



Proceedings of the 4th Radiowave Operators Working Group Meeting

Old Dominion University (Norfolk, VA)

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Executive Summary

The 4th Radiowave Operators Working Group (ROWG-4) meeting was held June 2-4, 2009 at Old Dominion University in Norfolk, VA. The purpose of the meeting as set forth in the ROWG charter is to foster collaboration between new and experienced HF radar operators, to develop procedures governing HF radar operations and to provide recommendations to users, developers, manufacturers and program managers. The meetings have been held approximately every 18 months since 2005, this time period has seen a significant growth in both the number of HF radar systems operated around the world and within the US as well as a significant expansion of their use in the US Integrated Ocean Observing System (IOOS). This has led to a strong emphasis on quasi-operational data delivery from the systems which has many technical challenges ranging from hardware and site logistics to communications, data management, quality control and products. The ROWG meetings bring together the technical personnel involved in all aspects of operating an HF radar system within the IOOS context. The meetings have focused on communication of innovative solutions to the technical issues that arise in HF radar operations.

1. Introduction

ROWG-4 was attended by 32 persons from academic institutions and US government agencies. To facilitate discussion of new approaches and solutions to operating HF Radars the meeting was structured as follows: There was an introductory session in which issues associated with the evolving national HF radar network on-line data delivery were discussed. The NOAA IOOS Program office perspective on the

national network and the radar operations was then presented. The meeting then split into two groups that focused on software and hardware issues associated with HF radar operations. Summaries of the discussions in the breakout groups are provided in section 2 of this report. On the second morning of the meeting the discussion focused on presentation and discussion of the breakout group reports and then a discussion of technician training requirements and the ROWG web site as summarized in section 3.

2.1 Summary of software breakout group discussion

2.1.1 Operational use of surface currents derived from HFR by U.S Coast Guard

- Search and Rescue Optimal Planning System (SAROPS) is the main application used by U.S. Coast Guard for search and rescue
- Developed and maintained by ASA
- SAROPS is configured locally but accesses data from an Environmental Data Server (EDS) at ASA headquarters
- MARCOOS was funded to provide surface currents measured by HFR via ASA's EDS for operational use in SAROPS
- MARCOOS provides near-real-time 6km data in the form of an optimally interpolated product (using Sung Yong Kim's OI technique) as well as a forecast product using ?? model.
- MARCOOS will provide higher resolution (1km) products in later phases of the project.
- Art Allen is particularly interested in short term forecasts (6 hour forecasts)
- Gap-free data (OI or otherwise) is not a requirement for USCG but is preferred
- Envision some form of gap-free product (probably OI) becoming the standard product for the HF-Radar Network as it will form the basis for further product development such as dynamic fields (e.g. vorticity and divergence) and simple modeling
- USCG has a static error for each product based on comparisons of HFR and drifter velocities. Surface currents from HFR is considered a single product overall. The error is fairly large (~15 cm/s) and is designed to capture sub-grid scale phenomena when HFR currents are compared to drifter tracks. Unclear whether the error is regional or global (e.g. if the error is configured locally for a given domain within a particular SAROPS application).

2.1.2 Waves derived from HFR

- National Plan for HFR mentions waves as a research grade product
- Although waves don't require integrated processing as surface currents do, HFRNet would probably be the natural solution to distributing and aggregating wave data. Wave data would likely be stored in a separate database with its own schema.
- WERA systems measure a 2D wave field with a wave measurement for each grid point corresponding to a radial solution
- CODAR systems measure the 'average' wave field for a given annulus (i.e. mean wave field as a function of range)

2.1.2 QA/QC

- QS/QC: Quality Assurance - Sensor level / Site Resiliency; and, Quality Control – Things done to the data to ensure quality. Seems most groups are monitoring quality but there is a disconnect to getting that potential problem into the data stream.
- CeNCOOS documented a draft protocol for near-real-time QA/QC of both radials and totals. Began implementation but stopped ~1-2 months from completion. Should be made available through ROWG site. Some forms of QC documented are too specific to be applied globally at the Node level but could potentially be applied for specific sites at the Portal level.
- Two basic layers of radial QC are:
 1. Global (file-wide) QC involving some form of key-value pair(s) which indicate whether data in the file is good, suspect, or bad. This can be a mix of software-managed semi-automatic flags set by local site operators and automated routines.
 2. Individual radial QC involving automated algorithms, which provide some metric of quality for each radial solution.
- Agreed that inclusion of a key-value pair in the radial LLUV header that is controlled solely by site operators would be useful and is needed. The flag would be used by local site operators to indicate that radial data produced by a given radar is suspect or known to be bad. Example scenarios include periods when the antenna pattern has changed or there has been a hardware failure. The mechanism for setting the flag should be through the vendor's software such that operators can toggle the flag setting, which is then written to radial files produced in near real time. Simple flags discussed were:

0	Data OK
1	Data Suspect
2	Data Bad

Any data having a flag other than '0' would likely be ignored by HFRNet for processing to total solutions. This flag could be used at all levels of automated product generation from radial data at both the local and National level. This gross form of QC can be viewed as a stopgap between available automated and developing forms of QC.
- Addition of a 'new site' flag was also discussed but it was later pointed out that the same site operator flag can be used for this purpose by setting the flag to '1', data suspect.
- Another global QC key-value pair may be set by automated algorithms configured to flag for exceedences beyond a given range for hardware diagnostic parameters (such as acceptable operating ranges for hardware diagnostics by Brian Emery & Libe Washburn at UCSB).
- There is a toolbox partially developed with QC tools that would require 2-3 people some time to implement on the national network.
- Brian Haus (UM) uses SNR ratios for QC at the radial level for his WERA systems in addition to a gross speed threshold of ~2.5 m/s. SNR values are not currently included in the LLUV format submitted to HFRNet.

2.1.3 Inventory of present QA/QC activities

- Scripps has NOAA IOOS funding to continue Tony DePaolo research using MUSIC simulations. Codar Ocean Sensors, Ltd. will provide an implementation for new QA/QC file that includes intermediate processing values like eigenvalues from the MUSIC processing on short term radials. Realtime settings are default manufacturer settings.
- OSU – more hands-on quality assurance: Generate a check list that includes noise issues (site specific). Check phases using real-time phases. Check header file for consistency. Check Alims (all above was done once). Daily basis: check automated plots of diagnostics

(bragg.coaes.oregonstate.edu/StoN.html - Check the site address – pretty sure its wrong). Automated emails sent to Walt, Anne, and Mike. Visit the sites every 2 months to measure antenna bearing

- ODU – need to block out regions of the coverage. Local implemented QC algorithms running at the radial level based on local knowledge. Beta version of a nearest neighbor consistency checks. These spatial tools maybe site specific. ODU has a spatial nearest neighbor test for their website that is available.
- UCSB – Compiled a document that describes normal values for diagnostic parameters for site level diagnostics (QA) reported in vendor files, based on data from 25 SeaSonde sites. (see <http://www.rowg.org/QAQC/DiagnosticsEvaluation.pdf>).
- NOAA – NOS use the matlab toolbox to combine to radials. Look at hardware and radial diagnostic files and generate real-time plots (phase, temperature, etc.). Implementing an automated email based on thresholds of these parameters. Check for file latency to trigger email notification.
- Miami – uses geometric error on vectors, SNR at the radial level and monitoring site status through a website that displays signal return from each antenna on a website (check for anomalies) . System has additional QC information that is not getting to the national network.
- Proudman – Daily monitoring, monthly site visits. – check hardware settings
- Rutgers – Regional coordination for real-time diagnostics. Testing and implementation of the OI combination algorithm. Sage has a wrapper for the OI (makeTotals).
- NOAA –Co-Ops will be developing tidal products (will not use Matlab because of license issues) Will probably implement an Octave version
- U-Delaware – looking into spokiness on measured patterns. Found that 10-15 degrees of smoothing, radial interpolation helps. Post-processing done to mask out trouble areas
- CODAR recommends daily reboots of the system, has a tool that allows a user to filter LLUV flies (LLUV cutoff) to filter data based on range, bearing, and velocity. CODAR also has a tool that will allow Doppler interpolation.
- National network presently defaults to measured pattern results when available. National network would like to setup a website so users can modify present settings used in the processing to optimize data quality.

2.1.4 HFRNet Software Configuration Management

- Would like to begin a development pathway which would enable local site operators to manage their sites in HFRNet through a web interface. The intention is to make it easy and efficient for local site operators to transfer knowledge about their sites to operations on HFRNet.
- Initial steps as simple as providing web display of current site settings for total production in HFRNet along with a form for emailing HFRNet administrators would help build communications between local site operators and HFRNet administrators. This may be integrated with new radial diagnostics being developed by Tom Cook (SIO). Should not require password protection at this level.
- Ultimately, we should work toward an ORB-based solution for configuration management such that routine tasks in HFRNet processing can be accomplished through a web interface – both for local site operators and HFRNet administrators. This would require a secure website (https) along with site specific permissions restricting modifications to a select group of users/accounts.

2.2 Summary of hardware breakout group discussion

2.2.1 How to make Robust and Resilient Sites

- What are causes of un-resilient? Symptoms include frozen screen, computer off, hard drive failures, problems often occur on re-boot (daily or once a week), Powered USB devices may cause problems with Computers starting up on power returns
- Solutions for computer resiliency:
 - iboot, or web power switch (www.digital-loggers.com)
 - Script/ remote controllable power strip to cycle computer power
 - Clear p-ram
 - OSU has a script to ping outside world and cycle power on modem if no response
 - Web power switch made by digital loggers
 - Sites with routers are good for networking ups, modem etc
 - Use Xserve, which has remotely controllable power (~\$2-3k). This uses a specific hardware design and a software application to remotely control the power to the computer (called lights off power management). Form factor may be an issue, as well as power consumption
 - Could design a custom piece of equipment to attach in power on/off circuit
 - Is there a better hardware platform that we should be using (other than the Mac)? Would take a major development effort to run SeaSondes on another platform.
- More resiliency options: could we have a 2nd computer at a site?
 - May take lots of engineering for COS to do it
 - Would need manual remote control USB switch, mirror settings between computers ...
 - USB 'failover' products may work to split USB stream
 - May be able to use remote control KVM switch
- USB to Ethernet probably would not work to operate the site with a remote computer
- Other hardware solutions for resiliency:
 - Conduit on cable
 - Climate control on enclosure
- SeaSonde reports should be used to document problems that have occurred
 - A standard operating procedure on SeaSondes should be to create a medium level report file (containing many system logs and state indicators) and send it to Codar who can aggregate these to identify common problems. This can also be scripted to run once a week. Keep records of downtime.
- Site visits are recommended at least 6mo to a year even when site working
- Other ideas:
 - Web cam at sites to look at antennas
 - More robust antenna design (for high winds and bad weather), flagpole with hinge setup, beefed up hardware, stainless etc.. E.g. Cliff Merz uses a 24" tube filled with concrete to put the antenna into the ground, with 130 mph wind loading certification
 - Redundant Ethernet connections (modems and router on battery backup)
 - Billing procedures to pay bills on time
 - Run 4th receive cable to use as a spare

- Spare Parts: Get a 5-13-25-42 multi freq system to use as a spare (have spares!) Have a van full of all equipment and spares for an entire site. Other parts: power supply, amplifier, receiver box ... a whole system is best (~1 spare for every 6-7 systems). The regional depot model of storing/providing spare parts and systems, spare communications parts, should be considered by IOOS. WERA users have spare amplifiers, cables and antennas. Codar tries to keep the configurations of hardware to fall within spec, such that rx/tx hardware is essentially interchangeable, however, this is a policy that has changed over time.
- Backup Power: Brian Zelenke has a solar array, which powers an a/c seasoned. These sites are fan cooled (no air conditioning). Mike Muglia uses a propane generator made by Generac at a site with backup to grid power. \$4000 for installation has large tank, runs 2 days, transfers switch automatically transfers power over. Alaska uses a 'hands off' site power generation using propane, solar and wind; SIO has a lot of experience with this. Oregon State has a propane power backup at one of their sites.
- A resiliency standard was discussed: 80% of network up 80% of the time. Should we define a metric for how quickly you can get the system back up and running?
- How reliable and robust is GPS syncing? With current clock in SeaSondes could run up to approx 48 hrs without a GPS signal (in theory) ... a few hrs currently before sync is lost
- How many sites have redundant communications? Of 26 Mid Atlantic, 2 have semi- redundant communications. Macs allow multiple ('homing') with multiple IP addresses, desktop Macs have 2 Ethernet inputs, USB to Ethernet is also a possibility ... global star is a reliable omni directional satellite (NOAA may build a network of these. Linksys routers allow dual Ethernet inputs.
- More about Iridium links: Installation ... iridium is \$15/mo plus usage ... both of these are reliable if costly backup communications links (see NAL research, who's the vendor, \$1000 for equipment, plus monthly subscription ... need to check into date rates, but these could be a good way to do
- For command line repair/diagnostics of a remote site, a dedicated analog phone line might be a robust backup link (during power outages)
- Timbuktu and Skype might be good way to connect to computers on private/hidden networks - this is a good backdoor to the site. Other back doors, include Marcel's write up on rowg.org ... www.logmein.com has a way of remote connecting to sites (it's free) – security issues are not known.
- Most people use rsync to pull data, but a once a day rsync from the remote site is a good way to get the site IP if using a dynamic IP.
- Recommendation: National network should be a depot for compiling failure stats, incident log to keep track of failure stats ... respond to why data dropout occurred

2.2.2 Diagnostic Monitoring

- Bill has a new tool (ss6) which provides easy site summaries, works on iphone, browser can do text only
- Marcel Loosekut (BML) has a tool on rowg.org
- Tom Cook has a new site <http://wharf.ucsd.edu/radialCoverage/>, a web based tool used to monitor and diagnose HFR net sites. Plots on the website are generated from reporting time, file size, number of solutions, and other meta-data reported in the radial file.

- Diagnostic Monitoring Idea: for GPS synced sites, the CSS file can log the APM at one bearing (bi-static transmitter) to see that the APM has not changed at that bearing (it's a .plist file) ... outputs amplitude and phase of signal obvious diagnostic to monitor ... operates on CSS files
- Meta-data additions need to be made to the WERA format so they can be included in network diagnostics.
- Other diagnostic monitor consists of knowing the normal range of values of parameters (such as phases, temperature, voltages, counts by range cell for a particular site, etc).
- Brian Emery has automated plots from the stat files and automated baseline comparisons.
- Developing a site that allows operators to manage the status of the sites going to the national network (e.g. toggle between red/yellow/green) was discussed. This would give user groups the ability to flag questionable data before it goes into the RTV calculations. A possible implementation of this would be to setup an online diagnostic tool that will allow regional technicians to notify the national network administrator on the status of sites.
- OEA Technologies Inc uses smart phones to access the internet when in the field, to access diagnostics. The existing National Network diagnostics page layout of graphs and tables displayed in a Web page table comprising three columns works very well on a smart phone. However, the HFRNet Google map page does not display well on a smart phone. Most operational agencies are now use Google Earth as a means to overlay data and imagery from various sources. Tom Cook's project facilitates including CODAR data in such activities. Would like to see the HFRNet Google Earth diagnostics pilot project expanded to include daily, weekly and monthly plots of total vectors by region / local network.

3.1 Technician Training discussion

Possible Training Requirements and Ideas

- Question discussed: what background would we recommend for an HF radar field technician, what kind of training would be needed for minor diagnosis, testing and repair (cookbook mentality), for a person being guided or directed by a more experienced tech. [this is in the context of developing an HF Radar operations and maintenance plan].
- Cable TV technician (remote monitoring, cable terminating/running, spectrum analysis)
- Electronics specialists, (soldering, continuity, electronic systems and components)
- NEXRAD techs are gs-9 (bachelors degree, ~2yrs experience) (100-150k/yr cost, \$40-50k/yr)
- AS degree in avionics (FAA certification), microwave radar (general radio operators license)
- HAM license? (ARRL handbook)
- Contracting/construction background, able to design things, use tools
- Navy ET's
- Some level of vendor (e.g. Codar, WERA) involvement would be needed
- Problem with upward mobility as the jobs exist now ...would want to pay people well to keep them around, minimize turnover. Program should have a plan for advancement to retain workforce
- New programs with associate's degrees in ocean technology

3.2 Suggestions for the rowg.org web site

Possible Improvements to the Group Website

- 'Express engine' to automatically update the web site, simplifies adding and making changes, and to install stuff
- Make the content world viewable, with login required to post
- Update Plone version to invoke mailing list when question posted to web site
- Site should be searchable
- Answers to the email list should be archived on the web site
- RSS feed or an monthly update digest sent to email list
- Facebook plug-in to site, or Facebook group settings. Linked in group account may also be an improvement
- Sage Lichtenwalner will look into adding RSS feed, Tom Cook will look into emailing module

3.3 Suggestions for ROWG-5

Next Meeting Suggestions

- Location must be domestic, close to airports, near an HF site if possible, and locally hosted ideally (e.g. Boulder, New Orleans, Gettysburg, PA) within hotel walking distance to the meeting site.
- Preliminarily scheduled for fall 2010, with no overlap in time with the ROW meetings.
- Discussions with targeted topics helped to enable more focused discussion
- Keep the posters but reinstate a description of the posters
- Brian Whitehouse suggested more could be done to encourage international participation, and volunteered to work with Codar Ocean Sensors and Wellen Radar to promote the next meeting to their foreign customers.

Recommendations and Conclusions

Group discussions during the 4th ROWG-4 meeting resulted in the following conclusions and recommendations. 1) When operators have knowledge of circumstances that impact radar operations, a QC flag for the radial data file should be implemented (simple 0,1,2 model). 2) Automation of the QA/QC process should continue to be investigated. 3) Computer errors were identified as a major source of site downtime, and Codar Ocean Sensors volunteered to investigate computer-related errors. It is thus recommended that CODAR users submit report files (medium level) after problems occur. 4) CODAR systems that are using GPS synchronization have the capability to perform radar-radar antenna pattern monitoring which has utility for data

QA. 5) Improvements can be made to the rowg.org site to better facilitate the exchange of information, including monthly summary emails, and publicly viewable content. 6) Efforts to improve international participation could increase future group diversity and knowledge base. Finally, ROWG-5 is being planned for fall 2010.

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