2	0.0835	1.24	-0.0112	-0.0399	--
16	2015-04-20	0.147	1.71	1.04	0.948	-0.317	1.4	51	10.9	0.242	1.78	-0.0956	-1.16	--
17	2015-05-04	0.182	1.49	1.29	0.845	-0.534	1.52	30.9	19.7	0.131	1.38	0.0507	0.545	--
18	2015-05-18	0.66	2.86	0.0934	0.693	-0.721	4.57	724	1.24	0.681	4.89	-0.0209	-0.147	--
19	2015-06-06	0.667	2.99	-0.0269	0.425	-0.905	4.65	972	0.94	0.709	5.21	-0.0411	-0.545	--
20	2015-06-15	0.461	2.35	-0.0605	0.28	-0.96	2.89	223	0.87	0.49	3.15	-0.0295	-0.367	--
21	2015-06-29	0.377	2.18	0.0212	0.043	-0.999	2.38	150	1.05	0.407	2.6	-0.0297	-0.396	--
22	2015-07-13	0.291	2.11	0.0955	-0.197	-0.98	1.95	130	1.25	0.362	2.34	-0.0709	-0.851	--
23	2015-07-27	0.217	2.01	0.673	-0.425	-0.905	1.65	102	4.71	0.255	1.83	-0.0373	-0.514	--
24	2015-08-10	0.15	1.93	0.593	-0.629	-0.778	1.41	85.3	3.91	0.226	1.71	-0.0764	-0.93	--
25	2015-08-24	0.0488	1.57	0.875	-0.796	-0.605	1.12	37	7.51	0.0719	1.2	-0.0231	-0.201	--
26	2015-09-08	0.0878	1.74	0.872	-0.924	-0.382	1.22	54.3	7.44	0.124	1.36	-0.0361	-0.484	--
27	2015-09-21	-0.101	1.55	1.1	-0.986	-0.167	0.792	35.5	12.6	0.0427	1.12	-0.144	-1.77	--
28	2015-10-05	0.00518	1.41	1.21	-0.997	0.0731	1.01	26	16.4	-0.00624	1	0.0114	0.201	--



29	2015-10-19	-0.0269	1.3	1.21	-0.951	0.309	0.94	20	16.3	-0.0327	0.945	0.00583	0.12	--
30	2015-11-16	-0.067	1.12	0.963	-0.699	0.715	0.857	13.3	9.19	-0.0339	0.943	-0.0331	-0.425	--
31	2015-12-14	0.497	2.41	0.364	-0.288	0.957	3.14	257	2.31	0.484	3.1	0.0131	0.228	--
32	2016-01-11	0.358	1.66	-0.128	0.188	0.982	2.28	45.3	0.744	0.324	2.15	0.0346	0.367	--
33	2016-02-08	0.275	1.41	0.21	0.622	0.783	1.89	26	1.62	0.238	1.76	0.0374	0.425	--
34	2016-03-03	0.0896	1.26	1.35	0.884	0.467	1.23	18	22.6	0.0822	1.23	0.00732	0.147	--
35	2016-03-21	0.114	1.11	1.1	0.984	0.176	1.3	13	12.5	0.0604	1.17	0.0539	0.707	--
36	2016-04-04	0.0759	1.3	1.32	0.998	-0.0645	1.19	20	20.8	0.0931	1.26	-0.0172	-0.12	--
37	2016-04-18	-0.058	1.2	1.1	0.954	-0.301	0.875	16	12.7	0.0722	1.2	-0.13	-1.4	--
38	2016-05-02	0.566	2.71	0.25	0.854	-0.52	3.68	510	1.78	0.634	4.39	-0.068	-0.777	--
39	2016-05-16	0.363	1.81	1.09	0.706	-0.709	2.31	64	12.3	0.239	1.77	0.124	1.48	--
40	2016-05-28	0.653	2.93	0.198	0.545	-0.838	4.5	842	1.58	0.677	4.84	-0.0237	-0.228	--
41	2016-06-06	0.427	2.04	0.364	0.409	-0.912	2.67	110	2.31	0.359	2.33	0.0673	0.813	--
42	2016-06-20	0.464	1.94	0.252	0.18	-0.984	2.91	88	1.79	0.319	2.12	0.145	1.77	--
43	2016-07-11	0.299	1.87	0.468	-0.18	-0.984	1.99	73.7	2.94	0.245	1.79	0.0537	0.673	--
44	2016-07-25	0.0652	1.41	1.07	-0.409	-0.912	1.16	26	11.8	0.0222	1.07	0.043	0.484	--
45	2016-08-08	0.27	1.95	0.47	-0.615	-0.788	1.86	89	2.95	0.245	1.79	0.0248	0.256	--
46	2016-08-22	0.193	1.76	1.04	-0.786	-0.619	1.56	58	10.9	0.12	1.34	0.0732	0.89	--
47	2016-09-12	0.378	2.44	0.102	-0.954	-0.301	2.39	277	1.26	0.432	2.75	-0.0532	-0.64	--
48	2016-09-26	0.653	2.89	0.179	-0.998	-0.0645	4.5	780	1.51	0.575	3.83	0.0784	1.02	--
49	2016-10-11	0.288	2.15	0.121	-0.981	0.192	1.94	140	1.32	0.346	2.26	-0.058	-0.673	--
50	2016-10-24	0.0422	1.41	1.19	-0.914	0.405	1.1	26	15.5	0.0125	1.05	0.0296	0.311	--
51	2016-11-07	-0.0899	1.36	1.31	-0.791	0.612	0.813	23	20.2	-0.000698	1.02	-0.0892	-1.06	--
52	2016-12-12	0.31	1.64	0.406	-0.305	0.952	2.04	43.7	2.55	0.227	1.72	0.0829	1.11	--
53	2017-01-09	0.108	1.05	-0.183	0.154	0.988	1.28	11.3	0.657	0.13	1.37	-0.0224	-0.174	--
54	2017-02-06	0.29	1.34	0.146	0.595	0.804	1.95	22	1.4	0.219	1.69	0.0709	0.851	--
55	2017-03-06	0.173	1.39	1.57	0.9	0.437	1.49	24.7	36.9	0.106	1.3	0.0672	0.777	--
56	2017-03-20	0.123	1.41	1.48	0.978	0.209	1.33	26	30.1	0.121	1.35	0.00163	0.0399	--
57	2017-04-10	0.422	2.23	0.152	0.989	-0.15	2.64	170	1.42	0.509	3.29	-0.0876	-1.02	--
58	2017-04-25	0.387	1.99	0.135	0.918	-0.398	2.44	98	1.36	0.42	2.68	-0.0332	-0.454	--
59	2017-05-08	0.456	2.23	0.141	0.806	-0.591	2.86	170	1.38	0.483	3.1	-0.0271	-0.339	--
60	2017-05-22	0.747	2.65	0.22	0.642	-0.767	5.59	447	1.66	0.594	4.01	0.153	1.92	--
61	2017-06-05	0.488	2.23	0.0768	0.441	-0.898	3.08	170	1.19	0.452	2.89	0.0357	0.396	--
62	2017-06-19	0.543	2.37	0.171	0.214	-0.977	3.49	233	1.48	0.468	3	0.0746	0.93	--
63	2017-07-10	0.288	1.73	0.773	-0.146	-0.989	1.94	53.9	5.93	0.173	1.52	0.115	1.4	--
64	2017-08-07	0.272	2	0.782	-0.588	-0.809	1.87	99.2	6.05	0.231	1.73	0.0412	0.454	--
65	2017-09-26	-0.0173	1.39	0.93	-0.997	-0.0817	0.961	24.6	8.5	0.00925	1.04	-0.0265	-0.311	--
66	2017-10-23	0.291	2.04	0.289	-0.928	0.374	1.95	110	1.95	0.305	2.06	-0.014	-0.0666	--
67	2017-12-11	0.268	1.71	0.266	-0.338	0.941	1.86	51.2	1.84	0.261	1.86	0.00779	0.174	< 0.03
68	2018-01-10	0.151	0.782	-0.398	0.171	0.985	1.42	6.06	0.4	0.0637	1.18	0.087	1.16	--
69	2018-02-05	0.0449	1.19	0.31	0.581	0.814	1.11	15.6	2.04	0.153	1.45	-0.108	-1.33	--
70	2018-03-05	0.372	1.26	1.29	0.892	0.452	2.35	18.3	19.6	0.0911	1.26	0.281	2.49	--
71	2018-03-20	0.507	2.41	0.882	0.978	0.209	3.21	259	7.63	0.507	3.27	-0.000104	0.0133	--
72	2018-04-16	0.00475	1.27	0.581	0.968	-0.251	1.01	18.5	3.81	0.147	1.43	-0.143	-1.66	--
73	2018-04-30	-0.0101	1.22	0.931	0.88	-0.475	0.977	16.5	8.53	0.0828	1.23	-0.0929	-1.11	--
74	2018-05-15	0.349	1.86	0.468	0.73	-0.684	2.23	72.8	2.94	0.322	2.14	0.0275	0.283	--
75	2018-05-29	0.012	1.55	0.975	0.545	-0.838	1.03	35.3	9.44	0.15	1.44	-0.138	-1.48	--
76	2018-06-11	0.0394	1.47	0.897	0.346	-0.938	1.09	29.2	7.9	0.112	1.32	-0.0731	-0.89	--
77	2018-06-25	0.214	1.61	0.927	0.112	-0.994	1.64	41.1	8.46	0.139	1.4	0.075	0.972	--
78	2018-07-16	0.236	1.9	0.956	-0.247	-0.969	1.72	79.5	9.04	0.203	1.63	0.0327	0.339	--
79	2018-08-21	0.05	1.78	0.712	-0.764	-0.645	1.12	59.9	5.16	0.158	1.46	-0.108	-1.27	--
80	2018-10-11	0.66	2.82	0.232	-0.984	0.176	4.57	666	1.71	0.555	3.66	0.105	1.33	--
81	2018-11-29	0.256	1.88	-0.0994	-0.523	0.852	1.8	76.4	0.795	0.337	2.21	-0.0806	-0.972	--
82	2018-12-18	0.359	2.02	-0.0873	-0.222	0.975	2.29	106	0.818	0.408	2.61	-0.0493	-0.607	--
83	2019-02-06	0.325	1.95	0.413	0.595	0.804	2.11	88.3	2.59	0.39	2.5	-0.0649	-0.741	--
84	2019-03-06	0.29	1.76	0.31	0.9	0.437	1.95	58.1	2.04	0.352	2.29	-0.0621	-0.707	--
85	2019-03-19	0.613	2.73	0.14	0.974	0.226	4.1	533	1.38	0.683	4.91	-0.0702	-0.813	--
86	2019-04-01	0.468	2.56	0.188	1	0.0043	2.94	366	1.54	0.62	4.25	-0.152	-2.12	--
87	2019-04-16	0.176	1.78	0.592	0.968	-0.251	1.5	60.6	3.91	0.315	2.1	-0.138	-1.56	--
88	2019-05-09	0.951	3.04	0.143	0.796	-0.605	8.94	1110	1.39	0.747	5.7	0.204	2.12	--
89	2019-05-20	0.701	2.77	0.0515	0.668	-0.744	5.02	595	1.13	0.654	4.6	0.0463	0.514	--
90	2019-06-03	0.422	2.15	-0.107	0.471	-0.882	2.64	143	0.782	0.449	2.86	-0.0262	-0.283	--
91	2019-06-26	0.627	2.59	-0.018	0.0945	-0.996	4.24	385	0.959	0.549	3.6	0.0787	1.06	--
92	2019-07-16	0.353	1.86	-0.0782	-0.247	-0.969	2.25	72.6	0.835	0.293	2	0.0602	0.741	--
93	2019-08-20	0.348	2.25	0.0816	-0.753	-0.658	2.23	177	1.21	0.374	2.41	-0.0258	-0.256	--
94	2019-09-24	0.245	2.45	0.218	-0.993	-0.116	1.76	282	1.65	0.425	2.71	-0.18	-2.49	--

## Definitions

**Cook's D:** Cook's distance (Helsel and others, 2020).

**D:** Date, in decimal years.

**DIFFITS:** Difference in fits statistic (Helsel and others, 2020).

**E.vars:** Explanatory variables.

**fCHL:** Chlorophyll fluorescence, in relative fluorescence units (32320).

**Leverage:** An outlier's measure in the x direction (Helsel and others, 2020).

**LOESS:** Local polynomial regression fitting, or locally estimated scatterplot smoothing (Helsel and others, 2020).

**LOWESS:** Locally weighted scatterplot smoothing (Cleveland, 1979; Helsel and others, 2020).

**MSE:** Model standard error (Helsel and others, 2020).

**MSPE:** Model standard percentage error (Helsel and others, 2020).

**Probability(>|t|):** The probability that the independent variable has no effect on the dependent variable (Helsel and others, 2020).

**RMSE:** Root mean square error (Helsel and others, 2020).

**t value:** Student's t value; the coefficient divided by its associated standard error (Helsel and others, 2020).

**TBY:** Turbidity, in formazin nephelometric units (63680).

**TN:** total particulate nitrogen (49570) plus total dissolved nitrogen (62854), in milligrams per liter.

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