A Unified Approach to HF Radar Data Quality Control for UGOS

The authors: Michael Smith, Scott Glenn, Anthony Knap, Clifford Merz, and Stephan Howden

1 Rutgers University, Department of Marine and Coastal Sciences; 2 Texas A&M University; 3 University of South Florida; 4 University of Southern Mississippi

Standard High Frequency Radar Processing Routine

CODAR Processing Toolbox

Rutgers has developed an open-source Python toolbox for parsing CODAR Columnar Table Format (CTF). The toolbox is hosted at: github.com/rucool/codar_processing

**Features**

1. Automatically reads all CTF filetypes (Radials, Waves, Totals, Diagnostics)
2. The toolbox also can load radial files from WERA HF radars
3. Both temporal and spatial aggregation depending on filetype
4. Quality Control (QC) Tests
   - All required/suggested radial tests described in the QARTOD HFR manual are implemented
   - New QC tests can be easily added

5. NetCDF4 Output
   - CF 1.6 compliant
6. Data Investigation
   - The data format can be used to easily investigate (cleaning, grouping, averaging, etc.) data both spatially and temporally.
7. Database insertion
   - MySQL (relational)
   - MongoDB (document storage)

**Users/Contributors**

We hope our open source code will be adopted by the HF Radar community as a standard way to analyze and execute quality control on HF radar datasets. Currently, the code is being utilized in real-time by the following:

- Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)
- SWARM (Palmer Deep, Antarctica)
- Old Dominion University - Center for Coastal Physical Oceanography
- Axiom Data Science

**QC Flag Results**

UGOS High Frequency Radar Processing Routine

**HF Radar Data Real Time & Delayed Mode Flow Chart**

CODAR Radar Admin Processing Web Application

Above: UGOS HF Radar Processing Routine. Real-time is displayed in green. Delayed mode is displayed in pink.

Low-level Data Quality Control

**First Order Lines (FOL) Tracking**

- Python toolbox utilized to track changes in FOL through time, range, and doppler bins
- Variability of FOL can be used to monitor changes in current strengths.
- Can be used to determine how well the real-time FOLs are performing on remote sites.

**Automatic Antenna Pattern Measurements using Vessel Tracks (AIS)**

- Testing new software developed at CODAR on our HOOK site
- Site utilizes a machine learning algorithm to pick out ship echoes in cross spectra and match them with known range and velocity of AIS detections to get a bearing.
- Use the antenna ratios from multiple ship peaks to generate an antenna pattern if the algorithm determines that the old pattern is invalid.
- If algorithm determines a new pattern is needed, it produces a result stating why it’s invalid.

**Delayed Mode Processing results**

Leveraging our existing Mid-Atlantic radar network for testing the quality control (QC) code, delayed-mode processing significantly improved data quality.

- Net Addition of 7,702 radial files (5.9%) increase
- Addition of 11,237 missing radial files
- Removal of 3,535 radial files with questionable data quality
- Diagnostics were reviewed to confirm proper hardware operation
- Valid antenna pattern were applied throughout the year
- 38% of radial files were reprocessed from spectra
- 14% more radials were flagged with additional QARTOD tests
- Removal of 3,535 radial files with questionable data quality

**Acknowledgements**

Funding is provided by the National Academies of Sciences, Engineering, and Medicine’s Gulf Research Program. The authors thank Hugh Reaity and Ethan Handel for providing test datasets, and Tessa Upby and Kyle Wilcox for testing and contributing code fixes to the codar_processing toolbox.