Shipboard ADCP visualization and diagnosis

INMARTECH 2018

Woods Hole, MA

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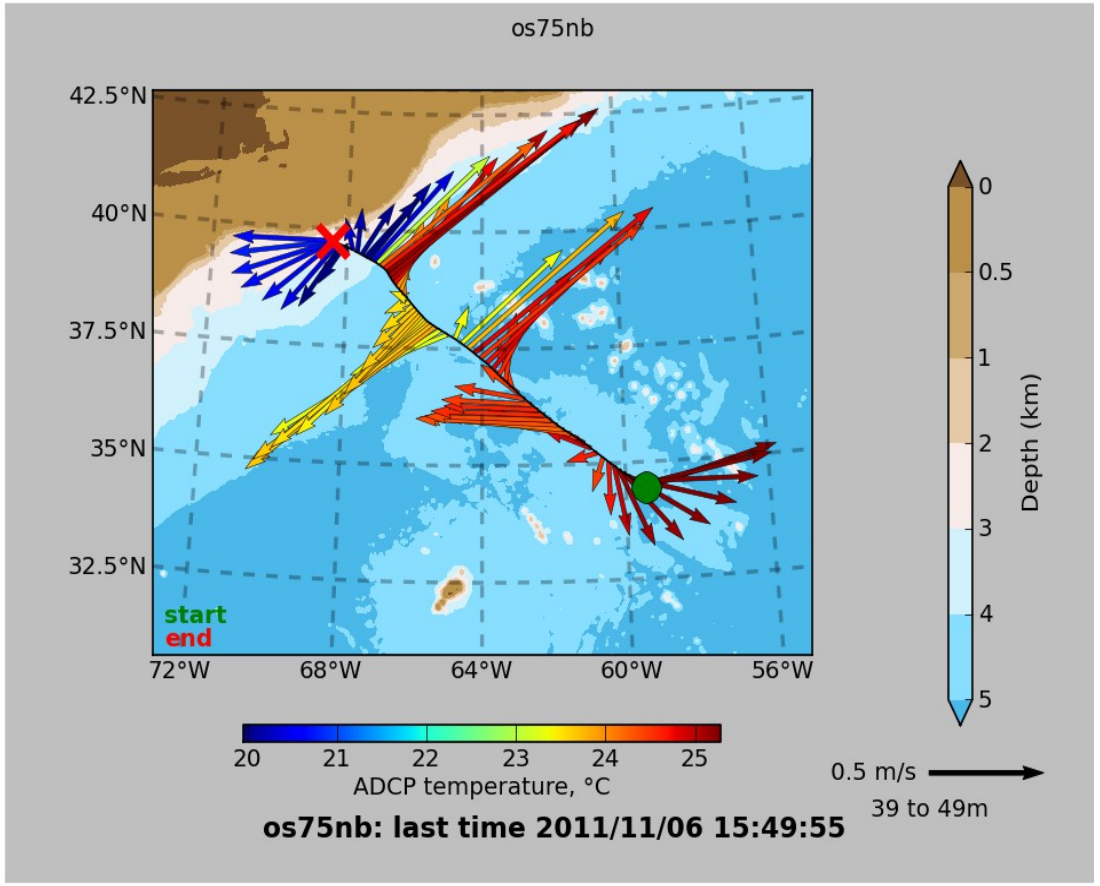
UHDAS + CODAS Documentation

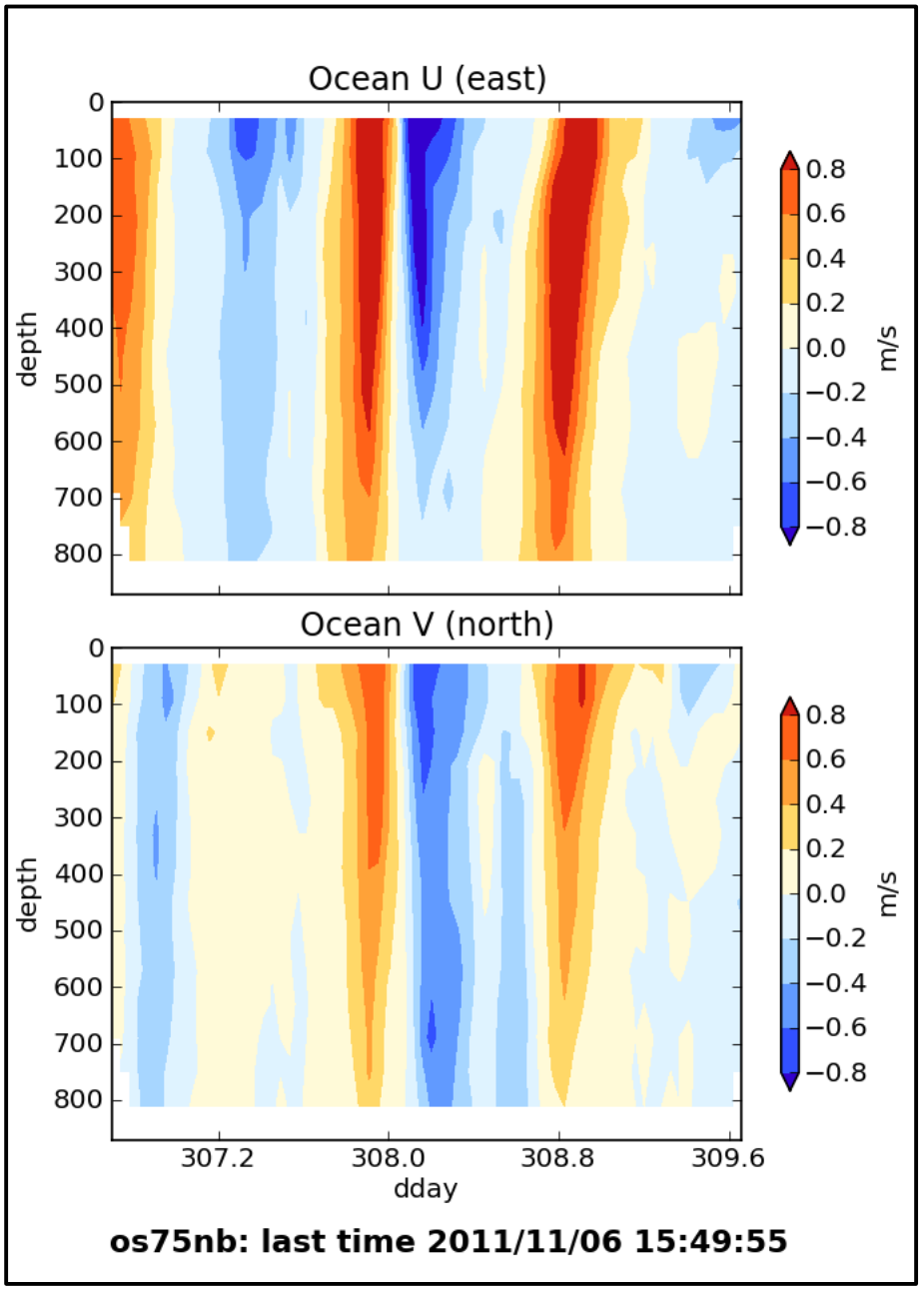
http://currents.soest.hawaii.edu/docs/adcp_doc/index.html

The Goal: science-ready ocean currents

Time, ADCP, Position, Attitude

primitive (raw) data





Outline

1. ADCP Data Acquisition
   - what is “ADCP data acquisition”
   - compare: VmDAS⬌UHDAS
2. Getting Ocean Currents from ADCP
3. CODAS Processing
   - single-ping processing
   - post-processing
4. Diagnosing Problems (examples)

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DATA ACQUISITION

Time, ADCP, Position, Attitude

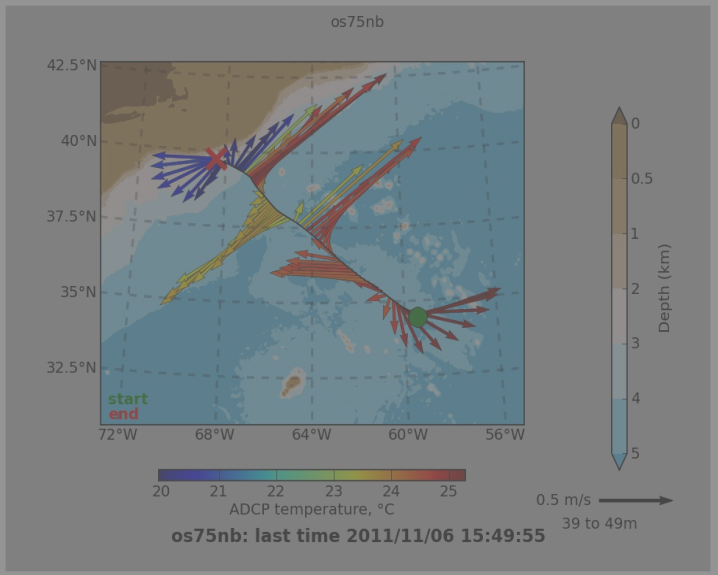
primitive (raw) data

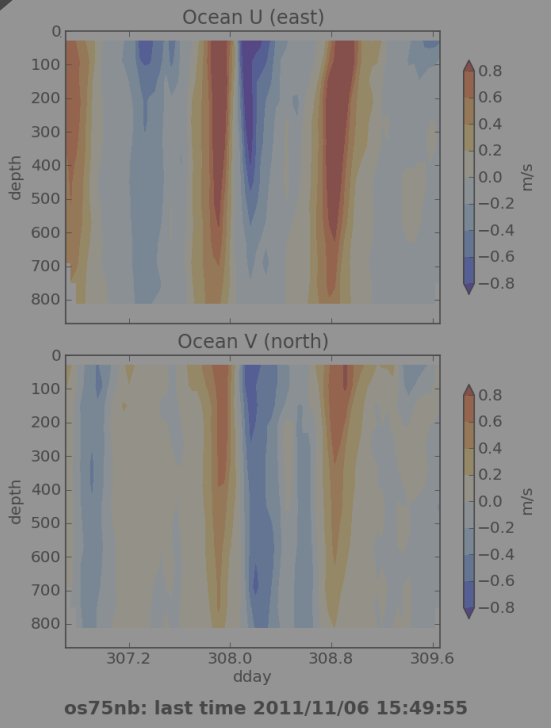
Time
ADCP
Position
Heading

Timestamp, Write to disk

DATA PROCESSING

(Data Products)
(Visualization)





ADCP Acquisition Systems

There are two acquisition systems for vessel-mounted ADCPs:

- **VmDAS** (provided with purchase)
- **UHDAS** (developed at Univ Hawaii)

} TRDI ADCPs

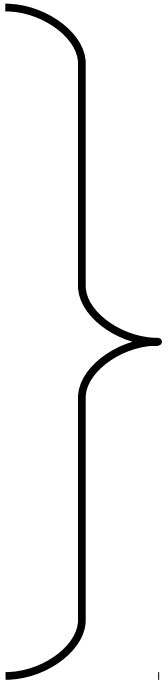
  - Installed on UNOLS ships, most NOAA ships, +7 more
  - Link to UHDAS **Table of ships**

Components – Overview:

- Basic requirements
- Processing
- Monitoring

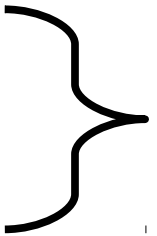
ADCP Acquisition Systems: Overview

- Basic requirements:
  - Control ADCP settings
  - Acquire ADCP data
  - Acquire ancillary data
    - Position
    - Attitude (heading)
  - Timestamp all



Core

- Processing
- Monitoring

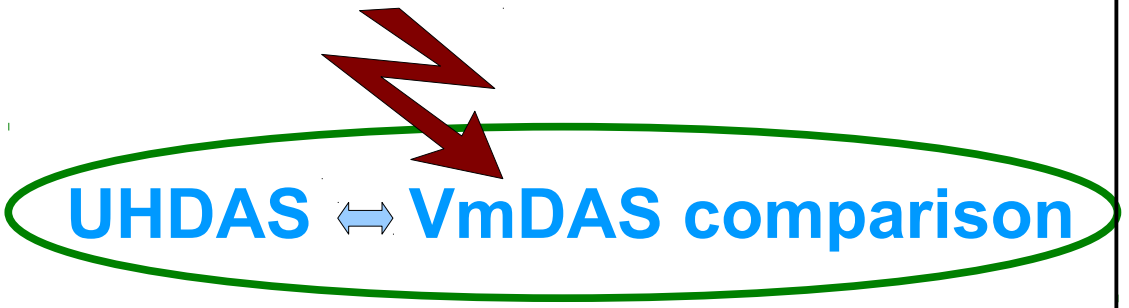


Extra

ADCP Acquisition Systems: Comparison

- Basic requirements
  - Overview
  - Serial setup
  - Data logging

Click link for more detail:



- Processing
  - Processing components
  - Accessing data products
- Monitoring

Summary of UHDAS vs VmDAS

resources: (1) PDF summary on line is here
(2) UHDAS+CODAS documentation (comparison section)

Aspect	UHDAS	VmDAS
• audience	scientists	ship, oil rig, navy
• computer	linux	windows
• software	modular	big Windows exe
• file storage	dir heirarchy	one dir w/files
• NMEA feeds (number)	any (so far, 5)	up to 3
• ADCPs (number)	any (so far, 3)	1 per computer
• ocean currents	CODAS	simple averages
• monitoring (cruise)		
• - at sea	local web site	PC monitor
• - on land	from emails to UH	---
• data after cruise	CODAS post-processing	---

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ADCP: what is it?

Acoustic (it pings along beams at a frequency)

Doppler (uses frequency shift to get velocity along the beam)

Current (include many more steps to get ocean velocity)

Profiler (listen for the return in small chunks of time to create a vertical profile)

ADCP: obtaining ocean currents

- **A**coustic **D**oppler **C**urrent **P**rofiler (shipboard)
- 4-beams, Doppler shifted currents as ship moves
- To obtain ocean currents:

  (1) transform beam coordinates into instrument coordinates

  (2) rotate horizontal velocities into ship coordinates using transducer angle in the hull (EA command for VmDAS)

  (3) rotate velocities on ship to North (using heading)

  - yields measured velocities in Earth coordinates

  (4) remove ship's speed using positions

- link to diagrams

ADCP:

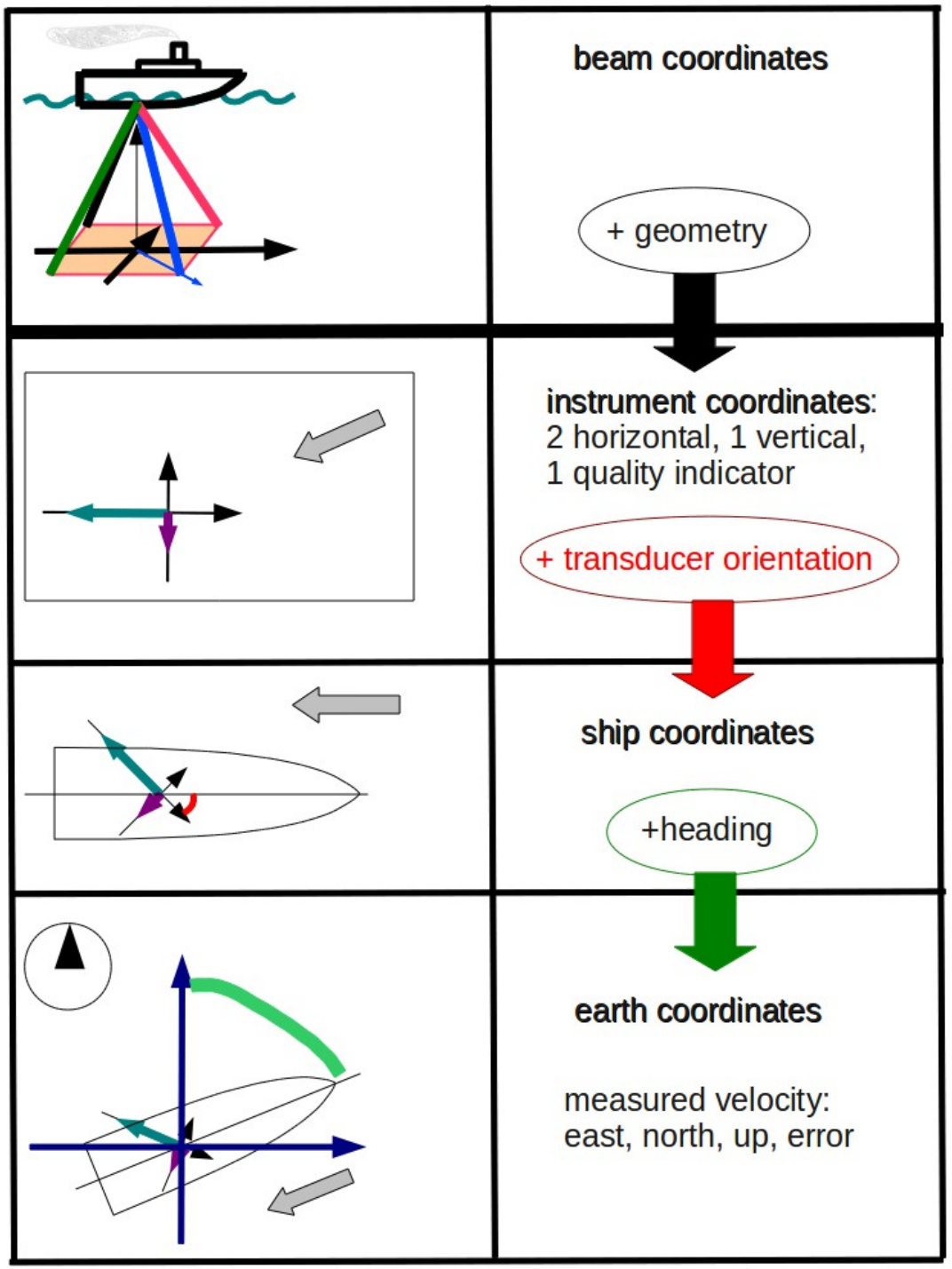
Getting Ocean Currents

Summary of steps:

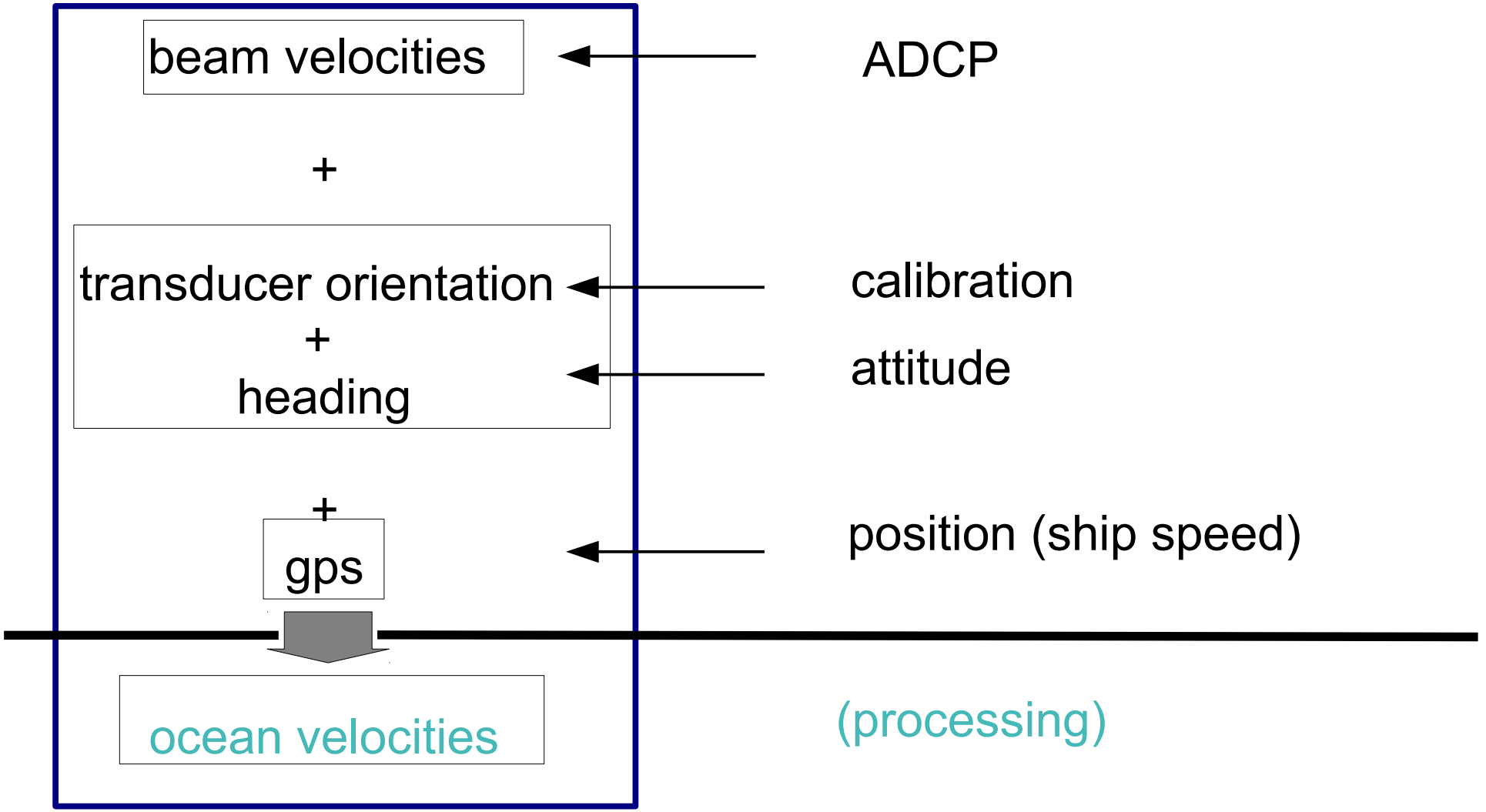
Doppler to beam
(not shown)

<u>below here: horizontal+vertical</u>

- beam to instrument
- instrument to ship
- ship to earth



ADCP: Data components



Overview: Matching UHDAS and VmDAS Components

Category	UHDAS	VMDAS
Acquisition	see	next
Logfiles Settings		page
Transformations Averaging	see	2nd
Preliminary processing Monitoring		page

Data flow: acquisition

task	UHDAS	VmDAS
• talk to instrument	DAS.py	vmdas.exe
• timestamps + write to disk:		
- ADCP(s)	raw/adcp/*.raw	*.ENR
- NMEA (serial, udp)	raw/serial/*.msg	*N1R, N2R, N3R
• write intermediate files	rbin/serial/*.rbin	
• correct the timestamps:		
- write lookup table	gbin /ztimefit.txt :	
- write ADCP data again		*ENS
• write logfiles	raw/log/*	*.LOG
• note settings	raw/config	*.VMO

Data flow: editing + averaging + calibration = preliminary processing

task	UHDAS	VmDAS
• transform to earth:	(in memory)	*.ENX
• create averages:		
- **edit single-ping earth data**:	(in memory)	--
- average, write averages	CODAS database	*STA, *LTA
• **preliminary processing:**		
- assess calibration:	**watertrack**	
	bottomtrack	
	ADCP-GPS offset	--
• monitoring, access		
- make plots	web site on ship	PC monitor
- store plots	**- web site on ship**	--
	- processing dir	--

DATA ACQUISITION

Time, ADCP,
Position,
Attitude

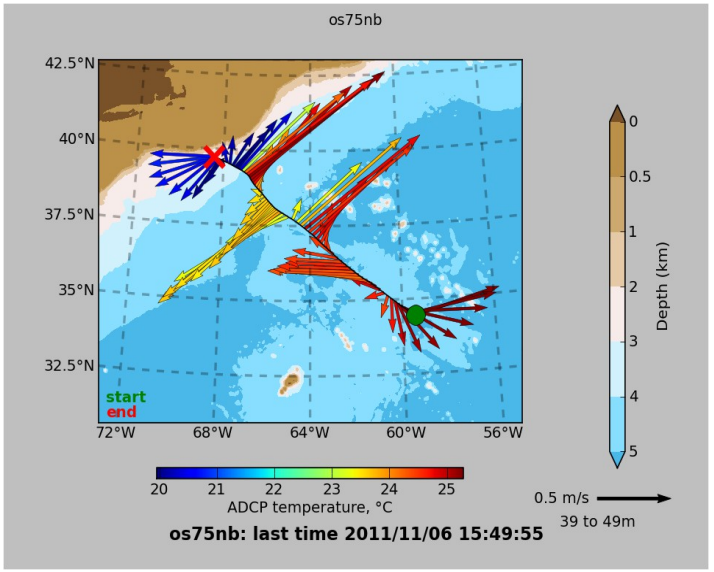
primitive (raw) data

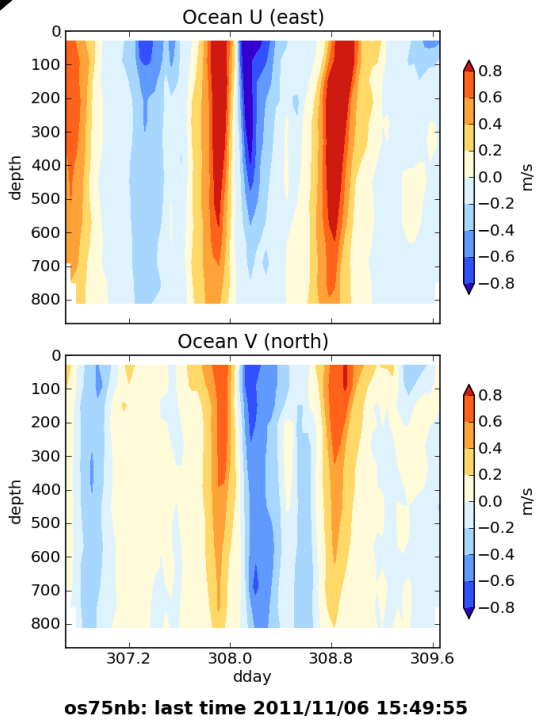
Time
ADCP
Position
Heading

Timestamp,
Write to disk

DATA PROCESSING

(Data Products)
(Visualization)





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CODAS Processing Overview

CODAS: **C**ommon **O**cean **D**ata **A**ccess **S**ystem

- Portable (multiple operating systems)
- Self-descriptive (like netCDF)
- Aggregated files (multiple files)
- Designed for ADCP data

"**CODAS Processing**" → produce ocean velocities

- Tools to access and modify CODAS files

“CODAS” ADCP Processing

Goals

- Run on multiple operating systems
  - (Windows, (*) OSX, Linux)
- Open source, free (Python)
- Flexible (tweak, tune, patch, augment)

Processing

- Written for ADCP data
- Works with most RDI ADCPs (link)
- Balance real-time product with recoverable dataset
- Single-ping (automated) and manual editing
- Calibration diagnostics and routines
- Documented

(*) via VirtualBox pre-configured Linux computer

CODAS = “**C**ommon **O**cean **D**ata **A**ccess **S**ystem”

CODAS preliminary processing: 2 flavors

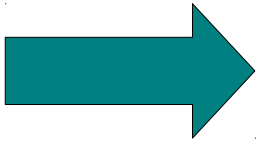
(1) **Preliminary processing single-ping data**

- beam-to-earth coordinates
- single-ping editing (acoustic interference, bottom)
- create averages; save to disk
- format averages into CODAS database

(2) **reformat pre-averaged data** into CODAS database

- 1980's PINGDATA
- VmDAS: *.LTA, *.STA

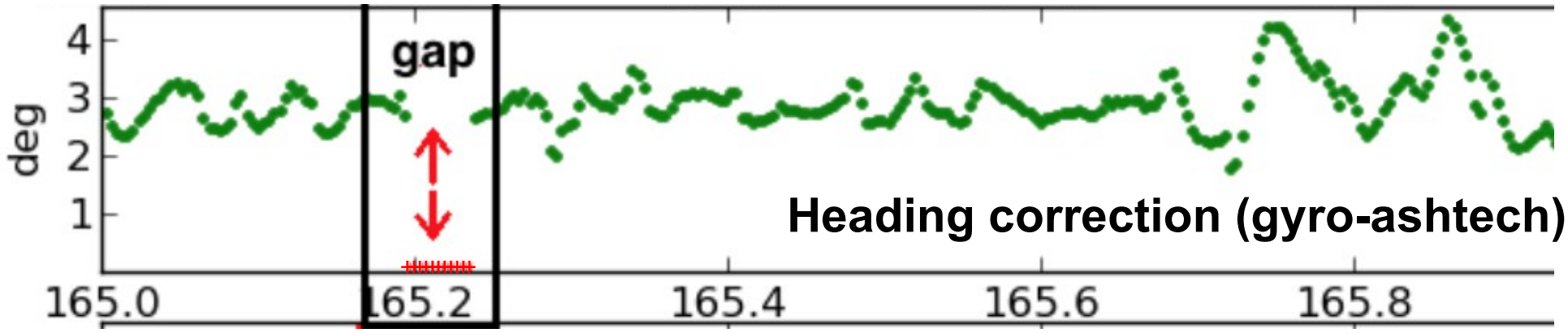
} (no single-ping editing)

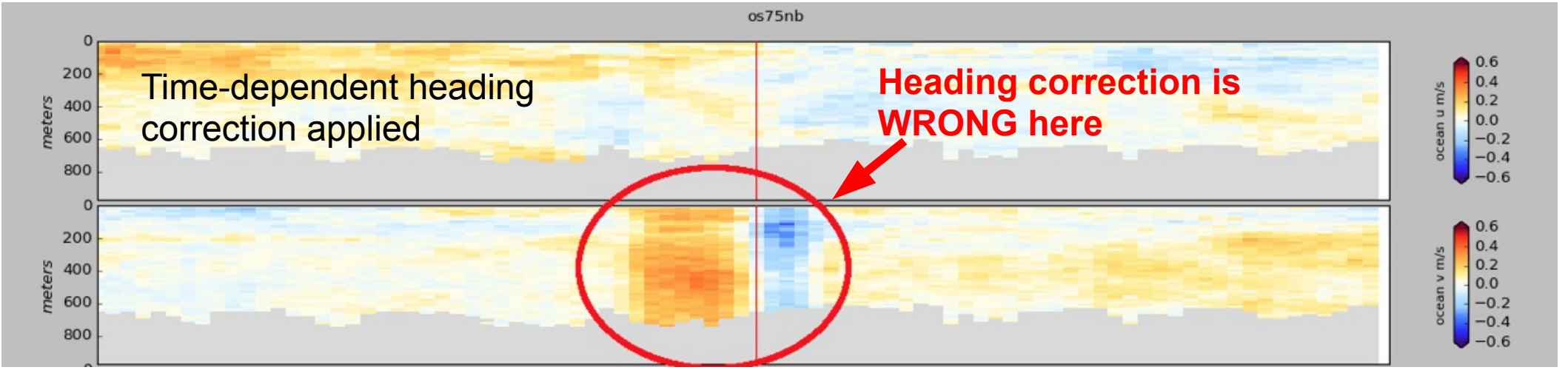


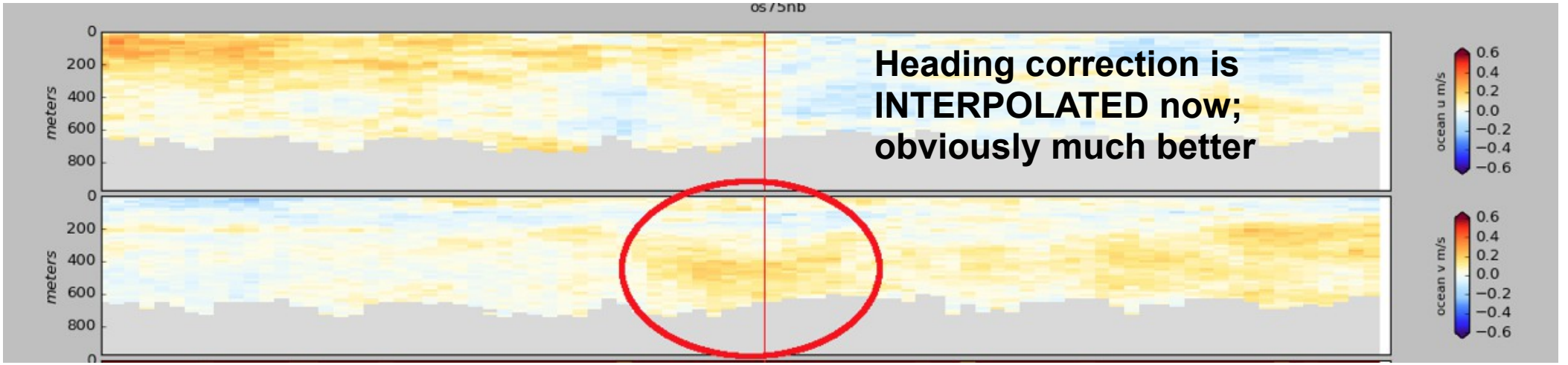
Next: "post-processing steps"

CODAS post-processing:

- View figures and logfiles
- Fix heading:
  - patch gappy but accurate heading correction (if relevant)
  - apply time-dependent heading correction
- Determine corrections/calibrations, then apply
  - remaining transducer angle offset
  - scale factor (if relevant)
  - transducer-GPS offset (in meters)
- Manually edit out bad data (dataviewer.py)
  - use thresholds for bulk editing
  - graphically select bins or profiles; use Seabed Selector for bottom
- check calibrations
- make figures (web page) export data (matlab, netCDF)


gap
deg
4
3
2
1
165.0
165.2
165.4
165.6
165.8
Heading correction (gyro-ashtech)


os75nb
Time-dependent heading correction applied
Heading correction is WRONG here
meters
ocean u m/s
ocean v m/s


os75nb
Heading correction is INTERPOLATED now; obviously much better
meters
ocean u m/s
ocean v m/s

CODAS software tools:

Codas Averages

- Starting point for Preliminary Processing: adcp_database_maker.py
- Visualizing, editing, or comparing CODAS averages: dataviewer.py

Tools for or raw (single-ping) ADCP data:

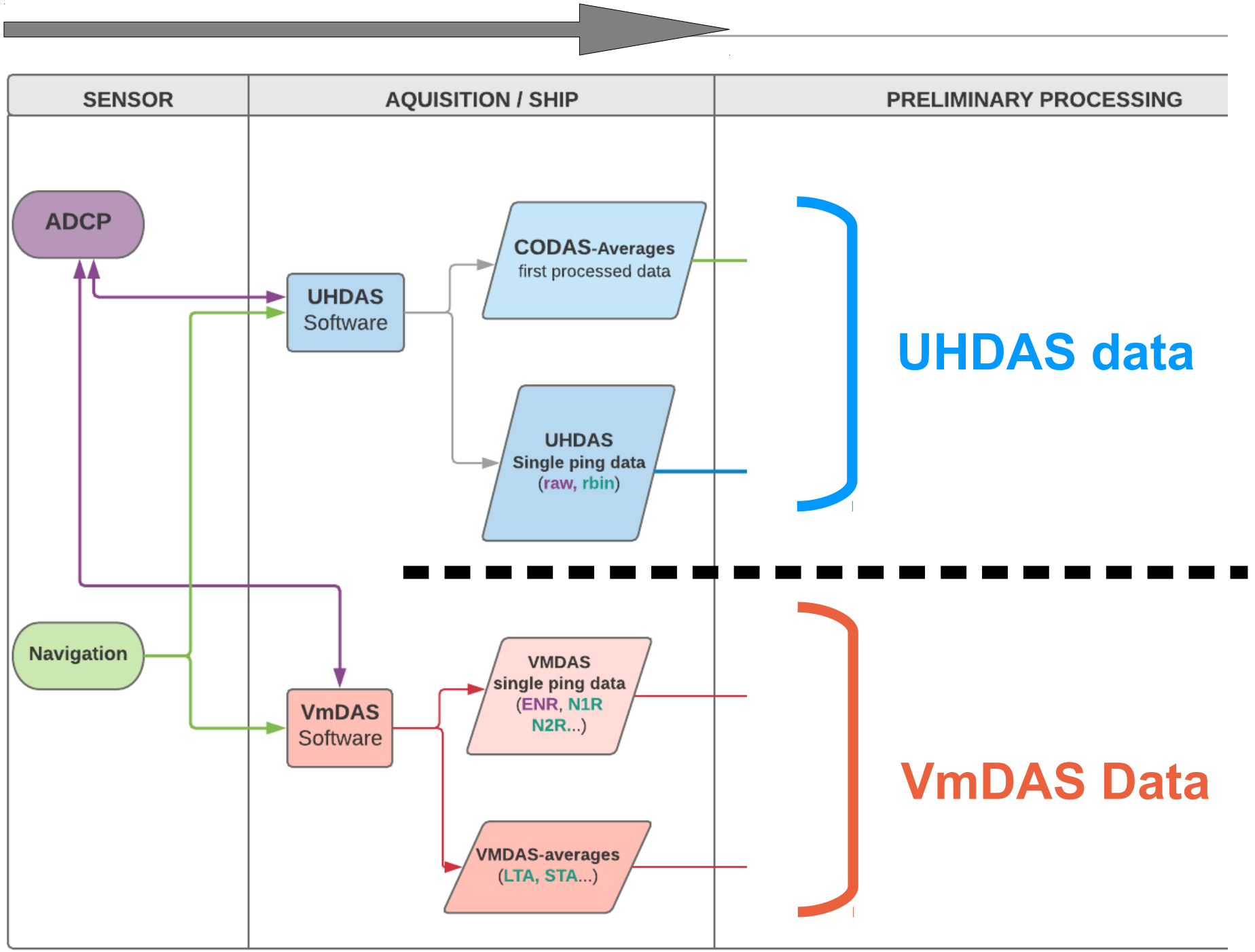
- visualization of beam values : RSSI (signal return) or velocity
- estimate EA (transducer angle)

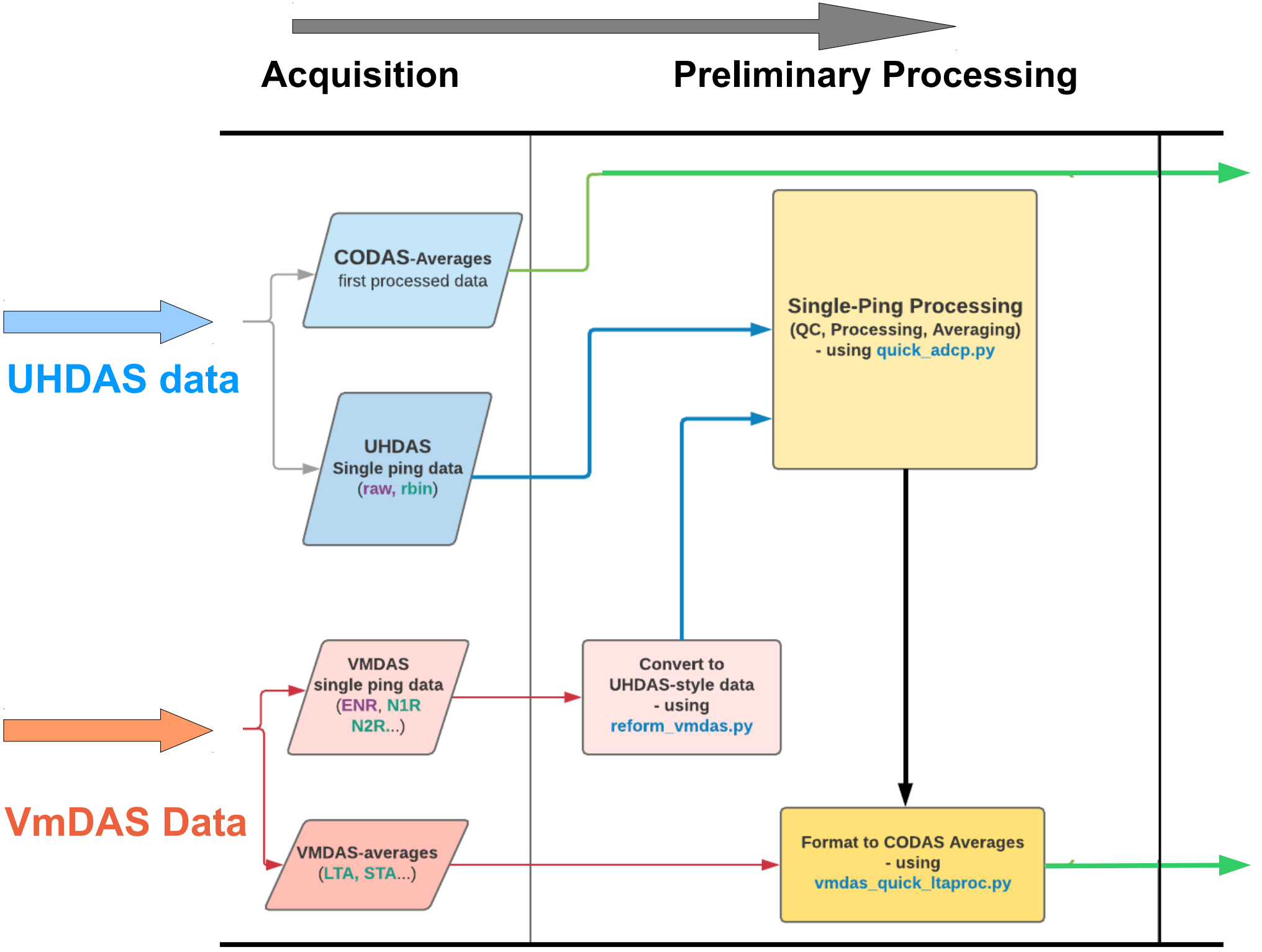
RDI ADCPs

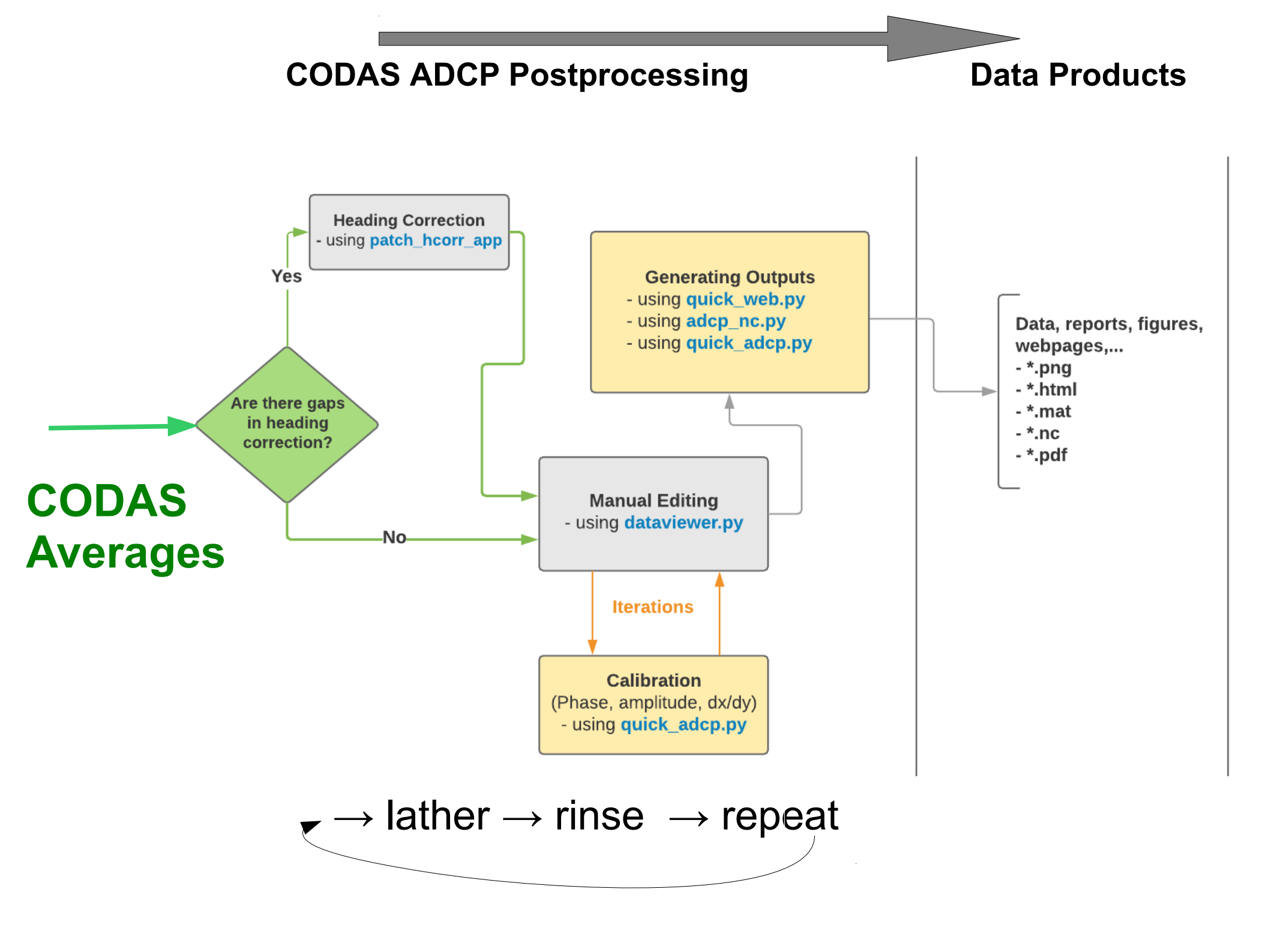
- conversion of NMEA strings to “rbin” data files
- tools to plot rbin data:
  - plot POSMV quality
  - plot navigation over topography
  - plot one (or compare two) rbin data streams

UHDAS data products

Sensors and Data Acquisition




Acquisition
Preliminary Processing
UHDAS data
VmDAS Data
CODAS-Averages
first processed data
UHDAS
Single ping data
(raw, rbin)
VMDAS
single ping data
(ENR, N1R
N2R...)
VMDAS-averages
(LTA, STA...)
Single-Ping Processing
(QC, Processing, Averaging)
- using quick_adcp.py
Convert to
UHDAS-style data
- using
reform_vmdas.py
Format to CODAS Averages
- using
vmdas_quick_ltaproc.py


CODAS ADCP Postprocessing
Data Products
Heading Correction
- using patch_hcorr_app
Yes
Are there gaps in heading correction?
No
Manual Editing
- using dataviewer.py
Iterations
Calibration
(Phase, amplitude, dx/dy)
- using quick_adcp.py
Generating Outputs
- using quick_web.py
- using adcp_nc.py
- using quick_adcp.py
Data, reports, figures, webpages,...
- *.png
- *.html
- *.mat
- *.nc
- *.pdf
CODAS Averages
→ lather → rinse → repeat

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CODAS Processing

- Editing (single-ping)
  - Acoustic interference
  - Bubbles
  - Below bottom

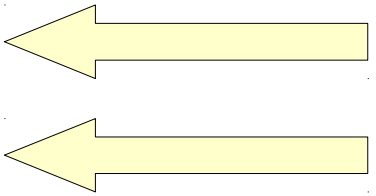
BEFORE AVERAGING

- Editing CODAS database averages "gee-autoedit"
- Interpolate missing heading correction
- Apply calibrations
  - Scale factor
  - Rotation
  - Transducer offset (uncommon/experimental)

ADCP Single-ping Editing

The most common causes of error
(addressed by single-ping editing)

- Acoustic Interference
- Bubbles
- Below bottom



Both tend to cause bias towards zero
in measured velocity

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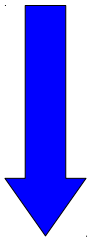
CODAS Post-processing

- Editing (single-ping)
  - Acoustic interference
  - Bubbles
  - Below bottom

AFTER AVERAGING



- Fix time-dependent heading correction (eg. if gaps)
- Apply calibrations
  - Rotation
  - Scale factor
  - Horizontal offset between GPS and ADCP (new)
- Manually edit CODAS database averages

Post-Processing: Calibration of Averaged Data

(1) Cross-track error (angle error)

- Inaccurate heading (time-varying)
- Incorrect transducer angle (constant)

(2) Alongtrack bias (scale factor)

- Soundspeed (single-ceramic transducers only)

(3) Transition Error

- Horizontal offset between GPS and ADCP

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Top “10” ways to damage ADCP data

These next examples describe problems with the ADCP beam velocity data itself.

They do not involve position, heading, or ship speed.

Top 10 ways to damage ADCP data

Problem: one beam fails

- Symptom: Velocities will not exist
- Solution: Short term:
  - use “3-beam solutions” or disable that beam
- Solution: Long Term
  - Fix the instrument

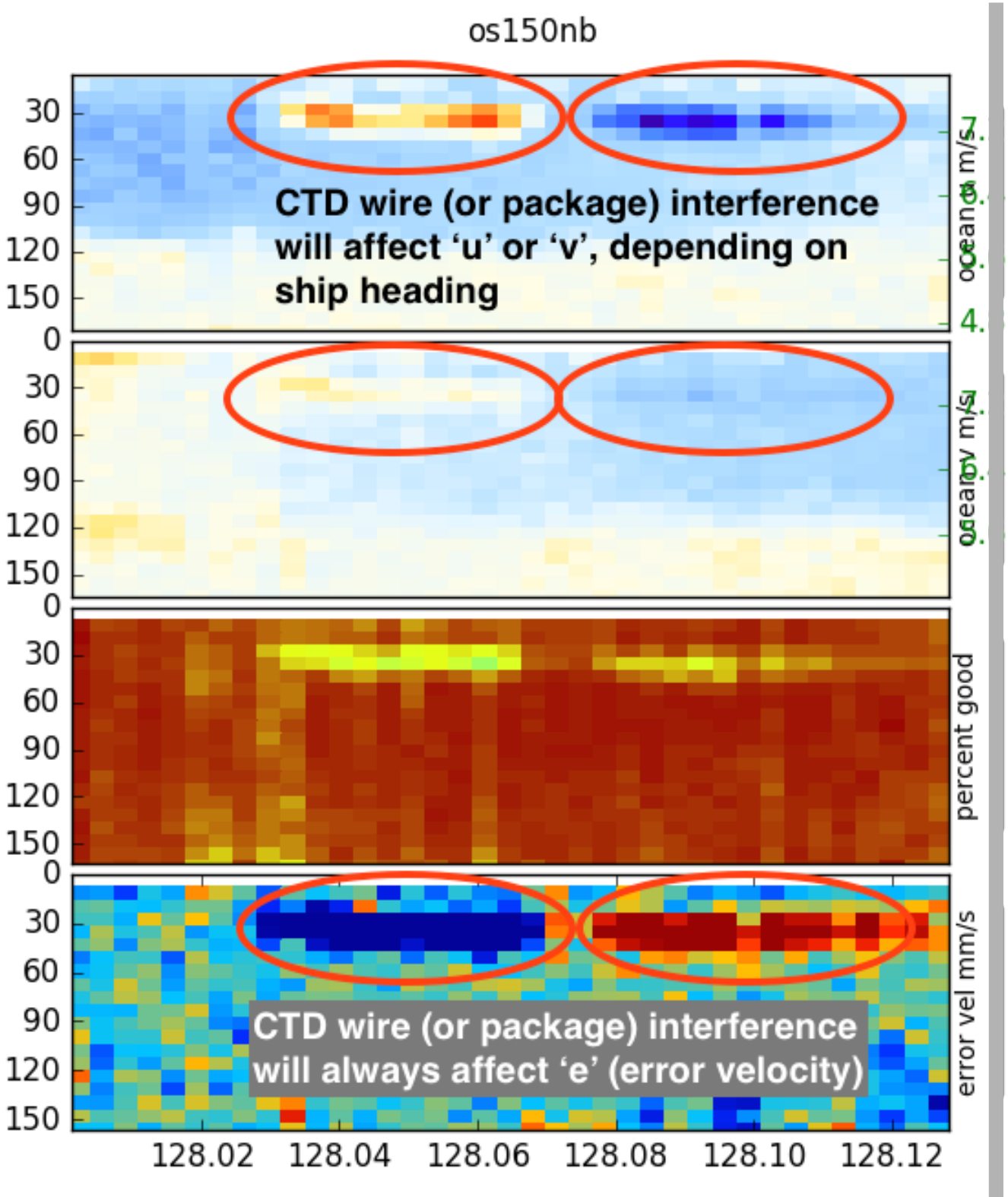
Top 10 ways to damage ADCP data

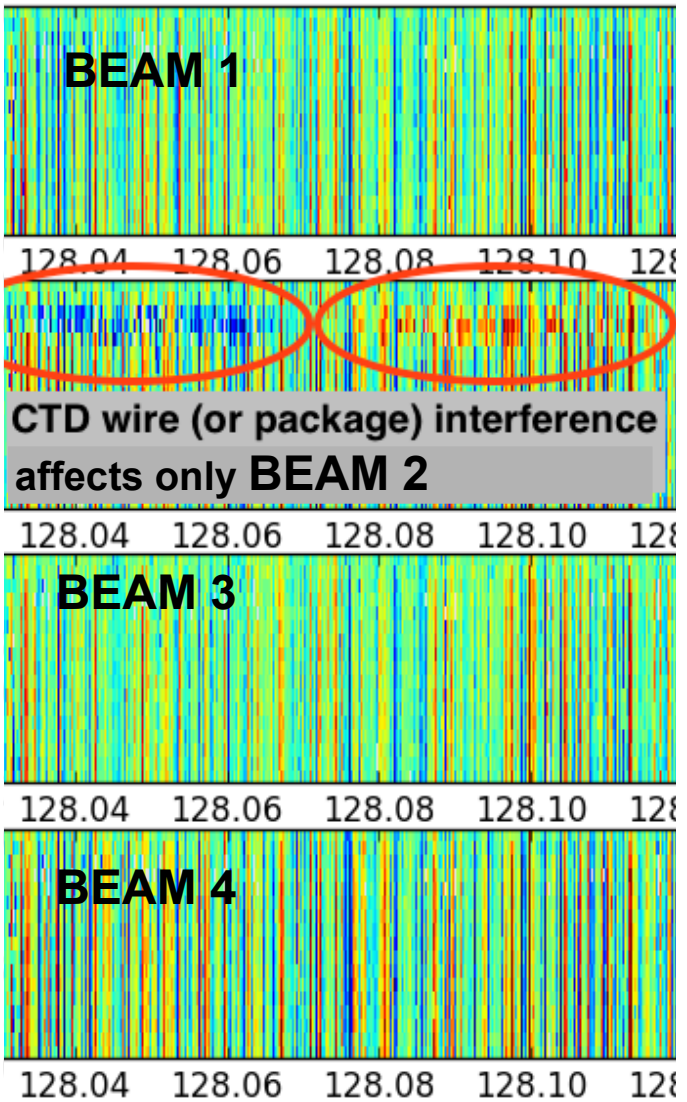
Problem: one beam is impacted by a physical object

- Symptom: Velocities are damaged in specific bins
- Solution: Short term:
  - edit those beams (using Error Velocity threshold)
- Solution: Long Term
  - check: can the transducer can be rotated?

    (so the wire misses the beams)

CTD wire interference





Top 10 ways to damage ADCP data

Problem: incorrect soundspeed at transducer face

- Symptom:
  - along-track bias when ship is underway
- Solution: Short term:
  - apply scale factor in post-processing
- Solution: Long Term
  - if freshwater, set ES0 in the acquisition
  - if Propylene Glycol, get soundspeed probe

NOTE: This only affects ceramic transducer faces

eg. WH300 or BB75

Calibration: scale factor (alongtrack bias)

Ocean U (original)

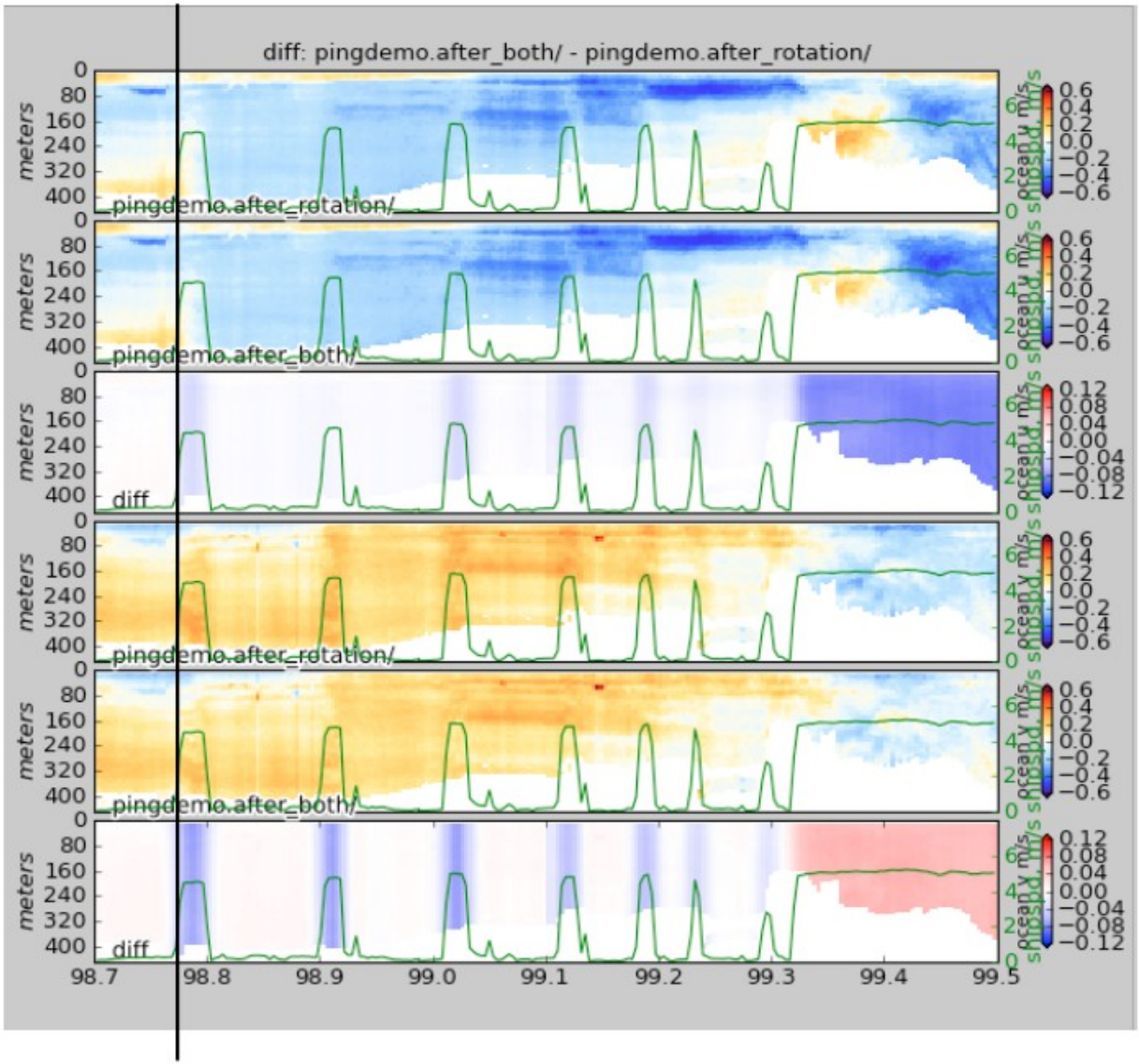
Ocean U (after scalefactor)

Diff: after-before

Ocean V (original)

Ocean V (after scalefactor)

Diff: after-before



Top 10 ways to damage ADCP data

eg. 20kts

Problem: Fast ship, EA is wrong **“ambiguity wrap”**

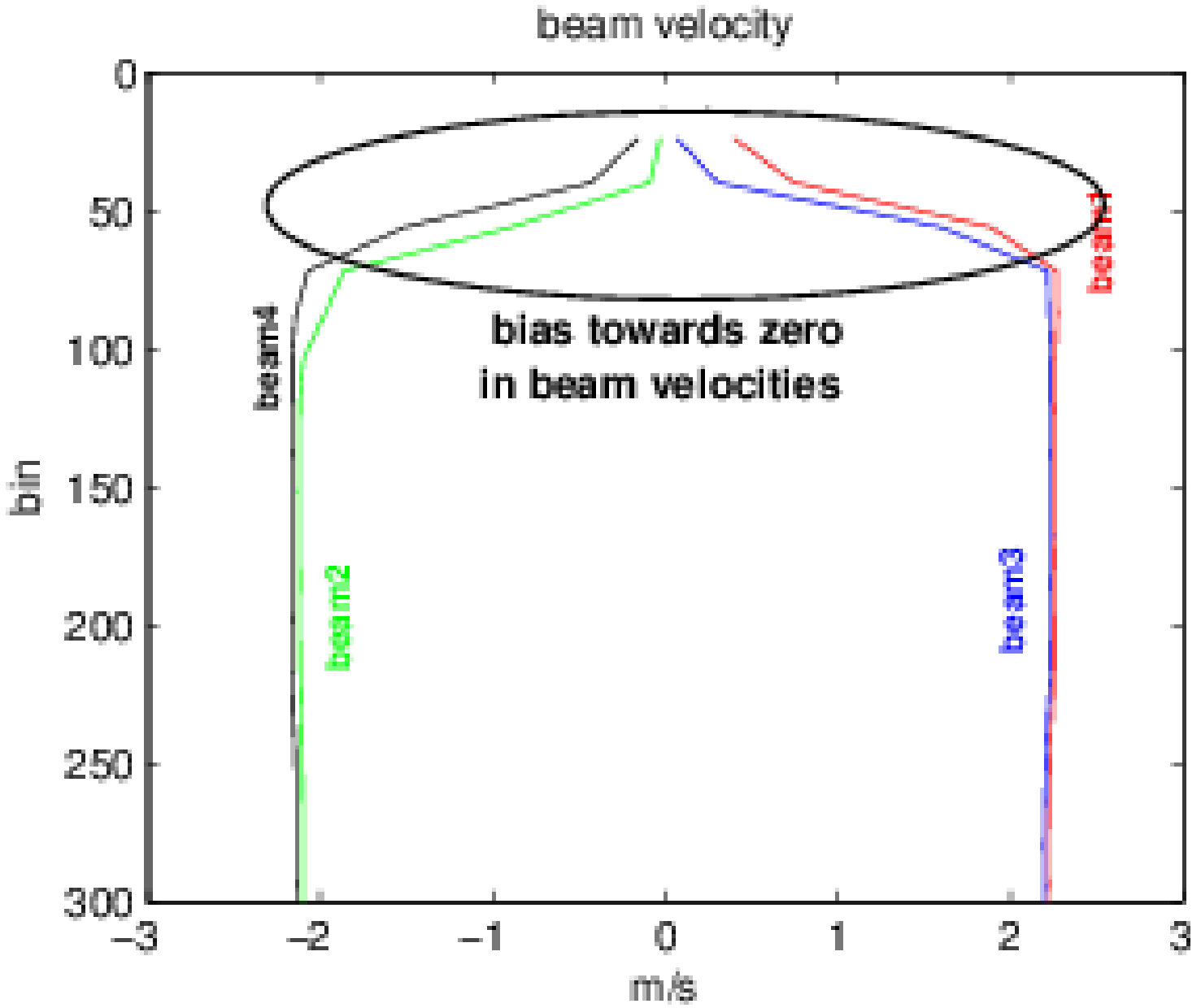
- Symptom:
  - Velocities disappear above some ship speed
  - beam velocities have good range (so it's not bubbles)
  - beam velocities “cross over” above some speed
- Solution: Short term:
  - There is no solution already coded
- Solution: Long Term:
  - Fix the EA in the software
  - Might need to also rotate the transducer (45deg)

Top 10 ways to damage ADCP data

Problem: ringing (shallow velocities biased to zero)

- Symptom:
  - Beam velocities biased towards zero near the surface
  - Ocean velocity biased in the direction of ship's motion
- Solution: Short term:
  - Increase blanking interval
- Solution: Long Term:
  - install foam in the transducer well
  - remove the window

Ringing: top bins biased towards zero

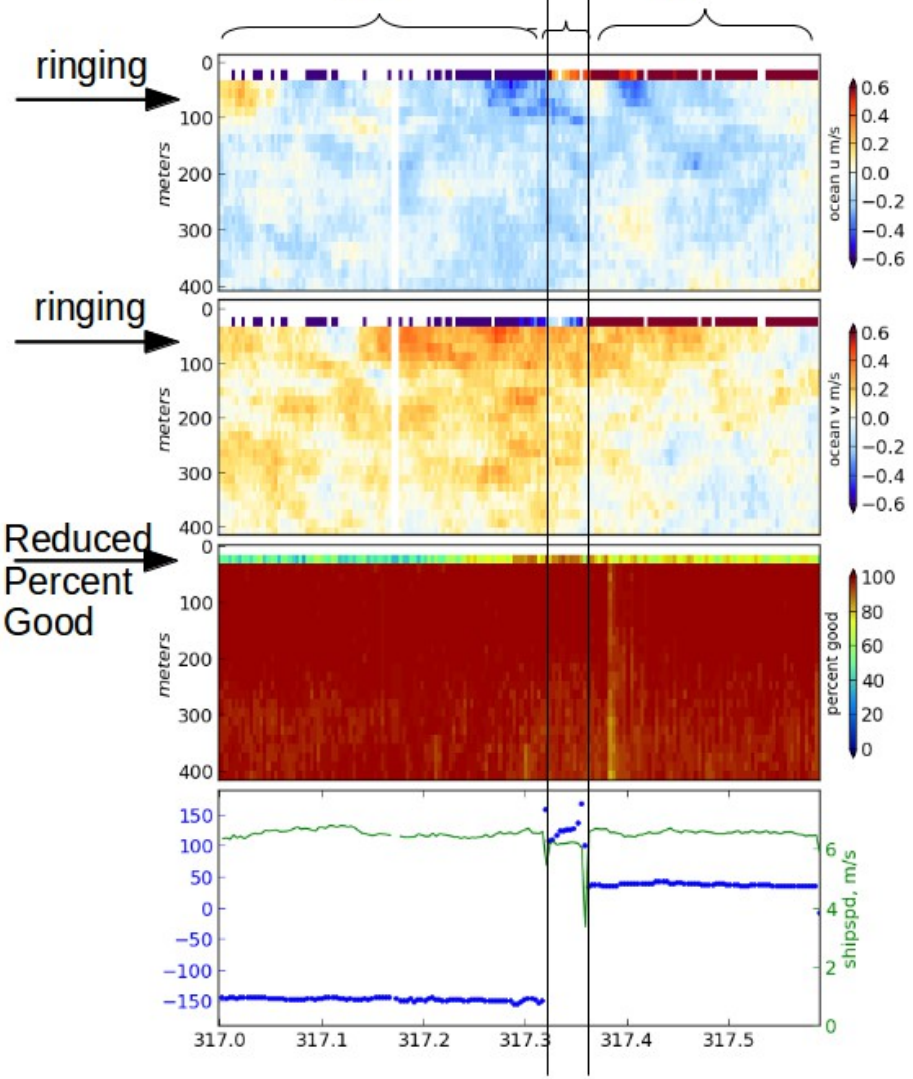


Ringing

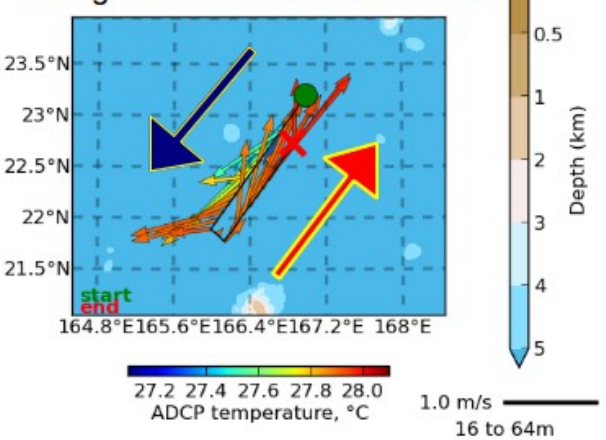
Ringing usually contaminates the top bin or two, and is most obvious when the ship is moving. The bias in the ocean velocities is in the direction of motion, because the ringing contaminates the **top bins** towards zero.

Ship going southwest
Bias is southwest

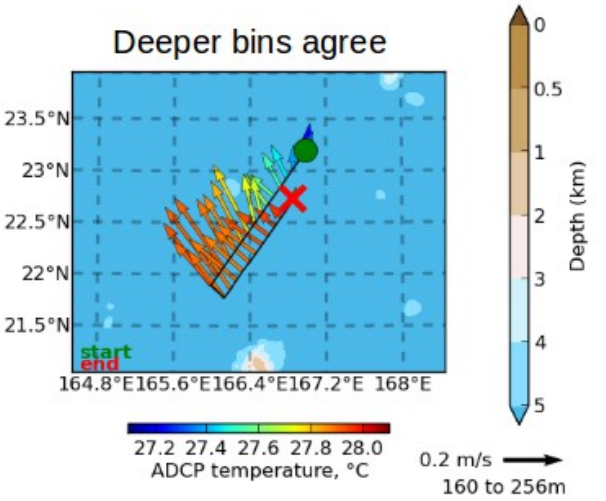
Ship going northeast
Bias is northeast



Alongtrack bias in shallow bins



Deeper bins agree

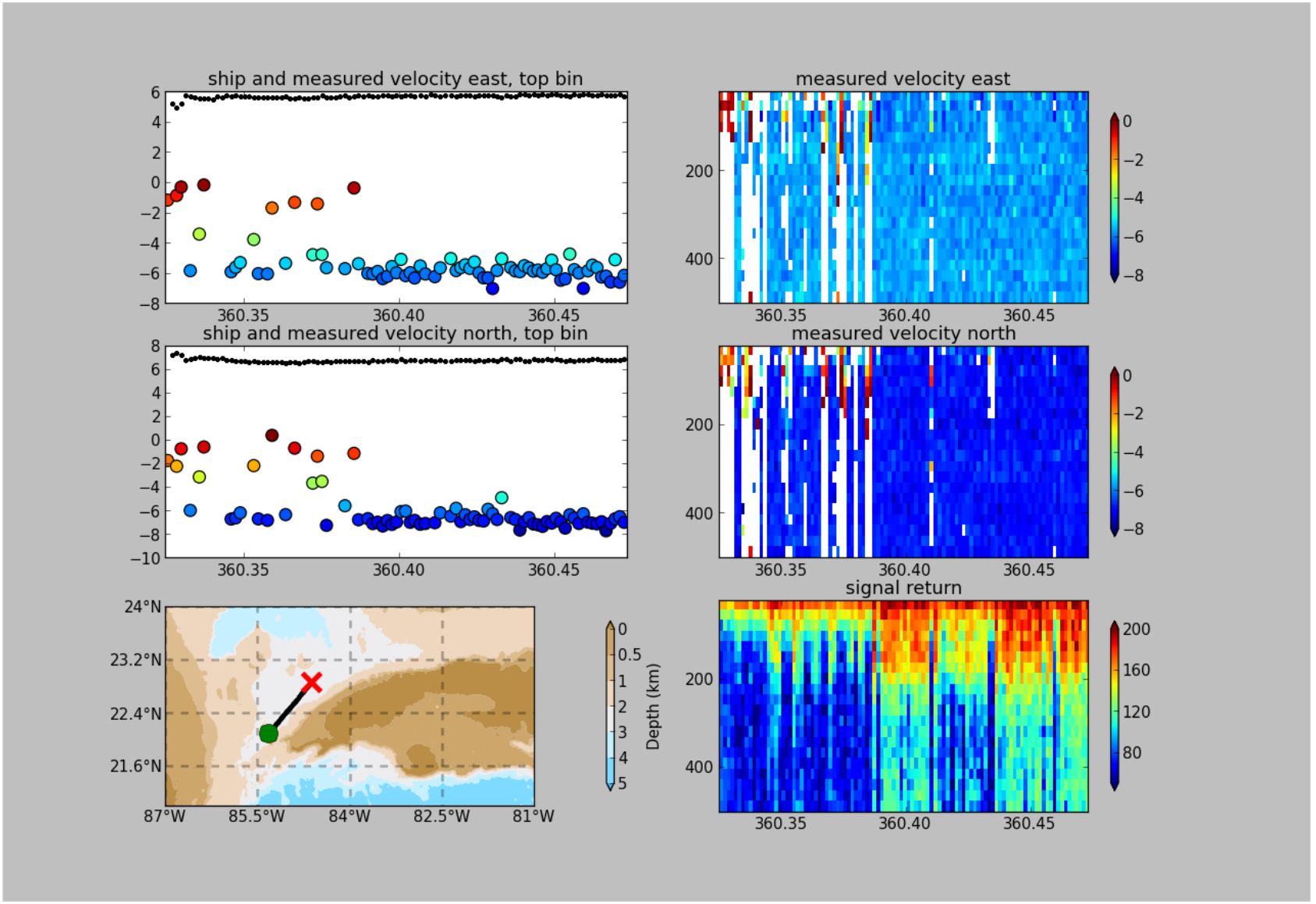


Top 10 ways to damage ADCP data

Problem: bubbles block sound, distort shallow bins

- Symptom:
  - Beam velocities biased towards zero near the surface
  - Ocean velocity biased in the direction of ship's motion
  - range is less, Percent Good is reduced near surface
- Solution: Short term:
  - slow down (if at sea), edit out bad data, be brutal
  - Do preliminary processing with single-ping data (editing)
- Solution: Long Term:
  - change the installation or hull; install a faring?

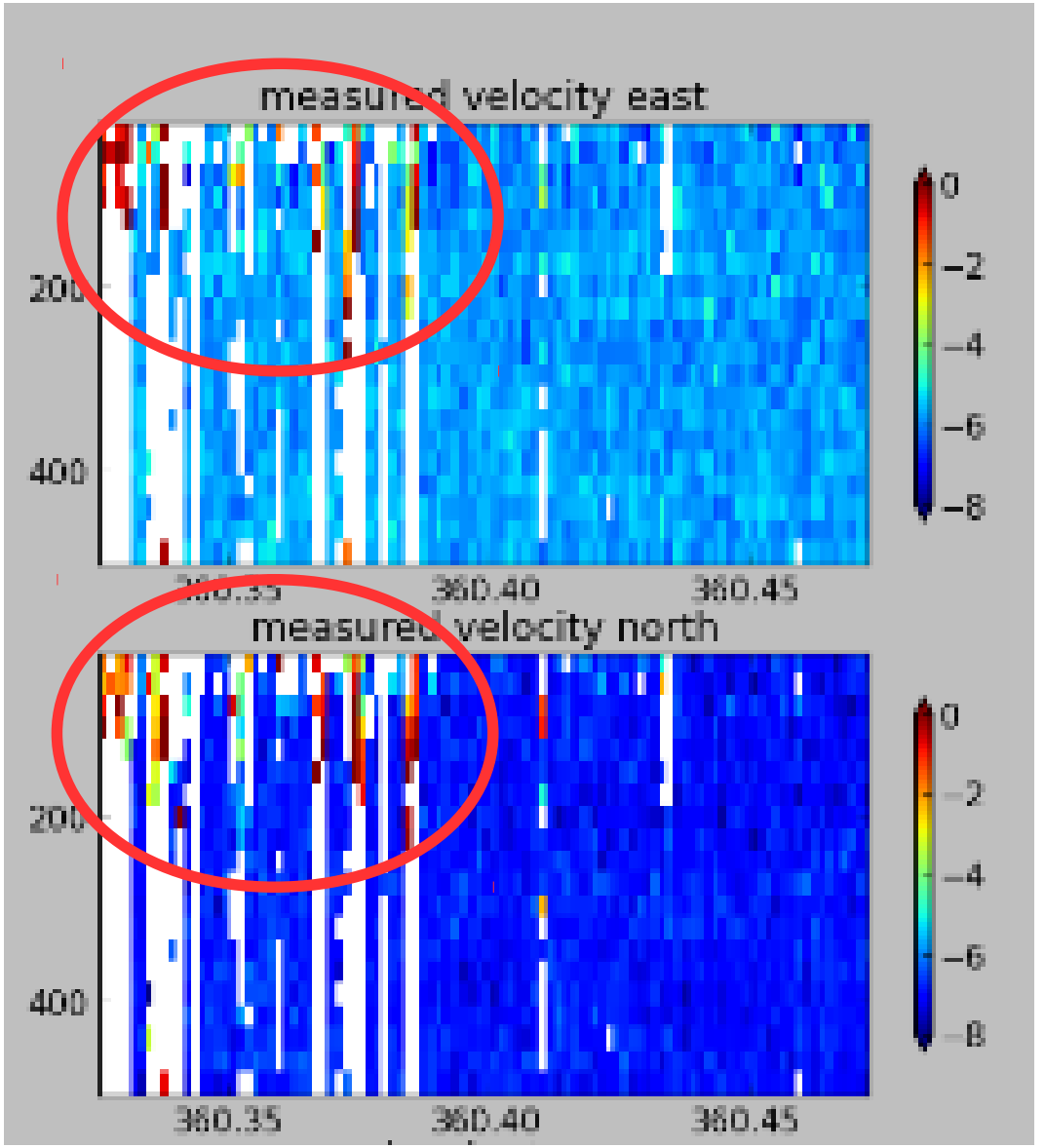
single-ping editing:underway bias



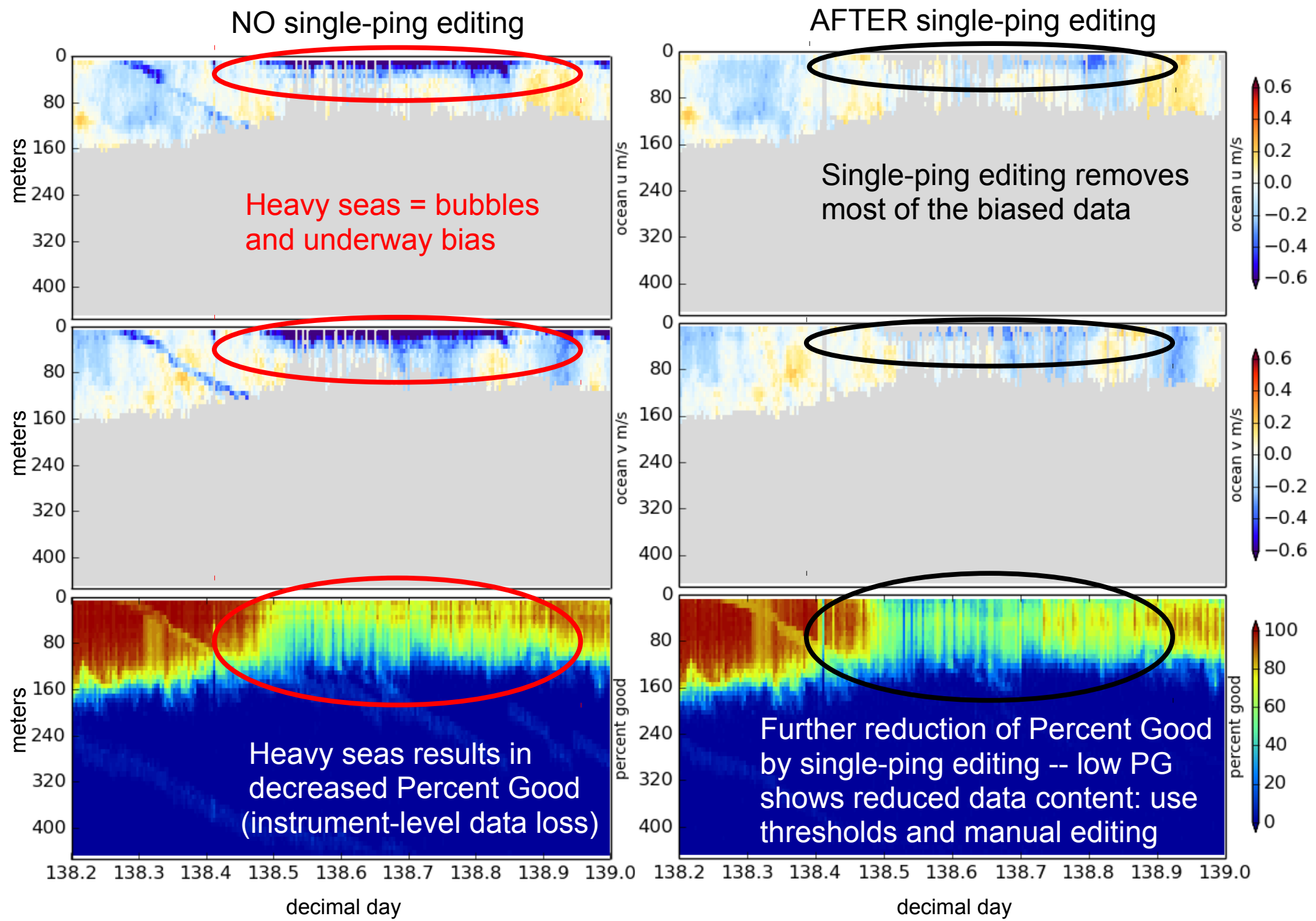
ADCP Data: effect of bubbles

Bubbles:
- short profiles
- strongly biased towards zero

Untreated:
- biased ocean velocities



Bubbles and alongtrack bias

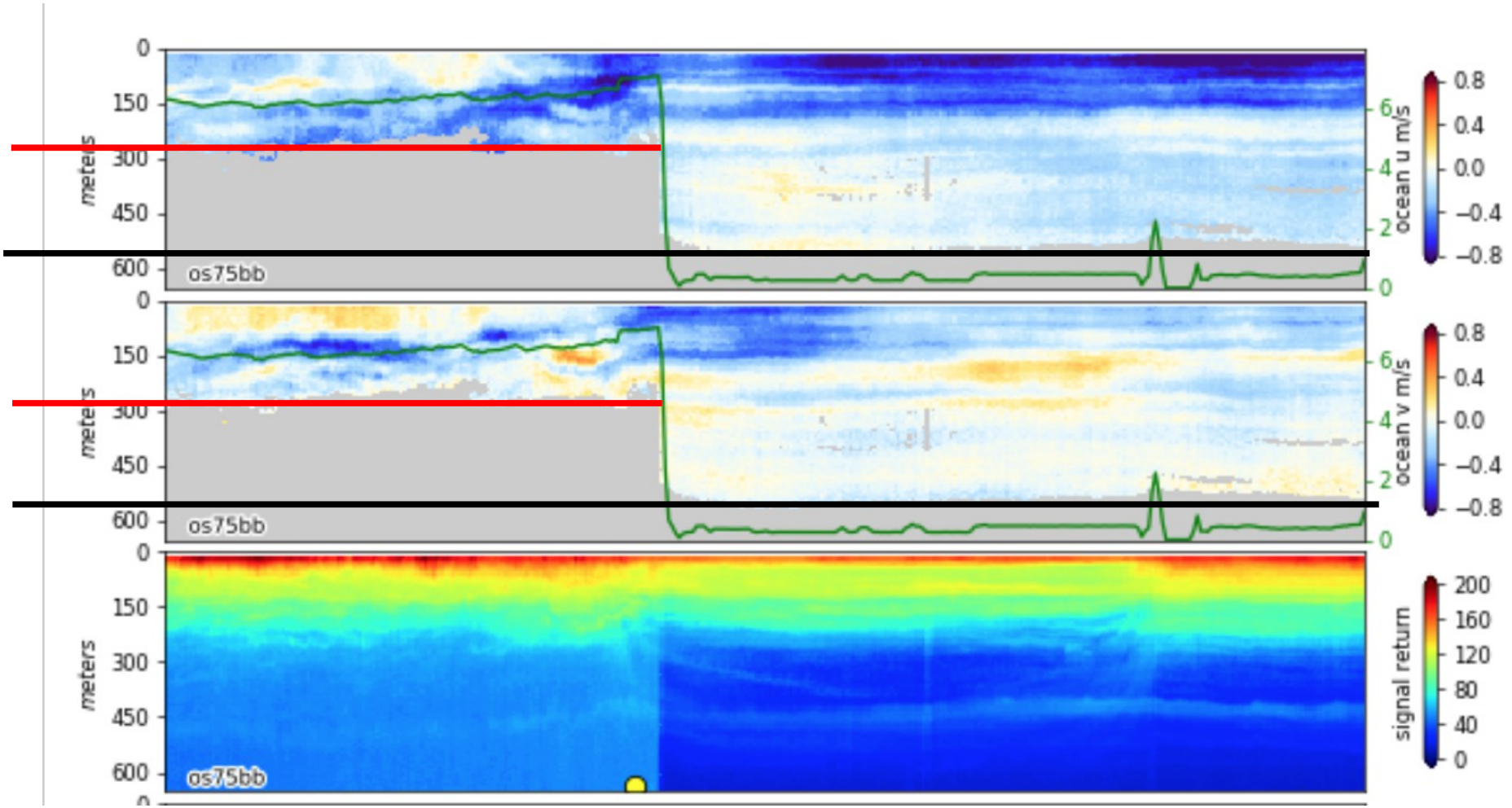


Top 10 ways to damage ADCP data

Problem: loss of range when ship is underway

- Symptom: range decreases when ship is underway
- Solution: Short term:
  - switch to narrowband mode
  - slow down
- Solution: Long Term:
  - scrub barnacles off hull and propellor
  - identify what is loud, remove it
  - redesign the hull to be quieter

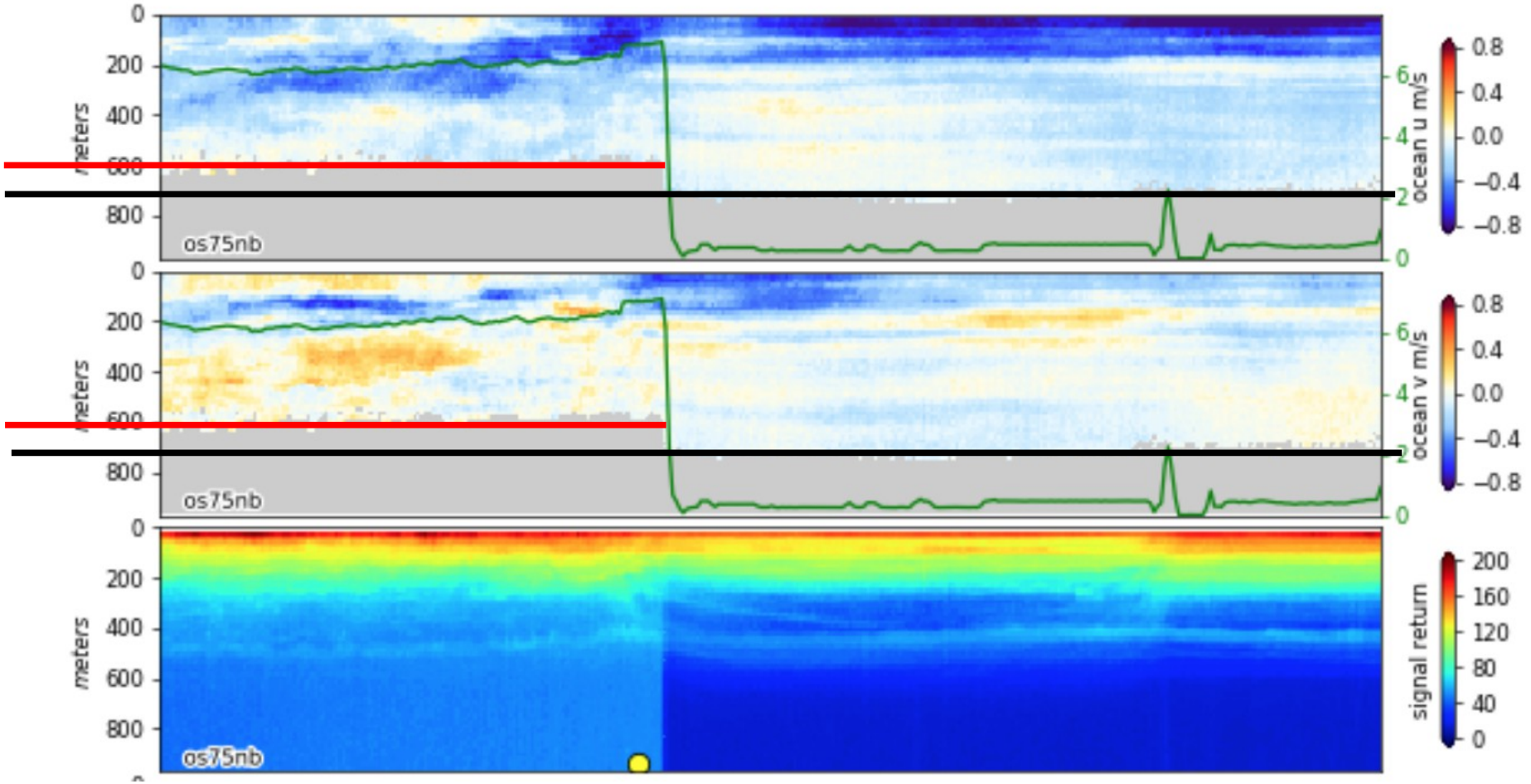
broadband mode more susceptible to loss of range (loud ship or low scattering)



~300m range when underway

~600m range when on station

narrowband mode less susceptible to loss of range (loud ship or low scattering)



~600m range when underway

~700m range when on station

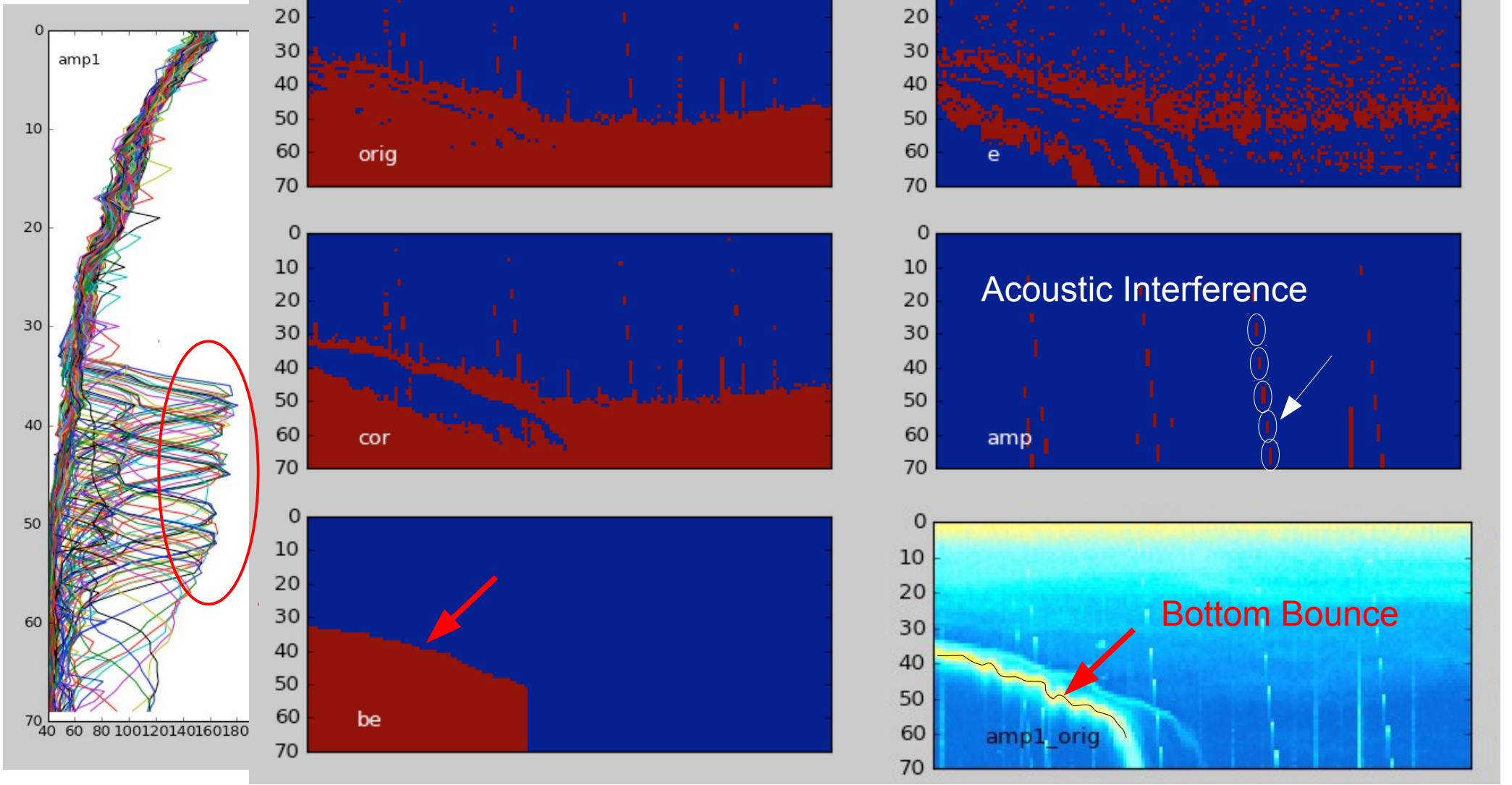
Top 10 ways to damage ADCP data

Problem: data contaminated by the bottom

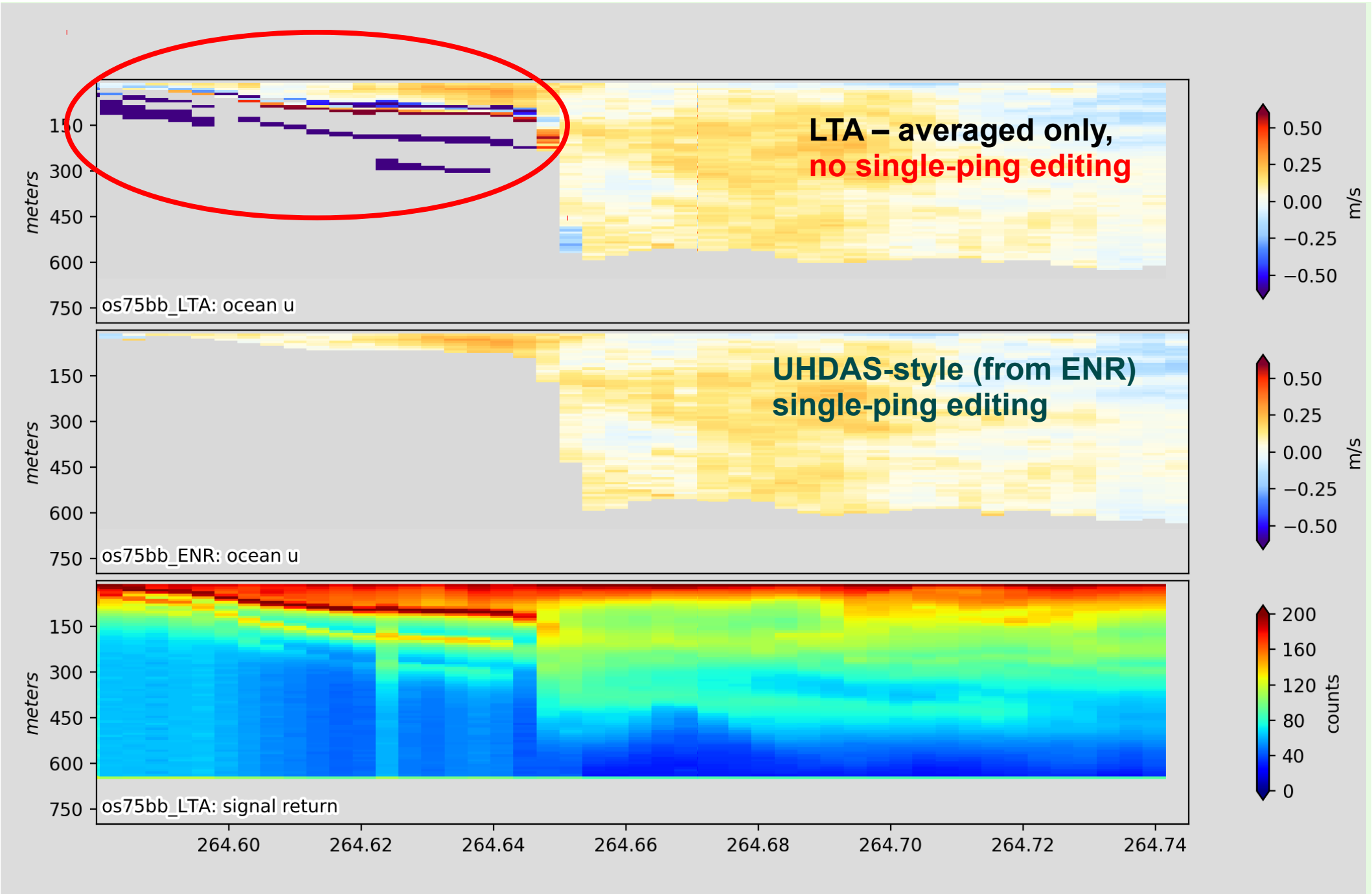
- Symptom:
  - velocity returned includes “below the bottom)
- Solution: Short term:
  - single-ping processing (or remove in post-processing)
- Solution: Long Term:
  - removal is automated in UHDAS

Bottom Editing:

- remove acoustic interference, identify maximum amplitude
- calculate region of side-lobe interference
- flag as BAD all data below the bottom or with side-lobe interference



Single-ping processing automatically identifies and removes data below the bottom



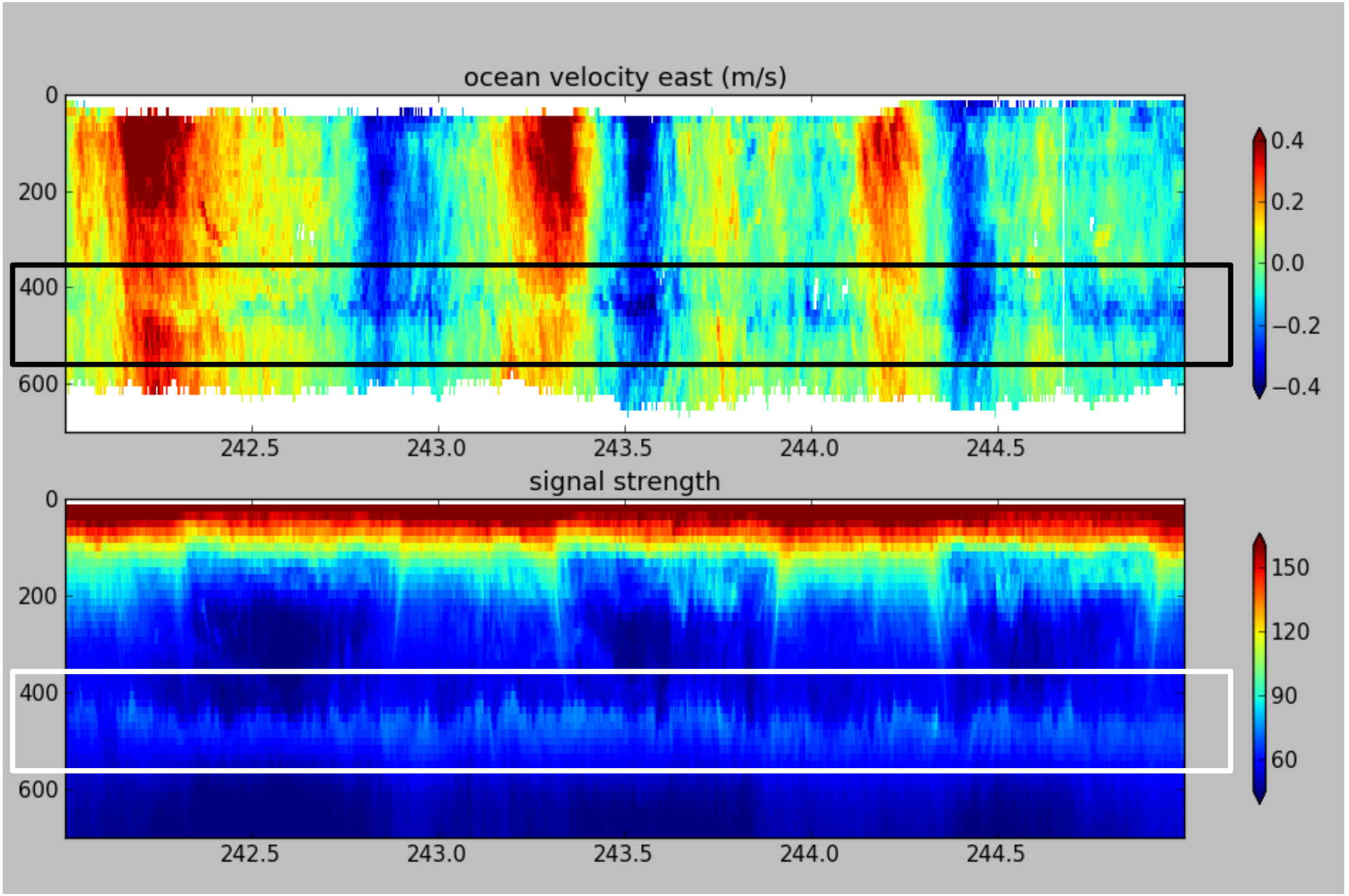
Top 10 ways to damage ADCP data

Problem: midwater bias due to scattering layer

- Symptom:
  - “S” shape in along-track direction
- Solution: Short term:
  - no solution. Note in the logs; user beware
- Solution: Long Term:
  - related to transducer design; we're stuck with it

Scattering Layer causes bias

Ship was going WEST
Bias is to the WEST

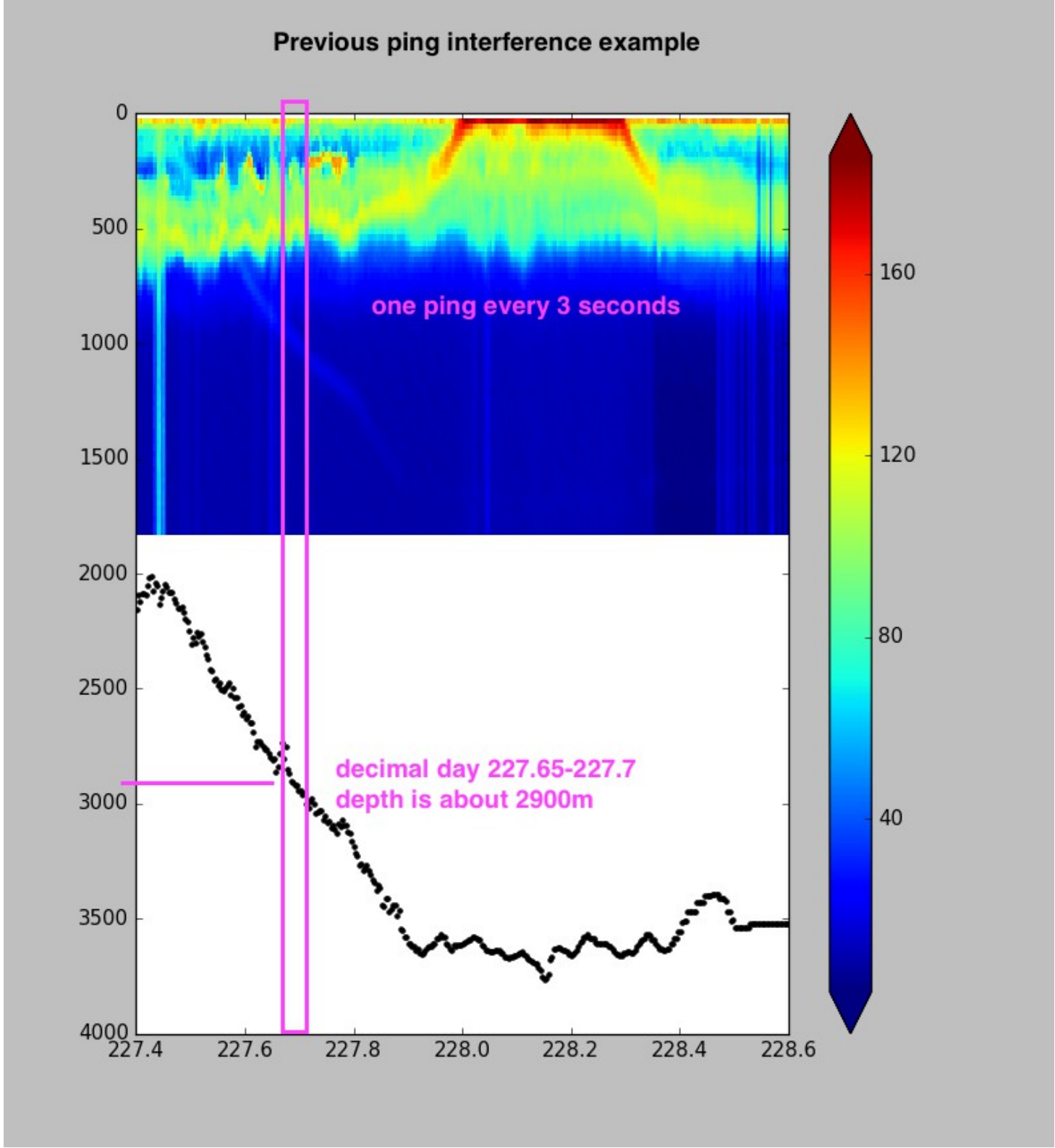


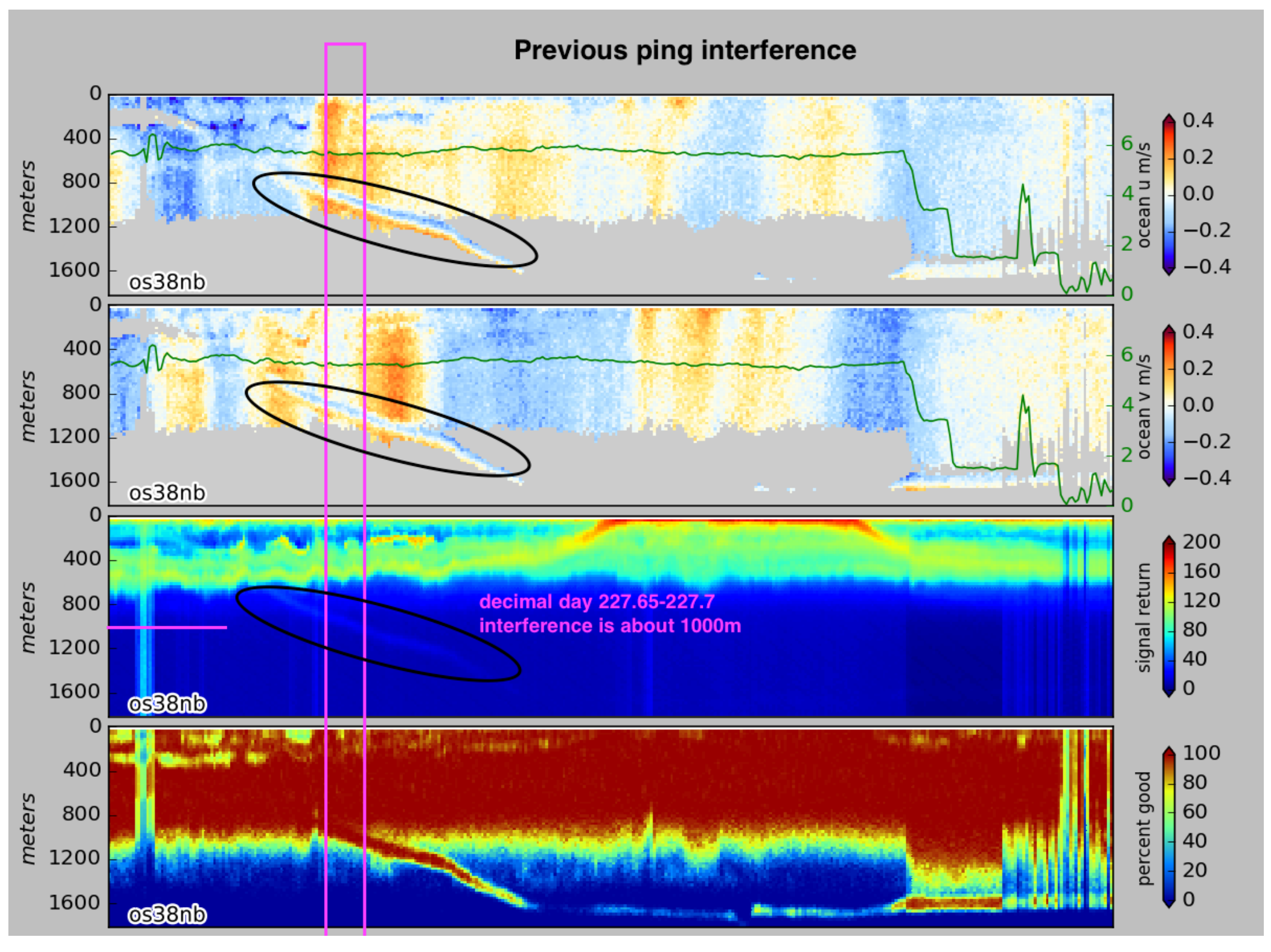
Top 10 ways to damage ADCP data

Problem: midwater bias due to previous ping

- (acts exactly like a strong scattering layer)
- Symptom:
  - “S” shape in along-track direction
- Solution: Short term:
  - if data already collected, no solution. Edit out?
- Solution: Long Term:
  - increase time between pings (let sound die down)

Previous Ping Interference

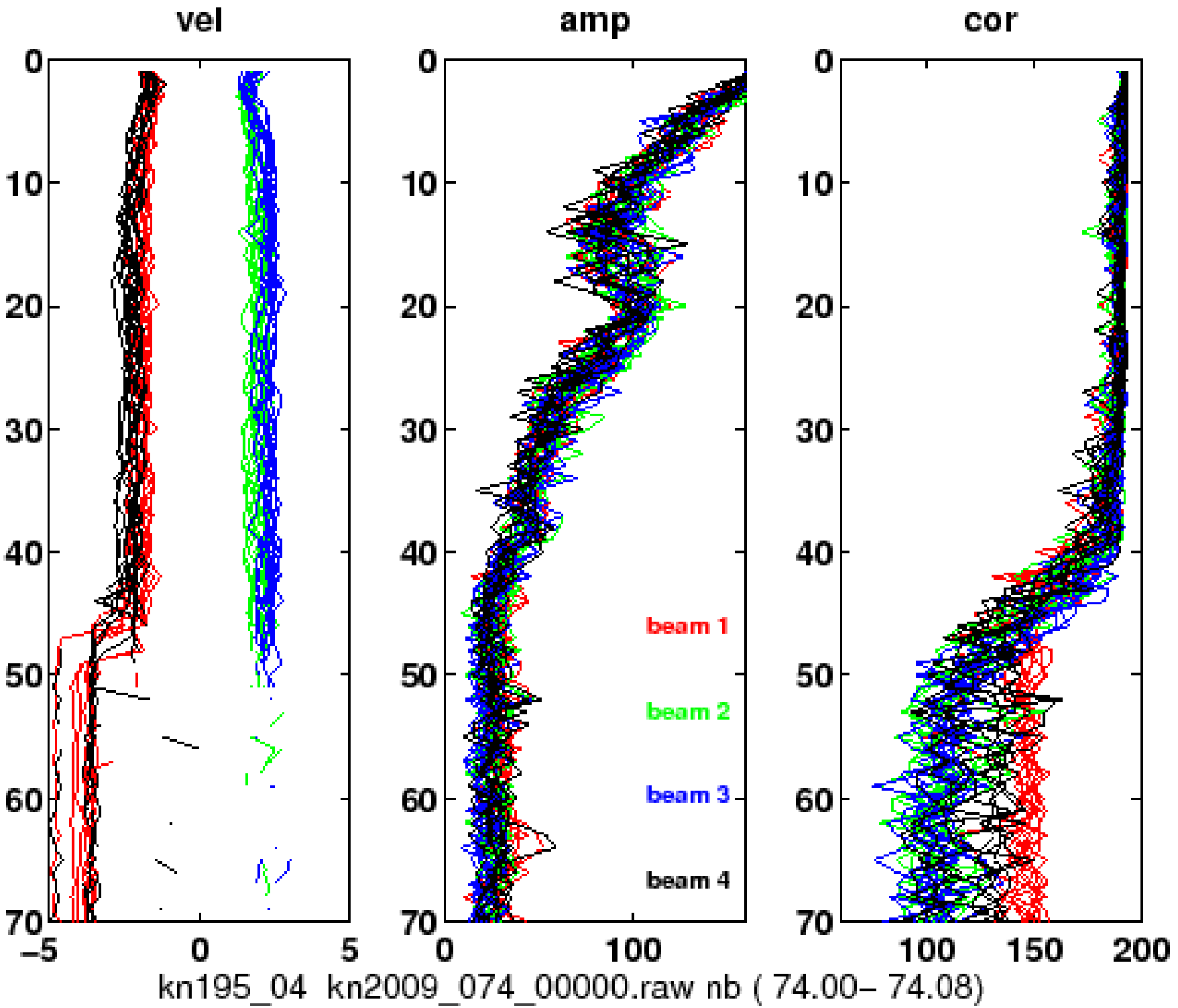



Previous ping interference
meters
0
400
800
1200
1600
os38nb
ocean u m/s
0.4
0.2
0.0
−0.2
−0.4
ocean v m/s
signal return
200
160
120
80
40
0
percent good
100
80
60
40
20
decimal day 227.65-227.7
interference is about 1000m

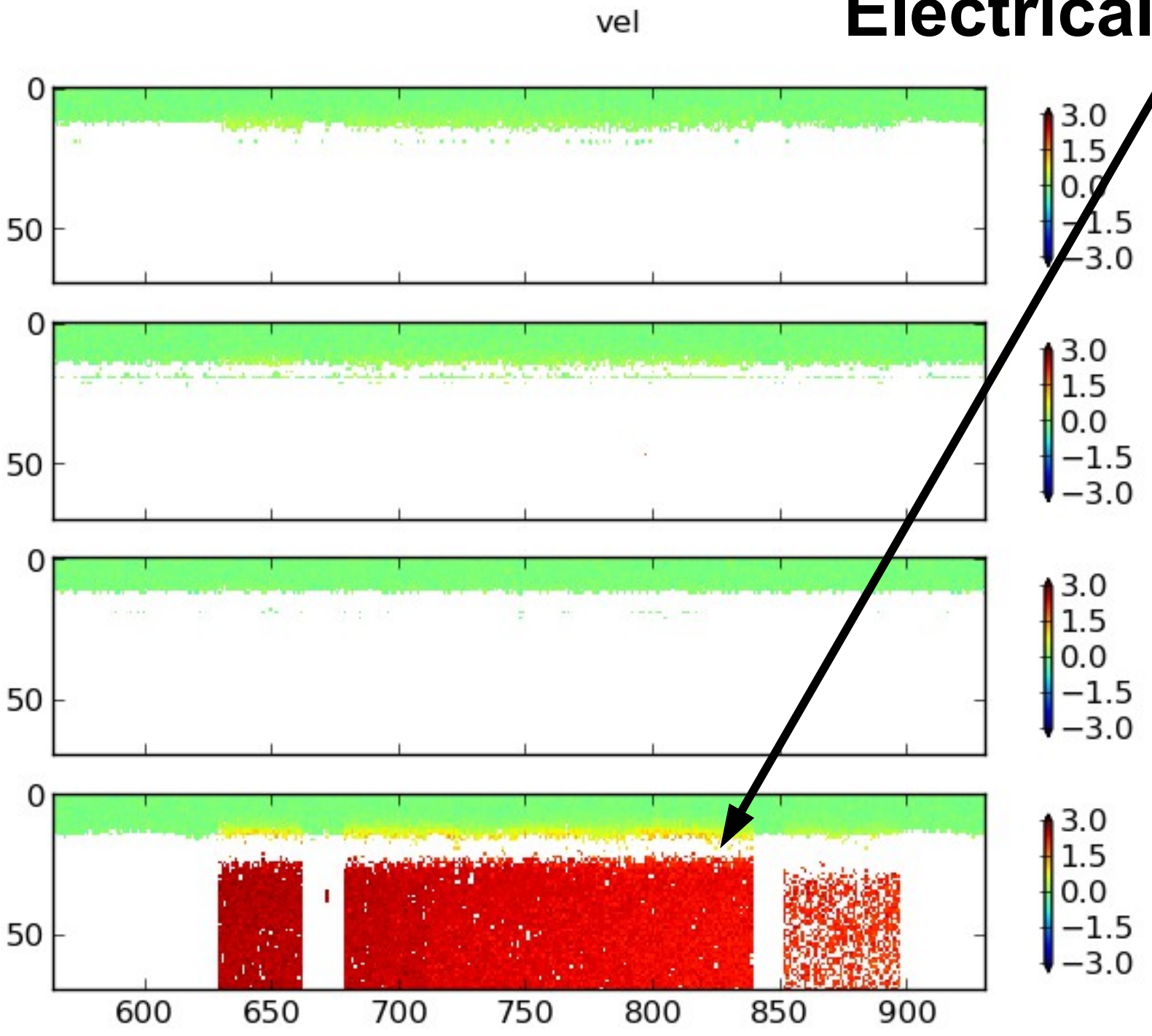
Top 10 ways to damage ADCP data

Problem: electrical interference

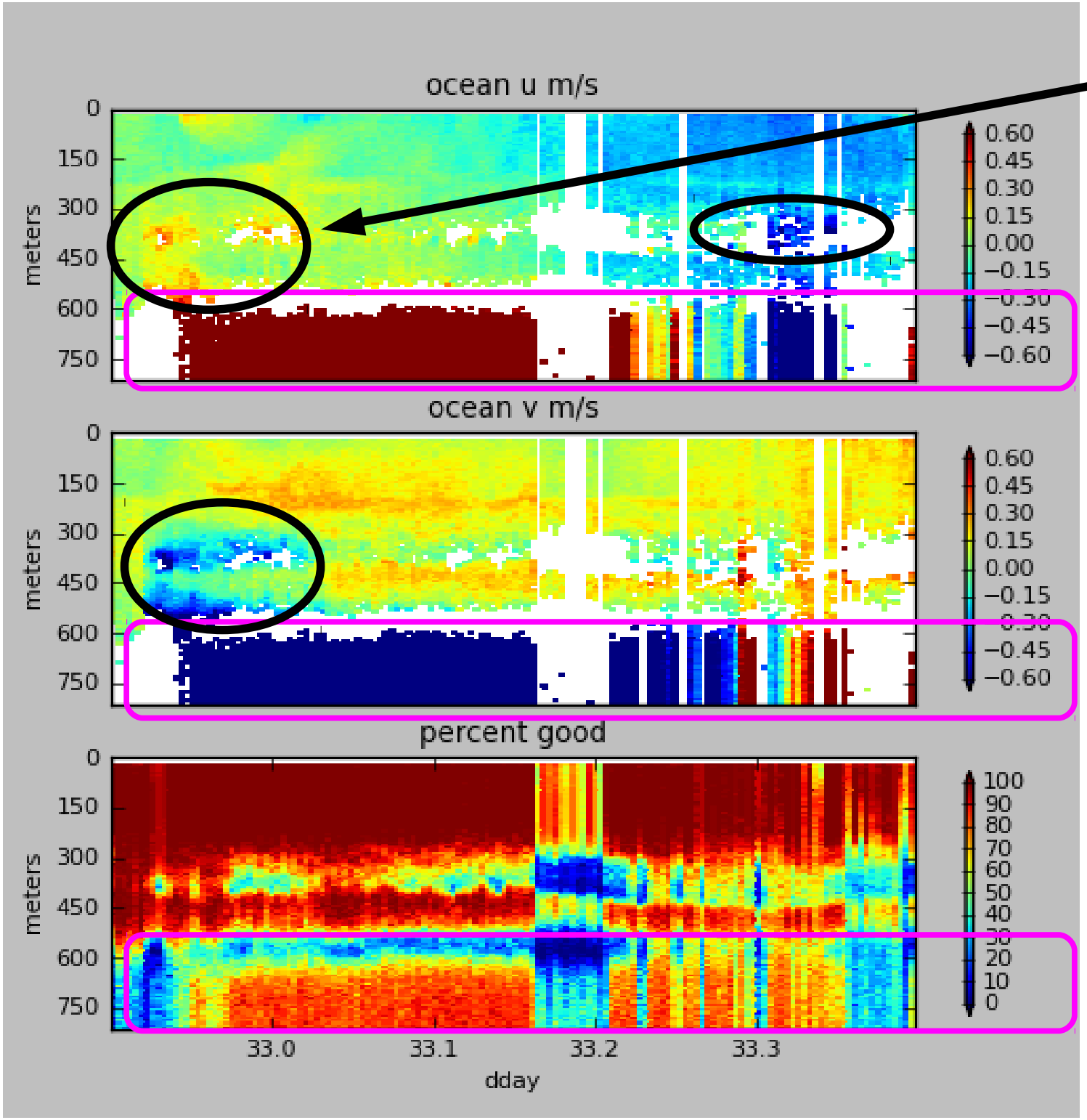
- Symptom: strange biases in deep water
- Solution: Short term:
  - change to the other mode broadband (narrowband)
  - single-ping processing might get rid of some
- Solution: Long Term:
  - identify the ground loop (change circuit)
  - move the chassis closer to the transducer
  - shorten transducer cable


vel
amp
cor
0
10
20
30
40
50
60
70
−5
0
5
0
100
100
150
200
beam 1
beam 2
beam 3
beam 4
kn195_04 kn2009_074_00000.raw nb (74.00– 74.08)

Electrical Noise

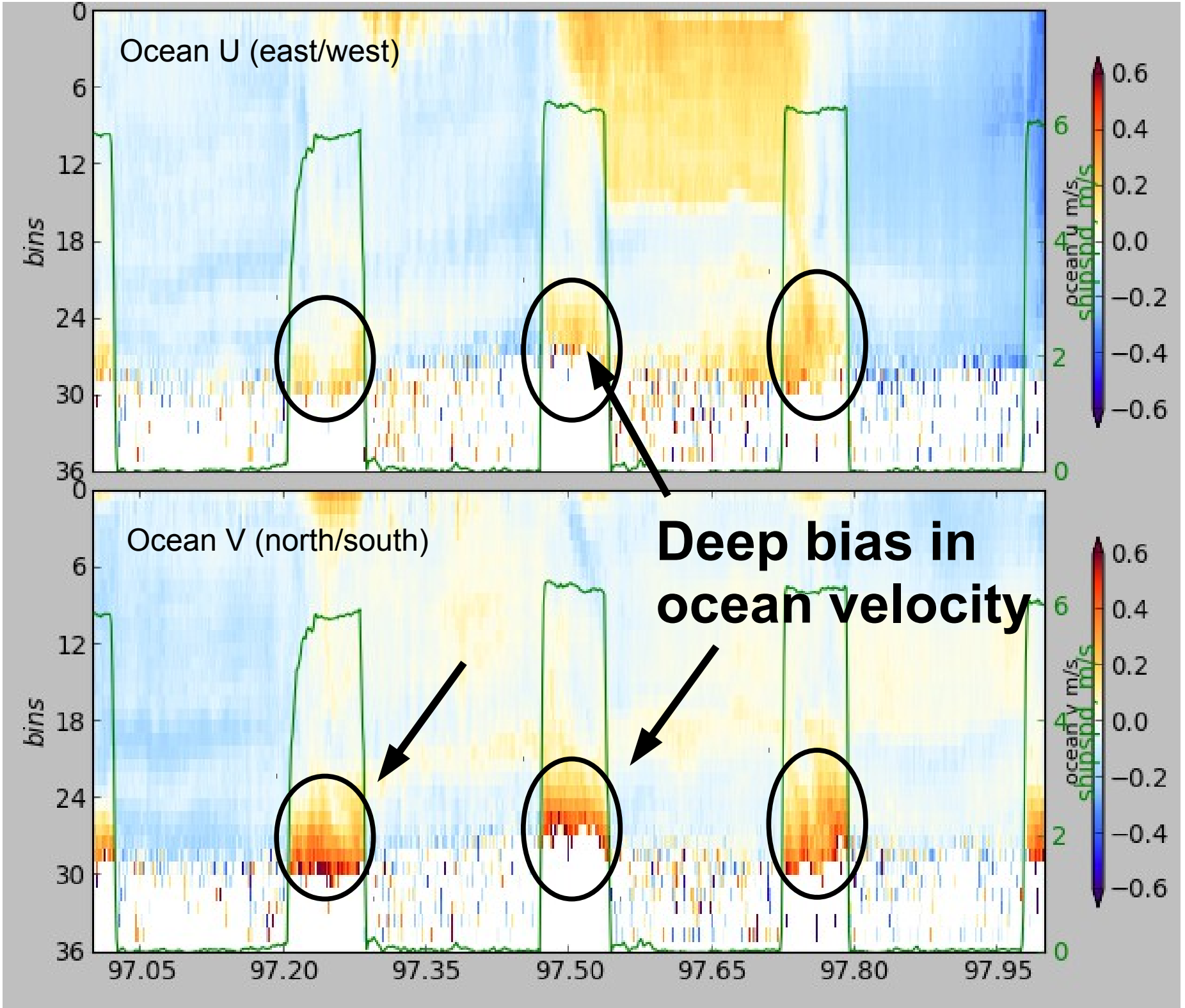


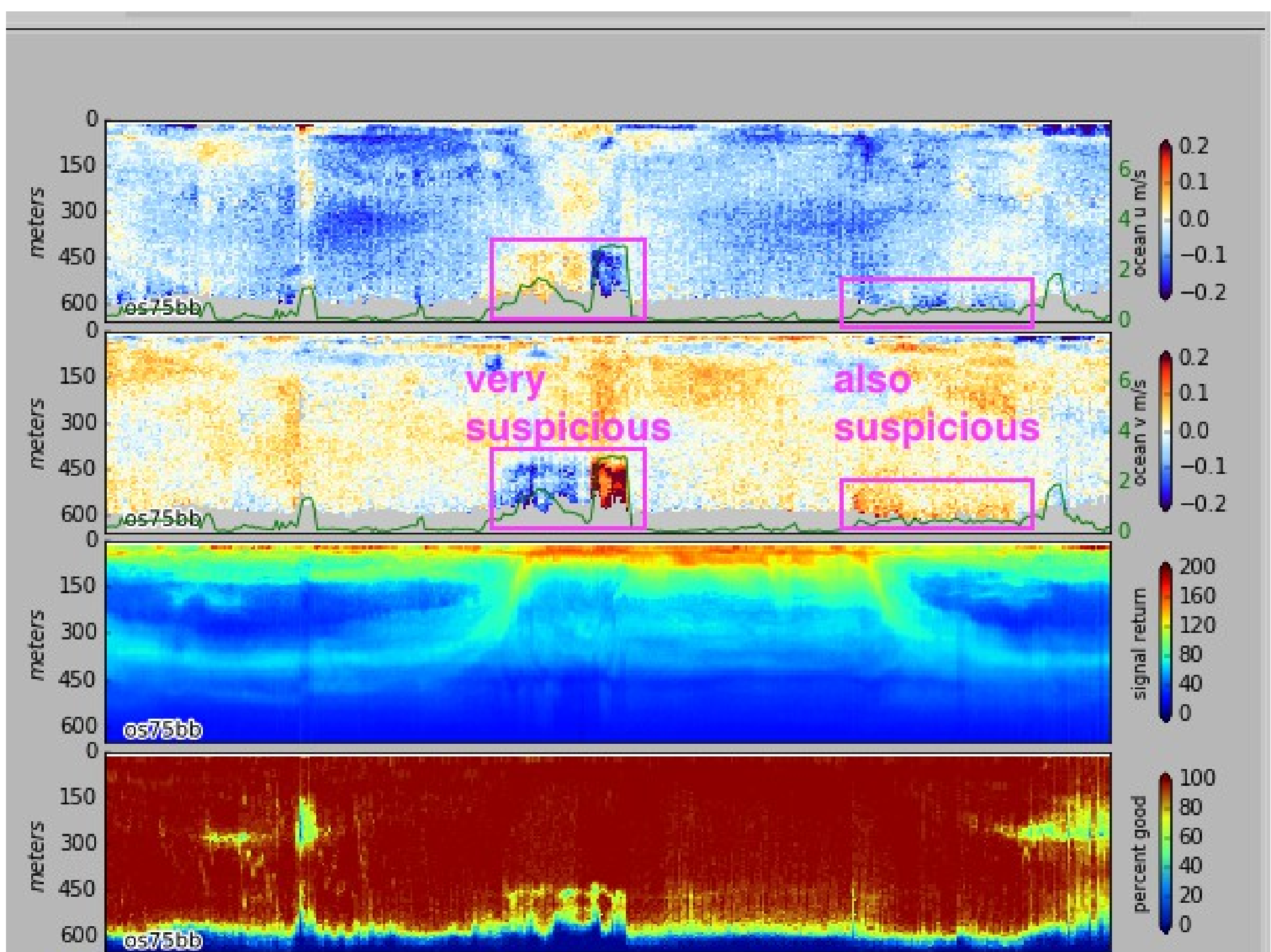
- strong signal in beam velocity
- deeper range than normal
- beams are often asymmetric (don't look like velocity)



Subtle bias extends into the water colum

Deep Bias Deeper than normal range


Ocean U (east/west)
Ocean V (north/south)
Deep bias in ocean velocity
bins
ocean_u m/s
ocean_v m/s
shipspd, m/s
0
6
12
18
24
30
36
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
2
4
97.05
97.20
97.35
97.50
97.65
97.80
97.95


meters
0
150
300
450
600
os75bb
ocean u m/s
0.2
0.1
0.0
−0.1
−0.2
6
4
2
0
very
suspicious
also
suspicious
ocean v m/s
signal return
200
160
120
80
40
0
percent good
100
80
60
40
20

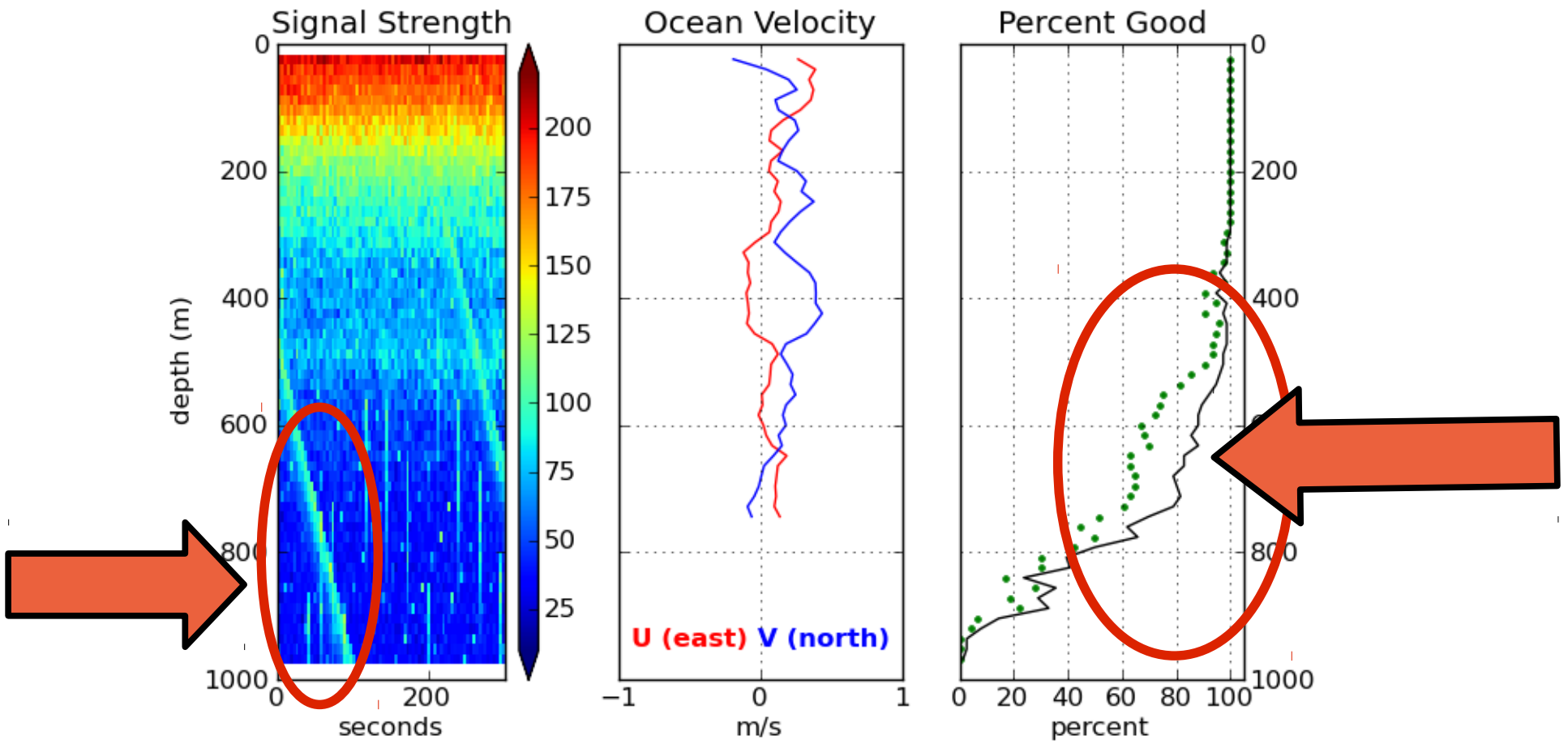
Top 10 ways to damage ADCP data

Problem: random acoustic interference

- Symptom: other sonar pings randomly impact velocities
- Solution: Short term:
  - single-ping processing will get rid of almost all
- Solution: Long Term:
  - switch to UHDAS – always uses single-ping editing
  - redo processing of all data with single-ping processing

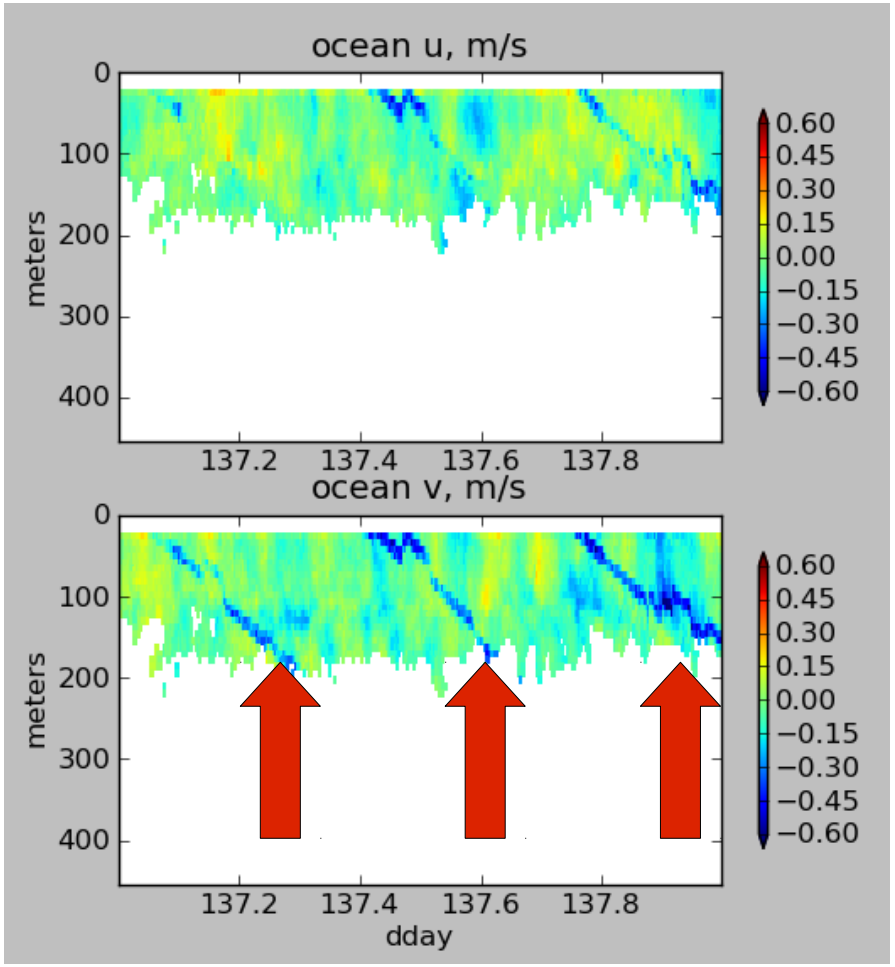
ADCP Processing

Singleping editing: acoustic interference

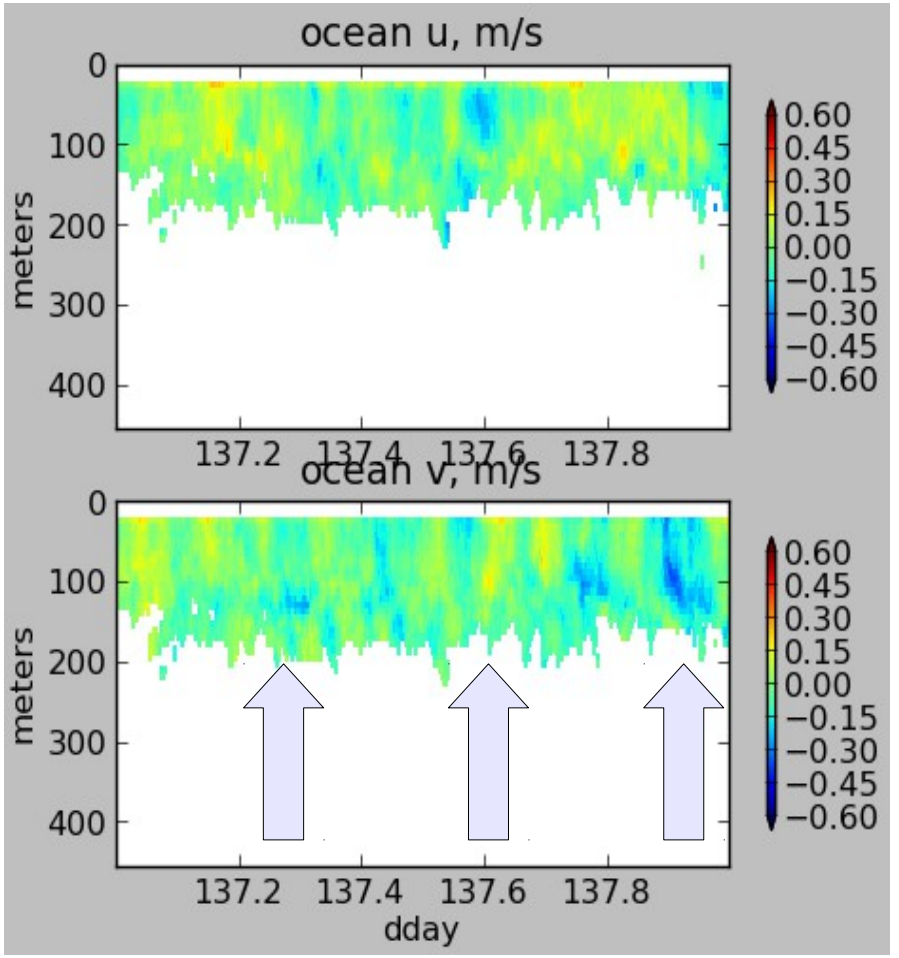


ADCP Processing: acoustic interference

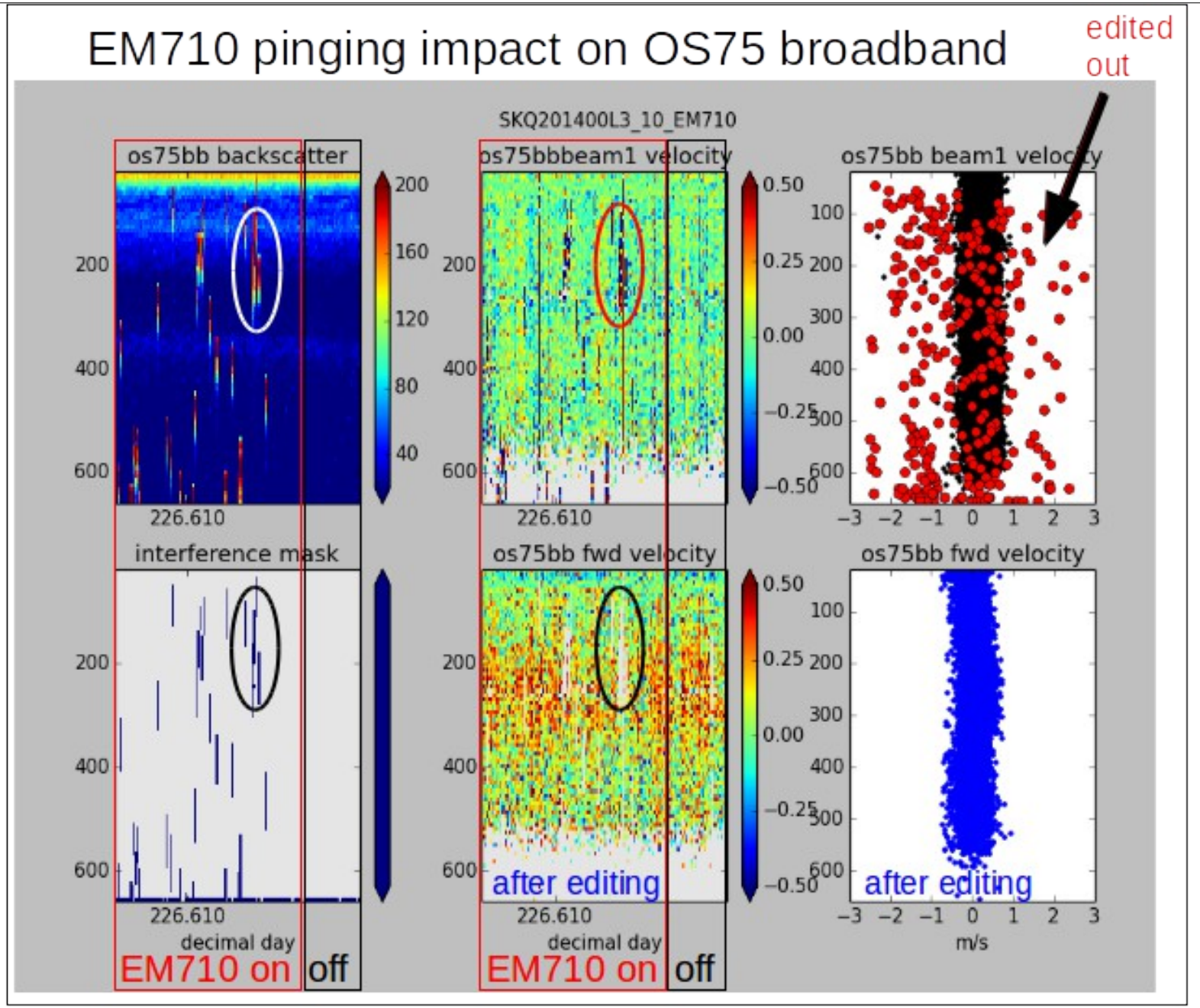
WITHOUT
singleping editing



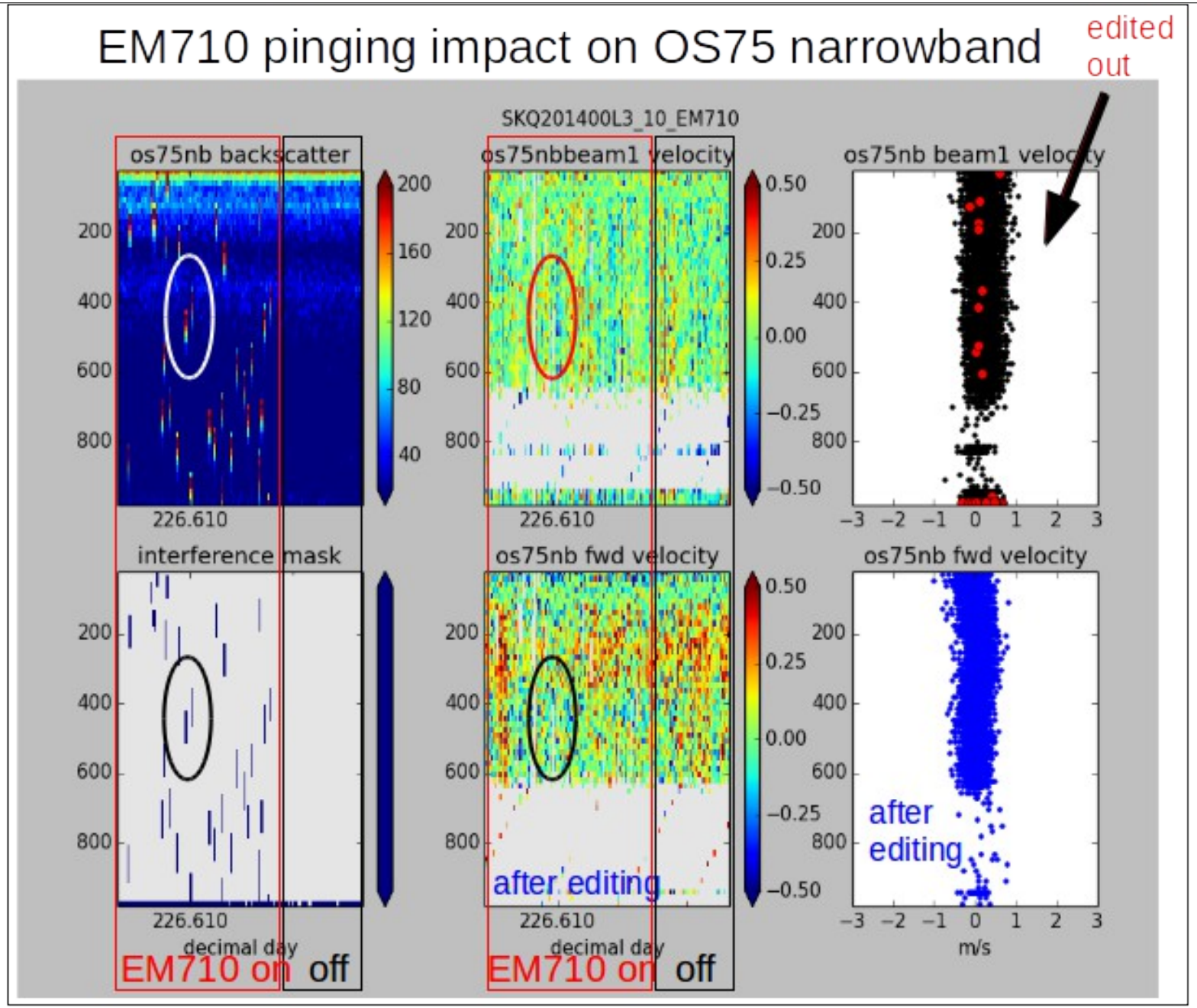
USING
singleping editing



ADCP Processing: editing out interference



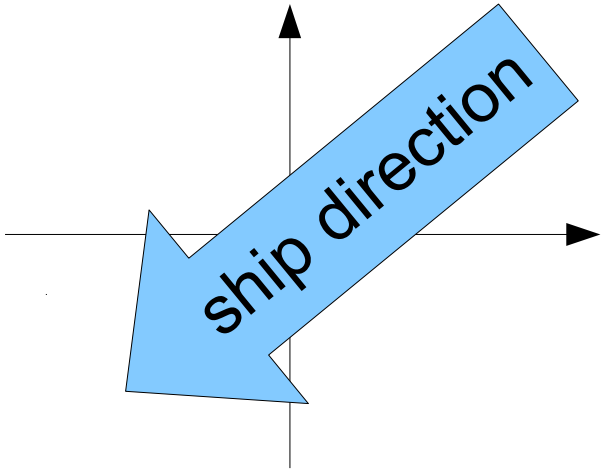
ADCP Processing: editing out interference

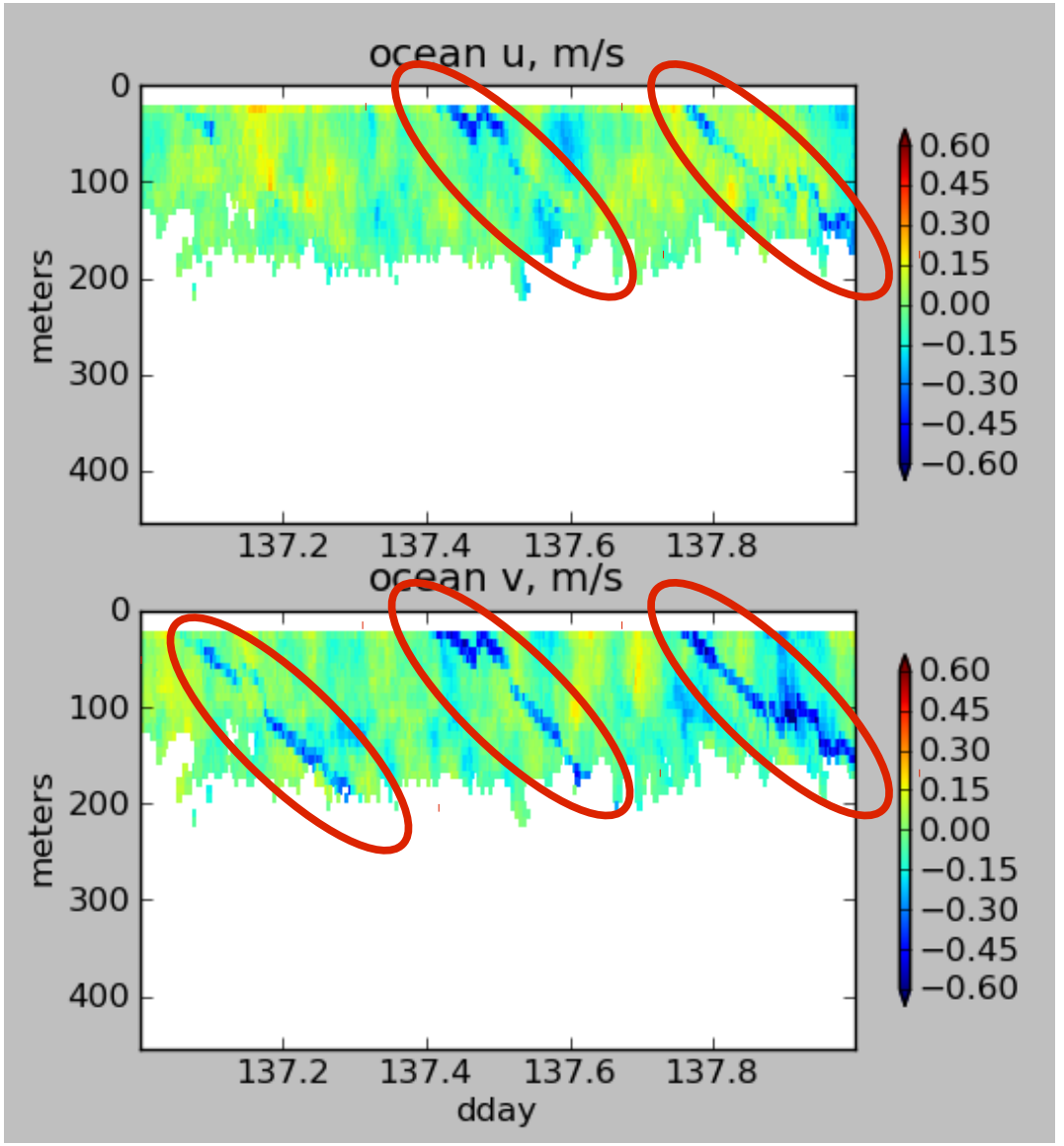


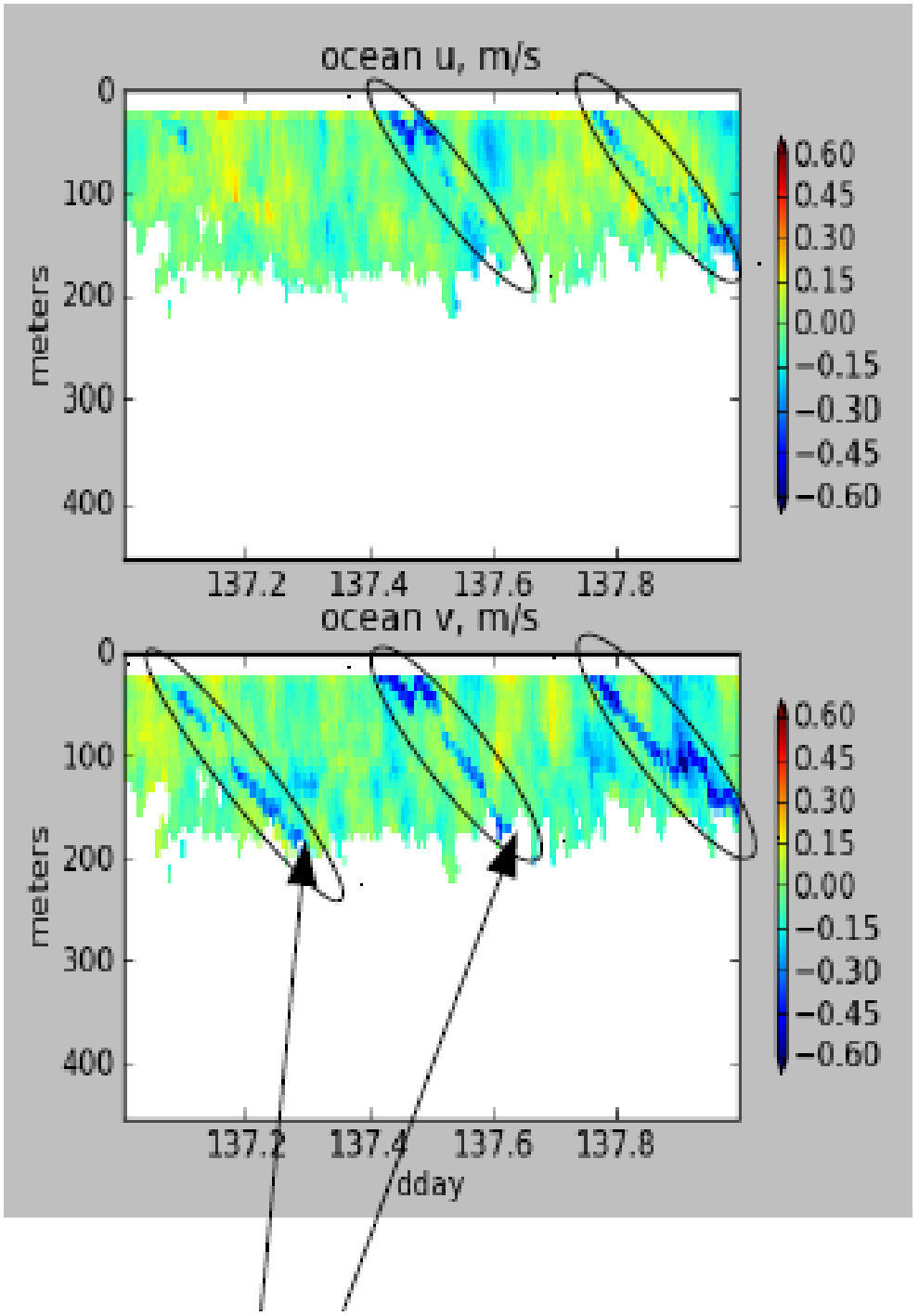
ADCP Processing **without** singleping editing

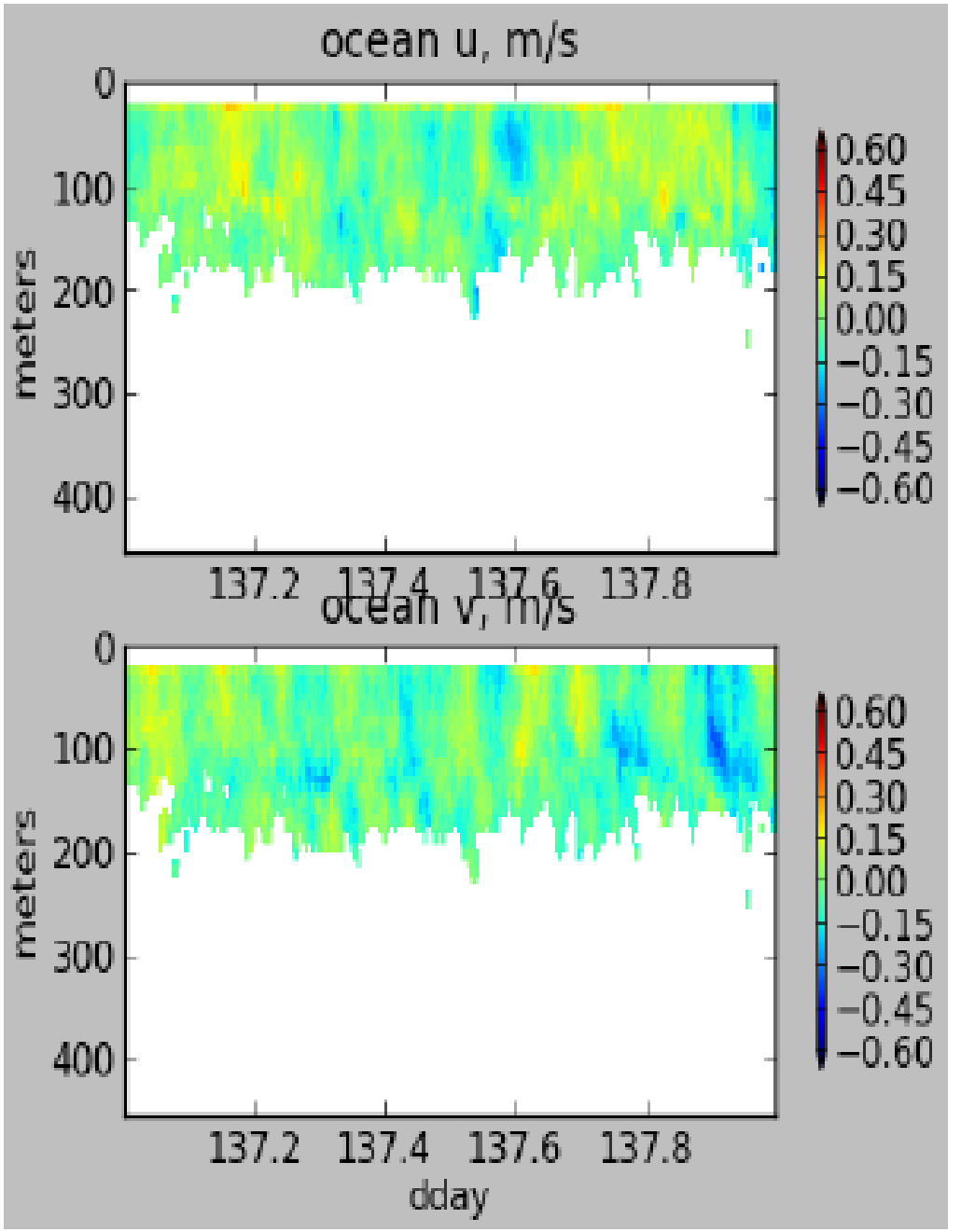
Averaged
ocean velocities

NOTE: along-track
direction bias



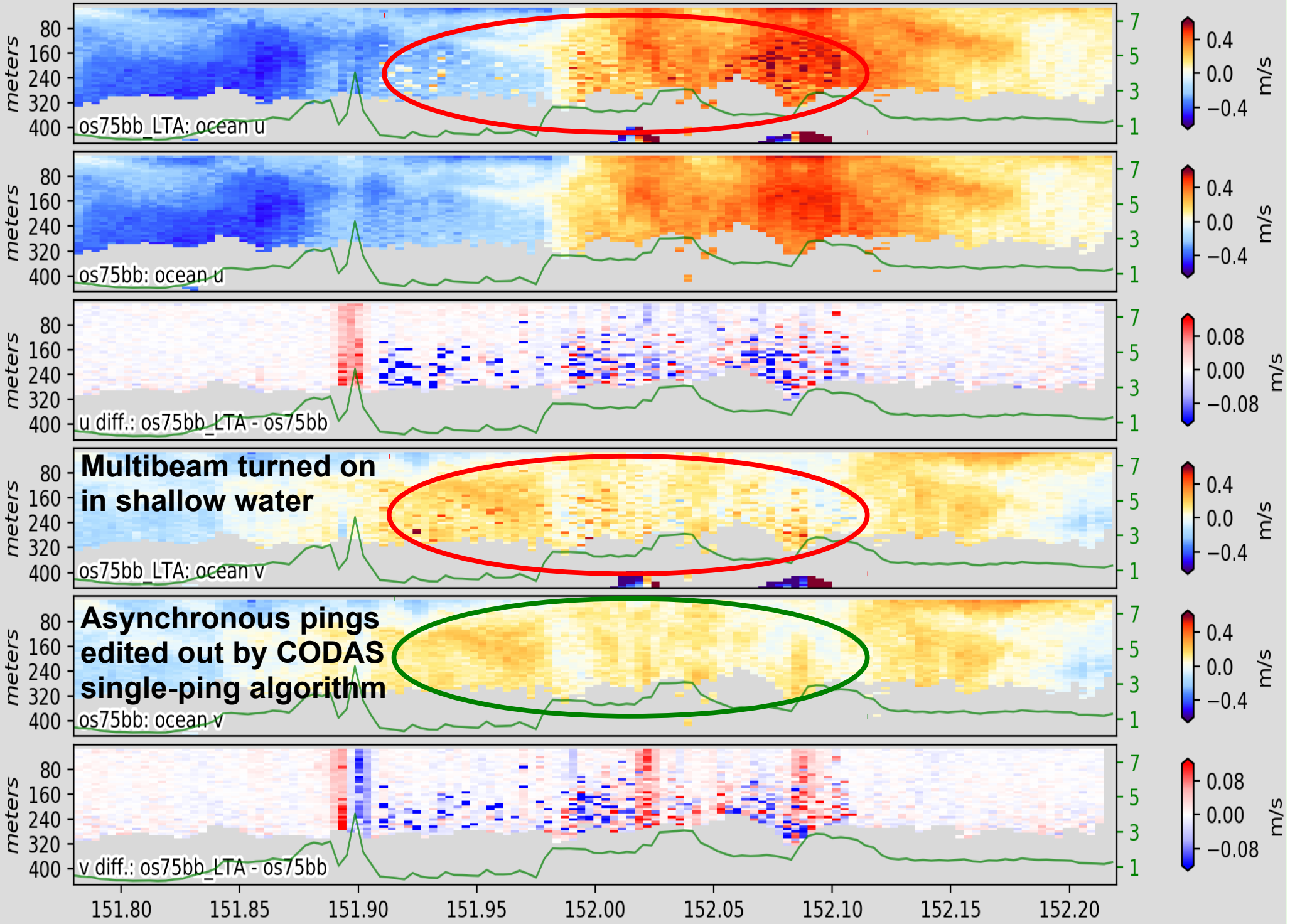


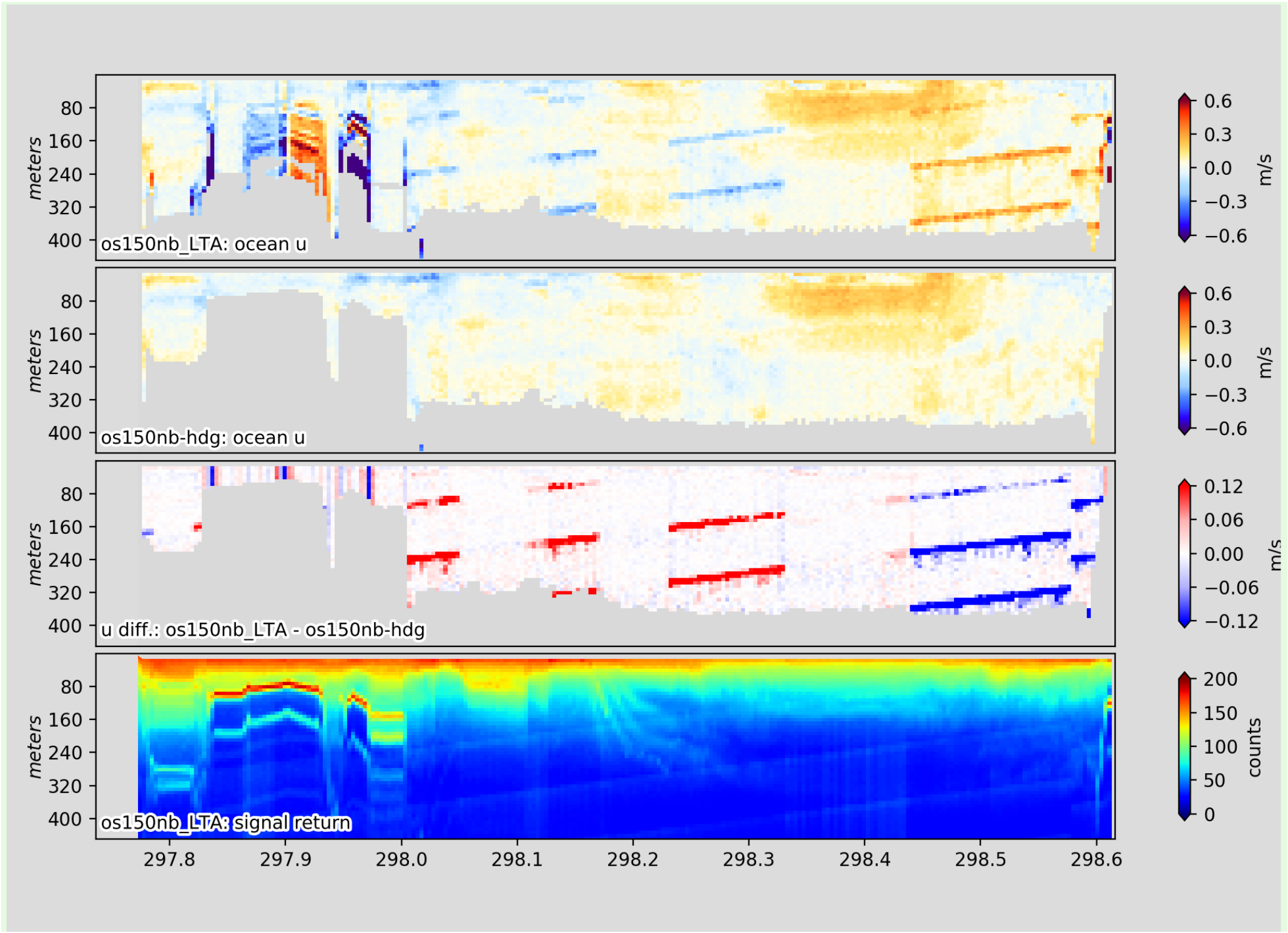




No Single-ping editing

Including single-ping editing

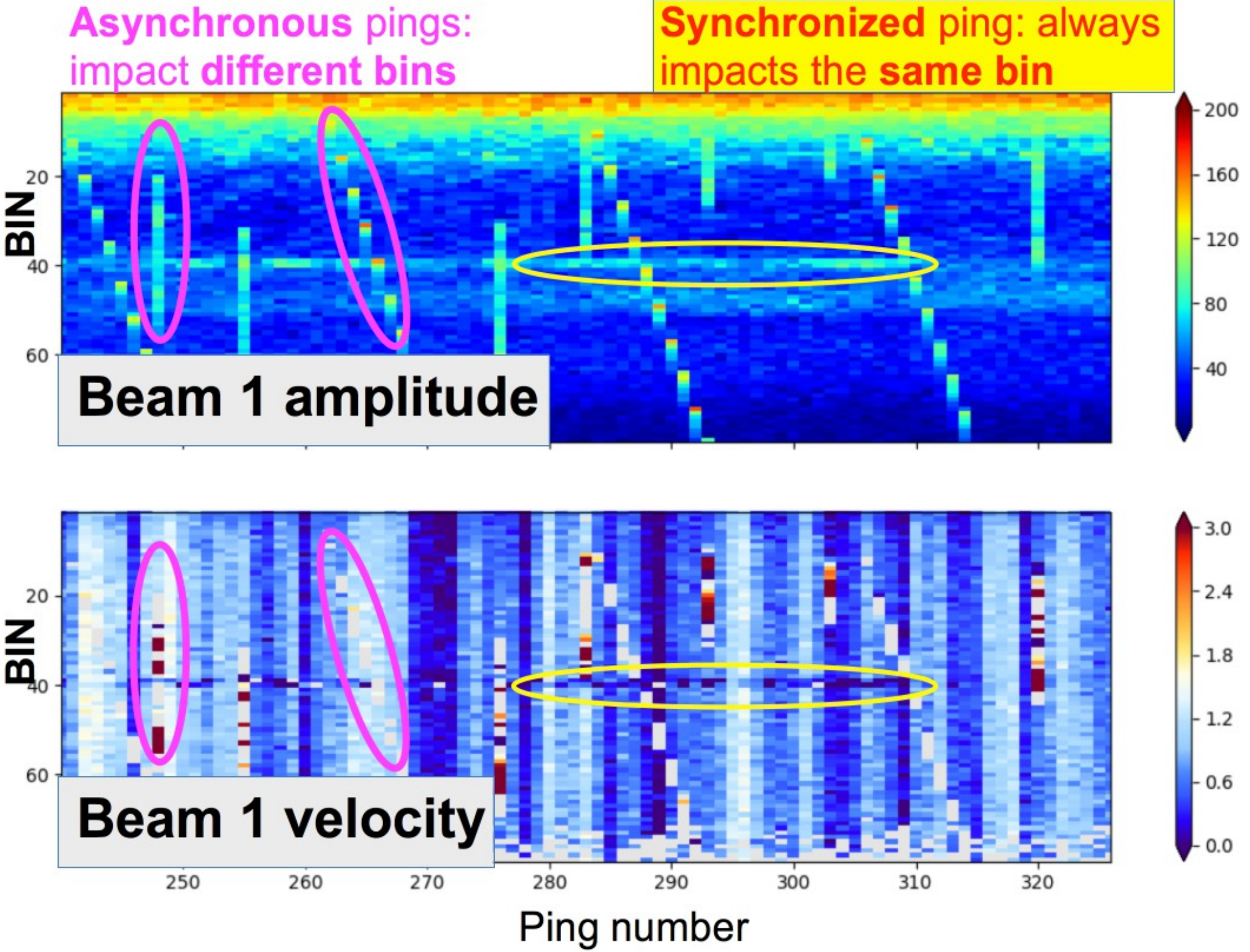

meters
80
160
240
320
400
os75bb_LTA: ocean u
os75bb: ocean u
u diff.: os75bb_LTA - os75bb
Multibeam turned on
in shallow water
os75bb_LTA: ocean v
Asynchronous pings
edited out by CODAS
single-ping algorithm
os75bb: ocean v
v diff.: os75bb_LTA - os75bb
7
5
3
1
0.4
0.0
−0.4
0.08
0.00
−0.08
m/s
151.80
151.85
151.90
151.95
152.00
152.05
152.10
152.15
152.20


meters
80
160
240
320
400
os150nb_LTA: ocean u
os150nb-hdg: ocean u
u diff.: os150nb_LTA - os150nb-hdg
os150nb_LTA: signal return
0.6
0.3
0.0
−0.3
−0.6
m/s
0.12
0.06
0.00
−0.06
−0.12
200
150
100
50
0
counts
297.8
297.9
298.0
298.1
298.2
298.3
298.4
298.5
298.6

Top 10 ways to damage ADCP data

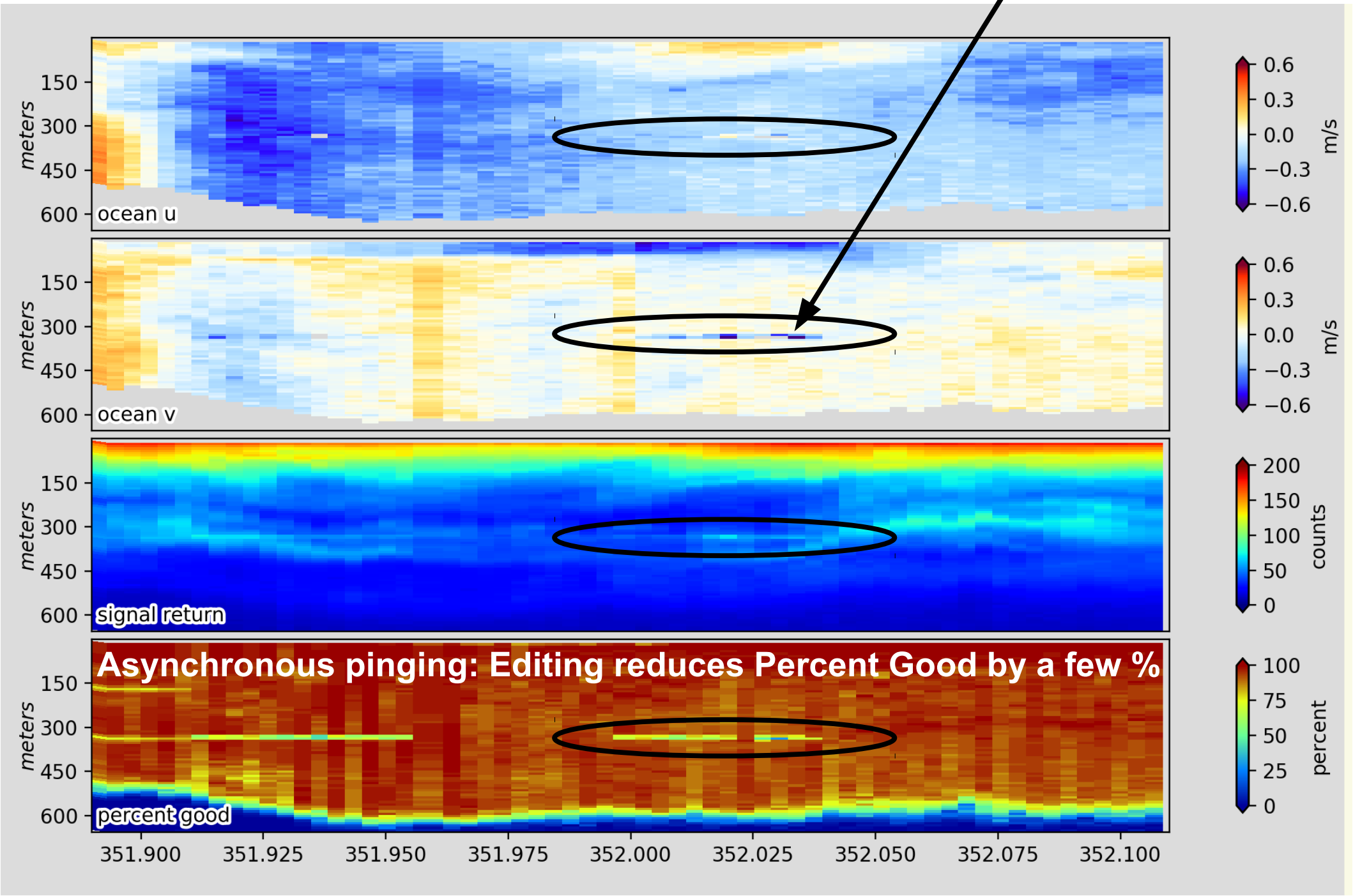
Problem: synchronized acoustic interference

- Symptom: other sonar pings impact velocities (same depth)
- Solution: Short term:
  - edit out the stripes in post-processing
- Solution: Long Term:
  - figure out how to make the interference asynchronous
  - figure out a different triggering scheme
  - make the noise random, and use UHDAS


Asynchronous pings: impact different bins
Synchronized ping: always impacts the same bin
BIN
20
40
60
200
160
120
80
40
Beam 1 amplitude
BIN
20
40
60
3.0
2.4
1.8
1.2
0.6
0.0
Beam 1 velocity
250
260
270
280
290
300
310
320
Ping number

Asynchronous pinging:
Editing is successful

Synchronized pinging: incomplete editing
leaves contaminated velocities in averages



Top 10 ways to damage ADCP data

Problem: ping rate is too slow

- Symptom:
  - bottom track is on in deep water
  - ADCP is sync'd to an instrument pinging infrequently
- Solution: Short term:
  - turn off bottom track
- Solution: Long Term:
  - do not run bottom track in deep water
  - look into different triggering scenario

Top 10 ways to damage ocean velocities

- In the remaining examples, the ADCP beam velocities may be fine; but a problem exists downstream in the flow of information. The remaining steps are:
- Transformations:
  - beam to instrument coordinates (matrix)
  - instrument to ship coordinates (transducer alignment)
  - ship coordinates to earth coordinates (heading)
- single-ping editing
- averaging
- applying ship speed to measured velocities (→ ocean vel)

Top 10 ways to damage ADCP data

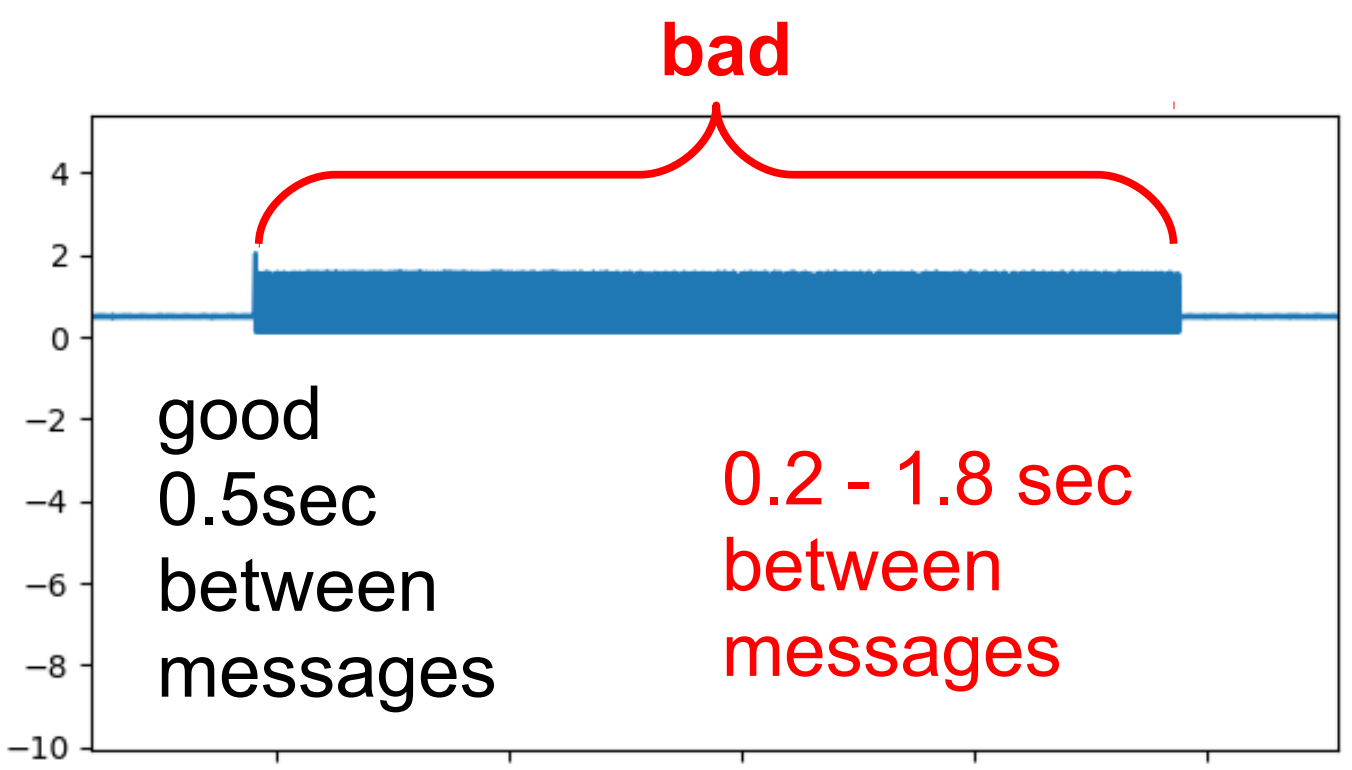
Problem: transformation beam to instrument coords

- Symptom:
  - subtle but wrong velocities
- Actual cause:
  - Beam former boards were wired wrong in the instrument
- Short Term solution:
  - swap beams in software
- Long Term solution:
  - swap beams in the instrument

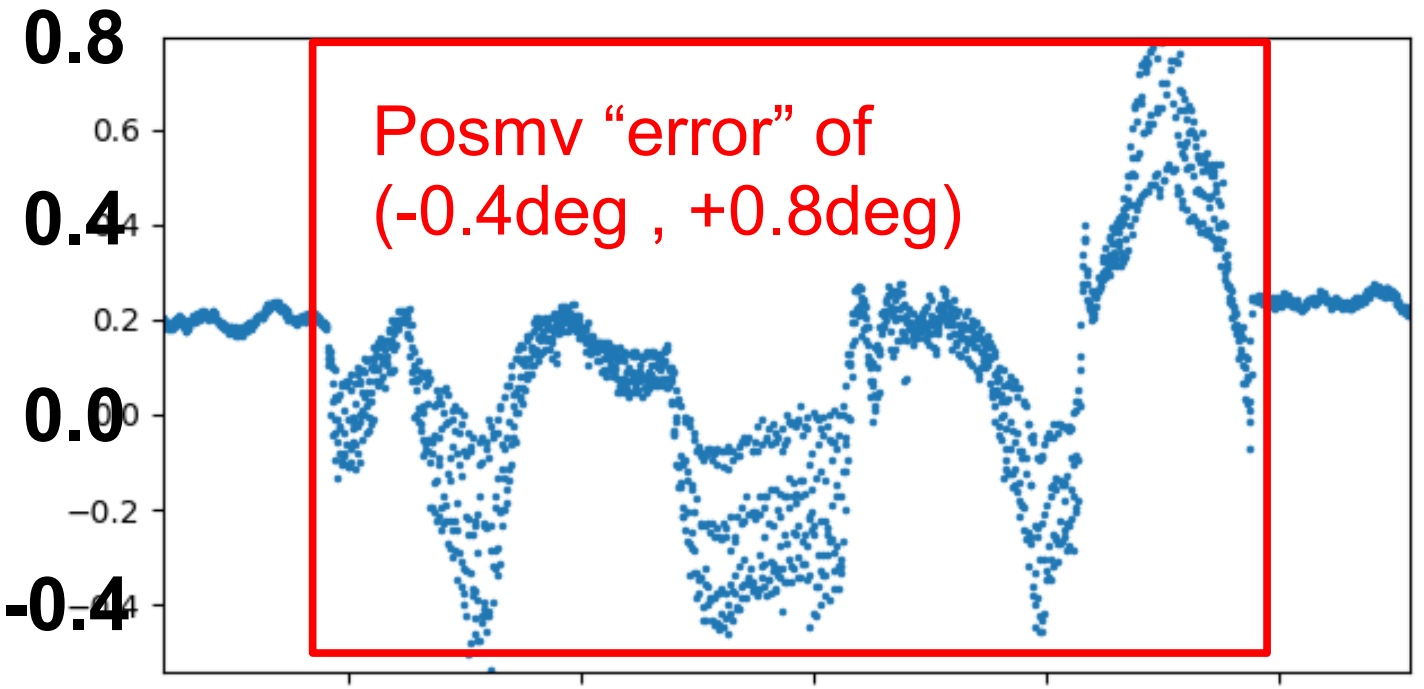
Top 10 ways to damage ocean velocities

Problem: bad timestamps

- Symptom:
  - processing cannot occur
- Short Term Solution:
  - None - data are damaged
- Solution: Long Term:
  - fix computer time behavior



NMEA messages:
- none missing
- timing delayed
- buffer cleared



Comparison of Seapath to Posmv:
- both work
- errors created by variable (bad) arrival times

Top 10 ways to damage ocean velocities

Problem: missing heading or position instrument

- Symptom:
  - no velocities (heading or position is missing)
- Short Term Solution:
  - process single-ping data using a different input(*)
- Solution: Long Term:
  - fix the broken instrument

This implies there are multiple sources of GPS and heading

Top 10 ways to damage ocean velocities

Problem: serial acquisition damaged: colliding messages

- Symptom:
  - processing cannot occur
- Short Term Solution:
  - None - data are damaged
- Solution: Long Term:
  - merge messages with a buffered combiner (do not simply twist wires together)

$GTG,A,054,35,27209.679,N7.5500.C
8,01HDT,354.5,-2.4,M8685.4,8507.0,03,W*6D
$GPM,0,356,13358,M
$H.4,N,3543,K*
$
$GPG,350545357272 7..5,5,N,.6,00.45
$GW,2,,0501.0,272$PADCP,4910,20110507,054659.19,70.00
5,M,94,.4,M,00.0,01,W,65
,01HDT,354.3,-2
$GPM,0,355,13358,M
$H.3,N,3542,K*
$
$GPG,350545358272 7..4,1,N,.5,00.45
$GW,2,,0501.0,2726,M,20,.4,M,00.0,01,W,64
,01HDT,354,M,T
$GPVTG,354,T,356,M,09.3,N,17.2,KT

Problems:
- **multiple NMEA sources**
- **no checksums**

- **low baud rate**
- **coming from a computer (multiple processes)**

Partial $GPGGA position messages

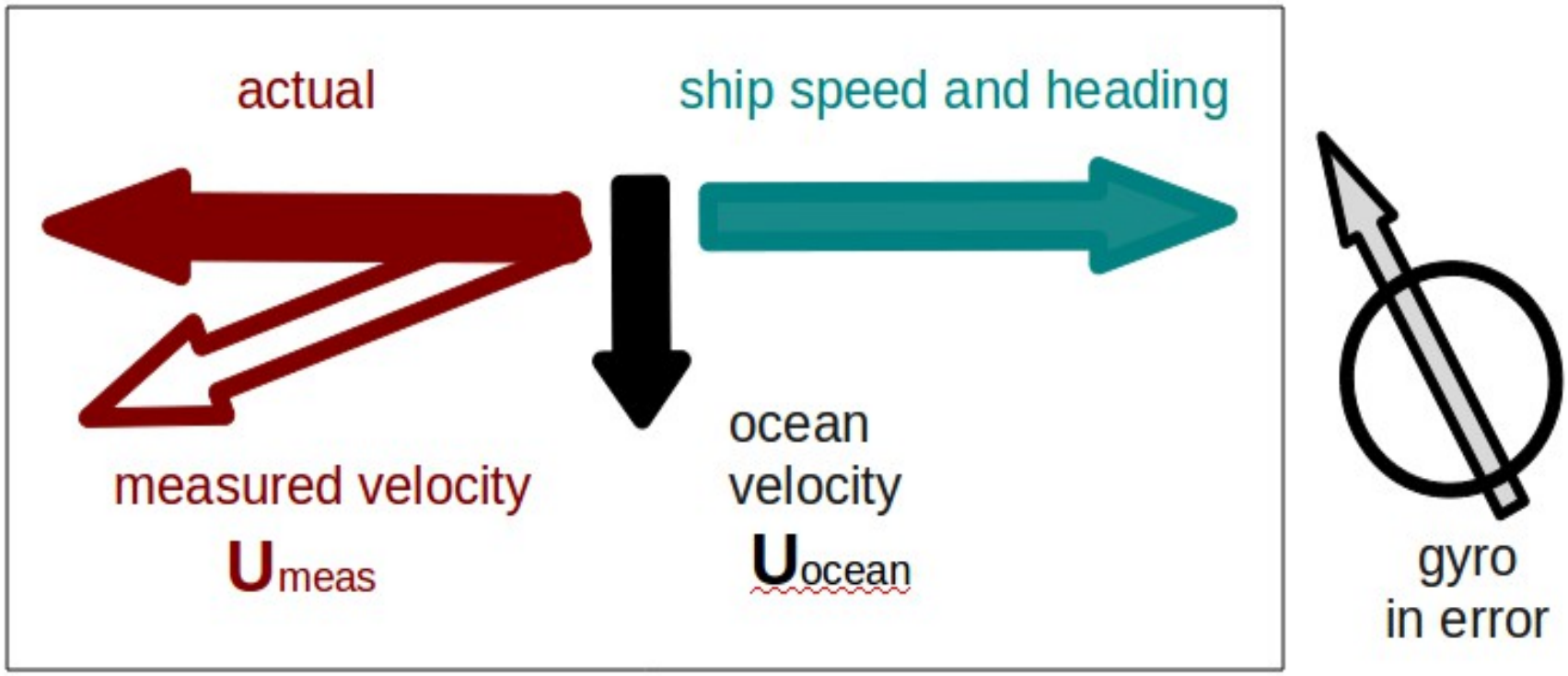
Partial $HEHDT heading messages

Heading: Rule of thumb

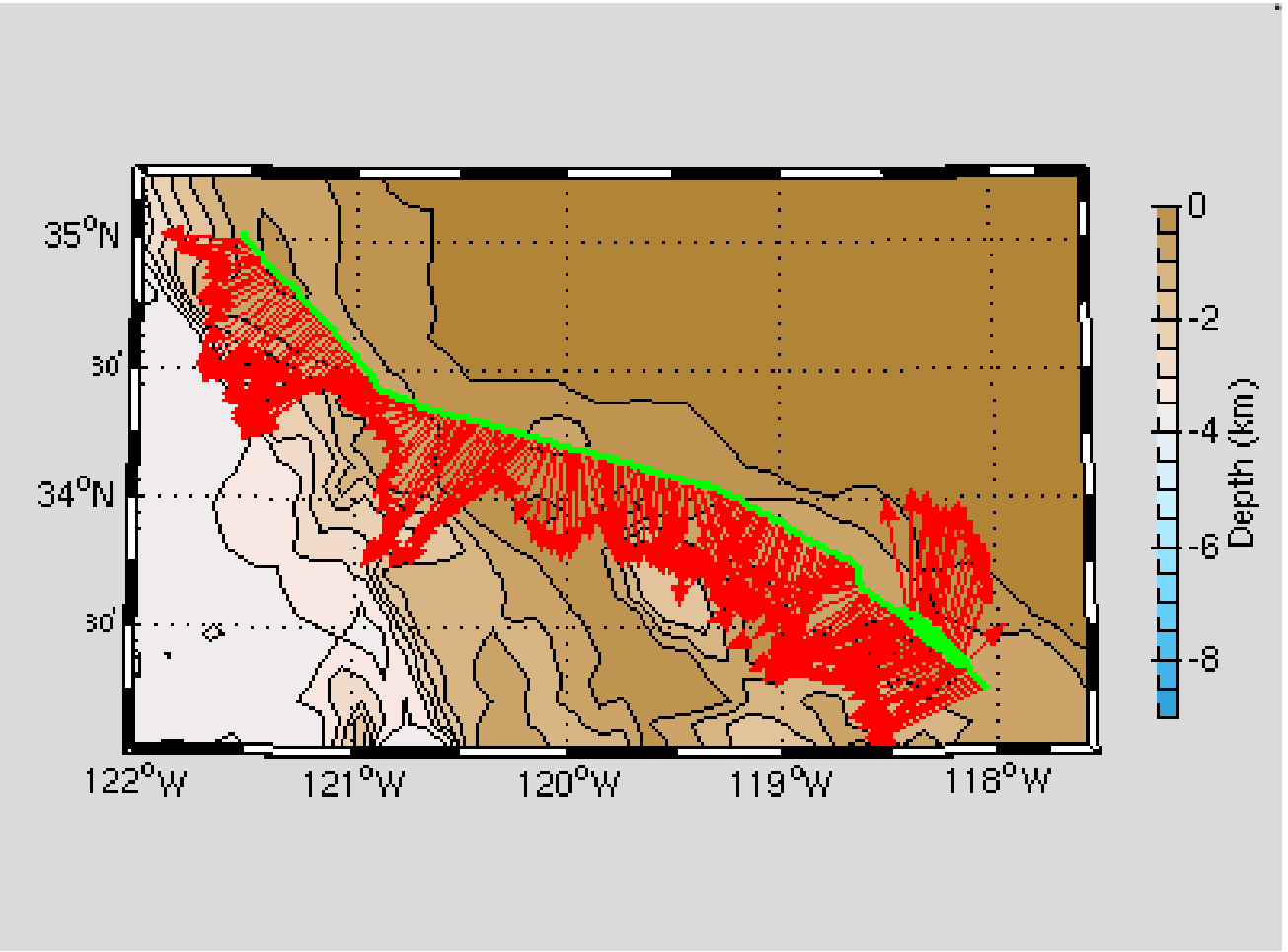
- At 5m/s (10kts)
- **A 1-degree heading error causes a 0.1m/s crosstrack velocity error.**
- **An error of 0.2deg or more is NOT GOOD**
- This is 50% of most typical open ocean currents
- The best heading devices for ADCP ocean currents have:
  - errors of 0.1deg
  - QC indicators

Calibration: Angle Error

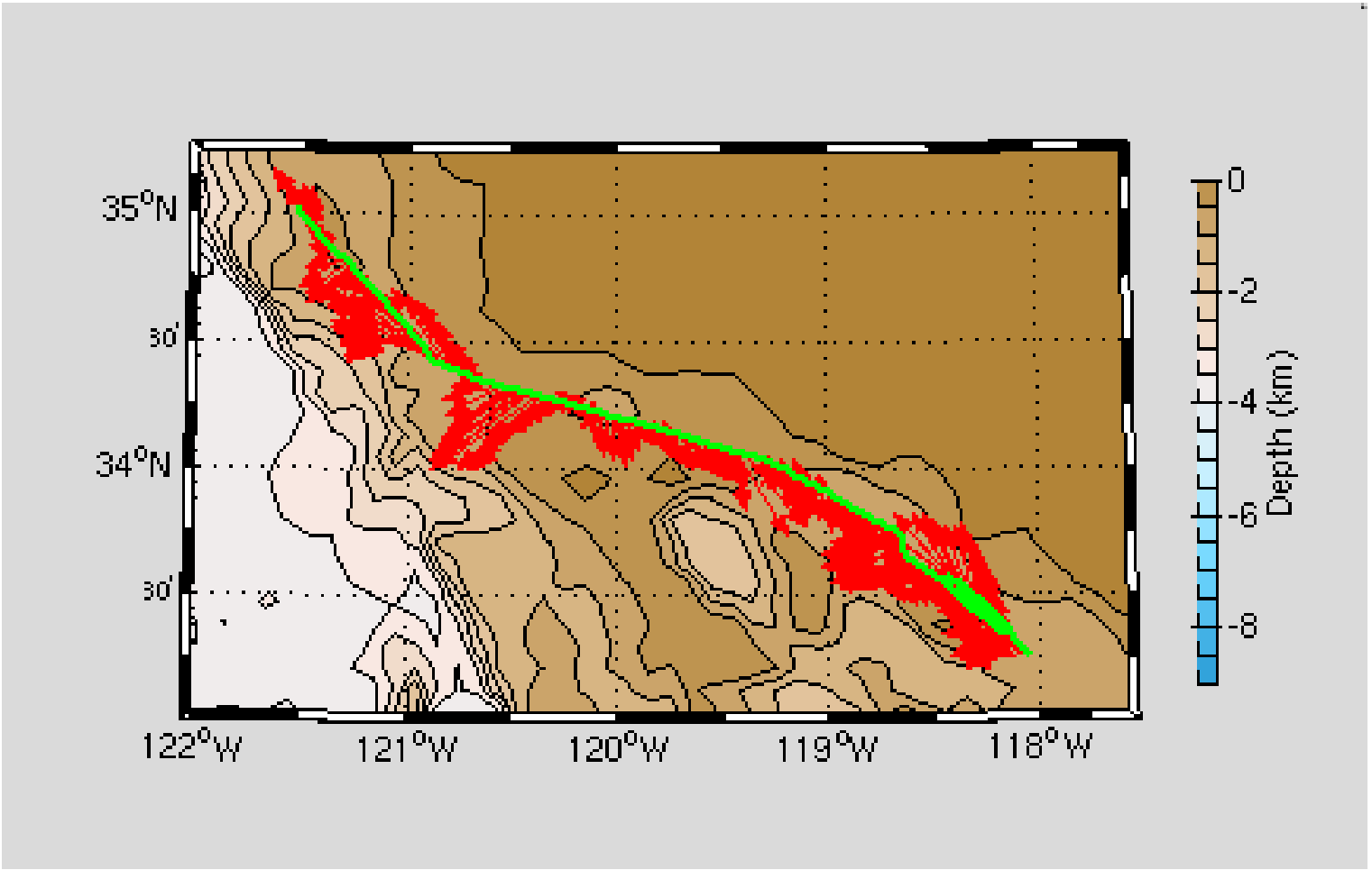
Cross-track bias in ocean velocity from angle error:
(heading + transducer angle)



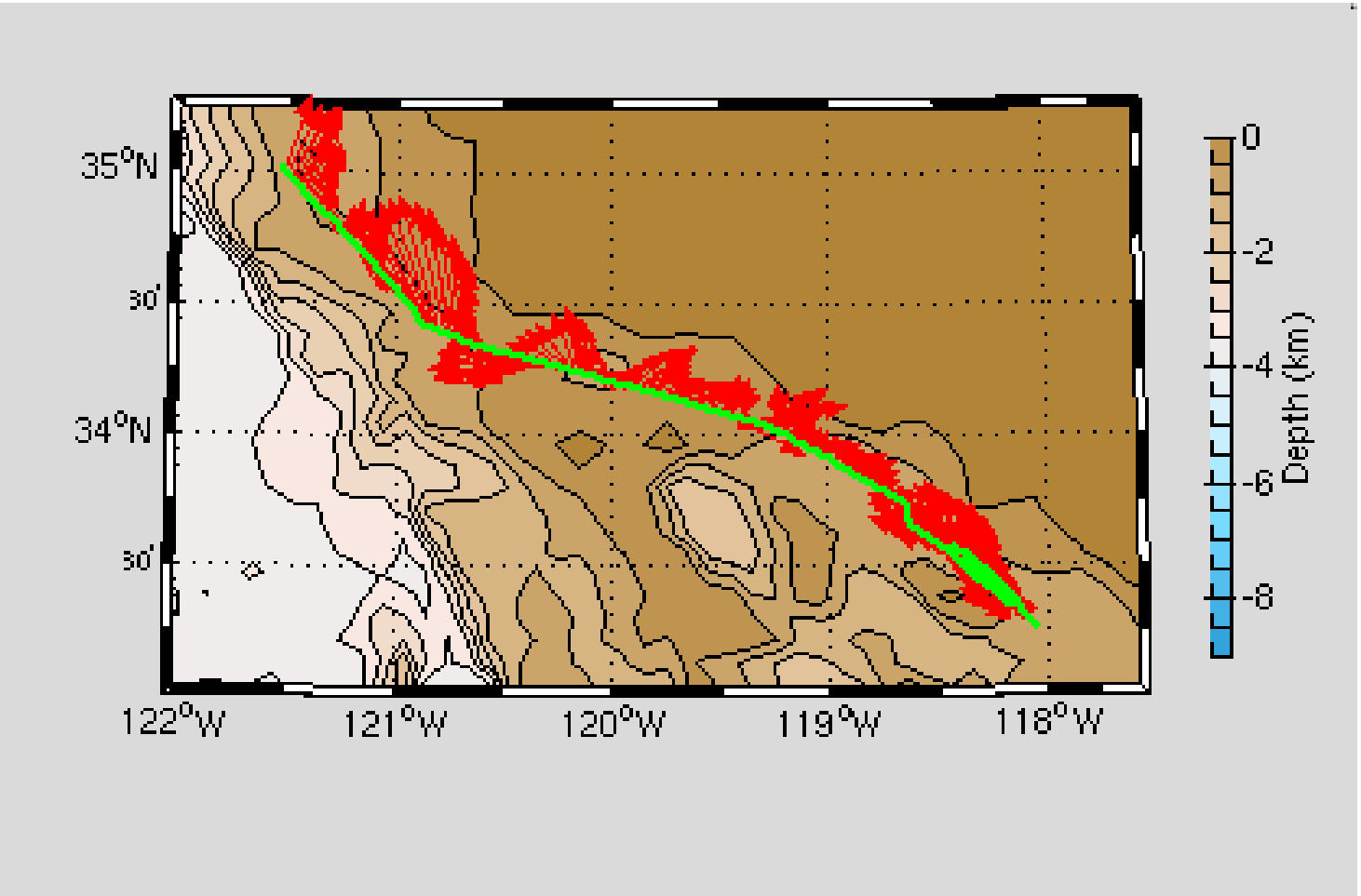
Calibration: angle error -3.6deg



Calibration: angle error -1.6



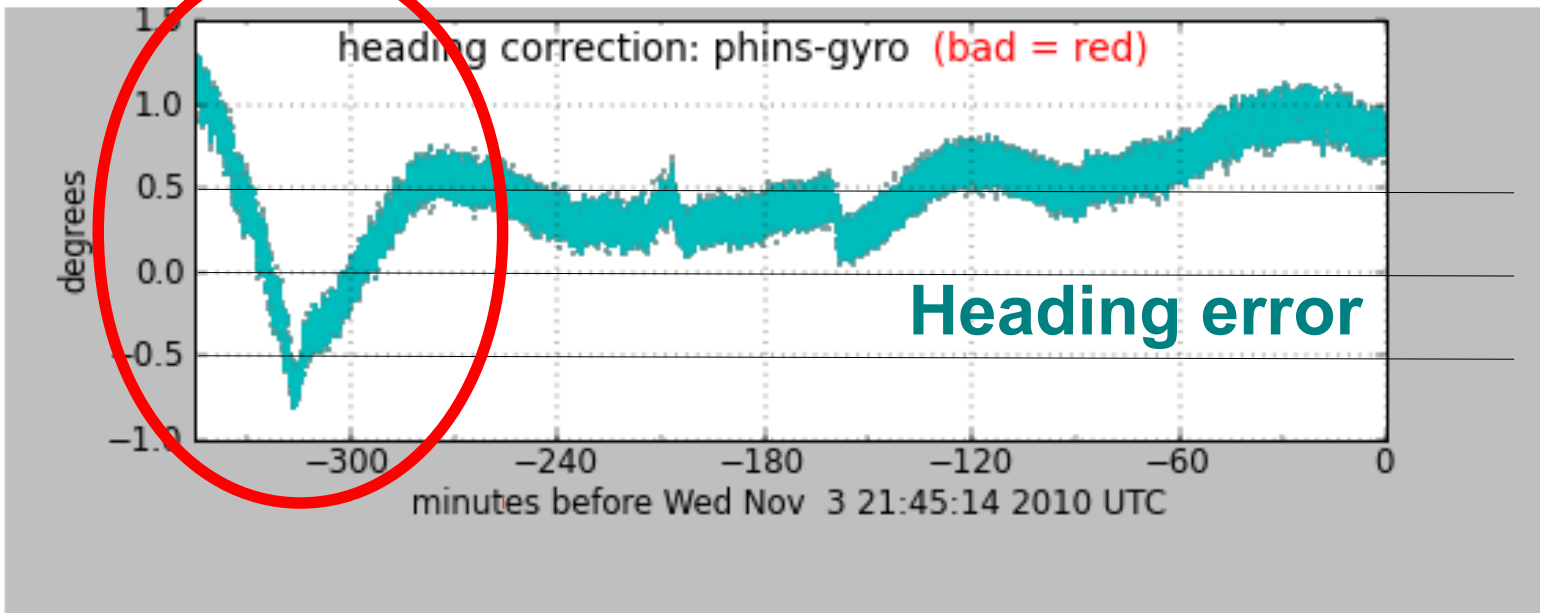
Calibration: angle error 0.4



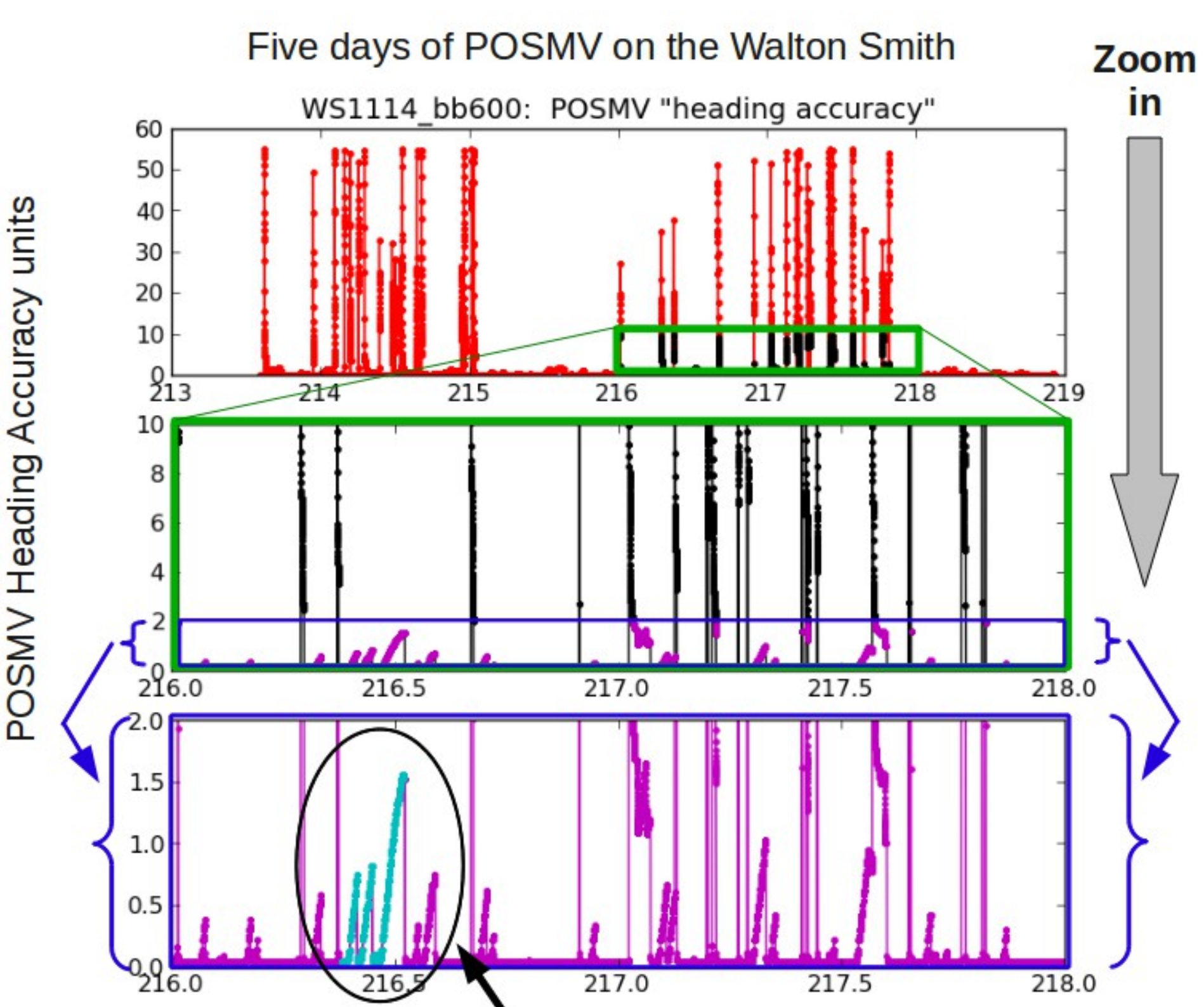
Effect of Time-Dependent Heading Error on Ocean Velocties

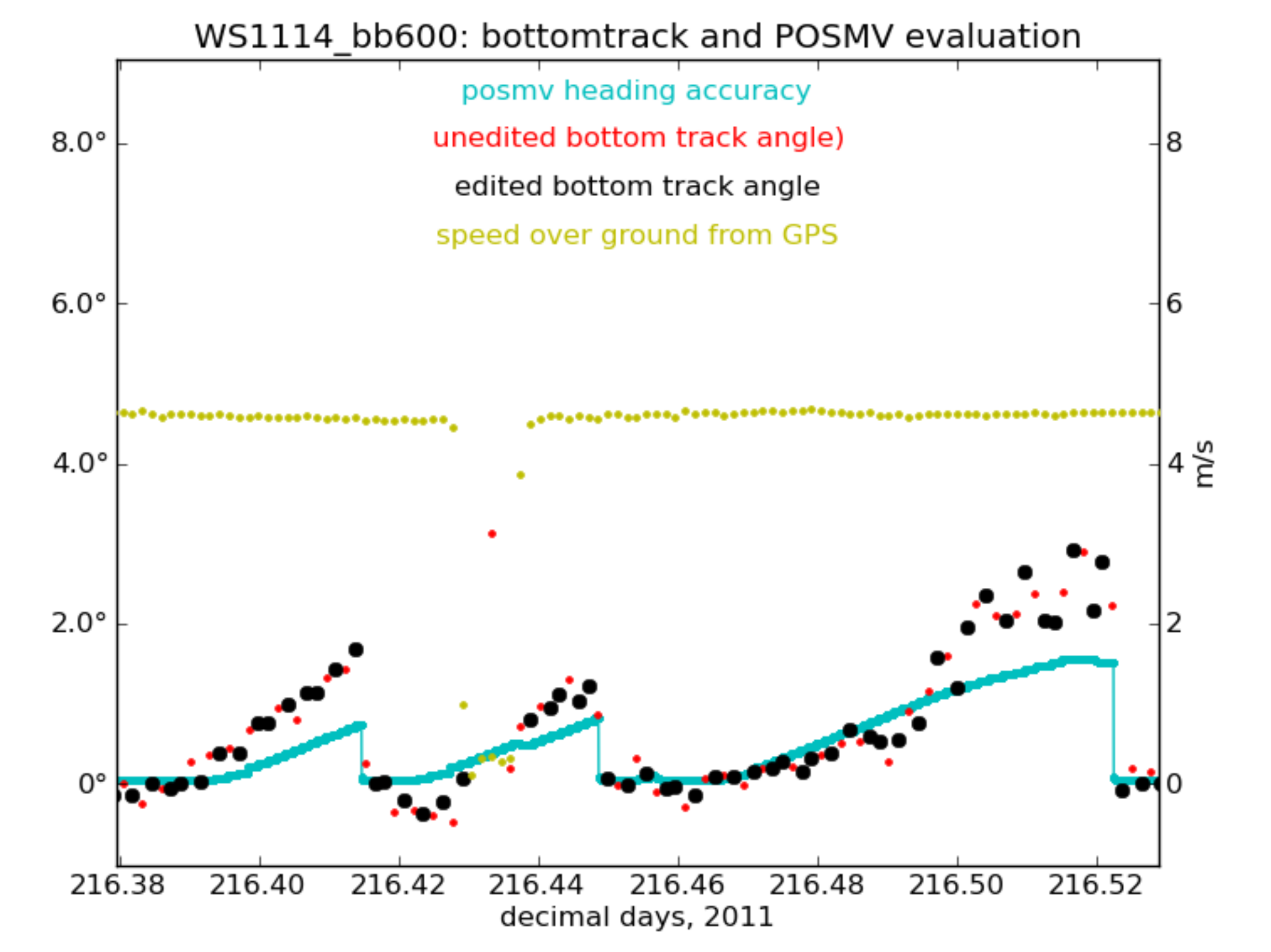
1 degree error in heading means:

- 0.1m/s error in ocean velocity
- in the cross-track direction



Changes in ship's heading affect heading error


Five days of POSMV on the Walton Smith
Zoom in
WS1114_bb600: POSMV "heading accuracy"
POSMV Heading Accuracy units
60
50
40
30
20
10
0
213
214
215
216
217
218
219
10
8
6
4
2
0
216.0
216.5
217.0
217.5
218.0
2.0
1.5
1.0
0.5
0.0
216.0
216.5
217.0
217.5
218.0


WS1114_bb600: bottomtrack and POSMV evaluation
posmv heading accuracy
unedited bottom track angle)
edited bottom track angle
speed over ground from GPS
8.0°
6.0°
4.0°
2.0°
0°
8
6
4
2
0
m/s
216.38
216.40
216.42
216.44
216.46
216.48
216.50
216.52
decimal days, 2011

Top 10 ways to damage ocean velocities

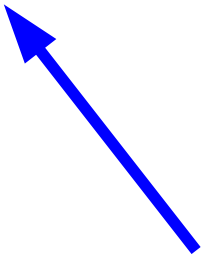
Problem: rotation to earth coordinates is wrong

- heading is inaccurate
- accurate heading is broken

- Symptom:
  - spurious cross-track velocities
- Short-term Solution:
  - only use on-station data

Long-Term solution

- get an accurate heading device with QC messages
- process using reliable first, then correct to accurate



General Category

Top 10 ways to damage ocean velocities

Specific Example

Problem: heading device is not accurate

- Symptom:
  - subtle spurious cross-track velocities
- Short Term Solution:
  - none
- Solution: Long Term:
  - buy an accurate heading device

Top 10 ways to damage ocean velocities

Problem: accurate heading device is not always good

- Case 1: NMEA message is $PRDID or $HEHDG
- Symptom:
  - subtle spurious cross-track velocities
- Short Term Solution:
  - none
- Solution: Long Term:
  - output an NMEA message with a QC indicator

Specific Example

Top 10 ways to damage ocean velocities

Problem: accurate heading device is not always good

- Case 2: NMEA message has a QC indicator
- Symptom:
  - subtle spurious cross-track velocities
- Solution:
  - single-ping processing using a reliable heading and correcting it my the mean offset (during the averages)
  - interpolate heading correction through the holes
  - CODAS processing has tool for this (patch_hcorr)

Specific Example

Top 10 ways to damage ocean velocities

Specific Example

Problem: wrong transducer alignment angle(*)

(affects conversion from instrument to ship coords)

- Symptom:
  - Unrealistic ocean velocities when ship is underway
  - Velocities vary with ship speed
- Solution: Short term:
  - post-processing – find the offset (CODAS calibrations)
  - post-processing – apply the correction
- Solution: Long Term:
  - Fix the transducer angle in the setup

(*) For VmDAS this would be the EA command

Top 10 ways to damage ocean velocities

Problem:

- wrong tilts converting from instrument to ship coords
- Symptom:
  - subtle
- Reality:
  - CODAS processing does not use tilts
  - VmDAS: no clue how they are using tilts
- Solution: Long Term:
  - Add tilts to CODAS processing

Top 10 ways to damage ocean velocities

Problem: no single-ping editing (see other slides)

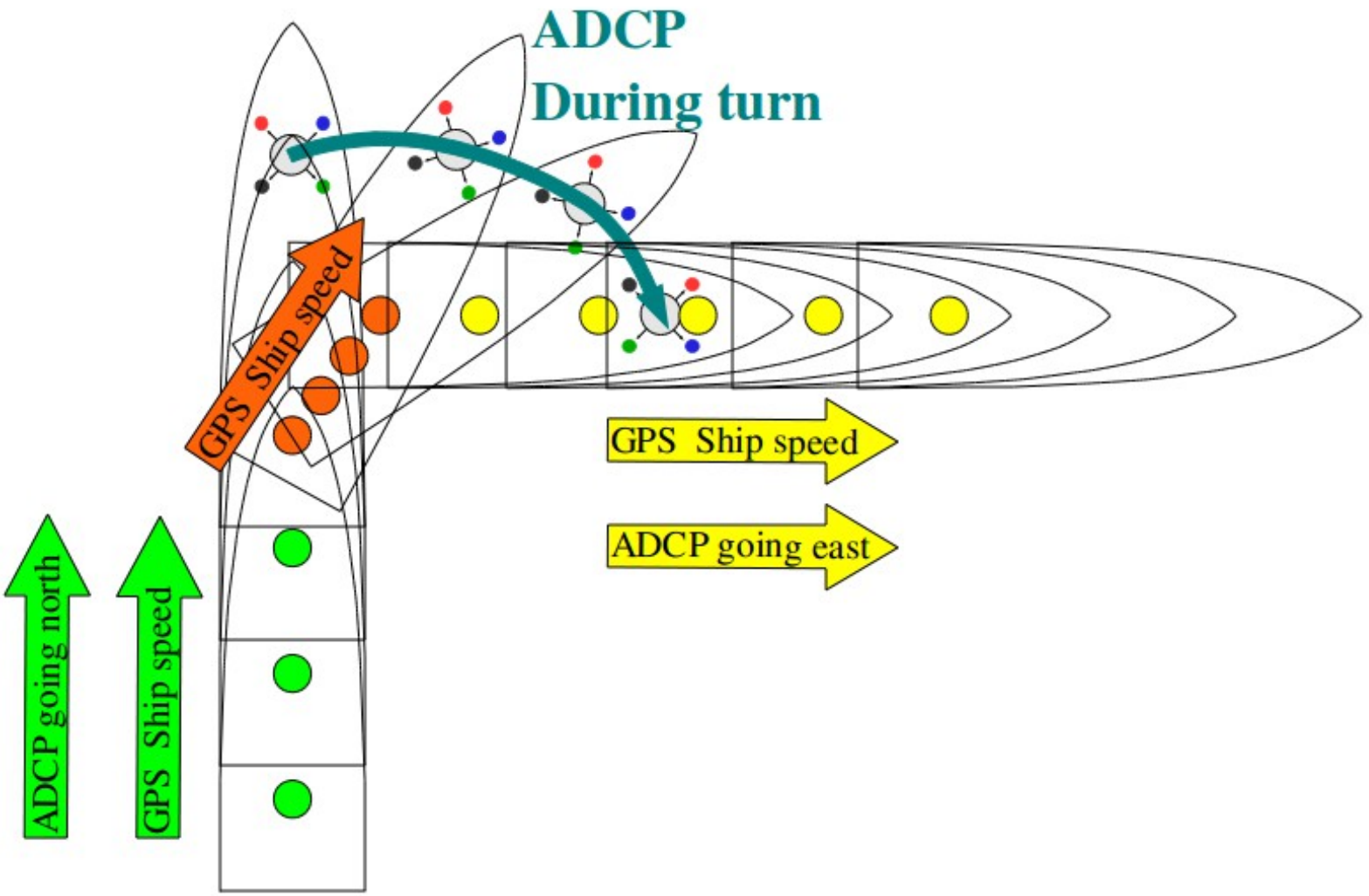
- Symptom:
  - bad velocities are used in the averages
    - bubbles, acoustic interference, data below the bottom
- Short Term solution:
  - CODAS single-ping processing
- Long Term solution:
  - Install UHDAS (CODAS preliminary processing at sea)

Top 10 ways to damage ocean velocities

Problem: horizontal offset between ADCP and GPS

- Symptom:
  - spurious spikes in velocity when coming on/off station
- Short Term Solution:
  - correct with post-processing calibration step
- Long Term Solution:
  - UHDAS does this automatically (part of configuration)

Example: offset between ADCP and GPS creates an artifact during maneuvering

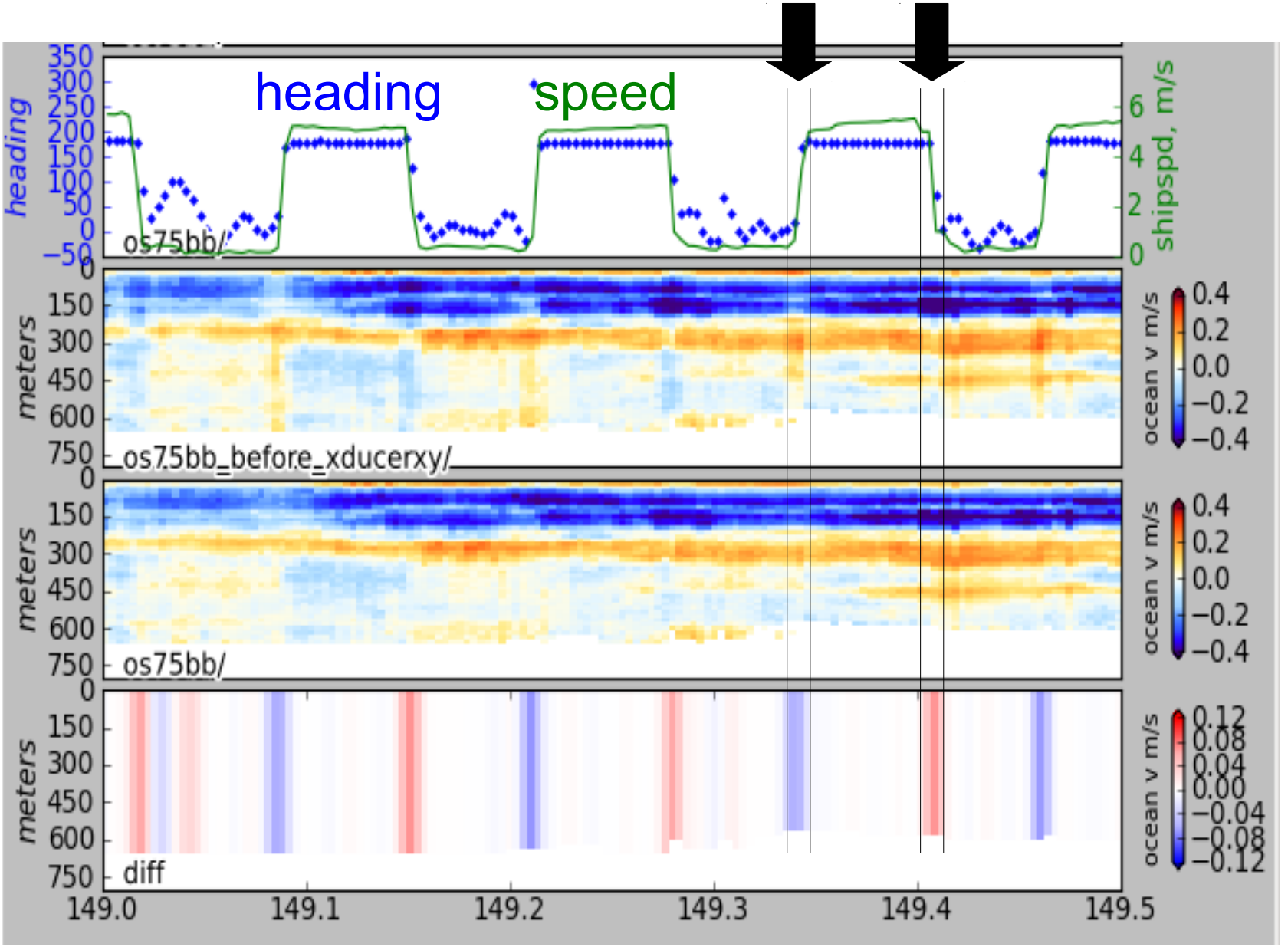


Transducer offset from GPS--error occurs: **transition** between on-station and underway

...using actual location

...using shifted GPS location

difference



Top 10 ways to damage ocean velocities

Problem: ship speed does not represent data

- Symptom:
  - underway biases in the along-track direction (bad PG)
- Short Term solution:
  - Experimental CODAS alternative ship speed
- Long Term Solution:
  - Test, implement; make it part of CODAS processing

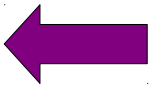
Experimental algorithm:

under construction

Summary

- Get the right feeds
  - with checksums, original NMEA messages, with QC
  - reliable heading, AND also accurate heading
- Get Computer clock right (UTC, no jumps)
- Do the best processing
- Assess the results
- Fix the settings
- Monitor to keep things working

UHDAS - What it does (follow the data)

(1) Acquisition  ADCP+position+heading

(2) Processing

(3) Data Access

- At Sea
- On Land (after the cruise)

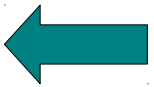
(4) Monitoring

At Sea

On Land

UHDAS - What it does (follow the data)

(1) Acquisition

(2) Processing  **CODAS**

(3) Data Access

- At Sea
- On Land (after the cruise)

(4) Monitoring

At Sea

On Land

UHDAS: What it does

- **(2) Preliminary Processing** ⟸ **CODAS**

- single-ping:
  - transformations, single-ping editing
  - time-dependent heading correction

- averaging

- calibration of averages
  - transducer angle: watertrack, bottom track
  - ADCP-GPS horizontal offset

UHDAS: What it does:

(3) Data Access...

- web site on ship with
  - plots for science and operations
  - full-resolution data (matlab, netcdf, CODAS)
- on land (in the cruise directory)
  - full-resolution data (matlab, netcdf, CODAS)
  - archive of figures from cruise

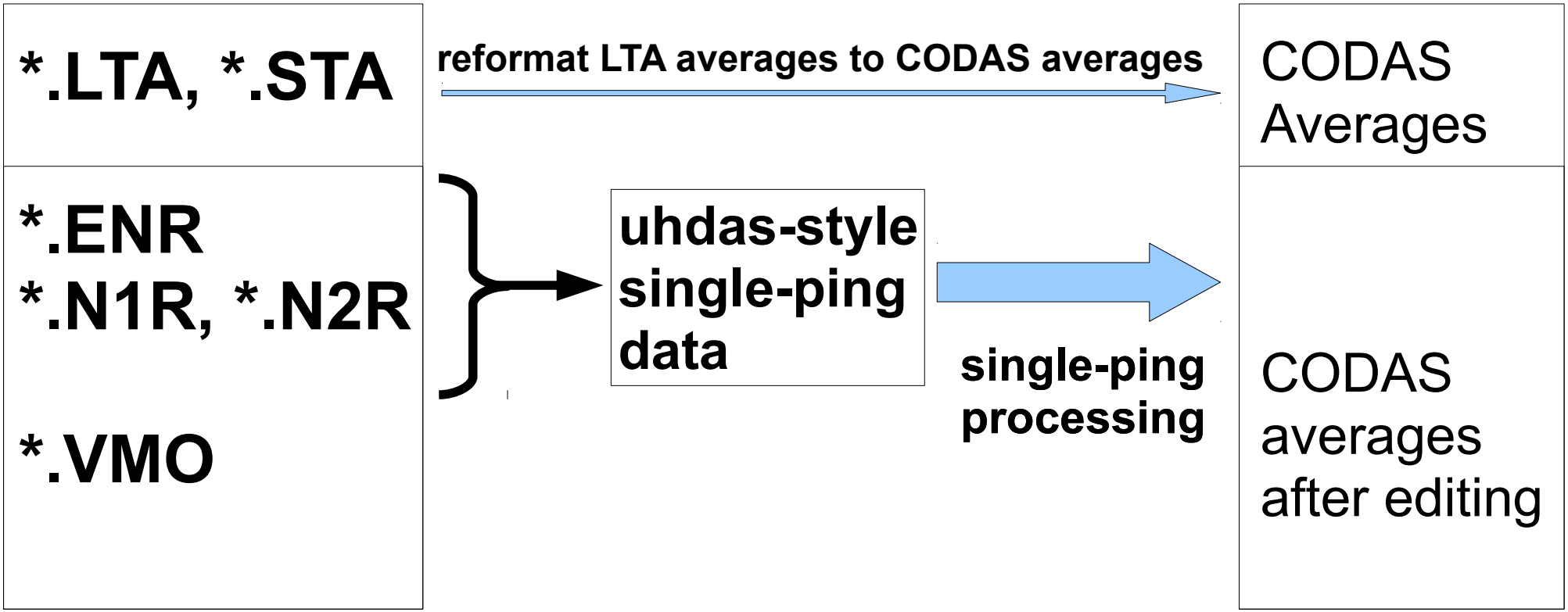
UHDAS: What it does

(4) Monitoring...

- **at sea:**
  - data acquisition (UHDAS GUI tool)
  - processing
  - health of accurate heading device
- **from shore: (uhdas.org)**
  - sends daily email with attachment for review
  - diagnostic files
  - data snippet for shore-based figures for review

green=good red=rubbish
web site figures
web site figures

Quick demo for VmDAS data: adcp_database_maker.py



… view with dataviewer.py