

U.S. IOOS QARTOD Project Plan

Final – 4/1/2012

1. Introduction

As part of the US IOOS DMAC core services, the US IOOS Program Office will initiate a sustainable, community-based project to establish authoritative procedures for quality assurance (QA) and quality control (QC) of real-time ocean sensor data collected for US IOOS. This project will be based on the QARTOD (Quality Assurance of Real Time Ocean Data) effort, existing community-based QA/QC efforts, and existing QA/QC standards developed by Federal Agencies and the US IOOS Regional Coastal Ocean Observing Systems (RCOOS). This project will retain the name of QARTOD. All of the known QA/QC programs in existence today provide parts to the solution, but none consolidates the various parts. This document outlines how QARTOD will be administered and funded. The result of this effort is to develop standards that can become formal IOOS data standards for data from the Regional Associations.

2. Objectives

Sustain a process for establishing QA/QC procedures that will:

- Establish authoritative QA/QC procedures for each of the 26 US IOOS core variables (<http://www.iooc.us/ocean-observations/variables/>), as necessary, including detailed information about the sensors and procedures used to measure the variables;
- Produce written manuals for these QA/QC procedures;
- From the list of individual QA/QC procedures and guidelines developed, define a baseline set of QA/QC procedures that can be used for certification of RCOOS data providers;
- Facilitate QA/QC integration with Global Ocean Observing System (GOOS) and other international ocean observation efforts;
- Engage the Federal Agencies and IOOS Regions that are part of, or contribute to, US IOOS who will use the established QA/QC procedures; and,
- Work efficiently, without duplication of effort, to facilitate the implementation of common QA/QC procedures amongst US IOOS Partners.

3. How the program will work

Step 1: Develop a matrix of the full spectrum of procedures needed (IOOS core variables and sensors)

Step 2: Determine procedures that are ready for formal adoption, such as those already being used by operational entities e.g. CO-OPS, NDBC, USACE (CDIP), EPA

Step 3: Assess previous QARTOD work and complete procedures as appropriate.

Step 4: Prioritize new QA/QC procedures needed based on the matrix developed in Step 1 and results of Steps 2 and 3.

Step 5: Embark on developing new QA/QC procedures:

- Review existing practices across U.S. IOOS community partners and international efforts;
- Convene a set of subject matter experts to develop the QA/QC procedures;
- Write the QA/QC procedures manual;

- Submit to the Interagency Ocean Observation Committee, National Federation of Regional Associations (NFRA) and Regional Association Executive Directors for 30 day review period;
- Review and refine manual based on formal comments, as necessary; and,
- Publish the QA/QC procedures, via a technical memorandum signed by the US IOOS Program Director.

Steps 1-4 will be completed in 2 months during the first year and updated as new procedures are developed. New procedures development is expected to take 6-12 months per year thereafter including the first year. The US IOOS Program will fund Steps 1-5 which will include, at a minimum, 1 QA/QC manual for a core variable annually.

4. Roles and Responsibilities

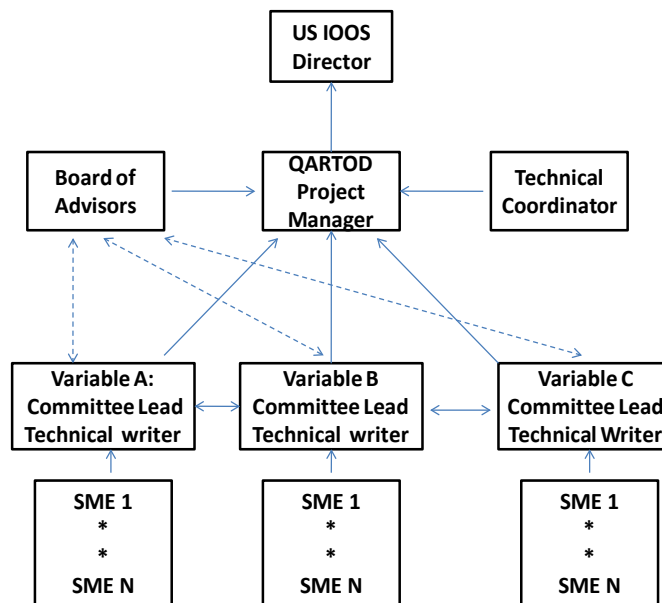


Figure 1: Structure of QARTOD.

Figure 1 illustrates the general construct and responsibilities of the QARTOD process, but not necessarily the functional process of meeting program goals and objectives. Functional responsibilities are described below.

- ***US IOOS Program Director:*** Approval of QA/QC manuals and the means by which the QA/QC manuals are applied to certification of non-federal assets.
- ***QARTOD Project Manager (PM):*** Responsible to the US IOOS Director for the implementation of the QARTOD project. The PM chairs the Board of Advisors, approves annual work plans and executes the funds. This position is physically located at the National Data Buoy Center (in-kind IOOS contribution), and is anticipated to be a 1 to 2 month effort annually.

- Technical Coordinator (TC): Overall coordinator and advocate of QARTOD project. Reports to the PM and the Board of Advisors. This person will have experience with ocean observations and the instrumentation used to collect the data, and will participate in the technical writing of the QA/QC manuals with the Committee Lead. This will be a 6 month effort (estimated) to establish the process, and thereafter a 2-3 month effort annually with QARTOD project funding. Responsibilities include:
 - Interact with IOOS Federal agencies and the Regional Associations to determine when/how to leverage existing QA/QC protocols and procedures (e.g. EPA Quality Assurance Protocol (QAP) for water quality data);
 - Collate material from various sources (QARTOD meetings, existing published procedures from other programs, scientific literature etc) into a single document for each variable/sensor that can be published by IOOS and used in the certification process;
 - Establish, with input from the Federal Partners and Regional Associations, then support the Board of Advisors;
 - With assistance from the Board of Advisors, prioritize the matrix of procedures; annually revisit the prioritization;
 - When embarking on a new variable – assemble existing procedures, practices;
 - Solicit nominations for a Variable Committee team leader, and work with team leader to assemble Subject Matter Experts (SME) team; and,
 - Process and document resultant efforts of the Variable Committee Lead and SMEs in a QA/QC procedures manual for review and recommendation by the community at large, BOA and the US IOOS Program Director.

- Board of Advisors: Volunteer group.
 - Composition: Anticipated to be 8-10 technical experts broadly representing the US IOOS community
 - Chaired by the QARTOD PM;
 - US IOOS DMAC System Architect; and,
 - Members from a percentage of IOOS Regional Associations and Federal Agencies, Open Geospatial Consortium (OGC), the Alliance for Coastal Technologies with expertise from both the observing and data management communities
 - Responsibilities:
 - Set priorities for annual work effort, ensuring that RA requirements are addressed;
 - Guide the overall progress;
 - Provide recommendations for approval of QA/QC manuals to the IOOS Program Director; and,
 - Identify appropriate subject matter experts for the working groups/sensor committees
 - Meetings: Quarterly via telecom.

- Variable Committees:
 - Composition:
 - Committee Leader: Chosen by the Board of Advisors as the expert on the variable chosen, and leads the group of SMEs. A 1-2 month effort (estimated) funded by the US IOOS office;

- Technical Writer: As needed to ensure the manual is written to be of maximum use to the Regional Associations and ocean observing community. A 1-2 month effort (estimated) funded by the US IOOS office; and,
 - Subject Matter Expert (SME) Membership: Comprised of expert volunteers from both observing and data management communities. Travel, if needed, for non-Feds will be covered by the US IOOS office.
- Responsibilities: The focus of the Committees will be on IOOS core variables, but the individual tests may be specific to a subset of sensors (e.g. tests for wave observations from moored ADCP's may differ significantly those appropriate for wave observations from wave rider buoys)
 - Committee Leaders will chair their respective SME committees;
 - The Technical Coordinator and Committee chair will collect existing standards and best practices and provide them to the SME membership prior to the first meeting;
 - The SME working group provides the intellectual capital to generate the QA/QC procedures; and,
 - The Technical Coordinator, Committee chair and technical writer have the responsibility for taking the input from the SMEs and producing the completed QA/QC manual. The SMEs will remain engaged to provide technical consultation until the QA/QC manual is completed and approved
- Meetings: Will be conducted via webinar. Face to face meetings approved by the PM.
- Deliverables: Manual with clear instructions on the procedures where implementation code could be written. If code exists it will be provided with the manual for others to use as appropriate. Writing of new code is not a deliverable. See Section 6 for further definition.

5. Additional Key Supporting Organizations/Roles

NDBC:

- Scope the process;
- Review existing procedures;
- Act as the QA/QC clearing house for US IOOS core variables QA/QC Best Practice Procedures;
- Continue to refine and upgrade the NDBC 2009 QC manual based in part on QARTOD results;
- Provide QC experts as appropriate to the QARTOD committees; and,
- Work with TC to determine placement of QARTOD website.

US IOOS Regional Associations:

- RA Executive Directors shall stay apprised of QARTOD, endorse and support members selected for the Board of Advisors and the Variable Committees; and,
- Adopt and implement approved QA/QC procedures.

US IOOS Federal Partners:

- Endorse and support members selected for the BOA and Variable Committees; and,
- Provide resources for the development of QA/QC procedures for specific QA/QC manuals to address particular needs.

6. Deliverables

For each variable, a manual will be published describing the individual quality control procedures that will be applied to the data stream prior to dissemination. The manual will also specify the set of QC tests required to be applied before dissemination. For example, for real time temperature data, the manual may describe 15 potential tests, but will identify the specific subset of these 15 QC tests to be applied prior to dissemination. The time lag between the data collection and dissemination will dictate the number and types of tests applied to the data stream (i.e. the real time vs delayed mode issue) and it will be up to the variable committee to decide the applicability of the tests. For example, the variable committee may decide to constrain its focus to strictly real time dissemination for certain data types and to include the entire delayed mode quality control lifecycle for others. Initially we expect a real time focus, but see no reason to constrain the project to real time indefinitely, given the value of delayed mode QC to producing “climate change grade” data.

The description of each QC test will be sufficient for a skilled software programmer to create software that implements the tests in different software environments. The code itself need not be a deliverable of the project. The focus is on the documentation. However, if a community code repository would be useful in developing the tests, this would be seen as a supplemental benefit. The description of individual tests should include:

- Assumptions of the algorithm or of the context in which it is applied: For example, with real time data, an assumption for the N^{th} data point might be that the $N+1^{\text{st}}$ data point is not available to the software implementation.
- Input thresholds: by thresholds, we mean adjustable thresholds of the algorithm implementation, not the environmental variable being subject to the test. For example, for a gross value test, the minimum and maximum allowable values for the variable of interest are thresholds of the test. The chosen values for application of the test to coastal water temperature data would be different from those values chosen for land based humidity data even though the logic of the test would be the same in each case.
- Individual flag syntax: The syntax chosen to represent the results of an individual QC test on a particular data value, or on an entire data set, is an important factor in data system interoperability. The code table of flag values should be described for each test. For binary tests in which the only allowable results are pass/fail, the syntax may simply be 0/1 but in tests in which the results can be characterized within a range, the specific meaning of each interval must be documented.

The manuals will be posted on the QARTOD website so that they are easily accessible and dynamic, thus allowing for updates, with the appropriate version control procedures in place. The website will allow for conversations between users to include code libraries, procedures for testing data, interactive graphics, etc.

This plan requires a tight connection with DMAC, and with data format standards, since QA/QC processed data should automatically come out in the right format, with the correct metadata, and quality flags.

7. Estimated Year 1 Budget

ACTIVITY	ANNUAL COST
Technical Coordinator <ul style="list-style-type: none"> 1/2 FTE to manage effort (expected to decrease in year 2) 	\$50K
Meetings <ul style="list-style-type: none"> BOA kickoff meeting Variable Committee mtgs (as necessary) 	\$30K
Technical “code-able” Manual(s) <ul style="list-style-type: none"> Technical writer (may increase in Year 2) Committee Lead (may increase in Year 2) 	\$ 30K
total	\$110K

Funds will be transferred from IOOS to NDBC to support the project. The \$30K allocated to “Meetings” will be used to fund the initial BOA meeting, and a start-up committee meeting. The two meetings should be held back to back. BOA member travel is estimated at \$10K of potential travel for the start-up committee (perhaps invitational travel for a specialist), and \$5K for meeting services.

The \$30K for generation of a QA/QC manual would fund a Committee Lead (1-2 month salary) and a technical writer.

Potential Additional Funding Scenarios:

With the key deliverable of a QA/QC manual being developed for each variable, the following scenarios are expected (based upon an initial community survey) for resourcing additional ones:

- USACE funds for an additional variable and QA/QC manual to meet mission requirements. Navy funds the software development of those variables for regional or global interests. Appropriate committees take the action to produce manuals. Results are shared with the aggregate leadership and throughout the IOOS community.
- USCG partially funds QA/QC manuals for those variables of interest as pertains to supporting navigation requirements. Appropriate committee takes the action to produce manuals, and results are shared with other committees and IOOS community.
- Industry partners fund the software development from the QA/QC manuals of high interest to them for commercial purposes.
- NSF / OOI funds for an additional variable and QA/QC manual to meet program requirements.

The anticipated tasks are scalable (i.e. more core variables, more QA/QC procedures) through expanded coordination, leveraging and collaboration to maximize return on investment. Scalability can be accomplished through properly engaging the ocean observing community and sensor manufacturers whereby each variable addressed will benefit multiple users and stakeholders in multiple regional associations and their data providers and stakeholders. Sharing of code with the regional, national and international partners enables this scalability to everyone’s benefit.

8. Implementation and Strategy

In addition to setting the QA/QC procedures, QARTOD will help facilitate adoption of the procedures through sharing of code, training in its use and establishing best practices. The Board of Advisors will refine and adjust the list below as the process matures, but initial implementations steps envisioned after QA/QC procedures are established might be:

- The sharing of code;
- Use of webinars, wikis, blogs, and other online tools to refine the code and foster its implementation;
- Establishment of best practices for data collection for each variable including instrument selection, deployment procedures, QA/QC, data processing, and product generation including formats; and,
- Training

9. Appendix: Other Relevant QA/QC Efforts

NAME	URL
NDBC Quality Control Procedures	www.NDBC.NOAA.GOV/
IOOS Strategic Plan	www.ioos.gov/library/ioos_stratplan_2009.pdf
QARTOD Wiki	http://nautilus.baruch.sc.edu/twiki/bin/view (QARTOD meetings summary)
QARTOD <ul style="list-style-type: none"> • 2 OGC Q20 • QARTOD on Facebook • QARTOD on LinkedIn 	<ul style="list-style-type: none"> • http://q2o.whoi.edu/ • (http://www.facebook.com/pages/QUALITY-ASSURANCE-OF-REAL-TIME-OCEAN-DATA-QARTOD/183720751655) • http://linkedin.com, with related subgroups Chemical and Biological Parameter and <i>In Situ</i> Currents, and Waves
Rolling Deck to Repository R2R (an NSF/UNOLS effort)	http://www.rvdata.us/
IODE <ul style="list-style-type: none"> • Best Practices 	<ul style="list-style-type: none"> • (http://bestpractice.iode.org/, click View all records to see an extensive list of QA/QC documents compiled by WMO or IOC over the past 20 years or so) Argo DM Manual OceanSITES DM Manual GTSPP (New manual under review now but previous version should be at bestpractice.iode.org)
Marine Metadata Interoperability	http://marinemetadata.org/references/qartod
IOOC	http://www.iooc.us/about/ocean-us/
Consortium for Ocean Leadership	http://www.oceanleadership.org/
National Water Quality Monitoring Council	http://acwi.gov/monitoring/
High Frequency Radar	- Quality Control Steering Committee group led by Jack Harlan.
EPA	- http://water.epa.gov/type/rsl/monitoring/132.cfm
JCOMM/IOC/WMO	www.jcomm.info
QA4EO	(http://qa4eo.org/)
IODE Ocean Data Standards	http://www.oceandatastandards.org/
CO-OPS QC Documentation Technical Reports: 6. A NWS Guide to the Use of NWLON	http://tidesandcurrents.noaa.gov/pub.html

<p>and PORTS Computer-Based Products, Appendix 4: QC Flags, NOS CO-OPS 026 8. NWLON/DMS Quality Control Software (QC): Functional Requirements Document, NOS CO-OPS 030 Sensor References: B7. CO-OPS Sensor Specifications and Measurement Algorithm</p>	