Processing Backscattering at the DAC level

ACTION 9
Plan

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- Recommendations for addressing the Particle Backscattering processing
- ECO sensor
  - Measurements and Data processing
  - Sensor METADATA
  - Particle Backscattering related parameters
Introduction

The measurements:

- Scattering coefficient of a medium is the scattered fraction of incident light flux, divided by the infinitesimal thin layer of the medium. (Forward and backward)

- The backward part is directly related to the density and size of particles, but also to their composition (i.e. organic vs inorganic)

- Measurements of the volume scattering function, VSF, $\beta(\theta, \lambda)$ at a single plane (i.e. assuming azimuthal symmetry) and at a single angle (around 117°) have been found to provide $bb$ with an uncertainty smaller than about 10% (Boss and Pegau, 2001)

- In order to obtain the particle backscattering scattering coefficient, the contribution of pure water $b_{bw}$ is subtracted:

$$b_{bp}(\lambda) = 2\pi \chi \beta(\lambda) - b_{bw}(\lambda)$$
Recommendations for addressing the Particle Backscattering processing

Here are the recommendations to address the Particle Backscattering processing:

- The official Bio-Argo unit for Particle Backscattering is m$^{-1}$

- Store any data transmitted by the backscatterometer with meaningful names. The proposed name for the counts transmitted by the backscatterometer is "BETA_BACKSCATTERING".

- Store in « PARTICLE_BACKSCATTERING » the Particle Backscattering in m$^{-1}$, estimated from the « BETA_BACKSCATTERING » counts.

- Fill properly the metadata to document the calibration, the conversions equations and the fields to identify a sensor.
ECO sensor: Measurements and Data processing

Raw data from the ECO backscatterometer BETA_BACKSCATTERING are transmitted as counts, ranging from 0 to 4120 +/- 5.

\[
\text{PARTICLE_BACKSCATTERING} = 2\pi \chi \left( (\text{BETA_BACKSCATTERING} - \text{DARK_BACKSCATTERING}) \times \text{SCALE_BACKSCATTERING} \right) - b_{bw}
\]

\text{PARTICLE_BACKSCATTERING} = \text{particle backscattering of a sample of interest (m}^{-1}\text{)}
\text{BETA_BACKSCATTERING} = \text{raw counts output when measuring a sample of interest}
\text{DARK_BACKSCATTERING} = \text{dark counts, the measured signal output of the backscatterometer in clean water with black tape over the detector}
\text{SCALE_BACKSCATTERING} = \text{multiplier in m}^{-1}/\text{counts}

The scale factor \text{SCALE_BACKSCATTERING}, dark counts \text{DARK_BACKSCATTERING} supplied by WETLabs for every wavelengths and will be stored in the "PREDEPLOYMENT_CALIB_EQUATION" and in the "PREDEPLOYMENT_CALIB_COEFFICIENT", as well as \( \chi \) and \( b_{bw}(i) \).
On the ECO sensor, there might be different backscattering sensors at different wavelengths

=> In the netcdf file, a new dimension should have been set: "N_SUBLEVELS".

=> In order to be compliant with previous version, N_SUBLEVELS will appear in the Netcdf File, only if it > 1.

For example, N_SUBLEVELS=2, for an ECO3 sensor with two particle backscattering measurements at 532nm and 700nm)

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_SUBLEVELS</td>
<td>N_SUBLEVELS=&lt;int value&gt;;</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Number of optical wavelengths&quot; for backscattering parameters)</td>
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</table>
### ECO sensor : Sensor metadata

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSOR</td>
<td>backscattering</td>
</tr>
<tr>
<td>SENSOR MAKER</td>
<td>WET labs</td>
</tr>
<tr>
<td>SENSOR_MODEL</td>
<td>ECO</td>
</tr>
<tr>
<td>SENSOR_SERIAL_NUMBER</td>
<td>To be filled</td>
</tr>
<tr>
<td>SENSOR_UNITS</td>
<td>Counts</td>
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<tr>
<td>SENSOR_ACCURACY</td>
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<tr>
<td>SENSOR_RESOLUTION</td>
<td>0.003m⁻¹</td>
</tr>
<tr>
<td>OPTICAL_WAVELENGTH_BACKSCATTERING(N_SUBLEVELS)</td>
<td>Wavelengths of the optical measurements (nm)</td>
</tr>
</tbody>
</table>

**Notes:**
- Sensor metadata includes details about the sensor, its manufacturer, model, serial number, units, accuracy, resolution, and optical wavelengths.
ECO sensor : Chlorophyll-a related parameters

**PARAMETER**="BETA_BACKSCATTERING"

**PREDEPLOYMENT_CALIB_EQUATION**="none"

**PREDEPLOYMENT_CALIB_COEFFICIENT**="none"

**PREDEPLOYMENT_CALIB_COMMENT**="Uncalibrated backscattering measurement"

This **BETA_BACKSCATTERING** is converted in **PARTICLE_BACKSCATTERING**

**PARAMETER**="PARTICLE_BACKSCATTERING"

**PREDEPLOYMENT_CALIB_EQUATION**="PARTICLE_BACKSCATTERING=2*π*χ*((BETA_BACKSCATTERING-DARK_BACKSCATTERING)*SCALE_BACKSCATTERING-bbw"

**PREDEPLOYMENT_CALIB_COEFFICIENT**="DARK_BACKSCATTERING=71, SCALE_BACKSCATTERING=0.008, χ=1.097, bbw=0.00034978 (at 700nm)"

**PREDEPLOYMENT_CALIB_COMMENT**="Sullivan et al. 2009, IOCCG 2006"