QARTOD

Quality Assurance of Real-Time Oceanographic Data

QARTOD V Final Report

Fifth Workshop on the QA/QC of Real-time Oceanographic Data

Omni Hotel, Atlanta, GA

November 16-19, 2009

Organizing Committee

Brenda Babin, LSU
Julie Bosch, NOAA/NCDDC
Bill Burnett, NOAA/NWS/NDBC
Mark Bushnell, NOAA/NOS/CO-OPS
Janet Fredericks, WHOI
Stephanie Kavanaugh, NOAA/NOS/SPO
Mario Tamburri, ACT

QARTOD V Participants in Atlanta

QARTOD Timeline

QARTOD I	December 2003 NDBC/Stennis
QARTOD II	March 2005 CO-OPS/ODU
QARTOD III	November 2005 NDBC/Scripps
QARTOD IV	June 2006 CO-OPS/WHOI
QARTOD V	November 2009 NDBC/Atlanta

Table of Contents

Introduction

Quality Assurance of Real-time Oceanographic Data (QARTOD) workshops are convened and attended by representatives from agencies and institutions with an interest in the quality assurance and quality control of oceanographic observations, including the Integrated Ocean Observing System (IOOS) community. Attendance is unrestricted, and participants are supported by their own organizations. In several cases, support for an invited speaker has been provided. The workshops bring together people from all aspects of data acquisition and delivery—those deploying systems, those responsible for the real-time quality control, database managers, people with an interest in the development of effective metadata, and data users.

The National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) National Data Buoy Center (NDBC) hosted the first meeting in 2003 in Bay St. Louis, MS. Over 80 participants attended with the goal of developing minimum standards for calibration, quality assurance (QA) and quality control (QC) methods, and metadata content. The workshop resulted in a report that summarized the recommendations on these issues and on future workshops. QARTOD II was held February 28-March 2, 2005 in Norfolk, VA, and it focused on calibration and metadata QA/QC issues for current (acoustic Doppler current profiling and high frequency radar surface current mapping) and wave measurements, primarily from buoys. QARTOD III was held November 2-4, 2005 at the Scripps Institution of Oceanography in La Jolla, CA. It continued the work on waves, including those using acoustic Doppler technologies, and current measurements, including high frequency (HF) radar and *in situ* observations, and commenced work on conductivity, temperature, and density (CTD) measurements. QARTOD IV was held at the Woods Hole Oceanographic Institution (WHOI) June 21-23, 2006, and the focus shifted from QC tests to data quality assessment.

QARTOD V was co-chaired by Dr. Bill Burnett (NOAA/NWS/NDBC) and Mark Bushnell (NOAA National Ocean Service [NOS] Center for Operational Oceanographic Products and Services [CO-OPS] and continued the pursuit of new standards, notably for a variety of biogeochemical parameters such as dissolved oxygen (DO), turbidity, and chlorophyll, and the evaluation and acceptance of previously developed standards for waves and *in situ* currents relating to acoustic Doppler quality control. The agenda included plenary presentations describing activities by the U.S. Geological Survey (USGS) (Dan Sullivan, Co-Chair, Methods and Data Comparability Board), NOAA's Chesapeake Bay Interpretive Buoy System or CBIBS Data Management System (Henry Pierce, Tellus Applied Sciences), IOOS (Charles Alexander, IOOS Operations Chief, Data Integration Framework), the Woods Hole Oceanographic Institution (Janet Fredericks, Q2O, WHOI Martha's Vineyard Coastal Observatory), and the Alliance for Coastal Technologies or ACT (Mario Tamburri).

QARTOD V

Workshop documentation is included in the appendix of this document, which includes the meeting agenda (appendix A), the list of QARTOD V participants (appendix B), and preparatory questions distributed to all participants, as well as presentations and meeting notes. Some of these documents are also available at http://qartod.org. QARTOD output such as templates that can serve as examples for the development of similar standards for other parameters are also available. These examples include wave measurement Quality Assurance/Quality Control http://cdip.ucsd.edu/documents/index/product_docs/qc_summaries/waves/waves_table.php and current measurement QA/QC http://opendap.co-ops.nos.noaa.gov/content/Docs/In-Situ_Currents_QC_Standard_for_IOOS.pdf. One key QARTOD outcome is the creation of the "Seven Laws of Data Quality," (http://nautilus.baruch.sc.edu/twiki/pub/Main/WebHome/SevenLaws.pdf). However, the most useful result of QARTOD may be the development of a process whereby QA/QC guidance for a specific parameter or sensor is generated and accepted by the community. The very existence of QARTOD and the broad participation in QARTOD workshops from the ocean observing community are also significant and critical.

QARTOD results are widely referenced, and notable related activities include the follow-on "QARTOD to Open Geospatial Consortium" or Q2O effort described at http://q2o.whoi.edu/ and the Marine Metadata Interoperability effort at http://marinemetadata.org/references/qartod. QARTOD also has a strong presence on Facebook (http://www.facebook.com/pages/QUALITY-ASSURANCE-OF-REAL-TIME-OCEAN-DATA-QARTOD/183720751655) and LinkedIn, (http://linkedin.com), with related subgroups Chemical and Biological Parameter and *In Situ* Currents, and Waves.

Seven Data Management Laws

1. Every real-time observation distributed to the ocean community must be accompanied by a quality descriptor.
2. All observations should be subject to some level of automated real-time quality test.
3. Quality flags and quality test descriptions must be sufficiently described in the accompanying metadata.
4. Observers should independently verify or calibrate a sensor before deployment.
5. Observers should describe their method/calibration accuracy in the real-time metadata.
6. Observers should quantify the level of calibration accuracy and the associated expected error bounds.
7. Manual checks on the automated procedures, the real-time data collected and the status of the observing system must be provided by the observer on a time scale appropriate to ensure the integrity of the observing system.

QARTOD V Workshop Preparation

Early QARTOD workshops wrapped up with a survey of participants' thoughts regarding the success of the meeting, and one clear message was that good meeting preparation can lead to a more successful outcome. Therefore, the organizing committee conducted a series of teleconferences prior to QARTOD V to develop the agenda, process guidance, and other input documentation to distribute to attendees.

The QARTOD V pre-workshop preparation resulted in the development of questions that were distributed to each participant so that s/he could study them and select the breakout group that best reflected the participants' interest and expertise prior to arriving in Atlanta. The organizing committee sought the following results from QARTOD V: (1) parameter identification and quality test definitions, (2) the inputs and outputs to each test, (3) the order in which tests need to be performed, and (4) how the test results are to be interpreted.

QARTOD V Discussion Questions

1. What is the definition of the scope of the Quality Control Application?
2. What real-time QC tests must be applied to each parameter?
3. What QC flags or flagging conventions must be applied?

QARTOD V Workshop Overview

Day 1

Plenary Session

Mario Tamburri, the Executive Director of ACT, welcomed participants and provided opening remarks. He described the ACT goals of furthering the state of sensor capabilities and evaluating technology and related these activities to the QARTOD mission. ACT orchestrates technology evaluations and demonstrations with the support of six academic institutions. Further information is available at http://www.act-us.info/. The presentation slides are in appendix C.

Dr. Bill Burnett, co-chairman of the series of QARTOD conferences, reviewed the history and purpose of QARTOD. He described the formation and grass roots of the organization, discussed the goals of the previous four workshops, and presented the group with the "Seven Data Management Laws" developed at the first workshop. He then introduced the goals of QARTOD V: a) recommend QC tests for biogeochemical parameters; b) review Q2O implementation of QC tests for waves and currents; and c) discuss ways to interact with similar international efforts. The presentation slides are in appendix D.

Charles Alexander, the Operations Chief at NOAA's IOOS office, provided participants with a description of IOOS and the relationship between IOOS, Data Management and Communications (DMAC), Interagency Working Group on Ocean Observations (IWGOO), Ocean Observatories Initiative (OOI), and QARTOD. IOOS oversees the resource allocation for the regional associations (RA) and is developing a Data Integration Framework—a limited scope risk reduction effort that initially is focused on seven core variables (water temperature, salinity, waves, water levels, currents, ocean color, and winds) from three providers (NDBC, CO-OPS, and Seawifs) to address four key issues (harmful algal blooms [HAB], coastal inundation, hurricane intensity, and integrated ecosystems). This led to a discussion about the definition of "interoperable data," i.e. what units, what to call them, how to describe location, and how to use web-based services to transform and provide data?

Dan Sullivan, of the U.S. Geological Survey (USGS) and co-chair of the Methods and Data Comparability Board (created in 1997 as a subgroup of the Advisory Committee on Water Information, http://ACWI.gov), provided a presentation on water quality. He discussed efforts to develop a QA matrix for initial vital signs (dissolved oxygen, pH, specific conductivity, temperature, turbidity, oxidation reduction potential [ORP], and depth). He provided the group with water quality information sources such as: a) the *Water Quality Data Elements: A Users Guide* developed by National Water Quality Monitoring Council (NWQMC), b) the National Environmental Methods Index

(http://www.NEMI.gov), which has 1100 methods from 28 sources, and c) the Smart Ocean Sensors Consortium, a consortium of manufacturers looking at things like PUCK (Plug and Work). The presentation slides are in appendix E.

Janet Fredericks from WHOI presented the group with information regarding the QARTOD to Open Geospatial Consortium (Q2O) effort. She reviewed the status of efforts to integrate QC tests into standards-based sensor web services at the WHOI Martha's Vineyard Coastal Observatory. She described work being done by the Q20 team using the Open Geospatial Consortium (OGC) Sensor Web Enablement (SWE) framework, described the use of resolvable URLs for the development of ontologies (relationships) in terms for QC tests and flags across disciplines and governmental boundaries. She presented the Q20 plans for other water quality parameters, such as DO and CTD. See http://q2o.whoi.edu for further information. She also questioned the process for developing standards for data quality assessment and promulgated and expressed strong continued endorsement of QARTOD. The presentation slides are in appendix F.

Orientation for Breakout Sessions

Stephanie Kavanaugh, process facilitator from NOAA's National Ocean Service/Special Projects Office (NOS/SPO), presented guidance to prepare the two breakout groups for the afternoon session. Her briefing slides are found in appendix G. She introduced process facilitators, technical facilitators, and recruited note takers for each breakout session. Sara Haines, from the University of North Carolina, recorded notes for the general session (appendix H).

Group 1 covered biogeochemical parameters, including DO, conductivity, temperature, turbidity, ORP, and depth. Although pH had initially been included, the group elected not to include it in the discussion because of the lack of expertise in that area. The charge for Group 1 was to identify and define quality control tests and practices for real-time biogeochemical observations for the selected biogeochemical parameters. The process facilitator was Stephanie Kavanaugh and technical facilitators were Brenda Babin (Louisiana State University) and Grace Cartwright (Virginia Institute of Marine Science). Stephanie Kavanaugh recorded Breakout Group 1 notes (appendix I).

Breakout Group 2 discussed waves and *in situ* currents. Their charge was to provide clarification and additional input to previously identified waves and *in situ* currents QC practices and to address additional QC tests and practices for additional wave and *in situ* observation methods. The process facilitator was Helen Worthington (REMSA, Inc.) and technical facilitators were Bill Burnett and Mark Bushnell. Sara Haines recorded Breakout Group 2 notes (appendix J).

Day 2

The second day began as Bill Burnett set the stage by discussing the logistics for the day's breakout groups. He also provided a set of slides to demonstrate quality control challenges for the group to discuss. These slides can be found in appendix K. For the remainder of the day, participants attended their selected break-out group.

Day 3

Plenary Session

The day began with additional presentations by conference participants. Robert Raye of Shell Oil Company provided an overview of data services and product generation and delivery at Shell. He showed a very interesting plot of a historical database of the Loop Current position. A great open source Google look-alike for private use is Openlayers; Google Inurl: "Arcmap/rest " inurl: "MapServer."

Tucker Pierce from Tellus Applied Sciences gave an overview of the CBIBS data management and the efforts toward QA/QC, which make use of off-the-shelf and/or open source products and services. The presentation slides can be found in appendix L.

Mark Bushnell and Chris Paternostro, (NOAA/NOS/CO-OPS), provided a brief presentation on the beam interference found on acoustic Doppler current profiler (ADCP) installations on aids-to-navigation (ATON) and planned solutions. Darryl Symonds from Teledyne RD Instruments, an acoustic Doppler current profiler manufacturer, explained that one beam side lobe hitting an obstruction in the near field can easily bleed into the two adjacent beams, which was a better explanation than the previous explanation (that coordinate imperfect transforms cause bleed over). The Waves and Currents Breakout Group 2 continued discussing the QA/QC of wave data generated from Teledyne RD Instruments ADCP systems. In the afternoon session Group 2 started developing QA/QC for Nortek currents and waves, Sontek currents, Aanderaa currents, and included placeholders for Sontek waves and Linkquest waves and currents.

Workshop Organization and Breakout Groups

Workshop participants selected one of two breakout groups: Group 1 (biogeochemical) includes DO, pH, conductivity, temperature, turbidity, ORP, and depth; Group 2 includes waves and *in situ* currents, which have been covered extensively at previous QARTOD workshops. For this reason, Breakout Group 2 was further along in developing QA/QC standards than Breakout Group 1, whose topics had not received as much attention.

As part of the pre-conference preparation, organizers developed a list of three questions to be addressed by each group:

Question 1: What is the definition of the scope of the Quality Control Application?

Question 2: What real-time QC tests must be applied to each parameter?

Question 3: What QC flags or flagging conventions must be applied?

Question 1 defines the problem and assesses the interest and expertise of the breakout group members (who is doing what type of work and using what instruments). This led to defining specifically what Question 2 (QC tests) applies to. Given the entries, the group agreed on a clear statement to keep the focus on what QC tests etc. will be discussed. From the given example in Table 1, the statement would be something like "We are addressing quality control for real-time surface wave measurements observed from a bottom-mounted ADCP." Certain tests may be needed for some uses/deployments of an instrument but not for others (e.g. you may need an additional test for currents from a hull mounted ADCP as opposed to a fixed side-looking ADCP). Each group was to decide whether the tests defined in Question 2 can be applied to other deployments, etc. The goal was to ensure that all participants were on the same page when addressing Question 2.

Description of fields in Question 1 (Table 1):

User: "Users" may be instrument operators, data managers, data assembly centers, etc. They may operate one instrument or be a hub of receiving data from several sources.

Manufacturer: The instrument manufacturer(s).

Application: What are the data being used for or why are they being collected: forecast models, real-time beach monitoring, alert/warning systems; engineering/assessment projects?

Type of Measurement: These are our topic area (may be direct observations or derived properties) surface waves; *in situ* currents; surface currents; conductivity, temperature, depth; DO; pH; turbidity.

Method of Measurement: The instrumentation used for the observations. It was suggested that the Make/Model be included in this field. **Example:** Not just ADCP but Teledyne RD Instruments Workhorse XXX ADCP.

Deployment: Fixed, moored, etc. and position/orientation (surface, bottom, mid-water)

Table 1

Question 1	Define the scope of the Quality Control Application				
User	**Application**	**Type of measurement**	**Manufacturer**	**Method of measurement /instrument**	**Deployment**
(e.g. Data Assembly Center)	(e.g. Ocean Model)	(e.g. Surface Waves)	(e.g. Teledyne RD Instruments)	(e.g. ADCP)	(e.g. bottom mounted)
(e.g. Observing system operator)	(e.g. monitoring project)	(e.g. temperature, conductivity)	(e.g. Sea-Bird)	(e.g. CTD (SBE 9plus))	(e.g. moored)

Question 2 (Table 2) basically asks "What test do you apply?" The description of fields in Question 2 is as follows:

Test name: Common, agreed upon name for each test.

Application: What data is the test applied to: time series data; parameter/observation values?

Test definition: Agreed upon definition of the test. (This will become the registered definition for Q2O.)

Test description: Further or associated explanation of the test or example of how it is handled.

Define inputs to the test: (see below) e.g. pressure data, temperature data, etc.

Define criteria used in the test: (see below) e.g. minimum, maximum, number of iterations, etc.

Define outputs from the test: (see below) e.g. temperature data, QC flag, etc.

Order: identify the order (if any) in which the tests should be performed.

Action: identify any action that should occur based on the results of a test (interpretation of a flag).

Inputs/criteria/outputs: Tests are applied as part of a process. Data are fed in, criteria (either user defined or calculated) are applied with the test and some result (data and test result/flag) is the output.

Table 2

Question 2	What real-time quality control tests must be applied to the observation?								
Observation Application (All, C, T, P, DO, pH, ...)	**Test Name**	**Data Application (Applied to Time Series (raw, calibrated data) parameter values, spectral data,...)**	**Test Definition**	**Test Description**	**Define the inputs to the test**	**Define any criteria (limits) used within the test**	**Define the outputs of the test**	**Test Order**	**Action (interpretation of flag)**
Waves	Mean Shift Test	time series data	This test breaks the time series into N segments (number of segments) of M points (number of points) each. The segment means are compared to neighboring segments. If the difference in the means of two consecutive segments exceeds P (acceptable shift), the two data segments are rejected and the test fails. The data-provider defines N segments, M points, and P.	Breaks the time series into N segments of M points each. The segment means are compared to neighboring segments. If the difference in the means of two consecutive segments exceeds P, the data are rejected.	Define the inputs to test	N segments (number of segments)	Define the outputs from the test pass/fail flag	3	
Pressure, Conductivity, Temperature (QARTOD-III)	Range Tests (Gross)								
Pressure, Conductivity, Temperature (QARTOD-III)	Range Test (Climatological)								
Pressure, Conductivity, Temperature (QARTOD-III)	Gradient Test								
Pressure, Conductivity, Temperature (QARTOD-III)	Spike Tests								
Pressure (QARTOD-III)	Compare with surface pressure								
Pressure, Conductivity, Temperature (QARTOD-III)	Dual Sensor comparison								
Pressure, Conductivity, Temperature (QARTOD-III)	Density Inversions								
Pressure, Conductivity, Temperature (QARTOD-III)	Freezing Point								
Temperature (QARTOD-III)	Nearest Neighbor								
Temperature (QARTOD-III)	TSP relationships (?)								
Temperature (QARTOD-III)	Compare w / Conductivity								
Conductivity (QARTOD-III)	Compare w / Temperature								
Conductivity (QARTOD-III)	Descent Rate								

Q2O material to reference while addressing Question 2.

In previous QARTOD meetings, the resulting recommended tests were presented in a tabular form. Q2O needed to turn that into "vocabulary" that could be registered with Marine Metadata Interoperability (MMI) (http://marinemetadata.org) in order to provide "resolvable" links in our SensorML descriptions of the data QC processing.

Output from QARTOD looked like this:

TIME SERIES (Raw Calibrated Data)				
Category	**Criteria**	**Order**	**Flag**	**Action**
Acceleration test	User defined (a>M*g)	3	Soft	Recommended M<=1/2. Interpolate/extrapolate up to N contiguous points. N is user defined. Include in % count.
Mean test, variance test	User defined, location dependent	4	1. Soft 2. Hard	1. Flag unexpected values. 2. Reject unreasonable values.

Q2O needed a definition, along with any of the variables/criteria needed for each of the tests. This was formed into a "vocabulary" or "dictionary" set initially as an Excel spreadsheet and then converted to a .csv file. The .csv file was then registered with the MMI Ontology Registry and Repository (ORR), where an RDF (Resource Description Framework) file and a resolvable URL were created.

Q2O dictionary looked like this:

=== Tests and Criteria ==========
"ID", "Long Name", "Short Name", "Definition", "Symbol", "Reference", "Figure", "Approval", "Relationship", "Equation", "[Notes]"
==========
"urn:__:Q2O:test:accelerationTest", "Acceleration Test", "", "The second derivative for each point of the time series of vertical surface displacement is a computed or direct measure of acceleration. The acceleration measurement is tested it against natural limits, approximated as M*g.", "", "urn:__:Q2O:ref:qartod_waves_2007", "", "", "urn:__:Q2O:criteria:maximumAccelerationFactor", "", "[Reworded from reference to make it more general for other applications besides waves.]"

The term registered at MMI gives a persistent URL that is used in the SensorML files and can be used to develop associations of tests across authorities:

http://mmisw.org/ont/q20/test/accelerationTest

So… the following were identified as needed from QARTOD: (1) those definitions of tests and variables, (2) the inputs and outputs to each test, (3) the order tests need to be performed, and (4) how the test results are to be interpreted.

Question 3 (Table 3) facilitated the discussion of how the output of Question 1 and Question 2 was passed on to the users in the form of flag indicators of data quality.

Table 3

Question 3:	**Questions related to QC flags or flagging conventions**		
What categories of real-time quality descriptor flags should be applied?	**Are flags applied to each specific test as well as to the overall data quality?**	**How is the aggregate data quality determined?**	**What real-time calibration flags should be applied?**
(e.g., 1 - Passed QC, 2 - Failed QC…)	(e.g. Yes / No - Why?)	(e.g., One failed flag then entire observation failed)	(e.g. Time since last calibration)

Breakout Group 1 - Biogeochemical

Group 1 sought to identify and define quality control tests and practices for real-time biogeochemical observations (e.g. conductivity, pH, turbidity, DO). Stephanie Kavanaugh served as process facilitator, Brenda Babin and Grace Cartwright were the technical facilitators, and Stephanie Kavanaugh recorded notes (appendix I).

Grace Cartwright provided findings from Group 1; a summary is found on the next page.

Breakout Group 2 – Waves and Currents

Group 2 sought to provide clarification and additional input to previously identified waves and *in situ* currents QC practices and to expand on them for different instruments. Helen Worthington (REMSA, Inc.) served as process facilitator, Bill Burnett and Mark Bushnell served as technical facilitators, and Sara Haines recorded notes (appendix J).

Bill Burnett provided findings from Group 2; a summary can be found on the next page.

Conclusions

In the final session, all participants reconvened, and Group 1 (biogeochemical) and Group 2 (waves and *in situ* currents) technical facilitators presented summaries from their respective breakout sessions.

Report out from Group 1 (Biogeochemical)

Grace Cartwright reviewed skill sets represented at QARTOD V and indicated that the group had eliminated pH because of a lack of expertise for that parameter. The group reduced the challenge to single time series of moored instruments, including temperature, conductivity, DO, turbidity, chlorophyll, and CTD pressure. They also reduced the tests to simple pass fail, gross range, rate of change, outlier, spike, stuck, syntax (combined parity and checksum). More development of higher level tests is required, such as neighbor checks and parameter/parameter checks.

Bill Burnett displayed several interesting water temperature/DO plots from NDBC sensors (see appendix K) and the group discussed the plausibility of applying the developed QC checks, and what new checks may need to be developed at QARTOD VI. Participants were enthusiastic in responding to real world data. The group agreed that reviewing historical data was critical to developing location-specific tests. A great QARTOD recommendation would be to require installation and operation for some period of time before data are released in real time.

Report out from Group 2 (Waves and Currents)

Bill Burnett provided an overview of the group effort to combine waves and currents, and to develop new QC for additional sensors. Janet Fredericks reviewed the combined TRDI ADCP waves QC developed for her cabled systems and for her further Q2O efforts. Dick Crout (NOAA/NDBC) reviewed the development of QC checks for new sensors. A synopsis of these QC checks can be found in Table 4.

General Wrap-up

Action items for wrap-up of QARTOD V include:

- Janet Fredericks offered to post PowerPoint presentation and newly-developed QC tables on the QARTOD.org web page.
- Perhaps tables may also be submitted to IOOS/DMAC and JCOMM IODE.
- Bill Burnett will draft a final report for review by the QARTOD Steering Committee.

Table 4

CATEGORY	CRITERIA	ORDER	FLAG	ACTION	COMMENTS	TRDI WAVES	TRDI CURRENTS	NORTEK WAVES	NORTEK CURRENTS	SONTEK CURRENTS	SONTEK WAVES	AADI CURRENTS	LINKQUEST	MAVS
Sensor Health	Sensor generated health status		3 = Pass 2= Suspect 1 = Fail		Check for change in Status		Bit Test Test 1	Error and Status Codes	Sensor Health Flag		Checksum for data recording and transmission			
Error Velocity	Pass >EVMax Suspect > EVMin Fail < EVMin		3 = Pass 2= Suspect 1 = Fail		Performed for each depth			NA						
Percent Good	Pass > PGMax Suspect > PGMin Fail < PGMin		3 = Pass 2= Suspect 1 = Fail	PGMax, PGMin values from setup	Performed for each bin in each depth			AST 10% bad outliers, replaced by PUV	Provide definition of bad detects?					
Correlation Magnitude	Pass > CMMax Suspect > CMMin Fail < CMMin		3 = Pass 2= Suspect 1 = Fail	CMMax, CMMin values from setup	Performed for each bin in each depth	CMMin=64		NA	Correlation reported out; represents what?					
Vertical Velocity	Pass > VVMax Suspect > VVMin Fail < VVMin		3 = Pass 2= Suspect 1 = Fail	VVMax, VVMin values from setup	Performed for each depth				User Defined Inputs?					
Horizontal Speed	Pass > HVMax Suspect > HVMin Fail < HVMin		3 = Pass 2 = Suspect 1 = Fail	HVMax, HVMin values from setup	Performed for each depth		Yes		Same , User defined inputs	Yes	(All TS) 1. Less than max speed. 2. Variability of UV components. 3. If UV strong, adjust frequencies.	Yes		
Current Direction	Pass > DirMiin and < DIrMax Fail < DirMin or > DirMax			DirMin = 0.00 DirMax = 360.00	Performed for each depth		Yes		Same	Yes		Yes		
In Water Interactions	Pass = No Beam delta > 30 counts Suspect = 1 beam delta > 30 counts Fail = 2 or more beams delta > 30 counts	Profile Test	3 = Pass 2 = Suspect 1 = Fail	Difference beam intensities in adjacent bins along each beam		NA	YES To find the surface or bottom		User Defined Inputs	NA		NA		
Tilt Variability/Variance					For waves processing, compute average/variance, then omit over variance	TEST2								
Sensor Tilt/Pitch&Roll					on ping by ping basis	TEST2								
Sensor Tilt/Pitch&Roll	Pass < TiltMin Suspect < TiltMax Fail > TiltMax		3 = Pass 2 = Suspect 1 = Fail		ensemble		YES	Yes for AST, less than 5 deg	Upper limits will be provided	TiltMax = 20 deg TiltMin = 5 deg PitchSD RollSD		TiltMax = 25 deg		
Sensor Tilt/Variance					ensemble hour to hour			Diagnostic data can be sampled depending on user input	Diagnostic data can be sampled depending on user input					
Sensor Comp SD										CmpMax = 25 deg CmpMin = 10 deg				
Data Gaps					Data gap includes short records, truncatoins, and too many random missing data points.	TEST 1		Gaps in AST replaced with PUV in optimized option (more than 10% data missing). Normal operation uses PUV only. AST only. SUV also. [AST reporting percentage/number]						
Pings	Pass > MaxPing Fail < MaxPing									MaxPing = 0.90		MaxPing = 110		
Orthogonal Currents SD	Pass 3 Comp < SCMSDX Suspect 1 Comp > SCMDX Fail 2 Comp > SCMSDX									Experience shows SDMDX values of 0.20 are appropriate				
Echo Amplitude					Indication of in-water objects. Related to correlation magnitudes.				Signal Strength, Range in counts from 0-255. NORTEK provide thresholds?					
Batt Voltage									Volts, User inputs	SCMBatt 10 volts				
Water Temp	Reasonableness with other available temperatures				Yes				Yes					
Pressure	Reasonableness with other available pressure and use for cutoff				Yes				Yes		(TS) PUV pressure variability -- (TS) Depths are appropriate (not too deep??)			
Time Stamp	Stuck or future time, insure increments are correct													
Speed of Sound	Use temperature measurement, range and rate of change check			written into data file,					Calculated or user input					
SNR									Yes					
Percent Solutions	Profile test			here										
Decay Factor	(TS) Insure Decay factor > X,										Manufacturer input			
Minimum # data points	(TS) # >128										Manufacturer input			
Wave Height	Range test							SWH > 20 meters,			Regional Wave Height values			
Peak Period	Range test, T < 20 secs													
Peak Spectral Period								< 50 seconds						

Acknowledgments

The participants of QARTOD V brought a tremendous collective wisdom to the table, resulting in a successful conference. This success may not have been possible without the efforts of the organizing committee, and we gratefully acknowledge the following for their contributions:

Brenda Babin (Louisiana State University)

Julie Bosch (NOAA/National Coastal Data Development Center)

Bill Burnett (NOAA/National Weather Service/National Data Buoy Center)

Mark Bushnell (NOAA/National Ocean Service/Center for Operational Oceanographic Products and Services)

Janet Fredericks (Woods Hole Oceanographic Institution)

Sara Haines (University of North Carolina)

Stephanie Kavanaugh (NOAA/NOS/Special Project Office)

Mario Tamburri (Alliance for Coastal Technologies)

Sue Sligh (University of Maryland Center for Environmental Science)

Helen Worthington (NOAA/NOS/CO-OPS – REMSA, Inc.)

List of Appendices

Appendix A Meeting Agenda

QARTOD V

Tuesday, November 17, 2009

Time	Topic	Location	Speaker
7:15 - 8:30am	Continental Breakfast/Registration	Omni Hotel	
8:30 – 8:45	Opening Remarks/Introductions	Omni Hotel	Mario Tamburri
8:45 – 9:30	Workshop Goals / "What is QARTOD?"	Omni Hotel	Bill Burnett NWS/NDBC
9:30 – 10:00	IOOS Program – "QARTOD and IOOS – Where does it belong?"	Omni Hotel	Charles Alexander NOAA IOOS Program
10:00 – 10:30	QA Initiative for sensors – methods and data compatibly	Omni Hotel	Dan Sullivan USGS Office of Water Quality
10:30 – 11:00	COFFEE BREAK	Omni Hotel	
11:00 – 11:45	QARTOD to Open Geospatial Consortium (Q2O) Status – Integrating QC tests into Sensor Web Services	Omni Hotel	Janet Fredericks WHOI
11:45 – 12:00	Breakout Group Preparations - Logistics	Omni Hotel	Bill Burnett
12:00 – 1:00	LUNCH (provided)	Omni Plaza	
1:00 – 3:00	Breakout Groups (Water Quality and ADCP-Waves/Currents)	Omni Hotel (Rooms TBD)	Facilitators
3:00 - 3:30	BREAK	Omni Hotel	
3:30– 5:00	Breakout Groups	Omni Hotel (Rooms TBD)	Facilitators
5:00 – 5:30	Facilitators Regroup – for meeting	Omni Hotel	Facilitators
6:00 – 8:30pm	Dinner gathering - Participants Responsibility	TBD	

Wednesday, November 18, 2009

Time	Topic	Location	Speaker
7:15 - 8:30am	Continental Breakfast	Omni Hotel	
8:30 – 10:00	Breakout Sessions	Omni Hotel (Rooms TBD)	Facilitators
10:00 - 10:30	COFFEE BREAK	Omni Hotel	
10:30– 12:00	Breakout Sessions		Facilitators
12:00 – 1:00	LUNCH	On Your Own	
1:00 – 3:00	Breakout Sessions	Omni Hotel (Rooms TBD)	Facilitators
3:30 – 3:30	BREAK	Omni Hotel	
3:30 – 5:00	Review of Breakout sessions	Omni Hotel (Rooms TBD)	Facilitators
Dinner	Participants Responsibility		

Thursday, November 19, 2009

Time	Topic	Location	Speaker
7:15 - 8:30am	Continental Breakfast	Omni Hotel	
8:30 – 10:00	Breakout Session Reports	Omni Hotel	Facilitators
10:00 - 10:30	COFFEE BREAK	Omni Hotel	
10:30 – 12:00	Review Action Items – Prepare for QARTOD VI	Omni Hotel	Bill Burnett
12:00	End QARTOD Meeting		

Appendix B List of Meeting Participants

Name	Organization	Contact Information	Interest
Brenda Leroux Babin	Louisiana Universities Marine Consortium	bbabi12@lsu.edu	none
Luke Beatman	CENCOOS/MBARI	lbeatman@mbari.org	CTD
Julie Bosch	NOAA NCDDC	julie.bosch@noaa.gov	CTD
Richard Bouchard	NOAA's National Data Buoy Center	richard.bouchard@noaa.gov	Waves
Bill Burnett	National Data Buoy Center	bill.burnett@noaa.gov	Insitu currents
Mark Bushnell	NOAA/NOS	Mark.Bushnell@noaa.gov	Waves
Grant Cameron	UCSD-Scripps Institution of Oceanography	grant@splash.ucsd.edu	Waves
Grace Cartwright	Virginia Institute of Marine Science	gracec@vims.edu	Turbidity
Dick Crout	NOAA NDBC	richard.crout@noaa.gov	Insitu currents
Jamie Davis	CenGoos	j.davis@usm.edu	
Jeff Donovan	USF - College of Marine Science	jdonovan@marine.usf.edu	Currents and Waves
Janet Fredericks	WHOI/MVCO	jfredericks@whoi.edu	Waves
Eli Greenbaum	Oak Ridge National Laboratory	greenbaum@ornl.gov	CTD
Karen Grissom	NOAA/NDBC	karen.grissom@noaa.gov	CTD
Sara Haines	University of North Carolina	sara_haines@unc.edu	ALL
Kent Hathaway	US Army Corps Engineers (FRF)	Kent.K.Hathaway@usace.army.mil	Waves
Lei Hu	Dauphin Island Sea Lab	lhu@disl.org	ALL

QARTOD V

Name	Organization	Contact Information	Interest
Carol Janzen, Ph.D.	Sea-Bird Electronics	cjanzen@seabird.com	CTD
Robert Jensen	USACE Engineer Research and Development Center	Robert.E.Jensen@usace.army.mil	Waves
Stephanie Kavanaugh	National Ocean Service, MBO	stephanie.kavanaugh@noaa.gov	ALL
Steven Le	CeNCOOS	leho@saic.com	
Brian McCall	U.S. Geological Survey	bemccall@usgs.gov	Waves
Ted Mettlach	SAIC-NDBC	ted.mettlach@noaa.gov	Waves
Steve Parmley	YSI	sparmley@ysi.com	All
Chris Paternostro	NOAA / CO-OPS	christopher.paternostro@noaa.gov	Insitu currents
Tucker Pierce	Tellus Applied Sciences	pierce@tellusappliedsciences.com	Dissolved Oxygen
Xiaoyan	UNC Wilmington	qix@uncw.edu	Data Management
Dan Ramage	Baruch Marine Institute	dan@inlet.geol.sc.edu	none
Rob Raye	Shell	robert.raye@shell.com	Waves
Rodney Riley	NOAA/NDBC	rodney.riley@noaa.gov	All
Rosemary Smith	Fugro GEOS, Inc.	rbsmith@fugro.com	Insitu currents
Derrick Snowden	NOAA Climate Program Office	derrick.snowden@noaa.gov	CTD
Vembu Subramanian	USF - College of Marine Science	vembu@marine.usf.edu	Currents and Waves
Dan Sullivan	U.S. Geological Survey	djsulliv@usgs.gov	QA/QC

Name	Organization	Contact Information	Interest
Darryl Symonds	Teledyne RD Instruments	dsymonds@teledyne.com	none
Mario Tamburri	Alliance for Coastal Technologies	tamburri@cbl.umces.edu	ALL
Dick Thayer	SAIC/NDBC	richard.thayer@noaa.gov	Dissolved Oxygen
Helen Worthington	REMSA, Inc.	helen@worthcom.com	All

Appendix C Presentation by Mario Tamburri, ACT

ALLIANCE FOR COASTAL TECHNOLOGIES

ACT Headquarters
One Williams Street
Solomons, MD 20688
(410) 326-7385
info@act-us.info
www.act-us.info

ACT Priorities

- Transition emerging technologies to operational use rapidly and effectively
- Maintain a dialogue among technology users, developers, and providers
- Identify technology needs and novel technologies
- Document technology performance and potential
- Provide the information required for deployment of reliable and cost-effective observing networks

ACT Services

- A third-party testbed for evaluating coastal technologies
- A forum for capacity and consensus building
- An information clearinghouse for coastal technologies

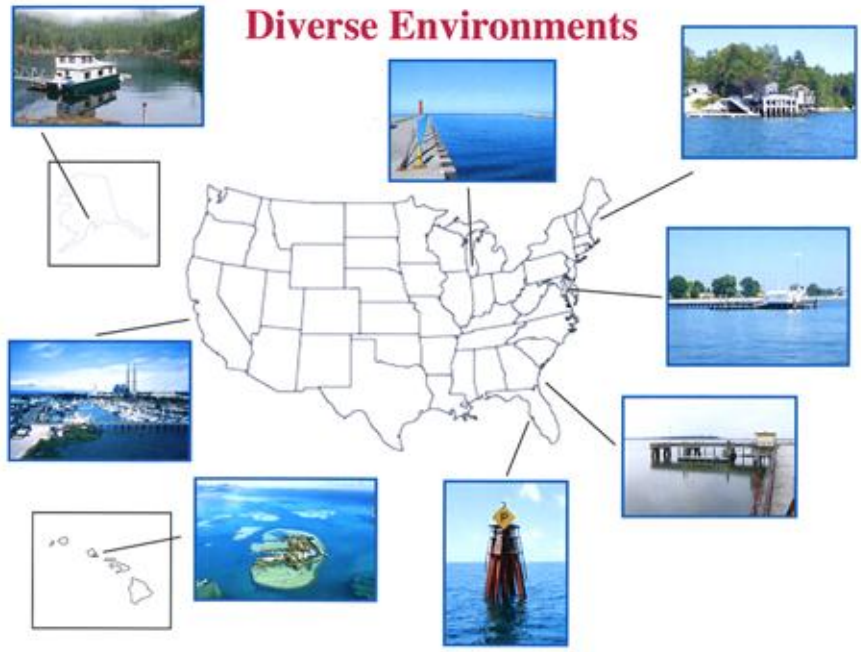
IOOS®

ACT Technology Evaluations

Enable existing and new technologies to be identified and made available for coastal science, management, and IOOS.

- Types of Evaluations:
  - Performance Verification
  - Performance Demonstration
- Purpose:
  - Document performance under third party tests
  - NO certifications, recommendations, or comparisons
- Benefits:
  - Access to relevant, reliable performance information
  - Enhanced ability to identify appropriate technologies
  - Level playing field among manufacturers
  - Accelerated adoption of innovative technologies
- Credibility:
  - Objective testing
  - Skilled, trained personnel
  - Sound methodologies with statistical rigor
  - Comprehensive documentation
  - Rigorous QA/QC


ACT Partner Institutions
UAF UNIVERSITY OF ALASKA FAIRBANKS
Alaska SeaLife Center
CILER
University of Michigan
Cooperative Institute for
Limnology & Ecosystems Research
GoMOOS
Gulf of Maine
Ocean Observing System
Moss Landing
Marine Laboratories
MBARI
Monterey Bay Aquarium
Research Institute
CENTER FOR ENVIRONMENTAL SCIENCE
Chesapeake Biological Laboratory
SkIO
Skidaway Institute
of Oceanography
soest
university of hawai'i
USF
UNIVERSITY OF
SOUTH FLORIDA

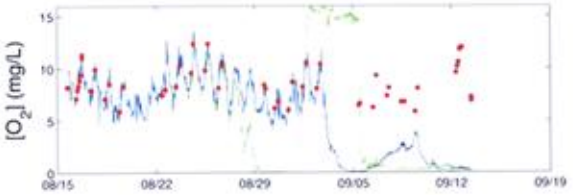

Diverse Environments

Performance Verifications/Demonstrations

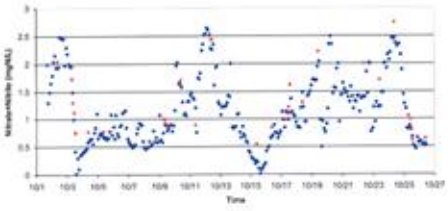
- **DO Sensors (2004)** - Aanderaa (optode), Greenspan (galvanic cell), In-Situ (optode), YSI (Clark cell)
- **Chl-a Fluorometers (2005)** - bbe Moldaenke, Chelsea (2), Hydrolab, Turner (2), WET Labs, YSI
- **Turbidity Sensors (2006)** - Aquatec, In-Situ, McVan, WET Labs, YSI
- **Nutrient Analyzers (2007)** - American EcoTech, Satlantic, WET Labs, YSI
- **C-T Sensors for In Situ Salinity (2008)** - Aanderaa, Campbell, Falmouth, Greenspan, In-Situ, RBR, Rockland, YSI
- **pCO_2 Analyzers (2009)** - Contros, NOAA/PMEL, Pro-Oceanus, Sunburst, YSI

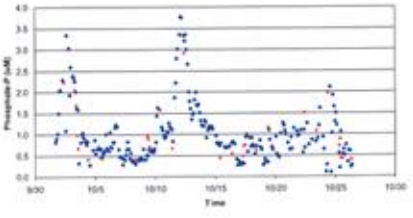
Performance Verifications/Demonstrations

- **Biofouling**



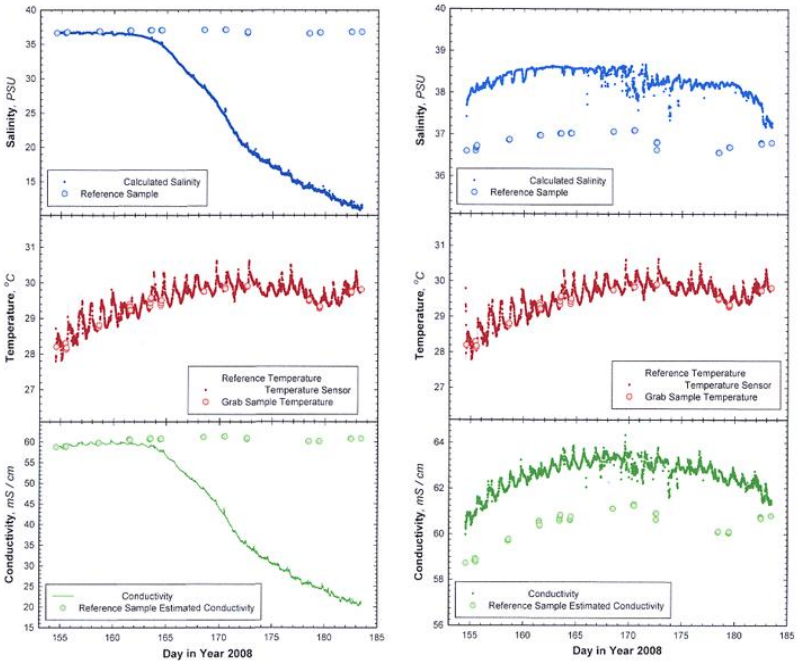
- **Nutrient Analyzers**

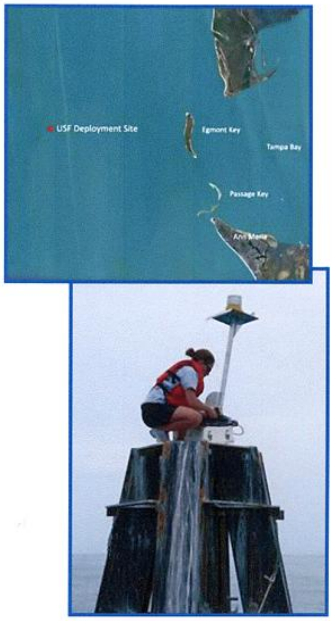




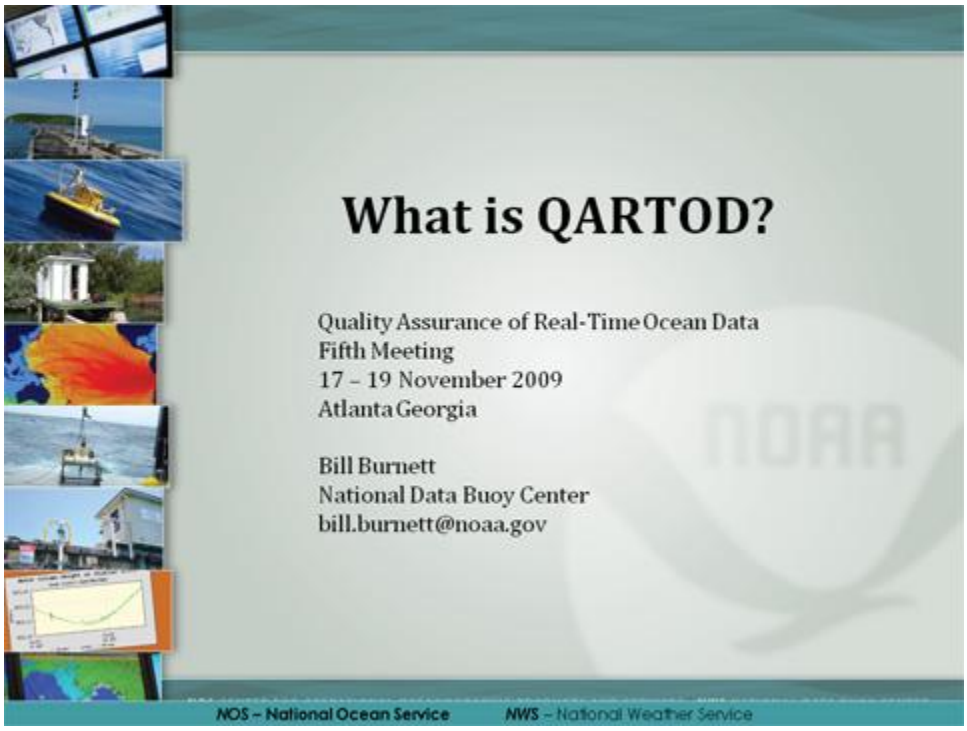
ACT Verifications of Salinity Sensors

Examples from offshore of Tampa Bay



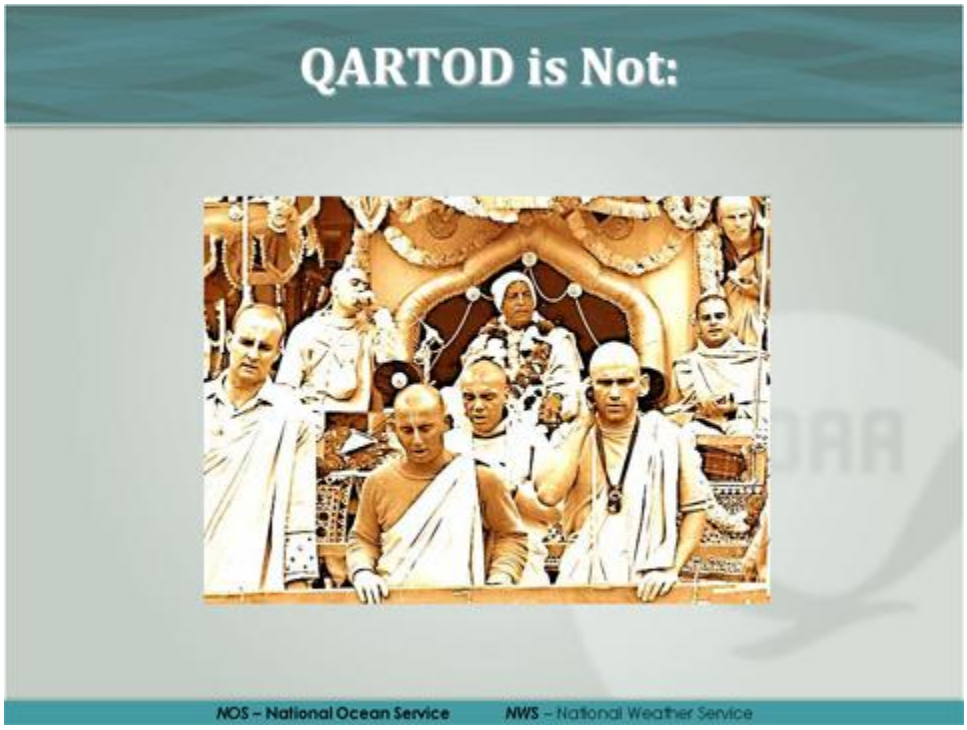


Appendix D Presentation by Bill Burnett, NWS/NDBC



QARTOD V


QARTOD is Not:
NOS – National Ocean Service
NWS – National Weather Service


QARTOD is Not:
NOS – National Ocean Service
NWS – National Weather Service

QARTOD is:

NOS – National Ocean Service NWS – National Weather Service

QARTOD is:

Websters defines QARTOD as a "grassroots" group that derives most of its power and reason for being from a community, and from "common ordinary people."

QARTOD is also independent of any one person: it has leaders, but no one leader is so important that if that person left or died, the organization would not be able to continue. Leadership is shared, skills are taught to all members of the organization so that each person in the organization has her or his job, but also has skills to do other jobs and a goal of the organization is to share information and skills to as many people as possible, as well as to invite as many people as possible to participate.

NOS – National Ocean Service NWS – National Weather Service

QARTOD V


QARTOD II – Norfolk, VA
28 Feb – 2 March, 2005
NOS – National Ocean Service
NWS – National Weather Service


QARTOD III – Scripps Institution
2 – 5 Nov, 2005
NOS – National Ocean Service
NWS – National Weather Service

QARTOD IV – Woods Hole
21 – 23 June, 2006

NOS – National Ocean Service NWS – National Weather Service

QARTOD I – Stennis Space Center
3 – 5 Dec, 2003

NOS – National Ocean Service NWS – National Weather Service

Ghosts of QARTOD-Pasts:

	Q1	Q2	Q3	Q4
# Attendees	~ 80	~80	~70	~60
Location	Gulf Coast	East Coast	West Coast	Northeast
Food	?	Regional	Scripps Aquarium	Lobster
Funding Agency	NOAA	NOAA	NOAA	NOAA

NOS – National Ocean Service NWS – National Weather Service

QARTOD OUTCOMES

QARTOD I

- Resulted in monumental decisions for an ocean community struggling to understand the challenges related to data from the IOOS®.

NOS – National Ocean Service NWS – National Weather Service

QARTOD I
Seven Data Management Laws

1. Every real-time observation distributed to the ocean community must be accompanied by a quality descriptor.
2. All observations should be subject to some level of automated real-time quality test.
3. Quality flags and quality test descriptions must be sufficiently described in the accompanying metadata.
4. Observers should independently verify or calibrate a sensor before deployment.
5. Observers should describe their method / calibration in the real-time metadata.
6. Observers should quantify the level of calibration accuracy and the associated expected error bounds.
7. Manual checks on the automated procedures, the real-time data collected and the status of the observing system must be provided by the observer on a time-scale appropriate to ensure the integrity of the observing system.

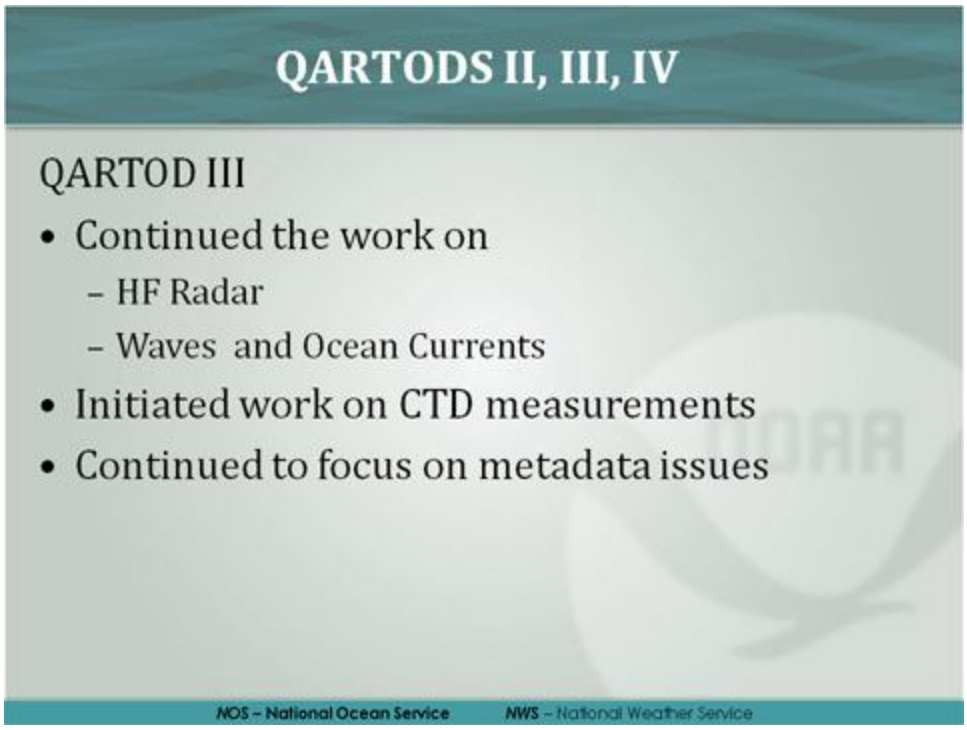
NOS – National Ocean Service NWS – National Weather Service

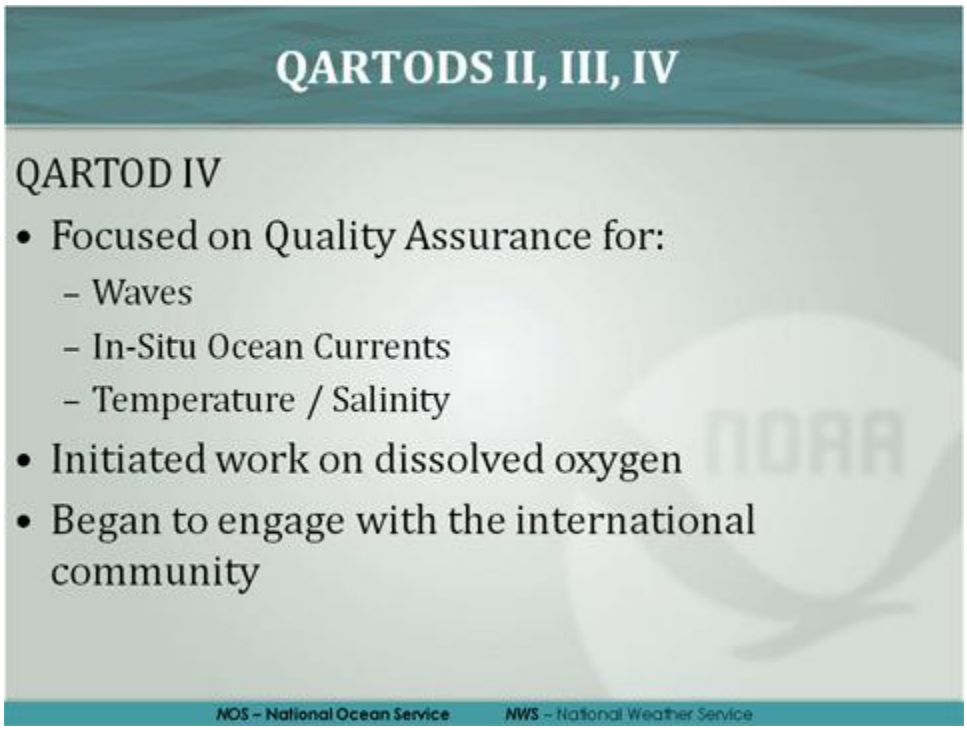
QARTODS II, III, IV

QARTOD II

- Focused on QA/QC issues in High Frequency Radar (HF Radar) measurements,
- Wave/current measurements and their unique calibration,
- Metadata requirements
- Developed quality descriptors for each system and set the level of automated (and manual) QC for each observation

NOS – National Ocean Service NWS – National Weather Service


QARTODS II, III, IV
QARTOD III
• Continued the work on
– HF Radar
– Waves and Ocean Currents
• Initiated work on CTD measurements
• Continued to focus on metadata issues
NOS – National Ocean Service
NWS – National Weather Service


QARTODS II, III, IV
QARTOD IV
• Focused on Quality Assurance for:
– Waves
– In-Situ Ocean Currents
– Temperature / Salinity
• Initiated work on dissolved oxygen
• Began to engage with the international community
NOS – National Ocean Service
NWS – National Weather Service

OUTCOMES

Waves QC Document

In-Situ Ocean Currents Document

Workshop Objectives

- To report on the recommended quality control tests for some biogeographic parameters and to review and approve the Q2O implementation of QC tests for waves and in situ currents.
- To explore ways to expand our interaction with similar international efforts.
- Workshop product: A final report will be posted on the QARTOD website.

Schedule for Breakout Groups

Day 1/Day 2

- Define the scope of the quality control application.
- Determine the real-time quality control tests that must be applied to the observation.

Day 2

- Answer questions related to quality control flags or flagging conventions.

NOS – National Ocean Service NWS – National Weather Service

Appendix E Presentation by Dan Sullivan, USGS

METHODS AND DATA COMPARABILITY BOARD

Dan Sullivan
USGS
Co-chair, Methods Board

Gayle Rominger
YSI, Inc.
Sensors workgroup co-chair

OUTLINE

- A brief history of the Board
- Current projects

WORKGROUPS

- Sensors
- NEMI – National Environmental Methods Index
- Water Quality Data Elements

- PBMS
- Laboratory Accreditation
- Nutrients
- DQO/MQO

- Biology
- New Technologies

HISTORY

- Created in 1997

- Preceded by Interagency Task Force on Monitoring

- Methods and Data Comparability Board is a workgroup of the National Water Quality Monitoring Council

THE MDCB – AN ACTIVIST FACA

- The Board & Council are ACWI subgroups
  - Empowered to give advice to the Federal government
- The Board has always brought products to fill important voids in the water quality monitoring enterprise
  - Usually doing the work itself
    - Funding from USGS, EPA, YSI

SENSORS WORKGROUPS

- QA Initiative
  - ACRR Matrix
  - Field Deployment Guide
  - Data Elements
  - Glossary
- Technology
- ACT/NEMI collaboration

SENSORS QA INITIATIVE

- After the 2008 conference, sensors became a priority for the Board
- Address issues of quality assurance
- Plan to roll out products at 2010 conference

SENSORS QA INITIATIVE

- Membership
  - Core group
    - Industry (YSI, In-Situ, Hach)
    - Gov't
    - Consultant
  - Review board (gov't. and academia)

SENSORS QA MATRIX

- "Vital Signs" parameters – DO, pH, SC, Temp, Turbidity, ORP & depth
- Matrix organized by sensor type
- "ACRR" – contains info on actions to ***affect*** (calibrate, clean probe, etc.), ***check*** (prec & bias), ***record***, and ***report***

EXAMPLE QA MATRIX FOR TEMPERATURE

Technology	Data quality aspect	Affect [Control]	Check	Record	Report	Comments
Thermistor or RTD	Accuracy/ bias	Wait for Stable reading	Conduct 3-point check	Avg. of 3, NIST value, NIST acc. value	Bias	Notes on technology, NIST, other
" "	Precision	Use consistent procedures	Repeat 3-5 times in lab conditions	Record repeated measurement	Compute SD	
" "	Interference	Clean probe				

FIELD DEPLOYMENT GUIDE

- Field guide w/ refs to more detail
- Micro site selection, not study design
- Environments:
  - Lakes/ponds
  - Rivers/streams
  - Estuaries/bays
  - Coastal
  - Ephemeral streams
- Continuous monitoring & episodic

FIELD DEPLOYMENT GUIDE (cont)

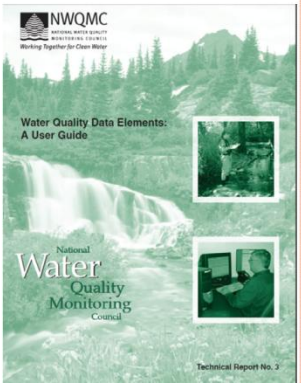
- Site considerations
  - Flow variation
  - Hydrodynamic
  - Vegetation
  - Biofouling
  - Anthropogenic
  - Meteorological
- Platform Design
- Sampling tips
  - In situ
  - Pump through & autosamplers
  - Spot sampling
  - Biofouling

FIELD DEPLOYMENT GUIDE (cont)

- Checklist of considerations
  - Spatial
    - Horizontal
    - Vertical
    - Location w/in vertical
  - Temporal
    - Seasonal
    - Diurnal
  - Number of samples

DATA ELEMENTS FOR SENSORS

- Metadata (who, what, when, where, why, & how)
- Add elements for continuous data, e.g.,
  - Dense time series
  - Corrections for drift
- Will update 2006 user guide



DATA ELEMENTS (cont)

- Modules
  - Who
  - Result – what
  - Reason – why
  - Date/time – when
  - Location – where
  - Sample collection – how
  - Sample analysis - how

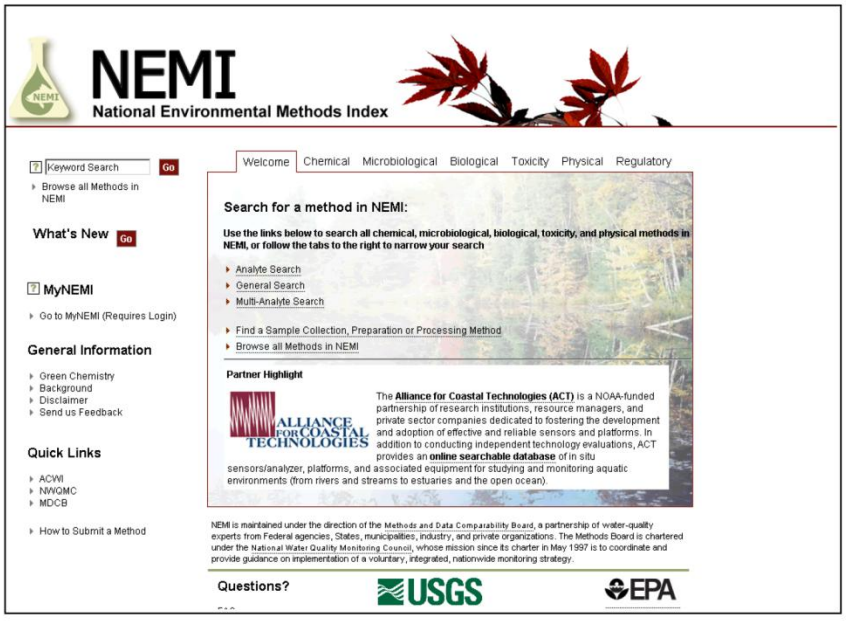
DATA ELEMENTS (cont)

3.1.1	Identity	3.1.1.1	Study Dataset ID
3.1.2	Scenario	3.1.2.1	Scenario or Question
		3.1.2.2	Season of Interest
3.2.1	Spatial intent	3.2.1.1	Station Selection Intent
3.2.2	Temporal Intent	3.2.2.1	Sample Timing Intent
3.3.1	Spatial design	3.3.1.1	Reach Selection Design
		3.3.1.2	Station Selection Design
3.3.2	Temporal design	3.3.2.1	Seasonal Sampling Design
		3.3.2.2	Diurnal Sampling Design
3.4.2	Documentation of change	3.4.2.1	Sampling Frequency
		3.4.2.2	Sampling Interval

SENSORS NEXT STEPS

- Phase II of QA matrix
  - Newer technology sensors
- ACT/NEMI collaboration
- Sensors for the National Monitoring Network

Sensors and NEMI



NEMI
National Environmental Methods Index

- Over 1,100 methods
- 28 sources
- Not just analytical
  - Analysis
  - Collection
  - Processing/prep
  - Toxicity
  - Statistical

NEMI
National Environmental Methods Index

- Allow rapid communication and comparison of methods
- Searchable by:
  - Analyte or group of analytes
  - Source
  - Instrumentation
  - Type of method

NEMI
National Environmental Methods Index

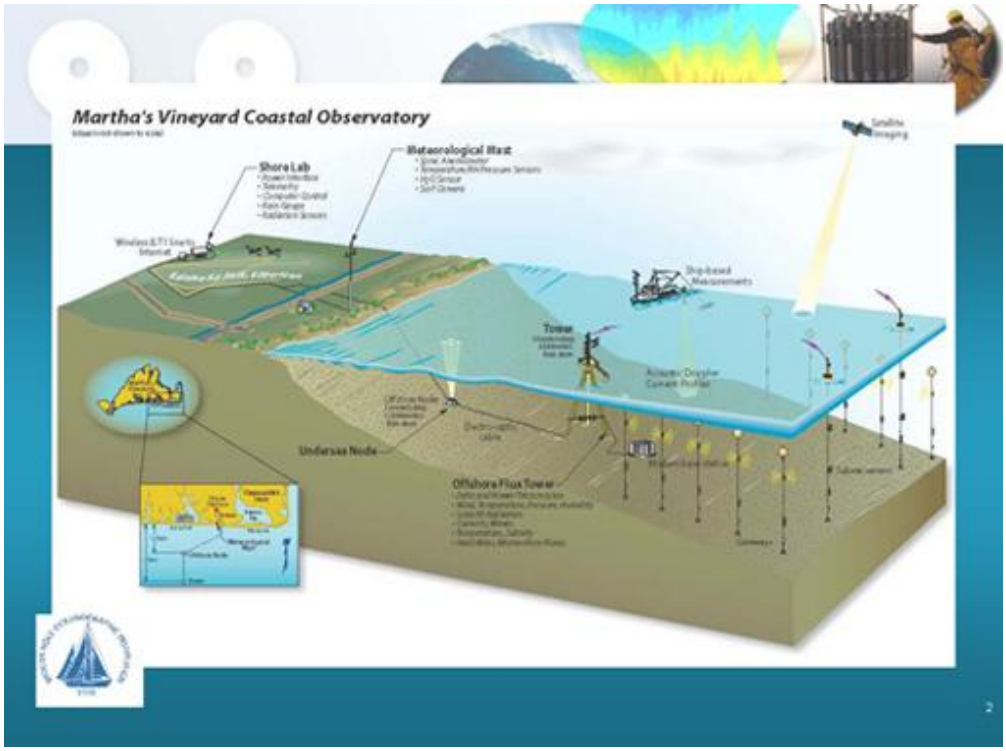
- Interest in connecting with ACT sensors database

FUTURE PLANS

- Continue sensors work
- Collaboration w/ other sensors groups
  - Value Engineering Study
  - QARTOD
  - Smart Ocean Sensors Consortium
- Assessments and Statistics
  - w/ WIS workgroup
  - Phase I: trends methods in NEMI

QARTOD V

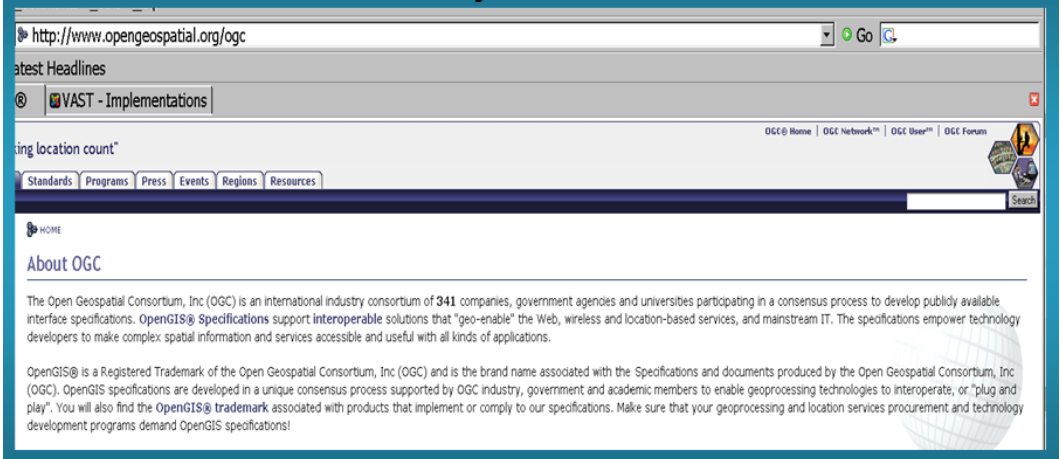
Appendix F Presentation by Janet Fredericks, WHOI




QARTOD --> OGC
Interoperability is a property referring to the ability of diverse systems and organizations to work together (inter-operate). The term is often used in a technical systems engineering sense, or alternatively in a broad sense, taking into account social, political, and organizational factors that impact system to system performance.
(Interop is also the name of several annual networking product trade shows.)
Contents [hide]
1 Definition
1.1 Syntactic Interoperability
1.2 Semantic Interoperability
Definition [edit]
The IEEE defines interoperability as:
the ability of two or more systems or components to exchange information and to use the information that has been exchanged.[1]
WIKIPEDIA
The Free Encyclopedia
3


QARTOD --> OGC
Active Communities …
GEO GROUP ON EARTH OBSERVATIONS
MMI Workshop '06
<MMI />
PRESENTS
QARTOD
QUALITY ASSURANCE OF REAL-TIME OCEANOGRAPHIC DATA
OOSTethys & The OGC OCEANS IE
Sensor Web Enablement (SWE)
The OGC's Sensor Web Enablement (SWE) standards enable developers to make all types of sensors, transducers and sensor data repositories discoverable, accessible and useable via the Web.
Environmental Monitor
Strain Gauge
Airborne Imaging Device
Health Monitor
OGC
OpenGIS® Standards
The main adopted or pending OpenGIS Standards in the SWE framework include:
• Observations & Measurements (O&M) - The general models and XML encodings for observations and measurements.
• Sensor Model Language (SensorML) - standard models and XML Schema for describing the processes within sensor and observation processing systems.
• Transducer Markup Language (TML) - Conceptual model and XML encoding for supporting real-time streaming observations and tasking commands from and to sensor systems.
• Sensor Observation Service (SOS) - Open interface for a web service to obtain observations and sensor and platform descriptions from one or more sensors.
• Sensor Planning Service (SPS) - An open interface for a web service by which a client can 1) determine the feasibility of collecting data from one or more sensors or models and 2) submit collection requests.
ALLIANCE FOR COASTAL TECHNOLOGIES
4

Why OGC?



5

WHY SensorML: designed to describe sensors and process chains!

Input to the system does NOT need to be a sensor – it can be data (real-time or archived)!! But you can describe the sensor as part of the system …

SWE Data Components:

- SensorML
- O&M (Observations & Measurements)

Now my data server just generates it's normal string (ascii; multi-record; binary – just so it's well described):

http://someplace.edu/path

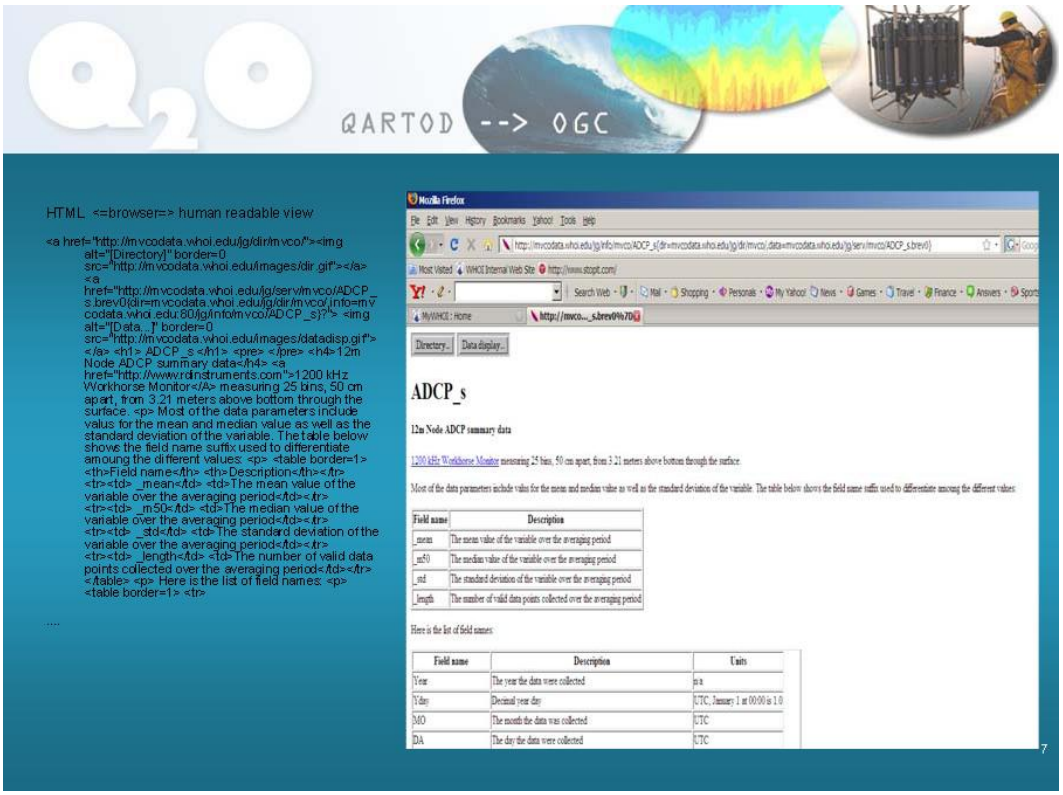
2009-04-19T18:40:00,41.3366,-70.5564,1106.1,42.0,7.0,0.06,0.17,55.9,24.0,42.3,6.0,9.0,6.0,192.1,165.6,192.1,9.6,3.1,1,0,0,0,0

SWE CORE Sensor Observation Services:

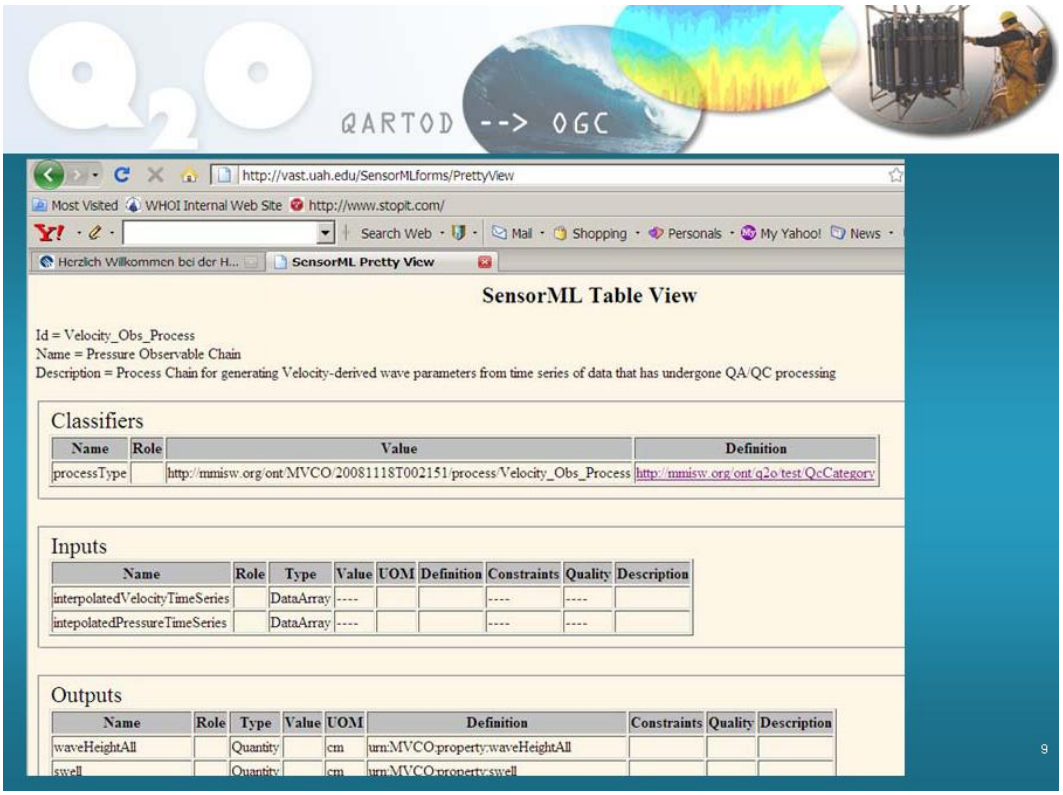
- getCapabilities – What have you got?
- describeSensor- Tell me about it!
- getObservation- Give me the data

(can have multiple offerings from one data set!)

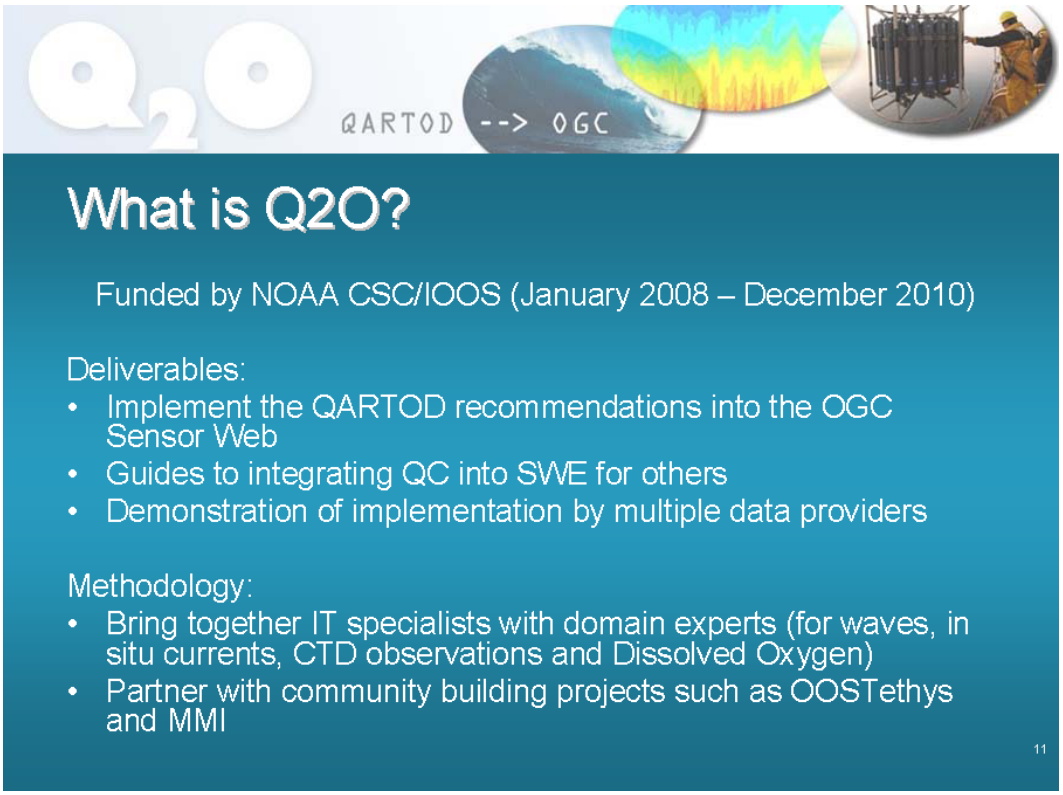
6

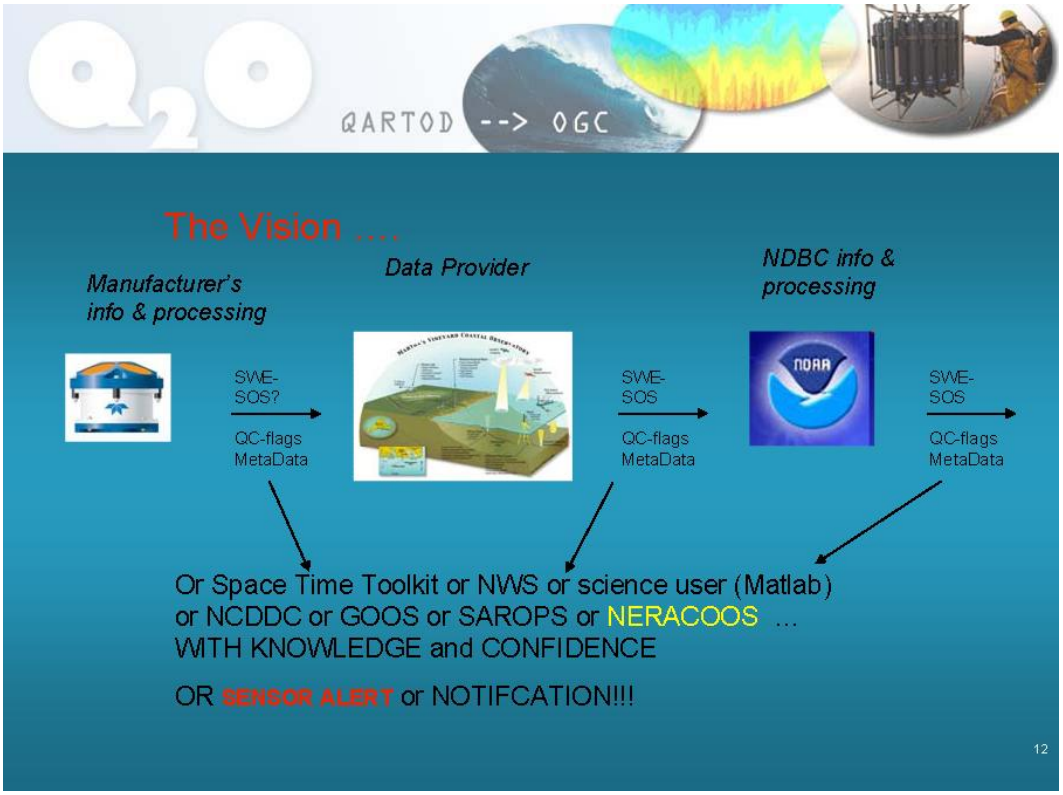

QARTOD --> OGC
HTML <=browser=> human readable view
<img alt="[Directory]" border=0 src="http://mvcodata.whoi.edu/images/dir.gif"> <img alt="[Data...]" border=0 src="http://mvcodata.whoi.edu/images/datadisp.gif"> <h1> ADCP_s </h1> <pre> </pre> <h4>12m Node ADCP summary data</h4> <a href="http://www.rdinstruments.com">1200 kHz Workhorse Monitor</A> measuring 25 bins, 50 cm apart, from 3.21 meters above bottom through the surface. <p> Most of the data parameters include valus for the mean and median value as well as the standard deviation of the variable. The table below shows the field name suffix used to differentiate amoung the different values: <p> <table border=1> <th>Field name</th> <th>Description</th></tr> <tr><td> _mean</td> <td>The mean value of the variable over the averaging period</td></tr> <tr><td> _m50</td> <td>The median value of the variable over the averaging period</td></tr> <tr><td> _std</td> <td>The standard deviation of the variable over the averaging period</td></tr> <tr><td> _length</td> <td>The number of valid data points collected over the averaging period</td></tr> </table> <p> Here is the list of field names: <p> <table border=1> <tr>
....
Mozilla Firefox
Directory..
Data display..
ADCP_s
12m Node ADCP summary data
1200 kHz Workhorse Monitor measuring 25 bins, 50 cm apart, from 3.21 meters above bottom through the surface.
Most of the data parameters include valus for the mean and median value as well as the standard deviation of the variable. The table below shows the field name suffix used to differentiate amoung the different values:
Field name
Description
_mean
The mean value of the variable over the averaging period
_m50
The median value of the variable over the averaging period
_std
The standard deviation of the variable over the averaging period
_length
The number of valid data points collected over the averaging period
Here is the list of field names:
Field name
Description
Units
Year
The year the data were collected
n/a
Yday
Decimal year day
UTC, January 1 at 00:00 is 1.0
MO
The month the data was collected
UTC
DA
The day the data were collected
UTC
7


QARTOD --> OGC
<sml:SensorML version="1.0.1" xsi:schemaLocation="http://www.opengis.net/sensorML/1.0.1 http://schemas.opengis.net/sensorML/1.0.1/sensorML.xsd">
<sml:member xlink:href="">
<!-- *SF* - Rename to ADCP_System, or not ?? -->
<sml:System gml:id="ADCP_ProcessChain">
<gml:description>Process Chain for ADCP data, version2.0</gml:description>
<gml:name>ADCP Process Chain</gml:name>
<sml:inputs>
<sml:InputList>
• <sml:input name="pressure">
....
<sml:OutputList>
• <sml:output name="systemOutputs">
• <swe:DataRecord>
• <swe:field name="time">
• <swe:Time definition="urn:ogc:phenomenon:time:iso8601"/>
• ...
8


QARTOD --> OGC
http://vast.uah.edu/SensorMLforms/PrettyView
Most Visited
WHOI Internal Web Site
http://www.stopit.com/
Search Web
Mail
Shopping
Personals
My Yahoo!
News
SensorML Pretty View
SensorML Table View
Id = Velocity_Obs_Process
Name = Pressure Observable Chain
Description = Process Chain for generating Velocity-derived wave parameters from time series of data that has undergone QA/QC processing
Classifiers
Name
Role
Value
Definition
processType
http://mmisw.org/ont/MVCO/20081118T002151/process/Velocity_Obs_Process
http://mmisw.org/ont/q2o/test/QcCategory
Inputs
Name
Role
Type
Value
UOM
Definition
Constraints
Quality
Description
interpolatedVelocityTimeSeries
DataArray
interpolatedPressureTimeSeries
DataArray
Outputs
Name
Role
Type
Value
UOM
Definition
Constraints
Quality
Description
waveHeightAll
Quantity
cm
urn:MVCO:property:waveHeightAll
swell
Quantity
cm
urn:MVCO:property:swell
9


QARTOD --> OGC
Bringing together science community members (domain experts) and IT specialists -- building bridges!
Janet Fredericks - WHOI, MMI, MVCO, QARTOD
Mike Botts/Tony Cook - UAH, OGC SWE
Julie Bosch - NOAA, MMI, IOOS DMAC, QARTOD
Harvey Seim/Sara Haines - SECOORA, NCCOOS, QARTOD
Philip Bogden/Eric Bridger - GoMOOS, IOOS DMAC, SURA, MMI, OOSTethys/OIE
[Luis Bermudez - SURA, OOSTethys, OpenIOOS, MMI, OGC Oceans-IE with Sara Haines for NetCDF to SWE Q2O]
USF COMPS (Vembu) and VIMS (Grace) test implementation project
10


Q2O
QARTOD --> OGC
What is Q2O?
Funded by NOAA CSC/IOOS (January 2008 – December 2010)
Deliverables:
• Implement the QARTOD recommendations into the OGC Sensor Web
• Guides to integrating QC into SWE for others
• Demonstration of implementation by multiple data providers
Methodology:
• Bring together IT specialists with domain experts (for waves, in situ currents, CTD observations and Dissolved Oxygen)
• Partner with community building projects such as OOSTethys and MMI
11


Q2O
QARTOD --> OGC
The Vision ….
Manufacturer's info & processing
Data Provider
NDBC info & processing
SWE-SOS?
QC-flags
MetaData
SWE-SOS
QC-flags
MetaData
SWE-SOS
QC-flags
MetaData
Or Space Time Toolkit or NWS or science user (Matlab) or NCDDC or GOOS or SAROPS or NERACOOS …
WITH KNOWLEDGE and CONFIDENCE
OR SENSOR ALERT or NOTIFCATION!!!
12

What had/has to be done by Q2O?

- Engage domain experts
- Gather QARTOD information
  - identify recommendations
- Define Processes
  - input / output / criteria
- Develop/Register vocabularies
- Convey as SWE instances
- Test implementation
- Develop Guidance Docs
- Extend to other data providers

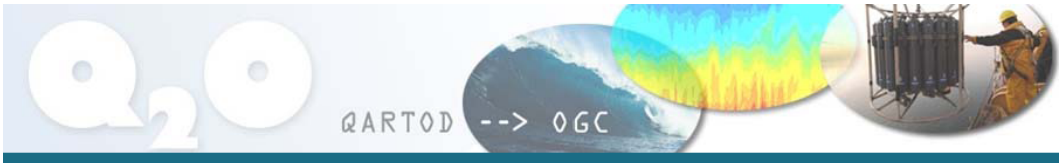
QARTOD | CDIP | FRF | NDBC | NOBSKA | NORTEK | RDI | SONTEK

QARTOD Quality Control Tests : Waves

The participants in this effort (shown on the table tabs) propose that the following required tests be performed on wave data to meet minimum IOOS quality control standards. In addition, there are a number of recommended tests.
Note: All tests listed are for open ocean waves.

TIME SERIES (Raw Calibrated Data)				
Category	**Criteria**	**Order**	**Flag**	**Action**
Data Gaps	Consecutive N missing data. Maximum number of missing data.	1	Soft	N is user defined. Include in % count.
Spikes	User defined Points >= M*std with P iterations	2	Soft	Interpolate/extrapolate up to N points. N is user defined. M can be user defined, recommended M=4. Include in % count.
Range test	Location, instrument defined.	2	1. Soft 2. Hard	Max/min user defined. 1. Interpolate/extrapolate up to n points. N is user defined. Include in % count. 2. Instrument spec exceeded, reject.
Mean shift (segments)	A mean shift "P" occurs in this time series.	3	Hard	Reject entire record. P is user defined.
Acceleration test	User defined (a>M*g)	3	Soft	Recommended M<=1/2. Interpolate/extrapolate up to N contiguous points. N is user defined. Include in % count.
Mean test, variance test	User defined, location dependent	4	1. Soft 2. Hard	1. Flag unexpected values. 2. Reject unreasonable values.
Percent points good	Check for M% good data (based on above 6 criteria)	5	Hard	Recommended M>=90%
SPECTRAL VALUES				
Category	**Criteria**	**Order**	**Flag**	**Action**
NON-DIRECTIONAL:				
Operational frequency range test	*defined by the environment and instrument	1	1. Soft 2. Hard	1. Max/min user defined. 2. Instrument spec exceeded, reject.
DIRECTIONAL:				
Incident low frequency energy direction	Location defined	1	Soft	User defined

13



What does that mean?

What do we have (know) to start with?

- A sensor (wave buoy or ADCP) with certain characteristics
- A sensor history
- QA info associated with a sensor
- Deployment characteristics
- Methods to process the data
- QC Tests to apply to the data
- …
- …

Julie Bosch

What information can we provide to data users via services?

- What sensors/observations we have available as a service
- Description of the sensor
- Description of where / how / when it is deployed
- List of the processing methods used on the data
- List of the QC tests applied
- The criteria used in the QC tests
- The results of the QC tests
- Observational data
- …

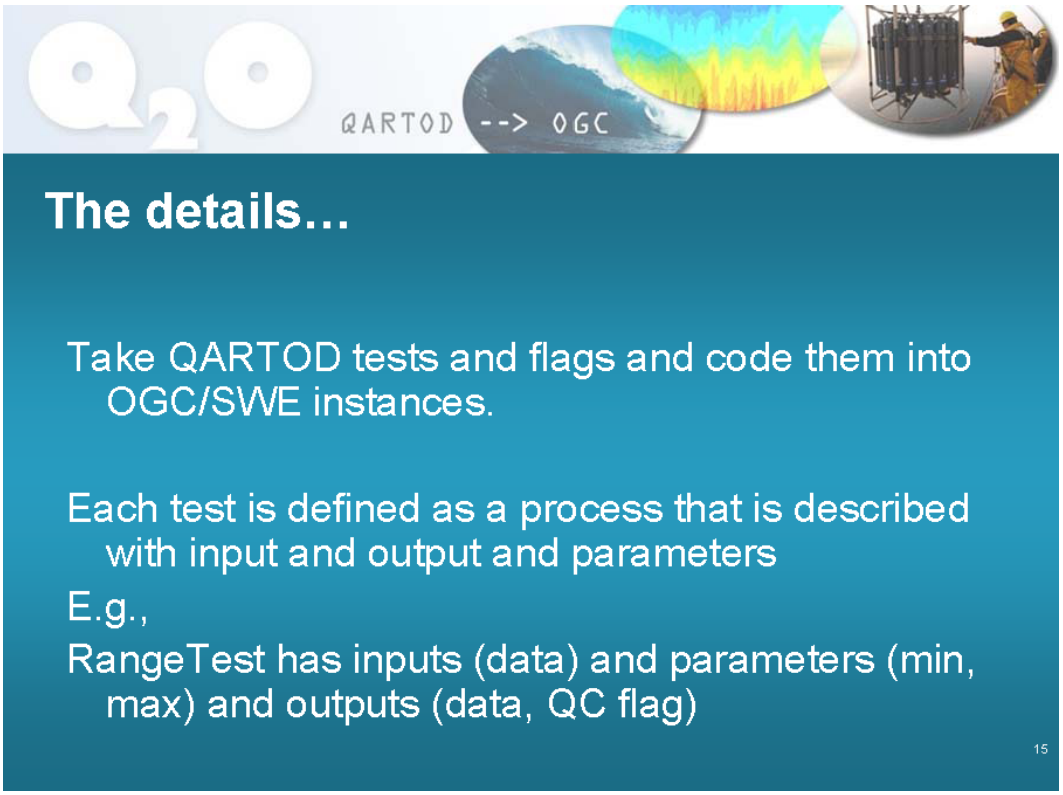
How do we convey that information in SOS?

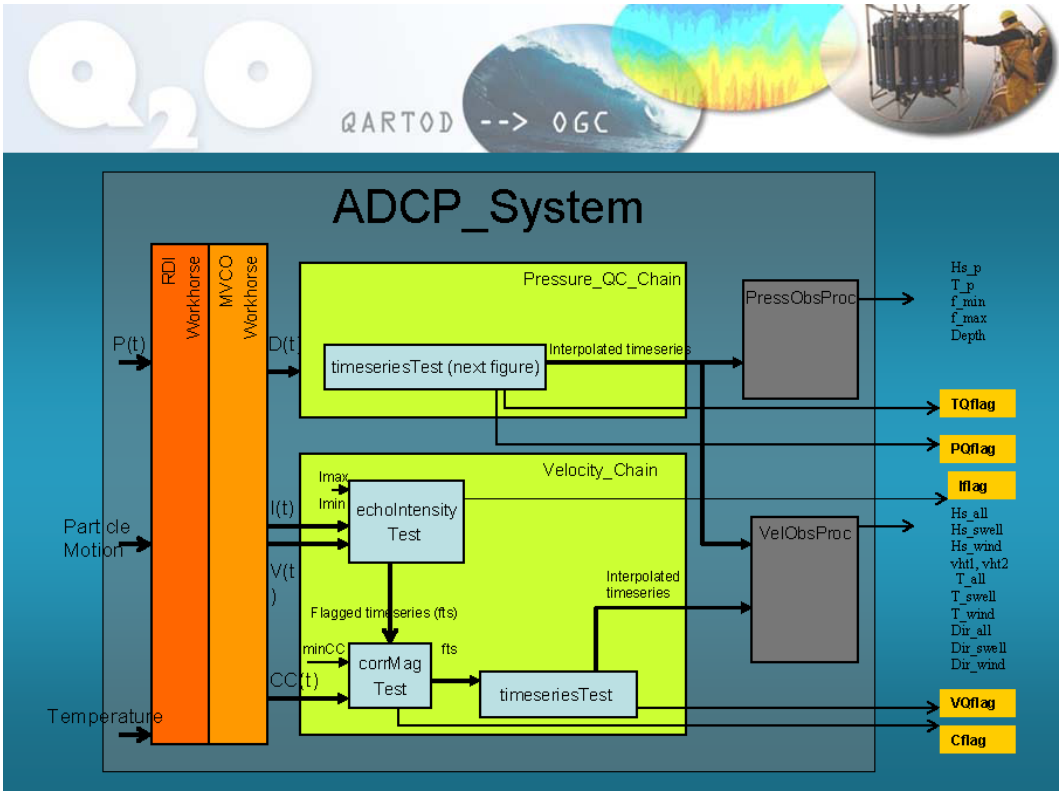
Get Capabilities
- Lists available data offerings
- Returns XMLcapabilities

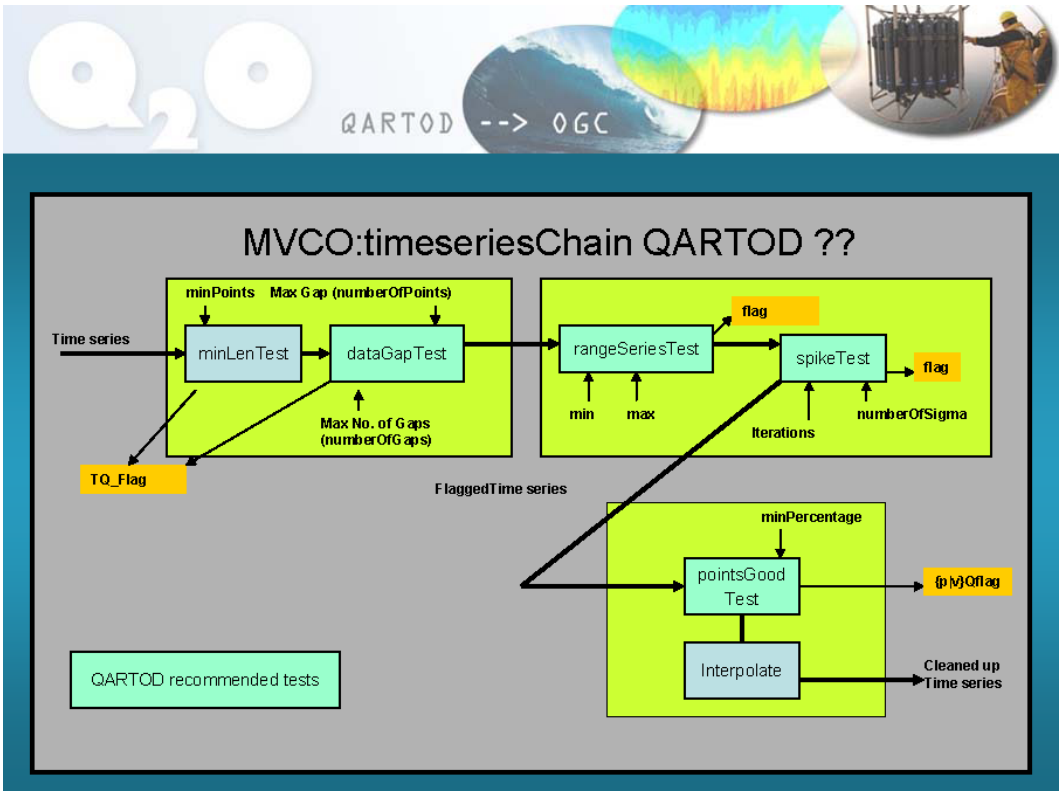
Describe Sensor
- Provides sensor and deployment characteristics and processing methods
- Returns SensorML

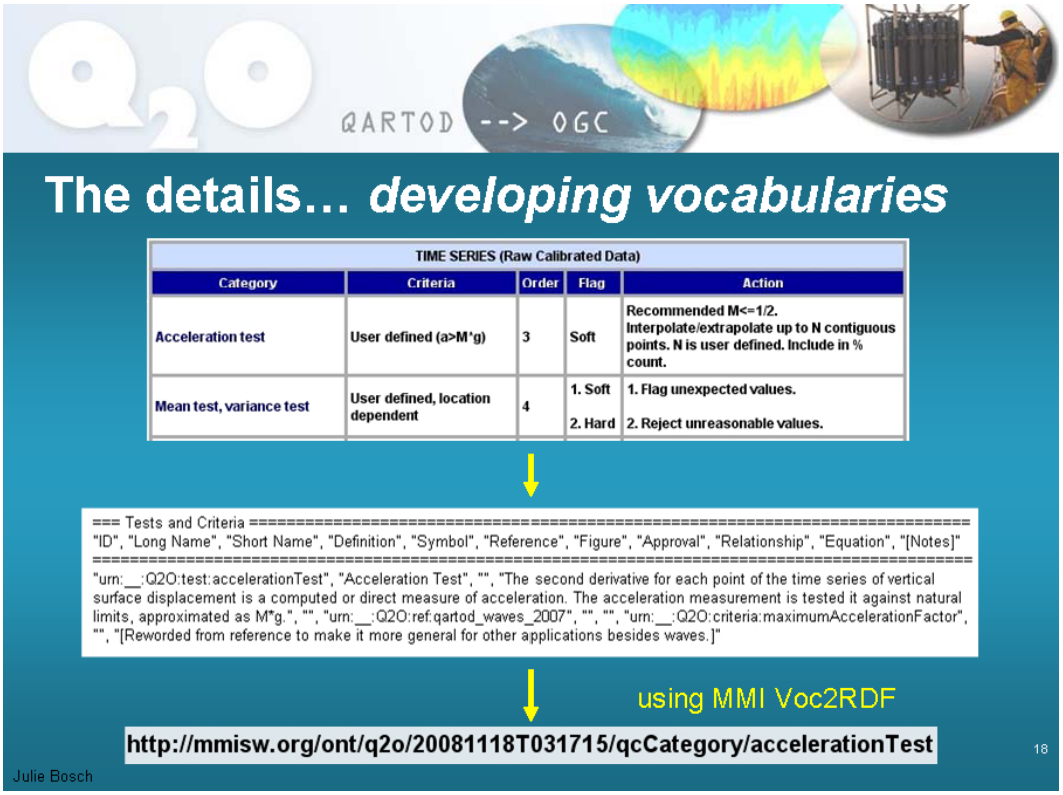
Get Observation
- Provides the data, test results and points to file with processing/test info
- Returns O&M

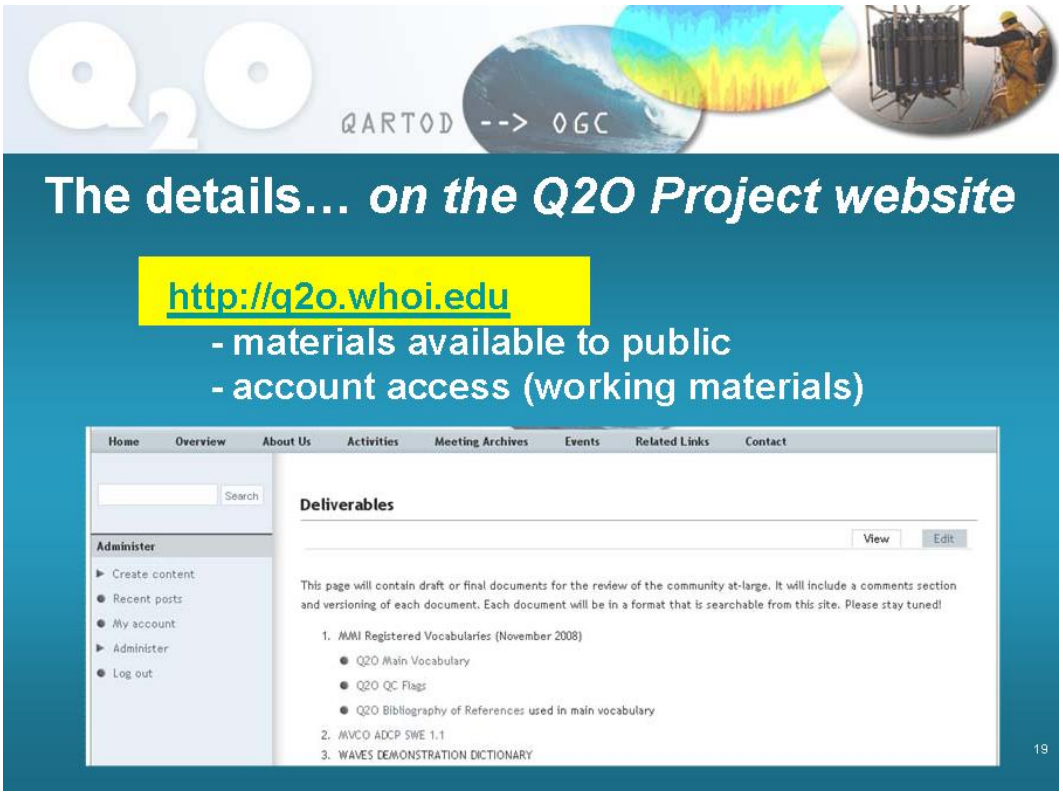
14

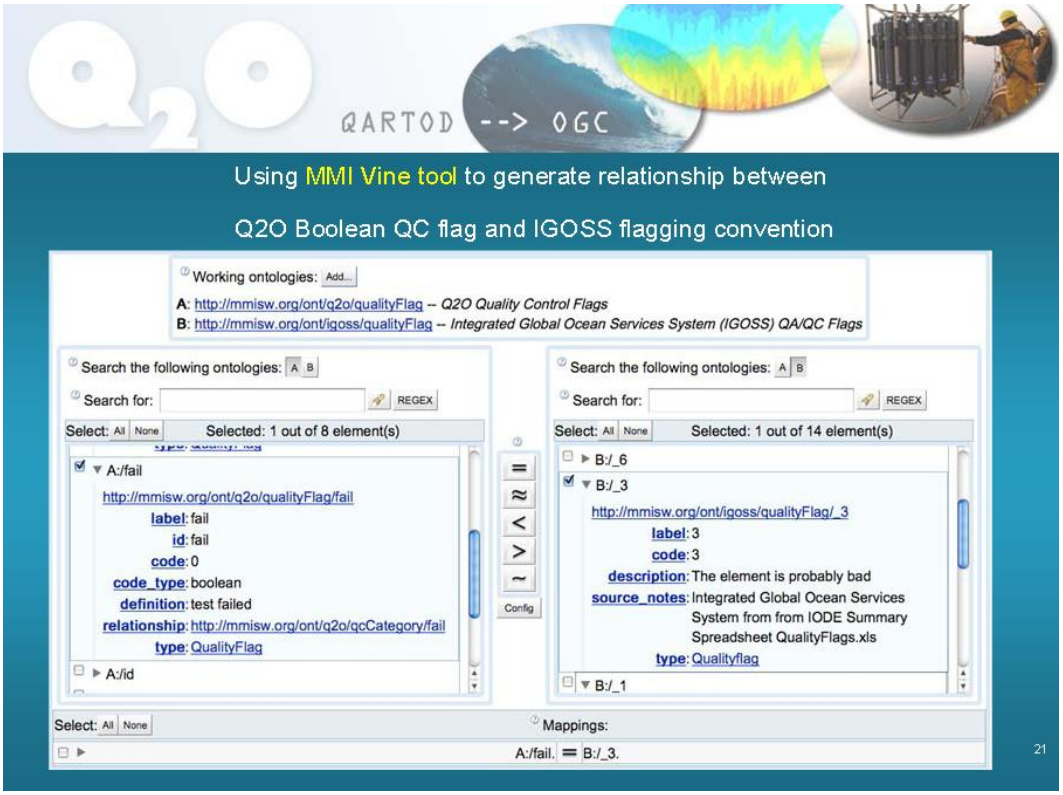

QARTOD --> OGC
The details…
Take QARTOD tests and flags and code them into OGC/SWE instances.
Each test is defined as a process that is described with input and output and parameters
E.g.,
RangeTest has inputs (data) and parameters (min, max) and outputs (data, QC flag)
15

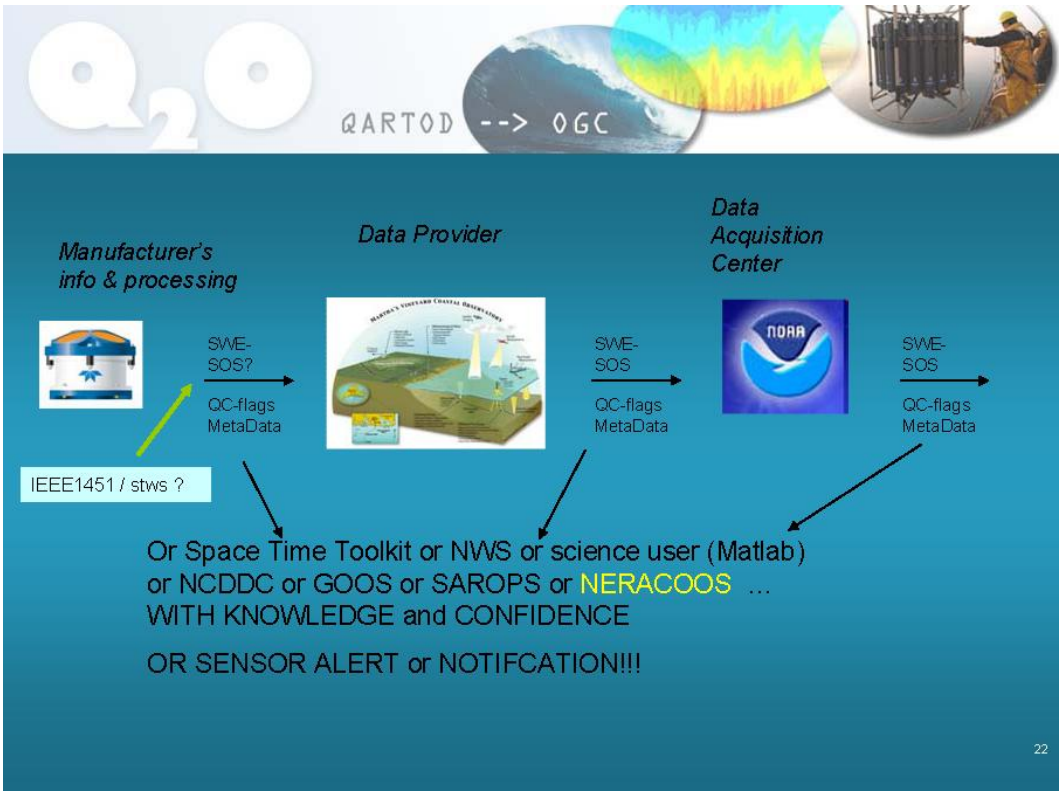

QARTOD --> OGC
ADCP_System
RDI Workhorse
MVCO Workhorse
P(t)
D(t)
Pressure_QC_Chain
timeseriesTest (next figure)
Interpolated timeseries
PressObsProc
Hs_p
T_p
f_min
f_max
Depth
TQflag
PQflag
Velocity_Chain
Imax
Imin
I(t)
echoIntensity Test
Iflag
Particle Motion
V(t)
VelObsProc
Hs_all
Hs_swell
Hs_wind
vht1, vht2
T_all
T_swell
T_wind
Dir_all
Dir_swell
Dir_wind
Interpolated timeseries
Flagged timeseries (fts)
minCC
corrMag Test
fts
CC(t)
timeseriesTest
Temperature
VQflag
Cflag


QARTOD --> OGC
MVCO:timeseriesChain QARTOD ??
minPoints
Max Gap (numberOfPoints)
Time series
minLenTest
dataGapTest
Max No. of Gaps (numberOfGaps)
TQ_Flag
rangeSeriesTest
flag
spikeTest
flag
min
max
Iterations
numberOfSigma
FlaggedTime series
minPercentage
pointsGood Test
{p}M}Qflag
Interpolate
Cleaned up Time series
QARTOD recommended tests


QARTOD --> OGC
The details… developing vocabularies
TIME SERIES (Raw Calibrated Data)
Category
Criteria
Order
Flag
Action
Acceleration test
User defined (a>M*g)
3
Soft
Recommended M<=1/2. Interpolate/extrapolate up to N contiguous points. N is user defined. Include in % count.
Mean test, variance test
User defined, location dependent
4
1. Soft
2. Hard
1. Flag unexpected values.
2. Reject unreasonable values.
=== Tests and Criteria ===
"ID", "Long Name", "Short Name", "Definition", "Symbol", "Reference", "Figure", "Approval", "Relationship", "Equation", "[Notes]"
"urn:__:Q2O:test:accelerationTest", "Acceleration Test", "", "The second derivative for each point of the time series of vertical surface displacement is a computed or direct measure of acceleration. The acceleration measurement is tested it against natural limits, approximated as M*g.", "", "urn:__:Q2O:ref:qartod_waves_2007", "", "", "urn:__:Q2O:criteria:maximumAccelerationFactor", "", "[Reworded from reference to make it more general for other applications besides waves.]"
using MMI Voc2RDF
http://mmisw.org/ont/q2o/20081118T031715/qcCategory/accelerationTest
18
Julie Bosch

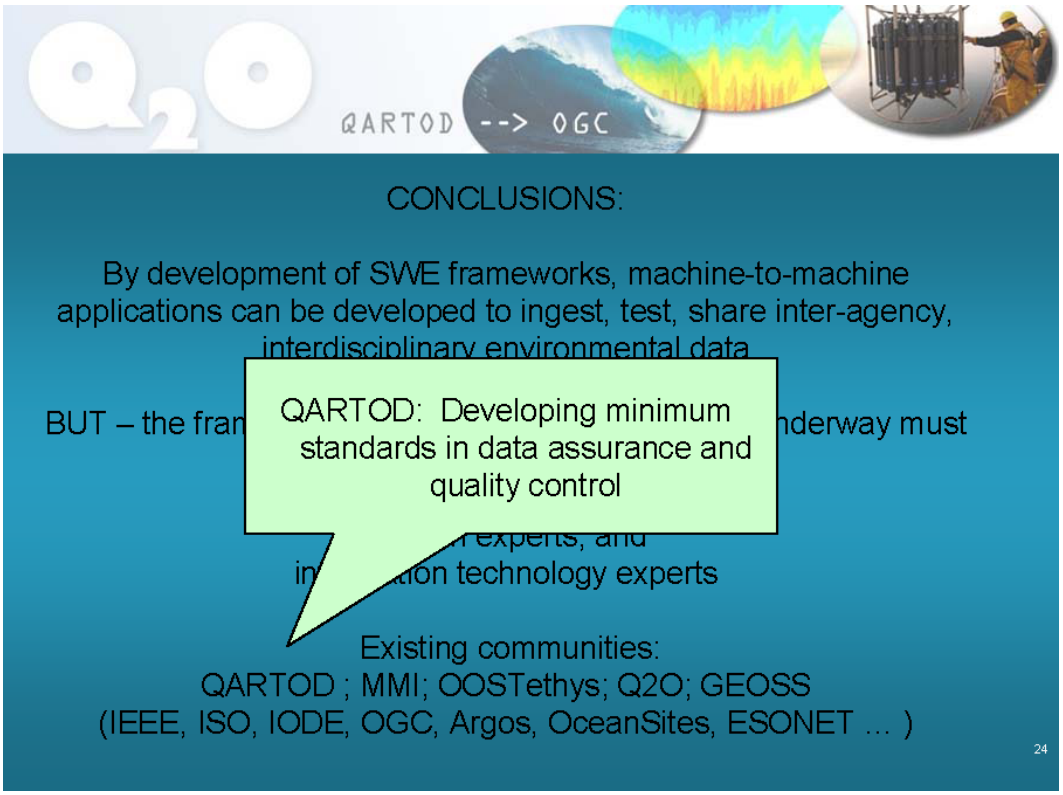

QARTOD --> OGC
The details… on the Q2O Project website
http://q2o.whoi.edu
- materials available to public
- account access (working materials)
Home
Overview
About Us
Activities
Meeting Archives
Events
Related Links
Contact
Search
Administer
Create content
Recent posts
My account
Administer
Log out
Deliverables
View
Edit
This page will contain draft or final documents for the review of the community at-large. It will include a comments section and versioning of each document. Each document will be in a format that is searchable from this site. Please stay tuned!
1. MMI Registered Vocabularies (November 2008)
Q2O Main Vocabulary
Q2O QC Flags
Q2O Bibliography of References used in main vocabulary
2. MVCO ADCP SWE 1.1
3. WAVES DEMONSTRATION DICTIONARY
19

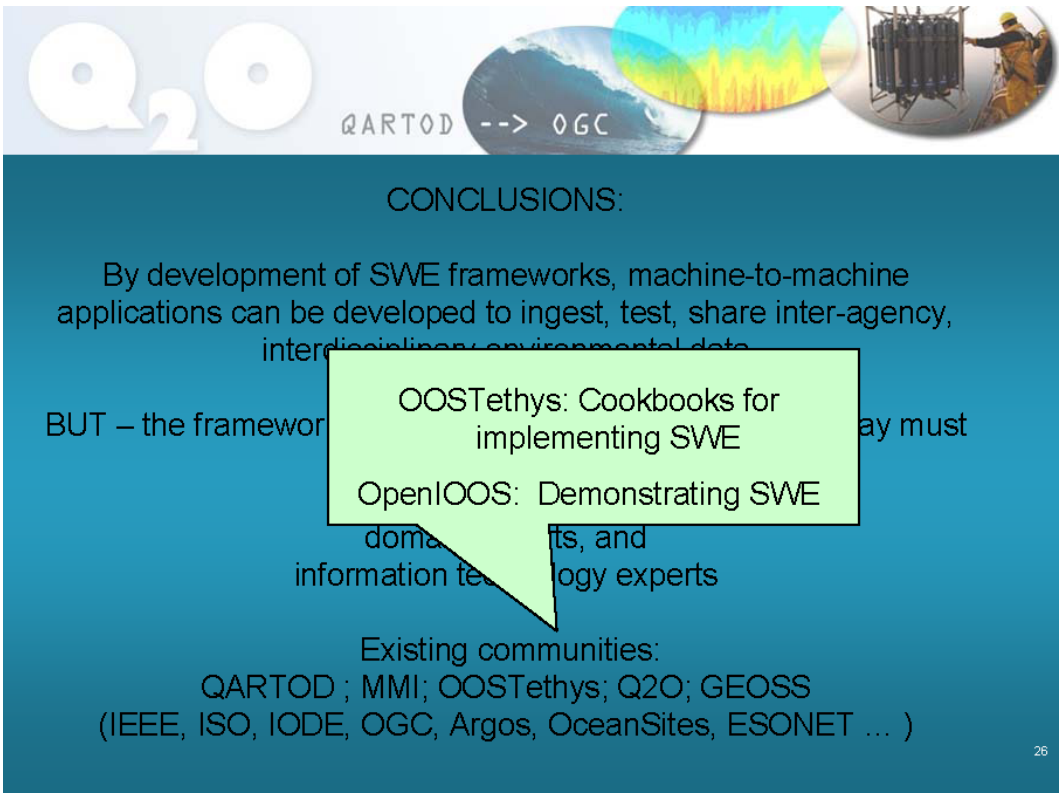

QARTOD --> OGC
Using MMI Vine tool to generate relationship between
Q2O Boolean QC flag and IGOSS flagging convention
Working ontologies: Add...
A: http://mmisw.org/ont/q2o/qualityFlag -- Q2O Quality Control Flags
B: http://mmisw.org/ont/igoss/qualityFlag -- Integrated Global Ocean Services System (IGOSS) QA/QC Flags
Search the following ontologies: A B
Search for: REGEX
Select: All None
Selected: 1 out of 8 element(s)
A:/fail
http://mmisw.org/ont/q2o/qualityFlag/fail
label: fail
id: fail
code: 0
code_type: boolean
definition: test failed
relationship: http://mmisw.org/ont/q2o/qcCategory/fail
type: QualityFlag
A:/id
Config
Search the following ontologies: A B
Search for: REGEX
Select: All None
Selected: 1 out of 14 element(s)
B:/_6
B:/_3
http://mmisw.org/ont/igoss/qualityFlag/_3
label: 3
code: 3
description: The element is probably bad
source_notes: Integrated Global Ocean Services System from from IODE Summary Spreadsheet QualityFlags.xls
type: Qualityflag
B:/_1
Select: All None
Mappings:
A:/fail. = B:/_3.
21


QARTOD --> OGC
Manufacturer's info & processing
Data Provider
Data Acquisition Center
SWE-SOS?
QC-flags
MetaData
SWE-SOS
QC-flags
MetaData
SWE-SOS
QC-flags
MetaData
IEEE1451 / stws ?
Or Space Time Toolkit or NWS or science user (Matlab)
or NCDDC or GOOS or SAROPS or NERACOOS ...
WITH KNOWLEDGE and CONFIDENCE
OR SENSOR ALERT or NOTIFCATION!!!
22


QARTOD --> OGC
By development of SWE frameworks, machine-to-machine applications can be developed to ingest, test, share inter-agency, interdisciplinary environmental data
with the ability to transfer KNOWLEDGE of what has been done to the data!!
23

QARTOD V


QARTOD --> OGC
CONCLUSIONS:
By development of SWE frameworks, machine-to-machine applications can be developed to ingest, test, share inter-agency, interdisciplinary environmental data
BUT – the fram
nderway must
QARTOD: Developing minimum standards in data assurance and quality control
experts, and
in ion technology experts
Existing communities:
QARTOD ; MMI; OOSTethys; Q2O; GEOSS
(IEEE, ISO, IODE, OGC, Argos, OceanSites, ESONET …)
24


QARTOD --> OGC
CONCLUSIONS:
By development of SWE frameworks, machine-to-machine applications can be developed to ingest, test, share inter-agency, interdisciplinary environmental data
BUT – the framewor
ay must
OOSTethys: Cookbooks for implementing SWE
OpenIOOS: Demonstrating SWE
doma ts, and
information te logy experts
Existing communities:
QARTOD ; MMI; OOSTethys; Q2O; GEOSS
(IEEE, ISO, IODE, OGC, Argos, OceanSites, ESONET …)
26

CONCLUSIONS:

By development of SWE frameworks, machine-to-machine applications can be developed to ingest, test, share inter-agency, interdisciplinary environmental data

BUT – the framework de t
inc

d
information tec xperts

Existing commun s:
QARTOD ; MMI; OOSTethys; Q2O; GEOSS
(IEEE, ISO, IODE, OGC, Argos, OceanSites, ESONET …)

Q2O? Develop partnerships to team IT specialists with domain experts to fully enable functionality!

27

CONCLUSIONS:

By development of SWE frameworks, machine-to-machine applications can be developed to ingest, test, share inter-agency, interdiscipl

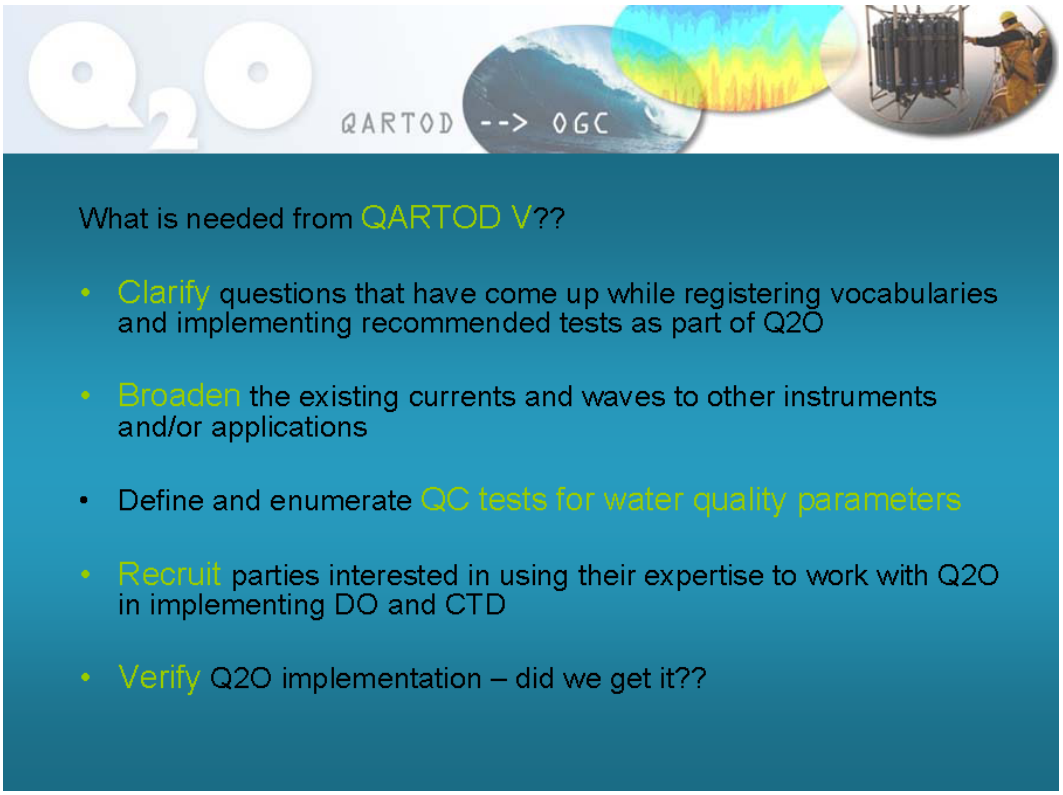
BUT – the framework deve
inclu

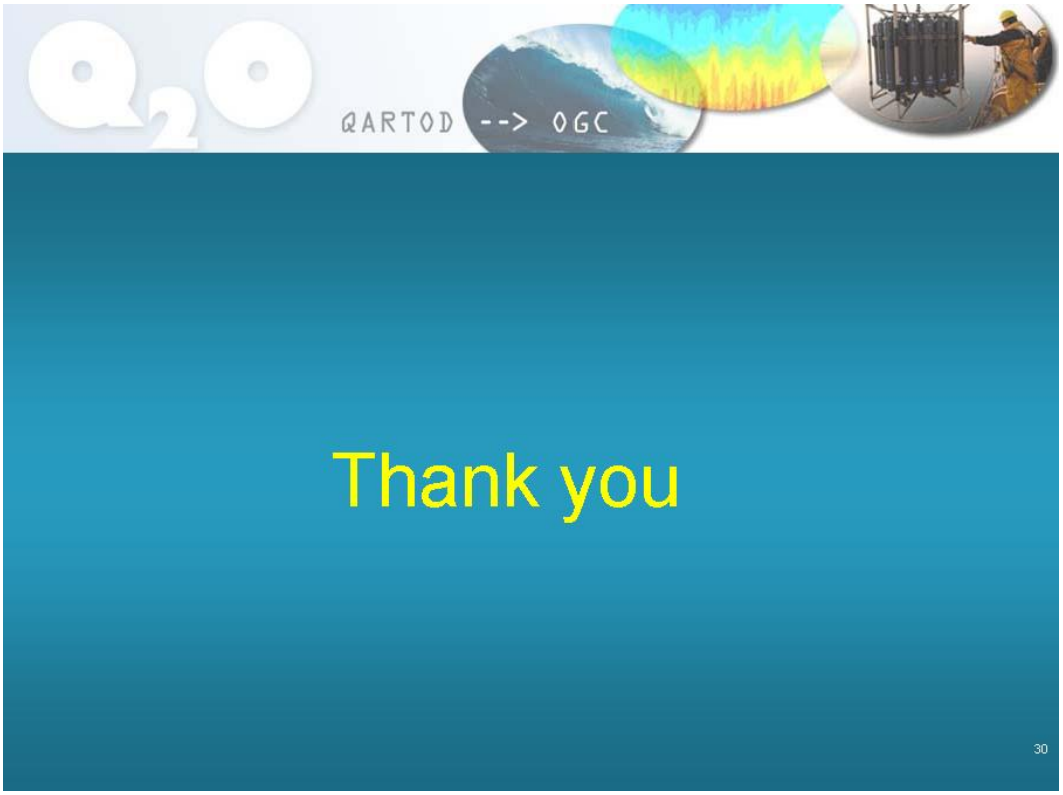
dom
information technol erts

Existing communities:
QARTOD ; MMI; OOSTethys; Q2O; GEOSS
(IEEE, ISO, IODE, OGC, Argos, OceanSites, ESONET …)

GEOSS: Register your services and/or data … enabling a Geo-enabled system of systems for global environmental data!

28


Q2O
QARTOD --> OGC
What is needed from QARTOD V??
• Clarify questions that have come up while registering vocabularies and implementing recommended tests as part of Q2O
• Broaden the existing currents and waves to other instruments and/or applications
• Define and enumerate QC tests for water quality parameters
• Recruit parties interested in using their expertise to work with Q2O in implementing DO and CTD
• Verify Q2O implementation – did we get it??


Q2O
QARTOD --> OGC
Thank you
30

Appendix G Facilitator's Guidance to Breakout Groups

Workshop Objectives

- To report on the recommended quality control tests for some biogeographic parameters and to review and approve the Q2O implementation of QC tests for waves and in situ currents.
- To explore ways to expand our interaction with similar international efforts. How will this happen? What part of the agenda?
- What is the concrete product from the meeting? (A summary report to be submitted to???)

Breakout Groups

Breakout Group 1 – Biogeochemistry – LOCATION

Charge: To develop quality control standards for some physical ocean parameters from past QARTOD meetings (e.g., conductivity, dissolved oxygen, turbidity, and pH)

Facilitators – Stephanie Kavanaugh (process) & Brenda Babin (technical lead)

Notetaker –

Breakout Group 2 – Waves & Currents – LOCATION

Charge: To provide additional input for parameters such as waves and ocean currents to complete the QARTOD Open Geospatial Consortium (OGC) or Q2O effort.

Facilitators – Helen Worthington, Mark Bushnell & Bill Burnett (process and technical)

Notetaker –

Schedule for Breakout Groups

Day 1 (Are these questions only for Group 1?)

- Define the scope of the quality control application.
- Determine the real-time quality control tests that must be applied to the observation.

Day 2

- Answer questions related to quality control flags or flagging conventions. (When will these be developed?)

Support Roles

Process Facilitator

- Keep the group on task and on time
- Ensure objectives are met
- Help prepare report out
- Keep track of process concerns and "parking lot" issues

Technical Facilitators

- Guide discussion; identify key issues
- Clarify technical questions
- Present results in report out

Note Takers

- Need volunteers
- Fill in tables on laptop provided

Participant Roles

- Most importantly, we need your thoughtful input!
- Listen to understand – don't just "wait to talk."
- If you have an idea for improving the process, please share it.
- Make sure the note taker is accurately capturing your input.

Things to Remember

- Your facilitators are here to serve the needs of the group, but may need to move the process along due to time constraints.
- Everyone's input has equal value.

PLEASE turn off your cell phones.

Appendix H General Session Notes

QARTOD-V **Tuesday, November 17, 2009, AM-NOON**

Opening Remarks/Introductions		**Mario Tamburri**

Presentation by Mario Tamburri, Executive Director of ACT (Alliance for Coastal Technologies). Major points:

- ACT performance verifications for QA/QC (bio-fouling, nutrient analyzers, salinity sensors)
- Calibration offset (conductivity)
- Bio-fouling (degradation of sensor output compared to ?)
- Testing the manual (precision and accuracy in lab, deployment procedures from manufacturers)
- Typically have moored and profiling sensors

Workshop Goals / "What is QARTOD?"		**Bill Burnett NWS/NDBC**

Major points:

- Provide best data we can, NDBC sends data out onto the GTS and needs
- Water quality
- Not a legislative body, not a cult, not a dictatorship.
- Grass roots organization, independent of any one organization, sharing info on data quality (procedures, tests)
- **QARTOD-I, Seven Data Management Laws**
  1. Quality descriptor
  2. Some level quality test
  3. Metadata describing tests and flags in RT
  4. Quality assurance (calibration)
  5. Methods in metadata in RT
  6. Quantify level of calibration
  7. Manual checks

QARTOD V

- QARTOD-II focused on high frequency radar (HFRADAR), waves, currents, quality descriptor, metadata requirements
- QARTOD-III focused HFRADAR, waves, currents, initiated CTD, and large focus on metadata fields
- QARTOD-IV main focus on quality assurance, waves, currents, temp/salinity, initiated DO

Documents published (recommended waves tests).
Either refine or approve what was submitted.

Previous QARTODs for In-situ currents information focuses only on RDI instruments (introduce other instruments)
Different levels of data quality (from low-end to high-end data assembly centers)

Workshop Objectives:

- Report on recommended QC tests for biogeochemical parameters
- Review and approve Q2O implementation of QC tests for waves and *in situ* currents
- Interaction with similar international efforts (www.oceanobs09.org/blog community wide paper) My Oceans, SeaDataNet
- Workshop product: final report posted on QARTOD website

Day 1-2 define scope of quality control
Day 3 added topic for last day (QARTOD guidance to data providers)

Dr. Burnett noted a decline of the number of QARTOD participants (from 70 to 60 to 40).
Discussion yielded the following points:

- Perhaps what was done at previous QARTODs was good enough.
- Done or not done, these are living documents.
- Not a decline in interest, but due to other meeting conflicts.
- Still need guidance for responsibility of data provider and regional associations. This is not clear from previous QARTOD workshops.

IOOS Program – "QARTOD and IOOS – Where do they belong?"		**Charles Alexander** **NOAA IOOS Program**

Presentation given by Charles Alexander from the NOAA IOOS Program. Main points include:

- Can NOAA IOOS Program provide a home for QARTOD?
  - NOAA IOOS engaging with QARTOD as possible sanctioned activity
  - Not engage at technical level
- IOOS Program office within NOAA
  - Lead funding process to regional associations
  - Executing operational requirements on DMAC
- Interoperability of data (DMAC subset to demo interoperable data)
  - limited 7 data variables (temp, salinity, etc),
  - limited providers (NDBC, NOS, Seawifs) ,
  - limited focus (coastal inundation, harmful algal blooms, integrated eco assessments)

Ocean.us -> DMAC Plan Doc -> DMAC Steering Team

IWGOO -> NOAA IOOS Program

OOI (ocean initiative) -> cyber infrastructure (standards)

Should IOOS host work of QARTOD??

Discussion points:

- "Interoperable data" what units, what to call it, how describe the location,
  - Web-based services expose the data and/or transform it

Who in IOOS Program office to contact:

Could QARTOD be supported through the Program Office?

Certification through standards:

Still defining thresholds for minimum standards.

QARTOD V

QA Initiative for Sensors: Methods and Data Comparability		**Dan Sullivan** **USGS Funded by Office of Water Quality located in Wisconsin Center**

Presentation given by Dan Sullivan, the USGS co-chair on Methods and Data Comparability Board, which was created in 1997 as a subgroup of the Advisory Committee on Water Information (ACWI). Major points include:

Board and council to fill void in water quality

Membership (YSI, Hach, *In situ*, state and Federal Government, consultant)

QA Initiative—ACRR Matrix, field deployment guide, data element, glossary

- Water quality data elements (metadata)
- Accreditation of calibration labs
- Vital signs (DO, pH, conductivity, temperature, turbidity, ORP, and depth)
- Matrix organized by sensor type
- "ACRR" actions to affect (calibration, clean probe, bias), check, record, report
- (vendor independent matrix)

Have content, working on content. Next step is how to get user adoption.

Field Deployment Guide, site selection, (not for study), platform design, checklist considerations of spatial and temporal sampling. Only recommend what to do – produce the guide and recommend for adoption.

Data Elements (who, what, when, where, why, and how)
NWQMC Water Quality Data Elements: A User Guide (2006) available in PDF

ACT/NEMI collaboration— http://www.nemi.gov
National Environmental Methods Index (analytical, statistical, collection)

Smart ocean sensor consortium (common data transfer, e.g. PUCK).

QARTOD to Open Geospatial Consortium (Q2O) Status – Integrating QC tests into Sensor Web Services		**Janet Fredericks** **WHOI**

Presentation by Janet Fredericks from Woods Hole Oceanographic Institution. Major points include:

- ACT-MMI–OOSTethys-QARTOD
- SWE CORE Sensor Observation Service
- getCapabilities -- What do you have?
- describeSensor -- Tell me about it.
- getObservation -- Give me your data.

- Sensor description across disciplines (not just IOOS, not just oceans)
- Bring together science community members (domain experts) and IT specialists

What is it to be interoperable?
Machine-to-machine communication to share QC

Implement QARTOD recommendations
Manufacturer > Data Provider > NDBC info and processing

QC	QC	QC
Metadata	metadata	metadata

Data may be grabbed at any place - need to have QC and metadata accurately describe what's been done to data.

Helpful to have some questions answered in the process of implementation (some stumbling blocks in setting up tests)—for example to interpolate data or not (in certain levels).

Q2O Website (http://q2o.whoi.edu)

Finish up waves and *in situ* currents, begin to demonstrate water quality
Cookbooks
Semantic implementation
Clarify, broaden, QC tests for WQ, Recruit, Verify

Q: How can this information be communicated to the community?

- Data (and QC info) discoverable on web because of web service
- Q2O to provide guidance documents on how to setup QC and what to provide
- A demo project to show that quality characteristics and tests with the data

Q: Will NOAA Program Office ratify a file format or standard like SOS or SWE?

- The Program Office will provide recommended standards different file formats (SOS, SWE, DAP).

This is the essence of what should go in the QARTOD Meeting Report

- Group should agree that this is the information that needs to be there no matter what the format.
- Discoverable and accessible

Breakout Group Preparations - Logistics

Stephanie Kavanaugh provided preparation for breakout groups:

Breakout Group 1:

> Charge: To identify and define quality control tests and practices for real-time biogeochemical observations (e.g. conductivity, ph, turbidity, dissolved oxygen)

Breakout Group 2:

Charge: To provide clarification and additional input to previously identified waves and *in situ* currents QC practices and to address additional QC tests and practices for additional wave and *in situ* observation methods.

Environmental Data Management System		**Robert Raye** **Shell Oil Company**

Presentation given by Robert Raye from Shell Oil Company. Main points include:

Source (web services, local and archived data, real-time measurements)
Integrate (process, import, combine, edit, etc)
Use (analysis programs, export/share, operational support and custom apps)

- Using ArcGIS Javascript API
- ADAM Advanced Data Acquisition M
  - Did not use Google because of private use
  - OpenLayers
  - inurl:"arcgis/rest" inurl:"mapserver" _____ (nexrad, etc.)
  - Google advanced search string to discover 11 million mapservers that serve data layers
  - Specify "nexrad"

Chesapeake Bay Interpretive Buoy System (CBIBS)—Data Management System		**Tucker Pierce** **Tellus Applied Sciences**

Presentation by Tucker Pierce from Tellus Applied Sciences. Main points include:

- CBIBS website (http://www.buoybay.org)
- Weather and Water Quality Data
  - Loosely coupled components, standards-based architecture, redundant framework, ease of access, Low operations and maintenance costs, easy, low risk implementation of new components (back end, middleware, front end)
  - Rudimentary flags or display on webpage that data are not reported since yesterday.

Will take back what developed here at QARTOD and add tests and flags into this system.

QARTOD-V **Wednesday, November 18, 2009, AM-5 PM**

Breakout Sessions	**Group 1 and Group 2**

Before AM break -- Summary of Breakout Groups
After AM break -- where does QARTOD go from here

Breakout Summary – Water Quality	**Grace Cartwright (VIMS)**

Not enough expertise in group to address pH.
Grace reviewed tables filled in by WQ group (see Tables):

Added another sheet to address definitions and descriptions to clarify

Syntax is checksum and parity in one, more general

Low-level tests have pass/fail.

Aggregate flags have more possibilities

How flags weighted and combined in aggregate is up to data provider or data group)

Order of tests (e.g. syntax first, then outlier and range can be at same level)

Example of water quality for DO presented. How do we use these tests to see what happens to this14-day record graph of DO and WTMP with time? Is this data set good enough? Can Bill feel good about releasing this data out onto the GTS?

Tests that can be done:

Syntax test (one place where data not there probably

Gross check (0-10 mgl) Is it reasonable?

Climatological range check some spikes look questionable (seasonal, daily changes

Do spikes fail rate of change?

Additional tests:

Multivariant with other parameters (This type of test not defined)

Coherence between DO and WTMP

Discussion points:

Don't want others analyzing the data (coherence above gets into analysis)

Dynamic ranges need to be studied and addressed.

QA is very important. When was last calibration or sensor cleaning? QC test of last calibration date and period. This should be added to the list of tests that WQ group does.

Site of sensor will have profound effect on what some qc parameters may be for example location within tidal. Each station has unique environmental conditions with some certain bounds.

Can data we are saving and archiving stand the test of time?

Breakout Summary – Waves and In-situ Currents		**Bill Burnett**

By bringing waves and currents together, whole is greater than sum of parts. Bill thinks that this is the most successful QARTOD to date for these two groups. Currents learned from waves, and vice versa.

Morphed currents and waves tests for ADCP Waves (Janet Fredericks):

- Still need to add spectral checks (and additional check factors that Kent listed yesterday) to this table

Morphed waves and currents for Nortek, RDI, Sontek instruments (Dick Crout)

- Added tests -- Dick will work on compressing tests added for Nortek and Kent's spectral tests if already conveyed
- Nortek to respond to questions on their columns
- Incorporated info from Q3 for Sontek Waves
- No info on AANDERA and Linkquest and MAVS
- Flags can be mapped to other flags as long as meaning is provided

Break

Wrap-up		**Bill Burnett and Stephanie Kavanaugh**

- Send PowerPoints and notes to Janet to post on website
- Synthesize meeting notes
- Bill will draft QARTOD Report

Currents/Waves Group will take CDIP page like html/layout and content and do same for currents. Put into a format that can be edited and maintained by QARTOD

Wait and see what we want to do with re-submitting to DMAC Standards Process (waves and currents)

Suggestions for future QARTODs (no current volunteers to host):

- Implement methods (outreach)
- Synthesize previous QARTODs (first timers had trouble getting up to speed before meeting)
- Post white paper summary of QARTOD findings?
- Provide homework and Tables ahead of meeting
- Raise significance and awareness of QARTOD effort
- Make QARTOD website more user friendly (needs overhaul?)

Additional notes:

Action item for group 2: would like to see the page where you can see the tabs and tests for waves in a format for currents and convert both those tables into NDBC format.

Ken has an html file from a previous QARTOD – maybe get the tables into html first for interactive tab format.

Group 1 table – not sure how to handle that table yet, not as succinct as group 2's table.

Don't plan on submitting waves and currents tables to IOOS because there isn't anyone to submit them to right now.

DMAC standards process still exists, but waves and currents that are out there should be retracted based on the results of this meeting.

Google code group – begin to use – post URL on QARTOD website.

Submit to JCOM IODE process? Sure

Need a better understanding of submitting things through IOOS versus IWGOO, how that's related – could do in parallel as they are independent processes.

Regional Association involvement – is this something that could be sent to all of the Regional Associations as to what happened here? Send to Josie and she'll put it in the next newsletter.

NERRS (National Estuarine Research Reserve System) and others doing similar things establishing near real time QA/QC. How do we reach those kinds of groups to disseminate our results properly? Those folks are doing similar things and face the same issues. We have to get to them so we can learn from each other. There is a water quality conference coming up, and there are water quality metadata standards efforts going on. Don't know how to ensure that this info trickles down to state agencies, etc.

Getting word out to Regional Associations – technical reps have a bi-weekly call that could be used as a channel for getting the word out.

Maybe the oceans meeting in Portland – too late for that one, but should target conferences like that.

QARTOD participants should disseminate info to those you know.

Appendix I Notes from Breakout Session 1 (Biogeochemical)

Breakout Group 1/Biogeochemistry
November 17, 2009

Charge: To identify and define quality control tests and practices for real-time biogeochemical observations (e.g. conductivity, ph, turbidity, dissolved oxygen)

Facilitators: Stephanie Kavanaugh (process); Brenda Babin and Grace Cartwright (technical); Stephanie Kavanaugh (notes).

Participants:
Brenda L. Babin
Luke Beatman
Julie A. Bosch
Grace M. Cartwright
Karen Grissom
Lei Hu
Carol D. Janzen
Steven Le
Steve Parmley
Tucker Pierce
Xiaoyan Qi
Derrick Snowden
Daniel J. Sullivan
Mario N. Tamburri
Dick Thayer

Question 1 – What is the scope of the quality control application?

- SCOPE for GROUP 1:
- Automated QC
- Near real-time dissemination
- Moored systems (includes non-moving platforms and buoys)
- Oceanography sensors
- Equally spaced time series
- Need to define "real time" for each application, i.e. "time to website" from when it was collected; the group added a column (G) to the Question 1 spreadsheet
- Argo is a platform community that has already done this for themselves.
- There was some confusion on the term application—what was meant is "who are you, what data are you collecting, why are you collecting it."
- Clarification on how to limit the number of applications we discuss:
- Just the real time applications for which QARTOD applies
- Of all the applications you use, pick the one that's the limiting factor, the one that's most demanding
- The Question 1 spreadsheet as an assessment of the people in THIS ROOM.

Feedback is wanted from those who aren't in this room, (for example Argo). The product of this workshop (recommendations for QC procedures) will be fine tuned as time goes on and additional input is received.

What is wanted: What do we do at a minimum to automated, real-time data before we post it; develop an industry standard…what are those algorithms?

What is wanted: what tests are applied, in what order they are applied, and what are the outputs?

How do you define what the human interprets – don't even try.

We're not saying that what we recommend at this workshop is grounds for exclusion; our recommendations are not meant to replace human QA/QC.

Concern: column A is generic operators, but we're talking about specific systems. For example, "MUDBED" is a specific program, but "observations" isn't. You have to ID method to come up with QC procedure because the QC would be specific to manufacturer's method of collection.

Remember this exercise is just to "set the stage" using the experience/expertise in this room.

We're not trying to derive just one end-all, be-all procedure/method—we're looking for more of an approach to QC based on the user.

Question: If what we are looking at is specific sensors – and next year they may be replaced, does it makes sense to say the first thing we're going to do is the QC steps that apply to everyone? Answer: Sure.

Question 1 was geared towards defining the scope of what we are going to deal with – the expertise within this room. In Question 2, there are some QC tests from past QARTODs we will address.

We're not prioritizing QC for pH data specifically because the technology is too limited. There are sensors out there, but no one in this room knows enough to talk about existing technology and the technology that is still in R&D.

Process change after break: List the parameters we want to work within and the tests for each parameter that people in this room use. We will use the rest of the time today to finish Question 1. A new sheet within the Excel sheet was created.

Parameters left off: pH

Pressure is needed for deriving salinity from conductivity and to correct for mooring motion QA/QC, e.g. pressure tells us if the system is moving. We're only looking at pressure as ancillary to the other measurements.

Notes on new sheet:

- Climo = climatological
- Stuck sensor = opposite of rate of change

Important to develop (at a future QARTOD) guidance on platform health issues, i.e. "these are general tests you should do for moored buoys."

Need to check what the group came up with today against the tests from the QARTOD III results – today's group came up with more/better tests.

Question: Are we doing these tests on the parameter values, or are we doing these on time series?

- Assume you have access to whatever you need to perform the check.

Breakout Group 1/Biogeochemistry
November 18, 2009

Question 2 – What real-time quality control tests must be applied to the observation?

Clarification on column titles:

- Column C = denotes time series or observation by observation
- Column F/Inputs = things that change each time; what values are we going to input
- Column G = parameters that will probably stay constant

Discussion of definitions in the spreadsheet:

- Global Temperature and Salinity Project (GTSP) definitions for tests were added to the QARTOD spreadsheet. Global Surface Underway Data definitions are almost the same.
- It's fine that our definitions are different from those for waves
- Users should be able to read the definition to decide whether or not they want to use the test, then the description tells them what they need to perform the test.

Group had a lively debate about the different between the 'rate of change test' and 'spike test'

Caveats for 'rate of change' test (2 point and 3 point)

- Define the time when you define your criteria
- These tests are ONLY APPLICABLE when you've got an equally spaced time series/ constant unit.

'Spike' test doesn't imply you have any prior knowledge

There's some overlap between these tests and that's okay; in fact that's good for flagging

Can you separate natural variability from 'trend analysis'? The group was not in agreement on this matter.

There was debate on the 'drift analysis' test and what it actually means and how complicated it would be to do it.

Check sum' was put under syntax.

Saving 'theoretical saturation' and 'Bayesian' analysis for later.

'Variance' test could be used for 'drift.'

'Remote sensing' was added to the list of tests for temperature and chlorophyll.

Suggestion: we really should do something about "how do we quality control a mooring?"

Suggestion: create a Google code group to collect and share these algorithms – you can see how well yours fits with others, etc.

- This idea has been brought up at just about every QARTOD; need to bring that up at the "next steps" session at the end of this workshop.
- Wouldn't endorse anything, just making it available.
- Would need a disclaimer on the group: use these at your own risk.
- http://code.google.com/p/qartod

Question 3 – QC Flags and Flagging Conventions

Limit to 1st level QC being released in "near real time"

Interoperability amongst systems is desired – we've been preaching this to the IOOS community.

There's an IOC convention for this (Argo floats, GTS, WOCE, etc.), and we've tried to map them all. Everyone may be moving to the World Ocean Circulation Experiment (WOCE) convention which has a '0-9' rating system.

Argo flagging convention would be best to adopt, as we would likely have the least headaches with mapping down the road.

- Perhaps use only the ones that apply to our tests. (0,1,4,…..).
- But would first need to give a 0/fail or 1/pass before mapping to the Argo system.
- Need a way to indicate which tests passed and failed.
- How to demonstrate how the flags for each test carry up to a final flag?
  - Suggestion: carry them in 2 separate fields. For example, a flag for each test that feeds into an aggregate flag.

- Suggestion: before next meeting – sharpen these up and get some folks to post examples.
  - The plan is to put what we come up with into practice with a few folks and report out.

Test Order of Implementation

Group debated whether or not tests with the same rank should be weighted and decided against it.

Don't confuse this ORDER with rank or weight – it's just a logical flow.

Not all participants agreed that suggesting an order was any different from ranking or weighing the tests.

The suggested order is:

Syntax check

Range tests (gross)

Range test (climatological)

Rate of change tests, outlier, spike, stuck value

Redundant sensor

Main Points for Report-Out

SCOPE for GROUP 1 =

- Automated QC
- Near real-time dissemination
- Moored systems (includes non-moving platforms and buoys)
- Oceanography sensors
- Equally spaced time series

First the group defined the parameters they would work with, i.e. the most common parameters and those which we had the collective expertise to address.

Then listed and defined tests for each parameter.

- All the tests the group fleshed out were applicable to all the parameters selected.
- Real time was definite as the time from collection to publication.
- Definite real time value for each test.

We have several descriptor flags we feel are important and the group decided that each specific test flag should be pass or fail, then those flags should be weighted for the aggregate final flag. (Weighting/mapping could be left to the user or may be a subject for a future QARTOD.)

We're not telling anyone how to make decisions based on the QC.

Next Steps

Implementation of the tests the group worked on.

Recommendation: create a Google code group (not endorsed, use at your own risk) to collect and share these algorithms. The URL is: http://code.google.com/p/qartod/

Report out for Breakout Group 1
Notes – 11/19/2009

Technical facilitators presented the main points of their discussion and the results of working through questions 1-3. See the breakout group notes and biogeochemistry excel spreadsheet for details.

The full group discussed the implementation of the tests discussed by the biogeochemical breakout group.

At times, finding the right word for a test was the hardest thing.

We didn't make the connection between individual QC test flags and the final aggregate – that will be up to the program, and some parameters will be different than others.

The other group spent lots of time talking about having a sufficient time series. Most of our tests look at fewer data points; but maybe one of the earliest tests you do should be to determine if you have a sufficient data set.

We discussed a broad spectrum of tests you could apply, but not all programs/systems will need or want to do them all.

pH and nutrient sensors may be too young, but the tests are actually independent of the sensor – though you'd probably get more flags. Want to be clear that our results could apply to other water quality sensors, though.

Bill presented a DO graph from the NDBC and the group looked at it from the perspective of the tests discussed by Group 1.

Some of the QC tests that are possible/plausible for the parameters we discussed may be delayed, but this group didn't deal with those tests because of how we defined our scope (near real-time).

The purpose of the QC checks isn't to analyze your data – it's to check whether or not your values are reasonable, not to correlate things. There was a lot of discussion about trying to make complicated QC checks – we want just what comes off the instrument PLUS a flag knowing whether or not something is suspect about it. We don't want it analyzed. A range test could be as simple as: what's the instrument range? Concern when we are talking about oxygen because the wind is blowing.

- It may be a slippery slope towards modeling.
- But there are plenty of other users who do want that further analysis.
- Providers could provide both. (There wasn't strong agreement within the group about this issue.)

The group didn't get to the point where they separated tests by variables. The aggregate flag may be different depending on the parameter and depending on which test(s) it failed.

So what's left for the next QARTOD?

- Looking at it by parameter, flesh out the table more, address additional tests, look at locations, look at sample data together to determine whether or not data would pass.
- Bring implementation results to the meeting to evaluate them.
- Revisit the recommended sequence of tests.

When is it appropriate to incorporate steps beyond looking at data? That's QA – you have to be able to verify that your instruments work, then you have to look at your platforms.

Want an absolute minimum for QC – taking out only the data we KNOW is wrong – because we don't want to lose data.

If info is going to be used for critical decisions you need to err on the side of caution in removing data that you think may be suspect, instead of flagging it and putting it out there.

NBDC – trying to put together a compendium of all the water stations we evaluate.

Need to talk about "what is good data for a particular location?"

What makes this all so difficult is that each station has certain unique characteristics. These QC's have to be developed uniquely for each geographic area.

Would it be useful for QARTOD to have a group ID the minimum amount of info about a site for the data. For example – what is the expected salinity range or that site? What is the tidal schedule?

- That's metadata!

QA is very important…are you QC'ing your QA? (Should have put that into the biogeochemistry group.)

Question: how often are time series taken? Every 2 minutes? 2 hours? That's a decision for the user.

- Different for different tests/instruments

What we're building in QARTOD – it's a national infrastructure. We may not realize how much help we need. We need to be careful of what we're providing for the future – is the data that we are providing – can it stand the test of law?

When we start a station – we have to realize we're starting a record.

QARTOD V

Breakout Session 1 Supporting Charts

Measurement typ	**temperature**	**conductivity**	**DO**	**turbidity**	**Chlorophyll a**	**CTD pressure**
X	range check	range check	range check	range check	range check	range check
	rate of change	rate of change	rate of change	rate of change	rate of change	rate of change
x	climo check	climo check	climo check	climo check	climo check	climo check
	stuck value test	stuck value test	stuck value test	stuck value test	stuck value test	stuck value test
	nearby sensor	nearby sensor	nearby sensor	nearby sensor		nearby sensor
	model output	model output	model output			
	redundent sens	redundent sens	redundent sens	redundent sensor		redundent sens
	parity character	parity character	parity character	parity character	parity character	parity character
	multivariant	multivariant	multivariant			
	nearby trend analysis	nearby trend analysis	nearby trend analysis	nearby trend analysis	nearby trend analysis	nearby trend analysis
	drift analysis	drift analysis	drift analysis	drift analysis	drift analysis	drift analysis
	spike check	spike check	spike check	spike check		spike check
	digit roll over	digit roll over				digit roll over
	Outlier check	Outlier check	Outlier check	Outlier check	Outlier check	Outlier check
	variance check	variance check	variance check	variance check	variance check	variance check
			theoretical saturation			
			bayesian analysis			
	Remote sensing				Remote sensing	

Question 1	Define the scope of the Quality Control Application					
User	**Application**	**Type of measurement**	**Manufacturer**	**Method of measurement/instrument**	**Deployment**	Data transfer rate
(Data Assembly Center)	forcasting and research	sal, chloro, turbidity, redox potential, DO, temp, pH	various	various	various	6 min to 24 hrs
climate program	Ocean observations and modeling forcasting	ocean temp and conductivity	Sea-Bird	electrode sensor	shipboard profiles	with-in 21 days
Argo climate program	and modeling forcasting	ocean temp and conductivity, O2	various		autonomous profiling float	12 hrs Argo
Program Manager MUDBED	Realtime observing for Basic Research	Turbidity	YSI, Sequia, Seapoint, Sontek, RDI	tubidity meter, LISST 100X, OBS, ADV, Acoustic Current Profiler	bottom mounted tripod	15 min burst average
environmental monitoring	long term realtime observing for basic research	temp, conductivity, turbidity, do, fluorometer	various	inductive cell, optical and electrochemical probes		1 min
CBIBS Observations	Near realtime	temp, conductivity, turbidity, do, fluorometer, pH	Seabird wetlabs WQM	electrode, optical and electrochemical probes	buoy	10 min
CBIBS Education	near realtime	temp, conductivity, turbidity, do, fluorometer, pH	Seabird wetlabs WQM	electrode, optical and electrochemical probes	buoy	10 min
NDBC ocean observations	forcasting	conductivity, te	seabird and various		buoy	6 min to 24 hrs
USGS	monitoring	temp, conductivity, turbidity, do, fluorometer, pH	various	various		
manufacturer		CTD and DO				
CORMP Observations	Near realtime	temp, conductivity, fluorometer,	Seabird	electrode, optical and electrochemical probes	buoy	15 min - 1hr

Question 2. What real-time quality control tests must be applied to the observation?											
Biochemical Observation Application (All, C, T, P, DO, Chlor_a, Turbidity)	**Test Name**	**Data Application (Applied to Time Series (raw, calibrated data) parameter values, special data …)**	**Test Definition**	**Test Description**	**Define the inputs to the test**	**Define any criteria (limits) used within the test**	**Define the outputs of the test**	**Test Order**	**Weighted Rank**	**Action (interpretation of flag)**	**Notes**
All	Range Tests (Gross)	Parameter Value	The check to ensure that all measurements or values fall within established upper and lower limits,	User defined with manufacturers' limits considered.	Point Observation	Max, min		2			Parameter value test. Applies to Biogeochem observation (Cond, Temp, Pressure, DO, Chlor_a and Turbidity)
All	Range Test (Climatological)	Parameter Value	The check to ensure that all measurements or values fall within established upper and lower limits	(Within the limits of the seasonal historical observations)	Point Observation	Max, min	Pass/ fail flag	3			Parameter value test. Applies to Biogeochem observation (Cond, Temp, Pressure, DO, Chlor_a and Turbidity)
All	Rate of Change Test (2 point)	Time Series	This test evaluates the difference between two consecutive measurements or values of a parameter is verifies to be less than a maximum allowable change defined for a specific time period.	This test is failed when the difference between adjacent measurements is too steep. Test value = (V2-(V3+V1)/2 where V2 is the measurement being tested, and V1 and V2 are the previous and next values.	Point Observation and previous point	Absolute rate of change	Pass/ fail flag	4			Time series test. Applies to Biochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity). Applies to profile data.
All	Outlier Check		Outliers are defined as points more than M times the standard deviation away from series mean.		Observed value, mean, standard deviation	*M* is the number of standard deviations	Pass/ fail flag	4			User defined time series of meaningful mean and standard deviations. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity).
All	Spike Check		Differences between sequential measurements, where one measurement is quite different than adjacent ones, is a spike in both size and gradient.	Test Value = V2–(V3+V1)/2 where V2 is the measurement being tested as a spike, and V1 and V3 are the values previous and next.	Three sequential point observations	Spike Threshold	Pass/ fail flag	4			Requires temp, sal, and pressure for calculation. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity).
All	Stuck Value Test	Times Series	Value does not change more than the resolution of the sensor over a period of several observations.	Rate of change of the data is below the threshold of the instrument over a specified period of time.	Sequential point observations	Instrument Resolution	Pass/ fail flag	4			Value doesn't change over time more than the resolution of the instrument. Time series test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity).

[I-12]

Question 2. What real-time quality control tests must be applied to the observation?											
Biochemical Observation Application (All, C, T, P, DO, Chlor_a, Turbidity)	**Test Name**	**Data Application (Applied to Time Series (raw, calibrated data) parameter values, special data …)**	**Test Definition**	**Test Description**	**Define the inputs to the test**	**Define any criteria (limits) used within the test**	**Define the outputs of the test**	**Test Order**	**Weighted Rank**	**Action (interpretation of flag)**	**Notes**
All	Nearby Sensor	Parameter Value or Time Series	This test evaluates the variability between a measurement and an identical parameter measurement from a nearby sensor		Parameter Values	User defined acceptable variability	Pass/ fail flag	6			This test can be used to verify measurements are consistent. Parameter value or time series test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity)
All	Redundant Sensor	Parameter Value	This test evaluates the variability between a measurement and an identical parameter measurement from a co-located sensor.	Sensors are located at same platform.	Parameter Values	User defined acceptable variability	Pass/ fail flag	5			Parameter value test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity)
All	Syntax Check	Parameter value or full data transmission	This test evaluates whether the observation is in the expected syntax.	Expected syntax is of specified length, proper characters and format	Data String	User defined syntax	Pass/ fail flag	1			Parameter value or full data transmission test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity)
All	Drift Analysis	Time Series	This test evaluates drift in data over a user specified period of time.					5			Time series test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity).
T, C, P	Digit Rollover		Test to evaluate a bit shift								Applies to Cond, Temp, Pressure observations.
All	Variance Check	Time series	Test that the variance or standard deviation of values are within limits defined by the data provider.	Over a user defined time period to define “noise” in the system.	Time Series	Standard deviation and time frame	Pass/ fail flag	4			Times series test. Applies to Biogeochem Observation (Cond, Temp, Pressure, DO, Chlor_a, Turbidity).
T, C, DO	Model Output										
T, C, DO	Multi-variant										
All	Nearby Trend Analysis										
DO	Bayesian Analysis										
Pressure, Conductivity, Temperature (QARTOD III)	Gradient Test	Sequence of parameter values									
Pressure, Conductivity, Temperature (QARTOD III)	Endpoint Spike Tests	Sequence of parameter values									

Question 2. What real-time quality control tests must be applied to the observation?											
Biochemical Observation Application (All, C, T, P, DO, Chlor_a, Turbidity)	**Test Name**	**Data Application (Applied to Time Series (raw, calibrated data) parameter values, special data …)**	**Test Definition**	**Test Description**	**Define the inputs to the test**	**Define any criteria (limits) used within the test**	**Define the outputs of the test**	**Test Order**	**Weighted Rank**	**Action (interpretation of flag)**	**Notes**
Pressure, Conductivity, Temperature (QARTOD III)	Spike Tests	Sequence of parameter values									
Pressure (QARTOD III)	Compare with surface pressure										
Pressure, Conductivity, Temperature (QARTOD III)	Dual Sensor Comparison	Parameter values form redundant sensors									
Pressure, Conductivity, Temperature (QARTOD III)	Density Inversions										
Pressure, Conductivity, Temperature (QARTOD III)	Freezing Point										
Temperature (QARTOD III)	Nearest Neighbor	Parameter values from distinct platforms nearby in space/time									
Temperature (QARTOD III)	TSP Relationships										
Temperature (QARTOD III)	Compare with Conductivity										
Conductivity (QARTOD III)	Compare with Temperature										
Conductivity (QARTOD III)	Descent Rate										
	Top and Bottom Spike										

[I-14]

Question 3. Questions related to QC flags or flagging conventions					
What categories of real-time quality descriptor flags	**Manual QC for suspect/bad data**	**Argo value**	**Are flags applied to each specific test as well as to the overall data quality?**	**How is the aggregate data quality determined?**	**What real-time calibration flags should be applied?**
(e.g. 1 Passed QC, 2 Failed QC…)			(e.g., Yes/No - Why?)	(e.g., One failed flag, then entire observation failed)	(e.g., Time since last calibration)
Missing data			No. Each test will have a pass/fail flag that is weighted for the aggregated final flag.		
Good data					
Suspect data					
	Verified data-good				
	Verified data - bad				
Bad data					
No QC done					

Appendix J Notes from Breakout Session 2 (Waves/Currents)

Breakout Group 2 (ADCP-Waves/Currents) – The Pine Room
November 17, 2009

Charge: To provide clarification and additional input to previously identified waves and *in situ* currents QC practices and to address additional QC tests and practices for additional wave and in situ observation methods.

Facilitators
Bill Burnett and Mark Bushnell (technical), Helen Worthington (process), Sara Haines (notes).

Participants:
Janet Fredericks, Sara Haines, Dan Ramage, Rodney Riley, Kent Hathaway, Mark Bushnell, Bob Jensen, Ted Mettlach, Rich Bouchard, Vembu Subramanian, James Davis, Robert Raye, Jeff Donovan, Richard Crout, Helen Worthington, Steven Le, Rosemary Smith, and Darryl Symonds

Two QC Test Proposals on the table, one for waves and second for *in situ* currents

Waves
http://nautilus.baruch.sc.edu/twiki/pub/Main/WaveQC/QARTOD_WAVE_QC_for_IOOS_DMAC_submission.pdf

***In-situ* Currents:**
http://opendap.co-ops.nos.noaa.gov/content/Docs/In-Situ_Currents_QC_Standard_for_IOOS.pdf

Janet Fredericks posed some questions to Bill Burnett with regard to implementation of the above documented waves QC tests. We will start with these questions. (Where is this email?? We need to get these questions into this report?). Minimum length (time span) record length – confusion of data gaps or long enough data record in one ensemble to generate a spectrum.

Janet uses in-situ current tests on velocities, then computes spectrum from velocities. There are many ways to arrive at a wave spectrum (accelerometers, surface ranging, near-surface velocities, near-surface radial velocities, some combination of other surface height measurement either from pressure or vertical beam). Need to use sensor type tests before processing further waves QC tests.

QARTOD V

Whether measure velocities or accelerations, have to do initial gap and spike evaluation for FFT. We are discussing high resolution (1-2 Hz data) for a wave ensemble that will generate the wave energy spectrum from which bulk wave parameters are derived.

Nortek PUV process (list from CDIP site)

Signal strength (test that strength of ?)

Are we talking about single-ping data or some averaging

Single-ping (no standard deviation)

300 ping sample (average of all)

Q: Should we be combining *in situ* and waves tests?

In situ currents get away from sensor (RDI) specific want to do another table for Nortek AWAC, pick out general tests or summarize them and then address sensor specific tests.

There are lots of different ways to measure waves besides ADCP, pressure array and wave riders like remote sensing via RADAR, for example SAR, HFRADAR, scatterometer, and Ship RADAR.

Q: Should we include these types of sensors in this table and discussion?

Can do same tests on bulk wave parameters

But with high resolution need sensor specific tests (at the sensor or cabled computer with high-bandwidth)

Raw high res 1 Hz (research mode)

Spectral wave data

Bulk wave parameters

Philosophical perspective of tests (cut down on amount of bad data that goes out -- 80% good)

Waves reported 2 ft but really 20 feet and tests catch this -- avoid loss of life

Or do these tests because QARTOD says so.

Real-time has different quality needs (and can do in automated mode)

Archived data needs all the info

Broaden ADCP tests to single ping (instead of ensemble tests)

** Minor Change to Correlation Magnitude Thresholds

1. Yellow “At least 3 of the 4 correlation magnitude values” to “At least 2 of the 4 correlation magnitude values” and
2. Red “At least 3 of the 4 correlation magnitude values” to “At least 2 of the 4 correlation magnitude values”

Break

Echo Intensity (test is for each beam and bin) to determine whether or not to throw out a beam in solution (e.g. encounter tower leg on one beam or cable of buoy). Is echo intensity check done again at end on whole profile to determine (??) surface or bottom?

** Add “for each beam” on Echo Intensity

** Move away from stating “required” to “recommended”

** Recommend any ordering of which QC tests are performed for *in situ* currents.

From a model ingestion perspective, need to know when data are bad or suspect. If we rely solely on manufacturer defaults, then not so confident compared to someone who looks and monitors datasets in depth. If only making checks on bulk wave parameters, probably would be thrown out for use in models.

** Create sensor specific in-situ current QC tests (copy RDI idea and do similar for Nortek, Sontek, Aanderaa)

** Generalize or summarize tests from sensor specific tests to be QARTOD recommended tests

** Create third document table to merge waves and in-situ currents tests from ADCP

Clarify what is interpolated and what is not. Near real-time data and hourly bulk parameter are not to be interpolated. However in order to perform FFT and determine energy spectrum, the high resolution (1-2 Hz) of acoustic return has to be filled to 2^n number of samples (256, 512, 1024, 2048, etc). So if gaps are acceptable (small one or two 1 second gaps), then probably safe to interpolate. But if too many gaps or gap is too long, then probably need to stop collecting or throw out the whole hourly sample. For RDI, if wave ensemble has any gap of 5 seconds (if not enough data points within a time period), then throw out whole sample (or just stop taking data) for the hourly ensemble.

Individual remarks at end of session

Do we want to standardize ensemble length of sampling? (e.g. resolve ocean frequency of waves).

QARTOD V

Does QARTOD want to add in reporting on other waves measurements (e.g. from remote satellites, etc.).

Blending waves and in-situ currents with ADCP seems fruitful.

Concerned about itemizing (onerous) all sensors manufactured but also hard to generalize.

Once we do a few, perhaps start having others fill in their own.

Want currents to look more like hard and soft flag.

But yellow is soft, red is hard.

Guidance for each instrument but pick low hanging fruit or most used ones.

Can vendors provide some kind of flag output that tells us what passed or failed?

Responsibility of data providers to regional aggregation.

Each manufacturer has own table or tab.

Main QARTOD page summary of what should be tested.

Full data (from archive), but maybe not.

Output format summaries provide low-level QC.

Breakout Group 2 (ADCP-Waves/Currents) – The Pine Room
November 18, 2009

Continued discussing QA/QC of wave data generated from TRDI ADCP. Review waves tests as apply to ADCP for Janet's application at MVCO. Janet built a table for combining *in situ* currents tests that should be applied before doing waves tests.

Acceleration is a range test and specific to buoy motion or wave rider. Delete it from QARTOD list of tests for ADCP wave tests.

Mean shift needs to stay for ADCPs (sensor flopping around and should be stable) want to determine if step change in mean of velocity data.

Dynamic or fixed-mount application of mean-shift test. Do you check tilt if fixed? Should check that sample is homogenous and stationary.

Pitch and roll test from ADCP Currents to ADCP Waves

Add Pitch/Roll Variance (was "delta" on currents sheet)

Variance Test of whole wave burst (for currents, it meant from ensemble to ensemble), but we are talking about a variance test on a single waves ensemble or complete sample for an hour. Variance Test is taking whole ensemble, computing a mean and variance, and determining if computed variance falls within specified tolerance.

Tests on collection of data points

Tests on statistics derived from the ensemble.

HPR = Heading/Pitch/Roll

Dick Crout is filling out tests recommended by QARTOD and what are done by RDI, Nortek, SONTEK for waves and *in-situ* currents.

On this table changed red, yellow, green "stop-light" to 0, 1, 2 flags meaning of flags of pass, suspicious and fail. It is the same semantic meaning. When the question is raised about what "hard, soft" means, the intent is to describe how to "release" the data. Hard and soft are like the pass/suspicious/fail distinction. Hard flag is fail and, you don't release the data. Soft is suspicious and, you may not want to release (up to provider).

Items clarified:

- Data Gaps -- number of gaps, and length of any one gap
- Water temperature QC'd on ADCP because it is used in speed of sound computation, so just needs a reasonableness check

At this point, “Bushnell & Paternostro provided a brief presentation on the beam interference found on ATON ADCP installations and our planned solutions. Darryl Symonds / RDI explained that one beam side lobe hitting an obstruction in the near field can easily bleed into the two adjacent beams, a better explanation than the previous explanation that coordinate imperfect transforms cause bleed over.” (from Bushnell’s meeting notes)

Q: What about computed error values placed on a data value (that thing we learned in physics 101 but forgot or ignored after our junior year)?

Q: Any further points that need to be discussed?

The group re-iterated that tests for summary data (if don’t have access to low-level binary to perform tests discussed in this table) can be done by ensuring that they are done on the sensor at deployment and range tests on summary or bulk parameters is only course of action. The group agrees that by removing “required” to “recommended” helps this situation.

We will need to specify levels of tests that can be performed by a data provider that categorize simple to more in-depth (or low-level) tests.

** Nortek to answer questions and clarify tests and parameters used for specific QC tests they do to fill in their columns on this table.

** Need to review content and fill-in for each manufacturer on this table

** Add check factors for health and character of wave energy spectrum before bulk parameters are calculated (check with Kent Hathaway for clarification)

- Mean of AST versus P
- Surface Hmo pressure and Hmo from AST
- Horizontal currents coherence with vertical displacement (P or AST)
- Coherence of AST versus P
- Signal-to-Noise Test on spectra (Is it flat dead calm – no waves?)

Possible places to present work from this workshop:

- Oceanography?? International
- Buoy Workshop (March 2010)

Currents Technology Conference (CTC?)

Breakout Group 2 (ADCP-Waves/Currents) Continued
November 18, 2009

By bringing waves and currents together, whole is greater than sum of parts. Bill thinks most successful QARTOD to date for these two groups. Currents learned from waves, and vice versa.

Morphed currents and waves tests for ADCP Waves (Janet Fredericks)

- Still need to add spectral checks (and additional check factors that Kent listed yesterday) to this table.

Morphed waves and currents for Nortek, RDI, Sontek instruments (Dick Crout)

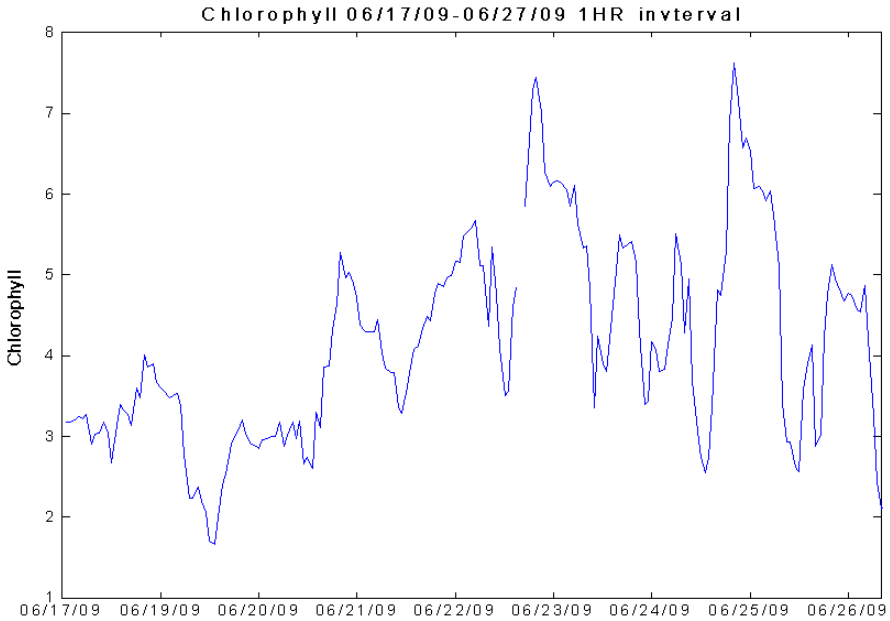
- Added tests -- Dick will work on compressing tests added for Nortek and Kent's spectral tests if already conveyed.
- Nortek to respond to questions on their columns.
- Incorporated info from Q3 for Sontek Waves.
- No info on AANDERA and Linkquest and MAVS.

Flags can be mapped to other flags as long as meaning is provided.

Appendix K NDBC Quality Control Challenges

Chlorophyll Data Quality

44013



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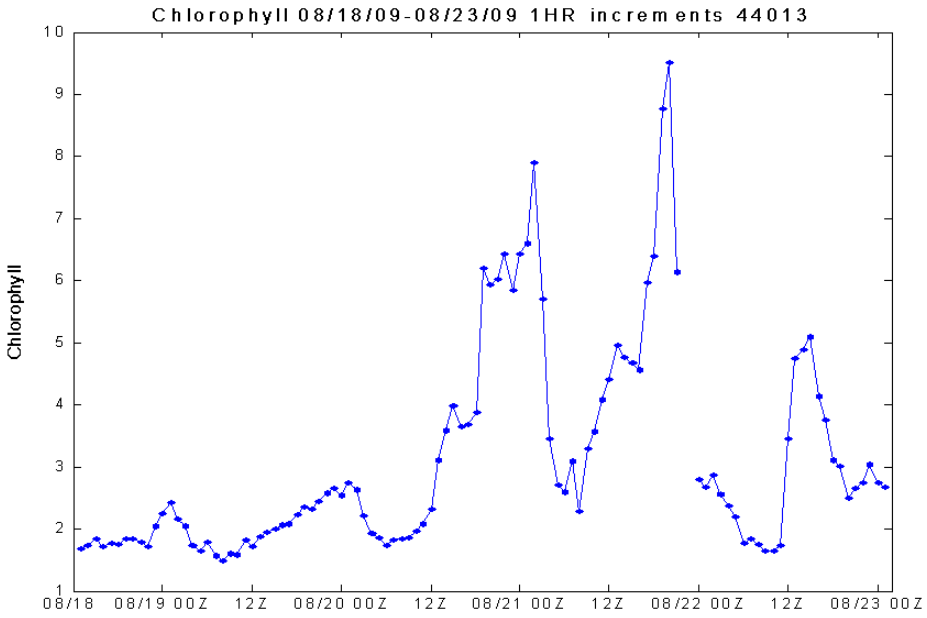
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Chlorophyll
10
9
8
7
6
5
4
3
2
1
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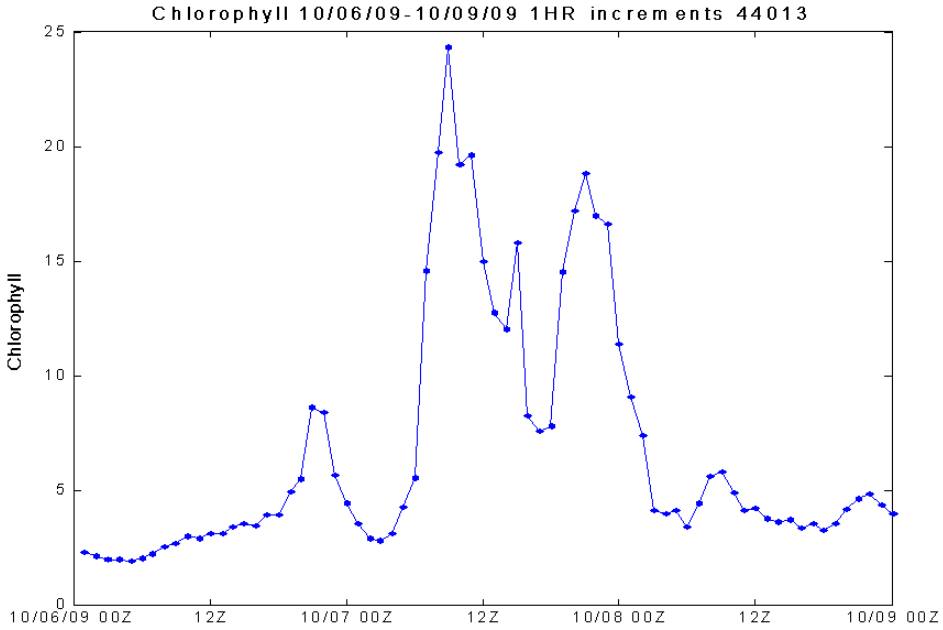
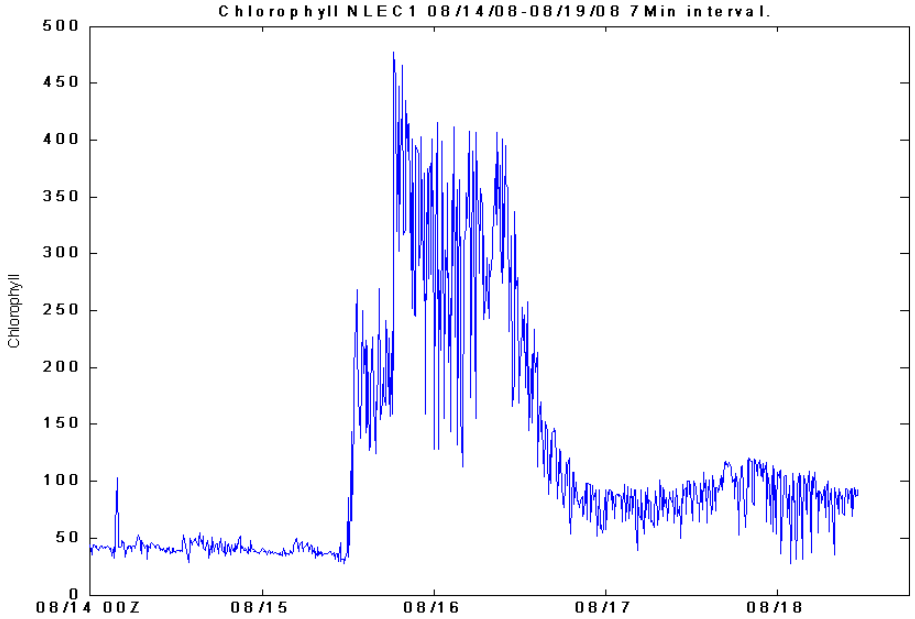
12Z
08/20 00Z
12Z
08/21 00Z
12Z
08/22 00Z
12Z
08/23 00Z

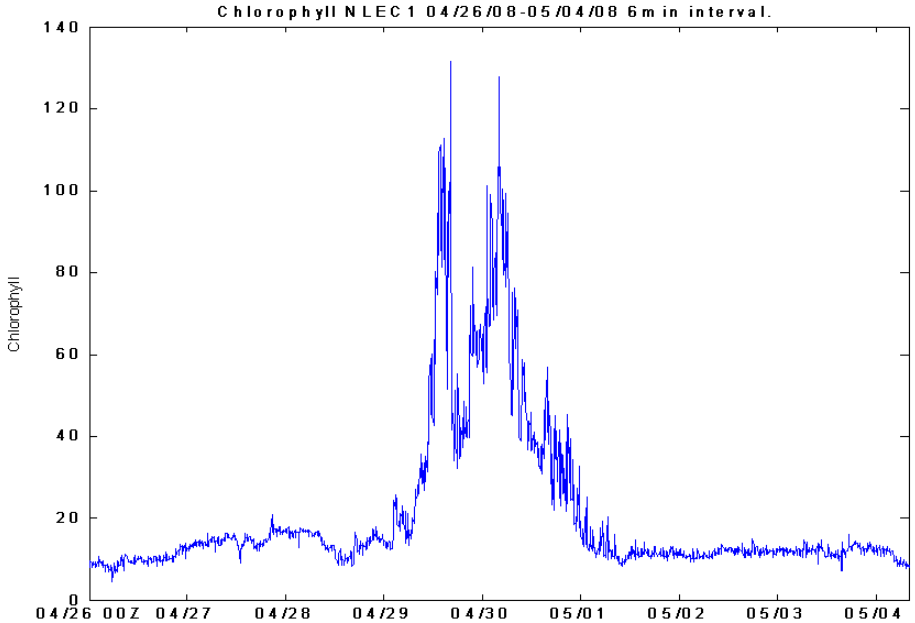
44013


Chlorophyll 10/06/09-10/09/09 1HR increments 44013
Chlorophyll
25
20
15
10
5
0
10/06/09 00Z
12Z
10/07 00Z
12Z
10/08 00Z
12Z
10/09 00Z

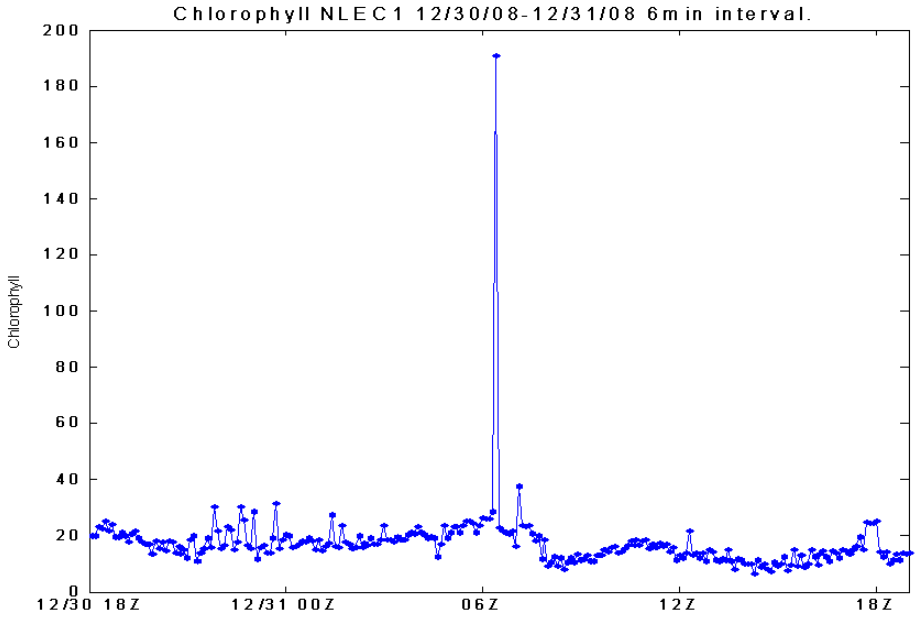
San Leandro Marina, CA

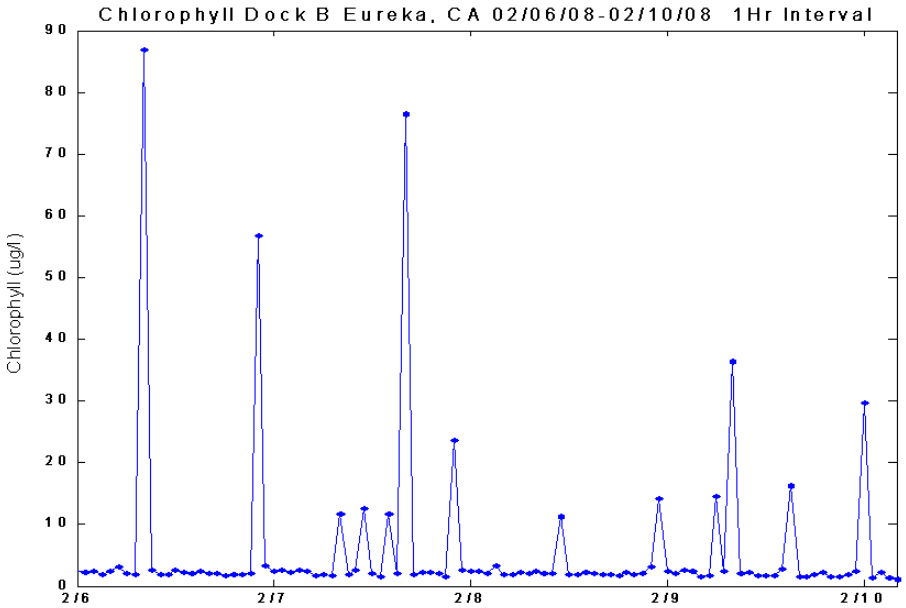


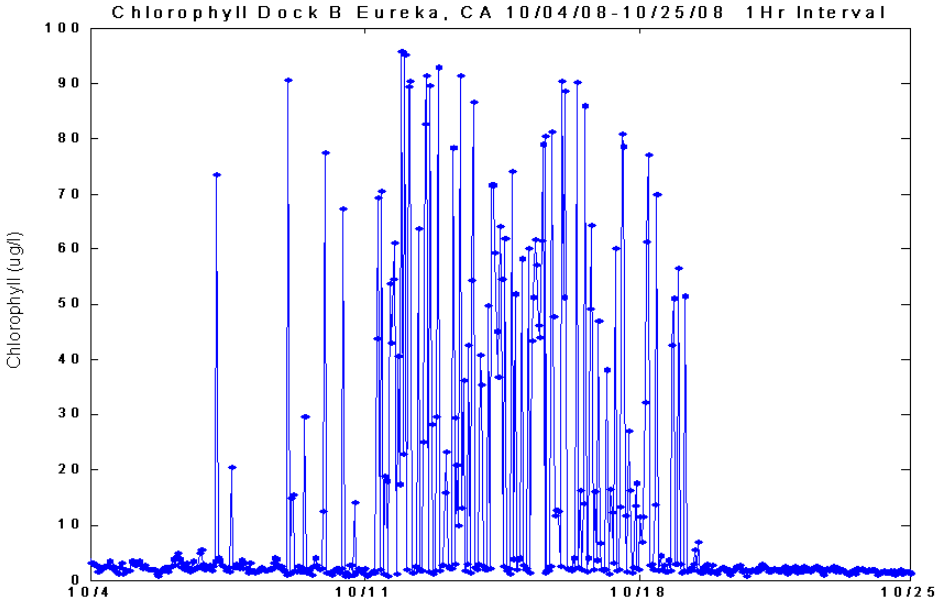
San Leandro Marina, CA



San Leandro Marina, CA






Chlorophyll Dock B Eureka, CA 10/04/08-10/25/08 1Hr Interval
Chlorophyll (ug/l)
100
90
80
70
60
50
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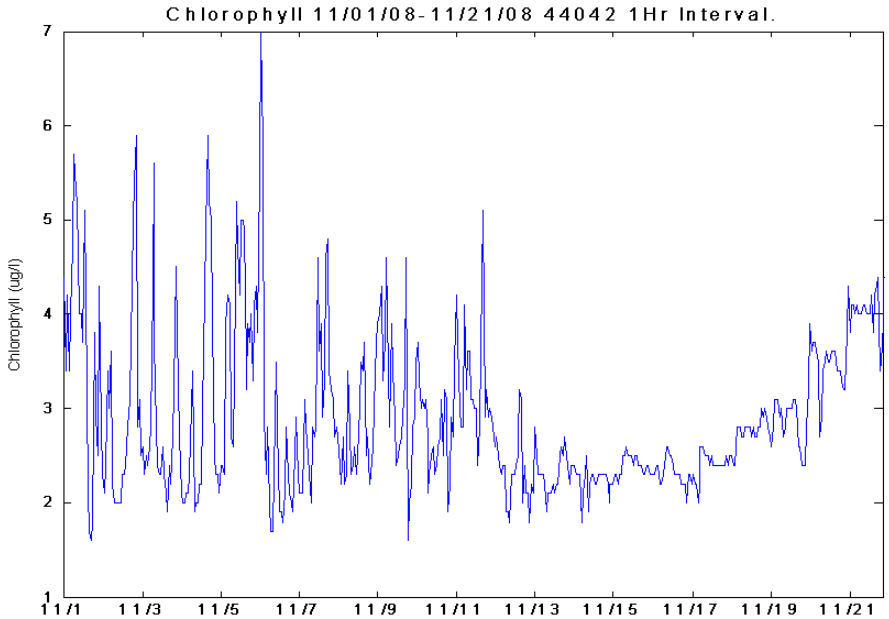
20
10
0
10/4
10/11
10/18
10/25


Chlorophyll 11/01/08-11/21/08 44042 1Hr Interval.
Chlorophyll (ug/l)
7
6
5
4
3
2
1
11/1
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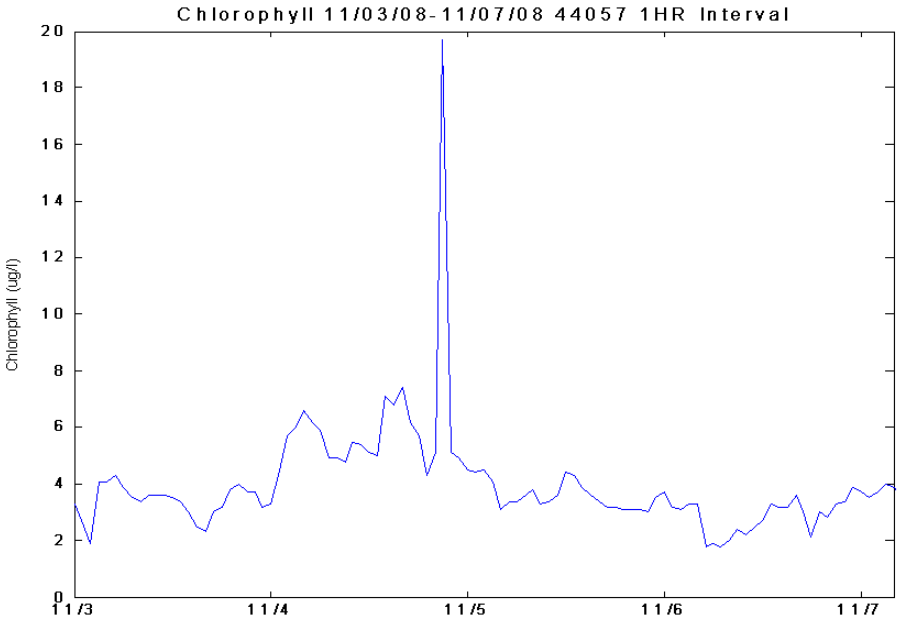
11/11
11/13
11/15
11/17
11/19
11/21


Chlorophyll 11/03/08-11/07/08 44057 1HR Interval
Chlorophyll (ug/l)
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18
16
14
12
10
8
6
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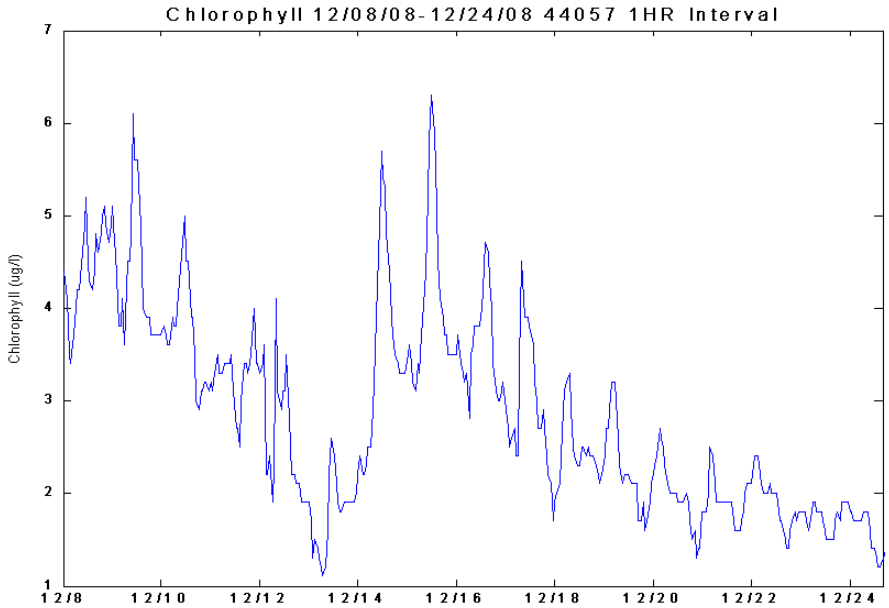
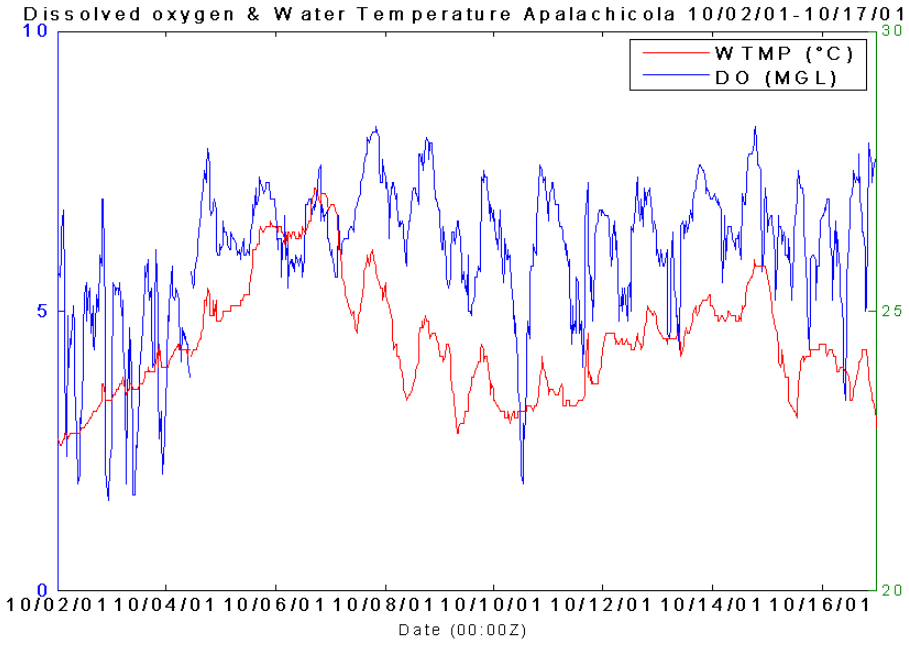
2
0
11/3
11/4
11/5
11/6
11/7


Chlorophyll 12/08/08-12/24/08 44057 1HR Interval
Chlorophyll (ug/l)
7
6
5
4
3
2
1
12/8
12/10
12/12
12/14
12/16
12/18
12/20
12/22
12/24

Apalachicola



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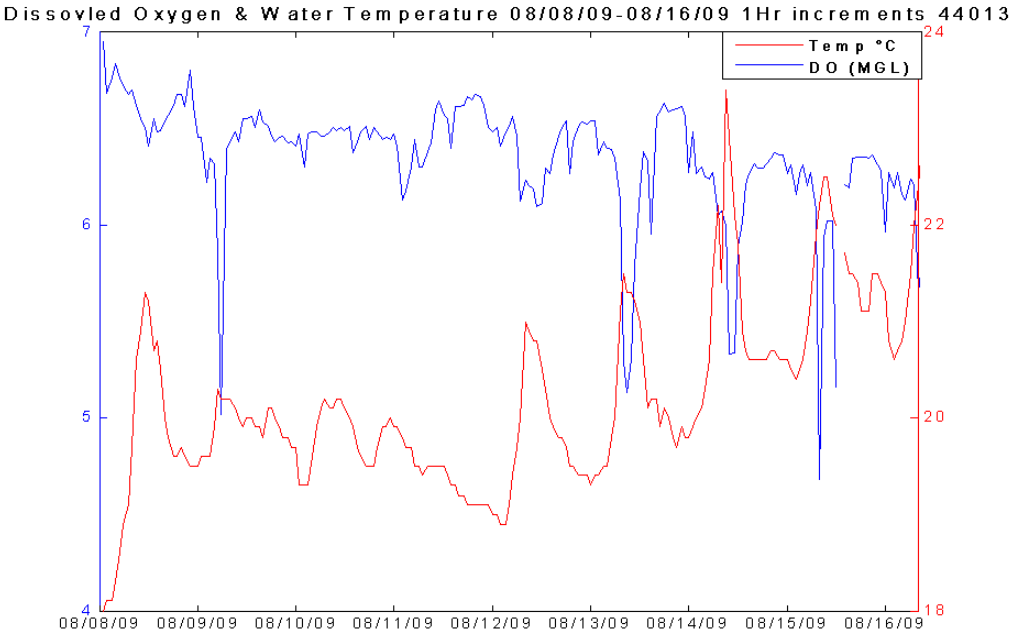
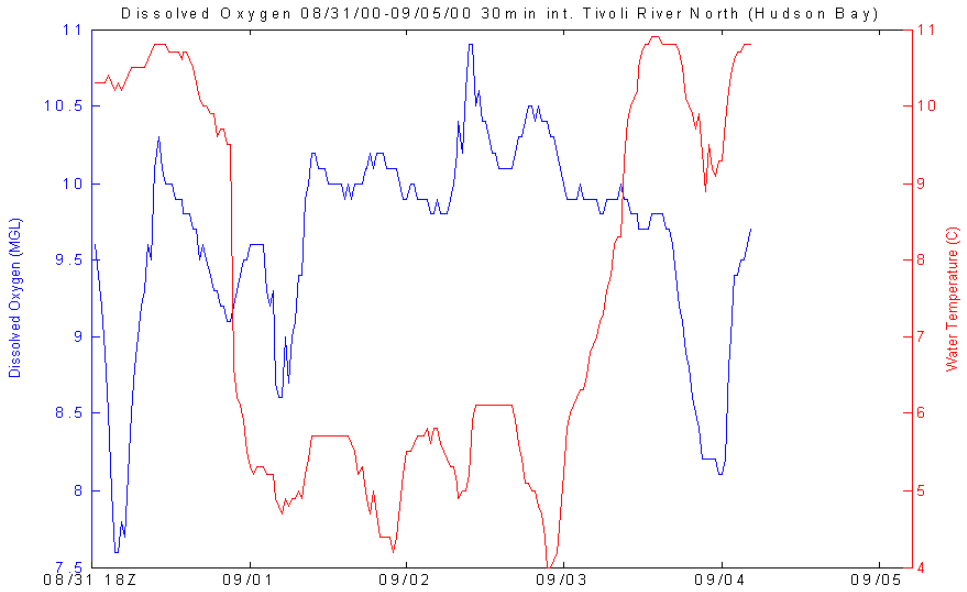
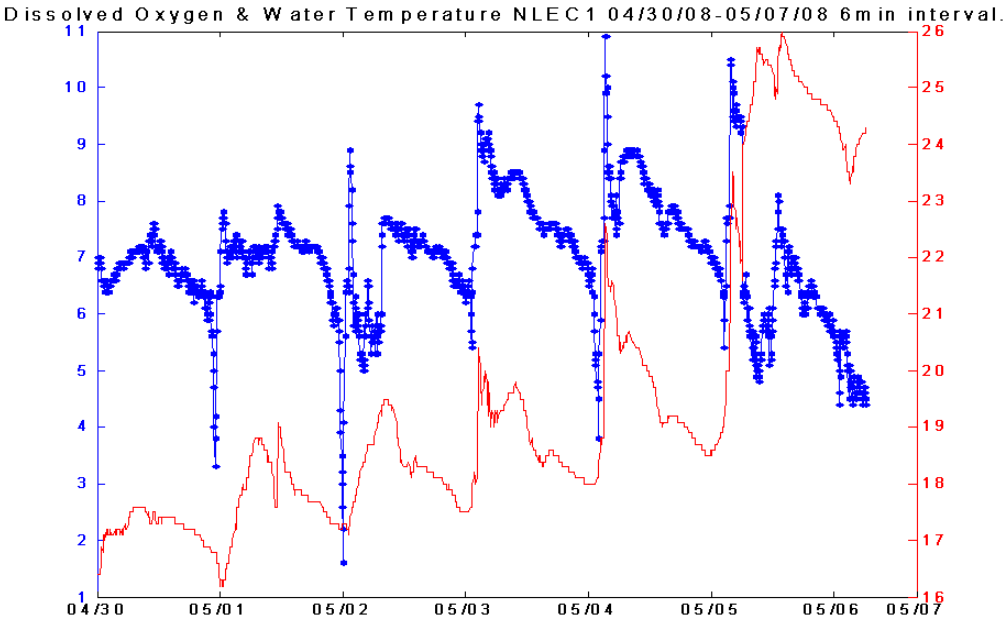


Tivoli Bay North



San Leandro Marina, CA



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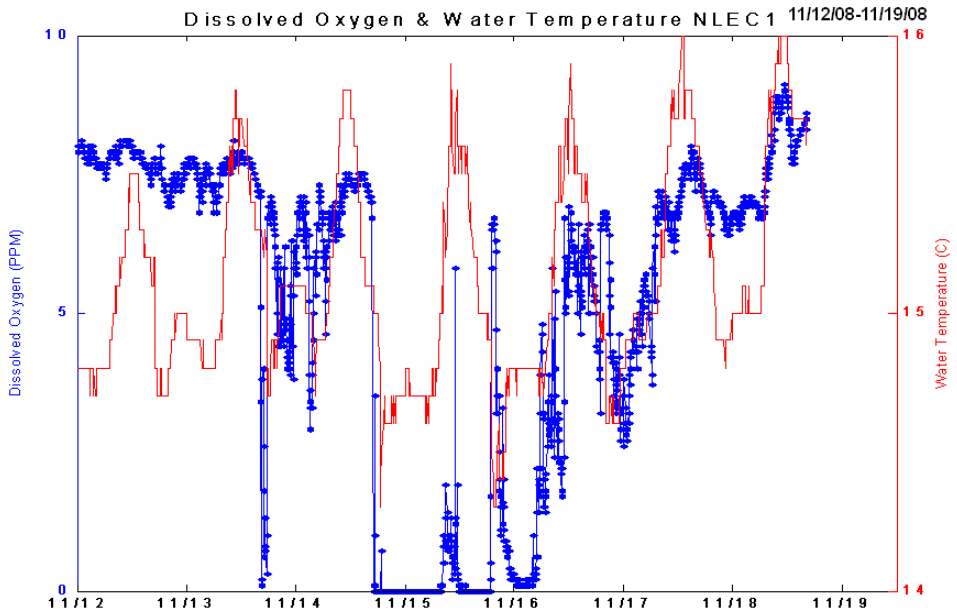

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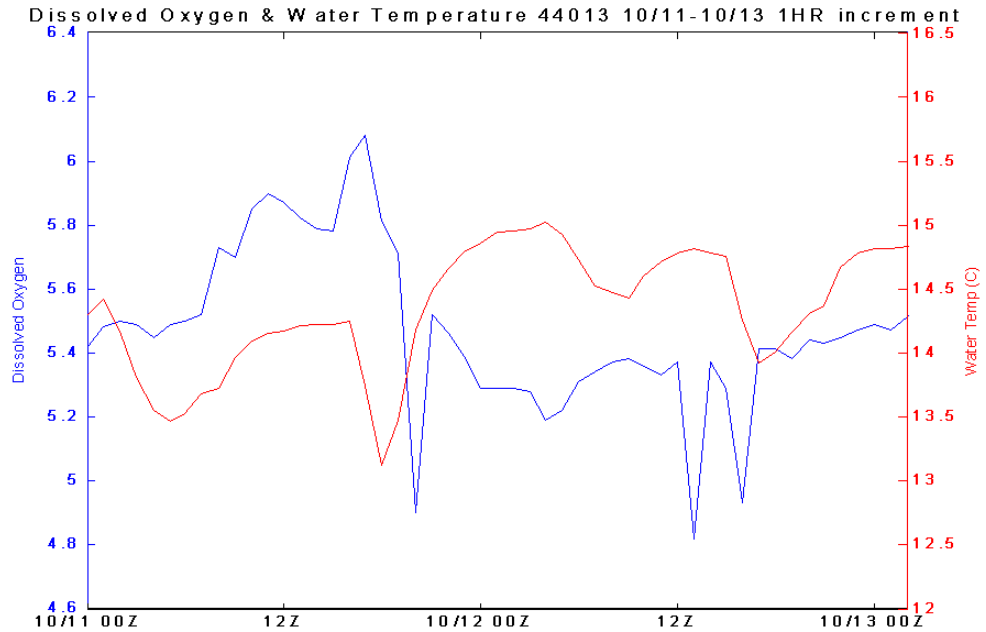

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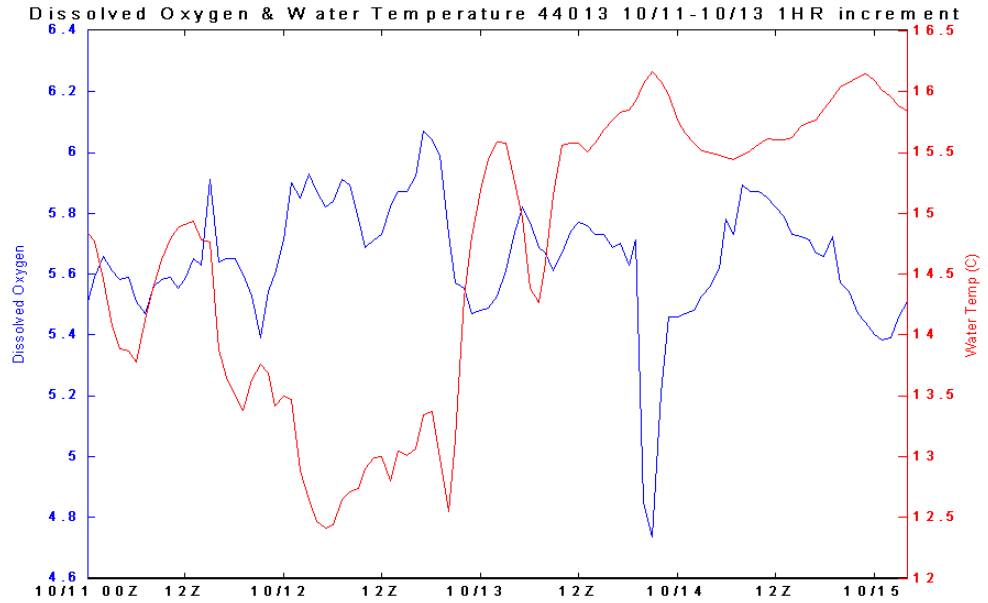
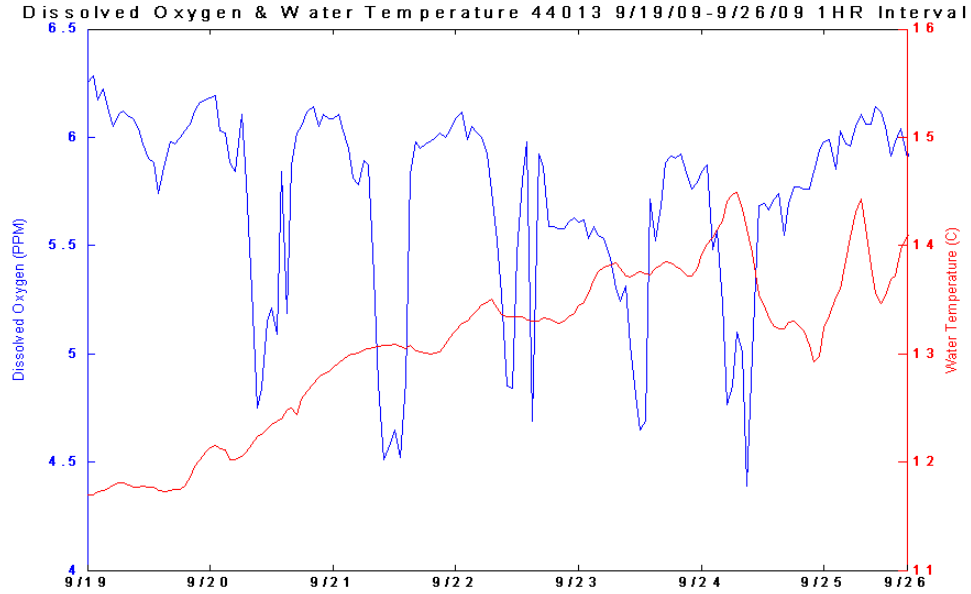
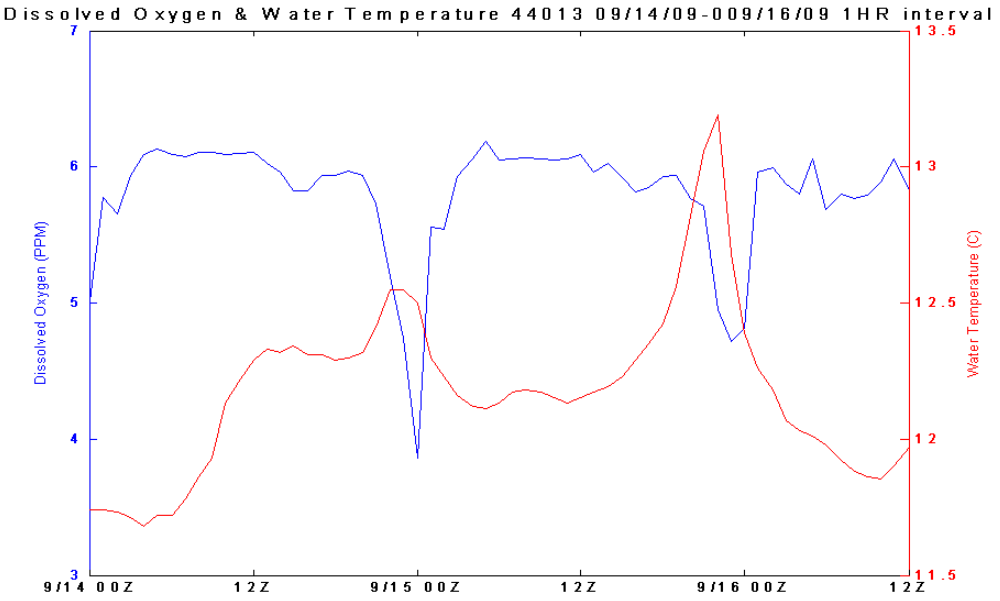

Dissolved Oxygen & Water Temperature 44013 10/11-10/13 1HR increment
Dissolved Oxygen
Water Temp (C)
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
16.5
16
15.5
15
14.5
14
13.5
13
12.5
12
10/11 00Z
12Z
10/12
12Z
10/13
12Z
10/14
12Z
10/15

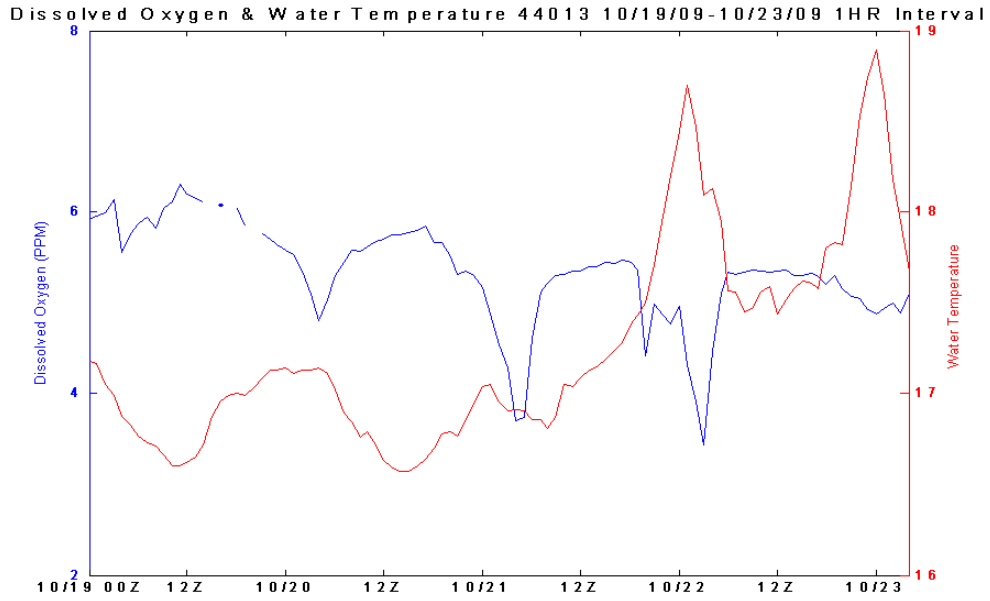
44013


Dissolved Oxygen & Water Temperature 44013 9/19/09-9/26/09 1HR Interval
Dissolved Oxygen (PPM)
Water Temperature (C)
6.5
6
5.5
5
4.5
4
16
15
14
13
12
11
9/19
9/20
9/21
9/22
9/23
9/24
9/25
9/26

44013


Dissolved Oxygen & Water Temperature 44013 09/14/09-009/16/09 1HR interval
Dissolved Oxygen (PPM)
Water Temperature (C)
7
6
5
4
3
13.5
13
12.5
12
11.5
9/14 00Z
12Z
9/15 00Z
12Z
9/16 00Z
12Z

44013


Dissolved Oxygen & Water Temperature 44013 10/19/09-10/23/09 1HR Interval
Dissolved Oxygen (PPM)
Water Temperature
8
6
4
2
19
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17
16
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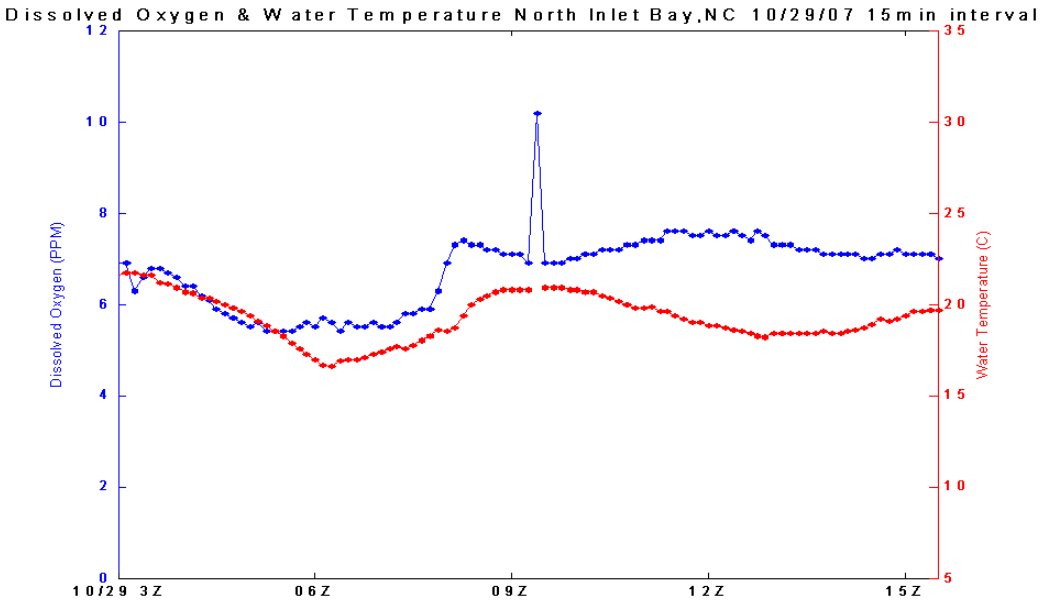
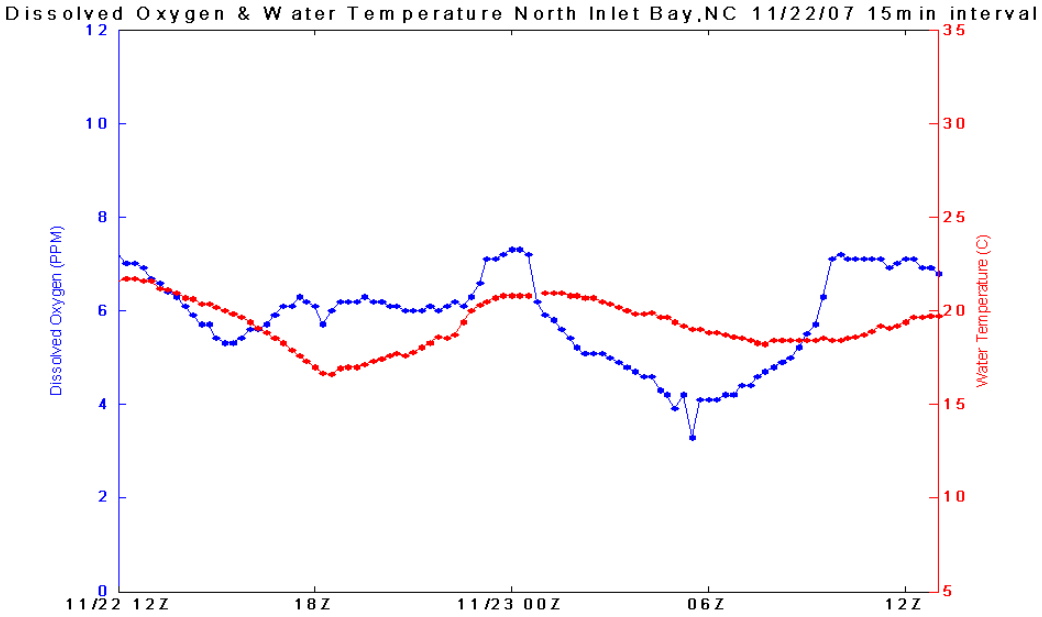
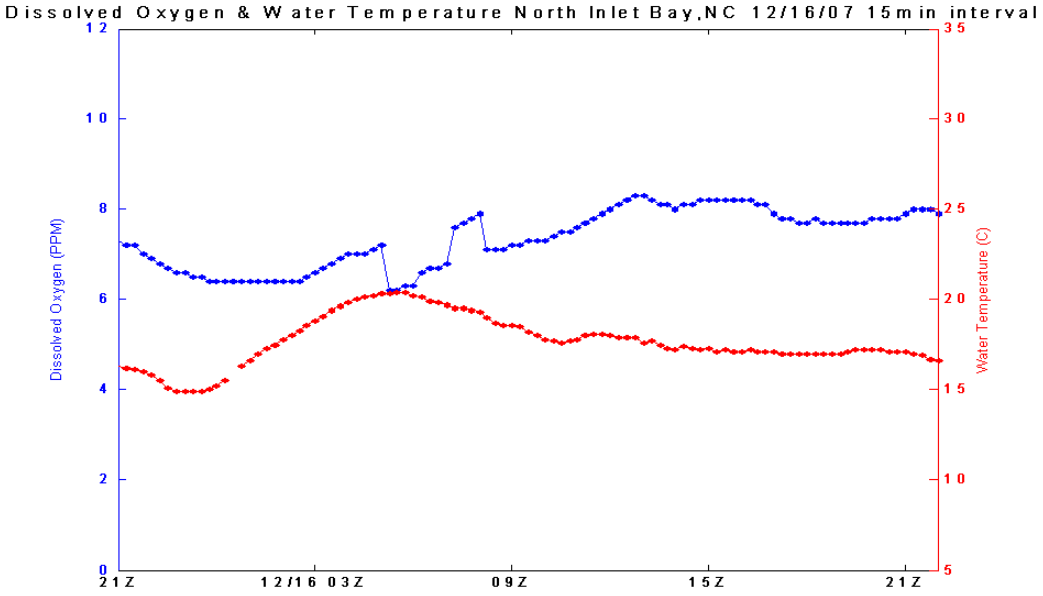
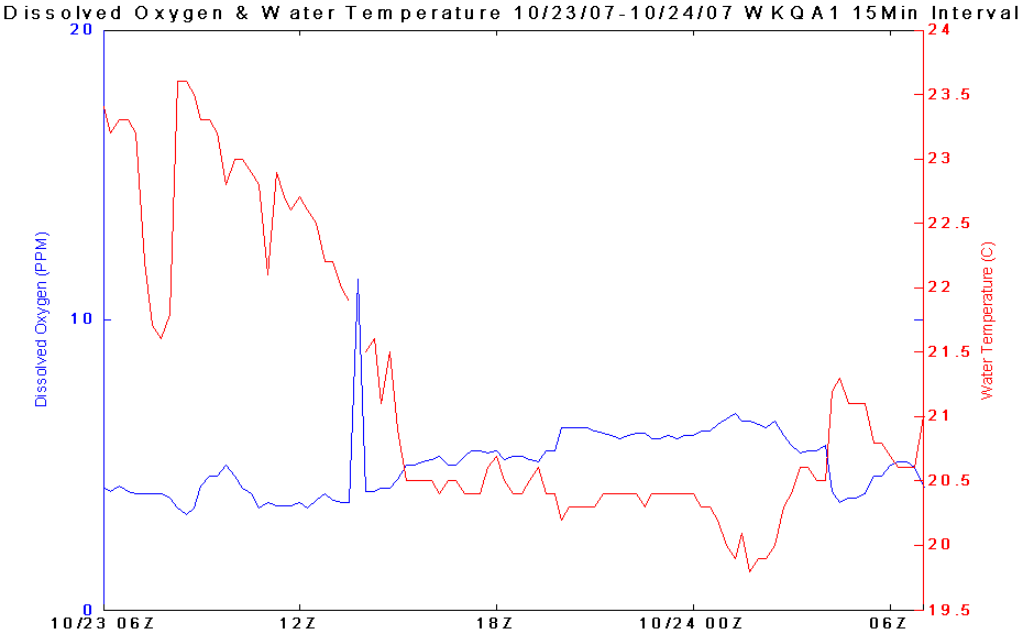
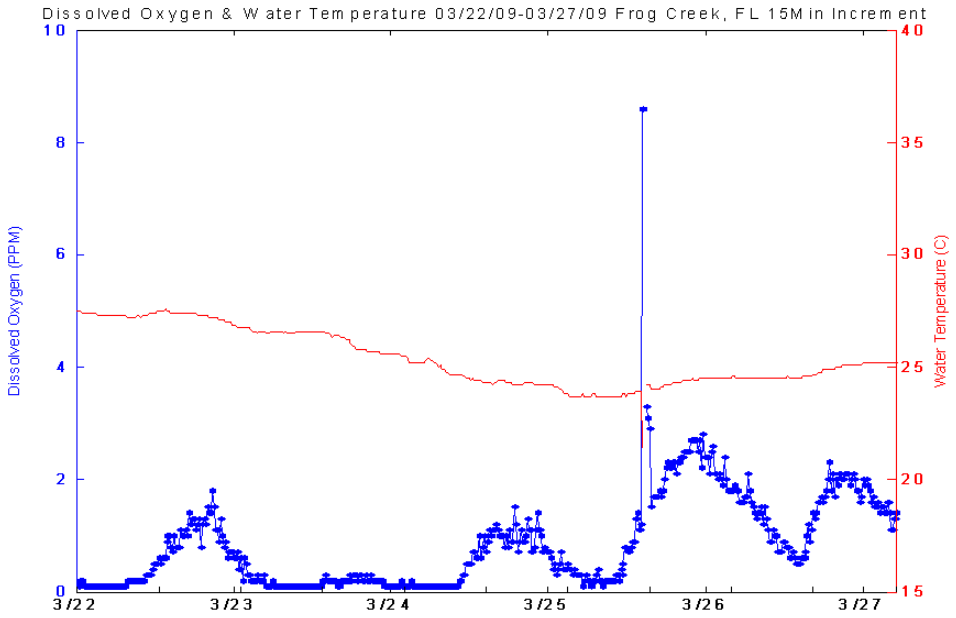
10/20
12Z
10/21
12Z
10/22
12Z
10/23

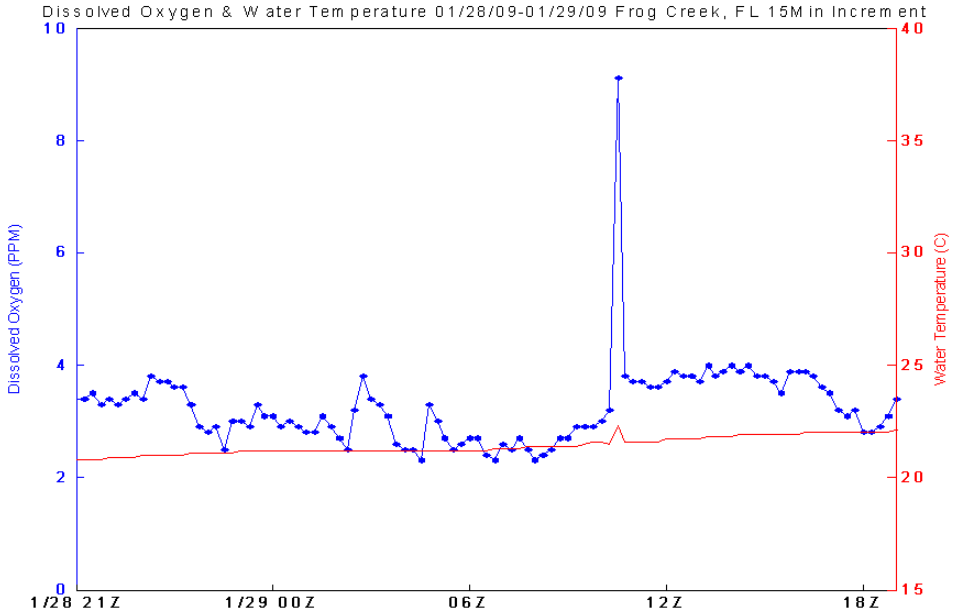

Dissolved Oxygen & Water Temperature North Inlet Bay,NC 10/29/07 15min interval
Dissolved Oxygen (PPM)
Water Temperature (C)
12
10
8
6
4
2
0
35
30
25
20
15
10
5
10/29 3Z
06Z
09Z
12Z
15Z

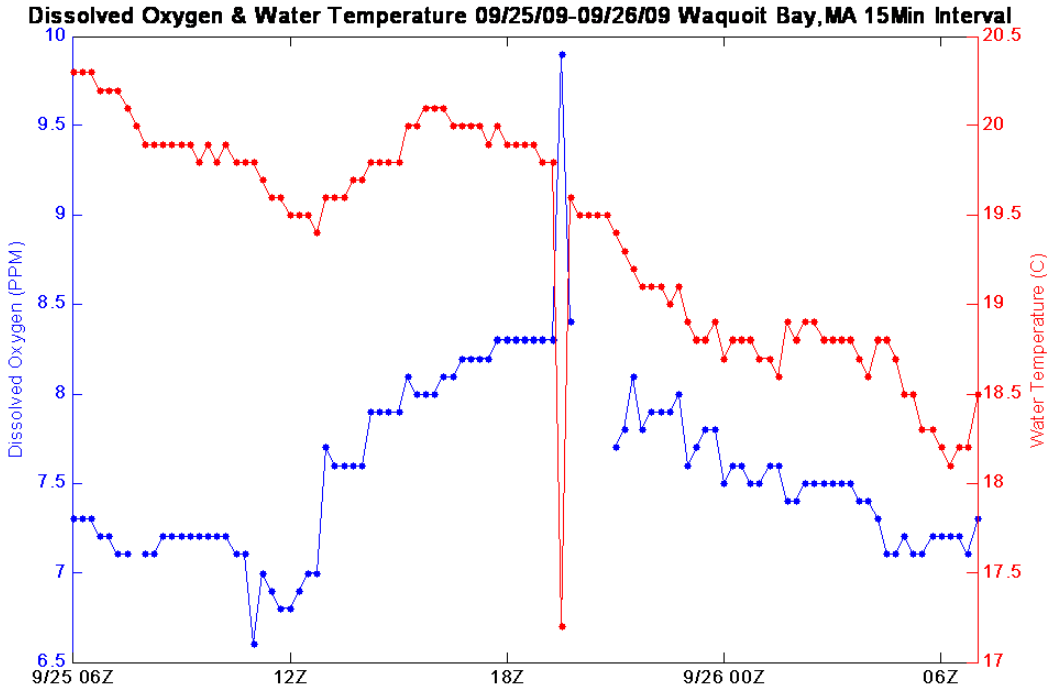

Dissolved Oxygen & Water Temperature North Inlet Bay,NC 11/22/07 15min interval
Dissolved Oxygen (PPM)
Water Temperature (C)
12
10
8
6
4
2
0
35
30
25
20
15
10
5
11/22 12Z
18Z
11/23 00Z
06Z
12Z


Dissolved Oxygen & Water Temperature North Inlet Bay,NC 12/16/07 15min interval
Dissolved Oxygen (PPM)
Water Temperature (C)
0
2
4
6
8
10
12
5
10
15
20
25
30
35
21Z
12/16 03Z
09Z
15Z
21Z

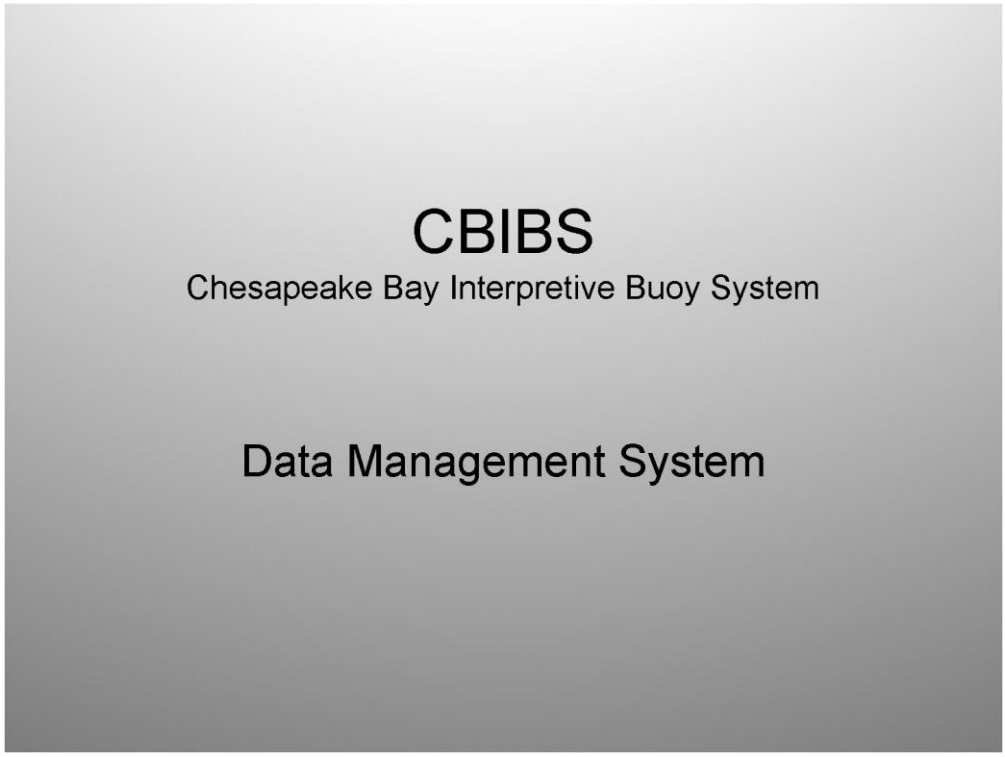

Dissolved Oxygen & Water Temperature 10/23/07-10/24/07 WKQA1 15Min Interval
Dissolved Oxygen (PPM)
Water Temperature (C)
0
10
20
19.5
20
20.5
21
21.5
22
22.5
23
23.5
24
10/23 06Z
12Z
18Z
10/24 00Z
06Z

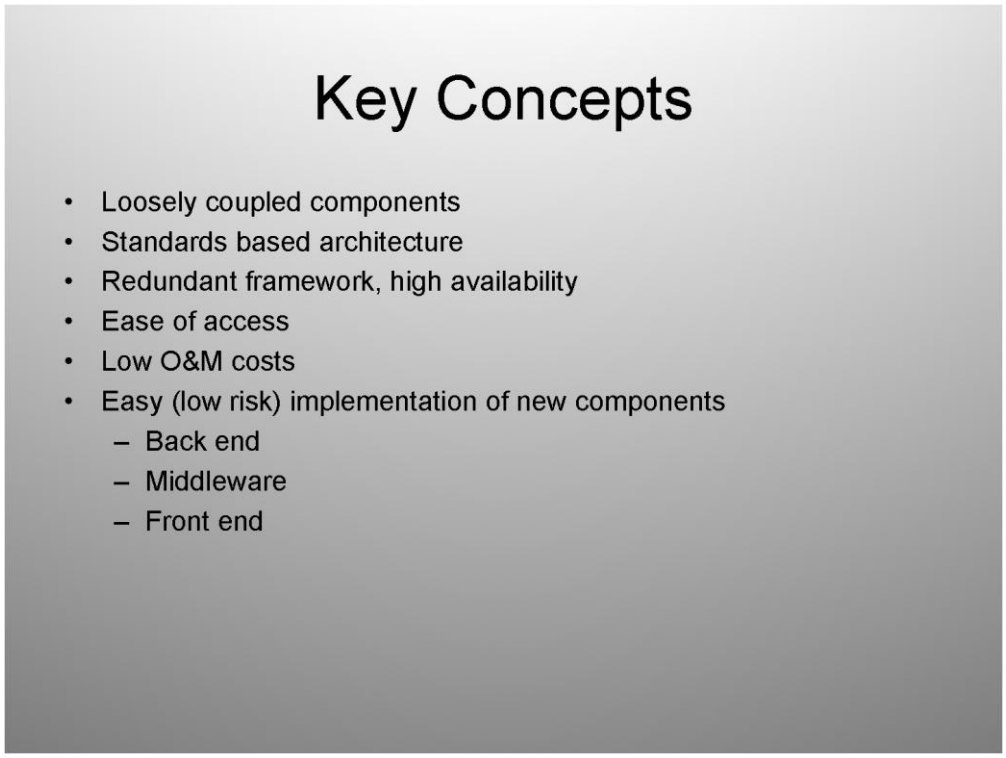

Dissolved Oxygen & Water Temperature 03/22/09-03/27/09 Frog Creek, FL 15Min Increment
Dissolved Oxygen (PPM)
Water Temperature (C)
10
8
6
4
2
0
40
35
30
25
20
15
3/22
3/23
3/24
3/25
3/26
3/27

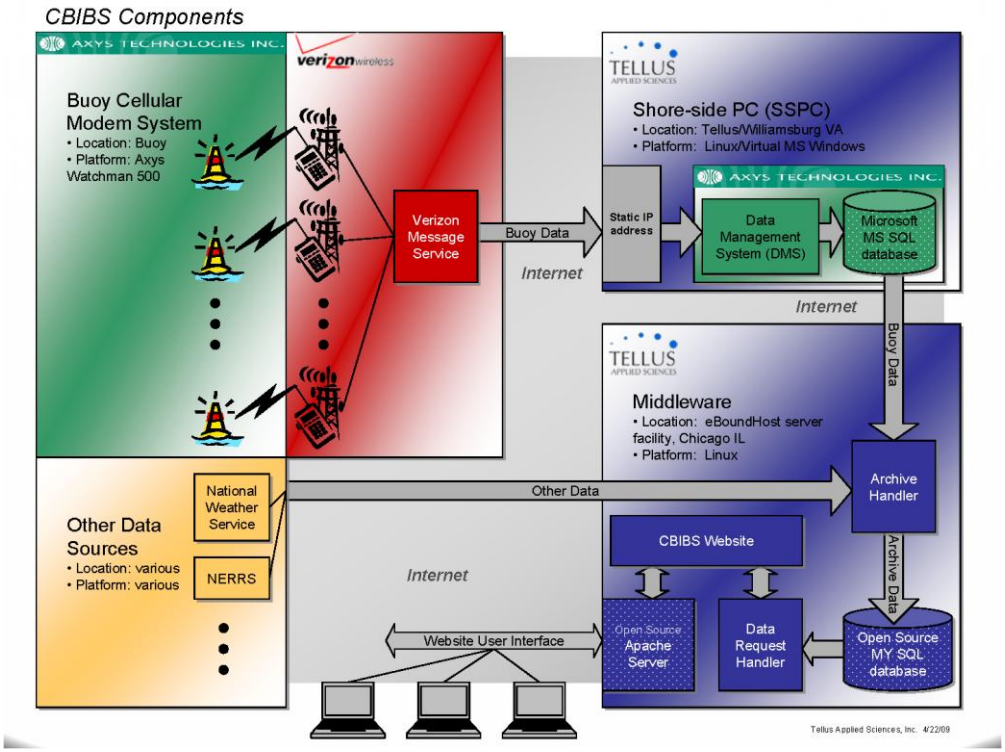

Dissolved Oxygen & Water Temperature 01/28/09-01/29/09 Frog Creek, FL 15Min Increment
Dissolved Oxygen (PPM)
Water Temperature (C)
10
8
6
4
2
0
40
35
30
25
20
15
1/28 21Z
1/29 00Z
06Z
12Z
18Z

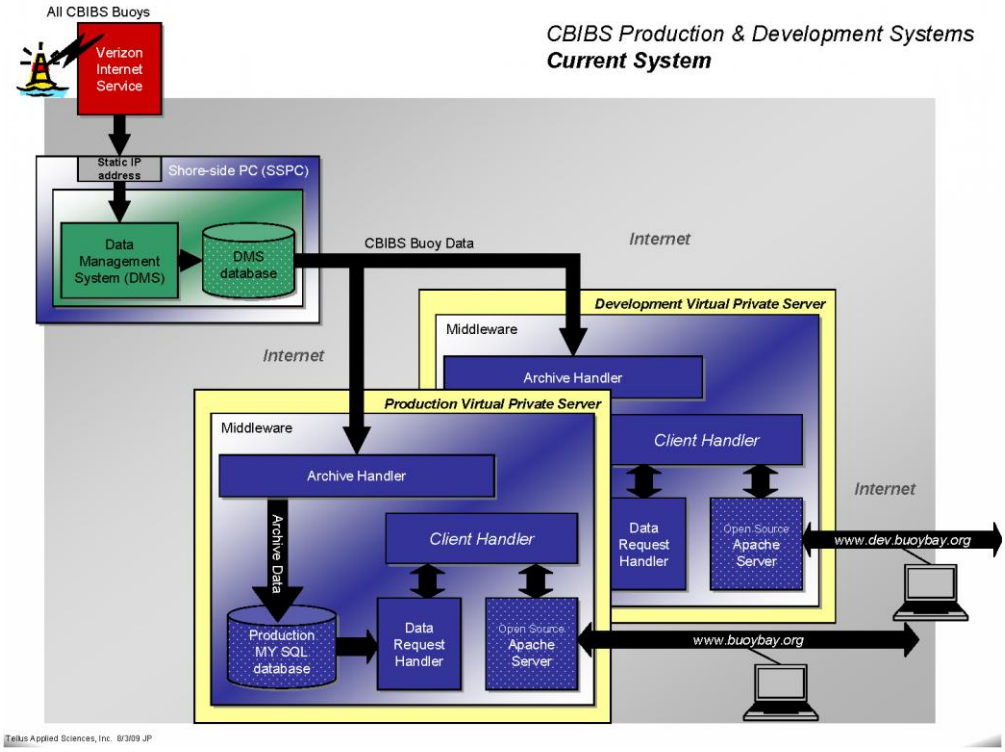

Dissolved Oxygen & Water Temperature 09/25/09-09/26/09 Waquoit Bay,MA 15Min Interval
Dissolved Oxygen (PPM)
Water Temperature (C)
10
9.5
9
8.5
8
7.5
7
6.5
20.5
20
19.5
19
18.5
18
17.5
17
9/25 06Z
12Z
18Z
9/26 00Z
06Z

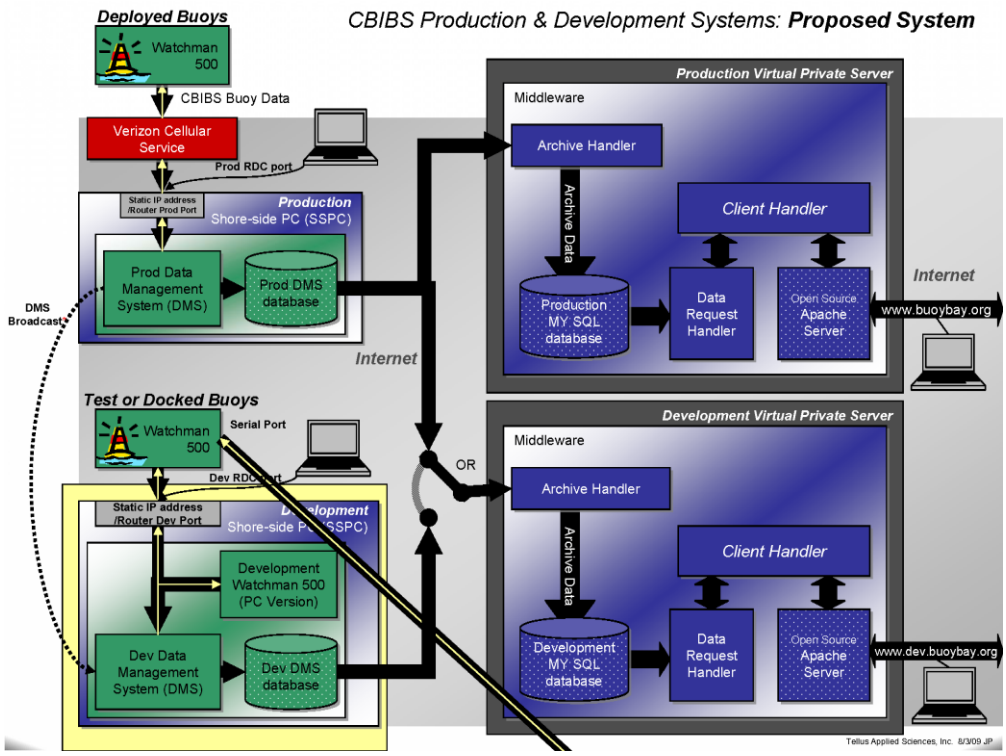
Appendix L Presentation by Tucker Pierce, Tellus Applied Sciences

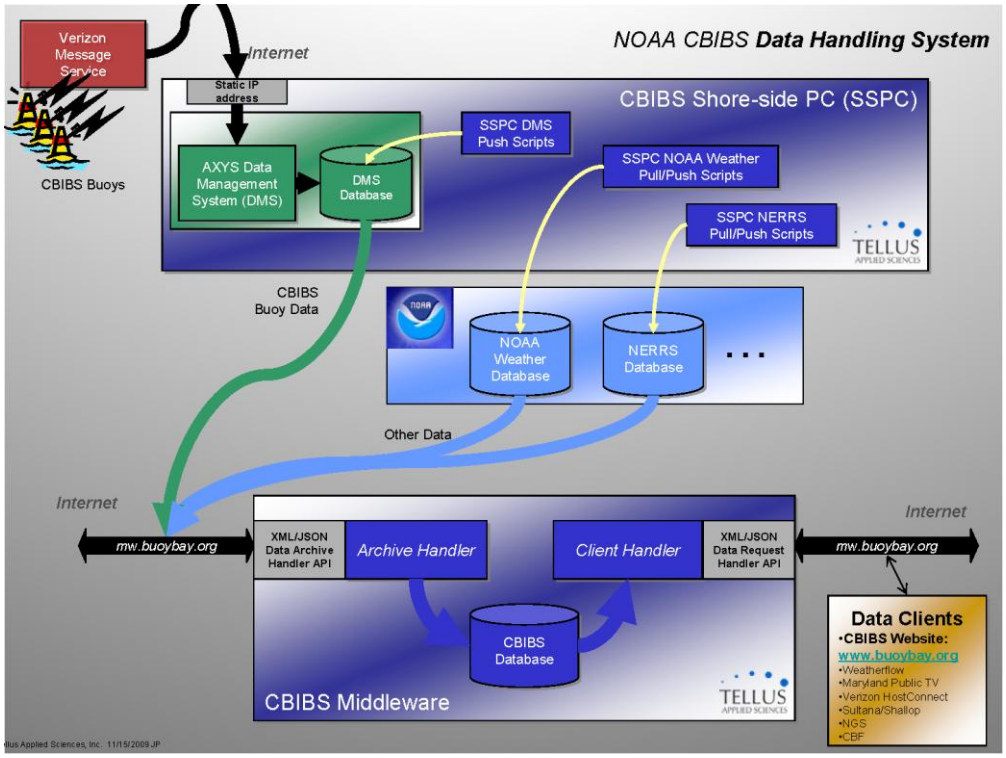


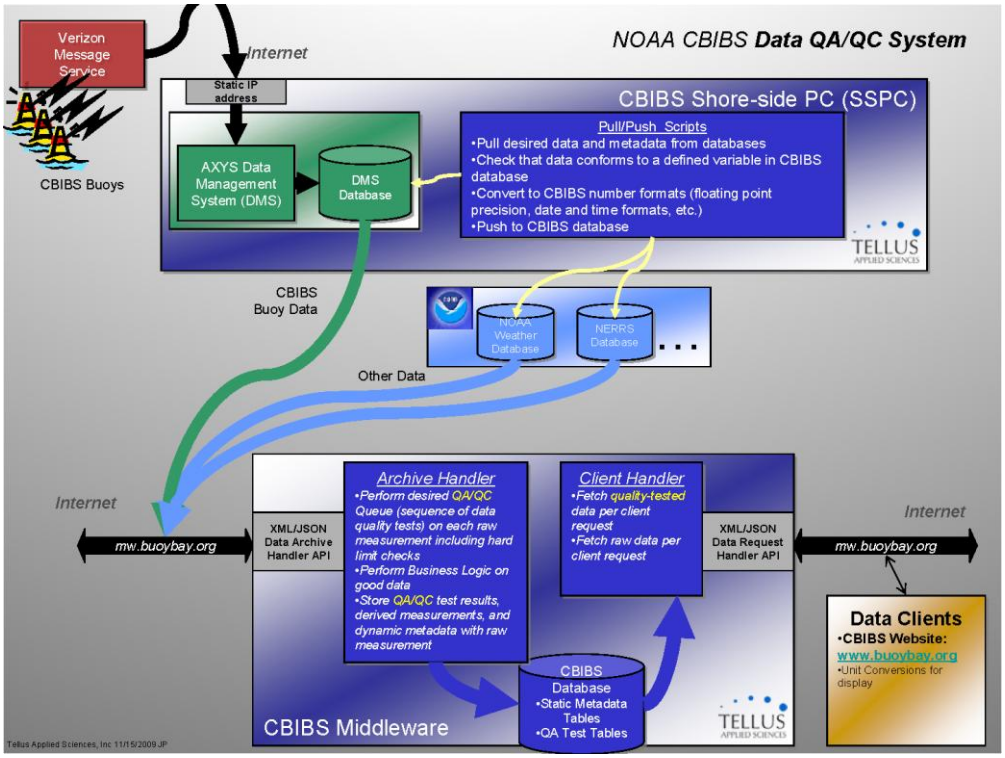



CBIBS Components
AXYS TECHNOLOGIES INC.
verizon wireless
Buoy Cellular Modem System
• Location: Buoy
• Platform: Axys Watchman 500
Verizon Message Service
Buoy Data
Internet
TELLUS
Shore-side PC (SSPC)
• Location: Tellus/Williamsburg VA
• Platform: Linux/Virtual MS Windows
Static IP address
Data Management System (DMS)
Microsoft MS SQL database
Internet
Buoy Data
TELLUS
Middleware
• Location: eBoundHost server facility, Chicago IL
• Platform: Linux
Archive Handler
Other Data
National Weather Service
NERRS
Other Data Sources
• Location: various
• Platform: various
CBIBS Website
Internet
Archive Data
Open Source Apache Server
Data Request Handler
Website User Interface
Open Source MY SQL database
Tellus Applied Sciences, Inc. 4/22/09


All CBIBS Buoys
Verizon Internet Service
CBIBS Production & Development Systems
Current System
Static IP address
Shore-side PC (SSPC)
Data Management System (DMS)
DMS database
CBIBS Buoy Data
Internet
Development Virtual Private Server
Middleware
Archive Handler
Internet
Production Virtual Private Server
Middleware
Client Handler
Archive Handler
Internet
Archive Data
Client Handler
Data Request Handler
Open Source Apache Server
www.dev.buoybay.org
Production MY SQL database
Data Request Handler
Open Source Apache Server
www.buoybay.org
Tellus Applied Sciences, Inc. 8/3/09 JP


CBIBS Production & Development Systems: Proposed System
Deployed Buoys
Watchman 500
CBIBS Buoy Data
Verizon Cellular Service
Prod RDC port
Static IP address /Router Prod Port
Production Shore-side PC (SSPC)
Prod Data Management System (DMS)
Prod DMS database
DMS Broadcast
Internet
Test or Docked Buoys
Watchman 500
Serial Port
Dev RDC port
Static IP address /Router Dev Port
Development Shore-side PC (SSPC)
Development Watchman 500 (PC Version)
Dev Data Management System (DMS)
Dev DMS database
OR
Production Virtual Private Server
Middleware
Archive Handler
Archive Data
Client Handler
Production MY SQL database
Data Request Handler
Open Source Apache Server
Internet
www.buoybay.org
Development Virtual Private Server
Middleware
Archive Handler
Archive Data
Client Handler
Development MY SQL database
Data Request Handler
Open Source Apache Server
www.dev.buoybay.org
Tellus Applied Sciences, Inc. 8/3/09 JP


NOAA CBIBS Data Handling System
Verizon Message Service
Internet
Static IP address
CBIBS Shore-side PC (SSPC)
CBIBS Buoys
AXYS Data Management System (DMS)
DMS Database
SSPC DMS Push Scripts
SSPC NOAA Weather Pull/Push Scripts
SSPC NERRS Pull/Push Scripts
TELLUS APPLIED SCIENCES
CBIBS Buoy Data
NOAA Weather Database
NERRS Database
. . .
Other Data
Internet
mw.buoybay.org
XML/JSON Data Archive Handler API
Archive Handler
Client Handler
XML/JSON Data Request Handler API
Internet
mw.buoybay.org
CBIBS Database
CBIBS Middleware
TELLUS APPLIED SCIENCES
Data Clients
•CBIBS Website:
www.buoybay.org
•Weatherflow
•Maryland Public TV
•Verizon HostConnect
•Sultana/Shallop
•NGS
•CBF


NOAA CBIBS Data QA/QC System
Verizon Message Service
Internet
Static IP address
CBIBS Shore-side PC (SSPC)
CBIBS Buoys
AXYS Data Management System (DMS)
DMS Database
Pull/Push Scripts
•Pull desired data and metadata from databases
•Check that data conforms to a defined variable in CBIBS database
•Convert to CBIBS number formats (floating point precision, date and time formats, etc.)
•Push to CBIBS database
TELLUS
CBIBS Buoy Data
NOAA Weather Database
NERRS Database
Other Data
Internet
mw.buoybay.org
XML/JSON Data Archive Handler API
Archive Handler
•Perform desired QA/QC Queue (sequence of data quality tests) on each raw measurement including hard limit checks
•Perform Business Logic on good data
•Store QA/QC test results, derived measurements, and dynamic metadata with raw measurement
Client Handler
•Fetch quality-tested data per client request
•Fetch raw data per client request
XML/JSON Data Request Handler API
Internet
mw.buoybay.org
Data Clients
•CBIBS Website:
www.buoybay.org
•Unit Conversions for display
CBIBS Database
•Static Metadata Tables
•QA Test Tables
CBIBS Middleware
TELLUS
Tellus Applied Sciences, Inc 11/15/2009 JP

Appendix M Workshop Evaluation

During the last session of QARTOD V, Stephanie Kavanaugh, process facilitator, solicited feedback from each participant by asking for input about what s/he liked most and what might be improved about the conference. The feedback is presented in two formats: a table and actual recorded comments. Comments in the table were distilled and organized in general categories for ease of reference. There is no specific hierarchy in either the table or the list of recorded comments. It should be noted that all participants expressed high praise for the conference and satisfaction with the outcome.

Positive Feedback

Pre-Conference Planning and Outreach
• Homework helped prepare for conference • Great NDBC real-world data examples • Liked that lunch was provided • Liked having two screens • Liked grassroots approach
Meeting Content
• Found having the waves and currents groups together beneficial • Learned a lot from an IT standpoint • Great momentum and timing for ADCP • Liked taking the time to clarify definitions of terms –when everyone understood those definitions, it was easier
Meeting Dynamics and Participation
• Enjoyed group interaction people being willing to accept the many different ways to deal with data made it easier when people are open to new ideas • Would like to see the same people at the next one • Group was diverse (felt it was important to maintain many of the same faces at QARTOD VI) • Enjoyed being a member of such a dedicated group • Discussions outside of meetings were a conduit for learning • Impressed with water quality group – the group size was perfect • Liked the informal nature of the discussion • Appreciated Vembu's social leadership • Good synergy among group members
Facility/Logistics
• Liked the location • Reasonably priced • Having the meeting at the hotel where we're staying was great

Raw Responses – Positive Feedback

- Group interaction
- Combining waves and currents worked great
- Liked two screens
- Liked meeting at the same hotel where we're staying
- Want to see the same people back at QARTOD VI
- Waves and currents productive – resolved lots of issues
- Venue great
- Impressed with water quality group – group size just right
- Liked informal nature of discussion
- Great group interaction – people willing to accept the many ways to deal with data
- Diverse group – is important to maintain the same faces at next meeting
- Homework a good idea
- Good synergy
- Makes it easier when people are very open to new ideas
- Happy with Waves and Currents, use different terms, once we got definitions straight, was easier
- Location excellent
- Liked that lunch was provided
- Reasonably priced
- Defining scope kept discussion focused – define a scope for QARTOD but we're dealing with QC. Define terms and put on website.
- From an IT standpoint, learned a lot
- Enjoyed interaction – will take back lots of info
- Process of doing it from grassroots is good
- Nice to be a member of such a dedicated group
- Enjoyed outside discussions – conduit for learning
- Good momentum – good timing on ADCPs
- Thanks to Vembu for social leadership
- Processes
- Great NDBC examples – apply to real-world

Suggestions for Improvement

Pre-Conference Planning and Outreach

- Send out essential information (homework, background) earlier to give participants more time to prepare and to reduce the amount of review of previous QARTODs required for new participants
- Promote the QARTOD website and provide information on the current QARTOD recommendation to alleviate confusion
- Submit information/questions to the manufacturers in advance
- Promote awareness of QARTOD through individual participants and networking sites such as LinkedIn and Google code created for software collaboration
- Strengthen usability of QARTOD website to make it easier to find information – take advantage of technology (e.g. Google code) that would use existing content (not re-inventing) the web interface
- Increase amount of communication with participants prior to conference
- Need more lead time – maybe join with another related meeting to improve attendance
- More Regional Association engagement – maybe require participation
- Work to promote IOOS data accreditation process – with a way to prove that Regional Associations and data providers are applying QC
- Work to elevate the standing of QARTOD so that it will not only have the responsibility for developing QA and QC standards but also will have the authority to enforce standards
- Provide ways for web visitors to understand QARTOD's role (write abstracts to make annotated bibliography more user-friendly

Meeting Content

- Provide more focus on the IT, coding, and programming aspects of QA/QC
- Open conference with a presentation from someone who is implementing QARTOD recommendations
- 15 element pressure gauge arrays

Meeting Dynamics and Participation

- Need more data providers to participate
- Attract more data consumers for each data type to bring their perspective; encourage uploading data to adhere to standards
- Disappointed that it was not possible to attend both sessions

Facility/Logistics

- Bigger screens – was difficult to see some pictures/tables
- Provide more lunches as part of the conference
- Table setup hindered discussion

Miscellaneous

- Secure formal funding commitments for staff and meetings to reduce burden on volunteers
- Apply multi-varied analysis to merge model and measurement to report a physical reality
- Must get over fear of putting data out
- More definition for background (general)to provide context and ensure that details (specifics) are not lost
- Track version changes, put code and example of a data set out on the web – require site registration on QARTOD website

Raw Responses – Suggestions for Improvement

- Need a few more data providers – should participate – step back and look at total QA and QC
- Need bigger screens – hard to see a one-shot picture or printout tables
- Avoid so much recap/rehash and background when bringing new people in
- Send out essential information prior to conference
- Secure formal funding commitments, especially for staff and meetings – all volunteer time now used
- Data consumer of each type of data should participate to hear their perspective – time to get people uploading data to adhere to standards
- Give the current recommendation to alleviate confusion
- Promote QARTOD website more
- Would have been nice to have better advance reading for introduction to QARTOD
- Earlier distribution of homework
- Give manufacturers the questions beforehand
- QARTOD is orphan organization – need to raise the standing of it – raise awareness individually
- QARTOD website difficult to navigate – confusing
- Need to better say what we want as the end product from QARTOD
- There are few communications until we arrive
- Google code – share instead of re-inventing the wheel
- Would like to see lunch provided more
- Beginning presentations from someone who is implementing QARTOD
- Focus more on IT, coding, and programming
- Examples on website –more oceanography.
- Should include more bibliography to help web visitors understand background – maybe use abstract lead-in
- Use other tools like LinkedIn to pull community together
- Google site – link Google code – created for software collaboration
- Everyone has to get over fear of putting it out there – spread the burden
- Disappointed not to be able to attend both sessions
- Generalities versus specifics – must define background - details get lost in free-flowing conversation
- 15 element pressure gauge arrays

- Version tracking changes – putting code out there – maybe require site registration – provide example data set
- Need more lead time – next QARTOD could hitch with another meeting
- More Regional Association engagement – should require participation
- IOOS data accreditation – process – proving that Regional Associations and data providers are applying QC
- Have all responsibilities but not the authority needed to elevate
- Don't like Excel on screen – use big white board
- Multi-varied analysis – how do you put it all together to represent a physical reality
- Merge model and measurement to arrive at reality
- Homework – wish I had done it – would have been more prepared
- Table setup hindered discussion
- Disagree with working lunches
- Other Feedback
- Produce a white paper that provides background
- Place article in Sea Technology about what QARTOD is doing
- Great ideas will not be implemented unless we do it
- Harness synergy between QARTOD and AC.

Acronyms and Abbreviations

ACRR	Affect, Check, Record, Report
ACT	Alliance for Coastal Technologies
ACWI	Advisory Committee on Water Information
ADCP	Acoustic Doppler Current Profiler
AST	Acoustic Surface Tracking
ATON	Aid-to-Navigation
AWAC	Acoustic Waves and Currents
CBIBS	Chesapeake Bay Interpretive Buoy System
CDIP	Coastal Data Information Program
CO-OPS	Center for Operational Oceanographic Products and Services
CORMP	Coastal Ocean Research Monitoring Program
CTD	Conductivity Temperature Depth
DAC	Data Assembly Center
DAP	Data Access Protocol
DMAC	Data Management and Communications
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FFT	Fast Fourier Transform
HAB	Harmful Algal Bloom
HFRSCM	High Frequency Radar Surface Current Mapping
IOOS	Integrated Ocean Observing System
IWGOO	Interagency Working Group on Ocean Observations
LSU	Louisiana State University
MMI	Marine Metadata Interoperability
NCDDC	National Coastal Data Development Center
NDBC	National Data Buoy Center
NEMI	National Environmental Methods Index
NERRS	National Estuarine Research Reserve System
NOAA	National Oceanic and Atmospheric Administration
NOS/SPO	National Ocean Service/Special Projects Office
NWS	National Weather Service
NWQMC	National Water Quality Management Council
OGC	Open Geospatial Consortium
OOI	Ocean Observatories Initiative
ORP	Oxidation Reduction Potential
ORR	Ontology Registry and Repository
PUCK	Plug and Work
PUV	Pressure U (x component of velocity) V (y component of velocity)
Q20	QARTOD to Open Geospatial Consortium

QARTOD V

QARTOD	Quality Assurance of Real-time Oceanographic Data
RA	Regional Association
RDF	Resource Description Framework
SensorML	Sensor Markup Language
SOS	Sensor Observation Services
SWE	Sensor Web Enablement
TRDI	Teledyne RD Instruments
USGS	United States Geological Survey
VIMS	Virginia Institute of Marine Science
WHOI	Woods Hole Oceanographic Institution
WOCE	World Ocean Circulation Study