



Continuous UV Nitrate Monitoring In Central Florida

Challenges and Opportunities



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Why Monitor Nitrate?

Overstimulation in growth of nonnative aquatic plants and algae.

Why Monitor Nitrate?

Decline in native submersed grasses and
vegetation.

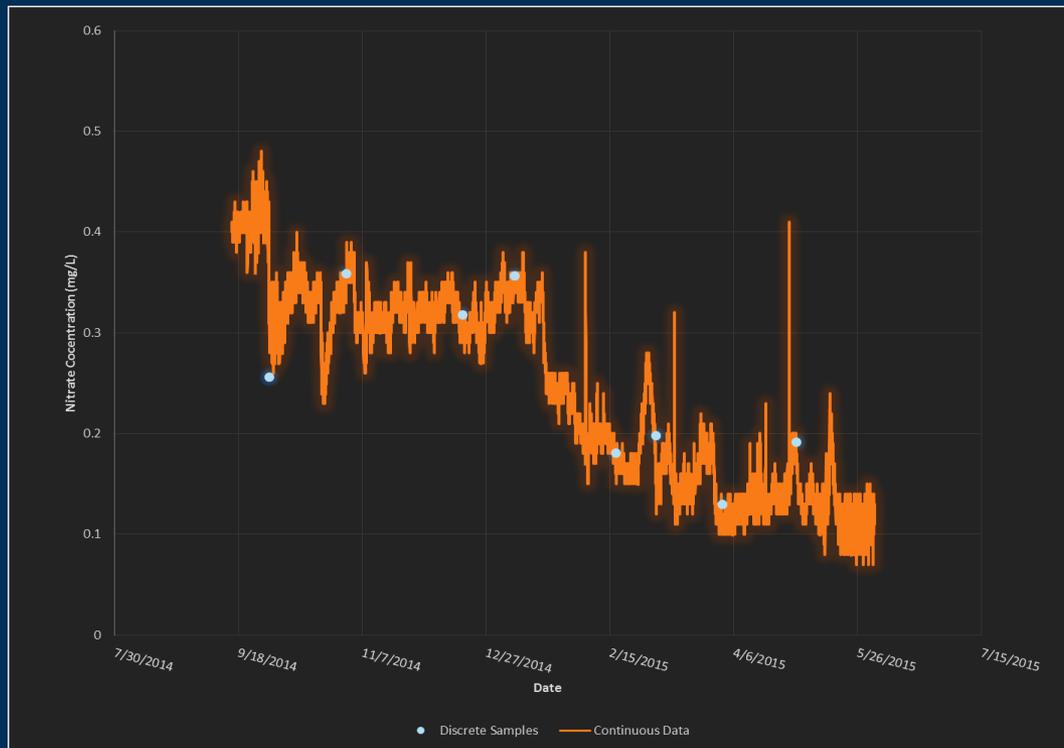


Why Monitor Nitrate?

Depletion of aquatic animals.

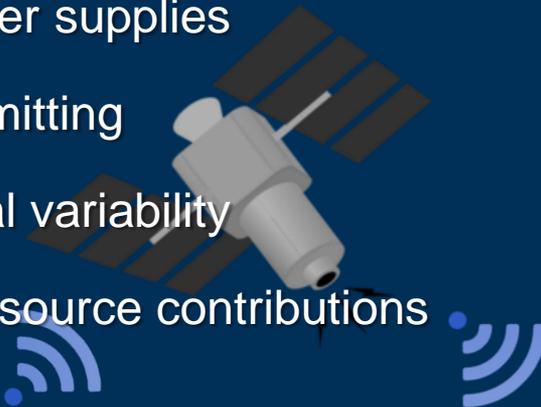
Why Continuous Monitoring?

- Discrete samples typically taken weekly or monthly.
- Continuous monitoring allows us to capture all events.



Why Continuous Monitoring?

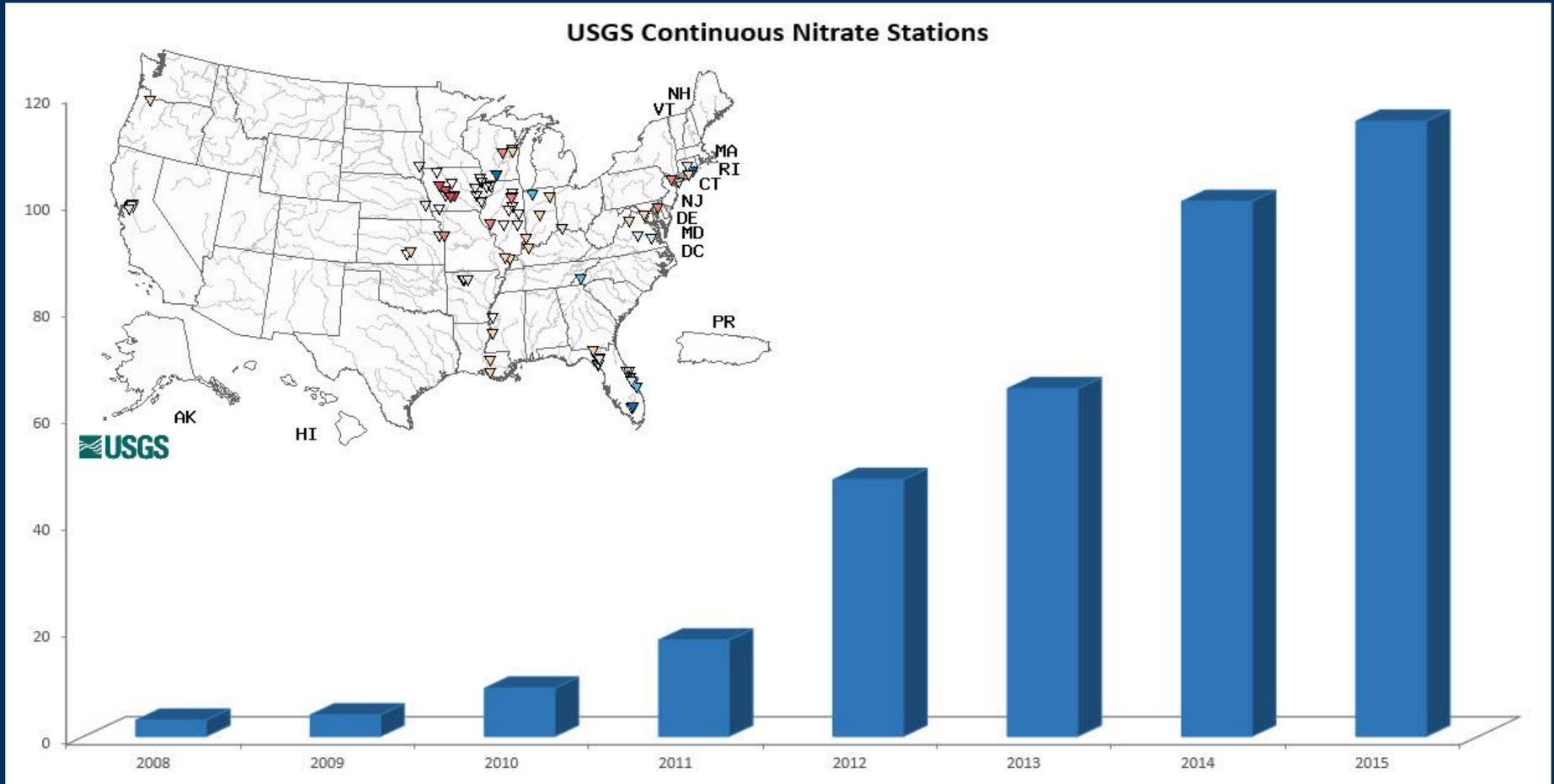
- Continuous data allows for transmission in real time!
 - Management of water supplies
 - Regulation and permitting
 - Spatial and temporal variability
 - Assist in identifying source contributions



Real-time data at <http://waterwatch.usgs.gov/wqwatch/>

USGS Continuous Nitrate Monitoring

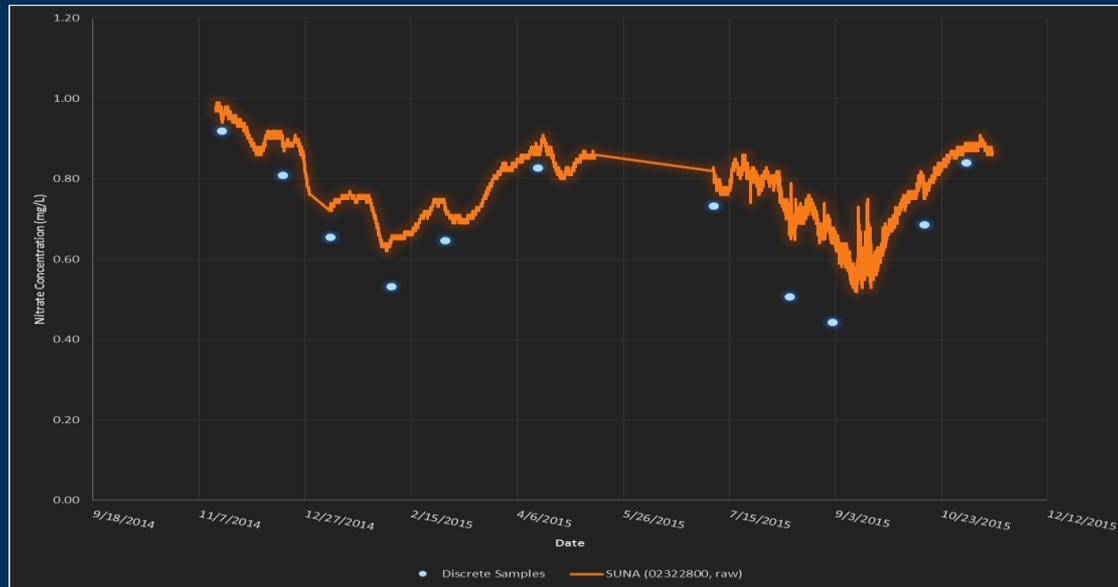
- Program seeing significant growth
- 100+ sites nationwide (operated in 24 states)



Challenges

➤ Conditional: Interference

- Colored dissolved organic matter (CDOM) and/or other constituents absorbing or scattering light.
 - Can cause data to be biased high vs. discrete samples.
 - Additional absorption from CDOM is proportional to calculated concentration.

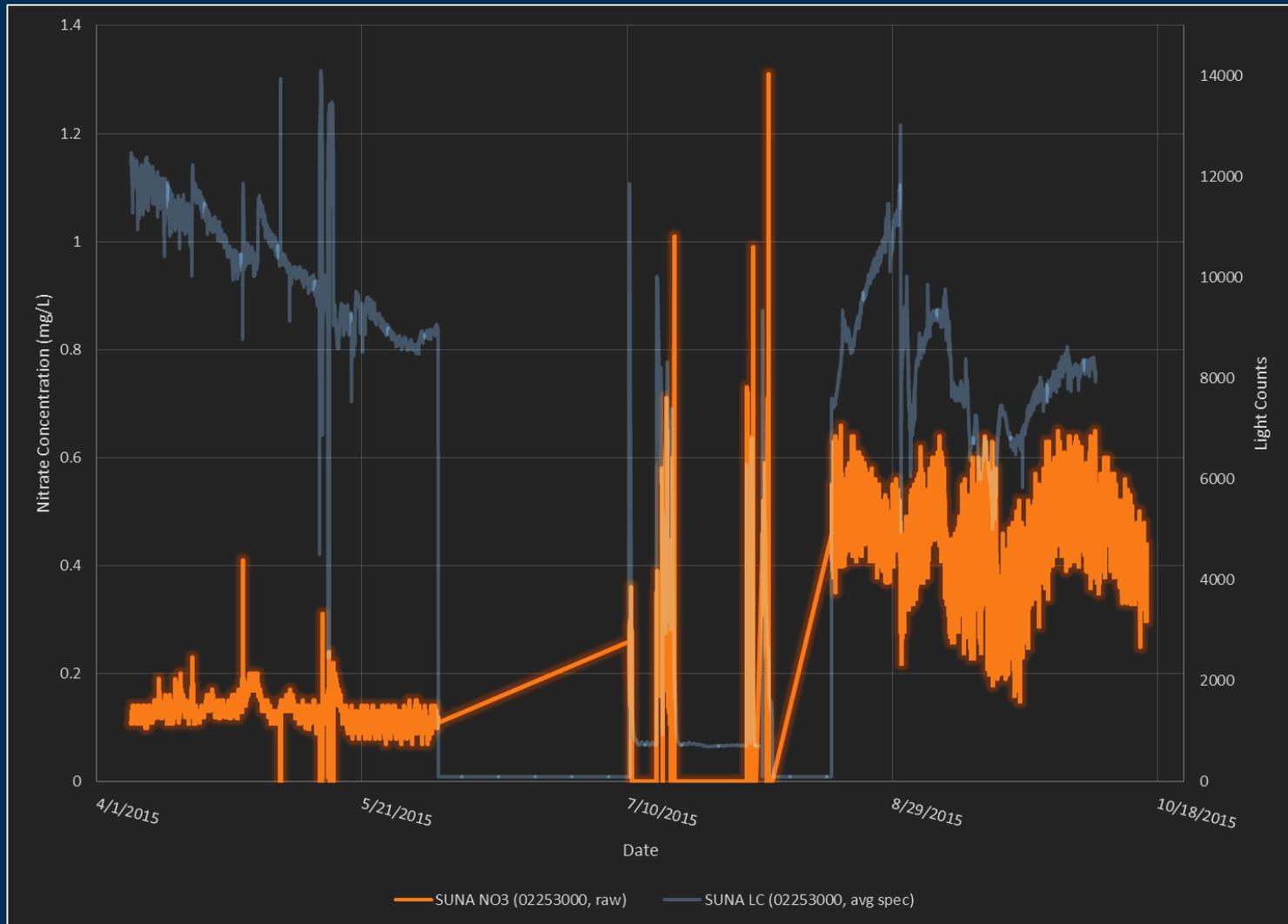


Challenges

➤ Conditional: Interference

- Colored dissolved organic matter (CDOM) and/or other constituents absorbing or scattering light.
 - Reduced transmittance of light.
 - Wavelength channels excluded at high absorption levels.
 - Less points for curve-fit model to compute concentration.
 - Increased noise in data.

Interference: Example

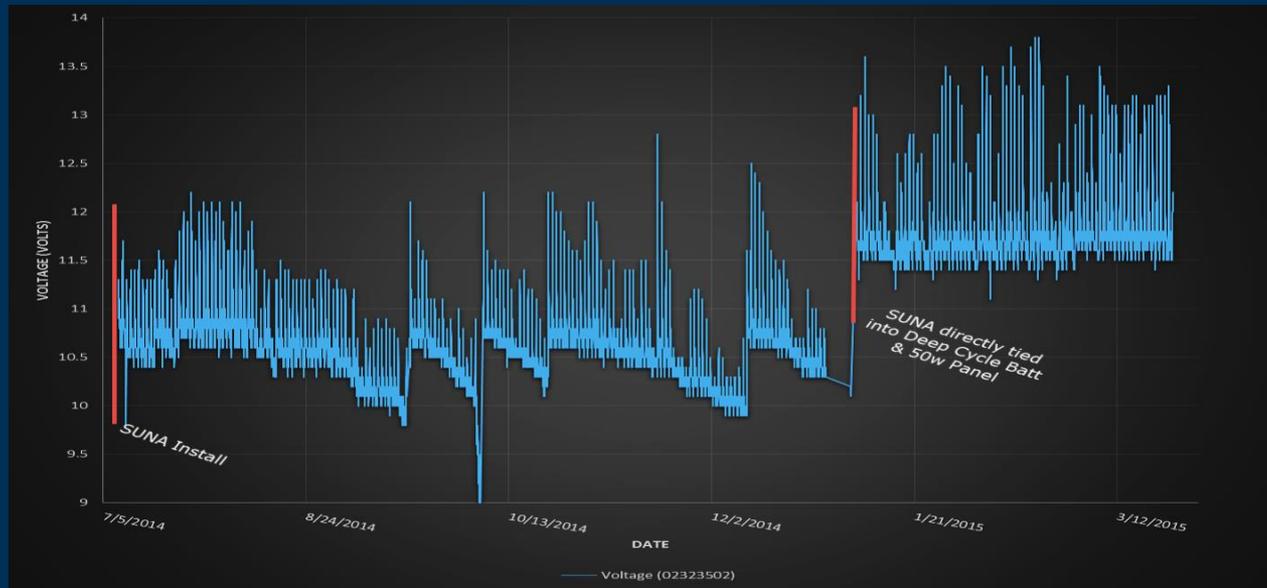


Challenges

➤ Physical

■ Power

- Reliable results when directly tying in SUNA's power with large deep cycle battery and 50w solar panel.
- Inadequate voltages can occur from SDI12 power only.

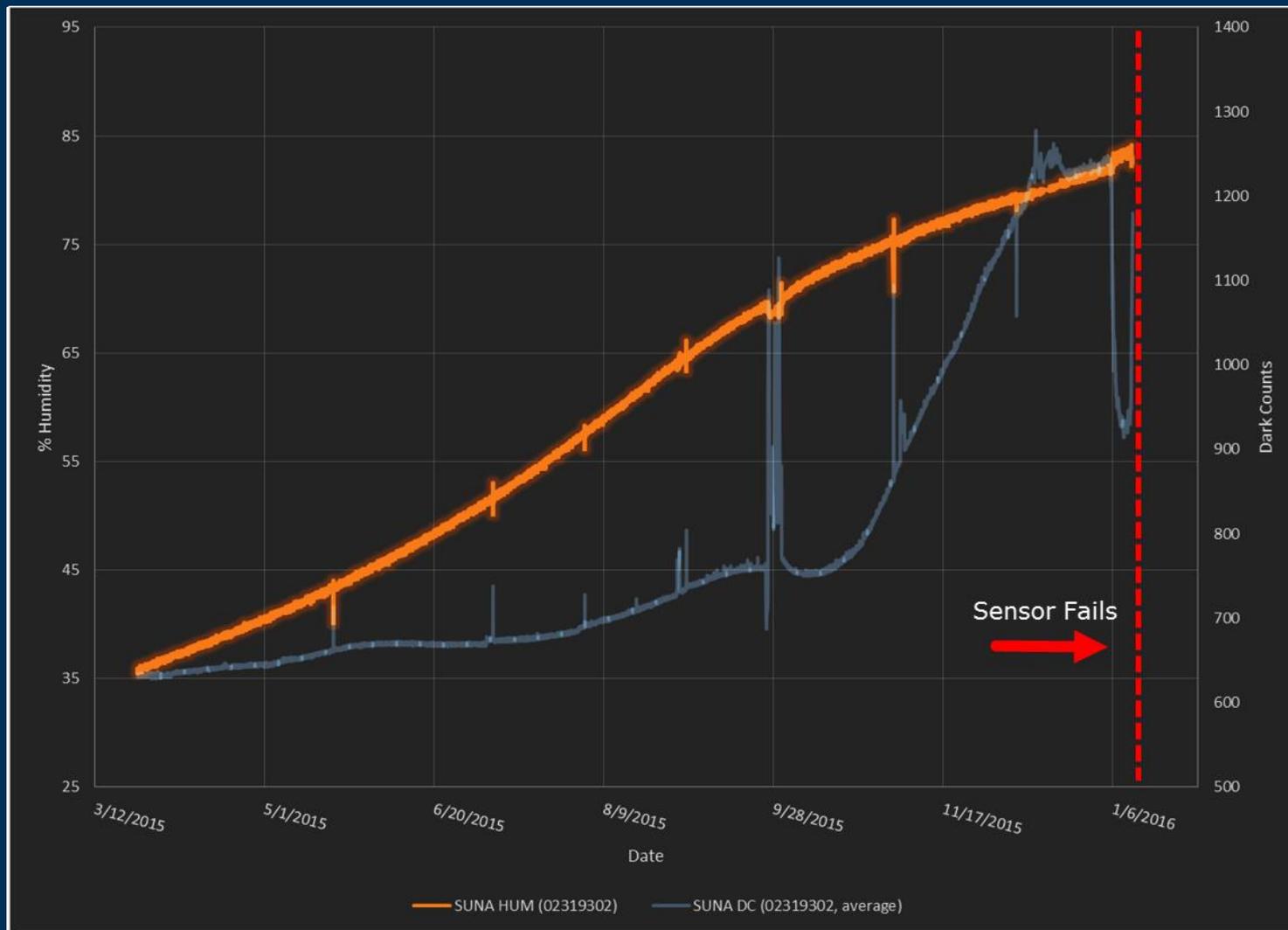


Challenges

➤ Physical

- Malfunction/Damage
 - High rate of humidity ingress.
 - Leads to increased instrument noise and premature failure.
 - Manufacturer has addressed issue over time.
 - Most recent fix in March 2016.
 - Backwards compatible titanium housing.

Malfunction: Example



QA/QC

➤ Reference Spectrum Update

- Accounts for degradation of light source.
- Perform regularly to minimize drift.
- Adjusts baseline for expected light intensity under null conditions.

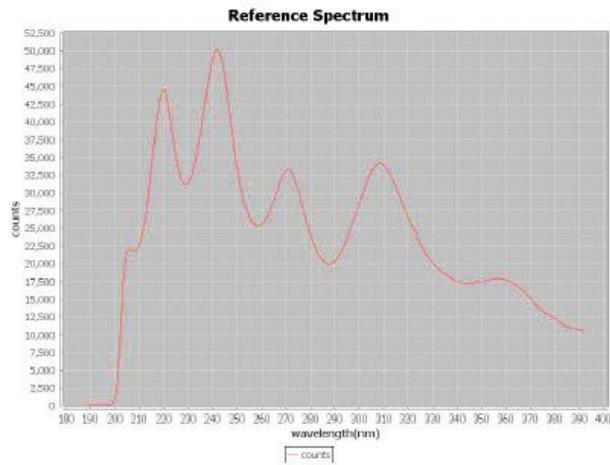
QA/QC

➤ Reference Spectrum Update: Expected Results

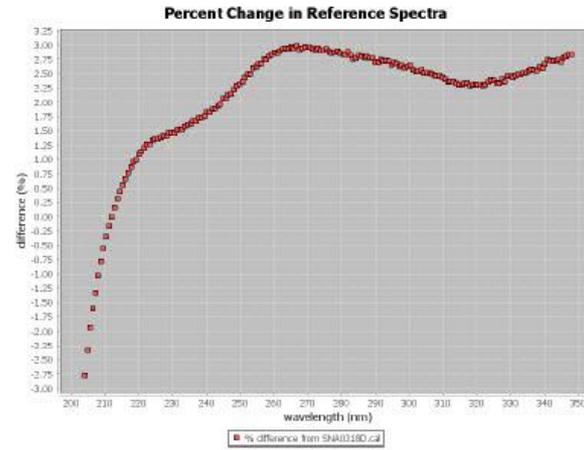
- Spectral differences plot should be smooth.
- Low percentages of shift.
 - 10% change acceptable given 3-4 months of lamp use in between.
 - Larger percentages can be observed below 215nm.
 - Usually indicates no issues.

Expected Results: Example

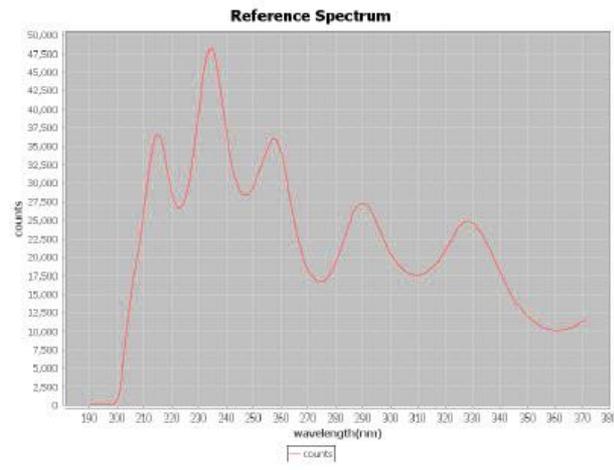
Reference Spectrum



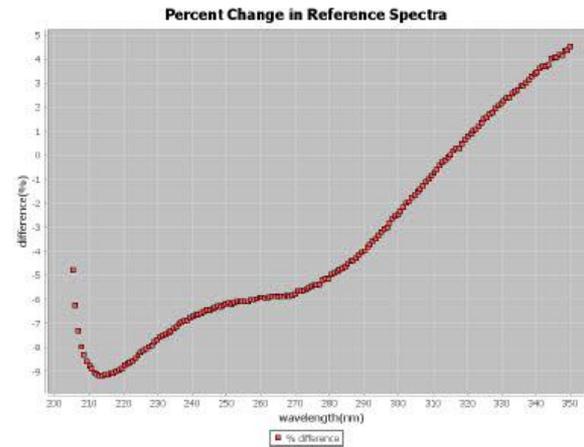
Spectra Comparison



Reference Spectrum Graph:



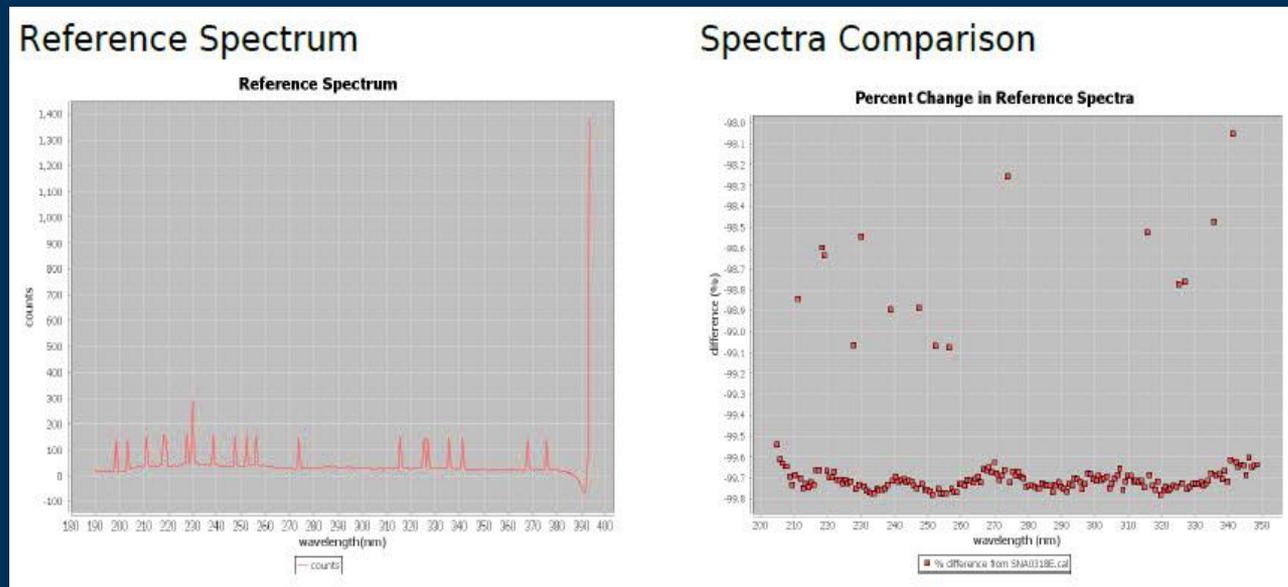
Spectra Comparison Graph:



QA/QC

➤ Reference Spectrum Update: Abnormal Results

- Spectral differences show scatter.
 - Frequently coincide with malfunction of the spectrometer.
 - Reference spectrum plot will show abnormalities as malfunction exacerbates.

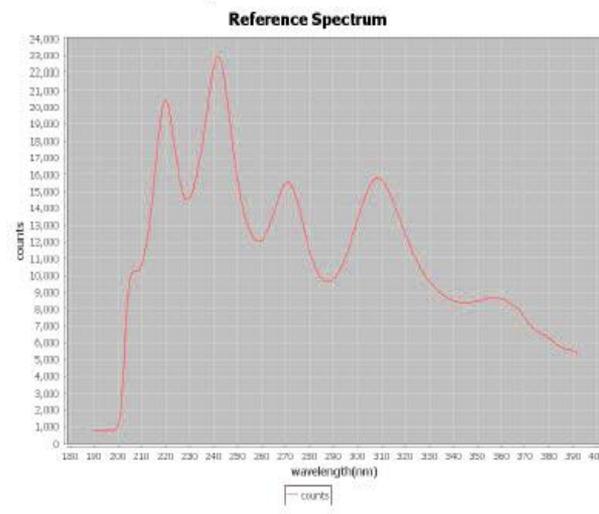


QA/QC

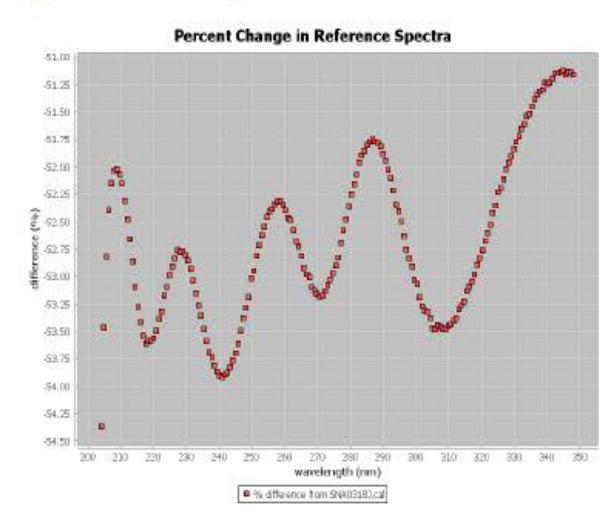
➤ Reference Spectrum Update: Abnormal Results

- Spectral differences show wave pattern.
 - Frequently coincide with scratched or damaged window(s).
 - Can change how light passes through path.
 - Can change how light enters spectrometer.

Reference Spectrum



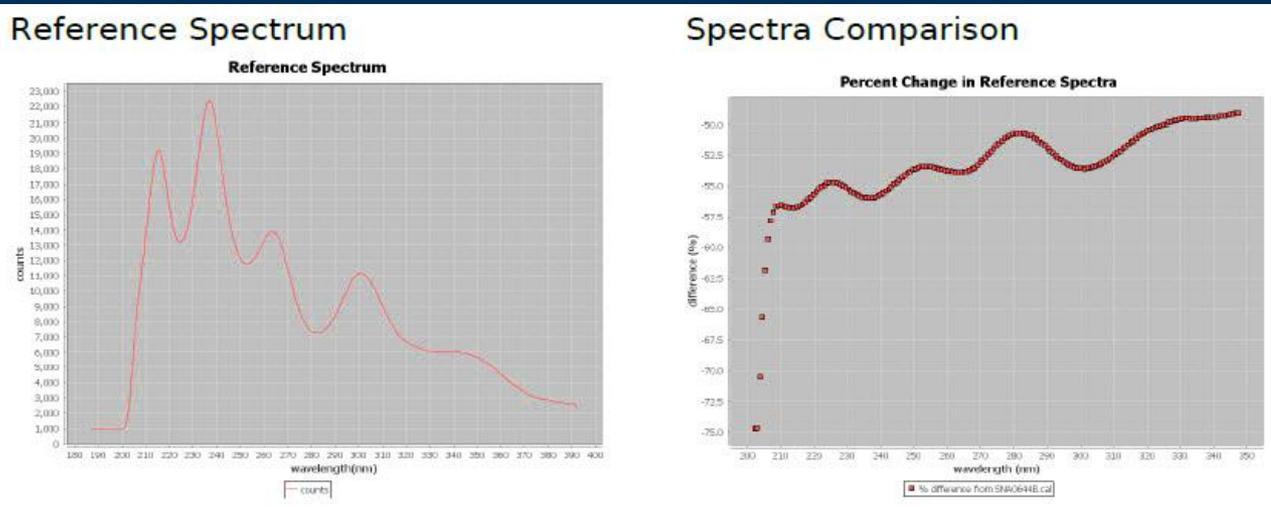
Spectra Comparison



QA/QC

➤ Reference Spectrum Update: Abnormal Results

- Large negative differences throughout spectrum.
 - Was calibration done in similar conditions to deployment?
 - Lamp output proportional to temperature.
 - Calibration at high internal temperatures could cause bias.
 - Check temperature, remove from sun/heat, and retry once cooled.



High Temperature Calibration Bias



Evaluation: Utilizing Ancillary Data

➤ Dark Counts

- Representative of instrument noise.
 - Increase with temperature.
 - Lamp output also affected by temperature.
 - Increase with humidity.
 - Spectrometer malfunction linked to high humidity.
 - Abnormalities typically indicate problems.
 - Excessive fluctuations
 - Rapid increase/decrease, or approach to zero.
 - Wandering spikes

Utilizing Dark Counts: Example

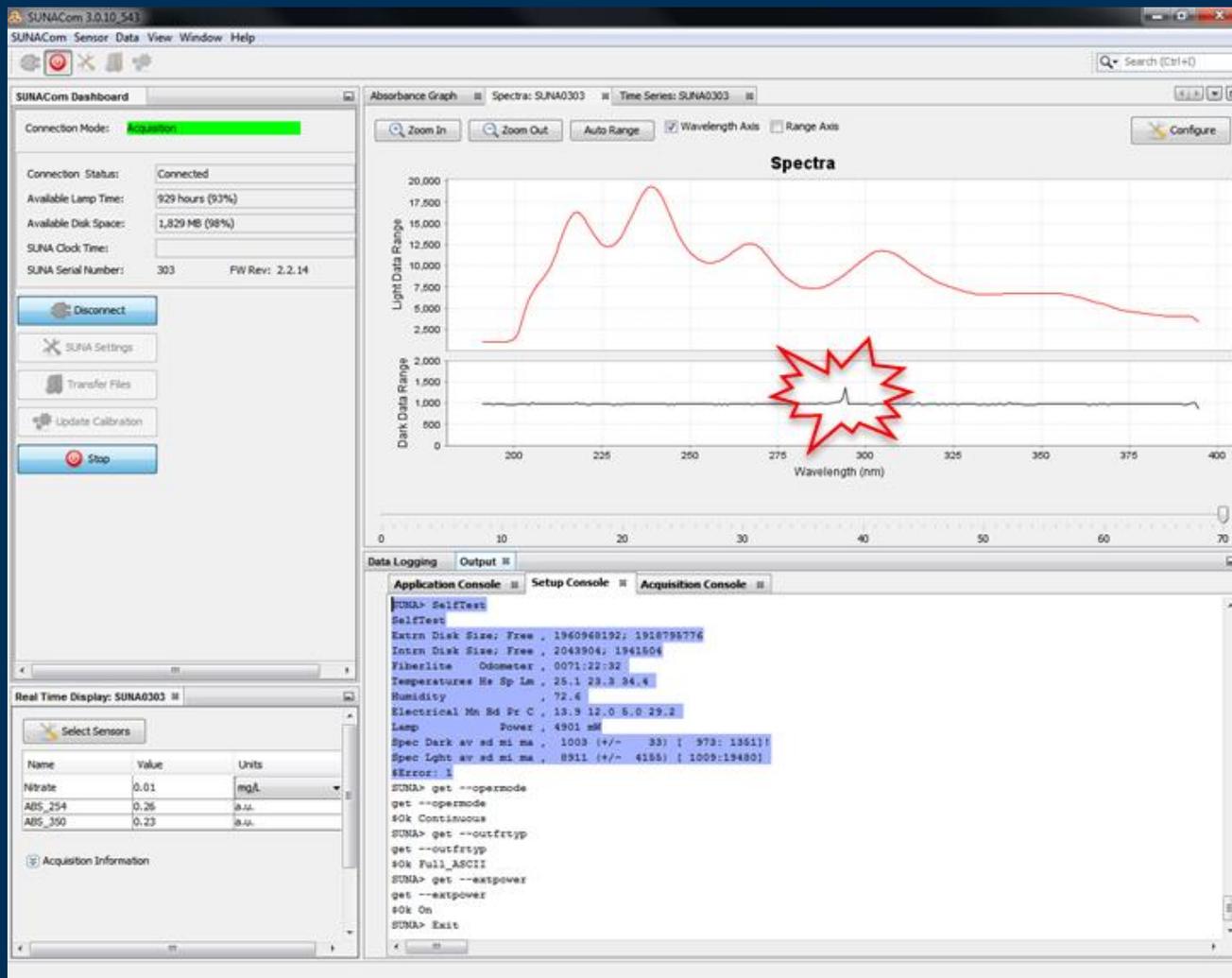


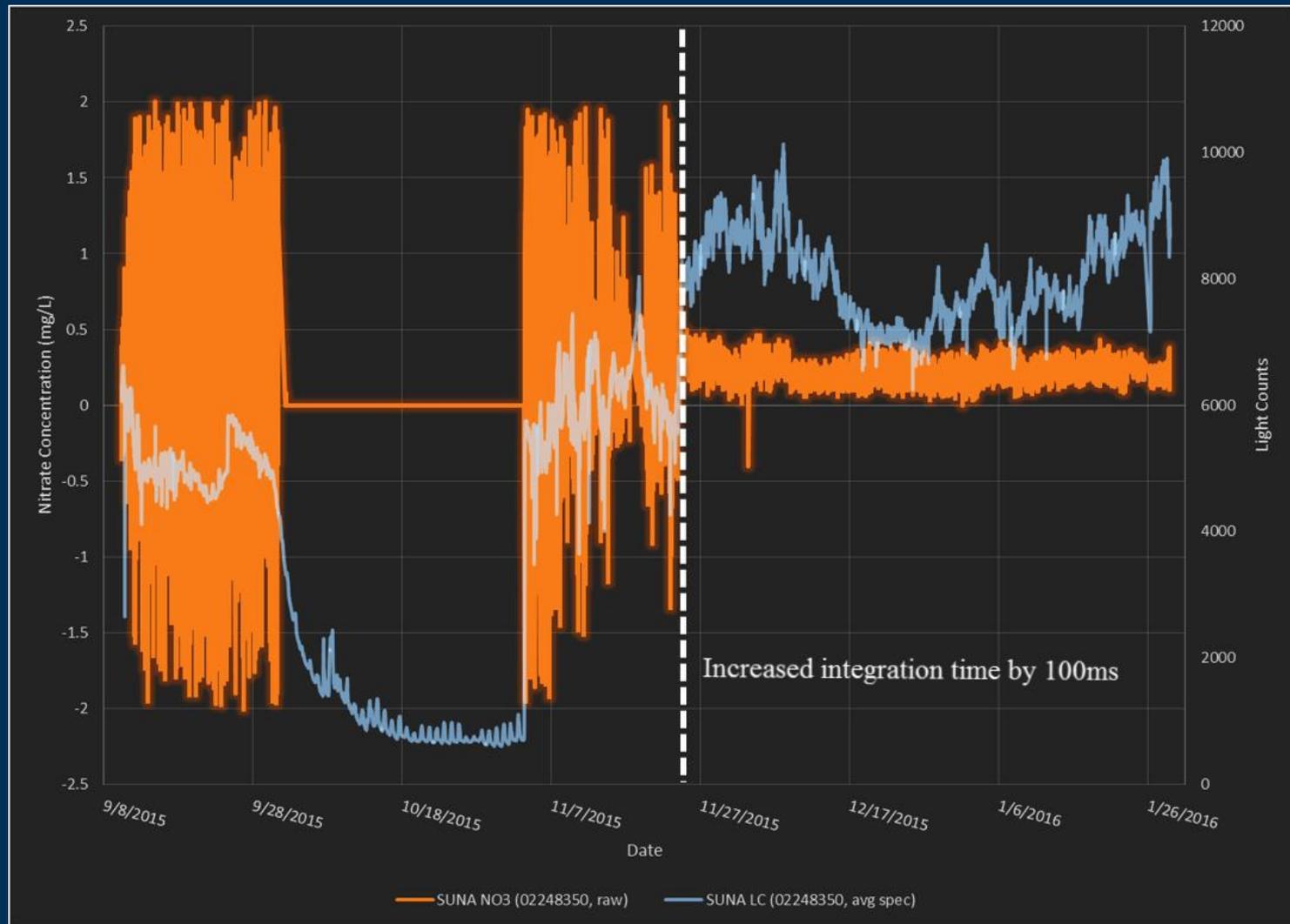
Photo Credit: Pellerin, B.

Evaluation: Utilizing Ancillary Data

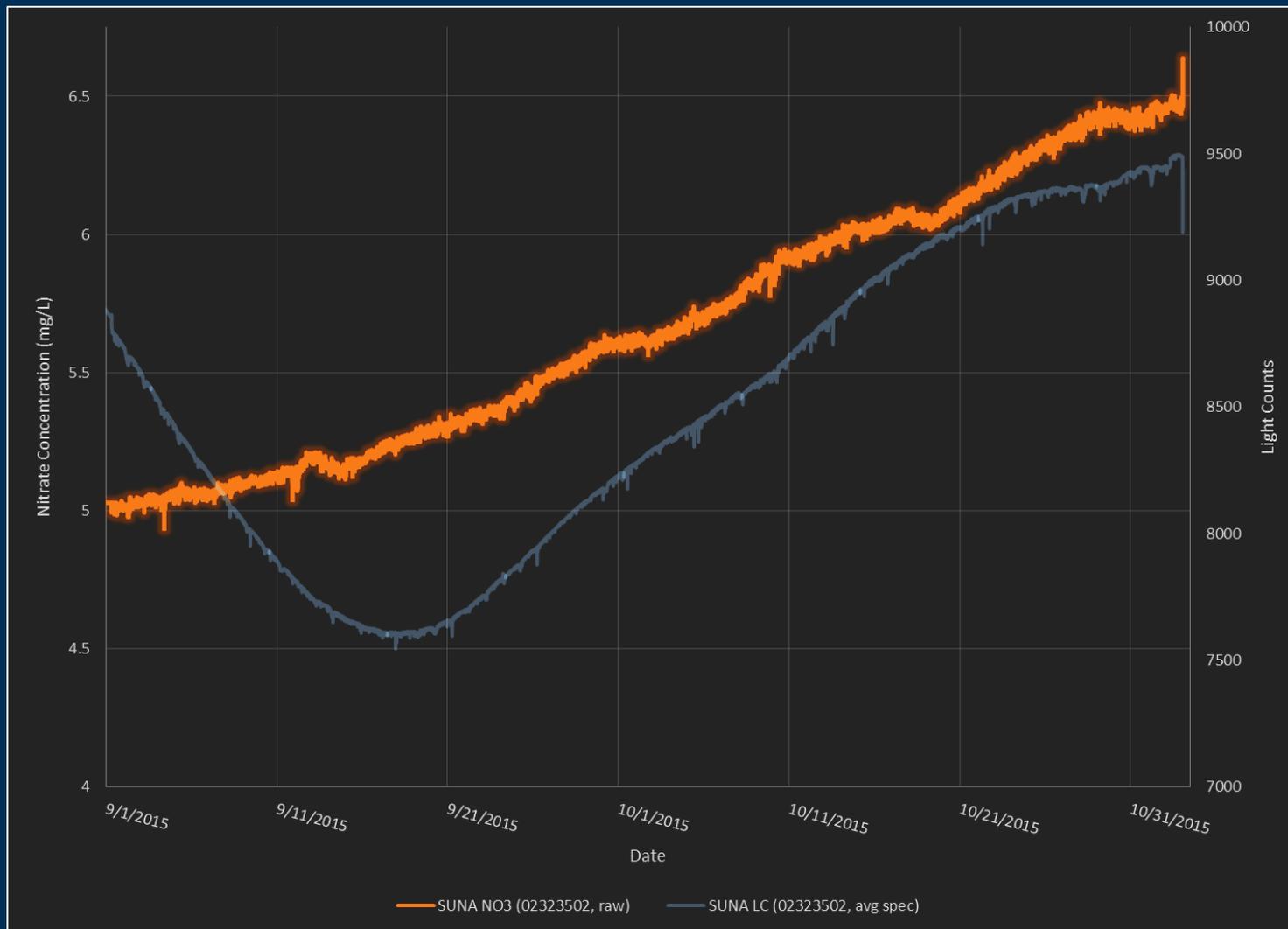
➤ Light Counts

- Representative of transmittance at each wavelength.
- Insufficient light conditions cause increased noise in data.
- Data showing noise >0.03 mg/L (>0.06 , 5mm) due inadequate light signal is considered outside manufacturer expected limits.
 - Applies to stable conditions only.
 - Data may need to be downgraded or excluded from computed record.
 - In the future, manufacturer may halt nitrate values sooner.
 - Increasing integration time has shown positive results.

Utilizing Light Counts: Example



Utilizing Fitting Parameter: Example

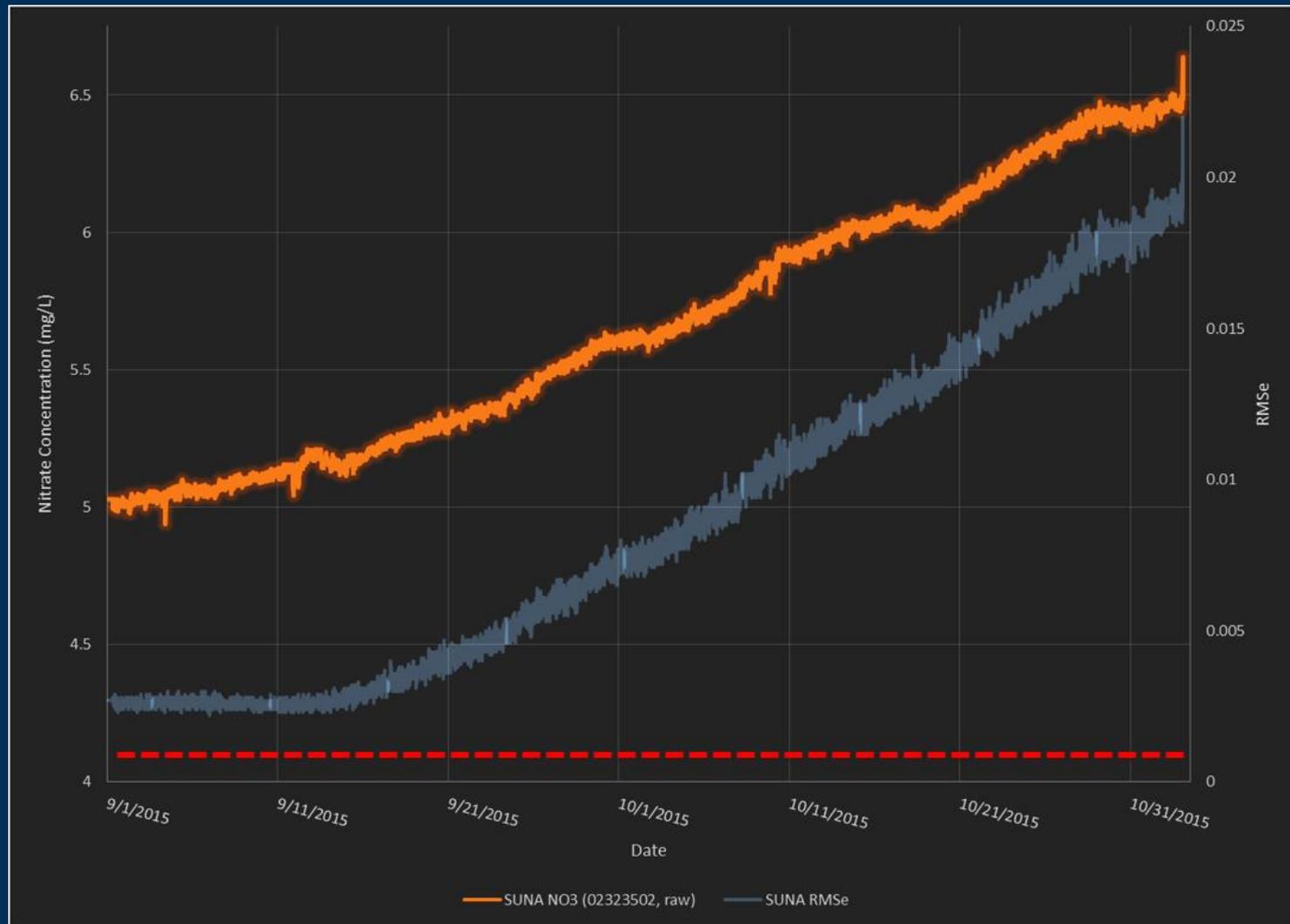


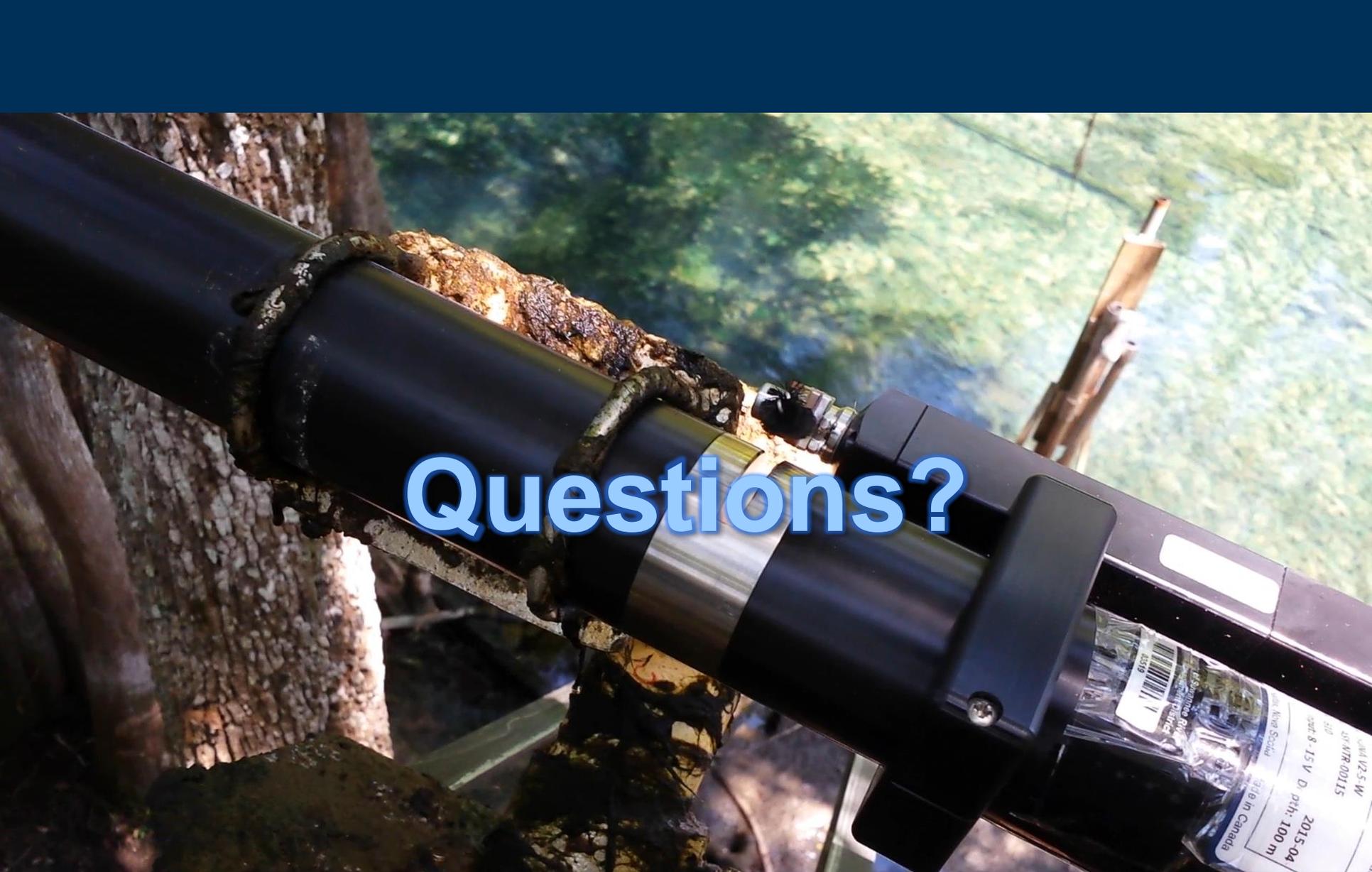
Evaluation: Utilizing Ancillary Data

➤ Fitting Parameter (RMSe)

- Indicator for the quality of the model's fit to the absorption curves.
- Manufacturer: values >0.001 = nitrate estimation affected adversely.
- Data with values >0.005 may need to be considered unsatisfactory for inclusion in computed record.
 - Further data collection and analysis required to better define.

Utilizing Fitting Parameter: Example (Cont.)





Questions?



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