The SOCCOM Data Stream
Processing & Quality Control for BGC-Argo Floats

Tanya Maurer, Josh Plant, Ken Johnson, Lynne Talley

ADMT19
San Diego
Dec 4, 2018
Outline

- SOCCOM program overview & status
- The use of shipboard data in SOCCOM
- SOCCOM float processing flow schematic & timeline
- RT Processing
- “DM” Processing (SAGE GUIs)
  - Oxygen QC with SAGE-O2
  - pH & Nitrate QC with SAGE
- Moving toward global BGC Argo
SOCCOM Overview

- 6-year program, launched Sept, 2014
- Funded by NSF Polar Programs, NASA, NOAA
- 23 senior researchers/co-investigators at 11 institutions
- Goal: 200 BGC-Argo profiling floats with $O_2$, $NO_3^-$, pH, bio-optics
- Goal: better understand Southern Ocean’s role in carbon cycle
- A basin scale BGC-Argo float program to demonstrate the viability of a global system

All data publically available, in real-time at http://soccom.princeton.edu and through the Argo Global Data Assembly Centers.
SOCCOM Status

- 20 cruises (4 in year 4)
- 132 floats (30 deployed in year 4)
- Hydrographic stations at all deployment locations
- 113 floats active (19 non-op)
- 21 floats currently under sea ice

<table>
<thead>
<tr>
<th>Sensor</th>
<th>N good samples 11/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTD</td>
<td>1,155,884</td>
</tr>
<tr>
<td>O₂</td>
<td>1,095,198</td>
</tr>
<tr>
<td>NO₃</td>
<td>500,523</td>
</tr>
<tr>
<td>pH</td>
<td>591,804</td>
</tr>
<tr>
<td>Bio-opt</td>
<td>1,076,532</td>
</tr>
<tr>
<td>Total</td>
<td>4,419,941</td>
</tr>
</tbody>
</table>
SOCCOM Status

- 20 cruises (4 in year 4)
- 132 floats (30 deployed in year 4)
- Hydrographic stations at all deployment locations
- 113 floats active (19 non-op)
- 21 floats currently under sea ice

<table>
<thead>
<tr>
<th>Sensor</th>
<th>N good samples 11/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTD</td>
<td>1,155,884</td>
</tr>
<tr>
<td>O₂</td>
<td>1,095,198</td>
</tr>
<tr>
<td>NO₃</td>
<td>500,523</td>
</tr>
<tr>
<td>pH</td>
<td>591,804</td>
</tr>
<tr>
<td>Bio-opt</td>
<td>1,076,532</td>
</tr>
<tr>
<td>Total</td>
<td>4,419,941</td>
</tr>
</tbody>
</table>
SOCCOM Status

- 20 cruises (4 in year 4)
- 132 floats (30 deployed in year 4)
- Hydrographic stations at all deployment locations
- 113 floats active (19 non-op)
- 21 floats currently under sea ice

The SOCCOM data set now dominates recent observations south of 30S.

<table>
<thead>
<tr>
<th>Recent Profiles</th>
<th>NODC 2010-2014</th>
<th>SOCCOM 2014-2018</th>
<th>SOCCOM/NODC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>1114</td>
<td>6983</td>
<td>6.3</td>
</tr>
<tr>
<td>Nitrate</td>
<td>1076</td>
<td>5738</td>
<td>5.3</td>
</tr>
<tr>
<td>pH</td>
<td>602</td>
<td>4557</td>
<td>7.6</td>
</tr>
</tbody>
</table>
SOCCOM floats improving our understanding of regional carbon flux in the Southern Ocean
Observation-based metrics helping to evaluate and compare ESMs in the Southern Ocean.
1. JC Ross
AMT28
(Tarran, Rees)
SOCCOM chemist aboard
Sept-Oct 2018
6 floats

2. Polarstern PS117 (Boebel, Bakker)
SOCCOM PhD student aboard
Dec. 2018-Feb 2020
7 floats

3. AND Kaiyo Maru South of Australia
(Murase, Katsumata)
6 floats (NOT PICTURED)

4. JC Ross
ANDREX II
(Meijers)
SOCCOM postdoc aboard
Mar-Apr 2019
6 floats

5. Thompson
GO-SHIP I6S
(US GO-SHIP)
March-May
2019
8 floats

SOCCOM Status

2018-2019 Deployment season underway
SOCCOM Status

- 2018-2019 Deployment season underway

![Map showing SOCCOM floats with 6 recently deployed marked](chart.png)
SOCCOM Shipboard data

Shipboard data is used mainly for Validation (not direct Calibration)

Required and ancillary shipboard measurements
1. CTD (with oxygen if available)
2. Winkler oxygen
3. Nitrate (and other nutrients if available)
4. pH/Alkalinity pair
5. HPLC, POC
6. FLBB mounted on CTD
7. Rosette salinity if possible
8. DIC if available
9. Underway pCO2 if available
Shipboard data is used mainly for *Validation* (not direct Calibration)

- Hydrographic stations at all but 2 SOCCOM float deployment locations
- Underway pCO2 on 19 cruises (all but one)
- All GO-SHIP cruises required SOCCOM augmentation for HPLC and POC
Shipboard data is used mainly for *Validation* (not direct Calibration)

**Mode of shipboard data use:**

- In climatologies and training of MLR algorithms used for sensor calibration
- Algorithm development for bio-optics (NASA; FLBB obs to chl, POC)
- Individual data points and profiles to compare with calibrated float data
- Underway pCO2 to compare with pCO2 calculated using float data
SOCCOM Shipboard data

Cruise types:
1. GO-SHIP
2. Float-deployment dedicated cruises with hydrography of nearly GO-SHIP standard
3. Cruises of opportunity without hydrography

Goal: Reduce use of direct shipboard data collection at deployment to almost entirely GO-SHIP, to maintain standards for sensors and provide continuing highly accurate measurements of evolving BGC fields for use in the MLRs and input to evolving climatology. (GLODAPv2, SOCAT, etc)
Science-quality Data!

Data Assembly

Raw data processing
Factory calibrations,
Automated QC adjustments

Science-quality Data!

Data Adjustment & Validation in MATLAB
(“SAGE” GUIs)

ftp

Informal Audit

USER

Argo GDACs

Adopt-A-Float

Data snapshots with doi

FloatVIZ

rsync

Satellite

Bottle

Ship

UNIVERSITY of WASHINGTON
SEATTLE

MBARI
Monterey Bay Aquarium
Research Institute

Argo GDACs

CCHDO
CO2 & Carbon Hydrosphere Data Office

AOML

FTP

Global Ocean Data Analysis Project

Empirical Algorithms
MLR, LIR, CANYON

NCEP

SOCOM
Data Assembly

Raw data processing

6x/day

Science-quality Data!

Data Adjustment & Validation in MATLAB ("SAGE" GUIs)

Empirical Algorithms MLR, LIR, CANYON

Informal Audit

USER
Data Assembly

Raw data processing

6x/day

Factory calibrations, Automated QC adjustments

Science-quality Data!

2x/day

FTP

Data Adjustment & Validation in MATLAB ("SAGE" GUIs)

PROCESSING FREQUENCY

Full float "refresh" every 5th cycle (per float basis) to pick up potential:
- Updates to QC rules
- Updates to "bad sensor list"
- Modifications to sensor cals
- Updates to code base

MBARI
Monterey Bay Aquarium Research Institute

CCHDO
Carbon & Chemical Oceanography Data Office

NCEI
National Centers for Environmental Information

AOML

Argo GDACs

FTP

Empirical Algorithms MLR, LIR, CANYON

Global Ocean Data Archival Project Support

USER

FloatVIZ
Data snapshots with doi
Adopt-A-FLOAT

rsync
**Data Assembly**

- **Raw data processing**
  - *6x/day*
  - Factory calibrations, Automated QC adjustments
- **Science-quality Data!**
  - FTP

**Data Adjustment & Validation in MATLAB**

- *~2x/year (per float basis)*
- Rules

- Full float “refresh” every 5th cycle (per float basis) to pick up potential:
  - Updates to QC rules
  - Updates to ‘bad sensor list’
  - Modifications to sensor cals
  - Updates to code base

**PROCESSING FREQUENCY**

- MBARI
  - Monterey Bay Aquarium Research Institute
- CCHDO
  - Center for Computational Hydrodynamics Data Office
- NCEI
  - National Centers for Environmental Information
- AOML
  - Atlantic Oceanographic & Meteorological Laboratory
- Argo GDACs
  - Global Ocean Data Analysis Clusters

**FTP**

**SOCOM**

**User**
SOCCOM RT processing

1. READ CALIBRATION DATA
- Parse & merge manufacturer-generated calibration files for all sensors into float-specific cal files used in processing.

2. CALCULATE PARAMETER VALUES
- Convert raw msg file values to meaningful #'s based on BGC Argo docs.
  - Perform RT QC.
  - <PARAM> vars created

3. CREATE USEFUL DATA PRODUCTS!
- If QC-adjustments exist (generated by SAGE GUIs), apply them.
  - If NO, determine O2 gain using SAGEO2 GUI
  - GOOD O2 data is needed before NO3 and pH can be corrected
- Derive NO3 & pH adjustments using SAGE
- Derive NO3 & pH adjustments using SAGE
- Create Argo B*.nc files
- Create raw & adjusted ODV-compatible files (used for FloatVIZ & SOCCOM snapshot archives)

4. ASSESS QC ADJUSTMENTS
- Create Argo B*.nc files
- Create raw & adjusted ODV-compatible files (used for FloatVIZ & SOCCOM snapshot archives)
SOCCOM RT processing

1. READ CALIBRATION DATA
   • Parse & merge manufacturer-generated calibration files
   • sensors into float-specific files used in processing.

2. CALCULATE PARAMETER VALUES
   • Convert raw msg file values to meaningful #’s based on BGC Argo docs.
     • Perform RT QC.
     • <PARAM> vars created

   • If QC-adjustments exist (generated by SAGE GUIs), apply them.
     • If QC-adjustments exist (generated by SAGE GUIs), apply them.
     • <PARAM>_ADJUSTED vars created

3. CREATE USEFUL DATA PRODUCTS!
   • Create Argo B*.nc files
   • Create raw & adjusted ODV-compatible files (used for FloatVIZ & SOCCOM snapshot archives)

4. ASSESS QC ADJUSTMENTS
   If NO, determine O2 gain using GOOD O2 data is needed before msg and pH can be corrected

QC FLAG 3
QC FLAG 1
QC

Derive NO3 & pH adjustments using SAGE
SOCCOM RT processing

- Gross range checks
- Additional screening based on sensor diagnostic data (APEX)
- Spike testing for O2, pH, NO3
- Auto flagging of identified failed sensors (“bad sensor list”)

Argo intermediate parameters for PH_IN_SITU_TOTAL and NITRATE are useful for identifying bad data and/or failing sensors.

<table>
<thead>
<tr>
<th>PARAM</th>
<th>INTERMEDIATE PARAM</th>
<th>DESCRIPTION</th>
<th>ACCEPTABLE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH_IN_SITU_TOTAL</td>
<td>IB_PH</td>
<td>Base current of the ISFET pH chip</td>
<td>-150 &lt; IB_PH &lt; 150 (nanoamps)</td>
</tr>
<tr>
<td>PH_IN_SITU_TOTAL</td>
<td>IK_PH</td>
<td>Counter electrode current</td>
<td>-150 &lt; IB_PH &lt; 150 (nanoamps)</td>
</tr>
<tr>
<td>NITRATE</td>
<td>ABSORBANCE_SW(240)</td>
<td>Baseline absorbance</td>
<td>&lt; 0.8</td>
</tr>
<tr>
<td>NITRATE</td>
<td>FIT_ERROR_NITRATE</td>
<td>Fit error</td>
<td>&lt; 0.003</td>
</tr>
</tbody>
</table>
9. Spike test

Spike test for DOXY and TEMP_DOXY

The difference between sequential measurements, where one measurement is significantly different from adjacent ones, is a spike in both size and gradient. This test does not consider differences in depth, but assumes a sampling that adequately reproduces changes in DOXY and TEMP_DOXY with depth.

Test value = \(| V2 - (V3 + V1)/2 | - | (V3 - V1) / 2 |\)

where V2 is the measurement being tested as a spike, and V1 and V3 are the values above and below.

For DOXY: The V2 value is flagged when
- the test value exceeds 50 micromol/kg for pressures less than 500 dbar, or
- the test value exceeds 25 micromol/kg for pressures greater than or equal to 500 dbar.

For TEMP_DOXY: The V2 value is flagged when
- the test value exceeds 6 °C for pressures less than 500 dbar, or
- the test value exceeds 2 °C for pressures greater than or equal to 500 dbar.

Action: Values considered as a spike should be flagged as bad data (QC = ’4’)

Spike test for DOXY: works well in certain regions. However, throws out good data for many floats in other regions.

5903272
Spike test for DOXY: works well in certain regions. However, throws out good data for many floats in other regions.
Proposed spike test:

TEST VALUE (TV) = ABS(V2 – MEDIAN([V0 V1 V2 V3 V4]))

TV is considered a spike and flagged if exceeds parameter threshold.

<table>
<thead>
<tr>
<th></th>
<th>DOXY</th>
<th>PH_IN_SITU_TOTAL</th>
<th>NITRATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>THRESHOLD</td>
<td>40 umol/kg</td>
<td>0.04</td>
<td>5 umol/kg</td>
</tr>
</tbody>
</table>
SOCCOM RT processing

5903272

"Test Value" (TV)

Profiles with spikes

![Graphs showing O₂ (umol/kg) vs. pressure for 5903272, "Test Value" (TV), and Profiles with spikes.](image-url)
SOCCOM RT processing

5903742

“Test Value” (TV)

Profiles with spikes

\[ O_2 \text{ (umol/kg)} \]

\[ TV \]

\[ O_2 \text{ (umol/kg)} \]

\[ \text{Pressure} \]

\[ \text{Pressure} \]
SOCCOM RT processing

9099SOOCN

"TEST VALUE (TV)"

9099SOOCN, Profiles with Spikes

5904468

$\text{THRESHOLD } 40 \text{ umol/kg } 0.04 \text{ umol/kg}$
pH spike test

TV = abs(V2 - median(V0 V1 V2 V3 V4))

0.0167 % of TVs are > 0.04

N = 515415
WHY DO WE NEED TO ADJUST BGC DATA?  

*Sensors aren’t yet perfect!*

**Argo User’s Manual**

1.3 **Disclaimer**

Argo data are published without any warranty, express or implied.

The user assumes all risk arising from his/her use of Argo data.

Argo data are intended to be research-quality and include estimates of data quality and accuracy, but it is possible that these estimates or the data themselves may contain errors.

**Argo Quality Control Manual for Dissolved Oxygen**

Users should be aware that although biogeochemical data are now freely available at the Argo Global Data Assembly Centres (GDACs) along with their CTD data, the accuracy of these biogeochemical data at their raw state is not suitable for direct usage in scientific applications. Users are warned that the raw biogeochemical data should be treated with care, and that often, adjustments are needed before these data can be used for meaningful scientific applications.

Any user of these biogeochemical data that would develop a specific and dedicated adjustment improving their accuracy is welcome to exchange with ADMT on the developed and applied method.
**DATA ADJUSTMENTS**

What kind of adjustments are required?

<table>
<thead>
<tr>
<th></th>
<th>Gain¹</th>
<th>Offset²</th>
<th>Drift³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Biooptics</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O₂</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NO₃⁻</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

¹Gain = (Reference)/(raw float)
²Offset = (raw float) – (reference)
³Drift = rate of sensor drift per year, relative to reference

- **O₂** optodes suffer from storage drift (0-20%) & deployment drift (+/- 1%/ yr) in gain
- **NO₃⁻** drifts and offsets result from dirty optics, reduction in light throughput
- **pH** drifts and offsets result from changes to sensor reference potential overtime
SOCCOM DM QC

- SAGE MATLAB GUIs developed at MBARI & used to assign gain, drifts and offsets in float data sets
- Float data compared & corrected to reference data sets
- Code freely available: https://github.com/SOCCOM-BGCArgo/

**SAGE-O2**
SOCCOM Assessment and Graphical Evaluation for Oxygen

**SAGE**
SOCCOM Assessment and Graphical Evaluation (for pH & NO₃)
**Correcting Oxygen with SAGE-O2**

O₂ 1ˢᵗ parameter to adjust → influences pH and NO₃ adjustments !!

**Adjustment process:**

<table>
<thead>
<tr>
<th>Method 1: Air-calibrate</th>
<th>Method 2: Shipboard data</th>
<th>Method 3: WOA2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>→ Measure air O₂ → convert to pO₂</td>
<td>→ Compare float data at the surface to shipboard samples</td>
<td>→ Compare float data at the surface to World Ocean Atlas climatology (%sat)</td>
</tr>
</tbody>
</table>

\[
(\text{O}_2)_{\text{corr}} = G \times (\text{O}_2)_{\text{raw}} \\
g_i = pO_2 / pO_2,\text{optode} \\
pO_2 = (P_{\text{NCEP}} - p_{\text{H}_2\text{O}}) \times 0.20946
\]

\[
G = \frac{\sum_i^n g_i}{n}
\]

\[
G = \frac{\sum_i^n (\text{[O}_2\text{]}_{\text{bottle}} / \text{[O}_2\text{]}_{\text{float}})_i}{n}
\]

\[
G = \frac{\sum_i^n (\%\text{sat}_{\text{WOA}} / \%\text{sat}_{\text{float}})_i}{n}
\]

*Johnson et al, 2015*

*Takeshita et al, 2013*
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE-O2 determines gain adjustment

Raw or QC data

Cycle, depth & crossover ranges

Plot type

Reference data choice

Current gain used

Raw or QC data

Average gain = 1.087

Mean = 1.0872

AIC = -8.1132

Gain used in QC
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE-O₂ – gain corrected data (air cal)

NCEP

avg gain = 0.9999

mean = 0.99997

AIC = 38.1132
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE-O₂ – gain corrected data  (air cal)

Application of average gain improves optode accuracy to within +/- ~1%, but apparent drift is observed in certain optodes.
Optode in-situ performance: drift or no drift?

Johnson et al. (2015)
- positive and negative from 29 floats
- no significant mean drift

Bushinsky et al. (2016)
- drift in 10 out of 14 optodes (95% CI)
- Mean of -0.12 %/yr

Bittig and Körtzinger (2017)
- Drift in 2 floats (both negative)

Yang et al. (2017)
- 1 positive, 3 negative

Bittig et al. (2018)
- Re-analyzed earlier studies
- Multipoint calibrated optodes – 1 positive, 11 negative
- Batch calibrated – 27 positive, 14 negative
Optode in-situ performance: drift or no drift?

**SOCCOM APEX Float O2 Gain Drifts**

O$_2$ gain timeseries slope (\%/yr)

N cycles

20 40 60 80 100 120 140 160 180
Optode in-situ performance: drift or no drift?

N = 21 out of 47 APEX floats with more than two years data have significant drift (~45%)
11 negative (increased optode sensitivity)
10 positive (decreased optode sensitivity)
Mean of -0.05%/yr
Stdv of 0.6%/yr
Optode in-situ performance: drift correction in SAGE-O2

General approach:

\[ y = g_i \]
\[ x = t - t_0 \]

Compute drift using Model 1 regression, y on x.
New gain factor for each cycle (i) becomes:

\[ G_i = m \cdot x + g_1 \]

\[ (O_2)_{corr} = G_i \cdot (O_2)_{raw} \]
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE-O\textsubscript{2} – gain corrected data (air cal)

NCEP

- Gain used in QC

mean = 1.0872

AIC = 8.4167
Bottle – Float Oxygen Profile matchups (SOCCOM array)

QC’d using average gains

QC’d using drifting gains
Correcting pH and NO$_3^-$ with SAGE

- Ideal world - sensors are perfect – no corrections!
- Not there yet - accuracy changes over time
- Sensors are improving

Basic Approach:
- Compare deep float data to model estimates over time
- Use depth of ~1500m (assumed stable)
- Use MATLAB “SAGE” GUI to derive adjustments (offset, drift)
- Akaike Information Criteria (AIC) or Bayesian Information Criteria (BIC) used to prevent over-correction of data
- Apply corrections derived at depth to entire profile
- Evaluate accuracy \( \rightarrow \) compare to shipboard data
- Evaluate long-term stability \( \rightarrow \) compare to GLODAPv2
Model estimates — require accurate P, T, S and O₂

**LIR’s - LINR, LIPHR** (Carter et al., 2018)
- Locally interpolated MLR’s, global
- Trained with GLODAPV2

**CANYON-B** (Bittig et al., 2018)
- Neural network approach, global
- Trained with GLODAPV2

**Williams MLR’s** (Williams et al., 2016)
- Multiple Linear regressions, S of 45S

Data adjustment using SAGE-O2 & SAGE GUIs
Data adjustment using SAGE-O2 & SAGE GUIs

LIMNOLGY AND OCEANOGRAPHY: METHODS

Updated methods for global locally interpolated estimation of alkalinity, pH, and nitrate

B. R. Carter,1,2* R. A. Feely,2 N. L. Williams,3 A. G. Dickson,4 M. B. Fong,4 Y. Takeshita5

Eq # 7 inputs: $z, S, \theta, AOU$

RMSE (pH) = 0.006

RMSE (NO3) = 0.47 umol/kg
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE - raw vs. LIPHR (1480m – 1520m pH)

- Choose parameter (pH or NO₃) & reference data
- Define nodes (breakpoints)
- Calculate adjustments (or enter manually)
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE - QC vs. LIPHR (1480m – 1520m pH)

Corrected pH = +/- 0.005
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE - QC vs. LIPHR profile view

bottle data serves as an independent check on correction

GLODAP

bottle data
Goal is to move toward automation & reduce subjectivity

- Automated change point detection + cost function (BIC)
- Loop through increasing # of change points
- Minimize BIC (optimal # nodes or breakpoints)
- Calculate corrections & apply

\[
BIC = \log \left( \frac{SSR}{n} + \alpha^2 \right) + \frac{K \log n}{n}
\]

- Goodness of fit
- Model complexity penalty

- BIC = Bayesian information criterion
- SSR = sum of squared residuals
- \( n \) = number of data points (residuals)
- \( \alpha \) = mean anomaly threshold cap (sensor accuracy term)
- \( K \) = number of model parameters (# change points* 2 + 2)
Goal is to move toward automation & reduce subjectivity

- Change point detection determines node location
- BIC determines optimum number

Work by MBARI summer intern Tatjana Ellis
Goal is to move toward automation & reduce subjectivity

Automated Fleet wide test on SOCCOM APEX floats

**pH**
- average # change points
  - manual = 4.9
  - auto CPD = 3.0

**nitrate**
- average # change points
  - manual = 4.8
  - auto CPD = 2.7

Work by MBARI summer intern Tatjana Ellis
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE - QC vs. LIPHR (1480m – 1520m pH)

Corrected pH = +/- 0.005

Manual process
6 nodes
BIC = - 10.14
Data adjustment using SAGE-O2 & SAGE GUIs

SAGE - QC vs. LIPHR (1480m – 1520m pH)

Corrected pH = +/- 0.005

Auto process
3 nodes
BIC = -10.31
NO3, modest reduction in scatter, esp around -2 umol/kg.
pH – mean shifts a bit closer to zero, no change in SD
CORRECTION SCHEME

- Corrections computed through discontinuous piecewise linear fit for each segment between nodes (offsets not cumulative!)

Correction at each node, \( j \), calculated as:

\[
\Delta N_j = O_j
\]

Net correction for subsequent profile, \( i \):

\[
\Delta N_i = \Delta N_j + D_j (T_i - T_j)
\]

\( N = [\text{NO}_3^-] \), \( O = \) offset, \( D = \) drift, \( T = \) time
Correction at each node, $j$, calculated as:

$$\Delta N_j = O_j$$

Net correction for subsequent profile, $i$ within segment:

$$\Delta N_i = O_j + D_j (T_i - T_j)$$

$N = [\text{NO}_3^{-}]$, $O = \text{offset}$, $D = \text{drift}$, $T = \text{time}$
Propagating Adjustments Back into the Data Stream

Float-specific QC text files:
- Simple text files to store matrix of corrections for each sensor
- Updated within the GUI
- Also serve as historical record of QC changes
- Easily read into processing system
  → derived corrections get applied to incoming data in real-time
How are we populating error fields for SOCCOM BGC data?

- **DOXY_ADJUSTED_ERROR** = \( \text{DOXY_ADJUSTED} \times 0.01 \)
- **PH_IN_SITU_TOTAL_ADJUSTED_ERROR** = 0.01
- **NITRATE_ADJUSTED_ERROR** = \( (\text{abs}(\text{NITRATE} - \text{NITRATE_ADJUSTED})) \times 0.1 + 0.5 \)
- **CHLA_ADJUSTED_ERROR** = \( \text{abs}(\text{CHLA_ADJUSTED} \times 2) \)
- **BBP700_ADJUSTED_ERROR** = empty (no adjusted data!)
ADDITIONAL DMQC EFFORTS

- Visual inspection with ODV (multi-parameter context for BGC data!)
- Observation - model misfits
  - BSOSE (Matt Mazloff)
  - LIRs, CANYON-B
Toward Global BGC Argo

Argo Networks October 2018

- Core (3371)
- Equivalent (206)
- BioGeoChemical (352)
- Deep (69)
Toward Global BGC Argo

Workshop on DMQC of BGC-Argo Data
July 16-20, 2018
SIO, Hangzhou, China
Toward Global BGC Argo

OCB Biogeochemical Float Workshop
July 9-13, 2018
University of Washington, Seattle
Thanks!