

WAVES BY SEASONDE

Preliminary conclusions on the analysis and improvements on wave outputs

Maria Fernandes, Pedro Agostinho, Nelson Martins, Jorge Sanchez and Andrés Alonso-Martirena

1. Introduction

Main target is to access environmental and technology variables that influence the quality of different HFR sites for wave measurement and eventually conclude on the readiness of each site for acquisition of wave measurements.

2. Objectives

Establishment of new methods for analysis of wave measurement capability, quality control and performance metrics for any HFR site.

Analysis of the performance of the HFR stations for wave measurement in different situations by modifying configuration parameters available on the radar proprietary software, testing different Software releases and comparing results with other available and overlapping measurements from other in-situ instruments

statistical analysis will be carried out (including average differences, RMSE, correlation...) comparing wave data bulk parameters (significant wave height, wave period and wave direction) from the following sources:

- **HF radar versus wave buoy**
- HF radar versus CMEMS wave model
- CMEMS wave model versus wave buoy

3. Environmental Analysis

Morphology of the area

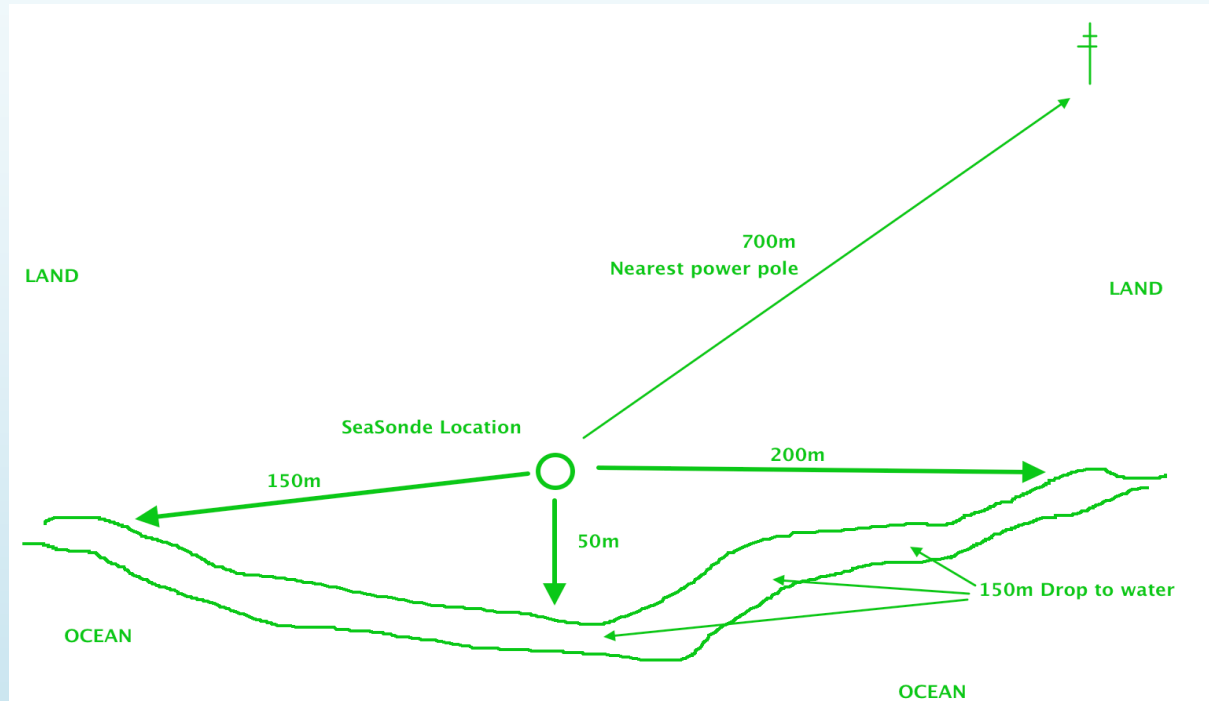
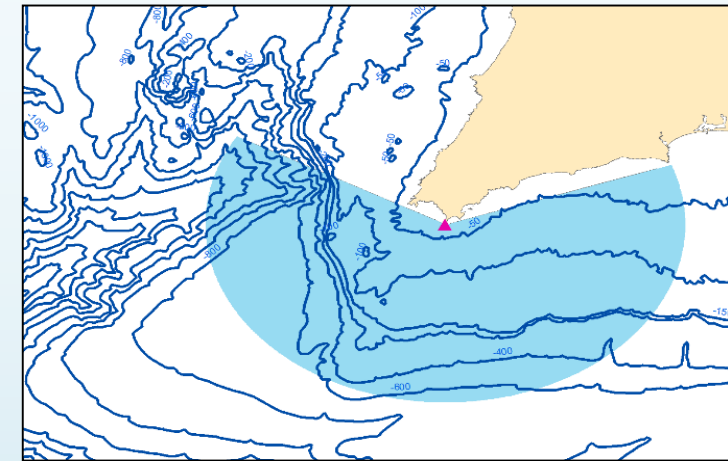
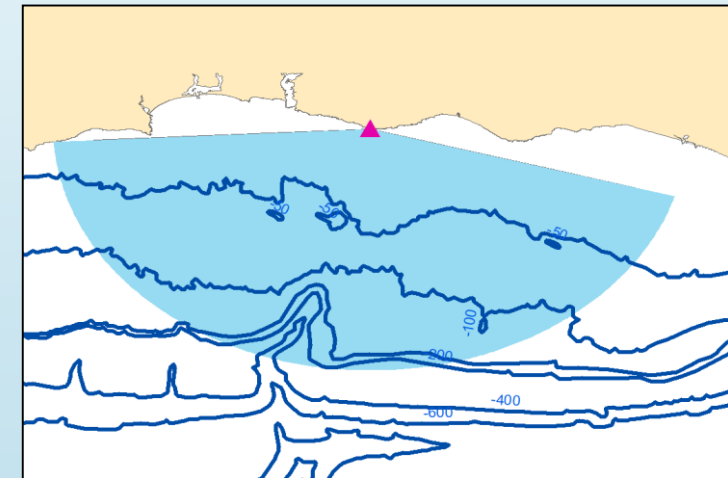


Figure 1. Ideal HF radar station installation (info from CODAR).



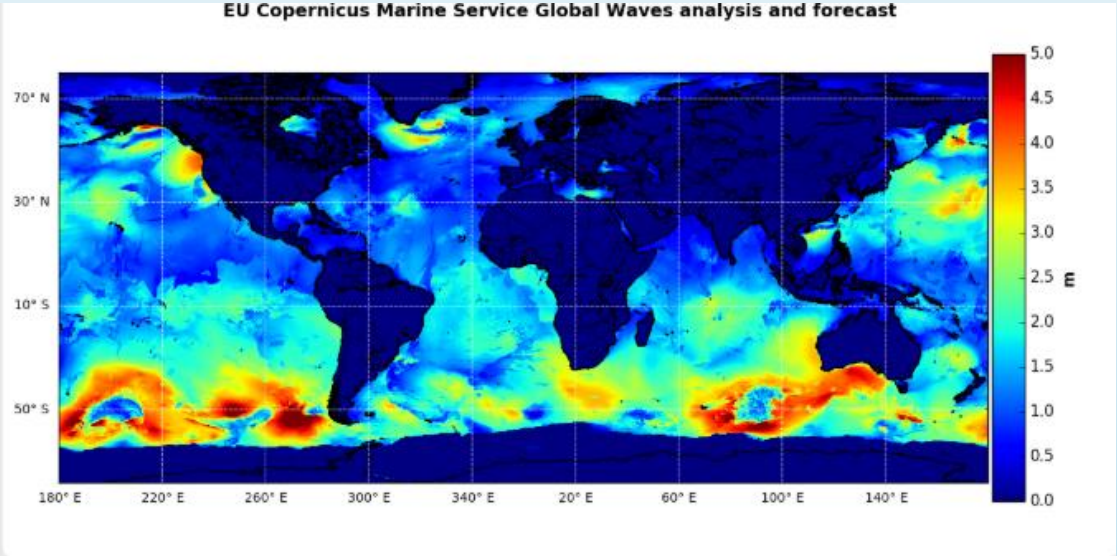
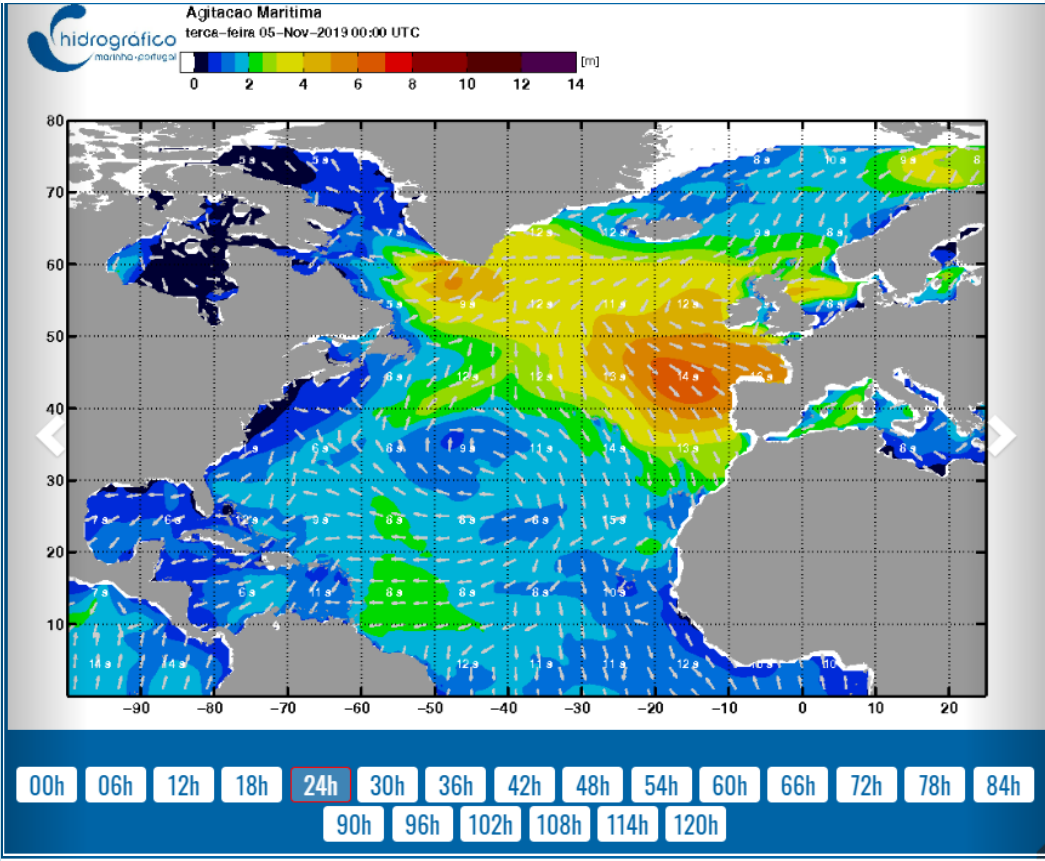
SGTR



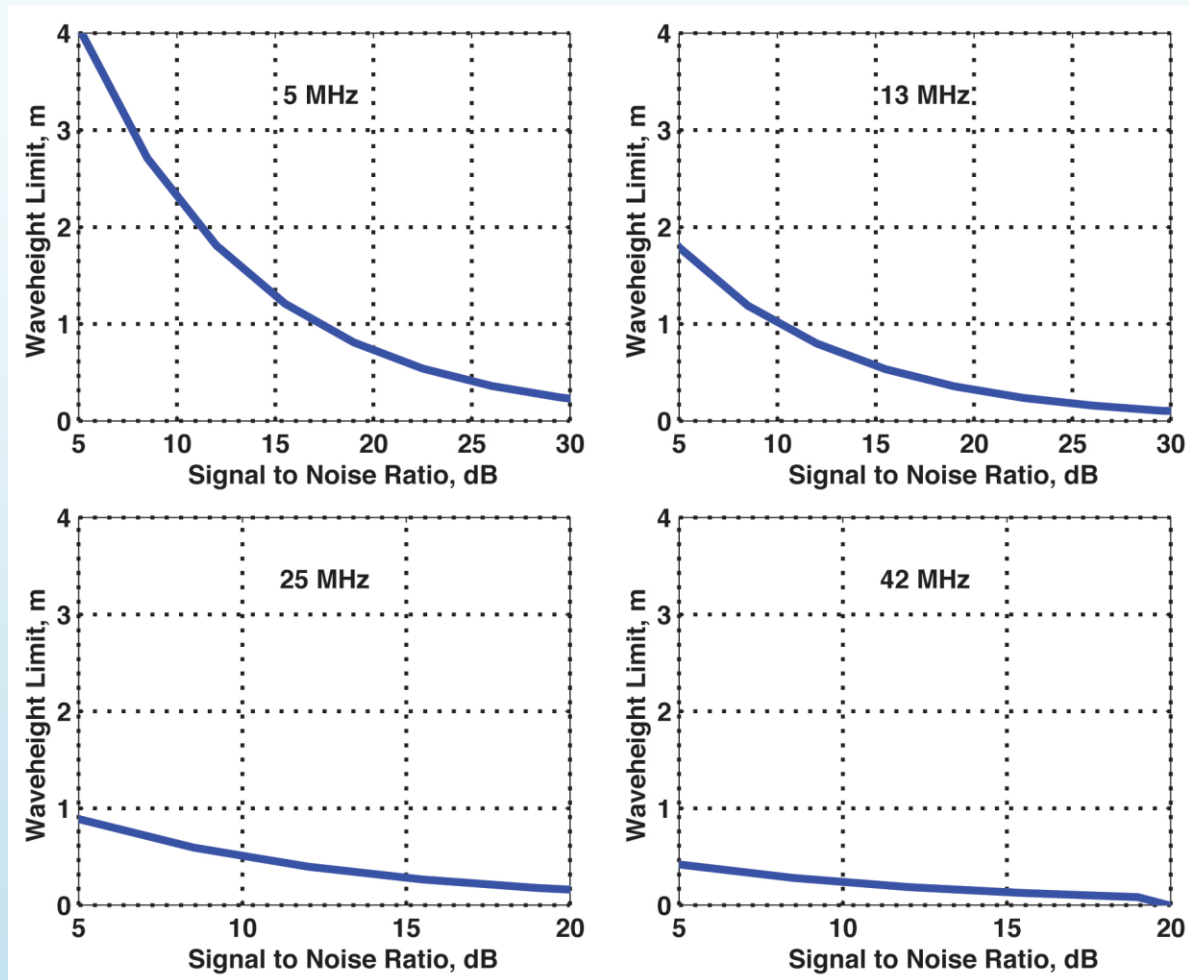
AFTR

3. Environmental analysis

Metocean conditions

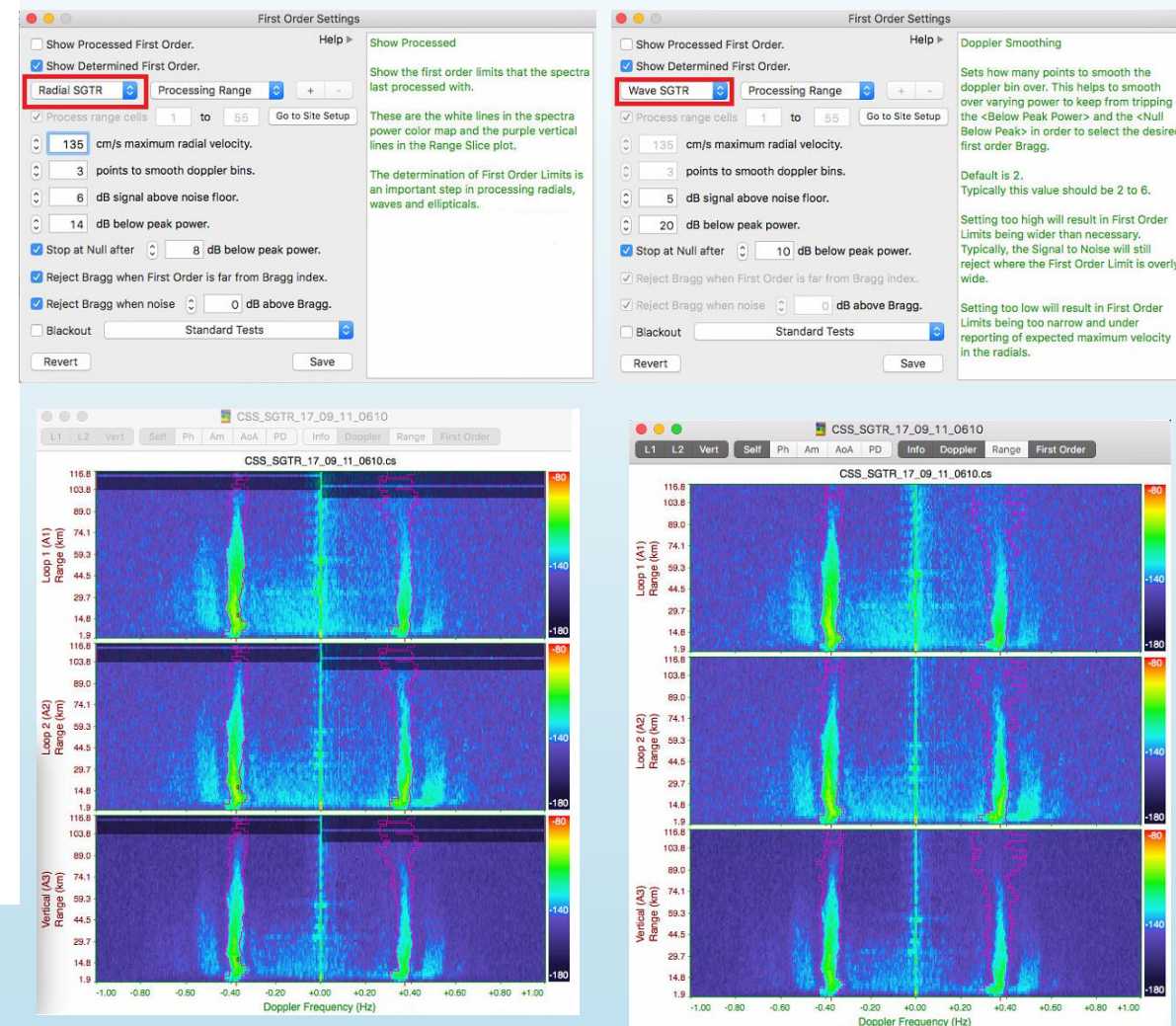


4. Software settings



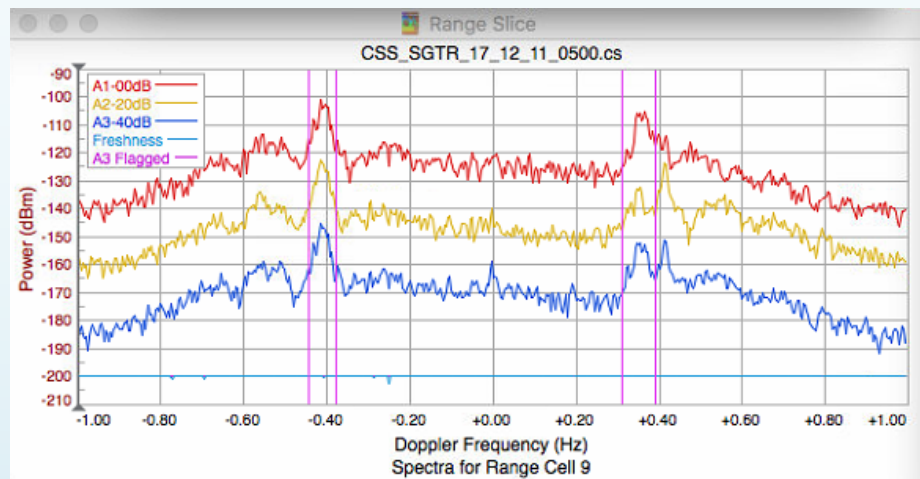
Don Barrick & Belinda Lipa, January 2013

a) First order settings (FOS)

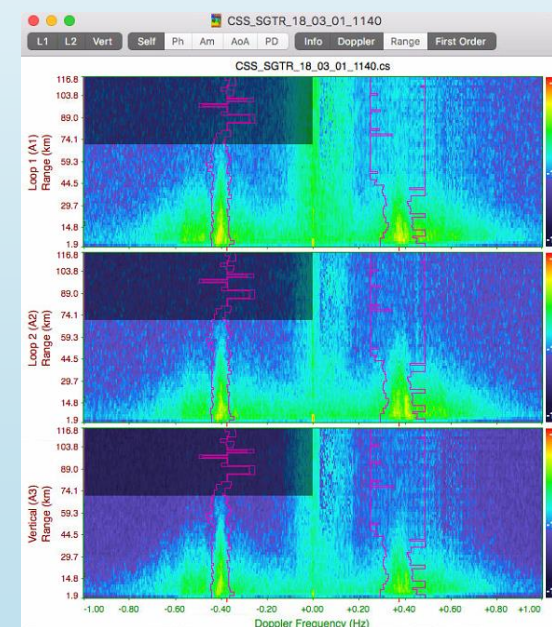
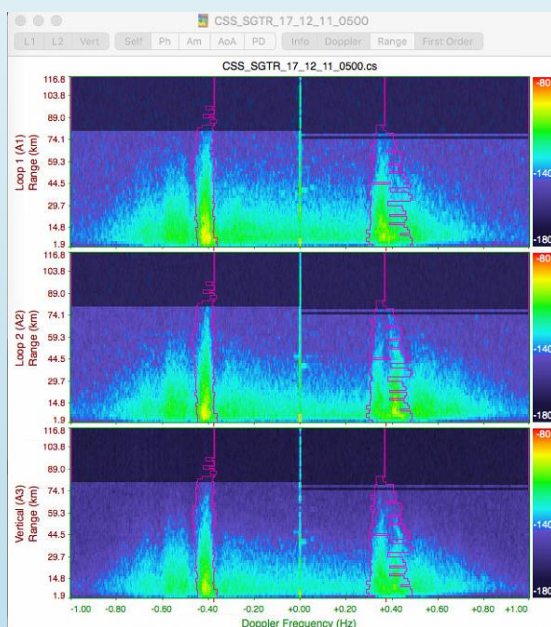
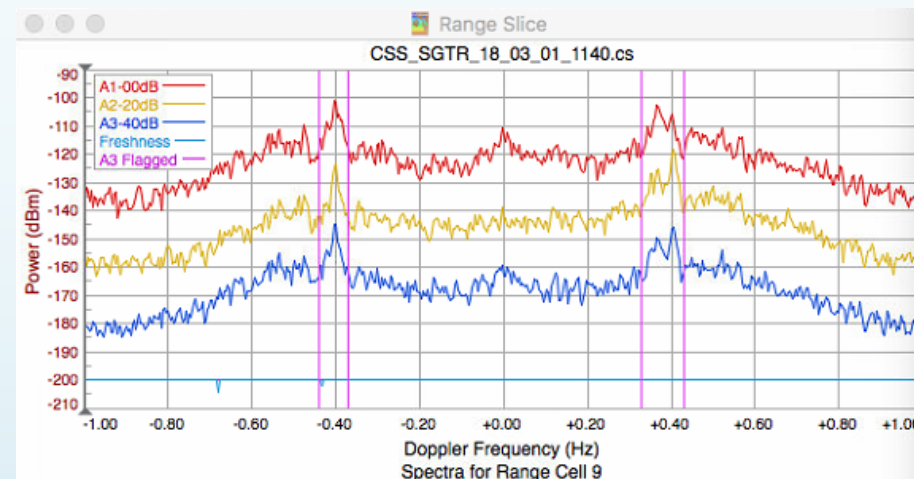


4. Software settings

Ana Storm

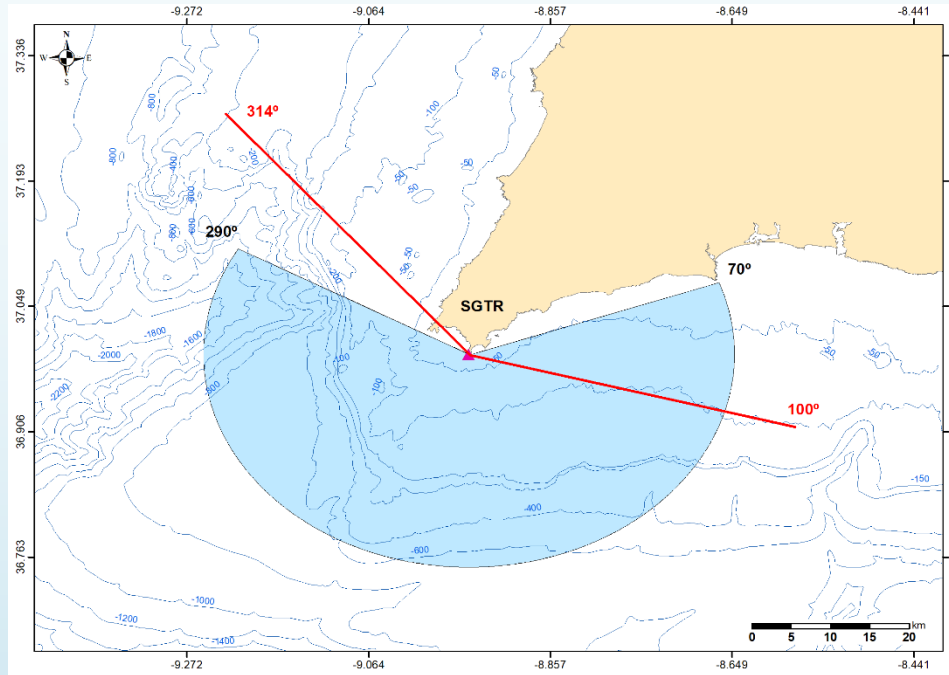


Emma Storm



b) Coastal bearings

- **coastline cutoff settings** - best coastline bearings from the site that covers the ocean;
- **wave bearing limits settings** - limits where dominant waves are expected to come from;
- **coverage time settings** - final wave coverage time of merged short-time wave from CSS in minutes;
- **output interval settings** - final wave output in minutes.



Coastline Settings	Value
Coastline Cutoff	70° - 290°
Wave bearing limits	100° - 314°
Coverage time	95 min
Output interval	10 min
Range cells	2 – 16

SeaSonde Radial Site Setup

Standard Detailed Advanced CallSign Overview License

Spectra

Doppler Bins: 512 Range Cells: 64

Sweep Rate: 2 Hz Update Rate: 1x

Averaging: 60 min Output Rate: 30 min

Radials

☒ Radial Processing Range Cells: 1 to 55

Merge Min. Vectors: 2 Angular Resolution: 5 Deg

Coverage Time: 75 min Output Interval: 60 min

Waves

☒ Wave Processing Range Cells: 2 to 16

Coastline Cutoff From: 70 °True CW To: 290 °True

Wave Bearings Limit From: 100 °True CW To: 314 °T

☐ Waves follow the wind.

Coverage Time: 95 min Output Interval: 10 min

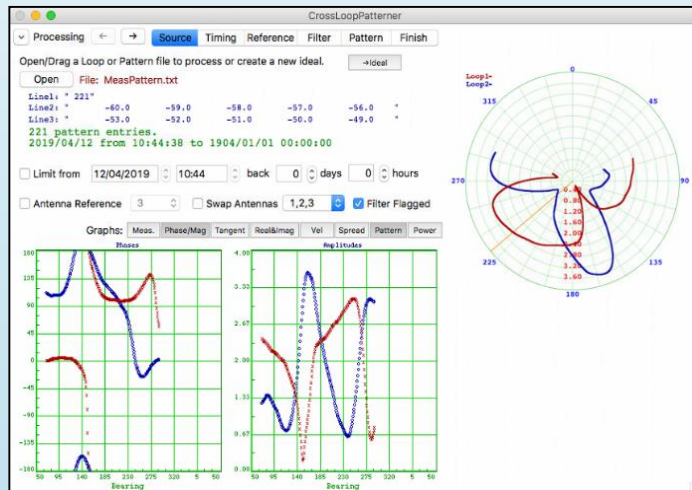
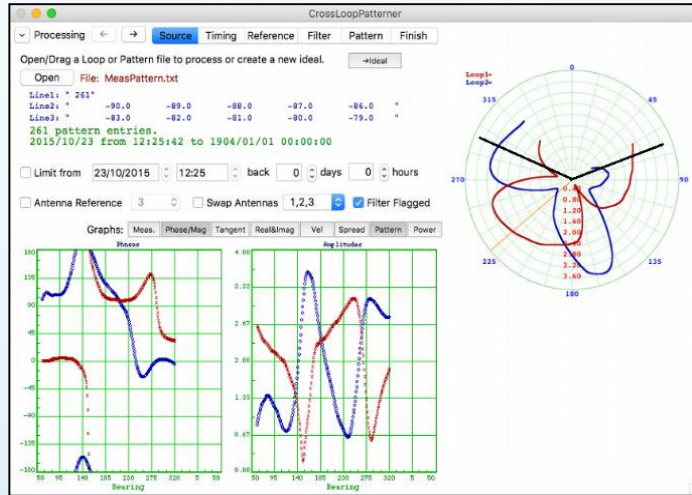
Wave Output Interval

Sets the final wave output rate in minutes. This value is a multiple of the spectra output rate. If the wave coverage time minus the spectra averaging is smaller than this value, then the final wave will overlap in time.

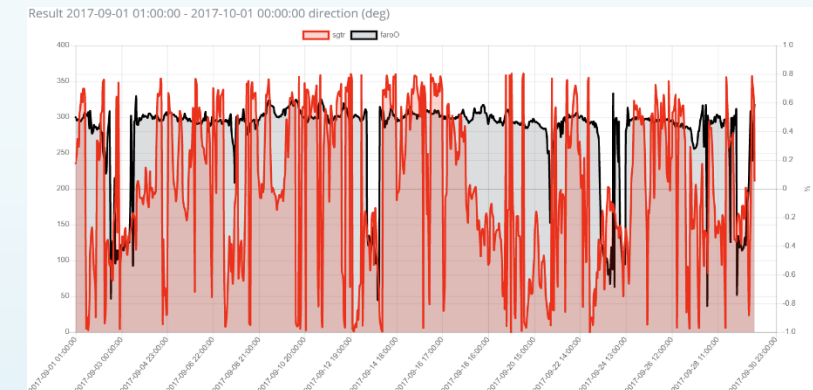
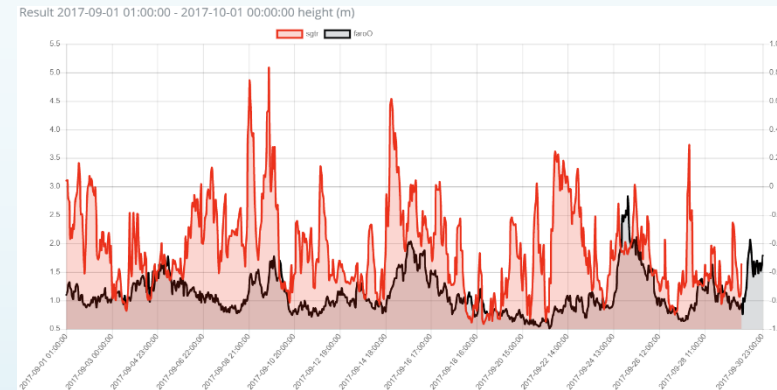
Loop Phases are not set. Radial License Release 8 found. System is configured.

Revert Save

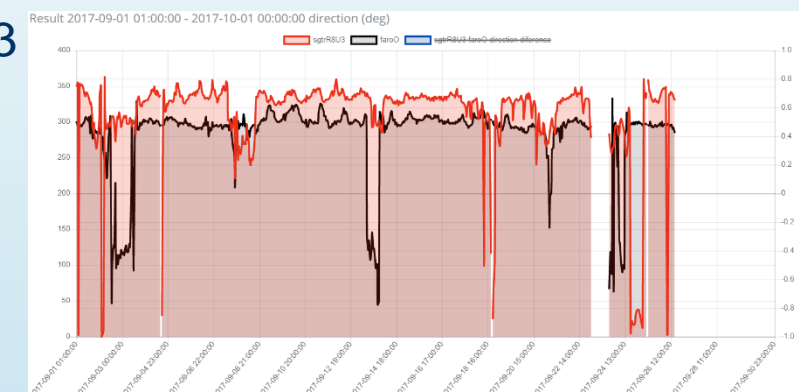
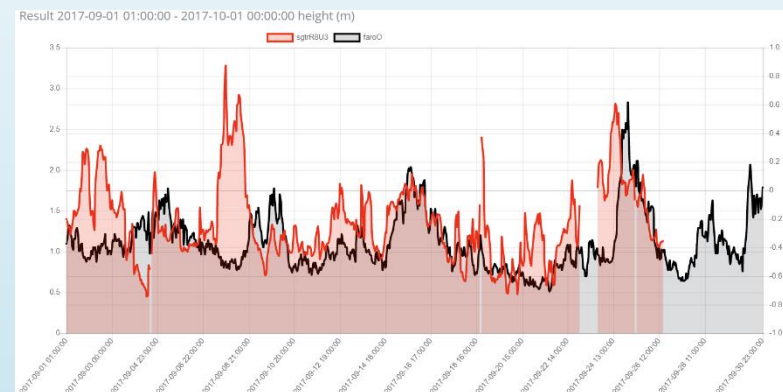
c) Software versions



R7U4



R8U3



R7U4

Variables	Value
RMS	1.12 m
CI	0.231
Availability SGTR	96.80%
Availability buoy	100.00%
Number of data	720
Average difference	0.82

R8U3

Variables	Value
RMS	0.595
CI	0.206
Availability SGTR	82.78%
Availability buoy	100.00%
Number of data	720
Average difference	0.34

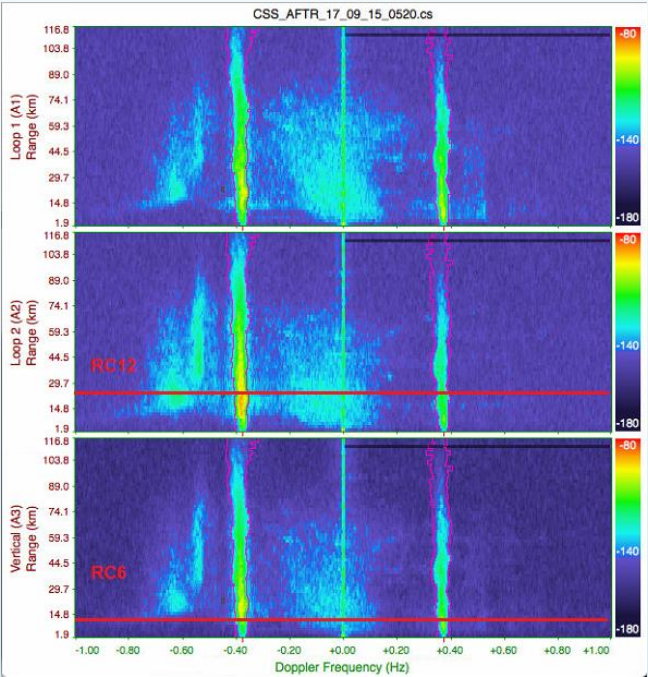
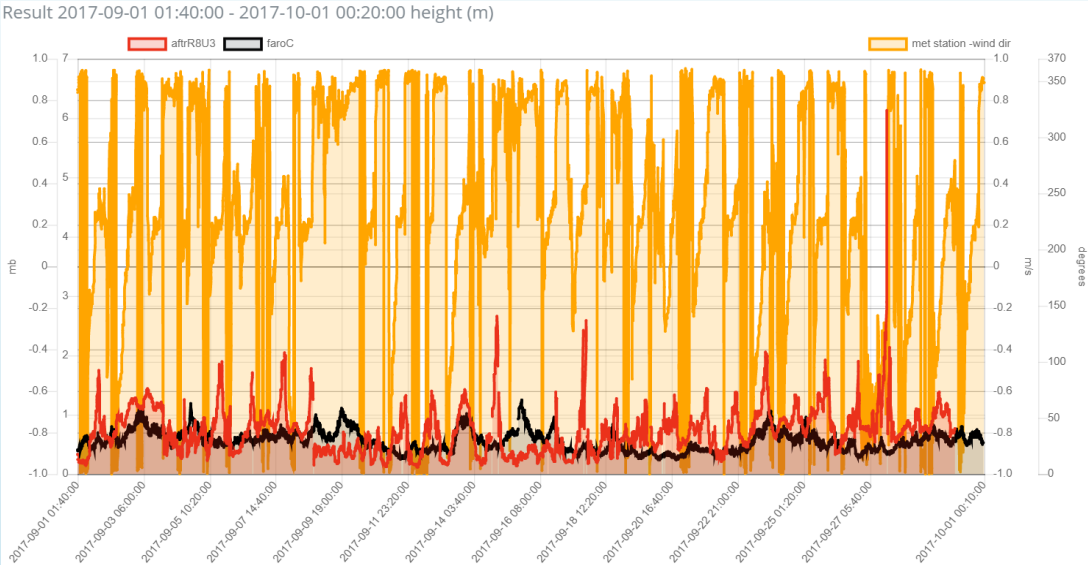
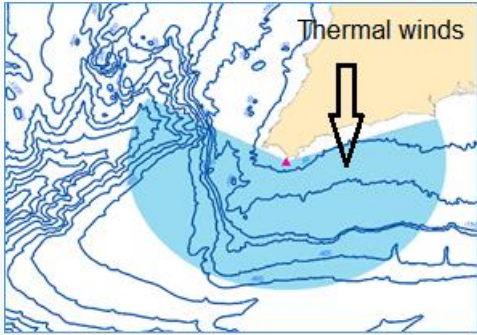
R7U4

Variables	Value
RMS	1.20 deg
CI	0.218
Availability SGTR	96.80%
Availability buoy	100.00%
Number of data	720
Average difference	71.79

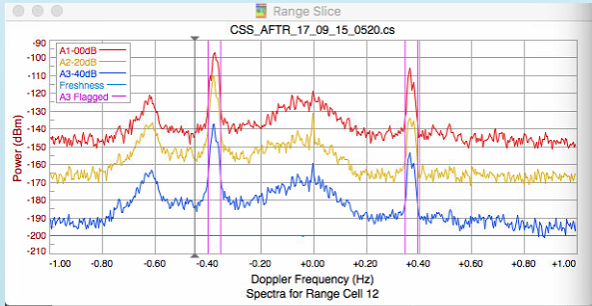
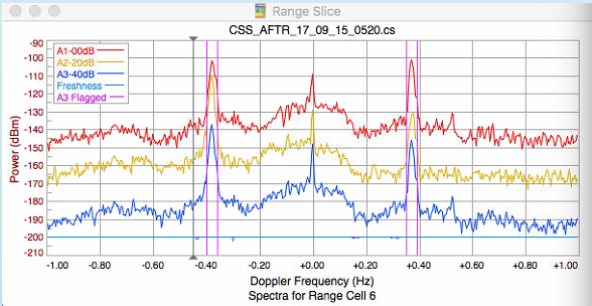
R8U3

Variables	Value
RMS	10.90 deg
CI	0.085
Availability SGTR	82.78%
Availability buoy	100.00%
Number of data	720
Average difference	38.59

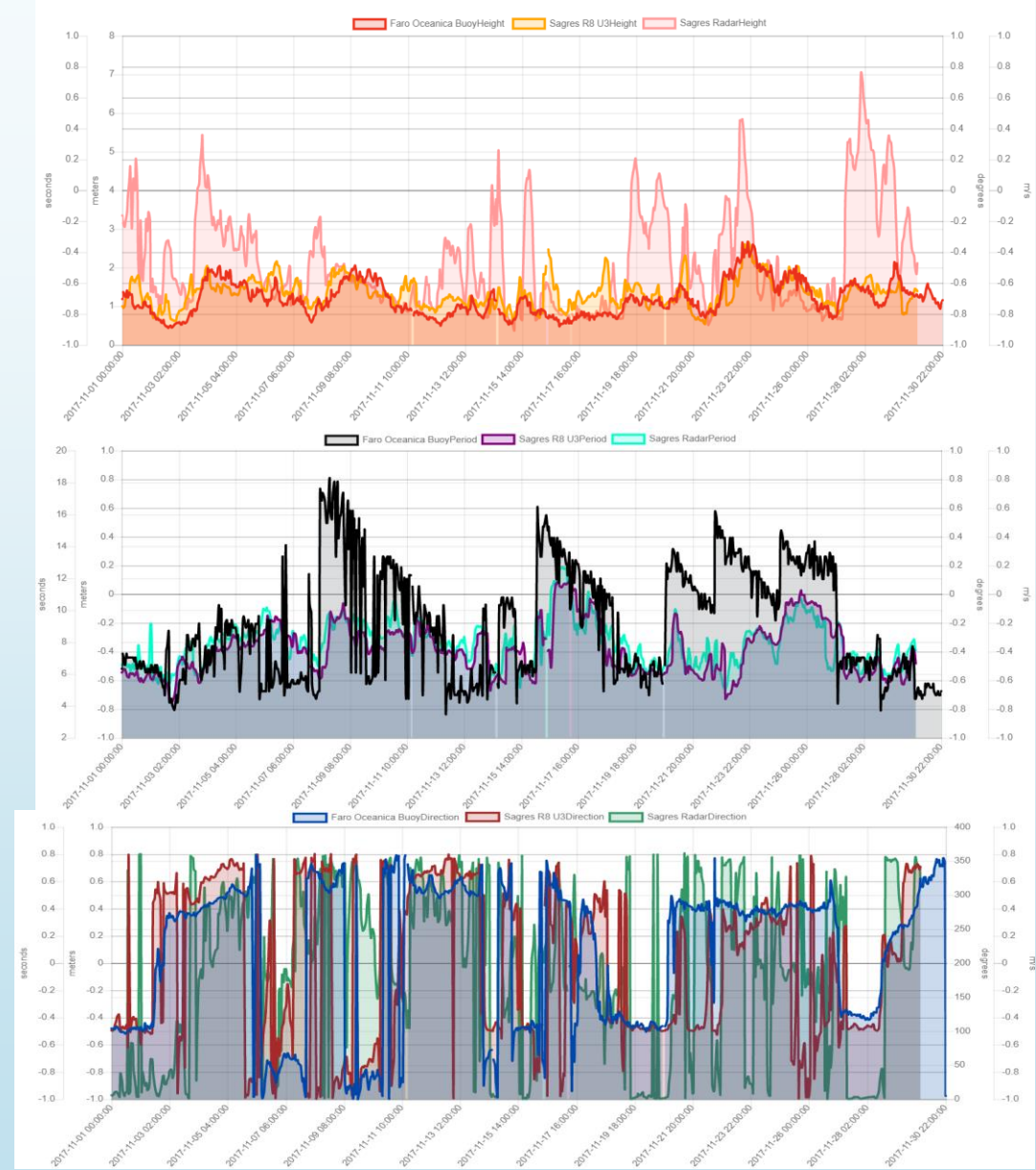
d) Sidebands



```
AnalysisOptions.txt
1 2 0
1 1 Radial Processing: 0(Off),1(On); RadPtFilter: 0(Off),>=1(min pts); RadSmooth: OBSOLETE
1 2 Wave Processing: 0(Off),1(Model),2(Spectral),3(Both)
0 3 OBSOLETE File Archiving
2 0
0 4 Antenna Pattern: 0(Ideal),1(Measured),2(Both); ForceAmplitudes: 0(Off),1(Header Amp Adj),2(SeaEcho)
0 5 Spectra Header Override: 0(Use CS Info),1(Use Header Info)
1 6 CSA Processing: 0(CSA->'Rad '),1(CSS only)
0 0 1
0 7 Wave Processing: Offshore Waves: 0(Off),1(On); Bragg Symmetry 0(Off),1(On); InnerWaves 0(Off),1(On)
0 8 Elliptical Processing: 0(Off),1(On)
1 9 Ionosphere Noise: 0(Ignore),1(Reject Offending Bragg/RangeCells)
0 10 ShortTime Rad/Ellipticals: 0(Off),1(Output)
0 11 Special FirstOrder: 0(Off),1(Enable)
0 12 Average CS FirstOrder: 0(On),1(Disable)
```



5. Radialsite Release 8 versus Release 7



R8U3

Variables	Value Hs (m)
RMS	0.398
CI	0.617
Availability SGTR R8	96.66%
Availability buoy	99.58%
Number of data	696
Average difference	0.302

Variables	Value Tp (s)
RMS	3.497
CI	0.468
Availability SGTR R8	96.66%
Availability buoy	99.58%
Number of data	696
Average difference	2.546

Variables	Value Dir (deg)
RMS	0.056
CI	0.364
Availability SGTR R8	96.66%
Availability buoy	99.58%
Number of data	696
Average difference	42.7

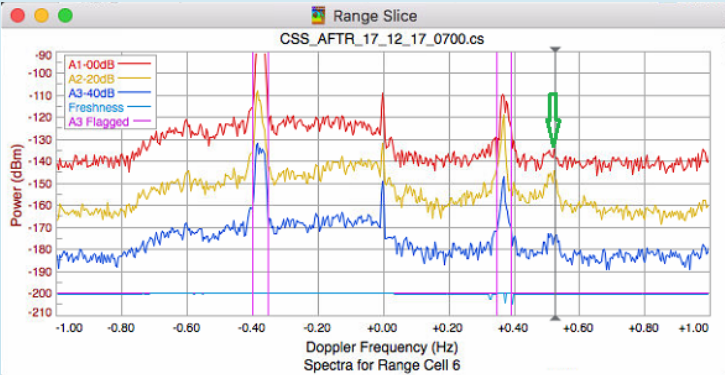
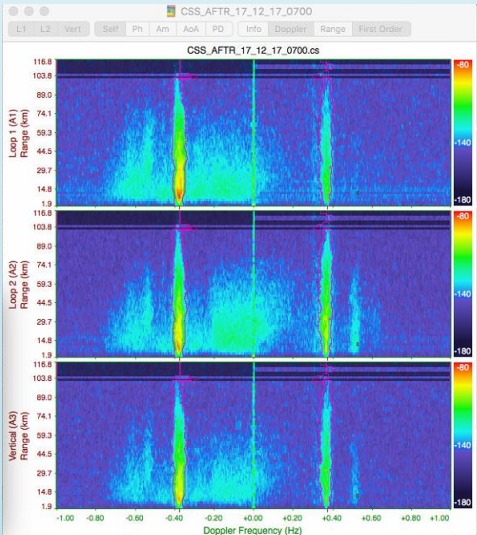
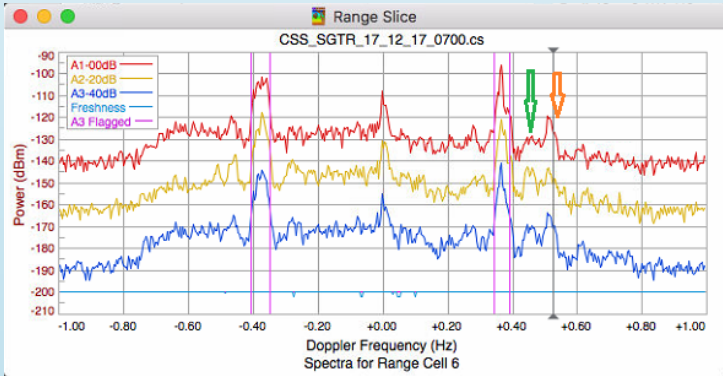
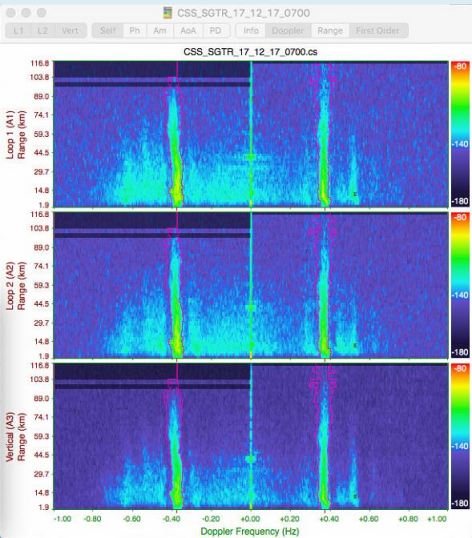
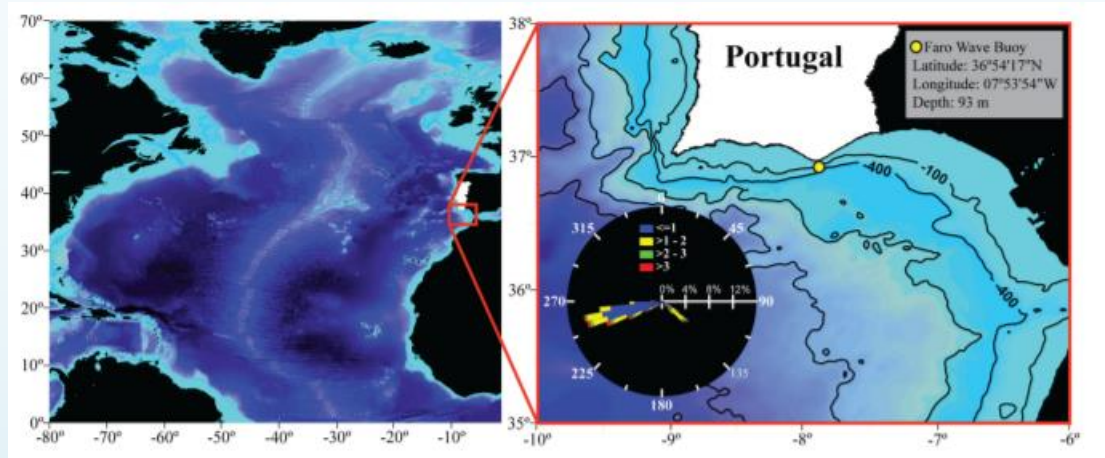
R7U4

Variables	Value Hs (m)
RMS	1.548
CI	0.373
Availability SGTR R7	96.59%
Availability buoy	99.58%
Number of data	717
Average difference	1.053

Variables	Value Tp (s)
RMS	3.391
CI	0.448
Availability SGTR R7	96.59%
Availability buoy	99.58%
Number of data	717
Average difference	2.516

Variables	Value Dir (deg)
RMS	2.898
CI	0.309
Availability SGTR R7	96.59%
Availability buoy	99.58%
Number of data	717
Average difference	83.852

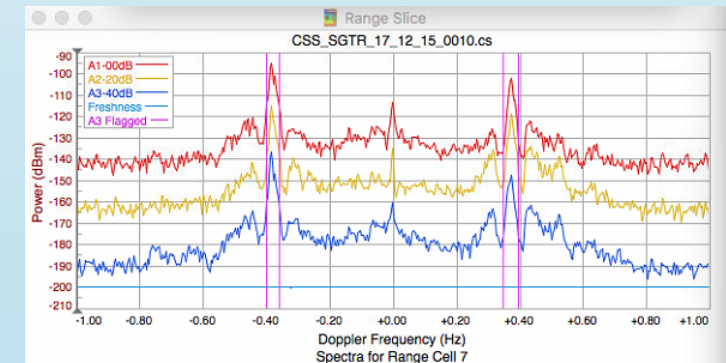
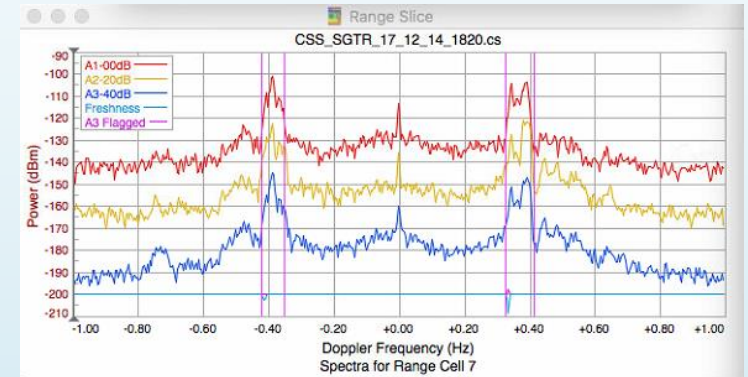
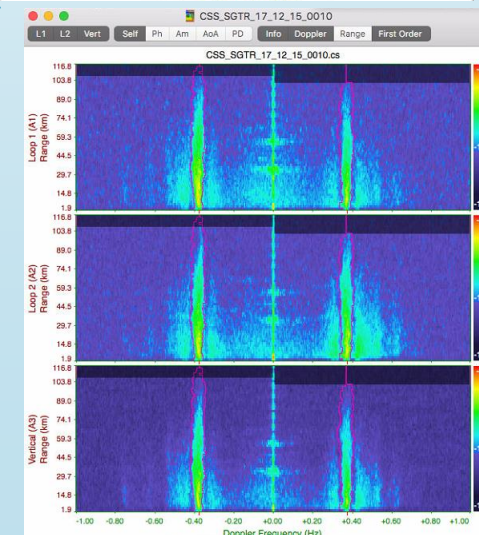
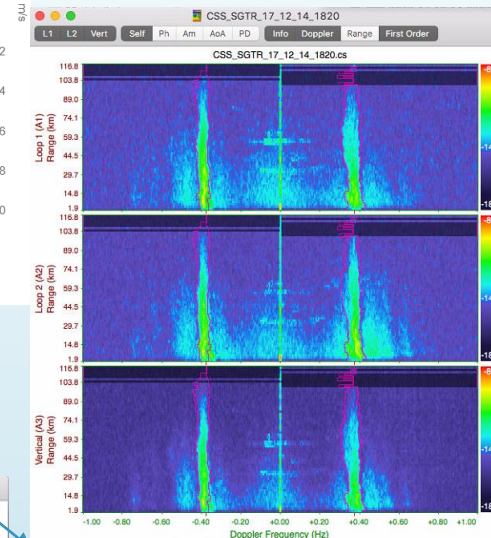
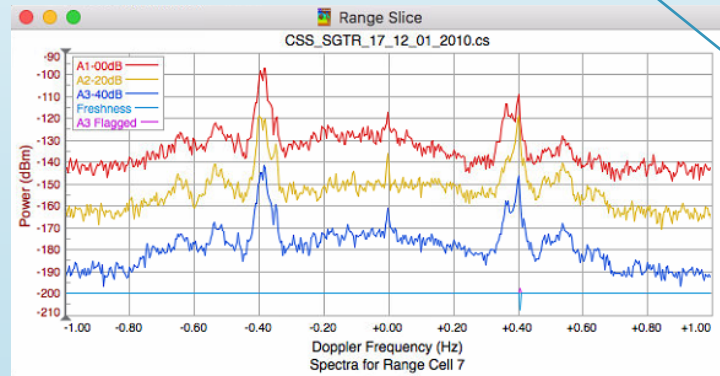
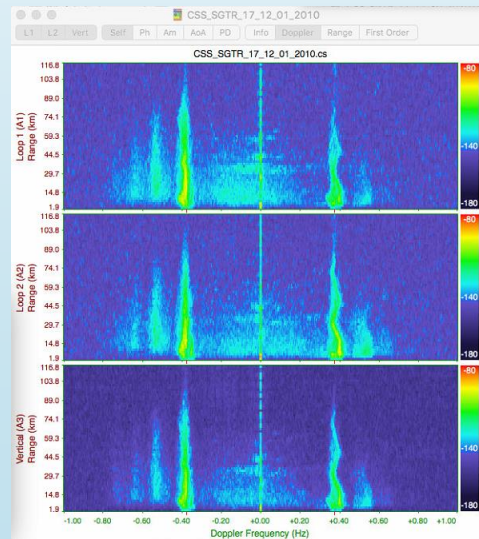
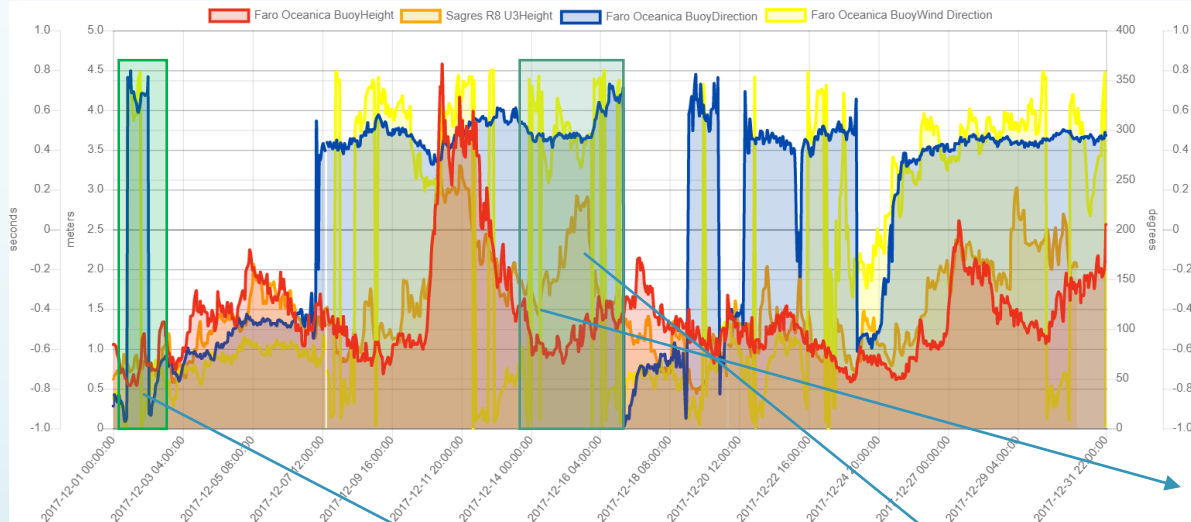
6. Importance of wind measurement



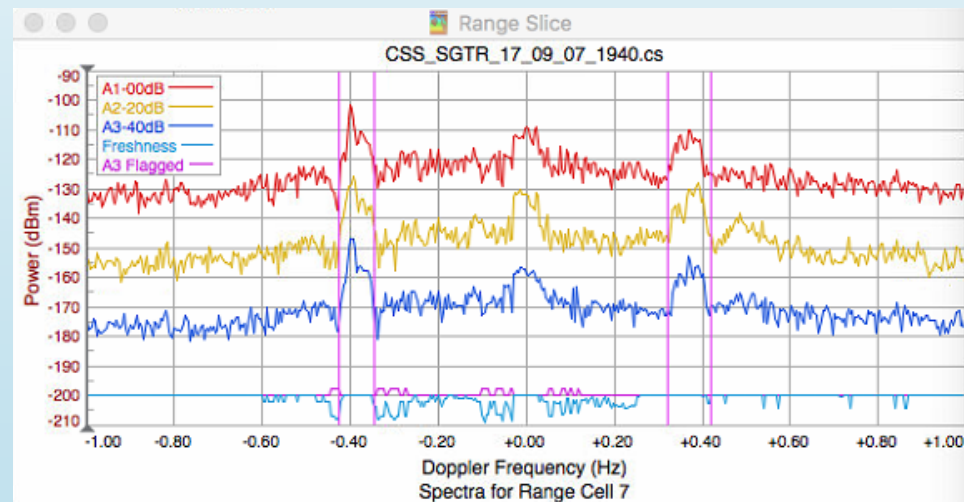
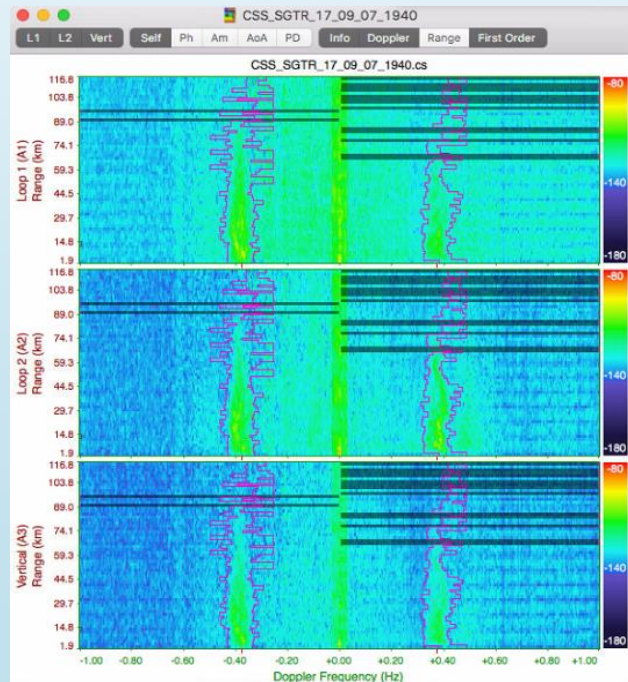
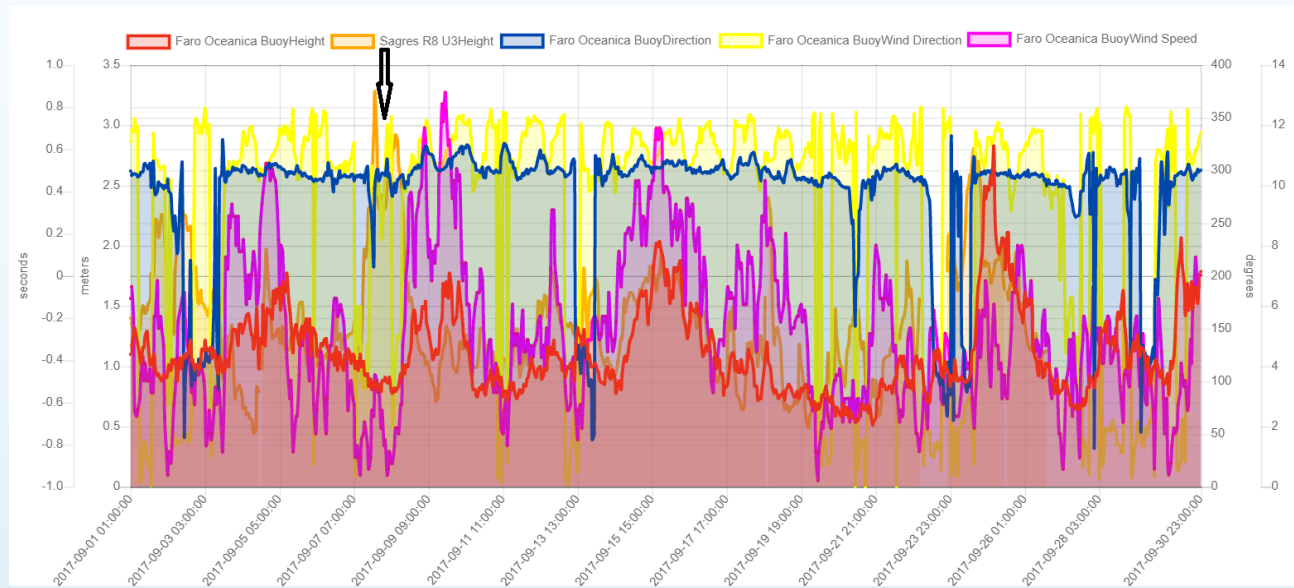
7. Variables and conditions that affect data quality

a) bi-modal seas

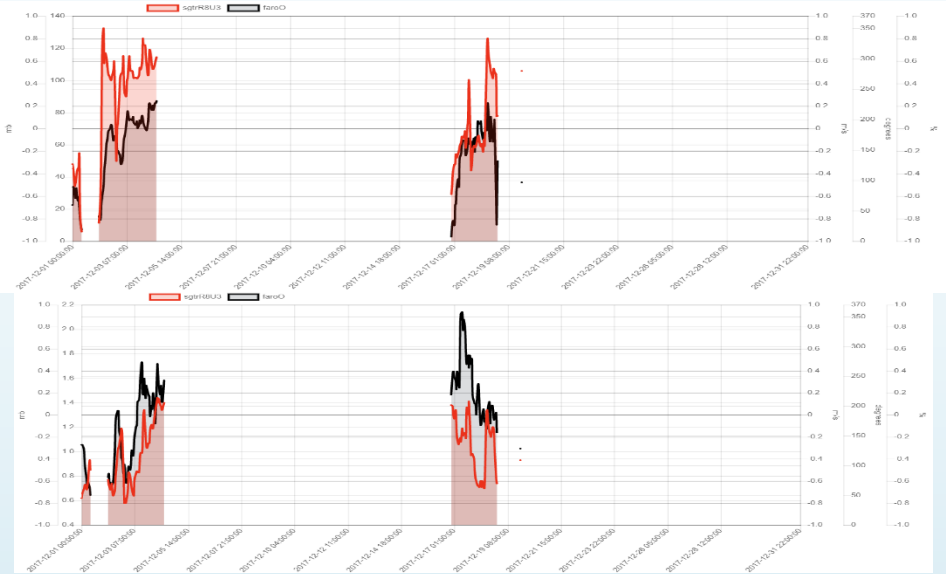
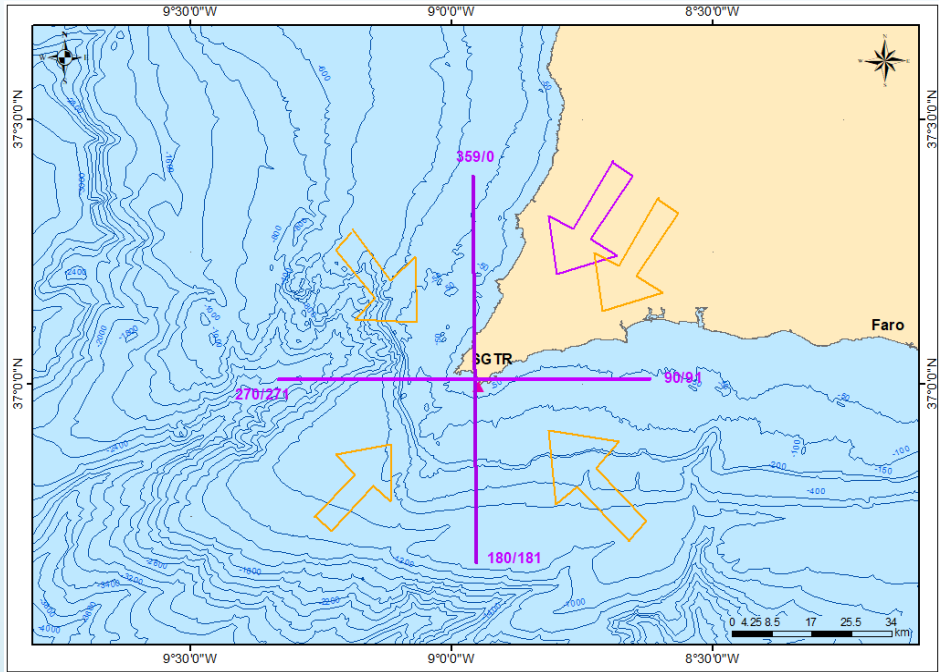
Presence of **bi-modal seas** (which can be checked in CMEMS data and HFR spectra). Bi-modal seas present bi-modal characteristics, meaning that we can have swell mixed with wind waves, both with different directions inducing 2 or more different oceanographic conditions.



a) Interference



c) Wind and wave direction



Wind 0-90 wave 0-90

Wind 0-90 wave 271-359

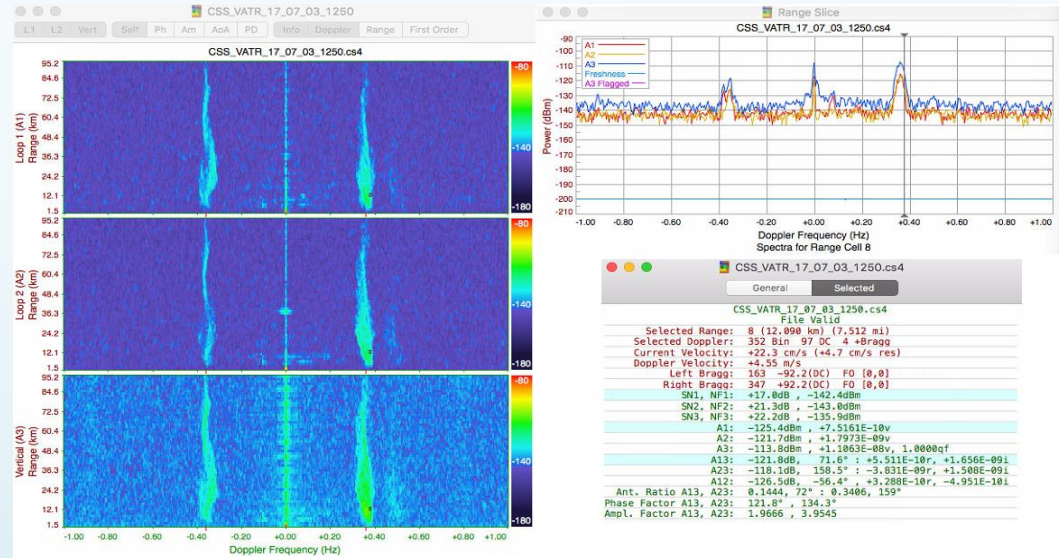
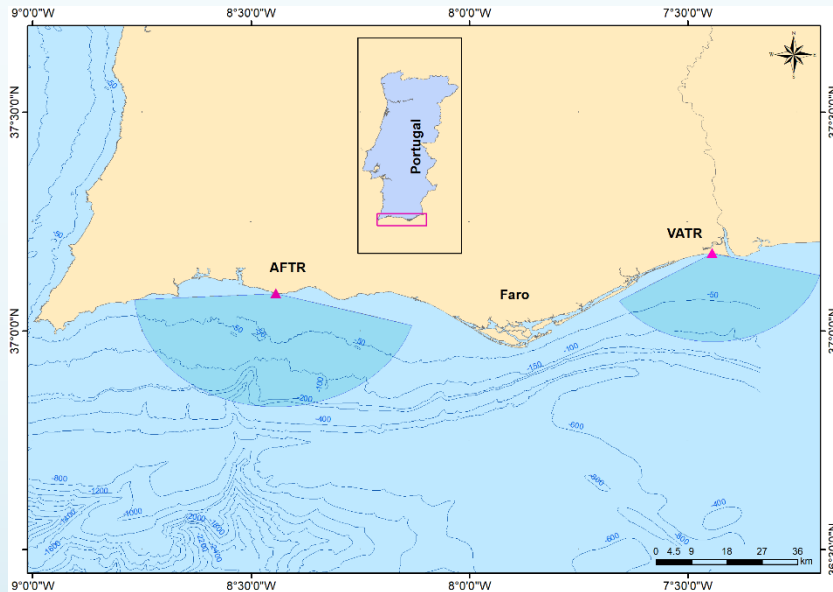
Variables	Wind 0-90 Wave 0-90	Wind 0-90 Wave 91-180	Wind 0-90 Wave 181-270	Wind 0-90 Wave 271-359
RMS	0.412 m	0.252 m	0.314 m	0.486 m
CI	0.63	0.585	-0.422	0.593
Availability SGTR R8	15.86%	10.22%	0.54%	20.97%
Availability buoy	15.86%	10.22%	0.54%	21.24%
Number of data	118	76	4	156
Average difference	0.053 m	0.019 m	0.002 m	0.076 m

Variables	Wind 0-90 Wave 0-90	Wind 0-90 Wave 91-180	Wind 0-90 Wave 181-270	Wind 0-90 Wave 271-359
RMS	3.938°	11.154°	54.336°	7.727°
CI	0.674	0.388	-0.934	-0.13
Availability SGTR R8	15.86%	10.22%	0.54%	20.97%
Availability buoy	15.86%	10.22%	0.54%	21.24%
Number of data	118	76	4	156
Average difference	27.9°	10.825°	104.54°	76.208°

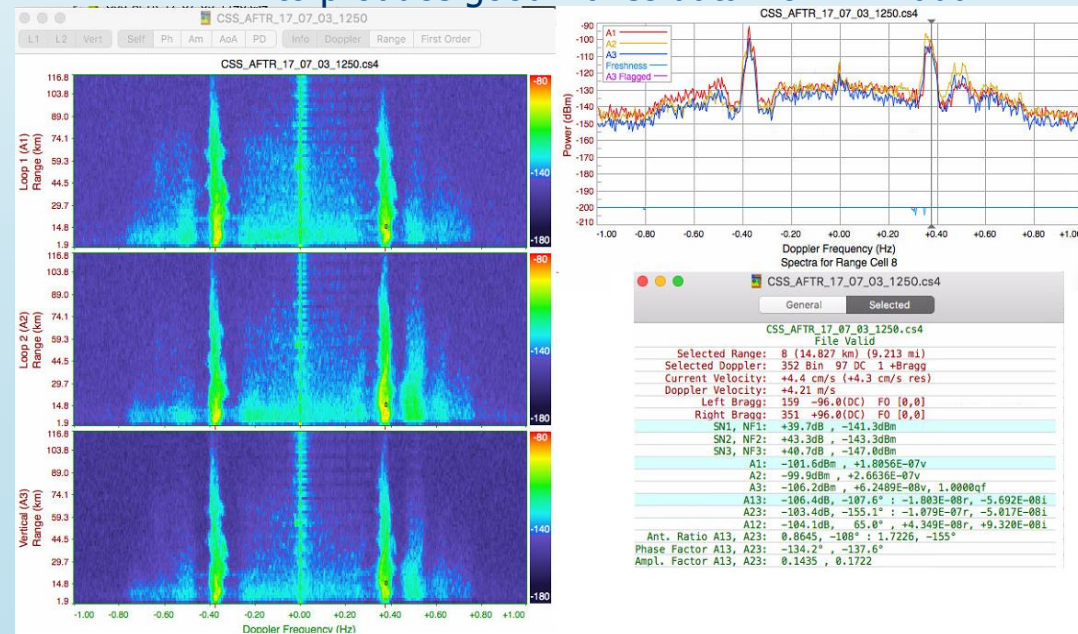


d) SNR and Noise floor

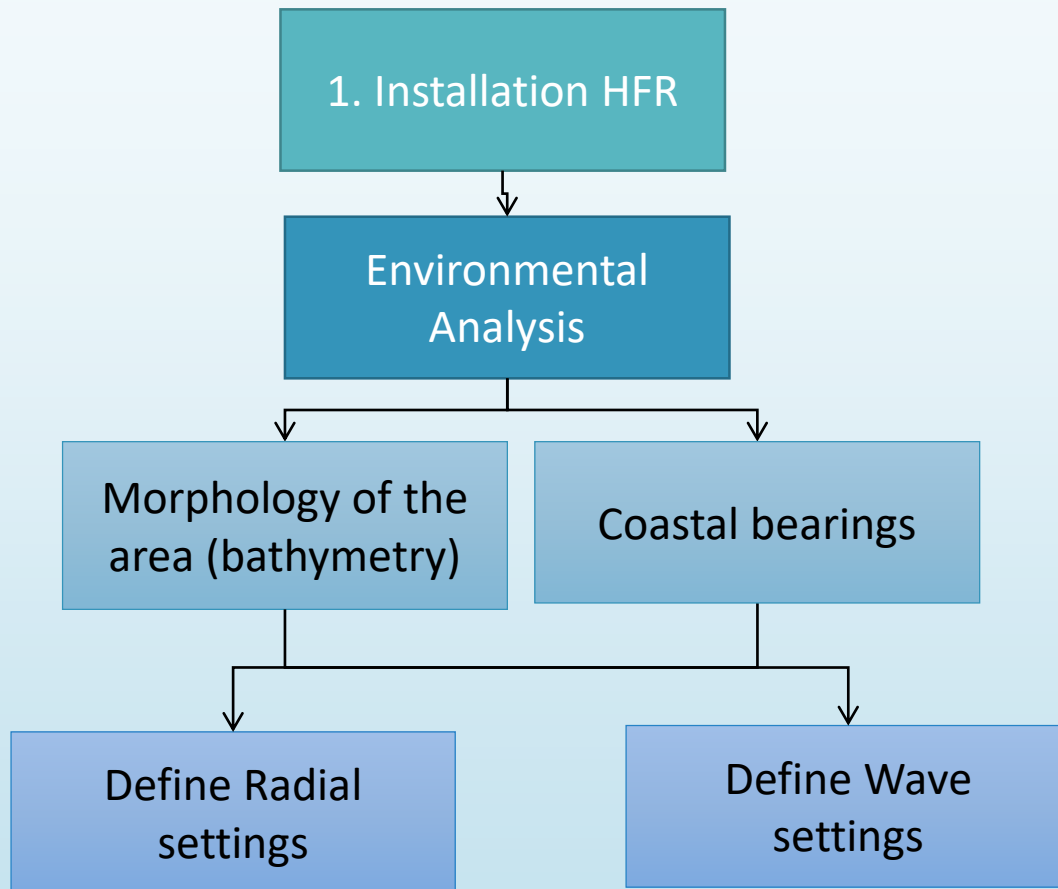
In places where the noise floor is steadily high or the SNR is low, one should expect very low quality/availability of waves data



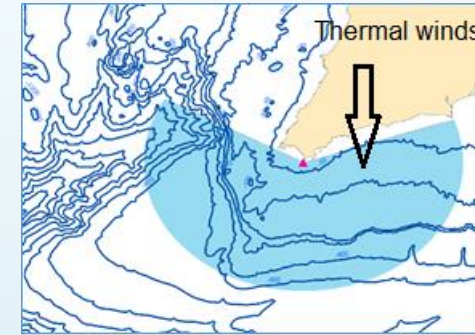
noise floor is regularly low and the SNR is above 30 db, there is a good potential to produce good waves data from HF radar



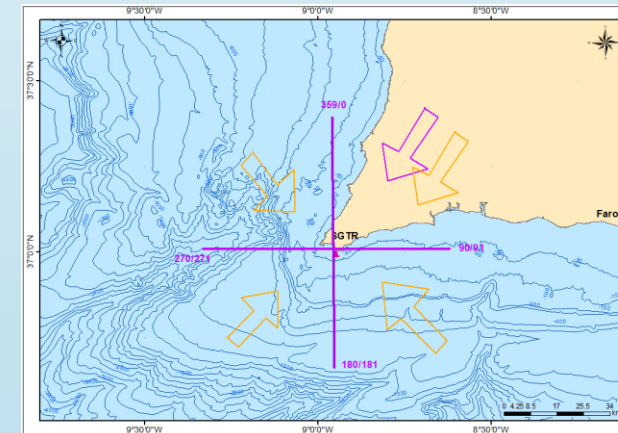
7. Conclusions



- Importance of wind direction versus the coast

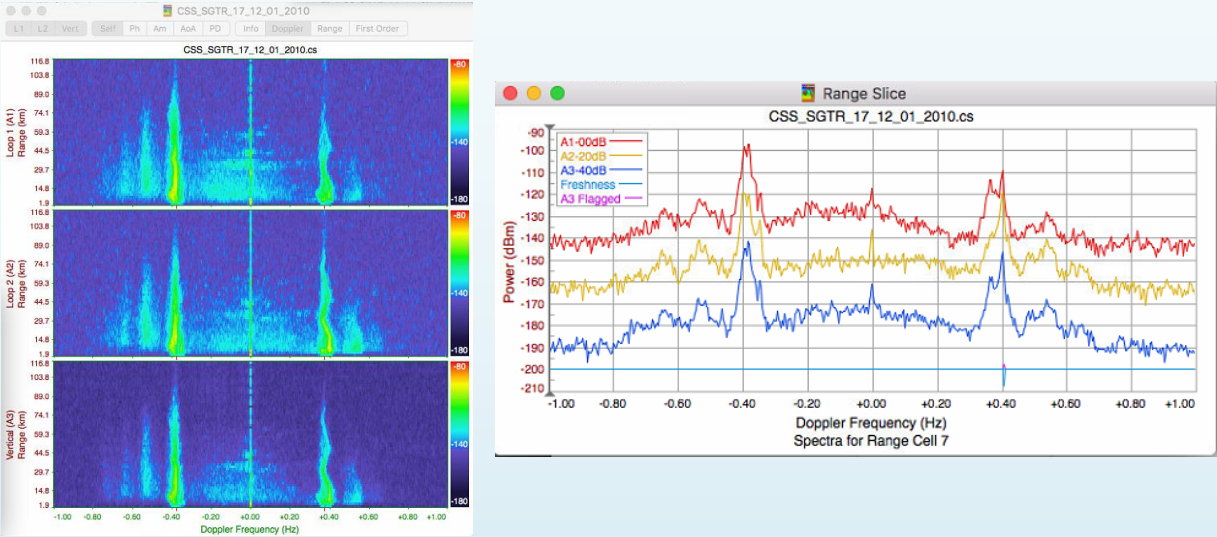


- Importance of wind direction versus the waves direction by HF radar

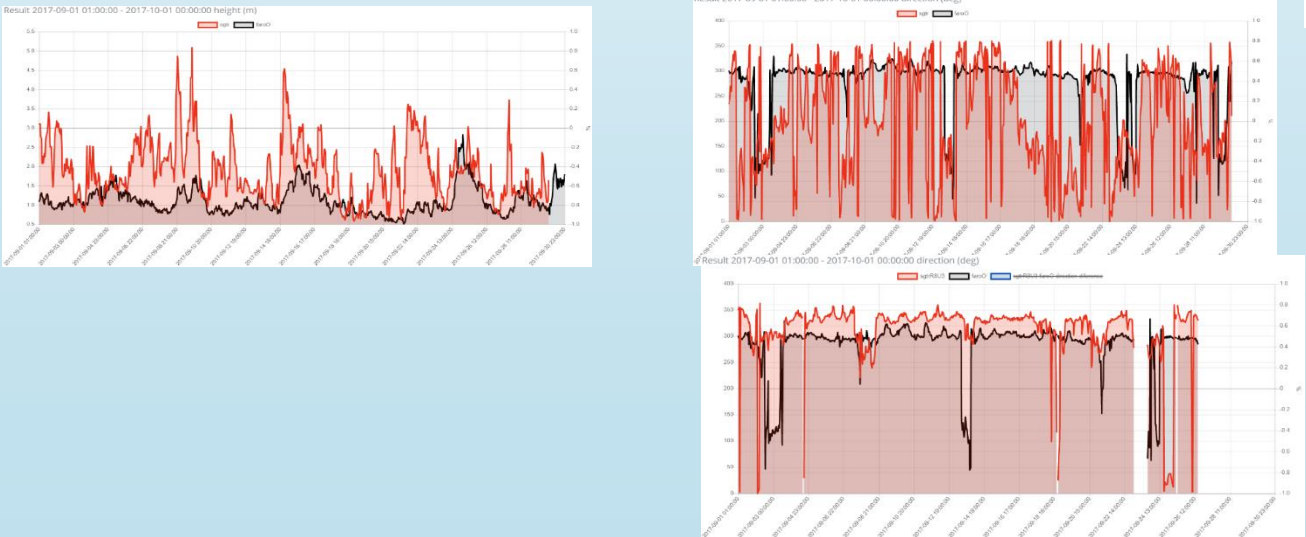


7. Conclusions

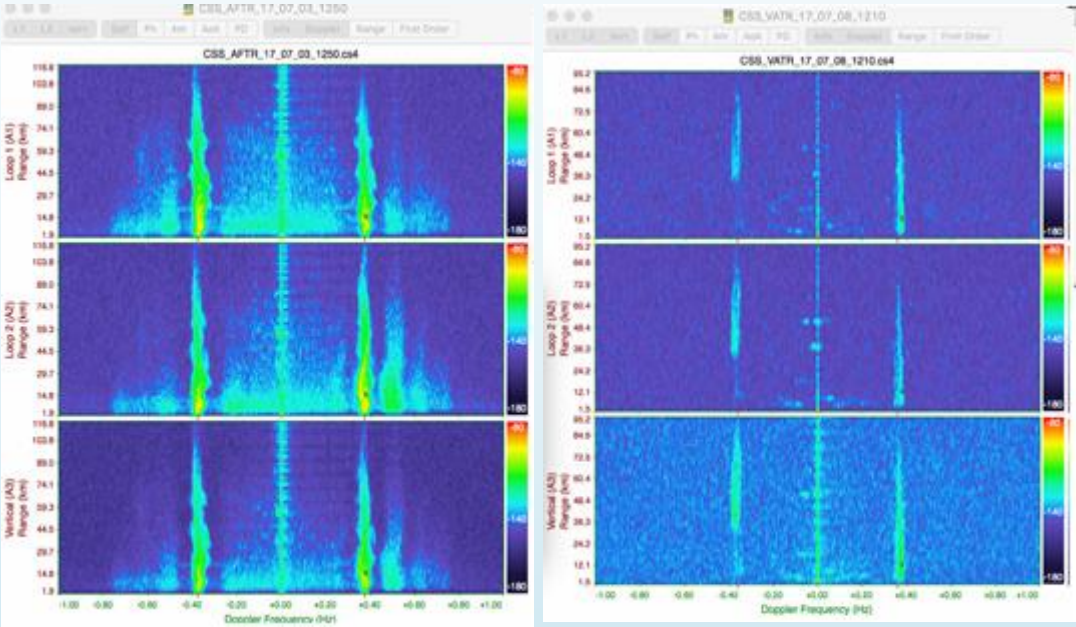
- Importance of bimodal seas



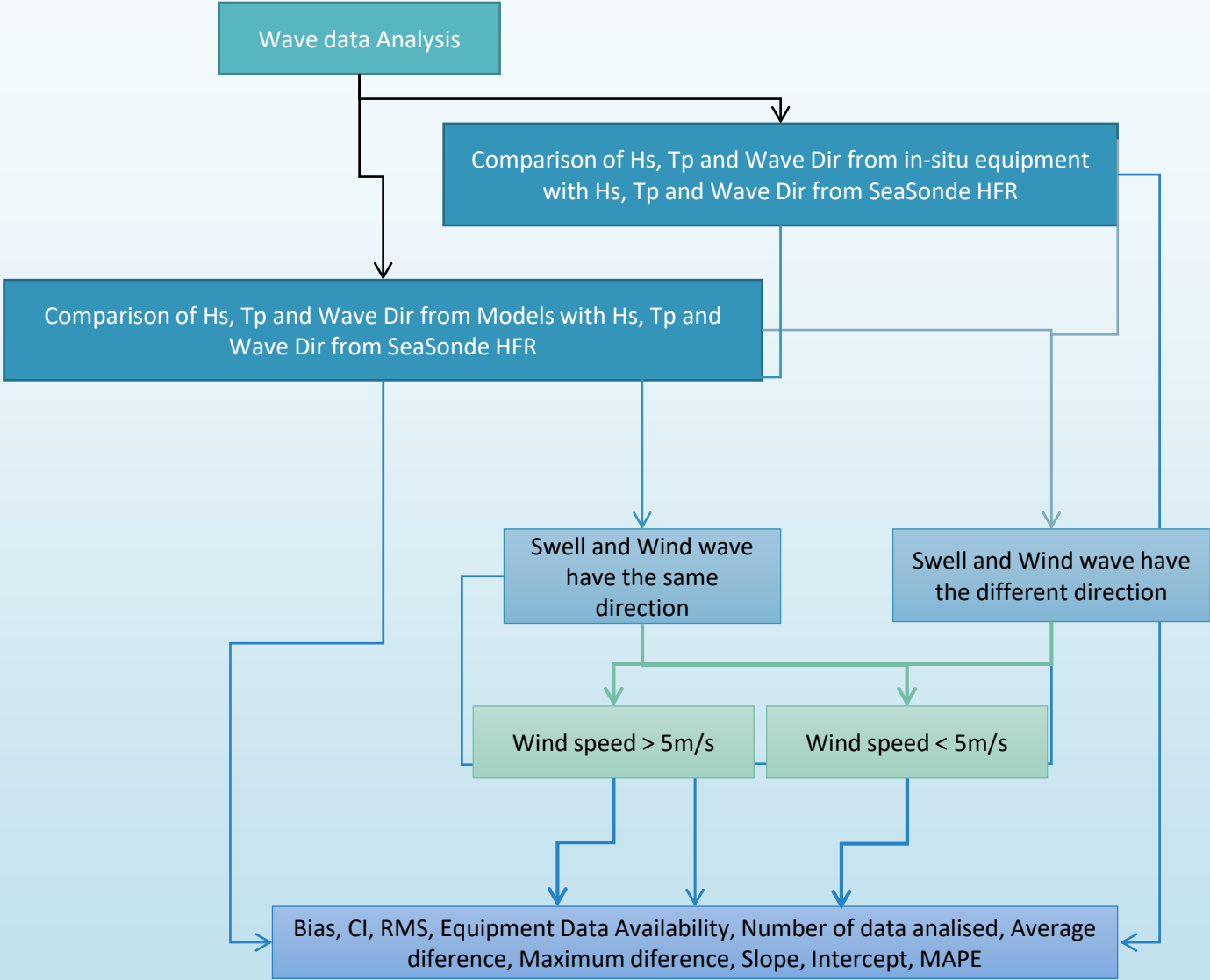
- Improvements on R8U3 vs. R7U4



- Importance of SNR and Noise Floor



7. Conclusions



The final goal is to be able to add a "Quality index" in real-time to SeaSonde wave outputs for each system based on different constraints SNR, waves/winds angles, wind speeds, CI, RMS, etc....



THANK YOU