UHDAS training Nov 14,15 (2019)

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http://uhdas.org

UHDAS + CODAS Documentation

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

- UHDAS at sea:
  - What it does; compare to VmDAS
  - How to drive it
  - Where the figures are
  - Where the files go
  - Most common modifications

Acquisition and Operations

  - CODAS processing

Processing

  - How to read the daily emails

Monitoring

- UHDAS on land:
  - How to read the daily emails
  - Ticketing Tour (Friday Morning)
  - Post-processing hands-on demo (Friday Afternoon)

Processin

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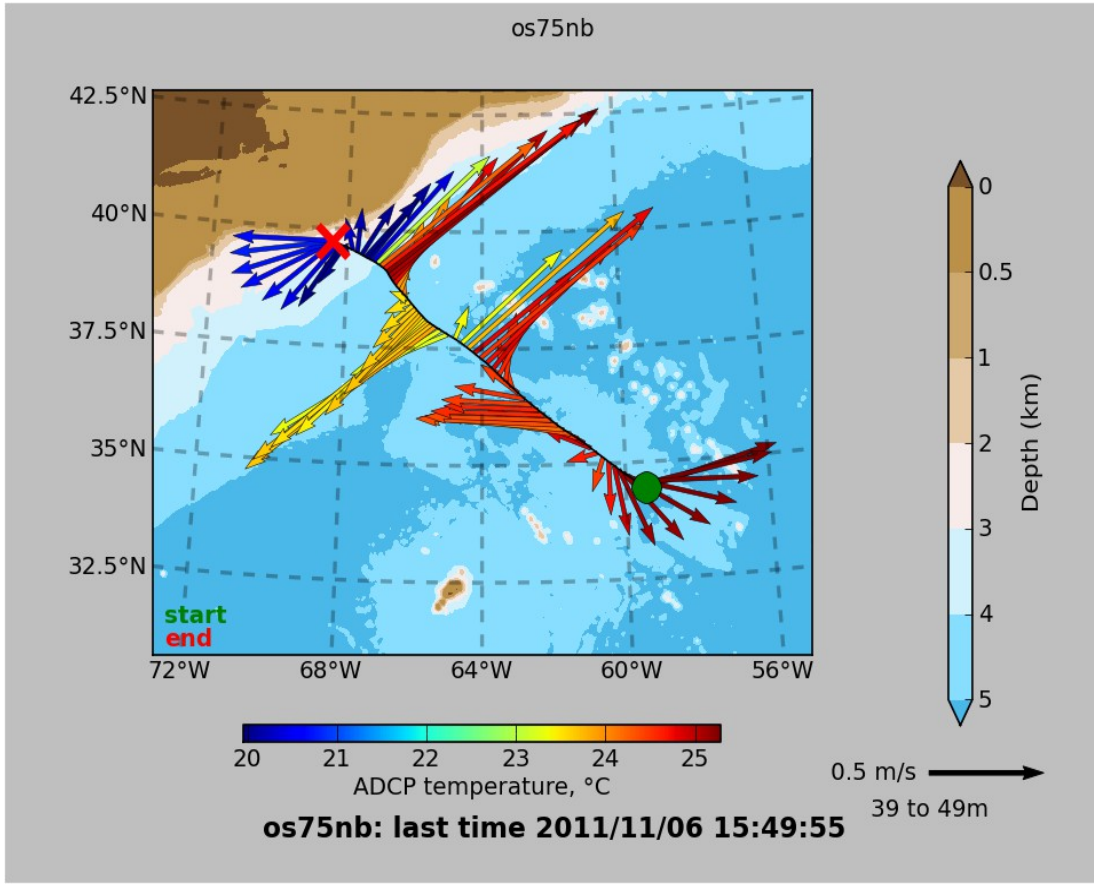
Processin

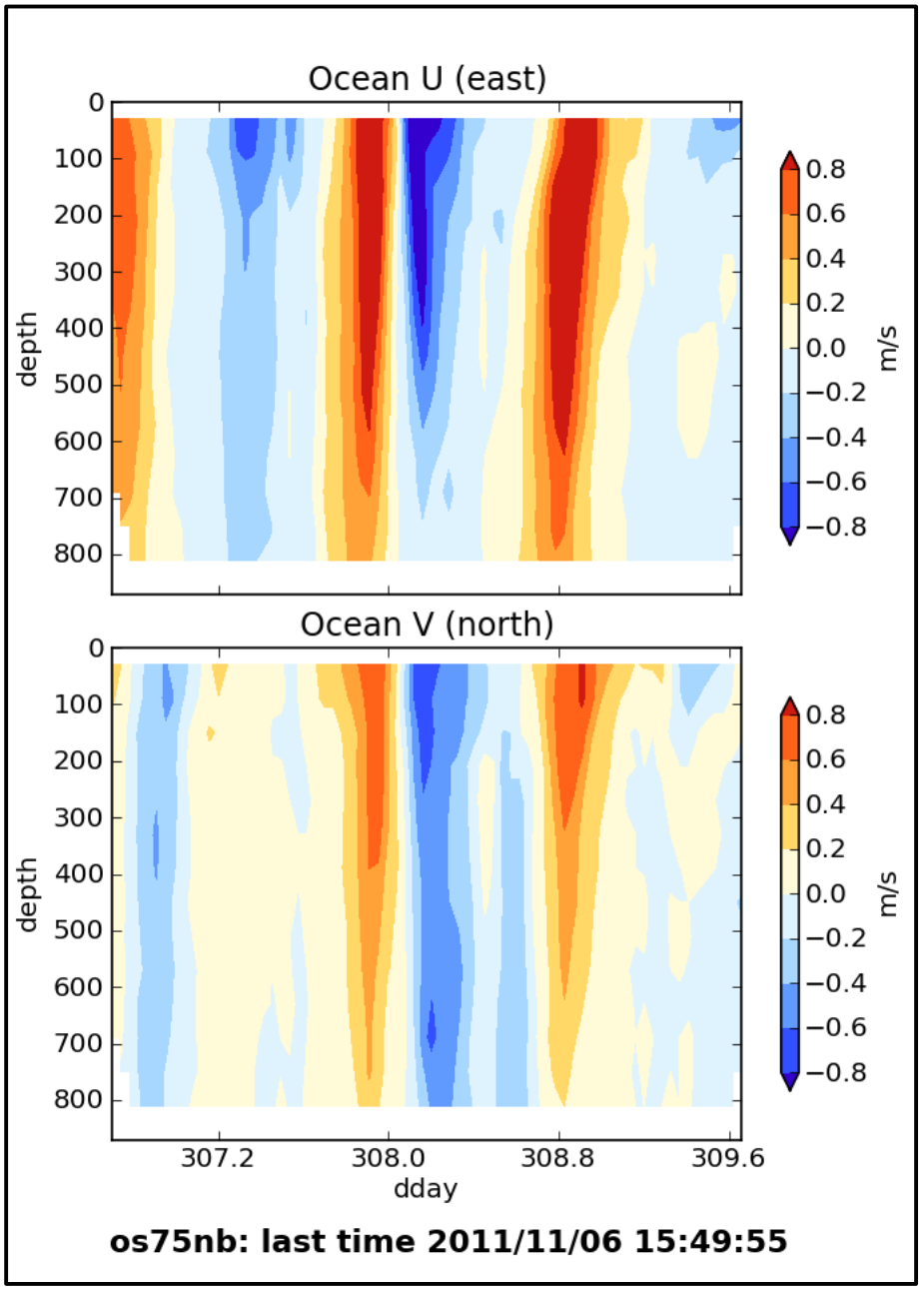
- Short overview; compare to VmDAS
- Tour of UHDAS
  - How to drive it (UHDAS GUI Tour)
- Where the figures are
  - How to read them
- Where the files go
  - data files
  - Introduction to /home/adcp
  - Tour of configuration files (“config” directory)
- What can be changed (what is required)
- How to read the daily emails

The Goal: science-ready ocean currents

Time, ADCP, Position, Attitude

primitive (raw) data





UHDAS - What it does (follow the data)

(1) Acquisition ⟸ ADCP+position+heading

(2) Processing

(3) Data Access

- At Sea
- On Land (after the cruise)

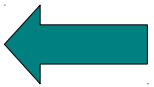
(4) Monitoring

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:

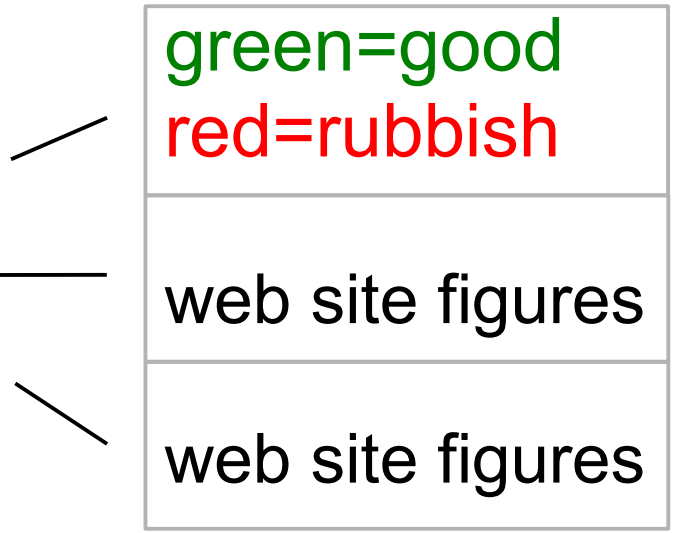
(3) Data Access...

- 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:**
  - sends daily email with attachment for review
  - diagnostic files
  - data snippet for shore-based figures for review



DATA ACQUISITION

Time, ADCP,
Position,
Attitude

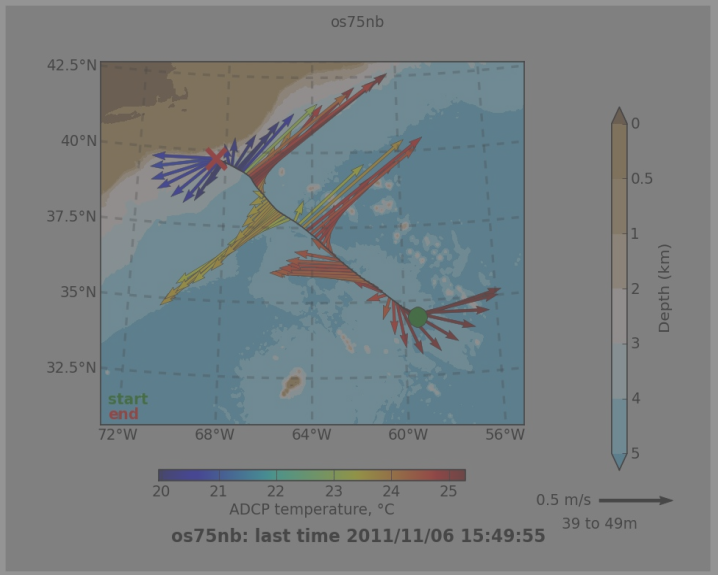
primitive (raw) data

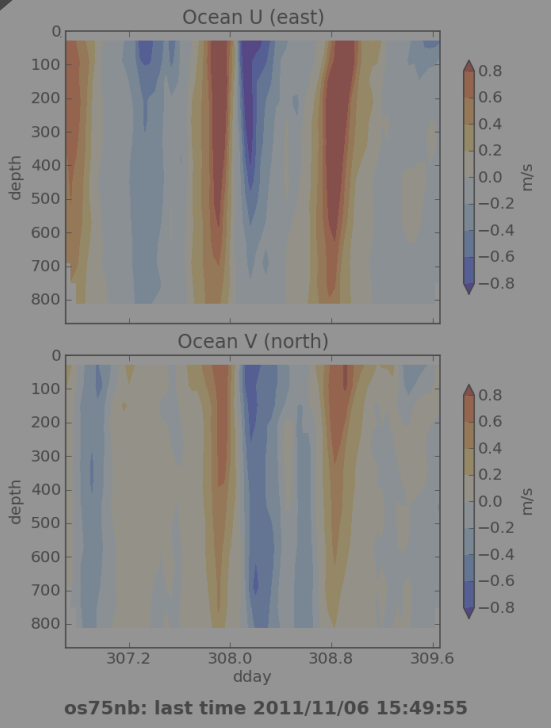
Time
ADCP
Position
Heading

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

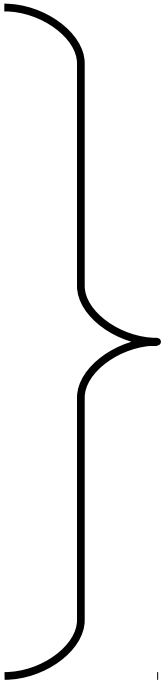
  - Installed on UNOLS ships, most NOAA ships, +7 more
  - Link to UHDAS **Table of ships**

Components – Overview:

- Basic requirements
- Processing
- Monitoring

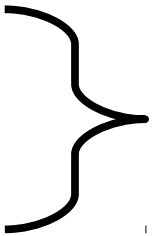
ADCP Acquisition Systems: Overview

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



Core

- Processing
- Monitoring



Extra

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	---

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	--

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- Where the figures are
  - How to read them
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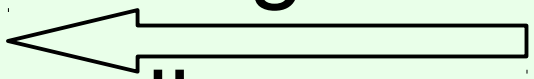
Running UHDAS

- UHDAS GUI tour
  - Start GUI
  - Start Cruise
    - change settings
  - Start Recording
  - Stop Recording
  - End Cruise



- Stop Recording
- Change settings
- Start Recording

- Files updated during data acquisition

Live demo on a fake ship

- ssh in to the remote system
- share the desktop
- communicate with the ADCP (run diagnostics)
- run UHDAS, see where the files go
  - `/home/adcp/cruise`
  - `/home/adcp/log`
  - `/home/adcp/config`
  - `/home/data/`

UHDAS at sea

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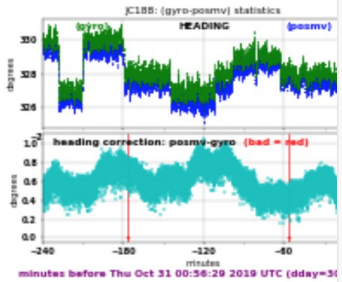
James Cook At-Sea web site (**example**)

HOME

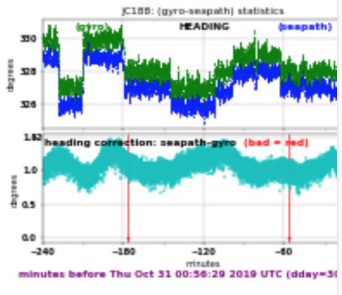
Monitoring: click opens a new figure

Attitude Devices

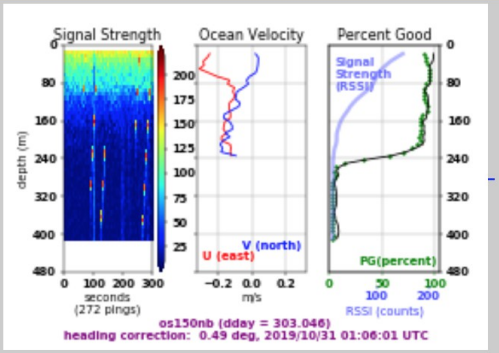
- posmv-gyro comparison (thumbnail)



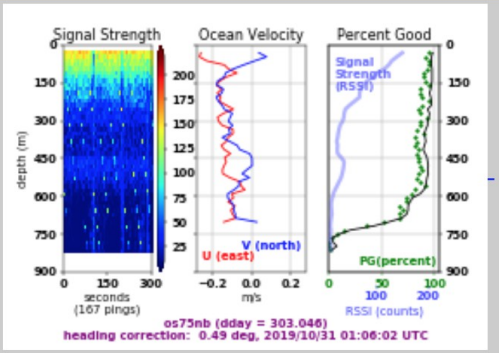
- seapath-gyro comparison (thumbnail)



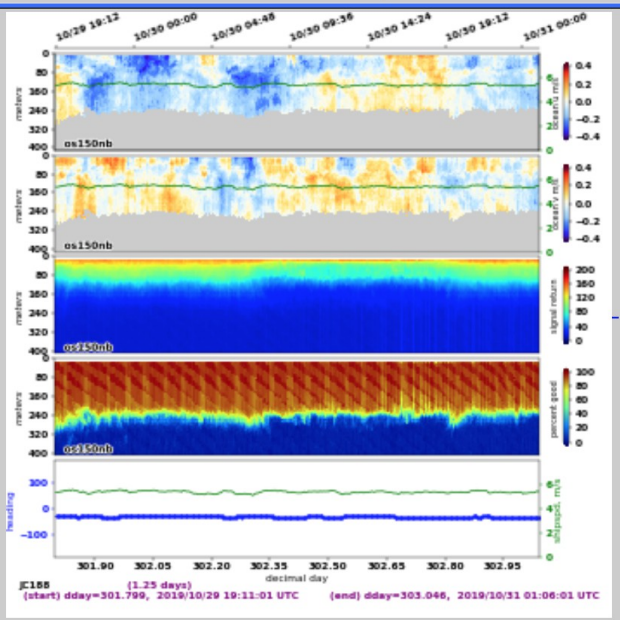
ADCP Thumbnails



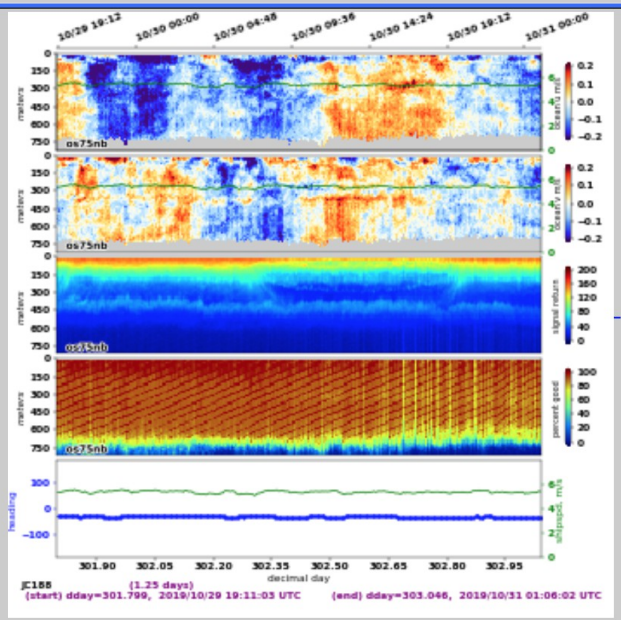
os150nb 5-minute profile



os75nb 5-minute profile



os150nb hi-resolution (time)



os75nb hi-resolution (time)

link to: at-sea web page

UHDAS at sea

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data = "**cruise directory**"

contents of /home/data/JC188

subdirectory	contents	importance	back up for …
raw	all raw data	critical	archiving
rbin	intermediate files	nice to have	anyone who gets 'raw'
gbin	intermediate files	nice to have	anyone who gets 'raw'
proc	processed data • CODAS database • underway figure archive • matlab files	final at-sea product	science CD after cruise
reports	mini-webpage with metadata and overview of processed data	nice to have (only in modern cruise directories)	science CD after cruise

- Do not alter ANYTHING in the data directory

link to more details

contents of /home/adcp

- These are all required directories

```
adcp_install_docs # notes about changes
config            # configuration files
daily_report      # staged tarball items
Desktop           # (gotta have it)
flags             # status indicators
log               # log files accreted
mail_buffer       # email staged here
morgue            # old logfiles
scripts           # home-brewed executables
tmp               # for large temporary files
uhdas_tmp         # files staged for web site
www               # web site
```

/home/adcp/config

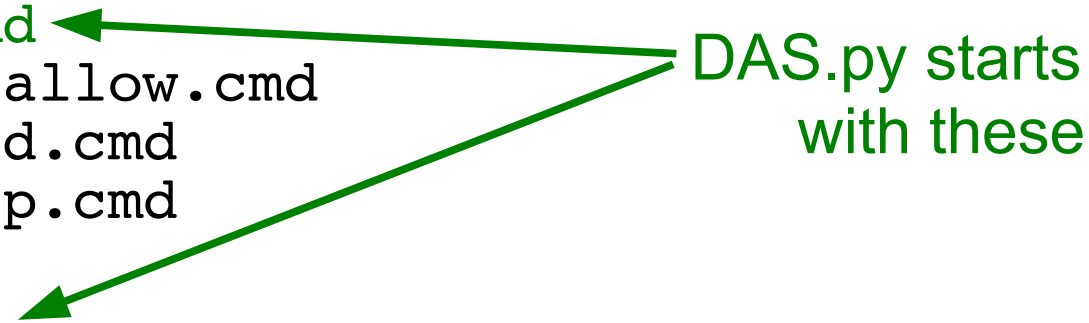
ADCP instrument settings, acquisition, and processing

config:

```
proc_cfg.py                    # processing configuration
sensor_cfg.py                  # acquisition configuration
uhdas_cfg.py                   # other configurations (eg.
                               #  backups, email)

config/cmdfiles:               # instrument configurations
os150_default.cmd
os150_highres_shallow.cmd
os150_interleaved.cmd
os150_lowres_deep.cmd

os75_default.cmd
os75_highres_shallow.cmd
os75_interleaved.cmd
os75_lowres_deep.cmd
```



sensor_cfg.py (settings for acquisition)

- `use_publishers=True #(zmq) or False`
- sets ADCP settings for 2-way communication
- sets all “read-only” communication (ADCP+NMEA)
  - port
  - baud rate
  - strings to acquire
  - “messages” to parse (for rbins)
- speedlog configuration block
- publishers block

proc_cfg.py (settings for processing)

- position (instrument and message)
- reliable heading (instrument and message)
- accurate heading (instrument and message)
- other heading devices to monitor
- transducer alignment ("**`h_align`**") for each ADCP
- transducer depth

The following variables are also set for at-sea processing (for re-processing after the cruise, these go in q_py.cnt

- averaging length (seconds, usually 300s=5min)
- transducer-gps horizontal offset (meters)

uhdas_cfg.py: other settings (email, backups)

- backup to /disk2/home
- sometimes backup to network-attached disk
- timing for making plots, timing for backups
- some settings for web plots
- email setup (SMTP, users)

logfiles (for troubleshooting)

```
DAS_main.log                    # new cruise,
                                # stop/start recording
                                # parameters sent to ADCPs

DAS_while_cruise.log            # backup, rsync to 'reports'

DAS_speedlog.log                # speedlog (www port)

Cruise_JC188.log                # subset of DAS_main.log
                                # for this specific cruise
```

```
daily.py.log                    # generate/send of email
send_buffered_email.log         # send buffered email
```

```
termos150log2019_264_41654.txt # dialog with os150
termos75log2019_264_41654.txt  # dialog with os75
```

```
asc2bin.log                     # conversion of NMEA to rbin
```

```
(all others)                    # processing, making plots
```

Most common modifications

sensor_cfg.py

- baud rate
- add NMEA feed (new instrument)
- change NMEA string

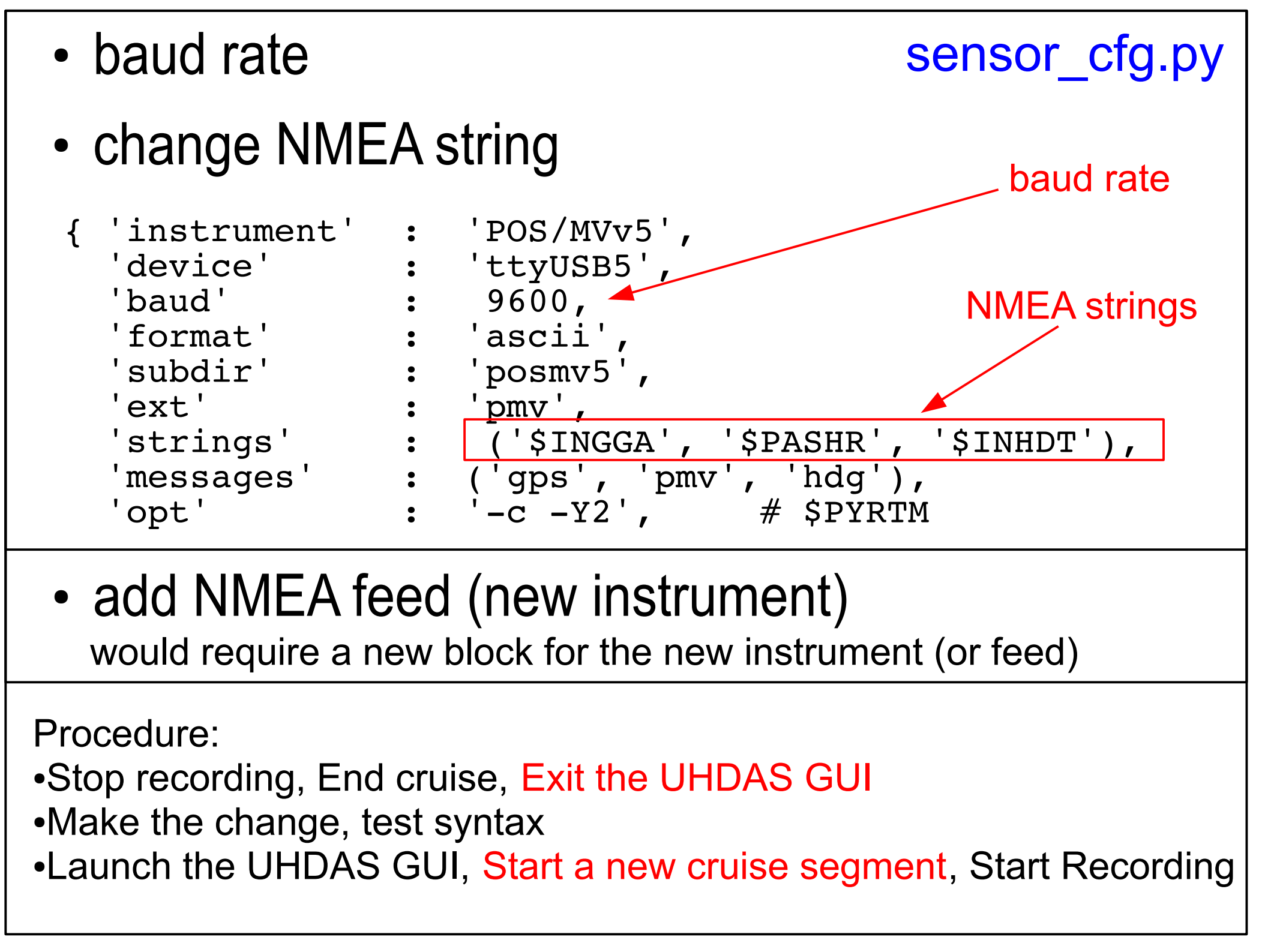
proc_cfg.py

- calibration (re-install an instrument)
  - transducer angle
  - transducer-gps horizontal offset
- change position used from GPS1 to GPS2
- disable 1 beam (if a beam fails)

- baud rate
- change NMEA string

sensor_cfg.py

```
{ 'instrument'   :   'POS/MVv5',
  'device'       :   'ttyUSB5',
  'baud'         :    9600,
  'format'       :   'ascii',
  'subdir'       :   'posmv5',
  'ext'          :   'pmv',
  'strings'      :    ('$INGGA', '$PASHR', '$INHDT'),
  'messages'     :   ('gps', 'pmv', 'hdg'),
  'opt'          :   '-c -Y2',      # $PYRTM
```



- add NMEA feed (new instrument)

  would require a new block for the new instrument (or feed)

Procedure:

•Stop recording, End cruise, Exit the UHDAS GUI

•Make the change, test syntax

•Launch the UHDAS GUI, Start a new cruise segment, Start Recording

modifications related to processing

- calibration (re-install an instrument)
  - transducer angle
- change position instrument from GPS1 to GPS2
- calibration (position source changes)
  - transducer-gps horizontal offset
- disable one beam (if a beam fails)

Procedure:
•Stop recording, End cruise, Exit the UHDAS GUI
•Make the change, test syntax
•Launch the UHDAS GUI, Start a new cruise segment, Start Recording

modifications related to processing

- change position instrument from GPS1 to GPS2
  - look in sensor_cfg.py to see what GPS devices exist
  - change **`pos_inst`**, **`pos_msg`** to match (in **`proc_cfg.py`**)
- collect data, wait for sufficient calibration values

- look at (**`xducer_dx, xducer_dy)`** in cals.txt
- if adjustment required, add the residuals to the values in proc_cfg.py

Procedure (for either change):

•Stop recording, End cruise, Exit the UHDAS GUI

•Make the change, test syntax

•Launch the UHDAS GUI, Start a new cruise segment, Start Recording

modifications related to processing

- disable one beam (if a beam fails)

In **`proc_cfg.py`**, add a block like this:

```
## bad beam is 1,2,3,4
badbeam = dict(
          os75bb = None,
          os75nb = None,
          os150nb = 3,
          os150bb = 3,
      )
```

Eg. if beam 3 is bad

Procedure:

- Stop recording, End cruise, Exit the UHDAS GUI
- Make the change, test syntax
- Launch the UHDAS GUI, Start a new cruise segment, Start Recording

Documentation related to the UHDAS server

UHDAS at Sea

- Monitoring the System
- Troubleshooting
- HOWTOs
- UHDAS Computer

Tea break??

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- UHDAS on land:
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Processing

DATA ACQUISITION

Time, ADCP, Position, Attitude

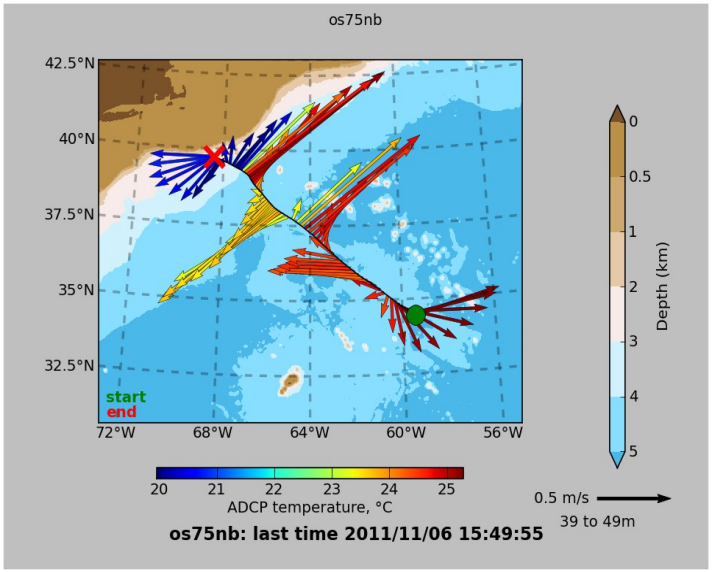
primitive (raw) data

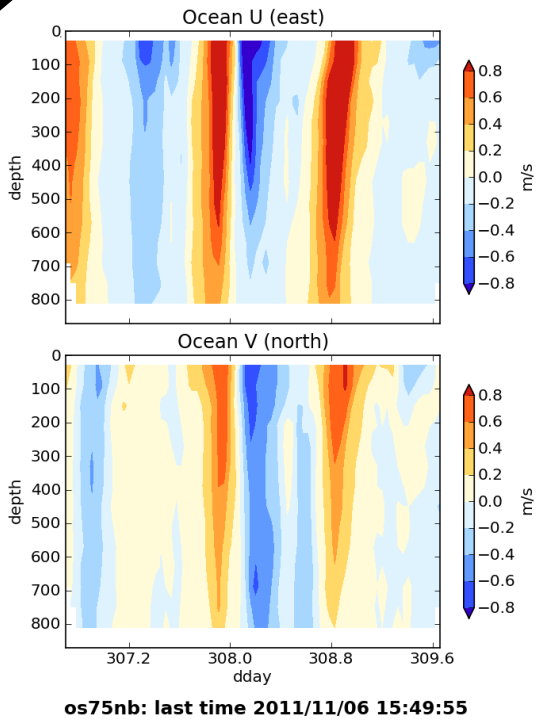
Time
ADCP
Position
Heading

Timestamp, Write to disk

DATA PROCESSING

(Data Products)
(Visualization)





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

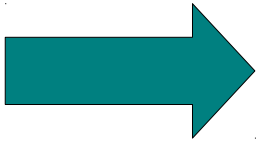
(1) **Preliminary processing single-ping data**

- 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 preliminary processing

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

} Automated at-sea processing

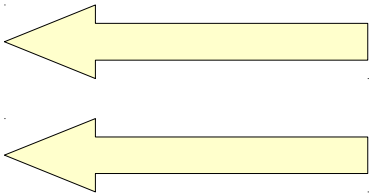
- Fix time-dependent heading correction (eg. if gaps)
- Apply calibrations
  - Rotation
  - Scale factor
  - Horizontal offset between GPS and ADCP (new)
- Manually edit CODAS database averages

post-processing = Manually, AFTER AVERAGING

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

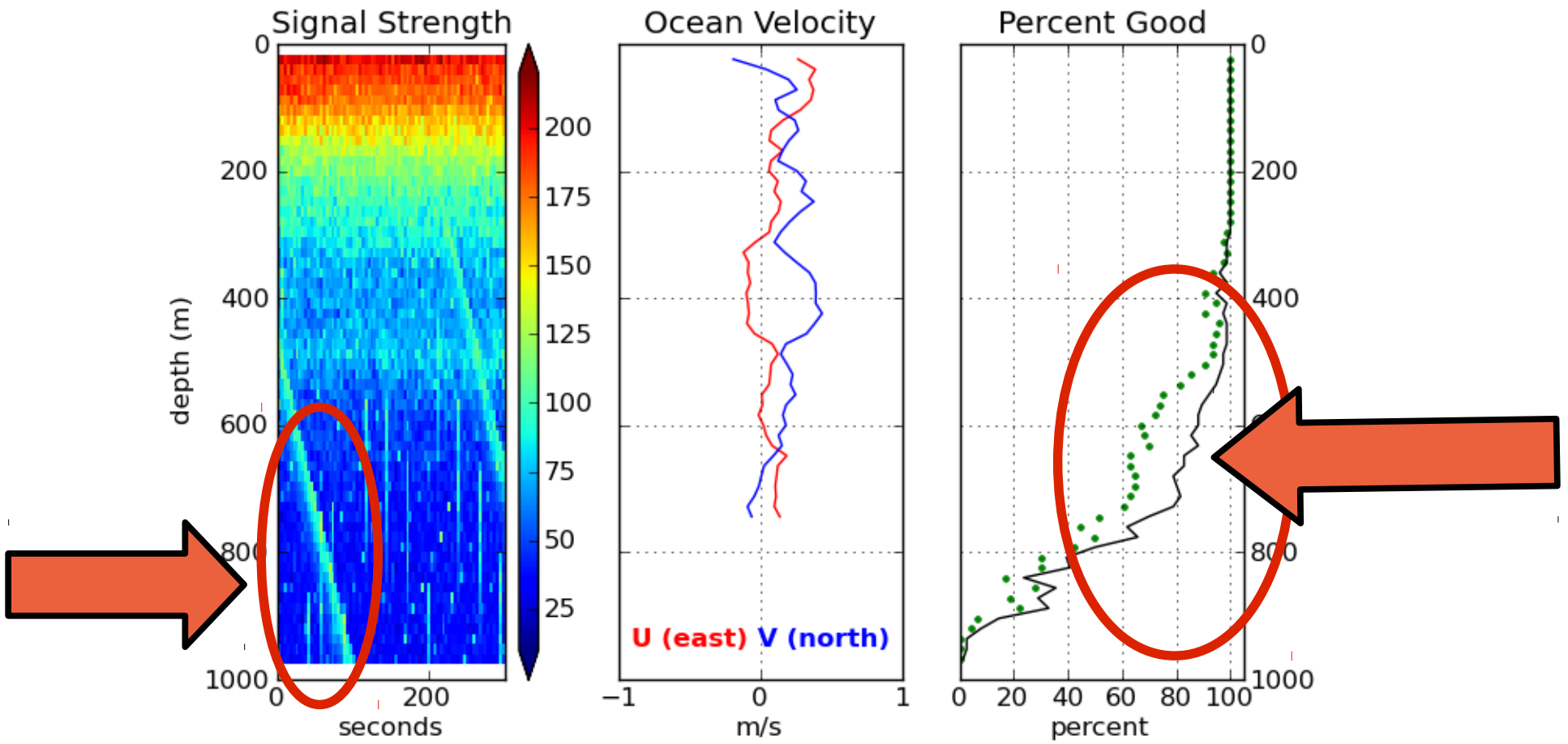
ADCP Single-ping Editing

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

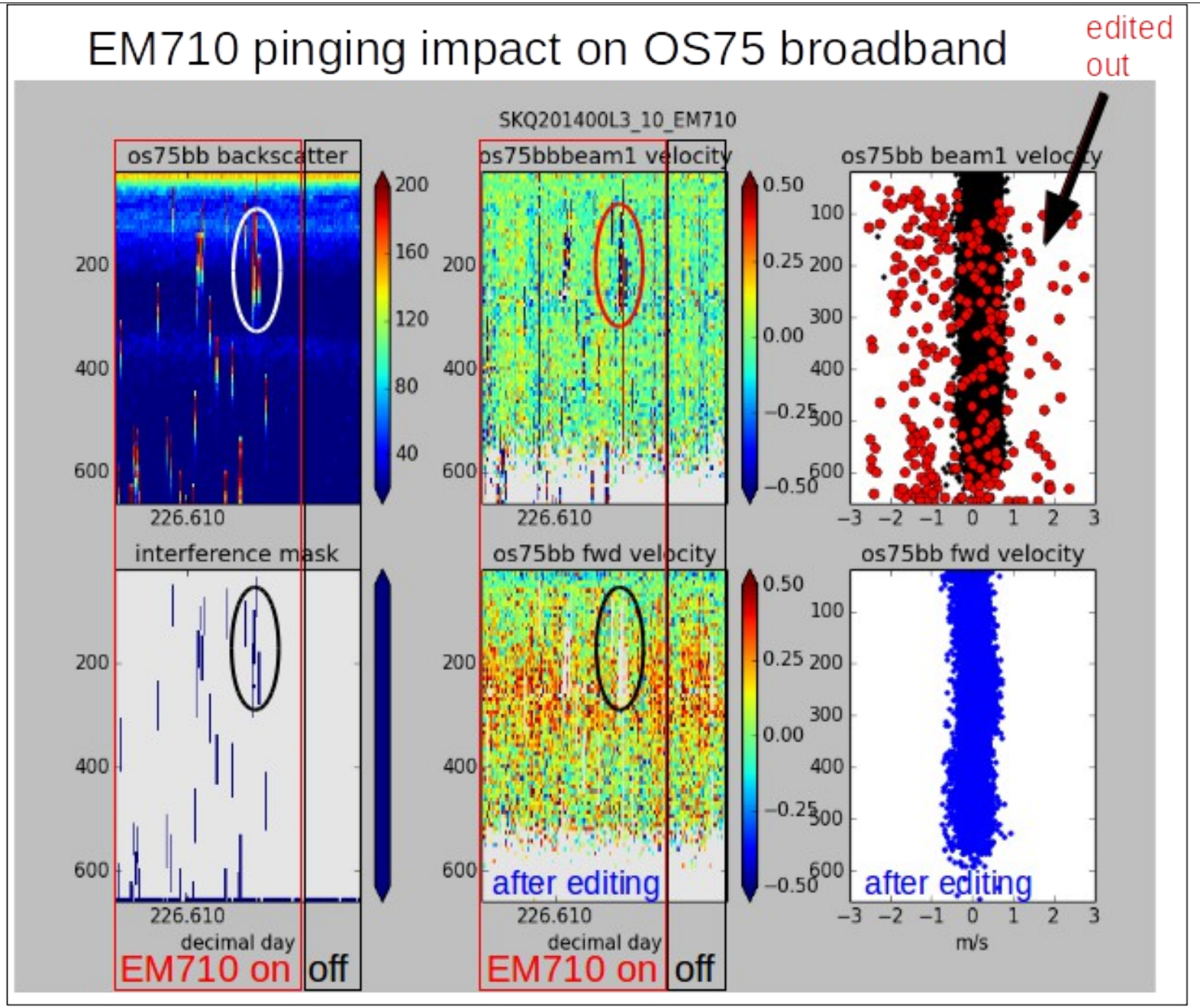
- Acoustic Interference
- Bubbles
- Below bottom

ADCP Processing

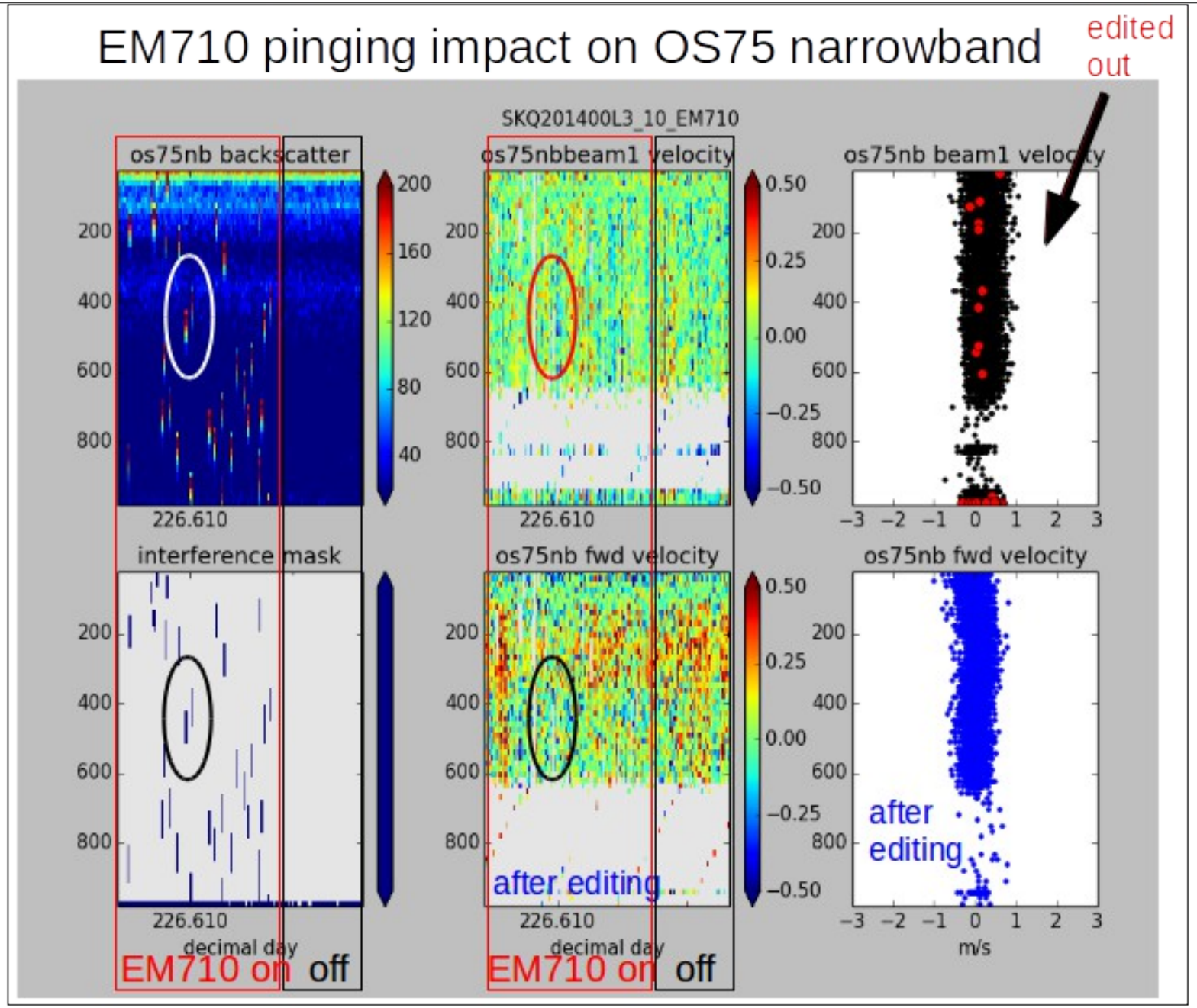
Singleping editing: acoustic interference



ADCP Processing: editing out interference



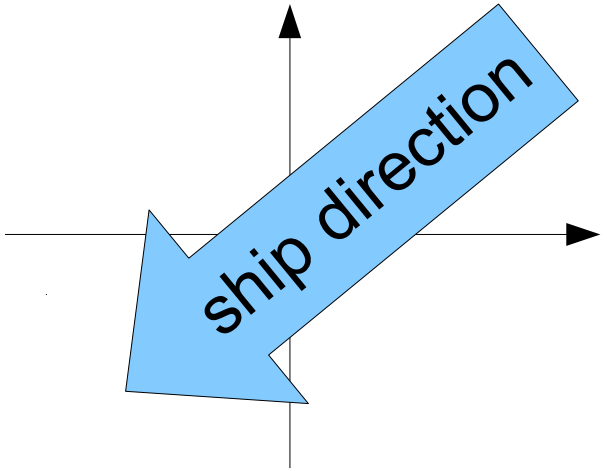
ADCP Processing: editing out interference

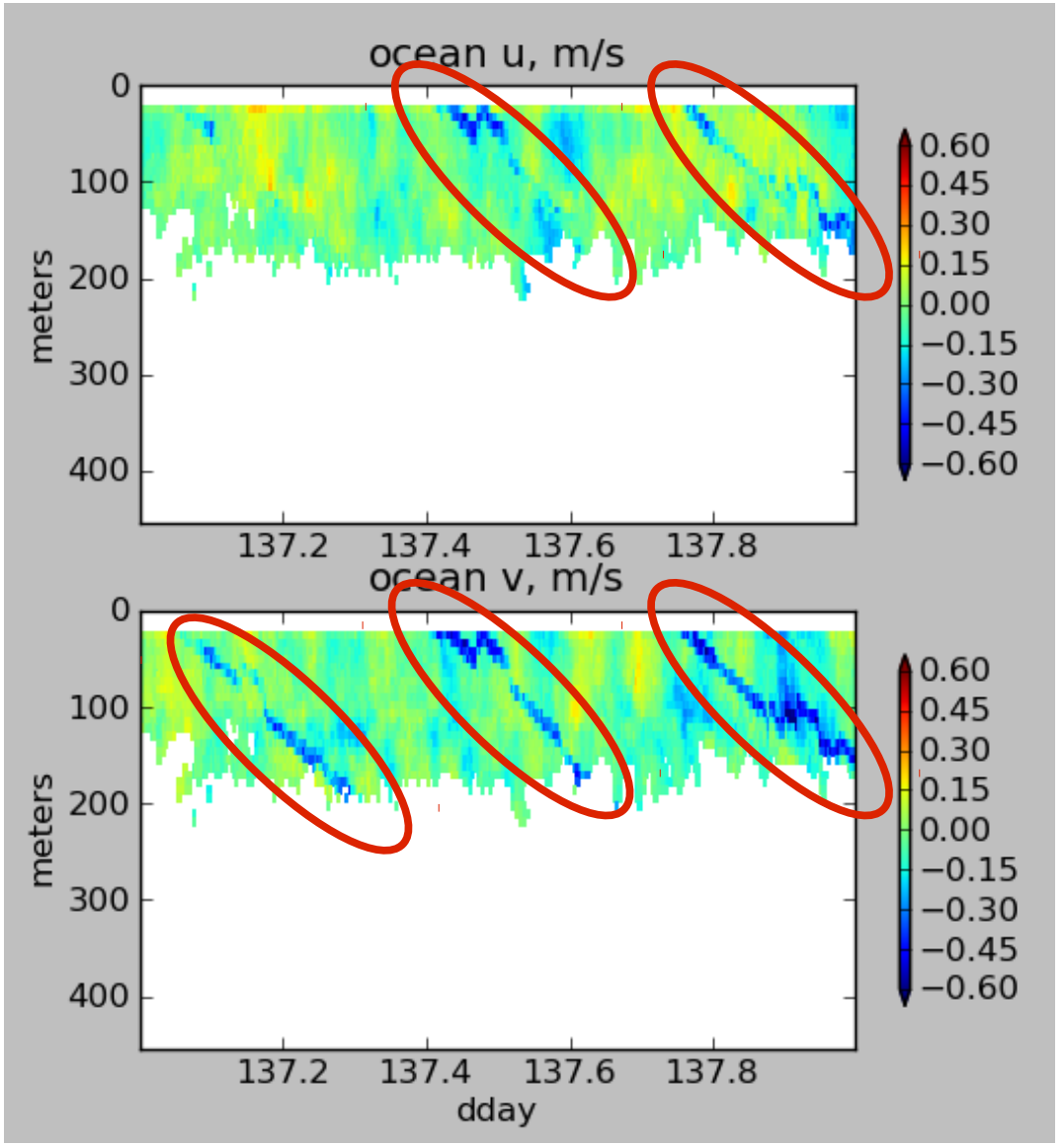


ADCP Processing **without** singleping editing

Averaged
ocean velocities

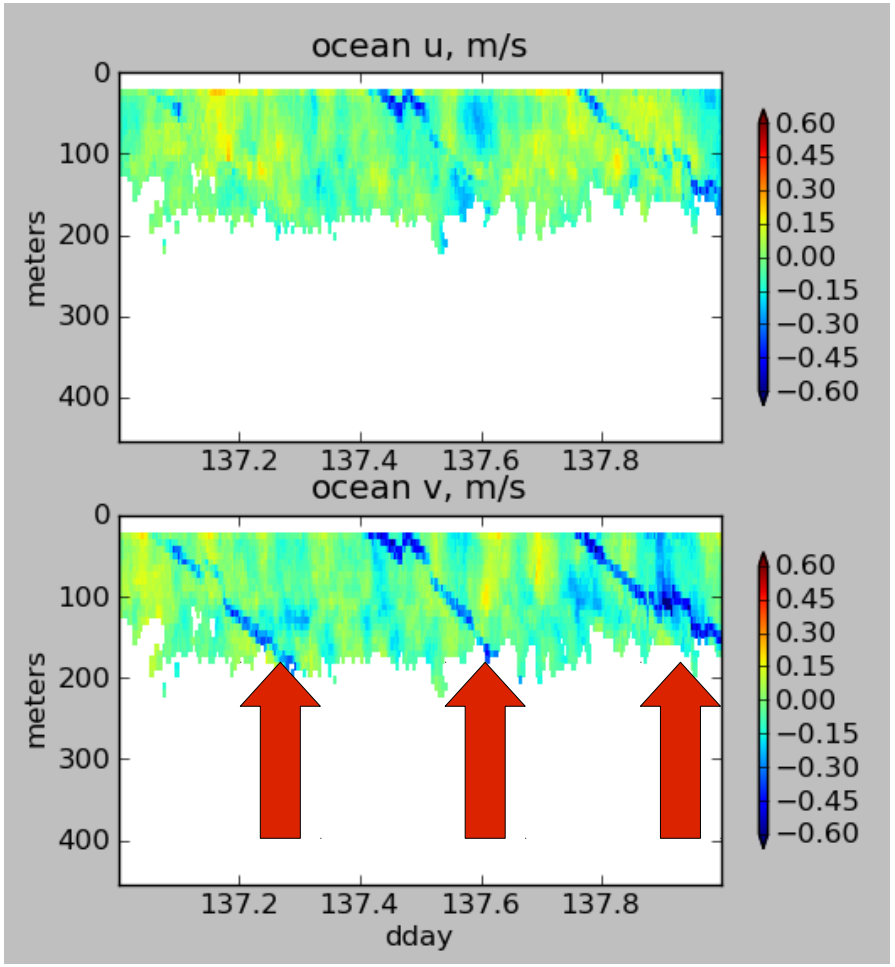
NOTE: along-track
direction bias



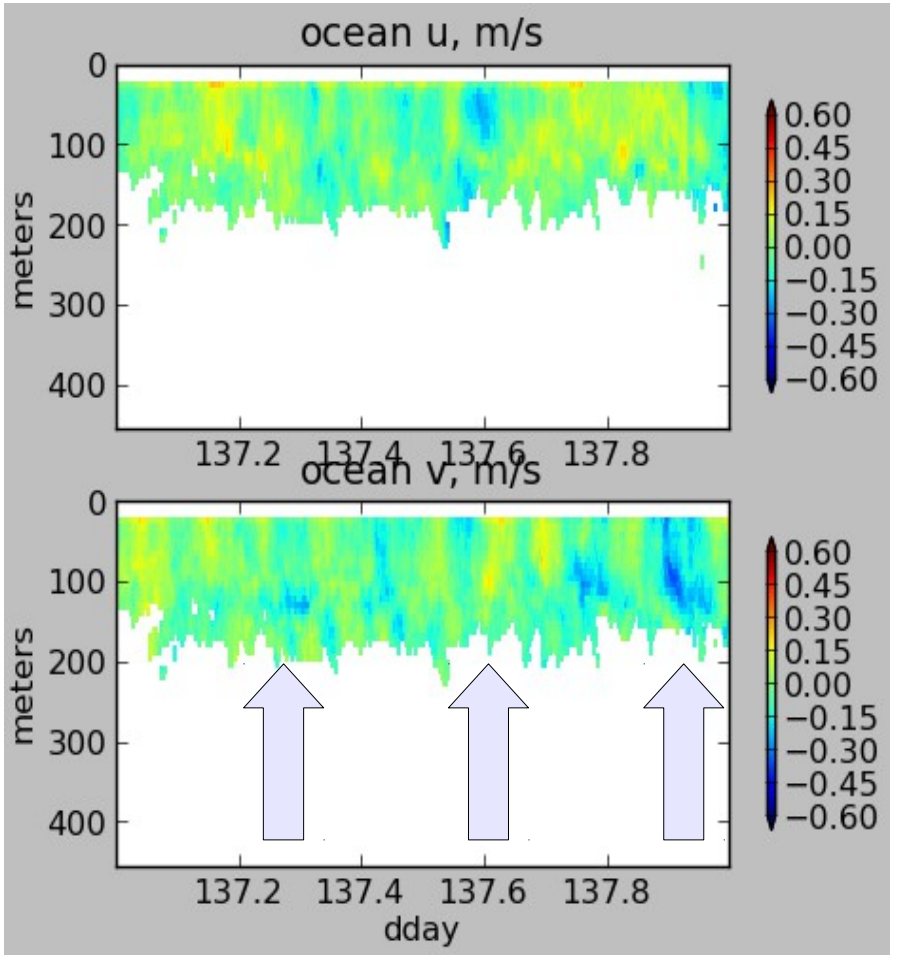


ADCP Processing: acoustic interference

WITHOUT
singleping editing



USING
singleping editing

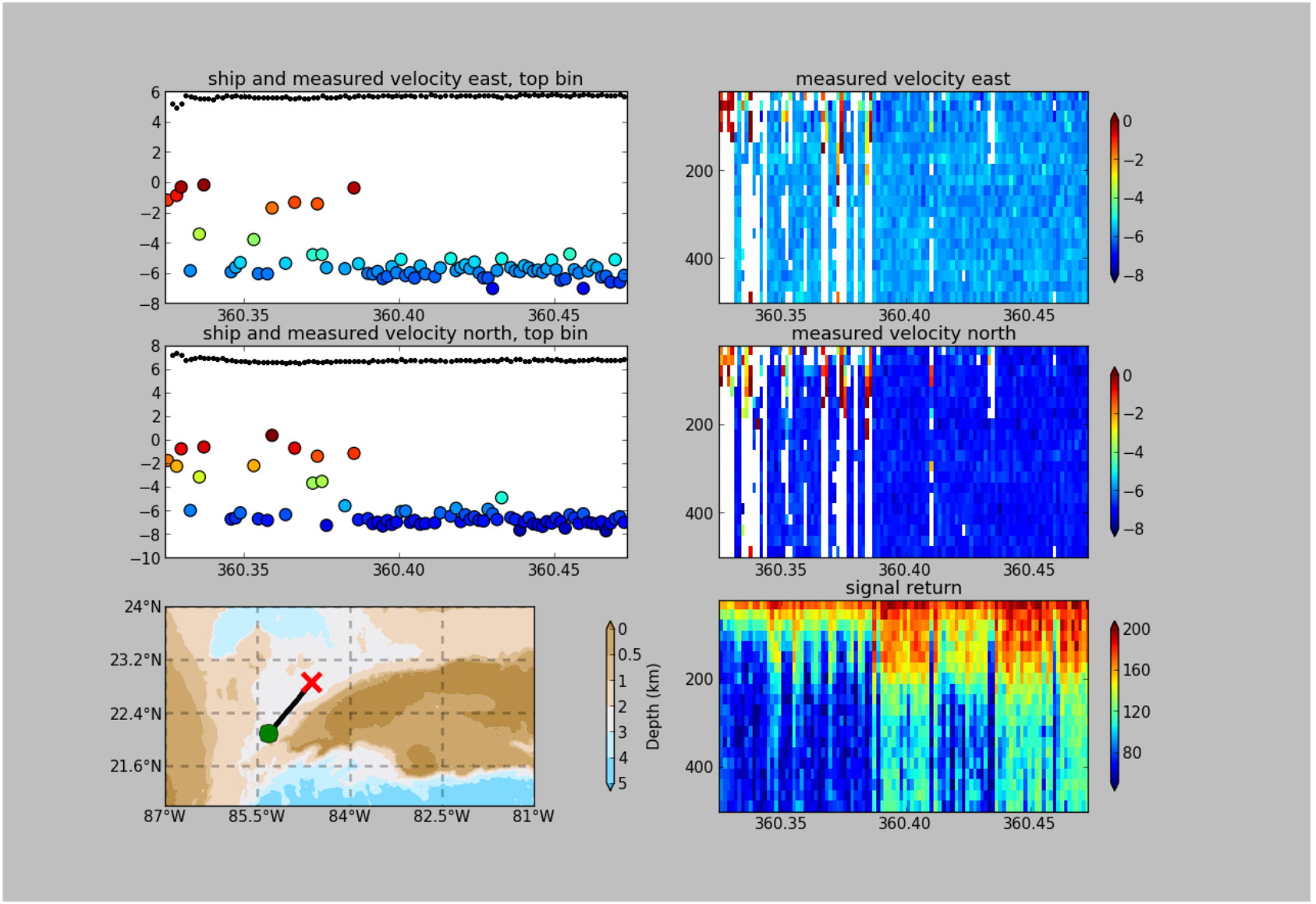


ADCP Single-ping Editing

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

- Acoustic Interference
- Bubbles
- Below bottom

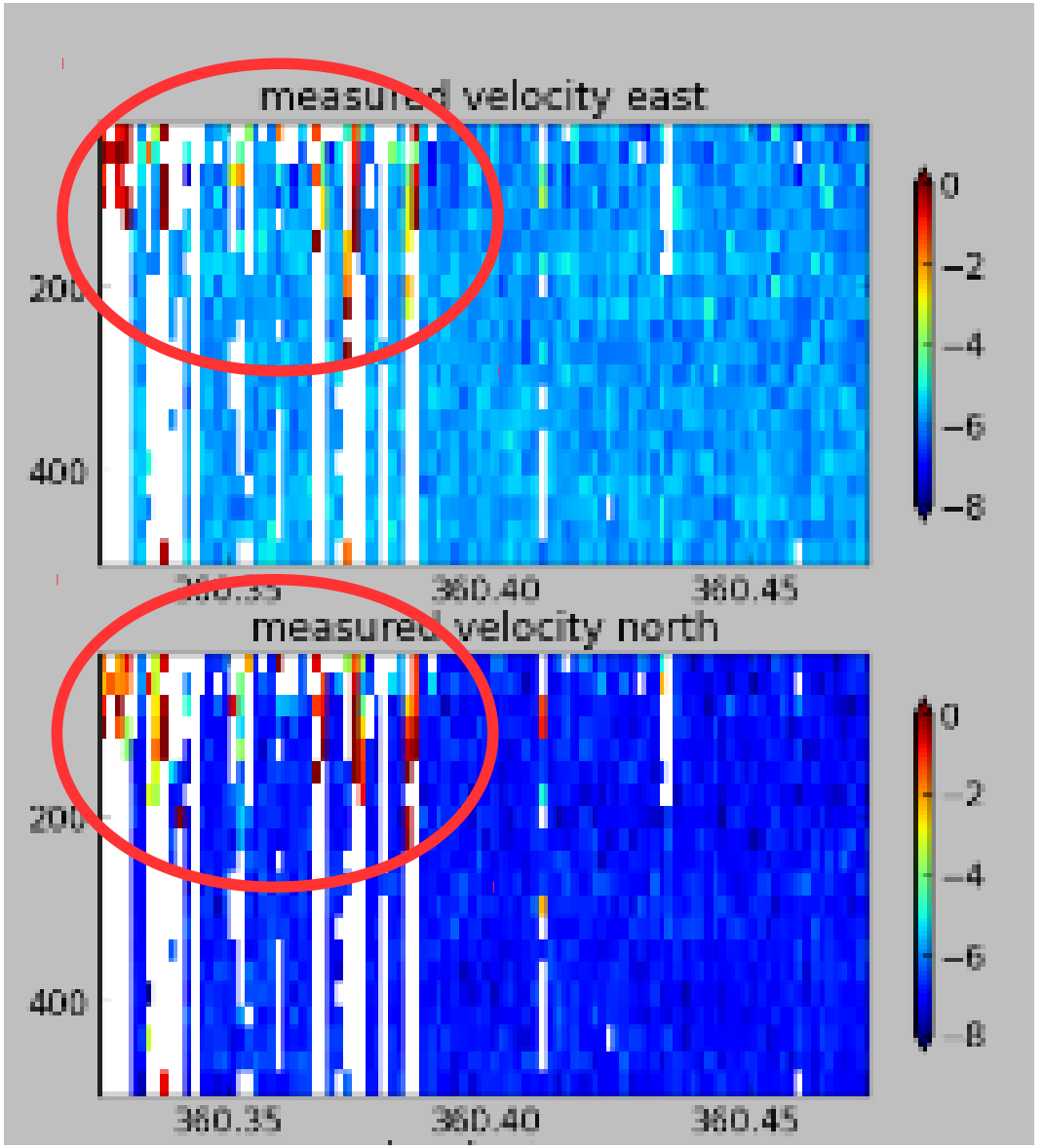
single-ping editing:underway bias



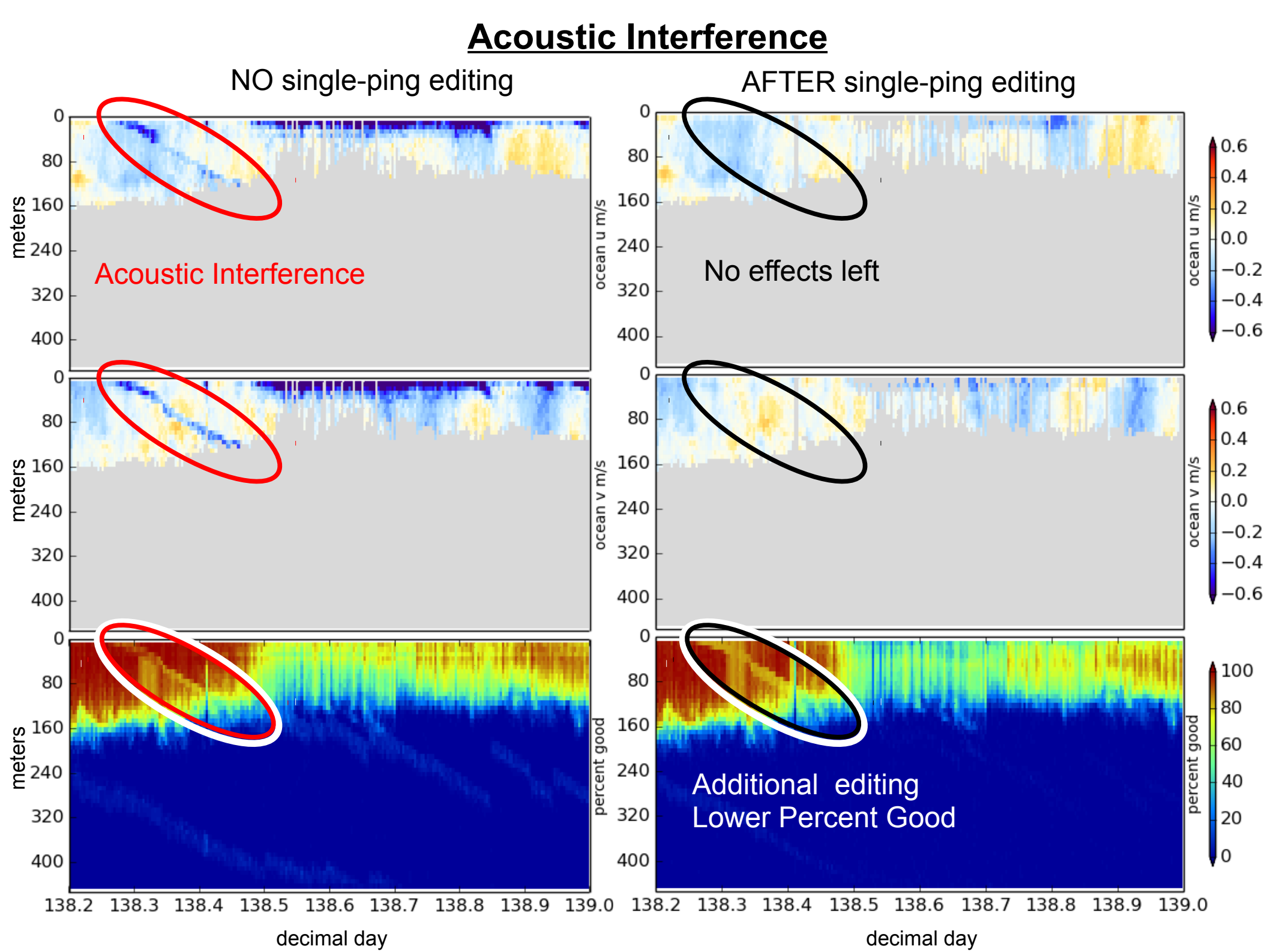
ADCP Data: effect of bubbles

Bubbles:
- short profiles
- strongly biased towards zero

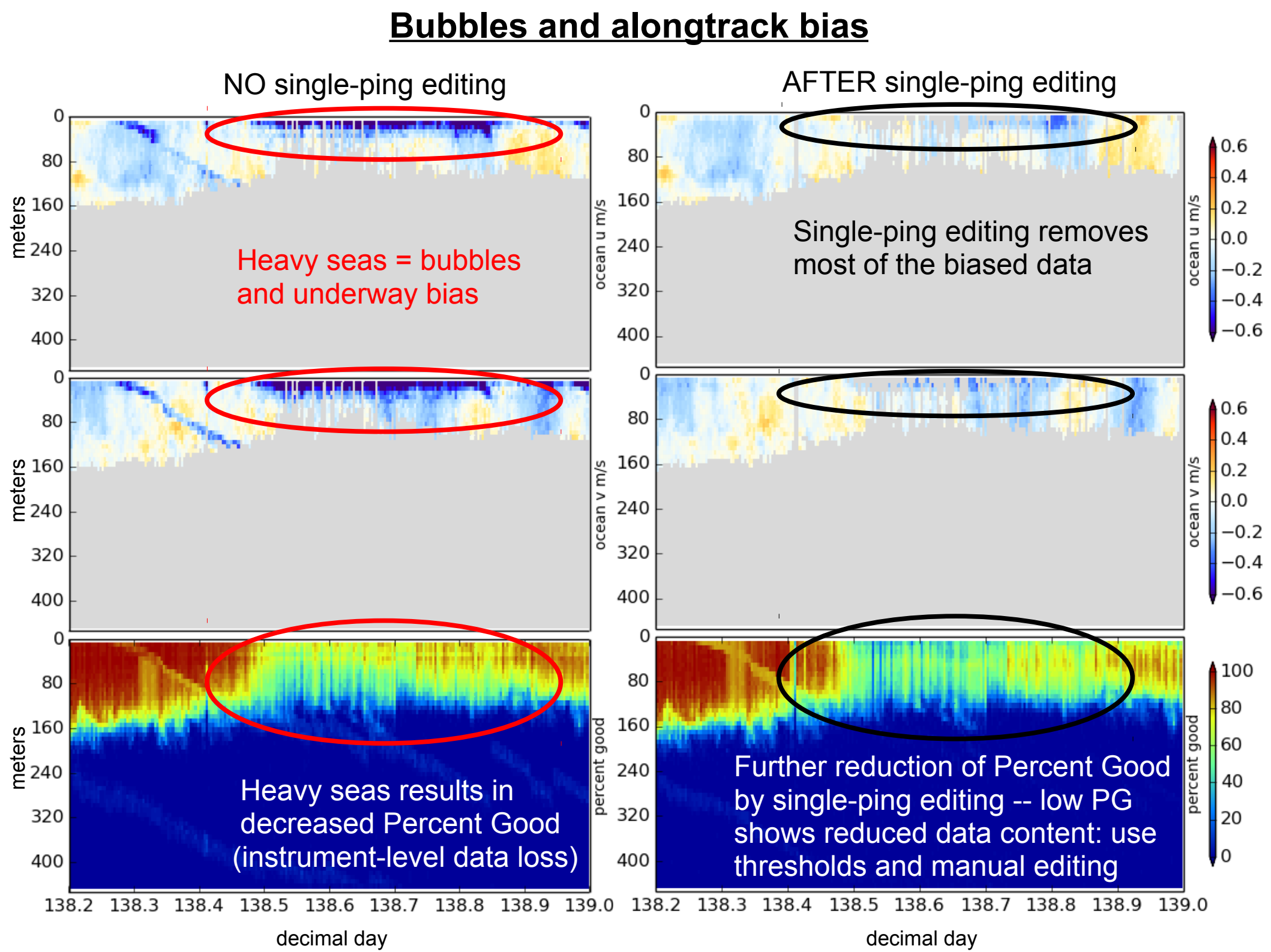
Untreated:
- biased ocean velocities



Acoustic Interference



Bubbles and alongtrack bias



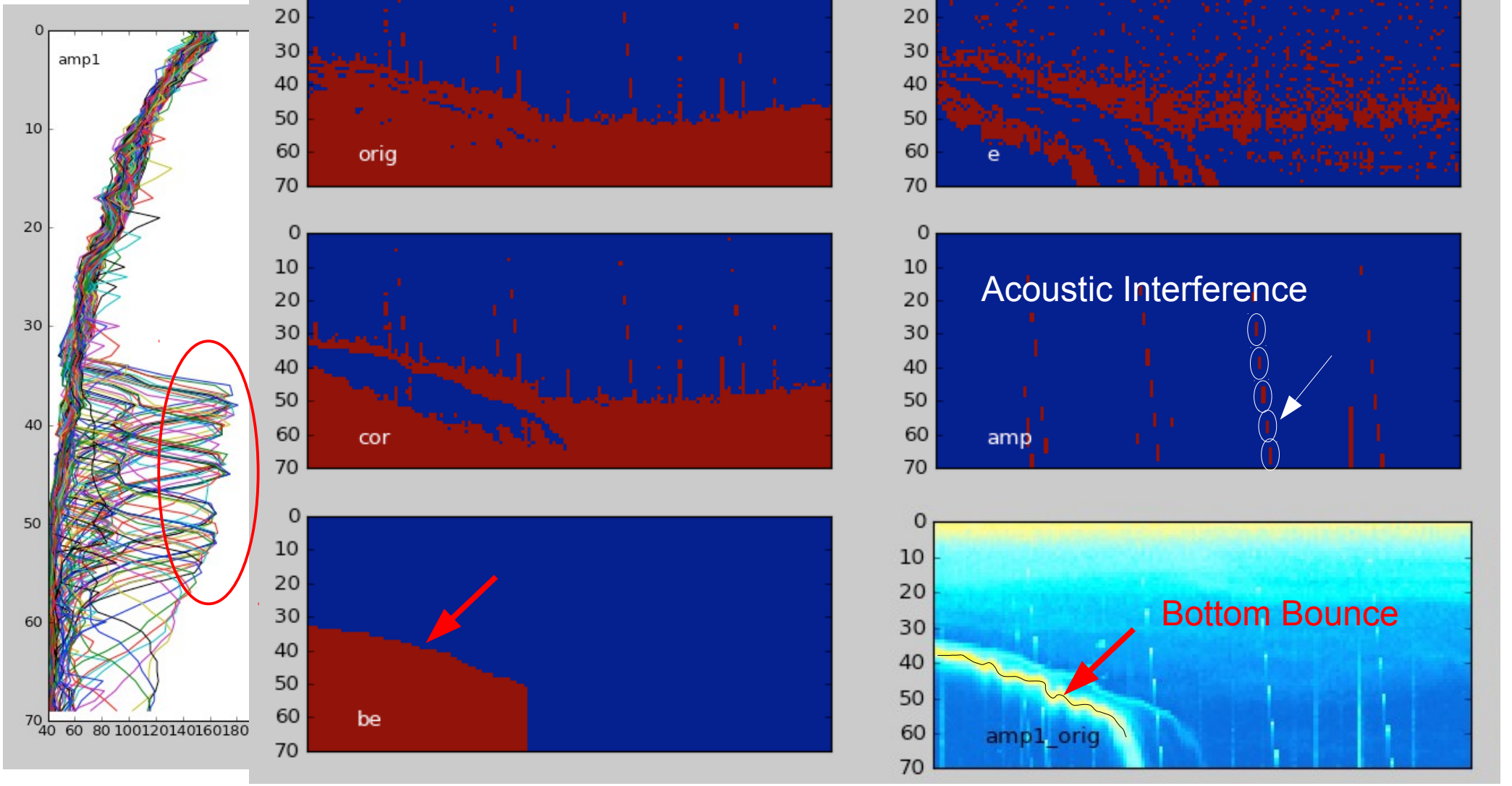
ADCP Single-ping Editing

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

- Acoustic Interference
- Bubbles
- Below bottom

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



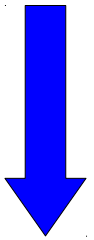
CODAS post-processing:

- 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)

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)

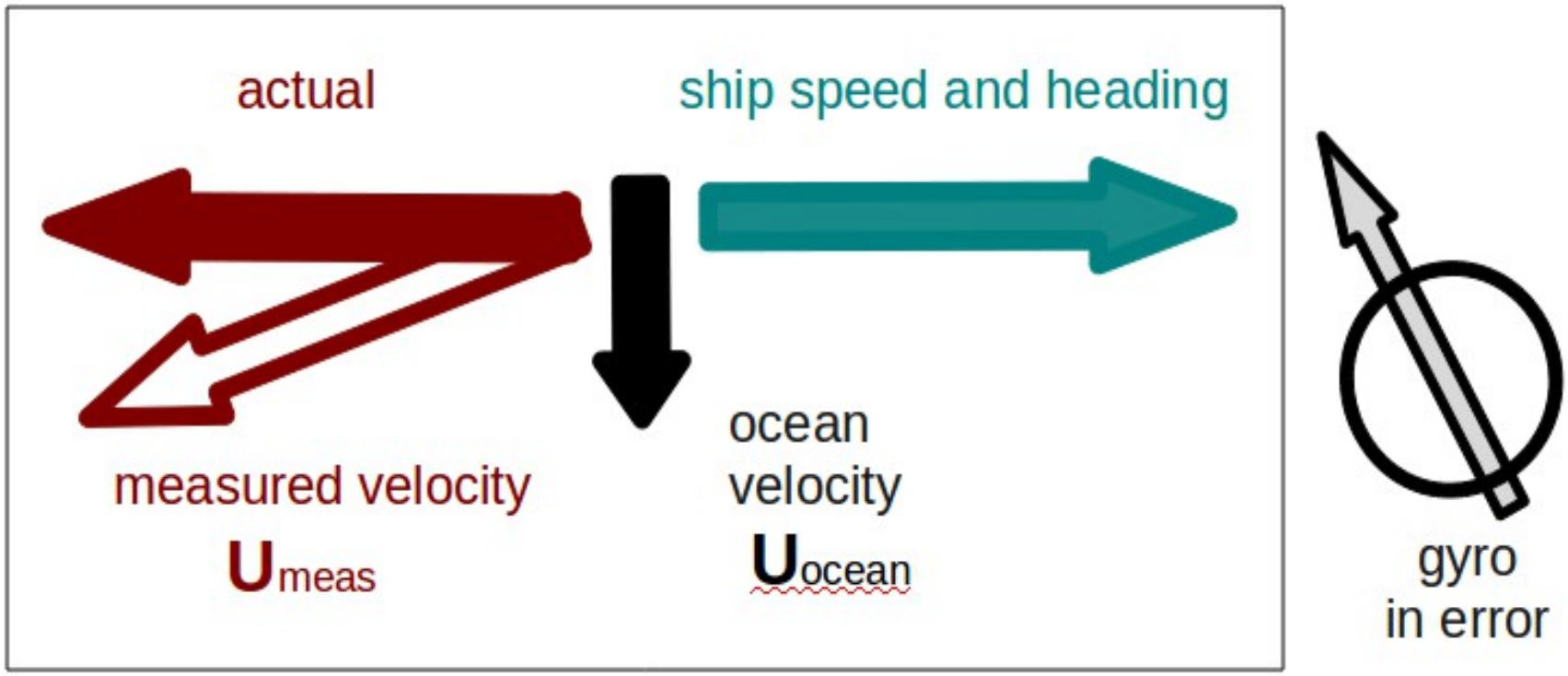
- Soundspeed (single-ceramic transducers only)

(3) Transition Error

- Horizontal offset between GPS and ADCP

Calibration: Angle Error

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



Symptom = Cross-Track Error
Cause = incorrect **angle applied**

Angle applied comes from

- Transducer angle (beam “3” clockwise from bow)
- Heading of ship
  - **VmDAS**,
    - “Primary” heading, often no QC message
    - If “Primary” fails, replace with “Secondary”
  - **UHDAS**,
    - Reliable heading for each ping (eg gyro)
    - Heading correction for each averaging period
    - Calculated relative to devices such as Ashtech, POSMV, Seapath, Mahrs, Phins (hopefully with QC fields)

Symptom = Cross-Track Error
Cause = incorrect **angle applied**

Angle applied comes from

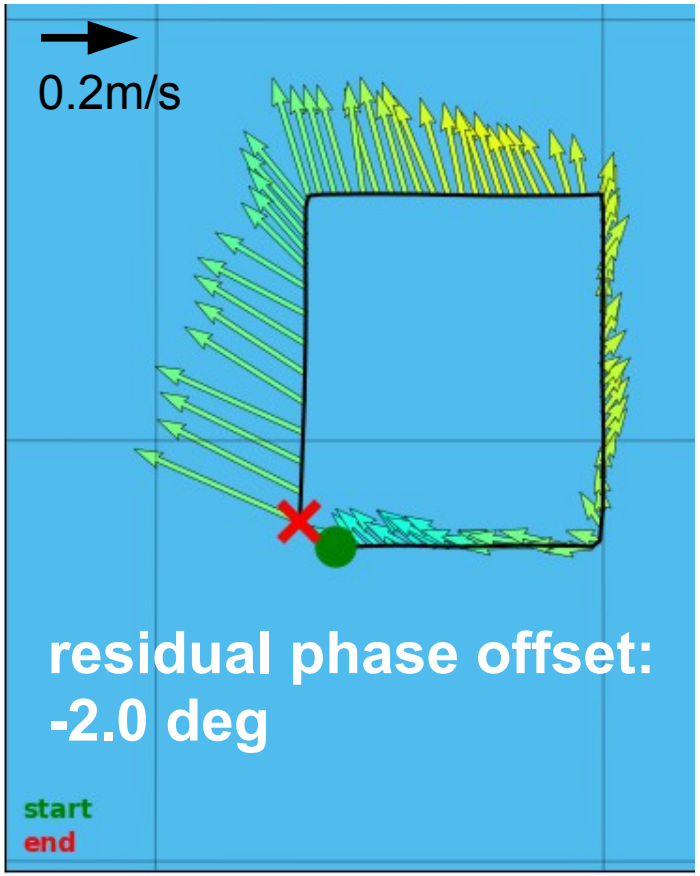
- Transducer angle (beam “3” clockwise from bow)

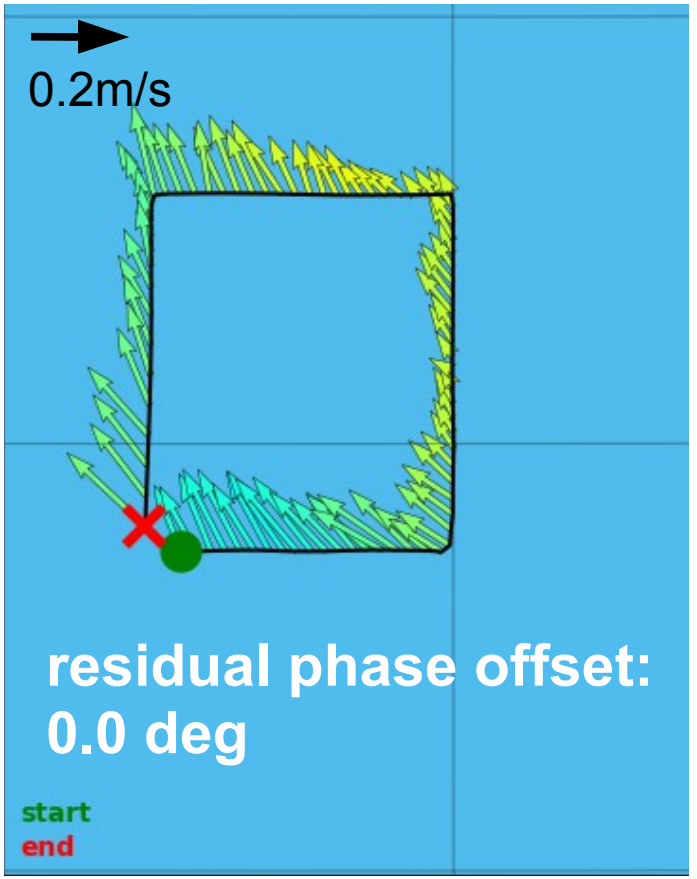
This is a **constant value** for the whole cruise

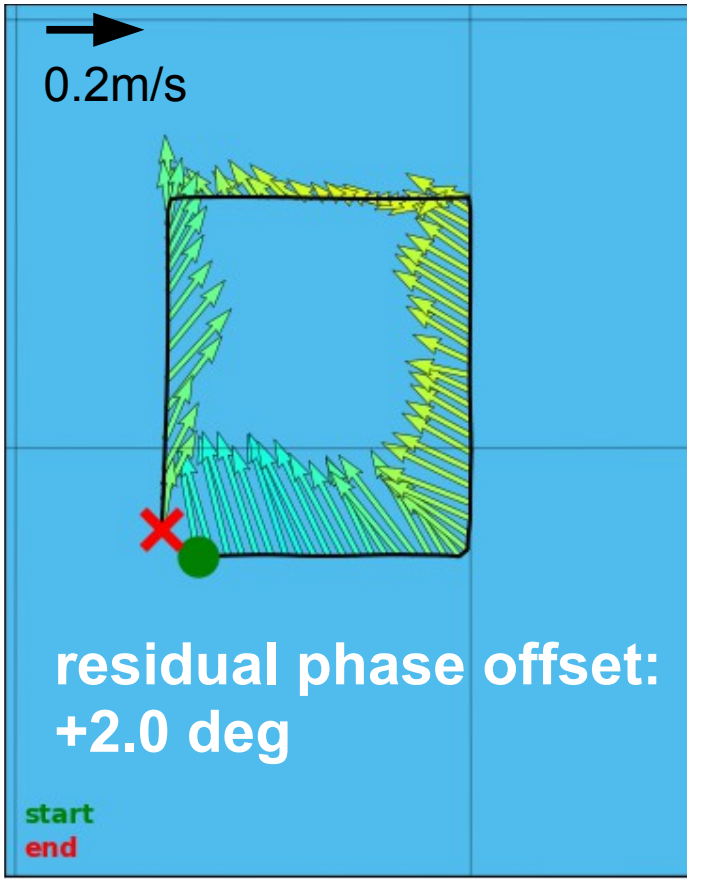
Examples of error in transducer angle follow...

water track phase calibration

1 deg. error = 10cm/s crosstrack error at 10kts







median	mean	std
-0.0085	**-0.0261**	0.3742

Goal: get within +/- 0.1deg

median	mean	std
-2.0020	**-2.0186**	0.3762

median	mean	std
1.9925	**1.9798**	0.3757

Examples of along-track error

Remove during single-ping editing

- Acoustic interference
- Bubbles (underway bias)

Correct after averaging:

- Scale factor (NB150 soundspeed correction)

Calibration: scale factor (alongtrack bias)

Ocean U (original)

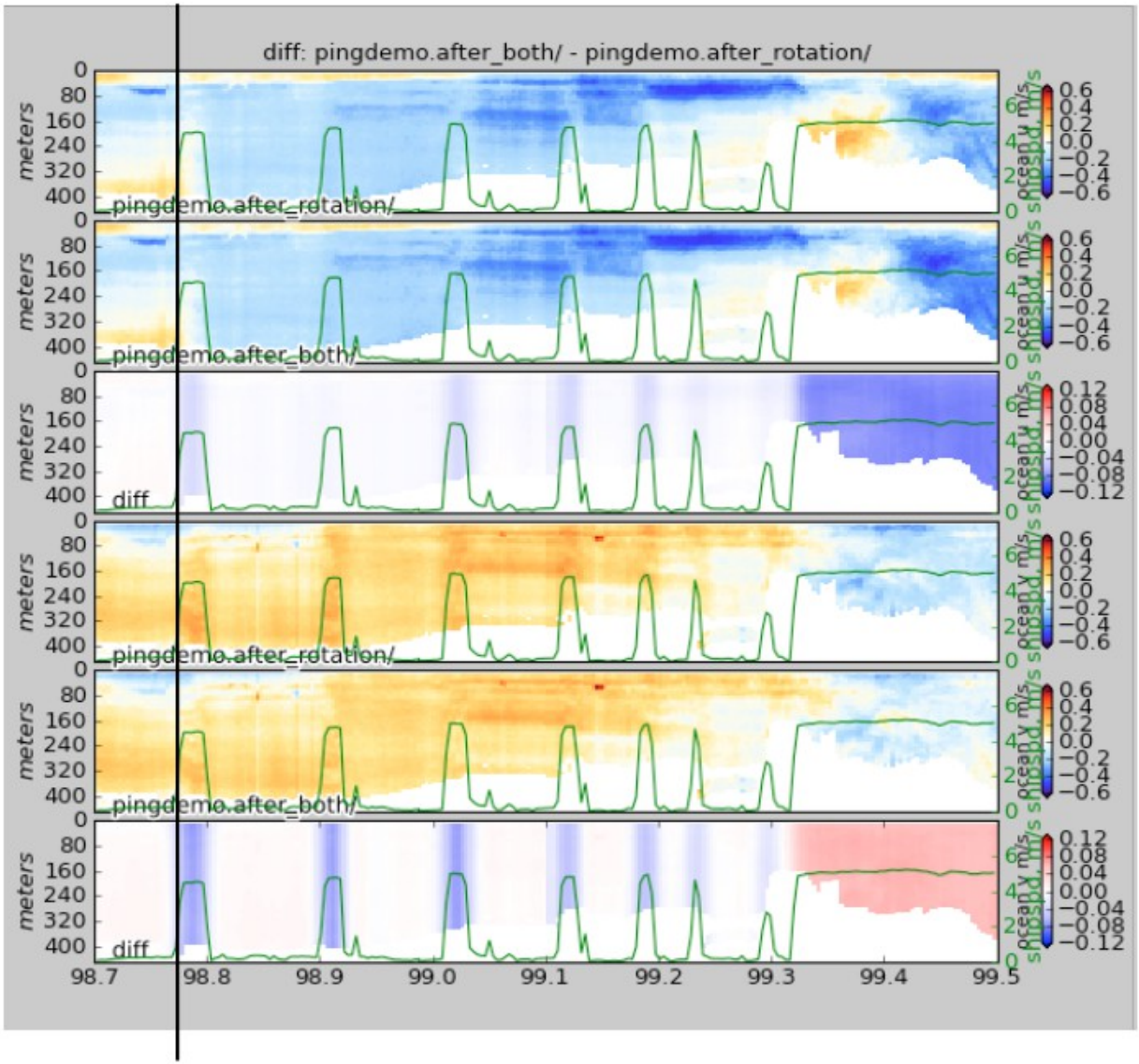
Ocean U (after scalefactor)

Diff: after-before

Ocean V (original)

Ocean V (after scalefactor)

Diff: after-before



Calibration: ADCP-GPS offset

(1) Cross-track error:

- recovery requires accurate heading

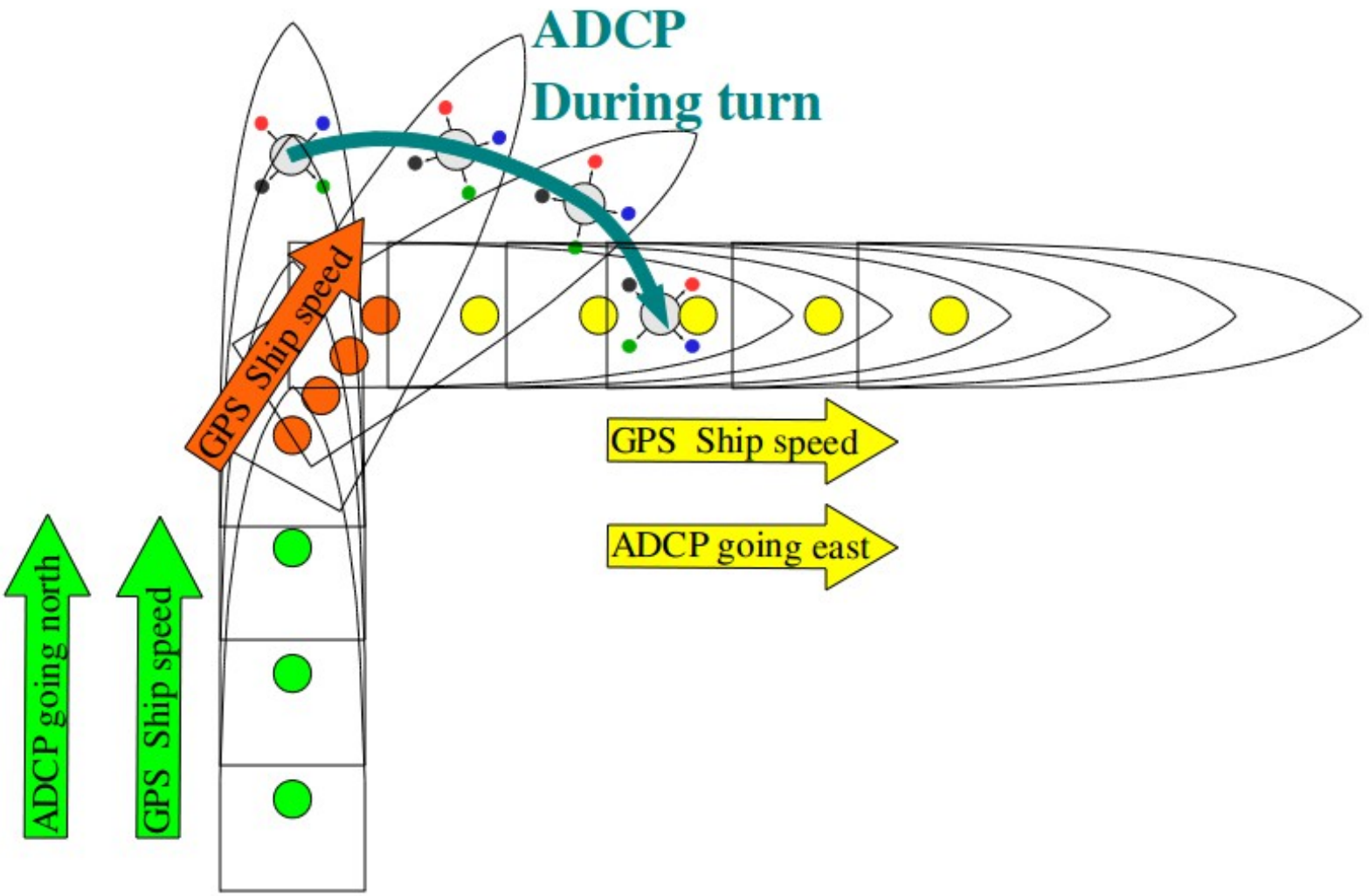
(2) Along-track error:

- may indicate a serious problem
- recovery may be possible, incomplete, ambiguous

(3) Transition/maneuvering error

- Lag or offset in time or space

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

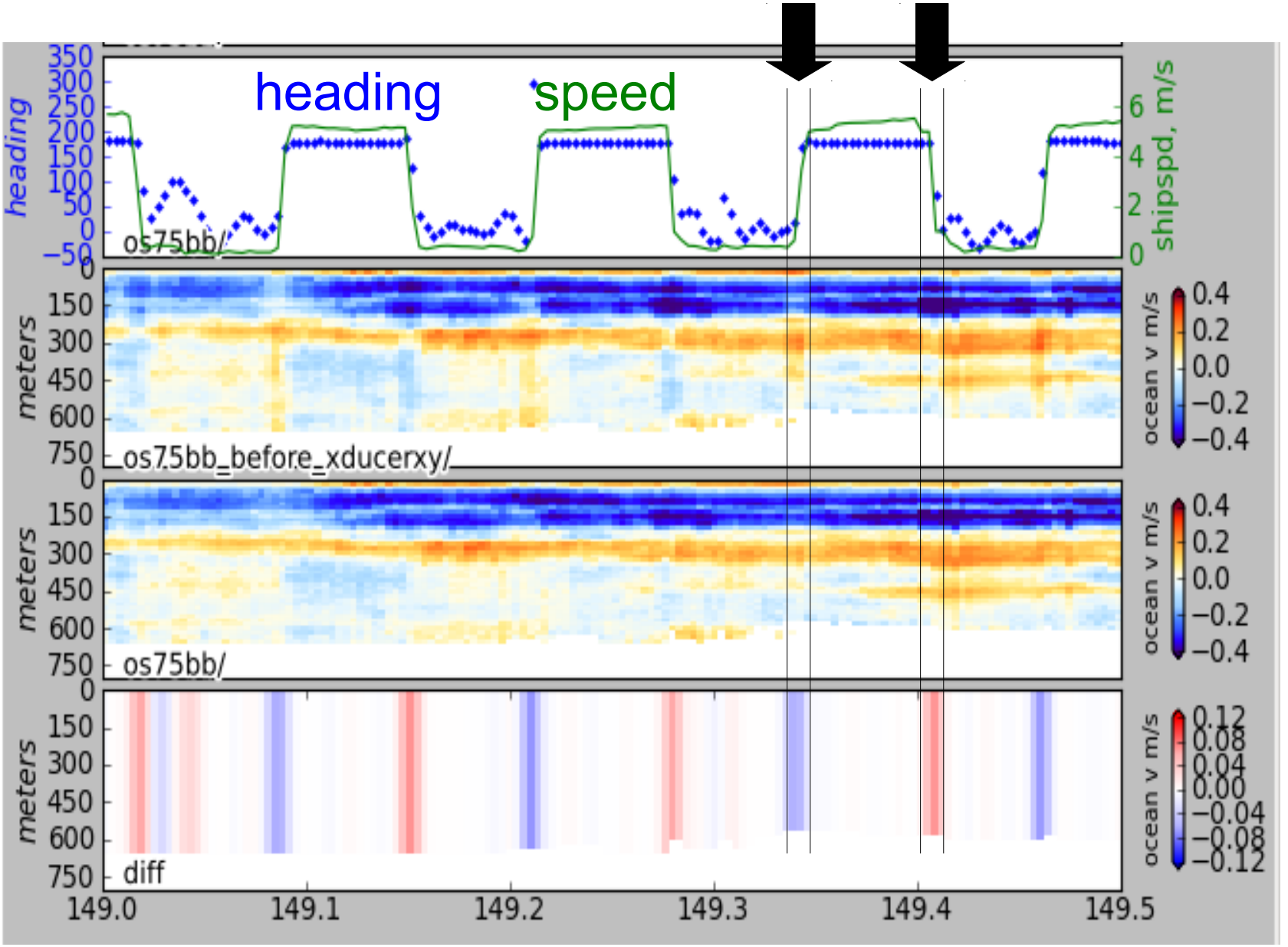


Transducer offset from GPS--error occurs: **transition** between on-station and underway

...using actual location

...using shifted GPS location

difference



Lunch??

- UHDAS at sea:
  - What it does; compare to VmDAS
  - How to drive it
  - Where the figures are
  - Where the files go
  - Most common modifications

Acquisition and Operations

  - CODAS processing

Processing

  - How to read the daily emails

- UHDAS on land:
  - How to read the daily emails

Monitoring

  - Ticketing Tour (Friday Morning)
  - Post-processing hands-on demo (Friday Afternoon)

Processing