HISTORICAL WATER USAGE AT DUKE

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Duke | Office of INFORMATION TECHNOLOGY

OUTLINE

- CONTEXT
- SUMMARY STATS
- BUILDINGS #1-7 TRENDS
- FUTURE WATER USAGE
- SYNOPSIS

Image: NC State University – Central Utility Plant

Background

- A .csv containing historical water usage for Duke facilities
- 7 buildings, with 6 of 7 using kBTU as unit of measurement
  - Building #2 has “STM” as unit of measurement, research suggests “Steam”
  - Often measured in pounds or kilograms per hour
  - A BTU is a unit of energy, it is the amount of energy required to raise the temperature of one pound of water by one degree Fahrenheit.
- Data is recorded in a sequential fashion with time + measure of heat (kBTU) as two variables
- Data starts on 8/11/2016 @ 12:00 and ends 8/1/2019 @ 0:00
- Total of 104113 entries

Objectives

- Describe buildings and water usage over time
- Predict future water usage, based on historical usage

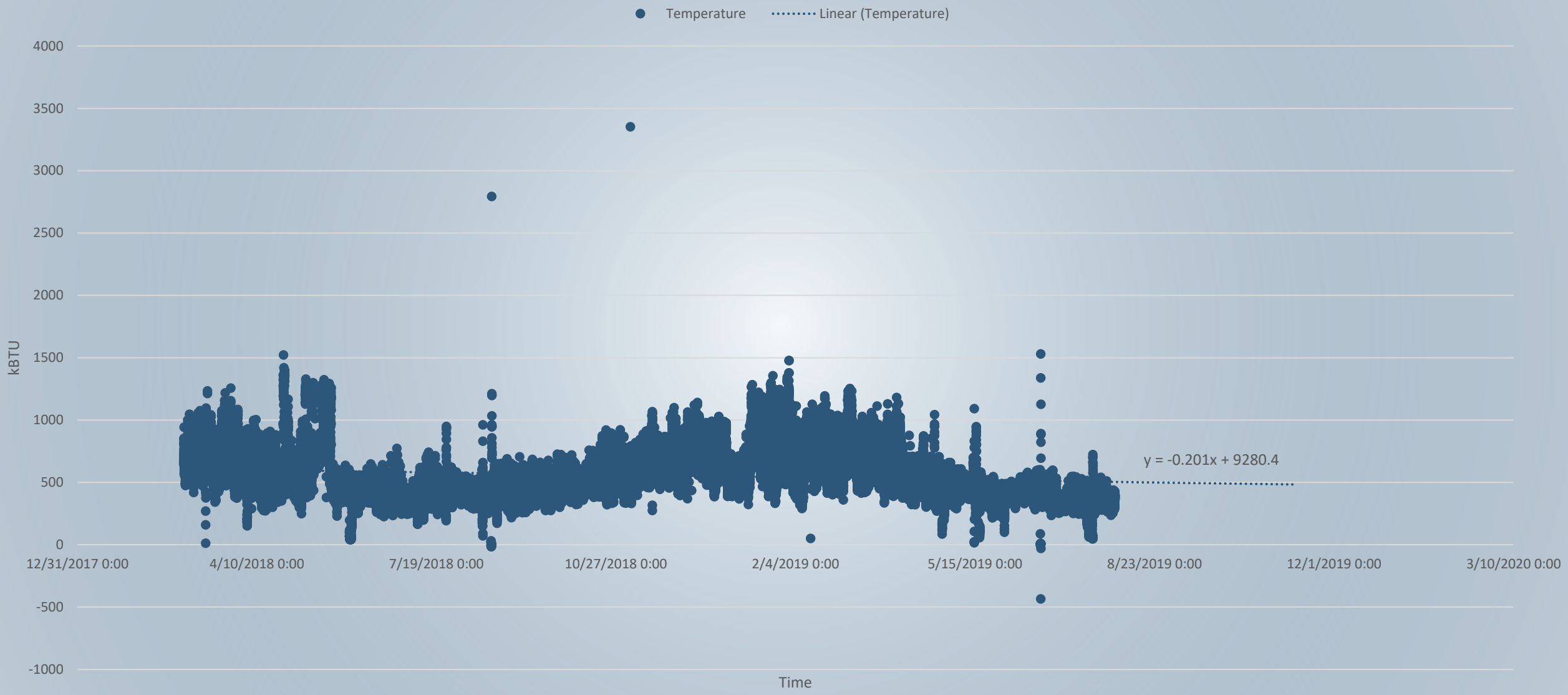
Summary Stats

	mean	median	std-dev	count	min	max	max w/o outliers
Building #1	555.24	511.99	194.26	49801	-436	3351	1530
Building #2	25444.72	22575.00	19204.25	67818	-19	163479	n/a
Building #3	674.73	652.06	445.61	47583	-334	4380	n/a
Building #4	218.50	188.00	190.51	76665	-1204	2058	n/a
Building #5	155.41	100.00	172.65	67417	0	15063	1129
Building #6	331.66	276.57	243.88	104109	-195	17868	3526
Building #7	1245.96	1014.00	686.31	58679	-1190	97420	5785

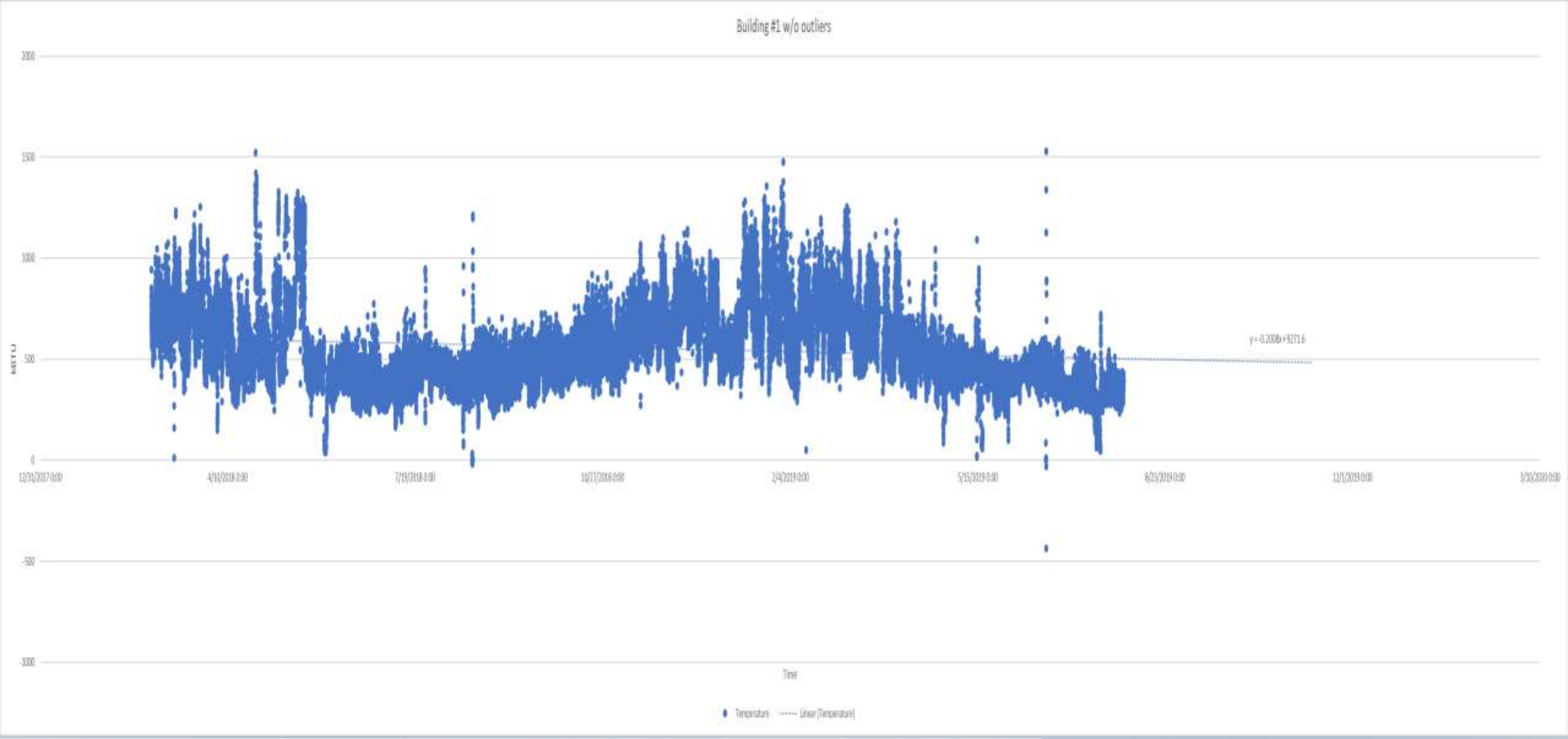
Initial Impressions

- Building #2 clearly has a different unit of measurement
- Buildings #5, 6, and 7 have significant outliers which could skew statistics
- Building #6 has the largest number of samples (counts)

Building #1 w/outliers

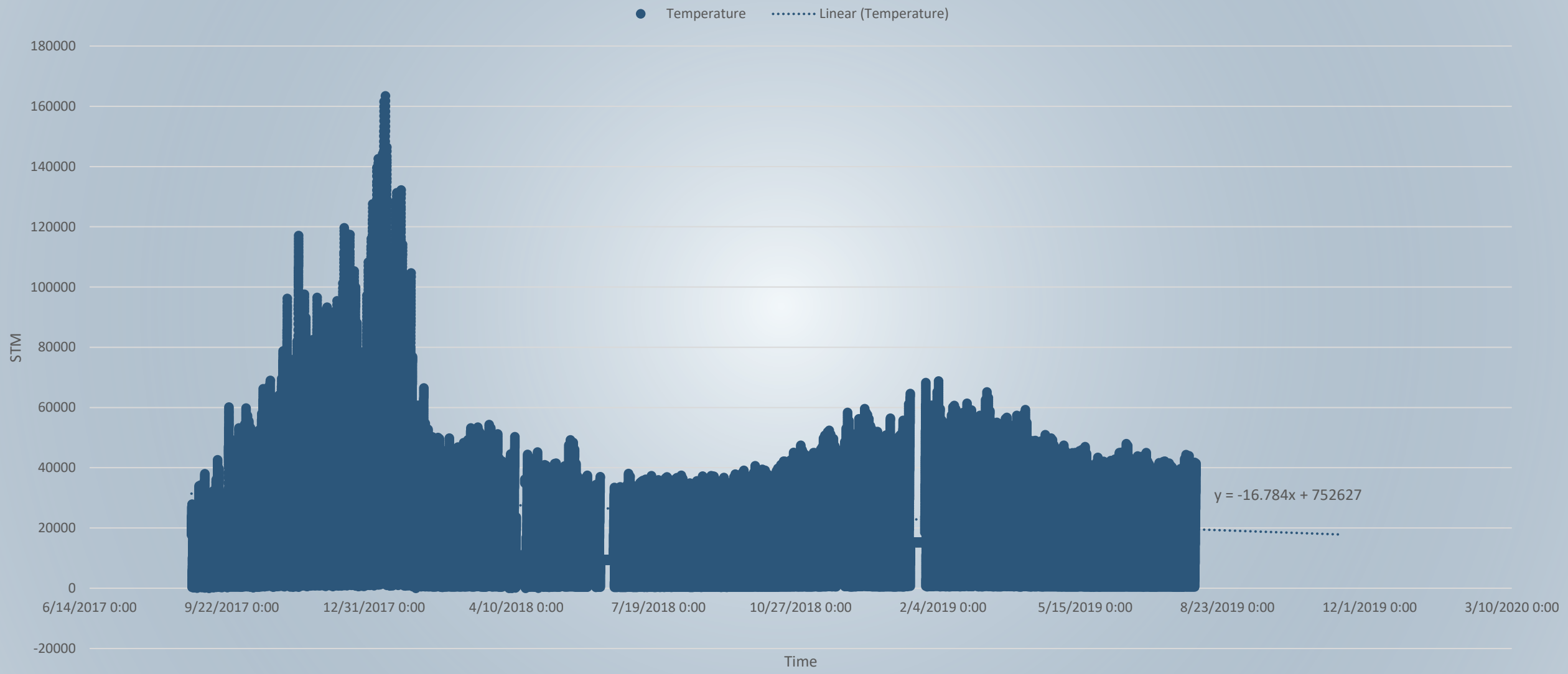


2/28/2018 @ 6:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #1	555.24	511.99	194.26	49801	-436	3351	1530



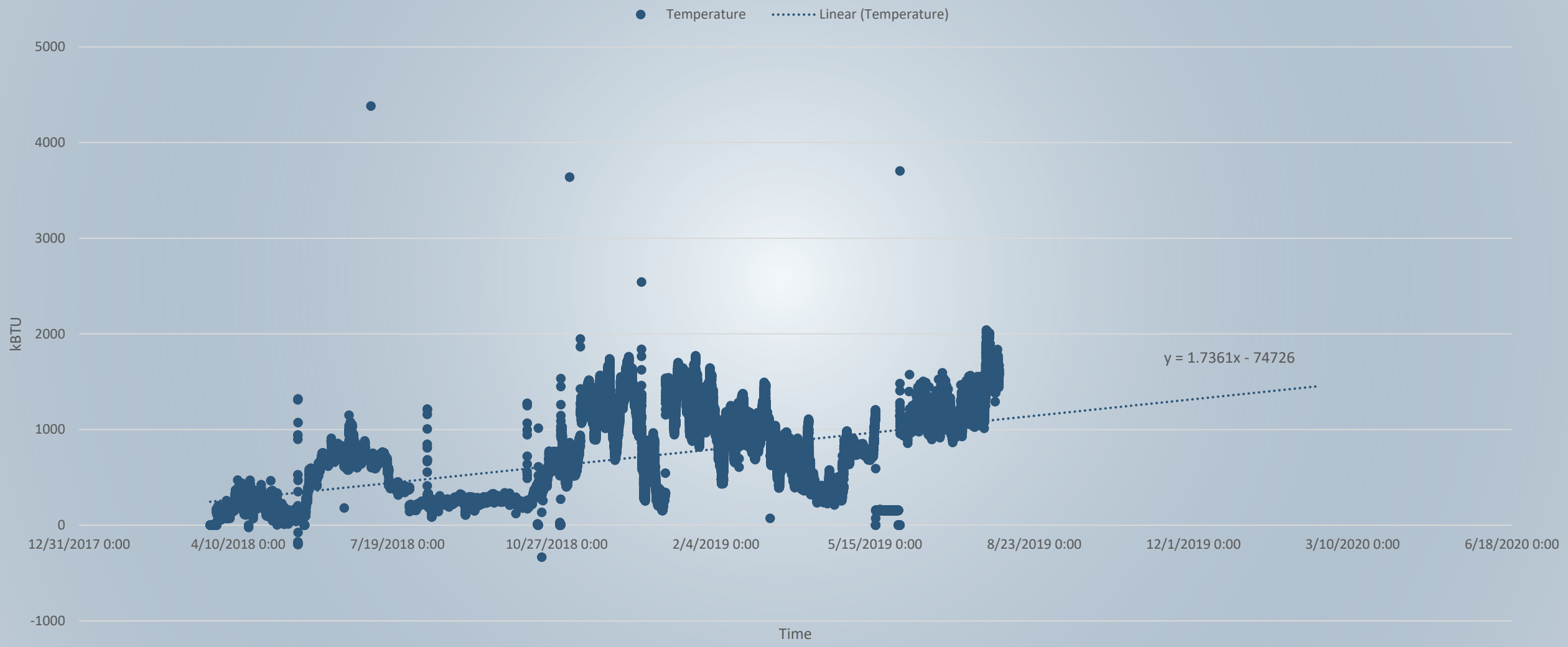
2/28/2018 @ 6:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #1	555.24	511.99	194.26	49801	-436	3351	1530

Building #2



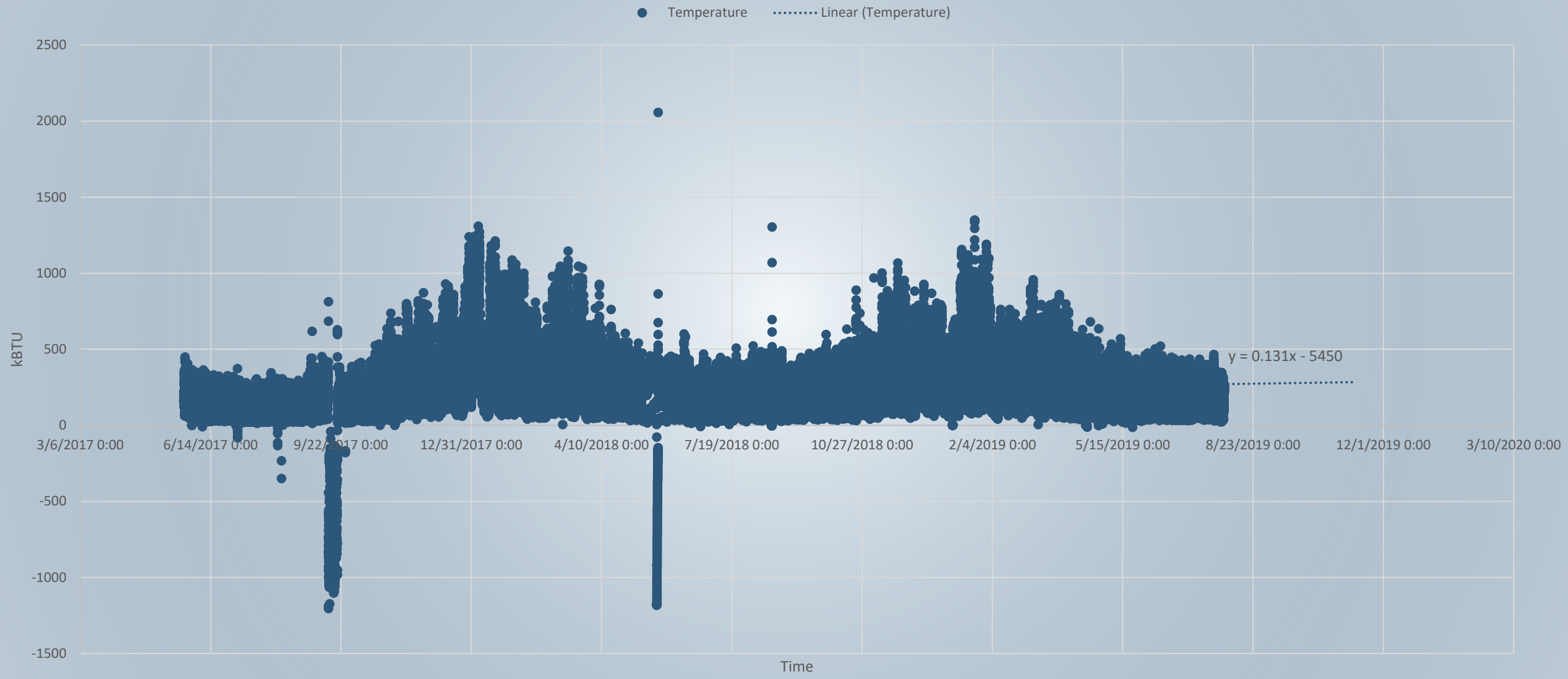
8/24/2017 @ 13:45	mean	median	std-dev	count	min	max	max w/o outliers
Building #2	25444.72	22575.00	19204.25	67818	-19	163479	n/a

Building #3



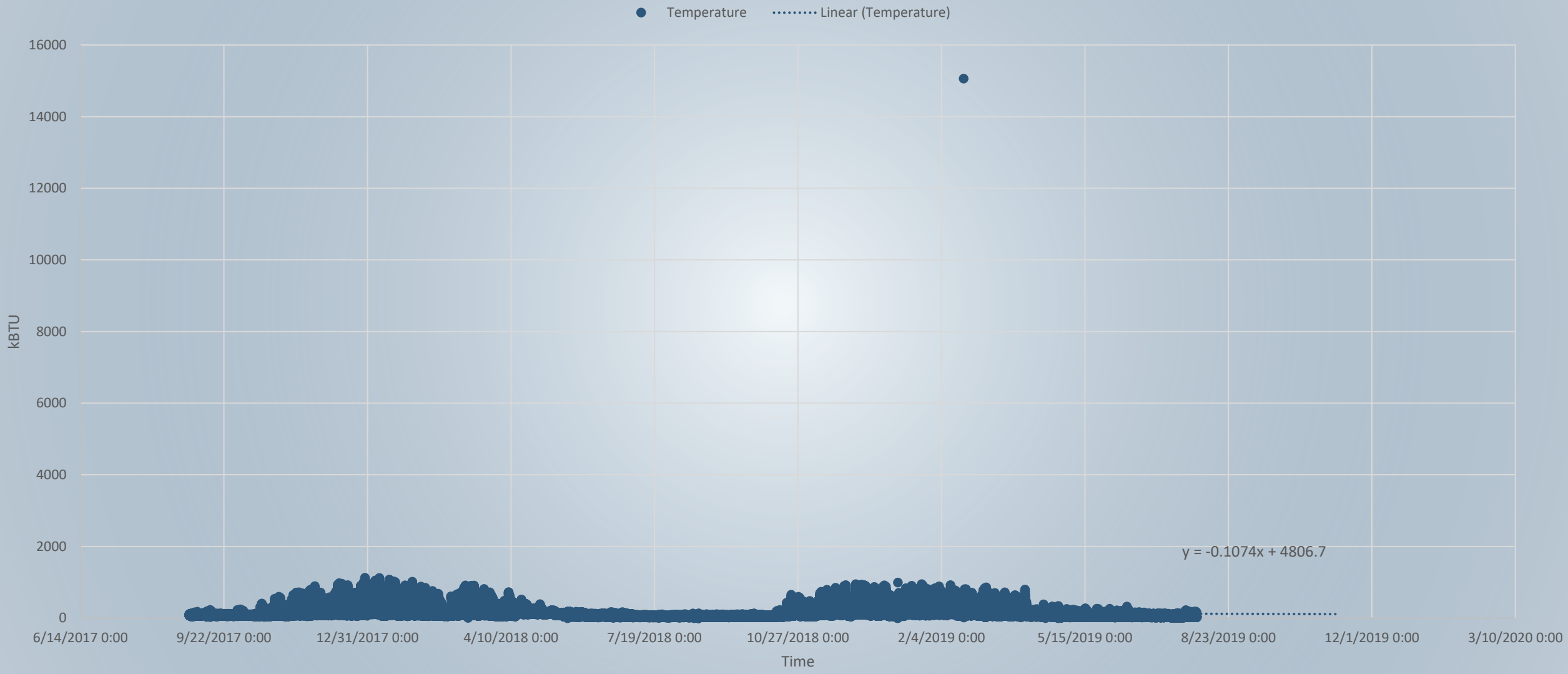
3/23/2018 @8:30	mean	median	std-dev	count	min	max	max w/o outliers
Building #3	674.73	652.06	445.61	47583	-334	4380	n/a

Building #4



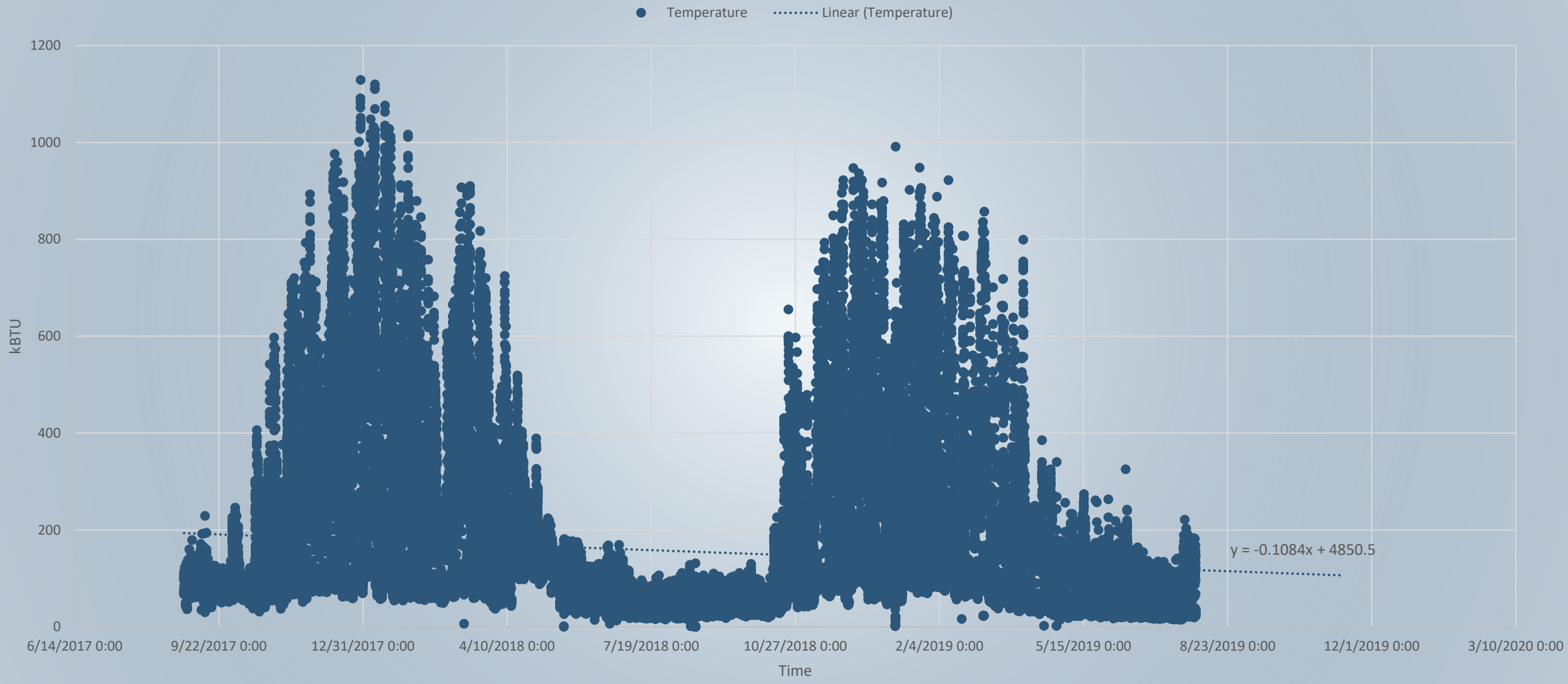
5/24/2017 @10:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #4	218.50	188.00	190.51	76665	-1204	2058	n/a

Building #5 w/outlier



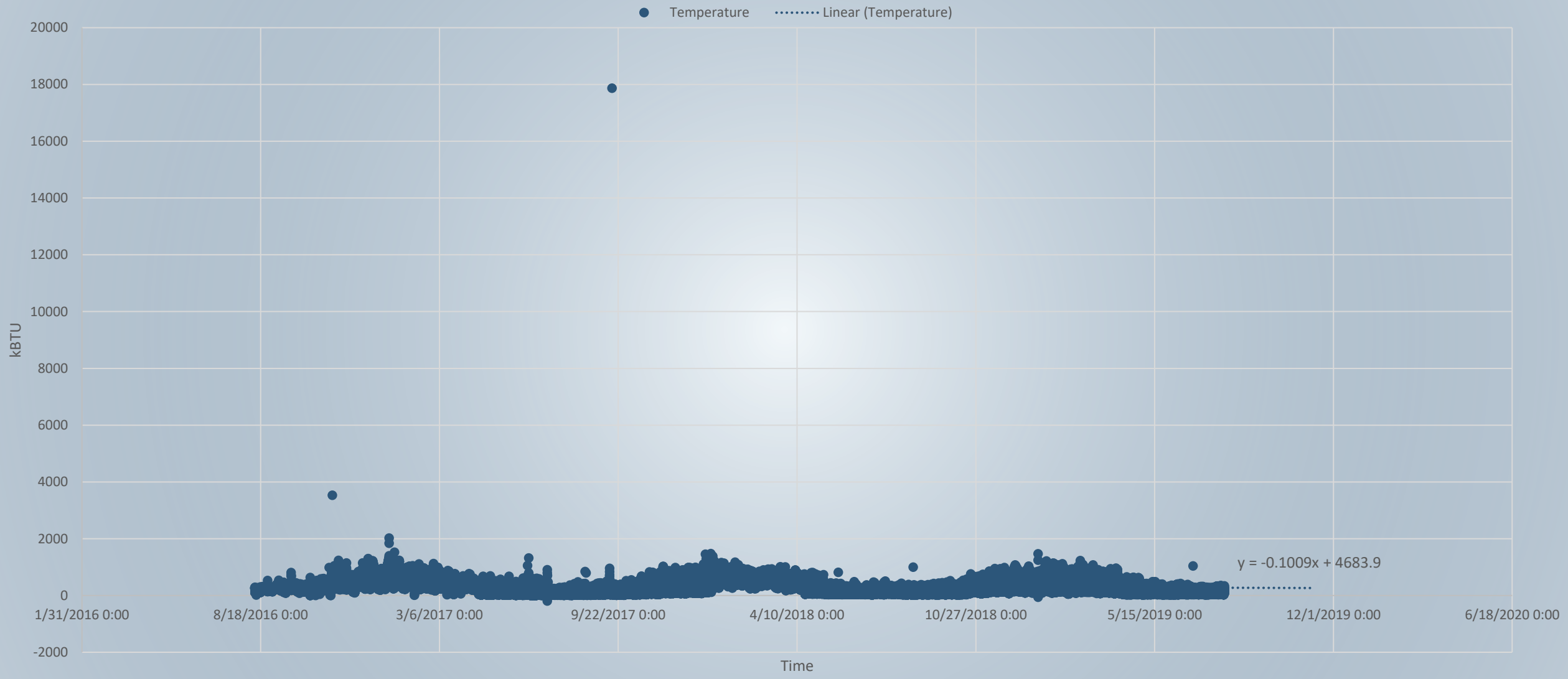
8/28/2017 @18:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #5	155.41	100.00	172.65	67417	0	15063	1129

Building #5 w/o outlier

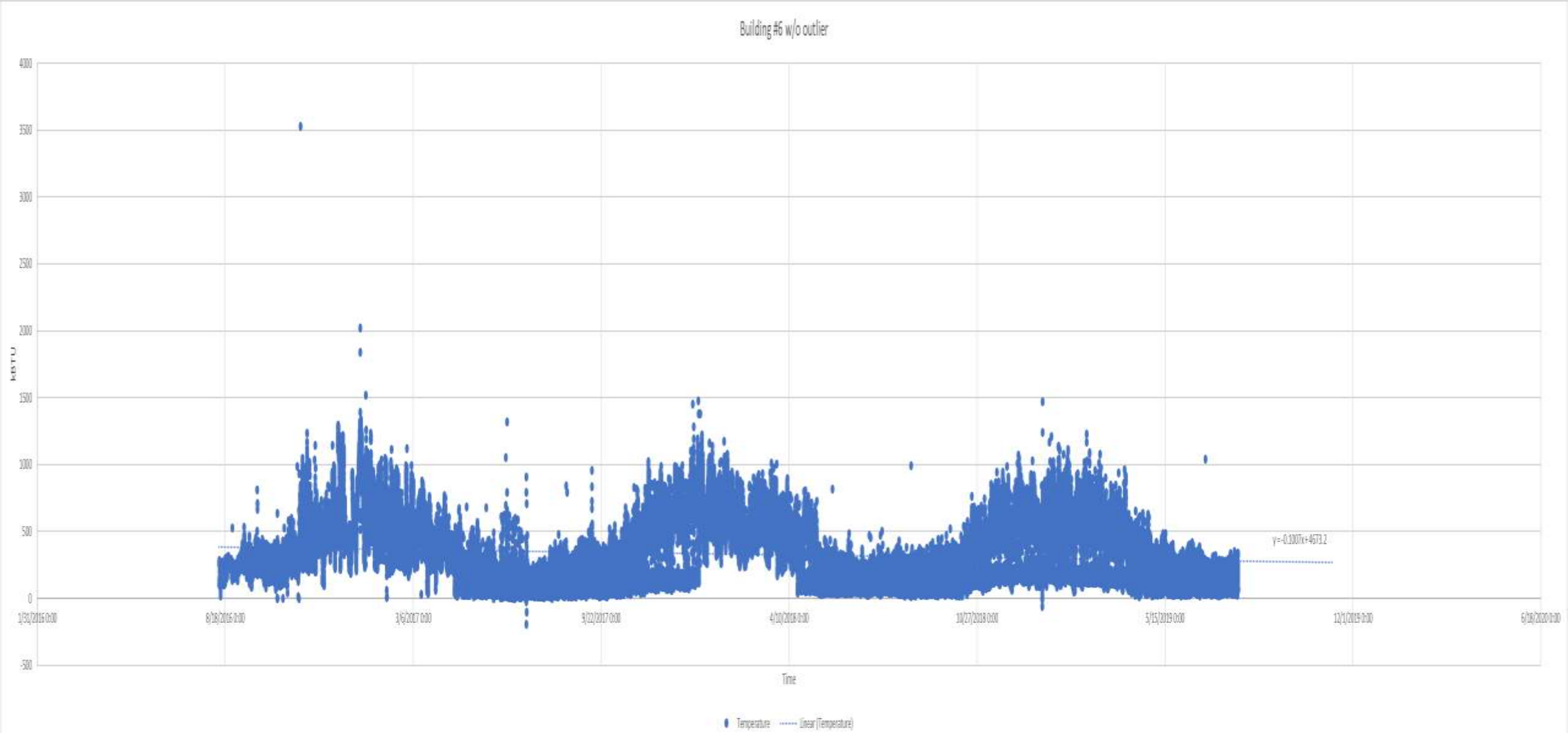


8/28/2017 @18:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #5	155.41	100.00	172.65	67417	0	15063	1129

Building #6 w/outlier

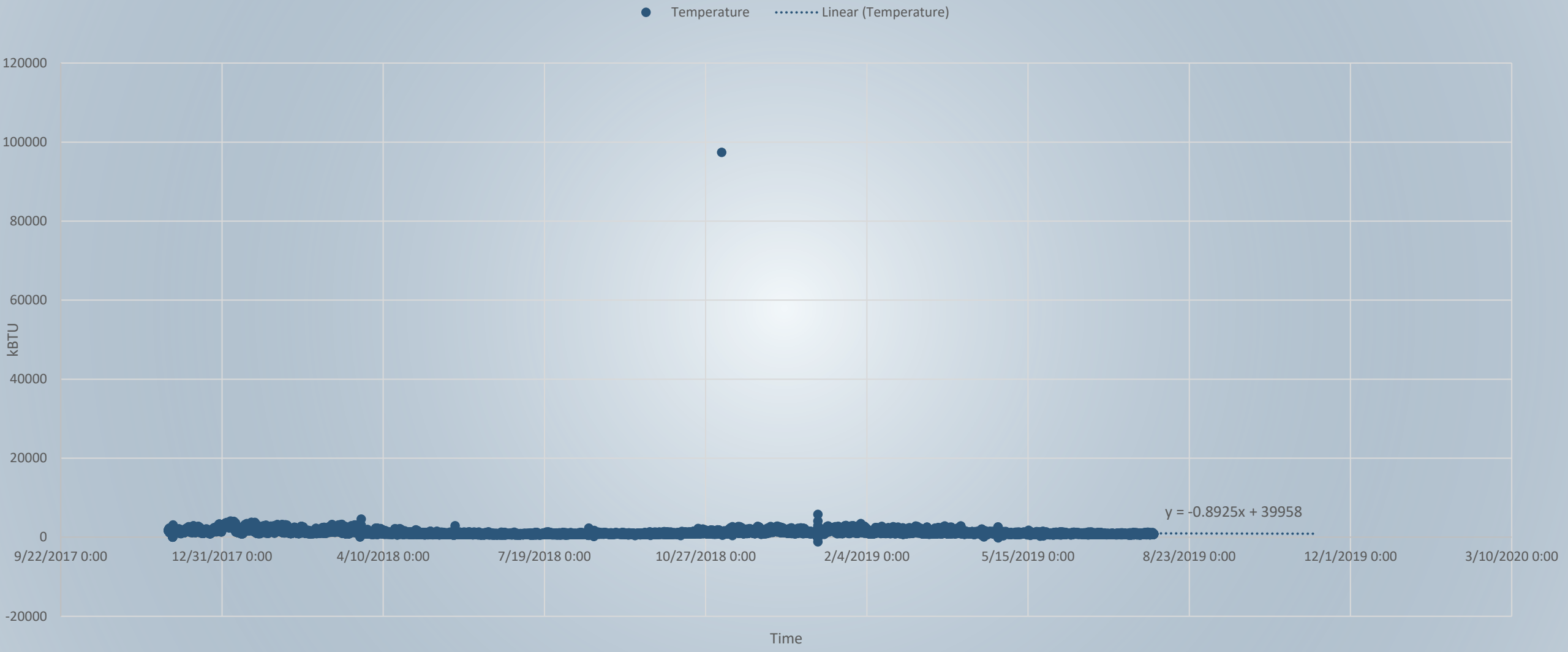


8/11/2016 @ 13:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #6	331.66	276.57	243.88	104109	-195	17868	3526

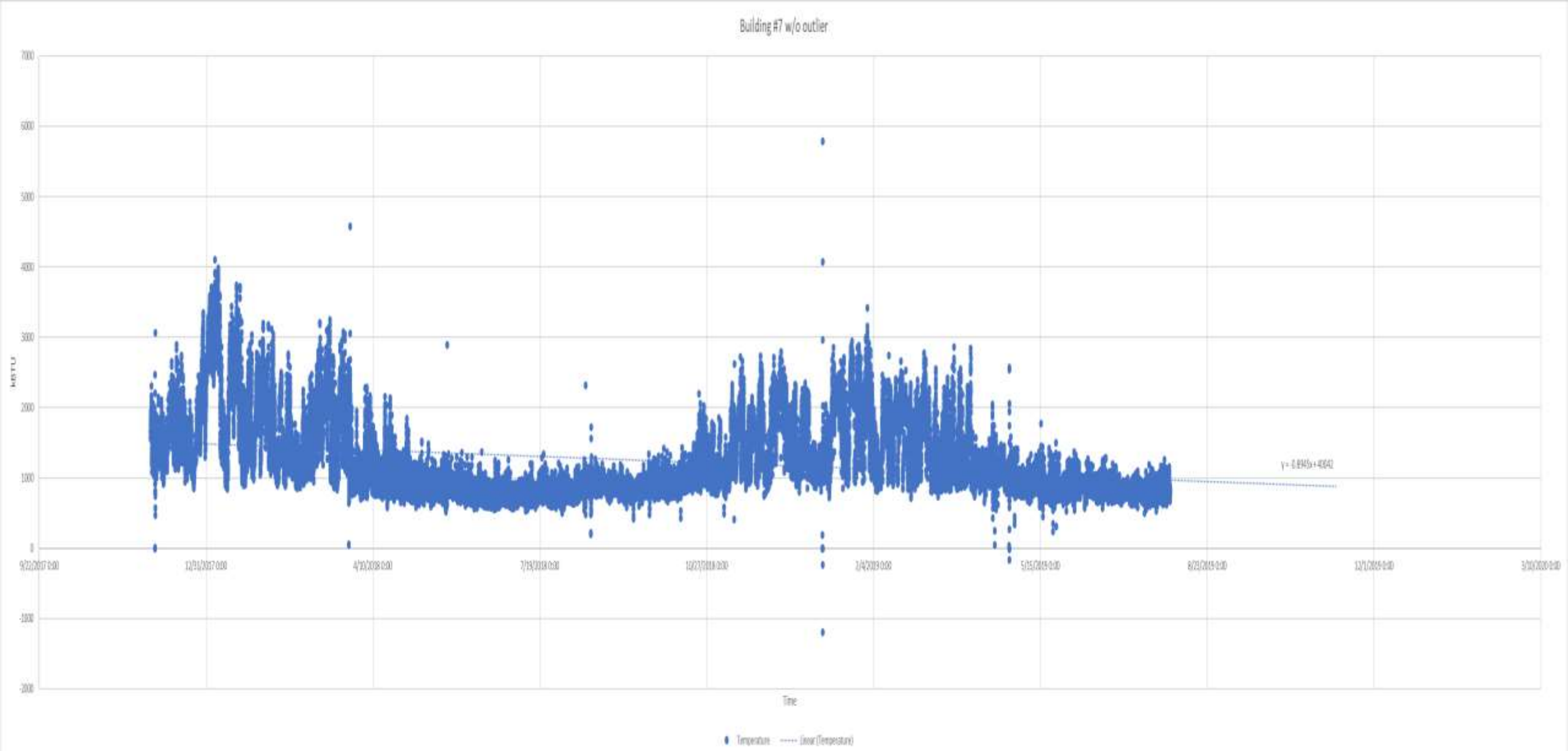


8/11/2016 @13:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #6	331.66	276.57	243.88	104109	-195	17868	3526

Building #7 w/outlier



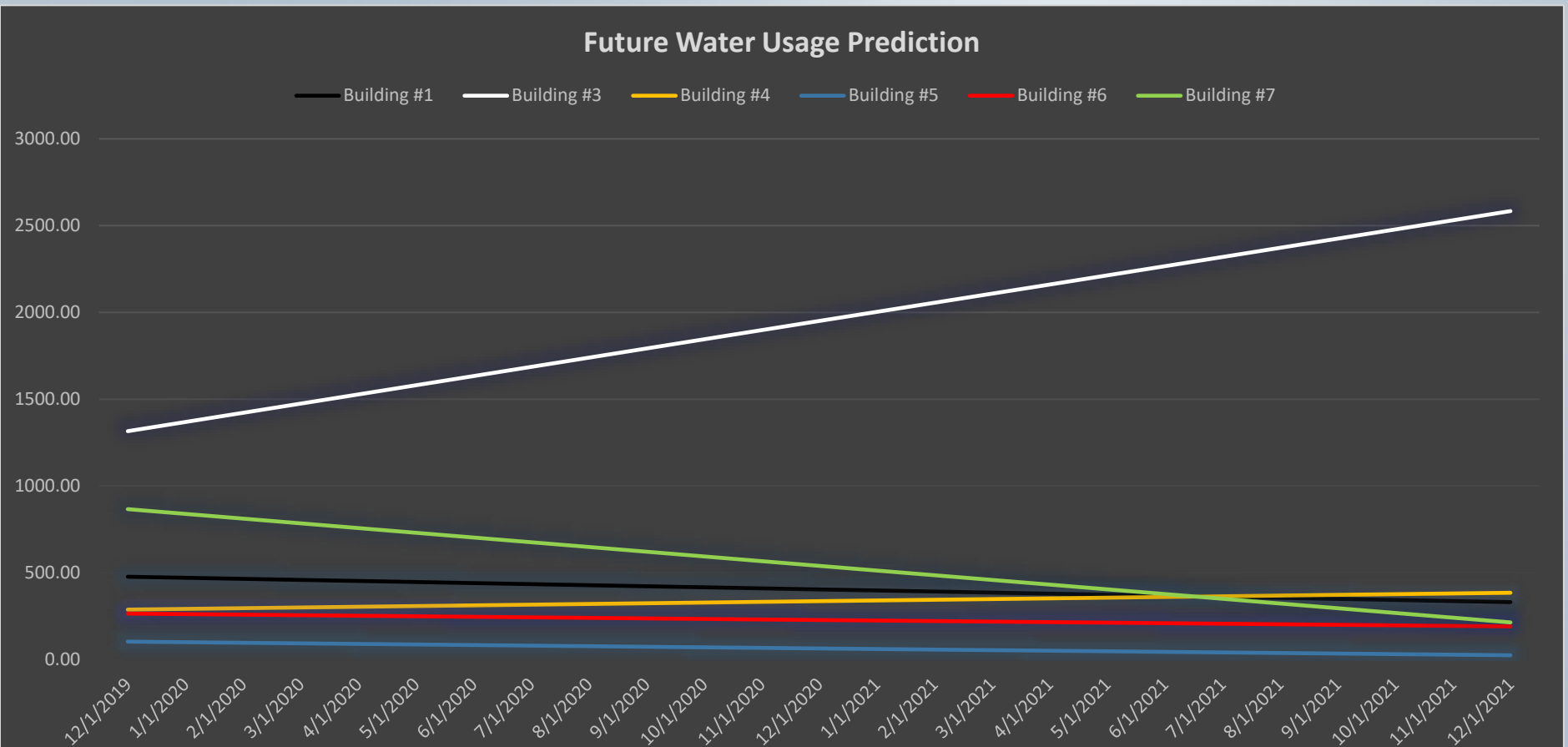
11/6/2018 @0:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #7	1245.96	1014.00	686.31	58679	-1190	97420	5785

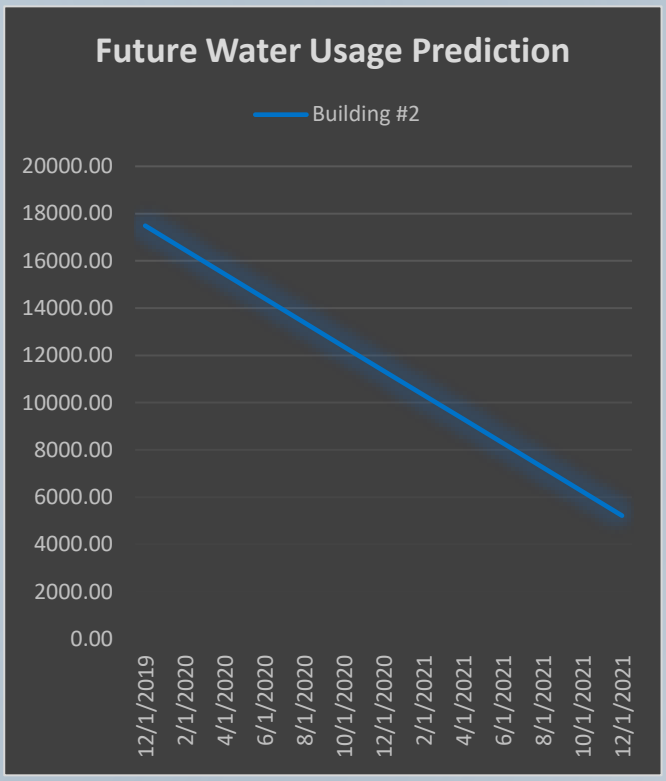


11/6/2018 @0:00	mean	median	std-dev	count	min	max	max w/o outliers
Building #7	1245.96	1014.00	686.31	58679	-1190	97420	5785

Future Water Usage

Future Date	Building #1	Building #2	Building #3	Building #4	Building #5	Building #6	Building #7
12/1/2019	476.60	17487.80	1315.18	287.80	102.58	264.48	866.50
4/1/2020	452.08	15440.15	1526.98	303.78	89.48	252.17	757.62
8/1/2020	427.56	13392.50	1738.79	319.76	76.37	239.86	648.73
12/1/2020	403.03	11344.86	1950.59	335.75	63.27	227.55	539.85
4/1/2021	378.71	9313.99	2160.66	351.60	50.28	215.34	431.85
8/1/2021	354.19	7266.34	2372.46	367.58	37.17	203.03	322.97
12/1/2021	329.67	5218.70	2584.27	383.56	24.07	190.72	214.08





Observations

- Overall, most of the buildings seem to have lower variability and spikes over time. Indicating better efficiency and utilization
- A seasonal effect does seem to be in play, with most buildings have winter highs and summer lows
    - If we use the logic of it requires more energy to heat water in winter, this makes sense
- 5/7 of the buildings seem to have an immediate trend downward (3 + 4 → up)

Additional Analysis

- Gather information regarding building #2's unit of measurement and convert to kBTU
- Upload .csv to a database and use SQL + python to further drill down or visualize
- See if additional metrics such as building occupation, weather stats, day of week, or building characteristics can be included or are desired
- Benchmarking against other university or similar facilities

Synopsis

THANK YOU

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Appendix

Table 1

	mean	median	std-dev	count	min	max	max w/o outliers	Outliers	Outlier Date	start	Beg Cell	End Cell	
Building #1	555.24	511.99	194.26	49801	-436	3351	1530	B78202, B70784	11/4/2018 2:00	2/28/2018 @ 6:00	B54315	B104115	$A$54315:$B$104115
Building #2	25444.72	22575.00	19204.25	67818	-19	163479	n/a	n/a	n/a	8/24/2017 13:45	C36298	C104115	$A$36298:$A$104115, $C$36298:$C$104115
Building #3	674.73	652.06	445.61	47583	-334	4380	n/a	D66229	7/2/2018 8:45	3/23/2018 8:30	D56533	D104115	in!$A$56533:$A$104115,in!$D$56533:$D$104115
Building #4	218.50	188.00	190.51	76665	-1204	2058	n/a	E62391	5/23/2018 9:15	5/24/2017 10:00	E27451	E104115	in!$A$27451:$A$104115,in!$E$27451:$E$104115
Building #5	155.41	100.00	172.65	67417	0	15063	1129	F88511	2/19/2019 11:15	8/28/2017 18:00	F36699	F104115	in!$A$36699:$A$104115,in!$F$36699:$F$104115
Building #6	331.66	276.57	243.88	104109	-195	17868	3526	G38347	9/14/2017 22:15	8/11/2016 @ 13:00	G6	G104115	in!$A$6:$A$104115,in!$G$6:$G$104115
Building #7	1245.96	1014.00	686.31	58679	-1190	97420	5785	H78386	11/6/2018 0:00	11/27/2017 18:30	H45437	H104115	in!$A$45437:$A$104115,in!$H$45437:$H$104115

Table 2

regression equation	y = -0.201x + 9280.4	y = -16.784x +752627	y= 1.7361x - 74726	y = 0.131x - 5450	y = -0.1074x + 4806.7	y = -0.1009x + 4683.9	y = -0.8925x + 39958
Future Date	Building #1	Building #2	Building #3	Building #4	Building #5	Building #6	Building #7
12/1/2019	476.60	17487.80	1315.18	287.80	102.58	264.48	866.50
4/1/2020	452.08	15440.15	1526.98	303.78	89.48	252.17	757.62
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