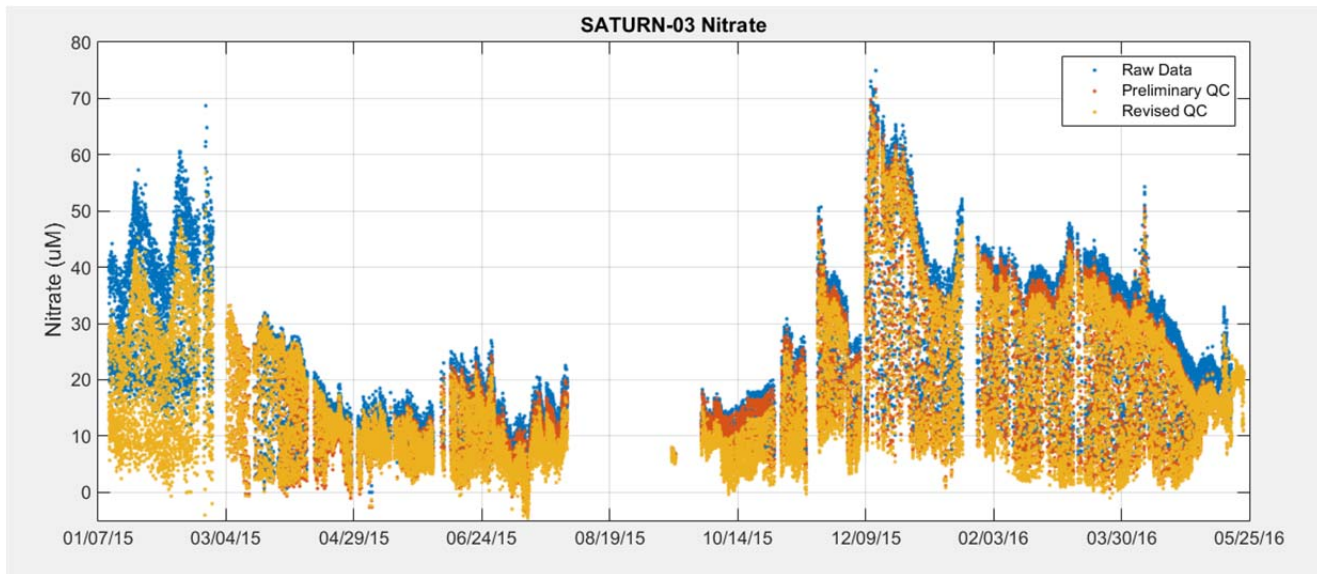
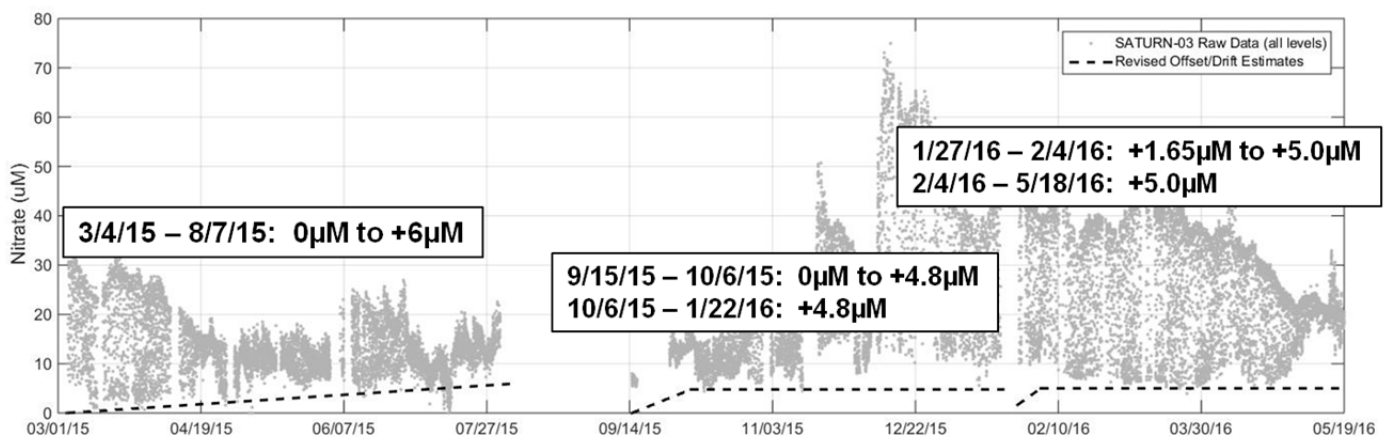


Quality Control of SATURN-03 Optical Nitrate Data March 2015 – May 2016

Data from samples collected between June 2015 and March 2016 have been used to update preliminary estimates of sensor drift/offset. This revision resulted in larger estimates of offset through most of this period.



The figure below shows the final offset estimates used to correct the data between March 2015 and May 2016. There were three sensor deployments during this period, as indicated in the figure. Each of these deployments, the data used to evaluate sensor performance, and the final vs. preliminary estimates of offset are reviewed in the sections on the following pages. A table of data used in the analyses of sensor performance is given at the end of this document



3/4/15 - 8/8/15:

- The addition of data from 6 samples collected toward the end of this deployment suggests that the sensor continued drift rather than maintain a stable offset.
- A linear fit of all sample and DI data was used. This fit intersects 0 offset at beginning of deployment and an offset of approximately $6\mu\text{M}$ at the end of deployment.

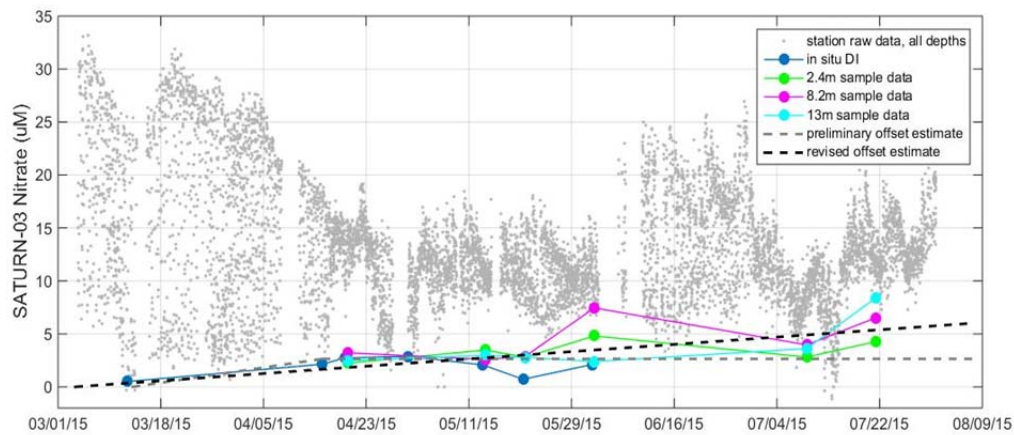


Figure1. The estimates of sensor offset are plotted with the station data from SATURN-03. On-station DI water readings are shown in dark blue. The offsets based on sample data are shown in green (2.4m), magenta (8.2m) and cyan (13m). These offset values are calculated as the measured sample concentration subtracted from the concurrent station sensor reading. The nutrient sample data should be considered preliminary (see table 1 below). The final estimate of sensor drift was based on the linear fit of all available data and is shown as the black dashed line.

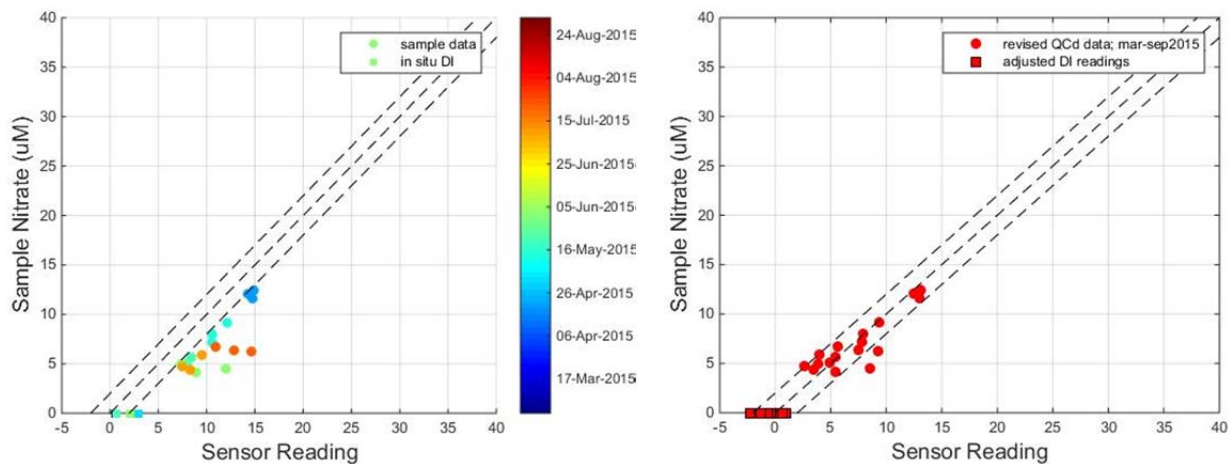


Figure 2. Station Sensor output (μM) vs Sample Nitrate Concentration (μM) for March – August 2015 sensor deployment. Raw station data are plotted in the left (colored by time) while the corrected station data are plotted in the right panel. The data were corrected using the revised offset estimates shown in figure 1. Following correction most sensor readings are within $\pm 2\mu\text{M}$ of the sample readings (the dashed lines).

9/15/15 - 1/22/16:

Samples from 4 time-points as well as data from a DI reading in October were added to the data used for the preliminary analysis. Taken together these data suggest a more rapid onset of drift.

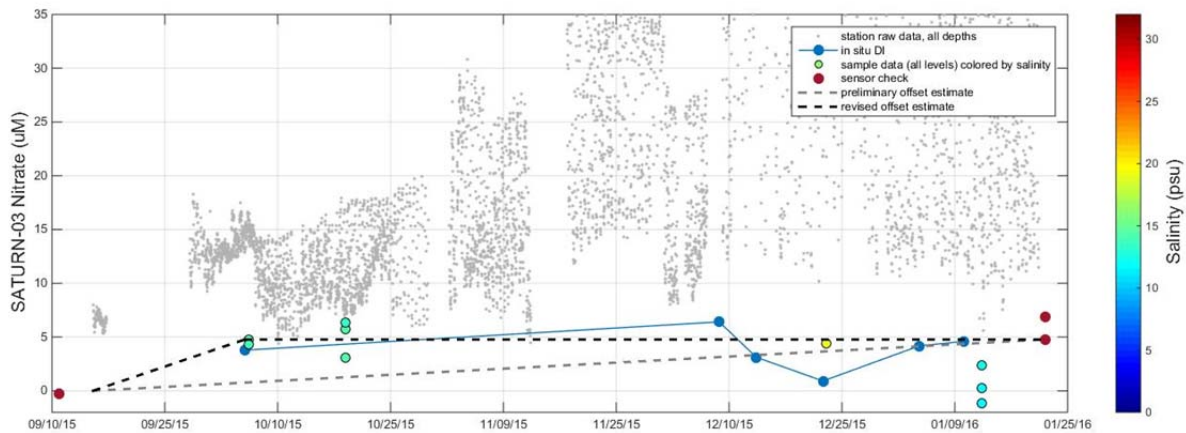


Figure 3. The estimates of sensor offset are plotted with the station data from SATURN-03. On-station DI water readings are shown in dark blue. The offsets based on sample data are colored by sample salinity. These offset values are calculated as the measured sample concentration subtracted from the concurrent station sensor reading. The nutrient sample data should be considered preliminary (see table 1 below). Pre & post deployment sensor checks in DI and a nitrate standard are shown in dark red. The final estimate of sensor drift was based on all available data and is shown as the black dashed line.

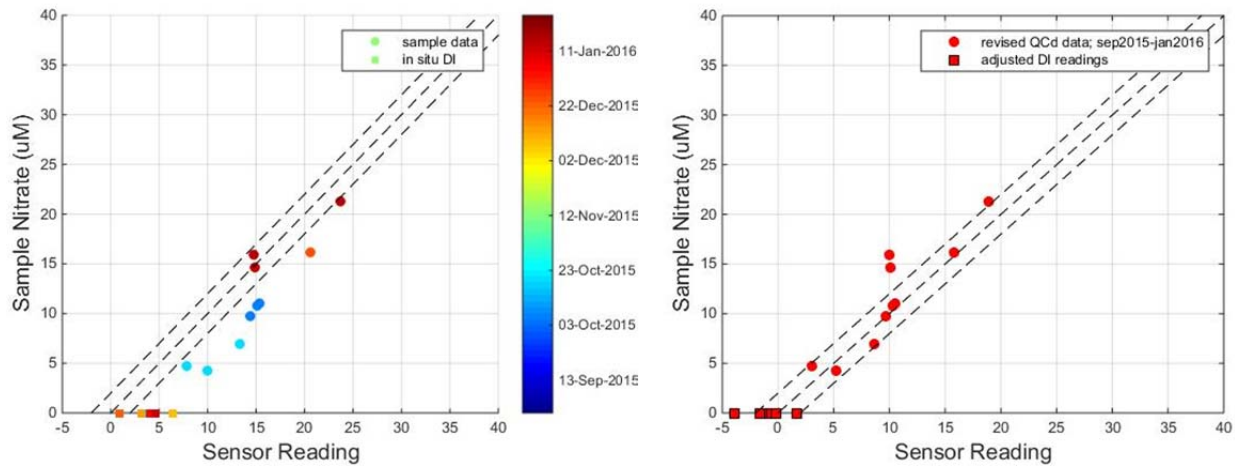


Figure 4. Station Sensor output (μM) vs Sample Nitrate Concentration (μM) for the September 2015 – January 2016 sensor deployment. Raw station data are plotted in the left (colored by time) while the corrected station data are plotted in the right panel. The data were corrected using the revised offset estimates shown in figure 3. Following correction most sensor readings are within $\pm 2\mu\text{M}$ of the sample readings (the dashed lines).

1/27/16 - 5/18/16:

- Samples from 4 time-points as well as data from a DI reading in October were added to the data used for the preliminary analysis. Together these data suggest a more rapid onset of drift.
- A linear fit of all data yield a stable offset of $\sim 5\mu\text{M}$ between 2/4/16 and 5/18/16. This offset correction should be considered approximate and data have been flagged as QL3.

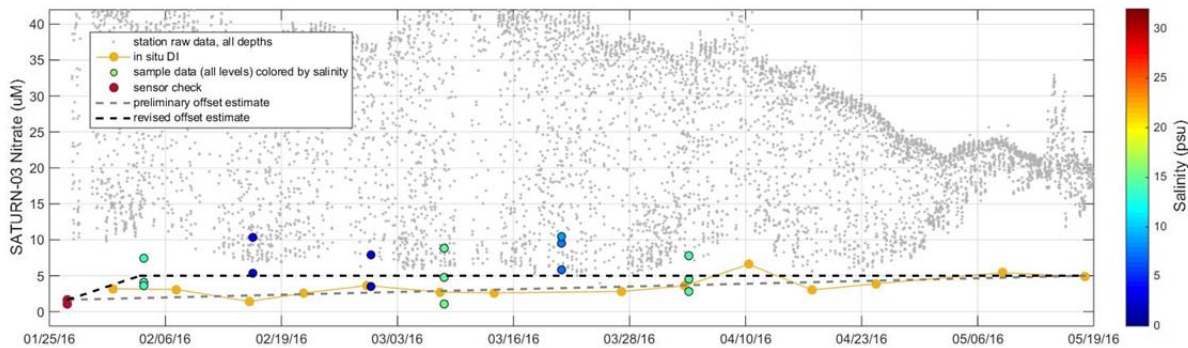


Figure 3. The estimates of sensor offset are plotted with the station data from SATURN-03. On-station DI water readings are shown in yellow. The offsets based on sample data are colored by sample salinity. These offset values are calculated as the measured sample concentration subtracted from the concurrent station sensor reading. The nutrient sample data should be considered preliminary (see table 1 below). Pre deployment sensor checks in DI and a nitrate standard are shown in dark red. The final estimate of sensor drift was based on all available data and is shown as the black dashed line.

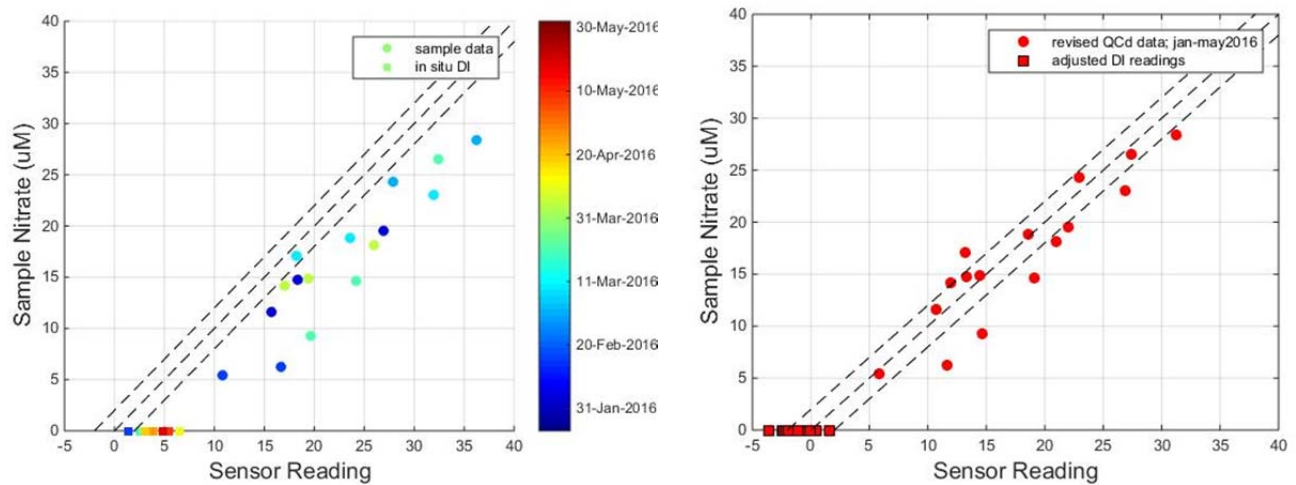


Figure 4. Station Sensor output (μM) vs Sample Nitrate Concentration (μM) for the January -May 2016 sensor deployment. Raw station data are plotted in the left (colored by time) while the corrected station data are plotted in the right panel. The data were corrected using the revised offset estimates shown in figure 5. Following correction about half of the sensor readings are within $\pm 2\mu\text{M}$ of the sample readings (the dashed lines). For this deployment there was a difference between the offset suggested by DI water and the offset suggested by samples. Because the final offset correction took both data-sets into account, about half of the sensor readings are within $\pm 2\mu\text{M}$ of the sample readings (the dashed lines) following correction.

Table 1. Data used in estimates of SATURN-03 sensor drift/offset during March 2015 through May 2016. Note that the nutrient sample data should be considered preliminary. The nutrient auto-analyzer was calibrated against both fresh-water and salt-water (35psu) standards. Because the majority of samples were in the mid-salinity ranges, the nutrient sample concentration was calculated by interpolating between the values obtained using the fresh and salt calibration curves, using the sample salinity value. Additional work is needed to validate this approach and sample data are therefore considered preliminary. For these deployments the sample data are used in conjunction with the DI and sensor check data.

<u>Station DI Readings</u>		<u>Nutrient Sample Data</u>					<u>Pre & Post Deployment Sensor Checks</u>				
Date	station Nitrate (μM)	Date	Salinity (psu)	Station Nitrate (μM)	Sample Nitrate (μM)	Offset (μM)	Date	Station Nitrate (μM)	Nitrate Standard (μM)	Offset (μM)	
3/13/15	0.5	4/20/15 10:04	2.89	14.80	11.59	3.21	9/11/15	-0.3	0	-0.3	pre-
4/16/15	2.14	4/20/15 10:09	3.00	14.90	12.41	2.49	1/22/16	4.77	0	4.77	post-
4/20/15	2.73	4/20/15 10:14	2.30	14.30	12.06	2.24	1/22/16	26.86	20	6.86	post-
5/1/15	2.88	5/14/15 10:18	27.56	10.60	8.00	2.60	1/27/16	1.65	0	1.65	pre-
5/14/15	2.07	5/14/15 10:24	16.80	10.60	7.12	3.48	1/27/16	21.02	20	1.02	pre-
5/21/15	0.72	5/14/15 10:27	28.70	12.10	9.11	2.99					
6/2/15	2.11	5/21/15 8:55	3.70	8.40	5.62	2.78					
10/6/15	3.78	5/21/15 8:59	3.60	7.90	5.10	2.80					
12/9/15	6.41	5/21/15 9:04	3.77	7.90	5.02	2.88					
12/14/15	3.12	6/2/15 9:31	3.50	8.90	4.09	4.81					
12/23/15	0.91	6/2/15 9:35	5.66	12.00	4.55	7.45					
1/5/16	4.18	6/2/15 9:39	7.00	7.30	4.90	2.40					
1/11/16	4.6	7/9/15 9:33	8.21	9.47	5.86	3.61					
2/1/16	3.19	7/9/15 9:39	7.44	7.48	4.67	2.81					
2/8/16	3.09	7/9/15 9:44	8.14	8.35	4.39	3.96					
2/16/16	1.42	7/21/15 10:02	4.33	14.65	6.26	8.39					
2/22/16	2.58	7/21/15 10:07	4.37	12.88	6.36	6.51					
2/29/16	3.64	7/21/15 10:11	4.50	10.96	6.69	4.27					
3/8/16	2.72	10/6/15 13:59	14.14	14.43	9.68	4.75					
3/14/16	2.61	10/6/15 14:01	14.09	15.11	10.81	4.30					
3/28/16	2.81	10/6/15 14:04	13.95	15.31	11.03	4.28					
4/4/16	3.6	10/19/15 12:53	14.11	9.97	4.25	5.72					
4/11/16	6.57	10/19/15 12:54	14.10	7.77	4.67	3.11					
4/18/16	3.02	10/19/15 12:56	13.16	13.36	6.98	6.38					
4/25/16	3.88	12/23/15 11:18	19.04	20.59	16.21	4.38					
5/9/16	5.42	1/13/16 11:34	11.79	14.87	14.60	0.28					
5/18/16	4.88	1/13/16 11:37	11.65	14.76	15.96	-1.20					
		1/13/16 11:38	12.22	23.67	21.33	2.34					
		2/4/16 10:01	13.61	15.67	11.58	4.09					
		2/4/16 10:08	13.92	18.34	14.70	3.64					
		2/4/16 10:09	13.92	26.97	19.51	7.45					
		2/16/16 10:33	3.71	16.61	6.29	10.32					
		2/16/16 10:38	3.71	10.79	5.43	5.36					
		2/29/16 10:07	2.59	27.93	24.37	3.56					
		2/29/16 10:09	2.64	36.23	28.36	7.88					
		3/8/16 10:29	14.87	31.90	23.06	8.84					
		3/8/16 10:31	14.87	23.62	18.86	4.76					
		3/8/16 10:33	15.24	18.18	17.12	1.07					
		3/21/16 9:46	7.47	32.38	26.59	5.79					
		3/21/16 9:48	7.92	24.14	14.61	9.53					
		3/21/16 9:52	8.61	19.70	9.30	10.40					
		4/4/16 9:29	14.24	25.93	18.12	7.81					
		4/4/16 9:31	14.24	19.44	14.87	4.57					
		4/4/16 9:33	14.20	16.96	14.20	2.77					