How can we increase the amount of adjusted data at the GDACS

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BGC Argo has produced over 118,000,000 BGC measurements!
But….only a small amount of good quality data is propagated to the “_ADJUSTED” parameters
Several reasons why

- Off-line corrected data bases are not propagated to the GDACs
- Undetermined definition for “adjusted” (BBP, CDOM)
- Premature sensor failure (pH)
- Resources lacking to generate adjusted data
1.7 Real-time and Delayed mode data

...scientists apply other procedures to check data quality and the target is for these data to be returned to the global data centres within 6 to 12 months. These constitute the delayed mode data (DM).
The good news

- Most of the CHL data (92%) has been adjusted.
- Many DACs are now producing DOXY_ADJUSTED for recent data.
- Older floats need to be corrected next!

Wondering if it would be possible to propose an action item:

*Have 90% DOXY data older than a year processed to delayed mode by ADMT21?*
Two main hurdles

• Off-line corrected data bases need to be propagated to the GDAC

• Resources lacking to generate the data
How can we help?

• Code sharing
  MBARI uses Matlab, SAGEO2 GUI
  https://github.com/SOCCOM-BGCArgo/ARGO_PROCESSING

• SAGEO2 GUI help

• Data processing for other dac's

• If air cal isn’t possible use the gain value we produce for all floats as a first step?

  \[ \text{DOXY\_ADJUSTED} = \text{DOXY} \times \text{Gain} \]
WOA gain compares well with Air cal

DOXY_ADJUSTED_ERROR ~ 3%

Gain list from MBARI

<table>
<thead>
<tr>
<th>DAC</th>
<th>PI</th>
<th>WMO</th>
<th>gain</th>
<th>std gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>aoml</td>
<td>STEPHEN RISER</td>
<td>1900722</td>
<td>1.118</td>
<td>0.023</td>
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<tr>
<td>aoml</td>
<td>BRECK OWENS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ Y = 1.025x -0.020 \]

Std slope = 3%
Thoughts / questions?
Generating adjusted data at MBARI
Why do we need to adjust BGC float data?

Sensors are not perfect (O$_2$, NO$_3$, pH) yet but ....

“Argo data are intended to be research-quality and include estimates of data quality and accuracy”
(from Argo User’s Manual)

Raw BGC Argo data should always be used with caution!
“... the accuracy of these biogeochemical data at their raw state is not suitable for direct usage in scientific applications”
(from Argo Quality Control Manual for Dissolved Oxygen)
What kind of data adjustments are required?

<table>
<thead>
<tr>
<th></th>
<th>Gain</th>
<th>Offset</th>
<th>Drift</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>X</td>
<td>?</td>
</tr>
<tr>
<td>$O_2$</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>$NO_3^-$</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

- $O_2$ optodes suffer from storage drift (0-20%) & deployment drift (-1.9 to +1.4%/ yr) in gain
- $NO_3^-$ drifts and offsets result from dirty optics, reduction in light throughput
- pH drifts and offsets result from changes to sensor reference potential overtime
**SOCCOM data processing**

### Automatic QC
- **Data Assembly**
  - **Raw data processing**
    - Factory calibrations
    - Automated QC flagging
    - Automated QC adjustments
  - **Science quality data to user**!

### Manual QC
- **Empirical Algorithms**
  - LIR, MLR, CANYON
- **GLODAP**
- **WOA2013**
- **Bottle data**
- **Informal Audits**

- **“SAGE” GUIs**
  - Adjustment & Validation
  - Rules
Single float manual adjustment timeline

**Step 1**
QC flags assigned based on range, spike & grey list checks
All BGC data flagged questionable at best (RAW)

**Step 2**
After 2 months 1st data adjustments occur (ADJUSTED)
Living data set - data flags re-assessed quarterly
Every 5th float cycle float is completely reprocessed

**Level 3**
Final data adjustments after end of float life
Manual QC process – “Step 2”

• Presently user interaction required to generate rules

• Rules defined automatically (Change point detection & BIC)

• Rules saved & fed to automated process (D mode)

• Rules automatically applied until next data reassessment (A mode)

Two manual tasks:
• Visual observation for outliers & odd behavior

• Get data adjustments using reference data sets in SAGE-O2 & SAGE GUIs (generate rules)
Visual observation for outliers

★ Look at your data set!

- Simple visualization tools are useful – ie ODV
- Multi-parameter context can help distinguish anomalies from real events
Data adjustment using SAGE-O2 & SAGE GUI’s

- Matlab GUIs developed at MBARI
- Used to assign gain, drifts and offsets in float data sets
- Float data compared / corrected to reference data sets
- Free code: https://github.com/SOCCOM-BGCArgo

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

**SAGE**
SOCCOM Assessment and Graphical Evaluation (for pH & NO₃)
**Data adjustment using SAGE-O2 & SAGE GUI’s**

**Correcting Oxygen with SAGE-O2**

$O_2$ 1st parameter to adjust $\rightarrow$ influences pH and NO$_3$ adjustments

**Adjustment process:**

**Method 1: Air-calibrate**

$\rightarrow$ Measure air $O_2$ $\rightarrow$ convert to pO2
$\rightarrow$ compare to atmospheric reanalysis (NCEP)  
Johnson et al, 2015

\[
(O_2)_{corr} = G \times (O_2)_{raw} \\
g_i = pO_2/pO_{2, opticde} \\
pO_2 = (P_{NCEP} - p_{H2O}) \times 0.20946
\]

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

**Method 2: Shipboard data**

$\rightarrow$ Compare float data to shipboard sample profiles

**Method 3: WOA2013**

$\rightarrow$ Compare float data at the surface to World Ocean Atlas climatology (%sat)  
Takeshita et al, 2013

\[
G = \frac{\sum_i^n ([O2]_{bottle}/[O2]_{float})_i}{n}
\]

\[
G = \frac{\sum_i^n (%sat_{WOA}/%sat_{float})_i}{n}
\]
A first step:

Increasing the quantity of DOXY_ADJUSTED DATA at the GDAC should be a priority!

- Good oxygen data needed for pH & Nitrate corrections
- B-traj files needed for routine air calibration
- If air cal not possible use gains generated from WOA
Undetermined definition of adjusted for BBP CDOM
What makes data “adjusted”? Sensor data quality generally good (maintains calibration response)
Accuracy of derived quantities less good
Should BBP & CDOM get automatically propagated to adjusted fields?

Oxygen gains from woa
Compare plot with MBARI air gains
Undetermined definition for “adjusted”

Example: BBP, CDOM

• Data quality generally very good!
  Sensors maintain factory calibration (mostly)

• Conversion to derived parameter (i.e. POC) less accurate (this is a different issue though)

• Community decision

Consider populating adjusted fields for BBP, CDOM, (more?) which pass automated tests?
Premature sensor failure

Example: pH

• Young sensor – still improving reliability

• Improved designs by MBARI & SBE in the works