ARGO netCDF Parameter Issues

Dissolved Oxygen Parameter
Names for Additional Parameters

There were a couple of attempts to resolve these issues via the DM mailing list. There was much discussion but the issue was never decided. It is important that the Data Management team reach a final decision at the 2005 Data Management meeting since there are DACs with floats currently in the water that want to start providing these data.

In the e-mail discussions, these issues were discussed together with the PROFILE_..._QC discussion. I have separated these issues for clarity. The PROFILE_..._QC issue will be discussed separately.

Section C contains a partial compilation of the e-mail discussion. This can be referenced to see how these proposals were formulated and, especially, to see the dissenting opinions.

A. Dissolved Oxygen Parameter

This part of the proposal seems to be mostly uncontroversial.

Proposal

Parameter Name:	DOXY	(no change from current standard)
Unit Designation:	micromole/kg	(changed from mmole/kg)

Additional Action: Publish the Argo standard conversion algorithms in the Users Manual and ensure that all DACs are converting the units consistently.

Rationale

Parameter Name: No change from the current User Manual. However, there was a proposal to change the name to DOX2 so that users used to the GF3 codes would not be confused by the Argo units of micromole/kg. There seems to be general consensus that the name DOX2 would cause more confusion than it would solve. The units are included in the Argo netCDF data files and users should use this information.

Unit Designation: The current unit designator is "mmol/kg"; there is an ambiguity in the meaning of the prefix "m". Spelling out the prefix "micro" seems like a good idea.

B. Names for Additional Parameters

This was the controversial part of the previous proposal and the following proposal is being submitted for consideration. Alternate opinions are included in section C below. The Data Management team MUST decide this issue at the 2005 meeting.

The first three items under "Proposal" are general proposals to deal with this issue as new cases are encountered. The fourth item addresses the immediate (and overdue) needs for floats already in the water.

Proposal

1. Change the allowed length of parameter names from STRING4 to STRING16. (The list of affected variables is below.) The allowed parameter names (<PARAM>) will still be defined in Table 3 of the User's Manual. The names already in the table will not change and will continue to be the preferred names.
   - **Important Note:** The DACs can implement this change incrementally. There is no reason for each DAC to reprocess their files or to have all of the changes synchronized. Only those DACs needing the longer names would need to change initially.

   AFFECTED VARIABLES:

   Profile File
   STATION_PARAMETER
   PARAMETER
   HISTORY_PARAMETER

   Trajectory File
   TRAJECTORY_PARAMETERS
   HISTORY_PARAMETER

   Meta-data File
   SENSOR
   PARAMETER

2. When a float has more than one sensor for a given parameter, the variable names for the profiles will be
   <PARAM>
   <PARAM>_B
   <PARAM>_C
   etc

   For example, if a float has two oxygen sensors the oxygen profile variables will be
   DOXY
   DOXY_B

3. When a float has a sensor that measures a secondary parameter, the variable names for the profiles will be

   <measured-PARAM>_<sensor-PARAM>

   For example, if an oxygen sensor also measures temperature, the variable name for the temperature profile measured by the oxygen sensor will be

   TEMP_DOXY

4. Specific modifications and additions to User Manual, Table 3

   Parameter Name: TEMP_DOXY
   Parameter Long Name: SEA TEMPERATURE FROM DOXY SENSOR
   All other attributes as for TEMP

Rationale

There is a requirement to store multiple profiles for a given parameter in a single netCDF file. The only available option with the current Argo netCDF files is to define a unique variable name for each parameter.

In the current file definition, names are restricted to four characters. This would force very cryptic names to be used for these parameters. For example, DOX1 / DOX2, TMP1 / TMP2, etc.

Another option is to allow for longer names that can be more descriptive. This option is proposed but there were opinions to the contrary (see section C below).

There are two distinct cases: 1) a float has more than one sensor for a given parameter and 2) a float sensor measures a secondary parameter that is also measured by another sensor. The proposed naming convention makes these two cases distinct. The two examples above illustrate the difference and will likely be the first actual uses.

NOTE: It is assumed that all parameters will be on the same pressure levels.

C. Comments of the Data Management Members

I could not realistically include all of the e-mails received regarding these issues; there were almost 50 messages. What I have tried to do is organize some of the relevant e-mail traffic to stimulate further discussion. I have specifically included all dissenting opinions to highlight the thoughts of those that disagreed with the proposal.

<<<< The next three messages started this whole discussion. The proposal, similar to the above, was sent to the mail list on June 15, 2004.>>>>>

Bob Keeley April 8, 2004

Dear Sylvie, Mark,

We are expecting to deploy a new Apex float equipped with an oxygen sensor later this month. I think I need some new codes for the variables. So, the oxygen vales are reported in units of micromoles/l which we think is equivalent to millimoles/m**3 assuming 1cc = 1ml. So, is it okay to use DOXY for the reported oxygen?

Second there is an additional temperature sensor with the oxygen sensor, so that now there is both a CTD temperature and an optode temperature. Our intention was to include this and to pass this temperature profile through the real-time QC. However, we need a code for this. We would suggest OTMP with units of degreesC. How does this sound?

Mark Ignaszewski April 9, 2004

Bob,

Thierry and I discussed the extra temperature profile when we were at the AST last month. We agreed that the correct course of action was to add a new <PARAM> to the standard to accept the data. We did not discuss a name at that time but I do not have any problem with the name you have proposed.

I can not comment on the oxygen units question. I have not had time to research it further. I would hope that you would report the data in DOXY. If the units are equivalent then no conversions will be necessary. However, if the units are not equivalent, I would suggest converting to the standard unit and reporting in DOXY, as opposed to using a different (new) parameter name.

I will be out of the office next week (April 12-16) and will return on 19 April.

Bob Keeley April 14, 2004

Dear Mark, Sylvie,

Following Mark's response we will use OTMP as the code for the temperature derived from the optode oxygen sensor.

Regarding the use of DOXY, I have a complication. The code DOXY originated from the GF3 codes and in there the units are millimoles/m**3. The Argo manual quotes units of millimoles/kg. This is not right and these units are not equivalent. Those of us using the original GF3 codes have all of our DOXY values in our archives recorded in millimoles/m**3. To introduce a different unit for the

same code is going to cause grief. Since it is early in the float oxygen "game" we should be able to correct the units of DOXY in the Argo manual with no great problem. Otherwise, we need to change the name of DOXY for Argo to be something else with units of millimoles/kg.

Bob Keeley May, 07, 2004

Dear All,
Here are my responses to Mark's questions.
1. Okay

2. The question really is how to store measurements of the same variable in the same units and perhaps from the same instrument in a single netCDF (or archive) file. To help clarify the discussion assume we have a temperature from the CTD, 2 temperatures from 2 oxygen probes as well as salinity and pressure. The codes that we use to designate the variable measured have, by convention, the units built in (hence the discussion surrounding DOXY and DOX2). But in this case, all of the temperature sensors report in the same units. In the netCDF file we could have three <PARAM>s all being TEMP. This is perfectly good except I think we want to associate the profile with the instrument. The quick solution for temperature from an oxygen sensor is to choose a different code, as we did. An alternative is to have some "hook" to link the variable to the instrument from which it derived. An solution not requiring any format change is to put TEMP in the <PARAM> and use the comment attribute to say "temperature from optode sensor 1". This is not so nice because it would require software to take apart this comment if automatic processing is to be done. An alternative that would require a small format change is to define another field in the <PARAM> definition that allows us to link to information in the float sensor table of the metadata file. I think we would also need to add a comment or more rigourously controlled attribute in the SENSOR field to do this properly. Though this adds another attribute, those with no need for it could just not use it. Overall, I would prefer something like the second option because it would allow software to readily link the profile to the instrument that collected it. It also preserves the idea of one variable-unit == one code.

3. I agree.

4. The reason I suggested OTMP was that in Canada we already use this to designate a temperature measurement from a electonic oxygen sensor. I think it is an optode, but you could interpret the "O" to be "other" or "oxygen" as well as "optode". I agree that we do not want a different code for each instrument. TEM2 is as good as any and I will go with the majority. My preference for OTMP is to avoid and internal code mapping issue in Canada if I can.

<<<<<<The following e-mail was the proposal that, after refinements suggested by others, became the current proposal. >>>>>>

Mark Ignaszewski June 14, 2004

Hello All:

Some issues regarding the DOXY variable have been raised. The Data Management team needs to make some decisions so we can move forward with getting the dissolved oxygen data and other parameters associated with the oxygen sensors distributed on the GDACs.

Please review these comments and respond. Floats with these new data are already in the water. We need to move forward with these changes very soon.

Thank you (in advance) for your help with these issues.

NOTE: These issues will NOT require a big format change like we experienced in February.

RECOMMENDATION 1: Oxygen <PARAM> name

It was the recommended and accepted at the last Data Management meeting (November 2003) that the dissolved oxygen units be changed to micromoles/kg. However, the name DOXY originated from the GF3 codes and is associated with the units of millimoles/m**3. A name change in the Argo files is recommended to prevent confusion with this historical name and unit.

The new recommended <PARAM> name is DOX2

Some floats will have two oxygen sensors. The recommendation for the second oxygen <PARAM> is DOX2_B.

(This will establish a pattern for naming parameters from floats with multiple sensors for a data type.)

RECOMMENDATION 2: Conversion equations

Publish the standard conversion equations in the "Argo Data Management User's Manual" for all unit conversions. These standards will be established as the official Argo conversions for all DACs.

In this case, the standard conversion equations for the dissolved oxygen will be published.

RECOMMENDATION 3: Additional <PARAM> variables for data from alternate sensors.

The oxygen sensors will be able to collect an additional temperature profile. New <PARAM> names are needed for these data.

Recommendation: TEMP_DOX2 (indicates it is temperature data collected by the sensor for DOX2.

(Again, this would establish a pattern for naming parameters of this type.)

The definition for this <PARAM> would be the same as for TEMP except:

```
   Code                  : TEMP_DOX2
   Parameter long name   : SEA TEMPERATURE, DOX2 SENSOR
   Comment               : In situ measurement from oxygen sensor
```

Bob Keeley June 15, 2004

Dear All,
   Ahn and I read this. Our responses are as follows.

Recommendation 1:
   Agree. Use DOX2 for oxygen values reported in micromoles/kg, use DOXY for oxygen reported in millimoles.m**3
   Agree DOX2_B or more generally <PARAM>_A, B, C... for multiple sensors.

Recommendation 2:
   Agree.

Recommendation 3:
   We prefer TEMP_DOX2 for the reasons Claudia stated.

If we understand this correctly then, the link between the profile file and the sensor information in the metadata file is is the name of the <PARAM> (TEMP_DOX2) which is the same as SENSOR in the sensor section of the metadata file.

Anh pointed out that if we extend the number of characters we use to identify variables, we will need to modify the format. Specifically in the section on general information about profiles, the STATION_PARAMETERS field is a STRING4 variable. This would need to change. The same is true of the PARAMETER field in the calibration part of the profile file as well as the HISTORY_PARAMETER of the history section of profiles. The same is true for SENSOR field, and the PARAMETER field in the metadata file. I suppose for consistency, we should also look for places where these names are used in the trajectory and technical files and extend the string lengths for them at the same time.

Shaohua Lin June 17, 2004

1: Oxygen unit

  It was the recommended and accepted at the last Data Management meeting (November 2003) that the dissolved oxygen units be changed to micromoles/kg. We agree that the dissolved oxygen should be micromoles/kg. In order to be consistent with historical dissolved oxygen data, the standard conversion equations for the dissolved oxygen should be published.

2: DOX1 and DOX2

Some floats will have two or more oxygen sensors. We recommend that the oxygen name consists of 4 characters. DOX1 and DOX2 separately represent first and second oxygen sensor. If there is one oxygen sensor, the mane is DOX1. In this case it can be consistent with names of other parameters and it is not need to change data format descriptions, such as Argo profile

format 2.1 and Trajectory format 2.1. It is only need to change Reference table 3 (Parameter code table).

3: TDO1 and TDO2

The temperature data obtained from oxygen sensors are very important. It should be provided in ARGO data. We recommend that it be named TDO1 and TDO2. T represents temperature. DO1 and DO2 separately represent first and second oxygen sensor.

Best Regards,

Bob Keeley June 18, 2004

Dear All,
I was the one pushing to have DOX2 when the oxygen reported was in different units from DOXY. I agree with Roy (and Annie) that it is far better to have the variable name separated from the units, but I was worried that people reading the netCDF files would see DOXY and assume units that are used in other files (but that may be different units). Granted, the difference would be evident pretty quickly. I argued that naming the variable differently would make the different units obvious.

<<<<PROFILE_<PARAM>_QC comments removed>>>>>

Annie June 18, 2004

Hi,

DOXY/DOX2: You know, if I wasn't privy to this discussion and I see the name DOX2, my reaction will be "what is DOX1 then?", or "maybe there are 2 oxygen sensors". It would not occur to me that it signifies a particular unit. That was the problem with User Manual Version 1, where so many codes just did not make sense to an outsider who wasn't privy to the evolution. I thought we've done a very good job of cleaning things up and I'd hate to see us go backwards. So, at the risk of being stoned by the majority, I shall continue to advocate sticking with DOXY, and promoting the practice of always looking up the units.

That said, I do think we need to think of some bombproof way of alerting users to any format/unit changes.
<<<<PROFILE_<PARAM>_QC comments removed>>>>>

Claudia June 21, 2004

All,

> DOXY/DOX2: You know, if I wasn't privy to this discussion and
> I see the name DOX2, my reaction will be "what is DOX1 then?",
> or "maybe there are 2 oxygen sensors". It would not occur to
> me that it signifies a particular unit. That was the problem
> with User Manual Version 1, where so many codes just did not
> make sense to an outsider who wasn't privy to the evolution.
> I thought we've done a very good job of cleaning things up

> and I'd hate to see us go backwards. So, at the risk of being
> stoned by the majority, I shall continue to advocate sticking
> with DOXY, and promoting the practice of always looking up the
> units.

Personally, I would prefer DOXY, but I do not have old programs that may have a problem due to assumptions about the units.

Currently we do:

```
        float DOXY(N_PROF, N_LEVELS) ;
                DOXY:long_name = "DISSOLVED OXYGEN" ;
                DOXY:_FillValue = 99999.f ;
                DOXY:units = "mmol/kg" ;
                DOXY:valid_min = 0.f ;
                DOXY:valid_max = 650.f ;
                DOXY:comment = "In situ measurement" ;
                DOXY:C_format = "%9.3f" ;
                DOXY:FORTRAN_format = "F9.3" ;
                DOXY:resolution = 0.001f ;
```

where mmol = micromol (not millimol). No matter if we decide to stick with DOXY or change to DOX2, I suggest that we change:

```
                DOXY:units = "mmol/kg" ;
```

to

```
                DOXY:units = "micromol/kg" ;
```

If we decide we have to switch to DOX2, then we should wait until version 3.1 and place an alert into version 2.2.

<<<<PROFILE_<PARAM>_QC comments removed>>>>>

Annie June 21, 2004

I agree with Claudia. A

No matter if we decide to stick with DOXY or change to DOX2,
I suggest that we change:

```
                DOXY:units = "mmol/kg" ;
```

to

```
                DOXY:units = "micromol/kg" ;
```