Apppendix 2.7. Model Archive Summary for Calcium Concentration at U.S. Geological Survey site 07144100; Little Arkansas River near Sedgwick, Kansas, during May 1998 through December 2019

This model archive summary summarizes the calcium model developed to compute hourly or daily calcium. Model development methods follow U.S. Geological Survey (USGS) guidance from Office of Surface Water/Office of Water Quality Technical Memoranda and USGS Techniques and Methods, book 3, chap. C4 (Rasmussen and others, 2009).

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Site and Model Information

Site Number: 07144100

Site Name: Little Arkansas River near Sedgwick, Kansas

Location: Latitude 37°52'59", longitude 97°25'27" referenced to North American Datum of 1927, in NE 1/4 NW 1/4 NW 1/4 sec.15, T.25 S., R.1 W., Sedgwick County, Kansas; hydrologic unit 11030012.

Equipment: A Sutron Satlink II High Data Rate Collection Platform and a Design Analysis Water Log H350/355 nonsubmersible pressure transducer transfers real-time stage and water-quality data via satellite. The primary reference gage is a Type-A wire-weight gage located on the downstream bridge handrail. Check-bar elevation is 33.614 feet. The orifice is enclosed in a well-screen and attached to a concrete pier on the left downstream side of the bridge. Gage height was measured during May 1998 through December 2019. A YSI 6600 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, and turbidity (a YSI Model 6026 [September 1998 through December 2006] and YSI Model 6136 [July 2004 through March 2015]) sensors collected data during April 1998 through March 2015. A YSI EXO2 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, turbidity, and fluorescent dissolved organic matter sensors collected data during September 2014 through December 2019. A Hach Nitratax monitor collected nitrate data during March 2012 through December 2019.

Date model was developed: June 1, 2020

Model calibration data period: May 1, 1998 through December 11, 2019

Model Data

All data were collected using USGS protocols (U.S. Geological Survey, variously dated; Wagner and others, 2006; Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010) and are stored in the National Water Information System (NWIS) database (U.S. Geological Survey, 2021). Explanatory variables were evaluated individually and in combination. Potential explanatory variables included streamflow, water temperature, specific conductance, pH, dissolved oxygen, YSI EXO2 turbidity, nitrate, and fluorescent dissolved organic matter. Seasonal components (sine and cosine variables) also were evaluated as explanatory variables.

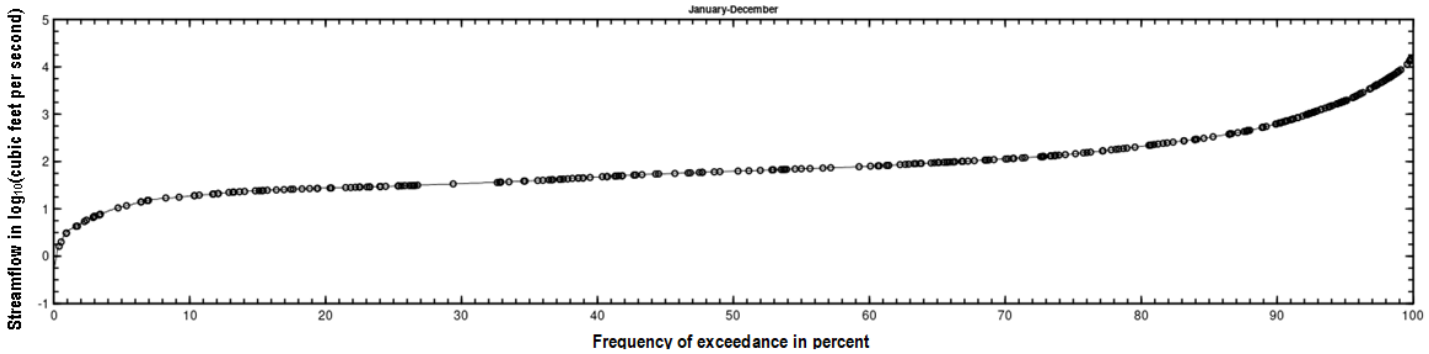
The regression model is based on 320 concomitant values of discretely collected calcium and continuously measured specific conductance during May 1998 through December 2019. Discrete samples were collected over a range of streamflow and specific conductance conditions. No samples had concentrations that were below laboratory detection limits. Summary statistics and the complete model-calibration dataset are provided below. Outliers and influential points were identified using studentized residuals, DFITS, Cook’s D (Cook, 1977), and leverage. Outliers in previously published versions of this model (Christensen and others, 2003; Rasmussen and others, 2016) were examined and retained in the dataset if there were no clear issues, explanations, or conditions that would cause a result to be invalid for model calibration. All samples were retained in the dataset.

Calcium

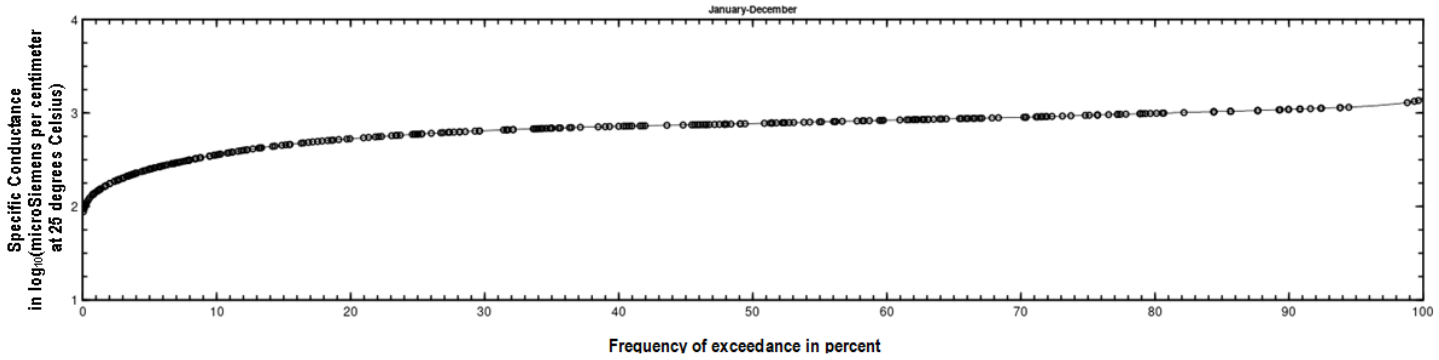
Discrete samples were collected from the downstream side of the bridge or instream within 50 feet of the bridge using equal-width-increment, multi-vertical, single vertical or grab-dip methods following U.S. Geological Survey (variously dated) and Rasmussen and others (2014). Discrete samples were collected on a semifixed to event-based schedule ranging

from 4 to 24 samples per year with a FISP US DH–95 or D–95 with a Teflon bottle, cap, and nozzle depth-integrating sampler, a DH–81 with a Teflon bottle, cap, and nozzle hand sampler or a grab sample with a Teflon bottle depending on sample location. Samples were analyzed for calcium by the Wichita Municipal Water and Wastewater Laboratory in Wichita, Kansas, or the USGS National Water Quality Laboratory according to standard methods (American Public Health Association and others, 1995).

Calcium Samples Plotted on Streamflow Duration Curve



Calcium Samples Plotted on Specific Conductance Duration Curve



Continuous Data

Concomitant specific conductance values were time interpolated. If no concomitant continuous data were available within 2 hours of sample collection, the sample was not included in the dataset.

Model Development

Ordinary least squares regression analysis was done using R (version 4.0.0) programming language (R Core Team, 2020) to relate discretely collected calcium to specific conductance and other continuously measured data. The distribution of residuals was examined for normality and plots of residuals (the difference between the measured and model-calculated values) compared to model-computed calcium were examined for homoscedasticity (departures from zero did not change substantially over the range of model-calculated values). Previously published explanatory variables were also strongly considered for continuity; however, the best explanatory variable(s) were ultimately selected.

Specific conductance was selected as the best predictor of calcium based on residual plots, high coefficient of determination (R^2), and low model standard percentage error (MSPE). Specific conductance was positively related to calcium because it measures water's capacity to conduct an electrical current and is related to the concentration of ionized substances in water (Hem, 1992).

Model Summary

Summary of final calcium regression analysis at USGS site number 07144100:

Calcium-based model:

$$\log_{10}(CA) = 1.05 \times \log_{10}(SC) - 1.14$$

where,

$\log_{10}$ = logarithm base 10;
CA = calcium, in milligrams per liter (mg/L); and
SC = specific conductance, in microsiemens per centimeter at 25 degrees Celsius (µS/cm)

The log-transformed model may be retransformed to original units so that CA 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 1.01. The retransformed model, accounting for BCF is:

$$CA = 0.0732 \times SC^{1.05}$$

Model Statistics, Data, and Plots

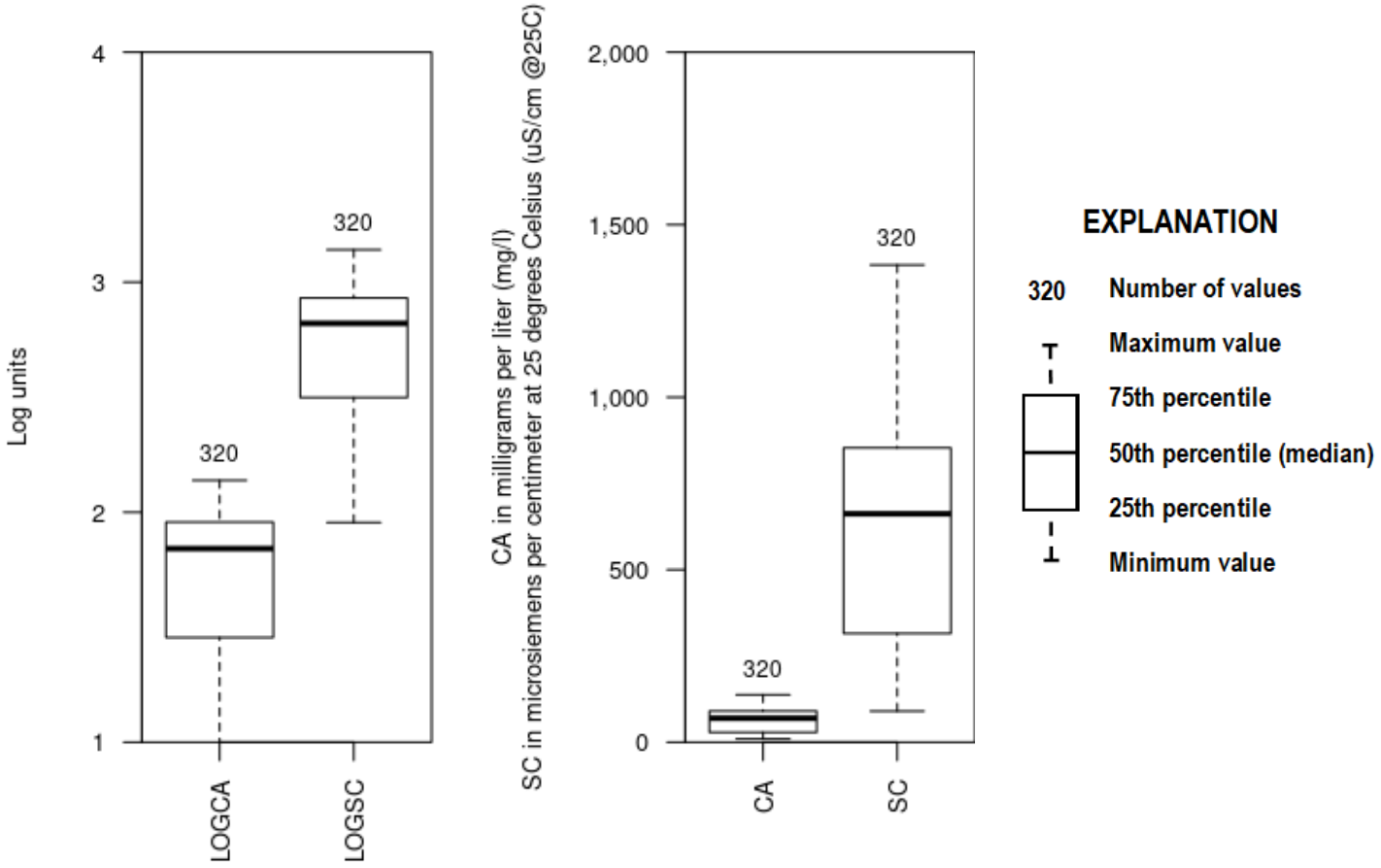
Model

LOGCA = + 1.05 * LOGSC - 1.14

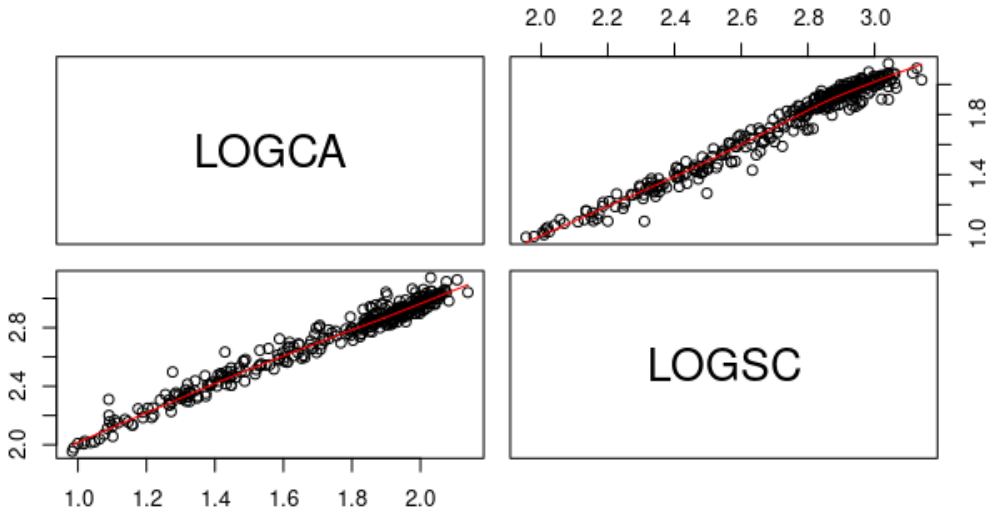
Variable Summary Statistics

	LOGCA	CA	LOGSC	SC
Minimum	0.984	9.63	1.96	90.2
1st Quartile	1.460	28.50	2.50	315.0
Median	1.840	69.50	2.82	662.0
Mean	1.720	63.20	2.71	610.0
3rd Quartile	1.960	90.50	2.93	853.0
Maximum	2.140	138.00	3.14	1380.0

Box Plots



Exploratory Plots



Basic Model Statistics

Number of Observations	320
Standard error (RMSE)	0.0528
Average Model standard percentage error (MSPE)	12.2
Coefficient of determination (R^2)	0.969
Adjusted Coefficient of Determination (Adj. R^2)	0.969
Bias Correction Factor (BCF)	1.01

Explanatory Variables

	Coefficients	Standard Error	t value	Pr(>|t|)
(Intercept)	-1.14	0.0287	-39.6	5.03e-125
LOGSC	1.05	0.0105	100.0	2.06e-242

Correlation Matrix

	Intercept	E.vars
Intercept	1.000	-0.995
E.vars	-0.995	1.000

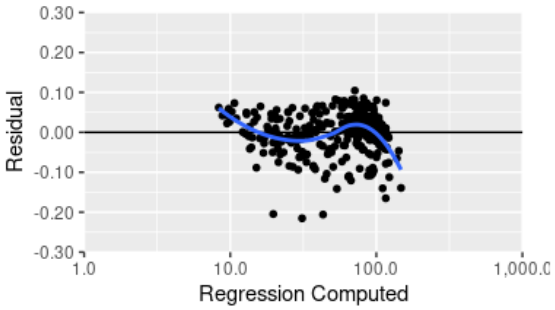
Outlier Test Criteria

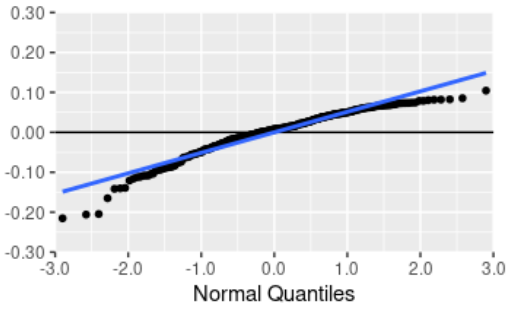
Leverage	Cook's D	DFFITS
0.0187	0.1947	0.1581

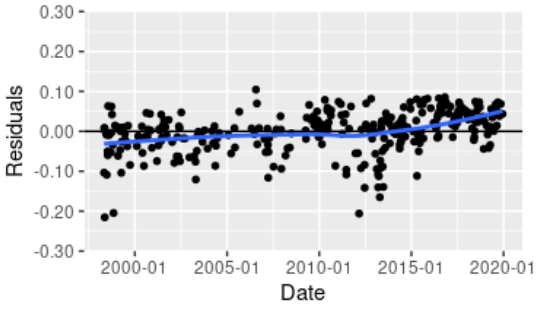
Flagged Observations

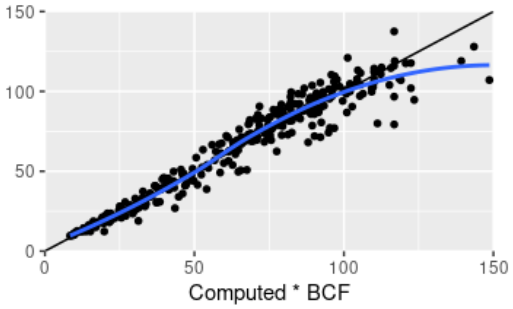
	LOGCA	Estimate	Residual	Standard Residual	Studentized Residual	Leverage	Cook's D	DFFITS
5/14/1998 9:25	1.28	1.49	-0.215	-4.09	-4.2	0.00493	0.0415	-0.295
9/25/1998 10:10	0.984	0.922	0.0621	1.19	1.19	0.0258	0.0188	0.194
10/5/1998 10:20	1.02	0.975	0.0422	0.808	0.807	0.0228	0.00763	0.123
11/5/1998 13:40	1.09	1.29	-0.205	-3.9	-3.99	0.0095	0.0728	-0.39
6/6/2001 10:10	0.988	0.946	0.0419	0.804	0.804	0.0244	0.00808	0.127
7/11/2007 12:10	1.09	1.18	-0.0887	-1.69	-1.7	0.0135	0.0195	-0.198
6/13/2010 15:20	1.04	0.984	0.0536	1.03	1.03	0.0224	0.0121	0.155
6/13/2010 19:20	1.05	0.99	0.0592	1.13	1.13	0.0221	0.0145	0.17
6/14/2010 9:40	1.06	1.01	0.0516	0.988	0.988	0.021	0.0104	0.145
7/6/2010 9:00	1	0.978	0.0221	0.424	0.423	0.0227	0.00209	0.0645
3/1/2012 12:00	1.43	1.64	-0.206	-3.91	-4	0.00336	0.0258	-0.232
3/13/2013 9:15	1.9	2.04	-0.14	-2.67	-2.69	0.00696	0.0249	-0.225
3/27/2013 11:35	1.98	2.09	-0.112	-2.14	-2.15	0.0081	0.0187	-0.194
4/15/2013 9:00	1.9	2.06	-0.165	-3.14	-3.18	0.00747	0.0371	-0.276
6/24/2013 9:40	2.03	2.17	-0.139	-2.65	-2.68	0.0105	0.0373	-0.276
8/7/2013 9:45	1.02	0.994	0.026	0.498	0.497	0.0218	0.00276	0.0743
9/6/2018 12:00	1.1	1.03	0.0731	1.4	1.4	0.0201	0.02	0.2
5/23/2019 12:20	1.08	1.04	0.0348	0.665	0.665	0.0194	0.00439	0.0936

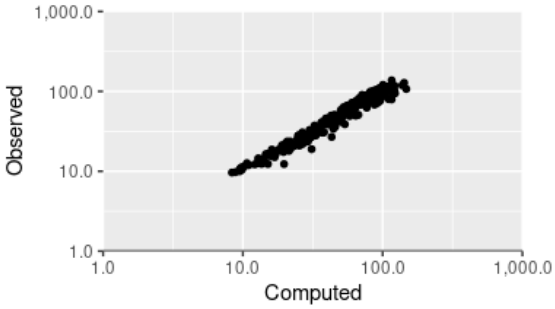
Statistical Plots

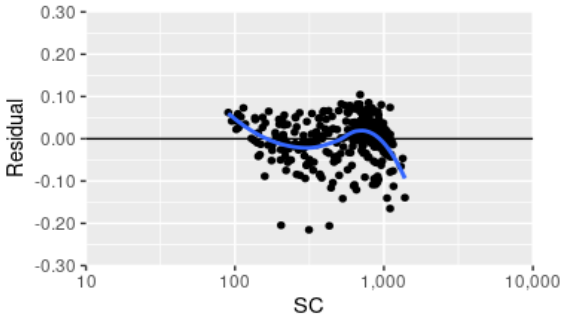


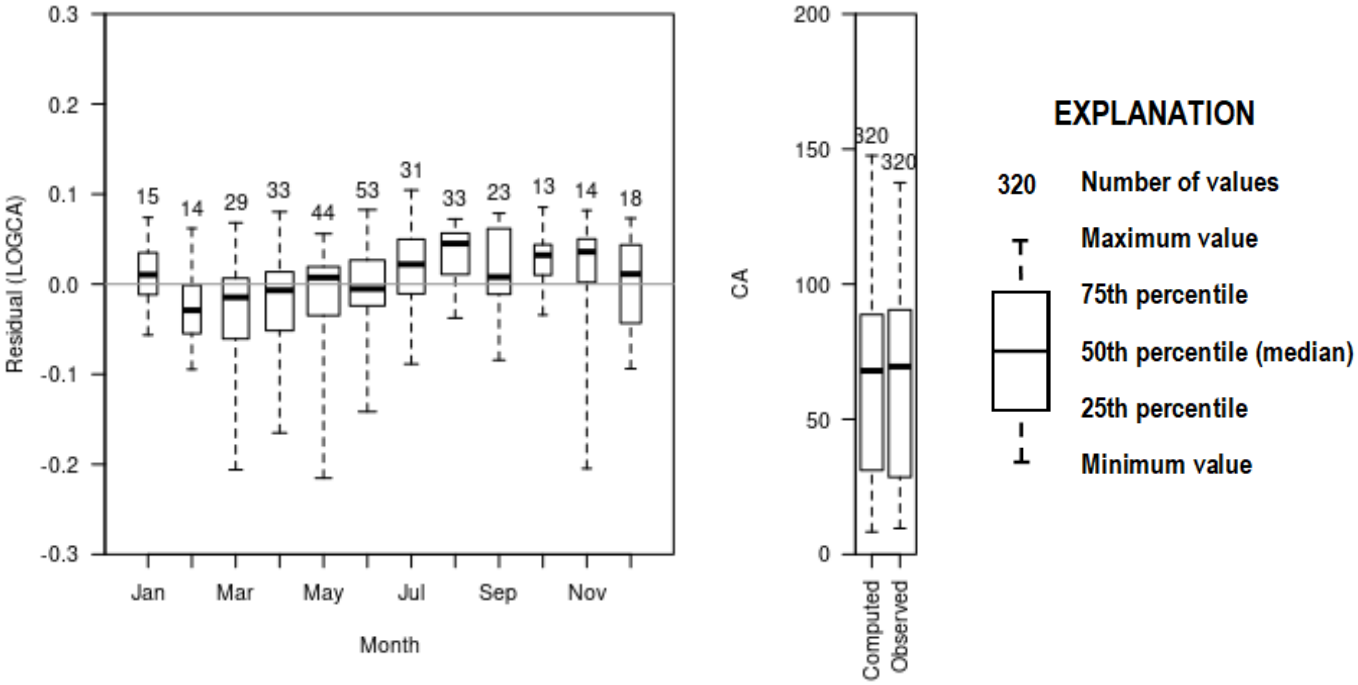












EXPLANATION

320 Number of values

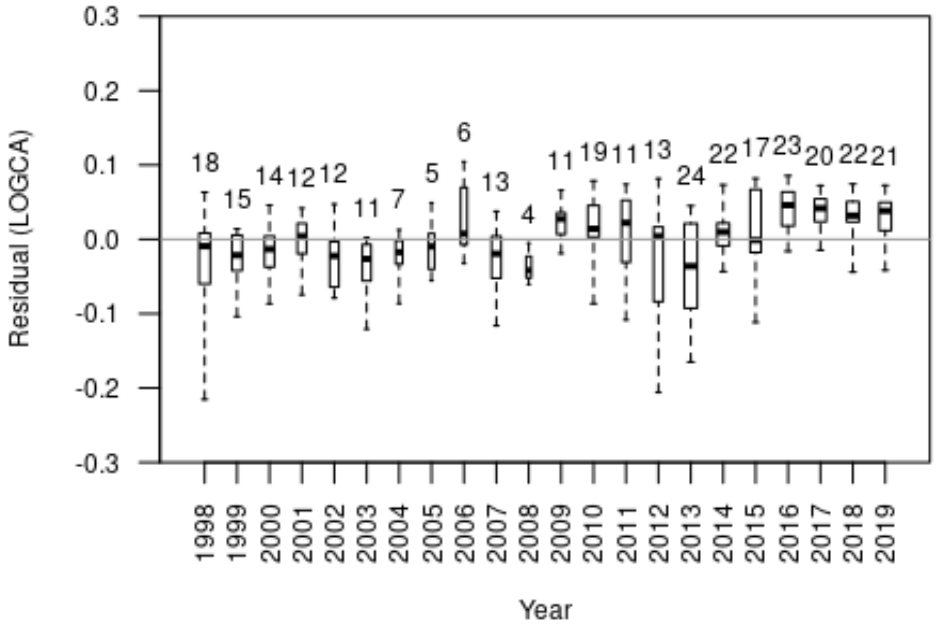
Maximum value

75th percentile

50th percentile (median)

25th percentile

Minimum value



EXPLANATION

18 Number of values

Maximum value

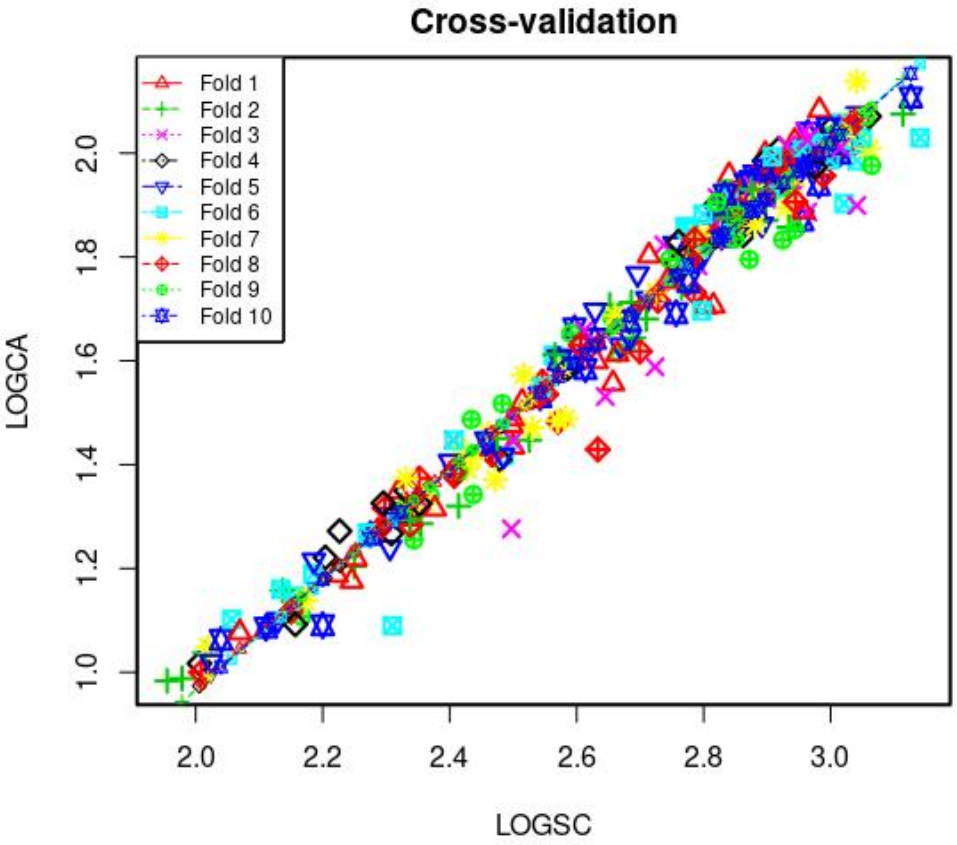
75th percentile

50th percentile (median)

25th percentile

Minimum value

Cross Validation

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             Minimum MSE of folds:  0.00144
                Mean MSE of folds:  0.00280
              Median MSE of folds:  0.00236
             Maximum MSE of folds:  0.00500
(Mean MSE of folds) / (Model MSE):  1.00000
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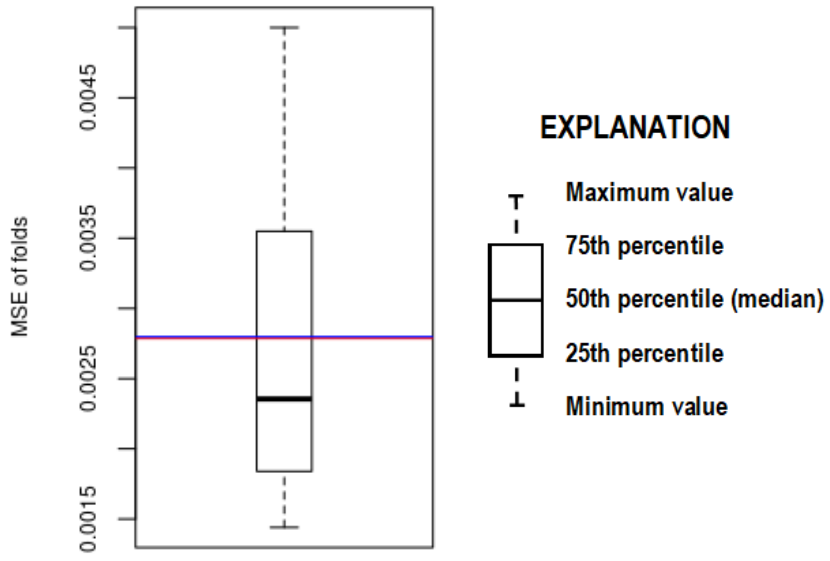


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Red line - Model MSE

Blue line - Mean MSE of folds
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Model-Calibration Dataset

	Date	LOGCA	LOGSC	CA	SC	Computed LOGCA	Computed CA	Residual	Normal Quantiles
1	5/1/1998	1.87	2.96	74.2	903	1.97	94.9	-0.104	-1.66
2	5/6/1998	1.93	2.91	85.8	811	1.93	84.7	0.00845	0.0587
3	5/11/1998	1.99	2.96	97.1	914	1.98	96.1	0.00771	0.0196
4	5/14/1998	1.28	2.5	18.9	314	1.49	31.3	-0.215	-2.9
5	5/27/1998	1.94	2.93	87.5	843	1.94	88.3	-0.000673	-0.193
6	6/16/1998	1.95	2.94	89.6	877	1.96	92	-0.00857	-0.356
7	6/24/1998	1.7	2.8	50.6	634	1.81	65.5	-0.109	-1.8
8	7/10/1998	1.24	2.31	17.4	202	1.29	19.7	-0.0501	-1.03
9	7/13/1998	1.43	2.5	27.2	316	1.49	31.4	-0.0599	-1.16
10	7/20/1998	1.83	2.75	66.9	568	1.76	58.2	0.0633	1.34
11	8/6/1998	1.92	2.91	82.9	817	1.93	85.4	-0.00976	-0.389
12	9/15/1998	1.9	2.93	78.6	853	1.95	89.4	-0.0529	-1.07
13	9/22/1998	1.31	2.32	20.2	210	1.31	20.5	-0.00354	-0.249
14	9/25/1998	0.984	1.96	9.63	90.2	0.922	8.41	0.0621	1.29
15	10/5/1998	1.02	2.01	10.4	101	0.975	9.5	0.0422	0.771
16	10/22/1998	1.6	2.63	39.7	428	1.63	43.3	-0.0342	-0.803
17	11/5/1998	1.09	2.31	12.3	204	1.29	19.8	-0.205	-2.4
18	12/4/1998	1.89	2.86	77.7	728	1.88	75.7	0.0144	0.217
19	1/12/1999	2.08	3.04	119	1100	2.07	117	0.0105	0.122
20	2/1/1999	1.42	2.49	26.2	306	1.48	30.4	-0.0615	-1.19
21	2/19/1999	2.05	3.02	112	1040	2.04	110	0.00987	0.0823
22	3/16/1999	2.11	3.13	128	1340	2.15	143	-0.0466	-0.977
23	3/23/1999	2.06	3.04	116	1100	2.06	117	0.000237	-0.177
24	4/7/1999	1.56	2.66	36	454	1.66	46.1	-0.104	-1.69
25	4/16/1999	1.27	2.31	18.5	203	1.29	19.8	-0.0257	-0.669
26	5/5/1999	1.92	2.91	83.9	806	1.92	84.2	0.00145	-0.145
27	5/24/1999	1.32	2.32	20.9	211	1.31	20.6	0.00999	0.098
28	6/18/1999	1.49	2.5	30.8	316	1.49	31.4	-0.00596	-0.298
29	6/21/1999	1.31	2.35	20.6	223	1.34	21.8	-0.0214	-0.63
30	7/20/1999	1.2	2.25	16	178	1.23	17.2	-0.0275	-0.709
31	8/3/1999	1.11	2.17	12.8	147	1.14	14.1	-0.0376	-0.858
32	8/19/1999	1.99	2.96	98.6	914	1.98	96.1	0.0141	0.201
33	9/28/1999	1.32	2.41	20.9	259	1.4	25.6	-0.0844	-1.38
34	2/9/2000	2.03	3.05	108	1120	2.07	119	-0.0373	-0.847
35	3/7/2000	1.44	2.46	27.5	287	1.45	28.5	-0.0117	-0.423
36	3/28/2000	1.38	2.41	23.9	255	1.4	25.1	-0.019	-0.611
37	5/19/2000	2.06	3.03	115	1060	2.05	113	0.0123	0.169
38	5/31/2000	1.62	2.67	41.3	464	1.67	47.1	-0.0541	-1.08
39	6/28/2000	1.48	2.57	30.4	372	1.57	37.4	-0.0867	-1.45
40	7/20/2000	1.86	2.86	72.5	725	1.87	75.3	-0.0136	-0.449
41	7/28/2000	1.54	2.55	34.3	356	1.55	35.7	-0.0143	-0.484
42	8/16/2000	1.93	2.87	85.6	745	1.89	77.5	0.0461	0.869
43	9/8/2000	1.93	2.93	85.8	849	1.95	89	-0.0127	-0.432
44	9/25/2000	1.95	2.93	90.1	857	1.95	89.8	0.00438	-0.0587
45	10/26/2000	1.35	2.32	22.3	208	1.3	20.3	0.0438	0.803
46	11/8/2000	1.72	2.71	52.4	515	1.72	52.5	0.00204	-0.13
47	12/4/2000	2.02	3.04	104	1090	2.06	115	-0.0414	-0.892
48	3/14/2001	1.45	2.53	28	335	1.52	33.5	-0.0745	-1.29
49	4/13/2001	1.68	2.71	47.9	513	1.72	52.3	-0.0351	-0.824
50	4/26/2001	2.02	3	105	989	2.02	104	0.00552	-0.0352
51	5/8/2001	1.84	2.82	68.9	666	1.84	68.9	0.00285	-0.098
52	6/4/2001	1.43	2.46	26.8	288	1.45	28.5	-0.024	-0.659
53	6/6/2001	0.988	1.98	9.73	95.2	0.946	8.9	0.0419	0.76

54	6/23/2001	1.19	2.22	15.4	167	1.2	16.1	-0.0149	-0.52
55	7/11/2001	1.94	2.91	87.6	815	1.93	85.2	0.0151	0.257
56	8/2/2001	1.93	2.89	84.9	769	1.9	80.2	0.0278	0.493
57	8/28/2001	1.92	2.9	83.9	790	1.91	82.4	0.0108	0.13
58	9/20/2001	1.12	2.15	13.1	141	1.13	13.5	-0.00962	-0.381
59	10/31/2001	1.98	2.93	94.8	853	1.95	89.4	0.0286	0.511
60	1/10/2002	2.01	3.01	102	1030	2.04	109	-0.0269	-0.699
61	2/21/2002	1.99	3.04	96.7	1100	2.06	117	-0.079	-1.34
62	4/9/2002	1.94	2.98	86.8	958	2	101	-0.0627	-1.2
63	4/22/2002	1.39	2.41	24.5	259	1.4	25.5	-0.0145	-0.493
64	5/13/2002	1.73	2.78	53.9	610	1.79	62.8	-0.063	-1.24
65	5/22/2002	1.64	2.63	43.9	425	1.63	43	0.0126	0.177
66	6/6/2002	1.6	2.59	40	393	1.59	39.6	0.00792	0.0274
67	6/13/2002	1.26	2.34	18	221	1.33	21.5	-0.0748	-1.31
68	7/9/2002	1.92	2.86	82.4	717	1.87	74.4	0.0473	0.904
69	8/15/2002	1.78	2.79	60.7	618	1.8	63.7	-0.0179	-0.574
70	9/19/2002	1.85	2.86	70.9	717	1.87	74.4	-0.0179	-0.583
71	12/18/2002	2.08	3.11	119	1300	2.14	139	-0.0652	-1.25
72	3/20/2003	1.41	2.48	25.7	301	1.47	29.9	-0.0629	-1.22
73	4/17/2003	2.01	3.06	102	1150	2.08	122	-0.0761	-1.33
74	4/23/2003	1.71	2.82	50.8	654	1.83	67.5	-0.121	-1.98
75	5/14/2003	1.45	2.5	27.9	316	1.49	31.4	-0.0489	-0.99
76	5/29/2003	1.68	2.68	47.6	482	1.69	49	-0.0098	-0.398
77	6/11/2003	1.84	2.83	69	673	1.84	69.6	-0.00101	-0.201
78	6/24/2003	2	2.99	100	967	2.01	102	-0.00563	-0.29
79	7/30/2003	1.96	2.95	91	889	1.97	93.3	-0.00788	-0.339
80	9/3/2003	1.39	2.43	24.7	267	1.42	26.4	-0.0264	-0.689
81	10/14/2003	1.27	2.29	18.8	194	1.27	18.8	0.00256	-0.114
82	12/11/2003	2.03	3.05	107	1120	2.07	119	-0.0432	-0.94
83	3/9/2004	1.31	2.33	20.6	213	1.31	20.7	0.000574	-0.169
84	3/30/2004	1.99	3	98.6	1010	2.02	106	-0.0301	-0.739
85	4/26/2004	2.03	3	107	989	2.02	104	0.0128	0.185
86	5/13/2004	1.34	2.44	22	274	1.43	27	-0.0864	-1.41
87	5/26/2004	2	3.01	99.8	1030	2.04	109	-0.0364	-0.835
88	6/22/2004	1.39	2.41	24.4	259	1.4	25.5	-0.0174	-0.556
89	7/27/2004	1.1	2.13	12.6	135	1.11	12.8	-0.00404	-0.257
90	1/27/2005	1.53	2.54	33.9	349	1.54	34.9	-0.00951	-0.372
91	3/23/2005	1.29	2.35	19.3	226	1.34	22.1	-0.0556	-1.13
92	5/27/2005	1.46	2.46	28.9	288	1.45	28.6	0.00795	0.0431
93	6/6/2005	1.42	2.47	26.3	293	1.46	29	-0.0403	-0.869
94	8/31/2005	1.61	2.56	40.8	366	1.56	36.7	0.0491	0.94
95	5/2/2006	1.89	2.86	76.8	732	1.88	76.1	0.00715	-0.0117
96	6/26/2006	1.44	2.46	27.7	287	1.45	28.4	-0.00727	-0.331
97	7/27/2006	1.96	2.84	90.6	692	1.85	71.8	0.104	2.9
98	8/15/2006	1.9	2.82	79.3	658	1.83	68	0.0698	1.63
99	8/23/2006	1.74	2.77	55.1	582	1.77	59.8	-0.0325	-0.771
100	9/27/2006	1.9	2.88	78.9	750	1.89	78.1	0.00794	0.0352
101	1/10/2007	1.94	2.94	86.9	873	1.96	91.5	-0.0194	-0.621
102	2/5/2007	1.96	2.99	90.5	974	2.01	103	-0.0524	-1.06
103	3/12/2007	1.87	2.85	74.1	708	1.86	73.5	0.00659	-0.0196
104	3/21/2007	1.84	2.86	69.5	728	1.88	75.7	-0.0341	-0.792
105	3/27/2007	1.53	2.65	34	442	1.65	44.7	-0.116	-1.93
106	4/2/2007	1.18	2.25	15	176	1.23	17	-0.0515	-1.04
107	4/18/2007	1.34	2.37	21.9	234	1.36	22.9	-0.0167	-0.538
108	7/11/2007	1.09	2.2	12.3	159	1.18	15.2	-0.0887	-1.49
109	8/16/2007	1.84	2.83	69.5	684	1.85	70.8	-0.00488	-0.273

110	9/6/2007	2	2.98	101	954	2	101	0.00454	-0.0509
111	11/26/2007	1.96	2.91	92.2	815	1.93	85.2	0.0377	0.659
112	12/6/2007	1.98	2.96	95.4	906	1.98	95.2	0.00413	-0.0744
113	12/13/2007	1.37	2.47	23.5	296	1.47	29.4	-0.0938	-1.57
114	3/6/2008	1.42	2.48	26.2	305	1.48	30.3	-0.0607	-1.17
115	4/14/2008	1.63	2.67	42.6	467	1.67	47.4	-0.0428	-0.928
116	5/29/2008	1.28	2.34	19.2	218	1.32	21.3	-0.0406	-0.881
117	6/30/2008	1.53	2.54	34.1	347	1.54	34.7	-0.00513	-0.282
118	4/6/2009	1.84	2.83	69.2	670	1.84	69.3	0.00217	-0.122
119	4/13/2009	1.72	2.73	52	535	1.73	54.7	-0.0189	-0.602
120	4/28/2009	1.32	2.3	20.7	198	1.28	19.3	0.0341	0.602
121	6/16/2009	1.66	2.6	46	395	1.6	39.8	0.066	1.41
122	7/30/2009	1.43	2.41	27.1	259	1.4	25.6	0.0281	0.502
123	9/9/2009	1.22	2.2	16.6	160	1.18	15.4	0.0376	0.65
124	9/24/2009	1.41	2.4	25.5	251	1.39	24.7	0.0157	0.265
125	11/3/2009	1.52	2.51	33.2	327	1.51	32.6	0.0112	0.137
126	11/19/2009	1.96	2.89	90.6	780	1.91	81.4	0.0497	0.965
127	12/1/2009	2.01	2.96	102	921	1.98	96.9	0.0275	0.484
128	12/17/2009	2.02	3.02	106	1040	2.04	110	-0.0139	-0.467
129	1/6/2010	2.07	3.06	118	1150	2.08	122	-0.0138	-0.458
130	1/19/2010	2.06	3.02	114	1040	2.04	110	0.0194	0.323
131	2/4/2010	2	2.98	100	949	2	100	0.00375	-0.0901
132	2/23/2010	1.99	3	97.1	997	2.02	105	-0.0322	-0.76
133	3/10/2010	1.88	2.85	75.3	713	1.87	74.1	0.0104	0.114
134	3/11/2010	1.8	2.79	62.9	619	1.8	63.8	-0.00267	-0.233
135	4/14/2010	2.05	3.02	112	1040	2.04	110	0.0112	0.145
136	4/23/2010	1.86	2.77	72.2	590	1.78	60.7	0.0787	1.98
137	5/13/2010	1.56	2.55	36.3	351	1.54	35.2	0.0165	0.273
138	6/9/2010	1.15	2.16	14	143	1.13	13.7	0.0142	0.209
139	6/13/2010	1.04	2.01	10.9	103	0.984	9.7	0.0536	1.08
140	6/14/2010	1.05	2.02	11.2	105	0.99	9.83	0.0592	1.19
141	6/14/2010	1.06	2.04	11.5	110	1.01	10.3	0.0516	1.04
142	6/15/2010	1.27	2.27	18.4	188	1.26	18.2	0.00747	0.00391
143	6/16/2010	1.3	2.31	20.1	206	1.3	20.1	0.00257	-0.106
144	7/6/2010	1	2.01	10	102	0.978	9.57	0.0221	0.389
145	8/19/2010	1.85	2.8	71.5	637	1.81	65.7	0.0395	0.709
146	8/25/2010	1.71	2.65	51	449	1.66	45.5	0.0528	1.07
147	11/16/2010	1.62	2.7	41.5	501	1.7	51	-0.0865	-1.43
148	1/19/2011	2.14	3.04	138	1100	2.06	117	0.0741	1.88
149	3/7/2011	1.96	2.88	91.8	759	1.89	79.1	0.0682	1.57
150	3/16/2011	1.96	2.91	92.1	808	1.92	84.4	0.0408	0.739
151	4/6/2011	1.99	2.98	98.5	956	2	101	-0.00685	-0.314
152	5/2/2011	2.01	2.97	103	936	1.99	98.5	0.0223	0.398
153	6/7/2011	1.9	2.84	78.6	692	1.85	71.7	0.0428	0.781
154	6/21/2011	1.89	2.96	77	920	1.98	96.8	-0.0963	-1.63
155	6/22/2011	1.83	2.92	68.1	841	1.94	88	-0.108	-1.76
156	8/15/2011	1.59	2.58	38.7	382	1.58	38.4	0.00654	-0.0274
157	9/22/2011	1.65	2.59	45	390	1.59	39.2	0.0622	1.31
158	12/20/2011	1.47	2.53	29.6	338	1.53	33.8	-0.0552	-1.11
159	2/6/2012	1.61	2.66	41	461	1.67	46.8	-0.0548	-1.1
160	3/1/2012	1.43	2.63	26.9	430	1.64	43.5	-0.206	-2.58
161	4/7/2012	1.49	2.58	30.8	382	1.58	38.4	-0.0926	-1.54
162	4/17/2012	1.88	2.86	75.6	725	1.87	75.3	0.0046	-0.0431
163	6/18/2012	1.48	2.57	30.5	372	1.57	37.3	-0.0839	-1.36
164	6/19/2012	1.59	2.72	38.8	529	1.73	54.1	-0.142	-2.19
165	7/12/2012	1.93	2.89	84.2	781	1.91	81.5	0.0169	0.298

166	7/19/2012	1.92	2.83	82.5	683	1.85	70.7	0.0699	1.66
167	9/11/2012	1.85	2.84	71.2	685	1.85	71	0.00422	-0.0666
168	10/24/2012	1.91	2.82	82.1	663	1.83	68.5	0.0817	2.19
169	11/7/2012	1.94	2.92	87.7	826	1.93	86.4	0.00963	0.0744
170	11/14/2012	1.93	2.93	85.8	860	1.95	90.1	-0.0185	-0.593
171	12/12/2012	1.97	2.93	92.4	854	1.95	89.5	0.0167	0.282
172	1/16/2013	1.91	2.94	80.6	880	1.96	92.4	-0.0564	-1.14
173	1/29/2013	1.91	2.9	81.6	791	1.91	82.6	-0.00193	-0.217
174	2/13/2013	1.86	2.93	72	860	1.95	90.2	-0.0945	-1.6
175	3/12/2013	1.85	2.94	71.3	878	1.96	92.1	-0.108	-1.72
176	3/13/2013	1.9	3.02	79.9	1050	2.04	111	-0.14	-2.11
177	3/27/2013	1.98	3.06	94.7	1160	2.09	124	-0.112	-1.88
178	4/15/2013	1.9	3.04	79.3	1100	2.06	117	-0.165	-2.28
179	4/24/2013	1.69	2.76	49.2	571	1.76	58.6	-0.0732	-1.27
180	5/6/2013	1.8	2.87	62.4	745	1.89	77.5	-0.091	-1.52
181	5/15/2013	1.8	2.78	62.6	599	1.79	61.6	0.00961	0.0666
182	5/21/2013	1.68	2.66	48.1	453	1.66	45.9	0.0234	0.415
183	5/28/2013	1.9	2.86	78.6	718	1.87	74.6	0.0259	0.449
184	6/5/2013	1.64	2.69	44.1	489	1.69	49.8	-0.0498	-1
185	6/13/2013	1.89	2.96	77.2	907	1.98	95.3	-0.0886	-1.47
186	6/24/2013	2.03	3.14	107	1380	2.17	149	-0.139	-2.04
187	7/9/2013	1.85	2.86	71.5	721	1.87	74.9	-0.0173	-0.547
188	7/29/2013	1.09	2.16	12.4	143	1.13	13.7	-0.0415	-0.904
189	8/7/2013	1.02	2.02	10.5	106	0.994	9.94	0.026	0.458
190	8/15/2013	1.16	2.14	14.4	137	1.11	13.1	0.0451	0.824
191	8/29/2013	1.87	2.82	73.7	665	1.83	68.8	0.0328	0.565
192	10/24/2013	1.98	2.94	95.6	878	1.96	92.1	0.0193	0.314
193	10/30/2013	1.58	2.61	38.4	411	1.61	41.4	-0.0303	-0.75
194	11/25/2013	1.99	2.94	97.3	863	1.95	90.5	0.0347	0.611
195	12/11/2013	2.06	3.03	114	1060	2.05	112	0.00829	0.0509
196	1/14/2014	2.04	3.03	111	1060	2.05	112	-0.00332	-0.241
197	2/20/2014	2.03	3.02	108	1040	2.04	110	-0.00695	-0.323
198	3/17/2014	2.02	3	104	998	2.02	105	-0.00207	-0.225
199	4/9/2014	2.03	2.99	108	989	2.02	104	0.0169	0.29
200	4/14/2014	2.02	2.99	105	967	2.01	102	0.0144	0.225
201	5/14/2014	1.75	2.78	56.5	597	1.79	61.4	-0.033	-0.781
202	5/15/2014	1.87	2.9	74.2	791	1.91	82.6	-0.0433	-0.952
203	5/29/2014	1.95	2.94	88.7	869	1.96	91.1	-0.00879	-0.364
204	6/3/2014	1.82	2.79	65.7	612	1.8	63	0.0213	0.347
205	6/5/2014	1.83	2.85	68.4	707	1.86	73.4	-0.0276	-0.719
206	6/9/2014	1.33	2.36	21.2	231	1.35	22.6	-0.0236	-0.65
207	6/12/2014	1.19	2.18	15.5	153	1.16	14.7	0.0266	0.467
208	6/24/2014	1.79	2.76	61.4	573	1.77	58.8	0.0218	0.372
209	7/10/2014	1.86	2.82	72.9	657	1.83	67.9	0.0337	0.583
210	7/15/2014	1.92	2.88	82.2	760	1.9	79.2	0.0196	0.331
211	7/24/2014	1.91	2.89	81.5	783	1.91	81.7	0.00198	-0.137
212	8/4/2014	1.99	2.92	98.3	823	1.93	86.1	0.0605	1.24
213	8/7/2014	1.92	2.9	83.3	786	1.91	82	0.00996	0.0901
214	9/3/2014	1.14	2.17	13.7	149	1.15	14.3	-0.013	-0.44
215	10/16/2014	1.8	2.78	62.5	598	1.79	61.5	0.01	0.106
216	12/9/2014	2.01	2.92	102	829	1.94	86.7	0.0732	1.8
217	12/15/2014	2.04	2.96	109	921	1.98	96.9	0.0562	1.11
218	2/11/2015	2.06	3.04	115	1090	2.06	116	-0.00104	-0.209
219	2/25/2015	2.01	3.02	103	1040	2.04	110	-0.0257	-0.679
220	4/6/2015	2.05	3	111	999	2.02	106	0.0269	0.475
221	4/16/2015	2.08	2.98	121	960	2	101	0.0804	2.11

222	4/22/2015	1.7	2.8	49.7	627	1.81	64.7	-0.112	-1.84
223	5/5/2015	1.89	2.88	78.2	763	1.9	79.5	-0.00418	-0.265
224	5/20/2015	1.33	2.35	21.4	226	1.34	22.1	-0.0112	-0.415
225	5/27/2015	1.31	2.38	20.7	238	1.36	23.3	-0.0501	-1.02
226	6/10/2015	1.8	2.8	63.3	627	1.81	64.7	-0.00651	-0.306
227	6/17/2015	1.29	2.34	19.7	217	1.32	21.2	-0.0292	-0.729
228	6/29/2015	1.95	2.87	88.5	735	1.88	76.4	0.0671	1.49
229	7/13/2015	1.59	2.59	38.5	385	1.59	38.8	0.000236	-0.185
230	8/3/2015	1.94	2.88	88	763	1.9	79.5	0.0467	0.892
231	8/17/2015	1.85	2.77	71.1	596	1.78	61.2	0.0679	1.54
232	8/27/2015	1.45	2.47	28.2	298	1.47	29.6	-0.0177	-0.565
233	9/8/2015	1.82	2.74	66.6	546	1.74	55.9	0.0788	2.04
234	11/17/2015	1.93	2.84	85.4	687	1.85	71.2	0.0819	2.28
235	1/19/2016	1.95	2.88	89.2	755	1.89	78.6	0.0579	1.17
236	3/16/2016	1.98	2.94	96.1	878	1.96	92.1	0.0212	0.339
237	4/20/2016	1.94	2.9	86.3	793	1.91	82.7	0.0215	0.356
238	4/21/2016	1.91	2.88	81.9	767	1.9	79.9	0.0137	0.193
239	5/3/2016	1.55	2.54	35.4	350	1.54	35	0.00756	0.0117
240	5/18/2016	1.84	2.82	69.4	654	1.83	67.5	0.0148	0.249
241	5/26/2016	1.48	2.5	29.9	314	1.49	31.3	-0.016	-0.529
242	5/31/2016	1.37	2.35	23.6	225	1.34	22	0.0339	0.593
243	6/7/2016	1.8	2.75	62.4	558	1.75	57.1	0.0414	0.75
244	6/17/2016	1.22	2.25	16.5	178	1.23	17.2	-0.0148	-0.511
245	6/21/2016	1.38	2.41	24.2	254	1.4	25	-0.011	-0.406
246	6/28/2016	1.8	2.71	63.5	518	1.72	52.9	0.0826	2.4
247	7/6/2016	1.16	2.13	14.4	136	1.11	13	0.0497	0.977
248	7/13/2016	1.66	2.61	45.5	409	1.61	41.3	0.0459	0.847
249	7/25/2016	1.92	2.84	83.1	698	1.86	72.4	0.0628	1.33
250	8/11/2016	1.45	2.41	28	255	1.4	25.1	0.0514	1.03
251	8/16/2016	1.77	2.7	58.5	497	1.7	50.6	0.0664	1.45
252	8/29/2016	1.33	2.3	21.2	198	1.28	19.2	0.046	0.858
253	9/7/2016	1.7	2.63	49.8	426	1.63	43	0.0664	1.47
254	9/13/2016	1.49	2.43	30.7	272	1.43	26.8	0.0614	1.25
255	10/24/2016	2	2.9	99.5	789	1.91	82.3	0.0855	2.58
256	11/15/2016	1.98	2.9	96.6	787	1.91	82.1	0.0734	1.84
257	12/14/2016	2.04	2.96	110	911	1.98	95.8	0.0647	1.36
258	1/10/2017	2.03	2.97	107	928	1.99	97.7	0.0443	0.813
259	2/14/2017	2.02	2.94	106	878	1.96	92.1	0.062	1.27
260	3/14/2017	1.99	2.95	96.6	890	1.97	93.5	0.0174	0.306
261	3/30/2017	1.32	2.35	21.1	225	1.34	22	-0.0146	-0.502
262	4/11/2017	1.71	2.69	51.6	485	1.69	49.4	0.0218	0.381
263	5/1/2017	1.6	2.57	39.9	373	1.57	37.4	0.0311	0.529
264	5/15/2017	1.83	2.8	67.1	637	1.81	65.7	0.0118	0.161
265	5/31/2017	1.95	2.9	89.2	786	1.91	82.1	0.0393	0.699
266	6/5/2017	1.87	2.84	75	687	1.85	71.2	0.0256	0.44
267	6/13/2017	2	2.95	99.7	886	1.97	93	0.0333	0.574
268	6/28/2017	1.97	2.94	94.3	862	1.95	90.4	0.0215	0.364
269	7/13/2017	1.92	2.86	84	725	1.87	75.4	0.05	0.99
270	7/31/2017	1.84	2.79	69.4	623	1.8	64.2	0.0369	0.63
271	8/2/2017	1.88	2.8	76.2	630	1.81	65	0.0724	1.69
272	8/16/2017	1.92	2.84	82.9	692	1.85	71.7	0.0661	1.43
273	8/30/2017	1.95	2.87	88.4	748	1.89	77.9	0.0578	1.16
274	9/6/2017	1.94	2.87	86.4	749	1.89	78	0.0476	0.928
275	10/17/2017	1.94	2.87	87.2	740	1.88	77	0.0571	1.14
276	11/15/2017	1.92	2.86	83.6	722	1.87	75	0.0502	1
277	12/12/2017	1.94	2.87	87.3	749	1.89	78	0.0518	1.06

278	1/18/2018	2	2.94	99	866	1.96	90.8	0.0403	0.719
279	1/31/2018	1.93	2.88	84.8	765	1.9	79.7	0.0296	0.52
280	3/6/2018	1.94	2.88	86.6	754	1.89	78.5	0.0454	0.835
281	3/22/2018	1.93	2.88	85.2	753	1.89	78.4	0.0389	0.689
282	4/18/2018	1.96	2.93	90.6	856	1.95	89.7	0.00722	-0.00391
283	5/2/2018	1.98	2.93	94.4	844	1.94	88.4	0.0318	0.547
284	5/9/2018	2.01	2.96	101	904	1.97	95	0.0316	0.538
285	5/23/2018	1.97	2.98	94	945	2	99.6	-0.022	-0.64
286	6/1/2018	1.41	2.43	25.8	272	1.43	26.9	-0.0142	-0.475
287	6/6/2018	1.73	2.73	54	531	1.73	54.3	0.000832	-0.161
288	6/20/2018	1.92	2.83	83.2	681	1.85	70.6	0.0743	1.93
289	6/26/2018	1.63	2.61	42.7	404	1.61	40.7	0.0234	0.406
290	7/19/2018	1.22	2.19	16.4	154	1.16	14.7	0.0508	1.02
291	7/31/2018	1.27	2.23	18.7	168	1.21	16.2	0.0649	1.38
292	8/16/2018	1.69	2.66	48.7	457	1.66	46.4	0.0237	0.423
293	8/28/2018	1.57	2.52	37.3	329	1.51	32.8	0.0598	1.2
294	9/6/2018	1.1	2.06	12.6	114	1.03	10.8	0.0731	1.76
295	9/18/2018	1.83	2.76	67.5	576	1.77	59.1	0.0605	1.22
296	10/16/2018	1.35	2.33	22.4	215	1.32	20.9	0.0322	0.556
297	11/19/2018	2.05	3	113	991	2.02	105	0.0371	0.64
298	12/4/2018	1.86	2.89	72.9	779	1.91	81.3	-0.044	-0.965
299	12/17/2018	1.98	2.93	94.7	859	1.95	90.1	0.0246	0.432
300	1/29/2019	1.95	2.92	90	837	1.94	87.6	0.0147	0.241
301	2/19/2019	2.07	3.05	118	1130	2.08	121	-0.0081	-0.347
302	3/14/2019	1.65	2.68	44.3	483	1.69	49.1	-0.0417	-0.916
303	3/19/2019	1.75	2.74	56.9	554	1.75	56.8	0.00387	-0.0823
304	4/11/2019	1.86	2.88	72.6	760	1.9	79.2	-0.0344	-0.813
305	4/16/2019	2.02	2.99	104	968	2.01	102	0.0117	0.153
306	5/1/2019	1.37	2.33	23.6	214	1.32	20.9	0.056	1.1
307	5/15/2019	1.52	2.48	32.9	304	1.48	30.2	0.0406	0.729
308	5/23/2019	1.08	2.07	11.9	117	1.04	11.1	0.0348	0.621
309	6/5/2019	1.83	2.79	68.2	610	1.8	62.9	0.0383	0.679
310	6/12/2019	1.96	2.9	92.2	799	1.92	83.4	0.0466	0.881
311	6/24/2019	1.09	2.11	12.2	129	1.09	12.3	0.000833	-0.153
312	7/10/2019	1.61	2.57	40.9	368	1.56	36.9	0.0475	0.916
313	7/30/2019	2.02	2.93	104	853	1.95	89.4	0.0677	1.52
314	8/7/2019	1.97	2.9	92.9	787	1.91	82.1	0.0566	1.13
315	8/20/2019	1.27	2.27	18.5	186	1.25	18.1	0.0144	0.233
316	8/26/2019	1.45	2.41	28	255	1.4	25.1	0.0497	0.952
317	9/11/2019	1.9	2.82	80.3	662	1.83	68.4	0.0727	1.72
318	10/9/2019	1.98	2.93	96.2	847	1.95	88.8	0.0382	0.669
319	11/6/2019	1.99	2.91	98.4	810	1.92	84.7	0.0686	1.6
320	12/11/2019	2.03	2.96	106	919	1.98	96.6	0.0436	0.792

Definitions

CA: Calcium in mg/L (00915)
SC: Specific conductance in µS/cm @25C (00095)

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