

# CODAS processing

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<http://uhdas.org>

[UHDAS + CODAS Documentation](http://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

[http://currents.soest.hawaii.edu/docs/adcp\\_doc/index.html](http://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

# DATA ACQUISITION

Time, ADCP,  
Position,  
Attitude

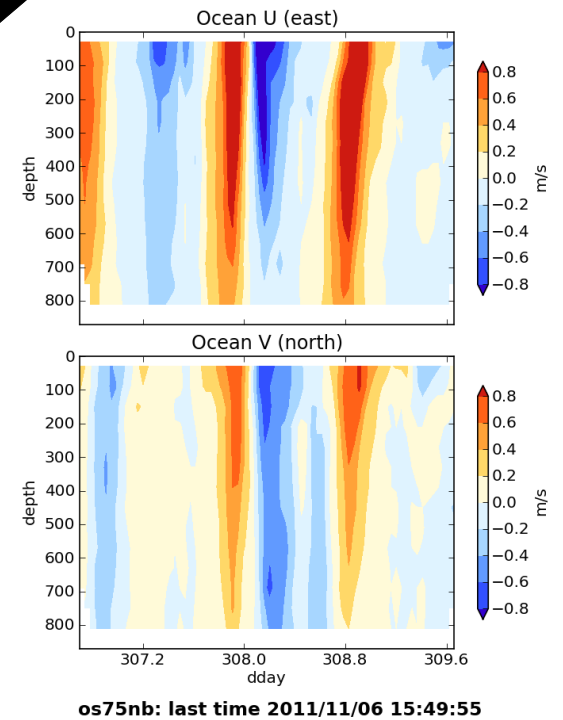
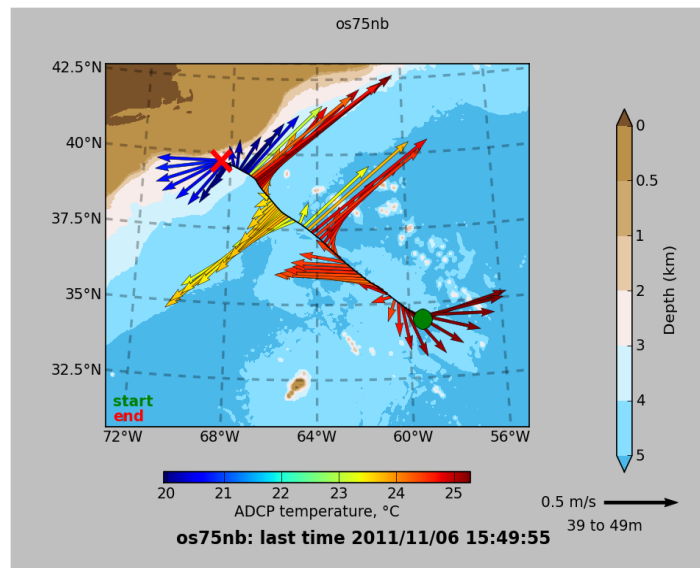
primitive (raw) data

Time  
ADCP  
Position  
Heading

Timestamp,  
Write to disk

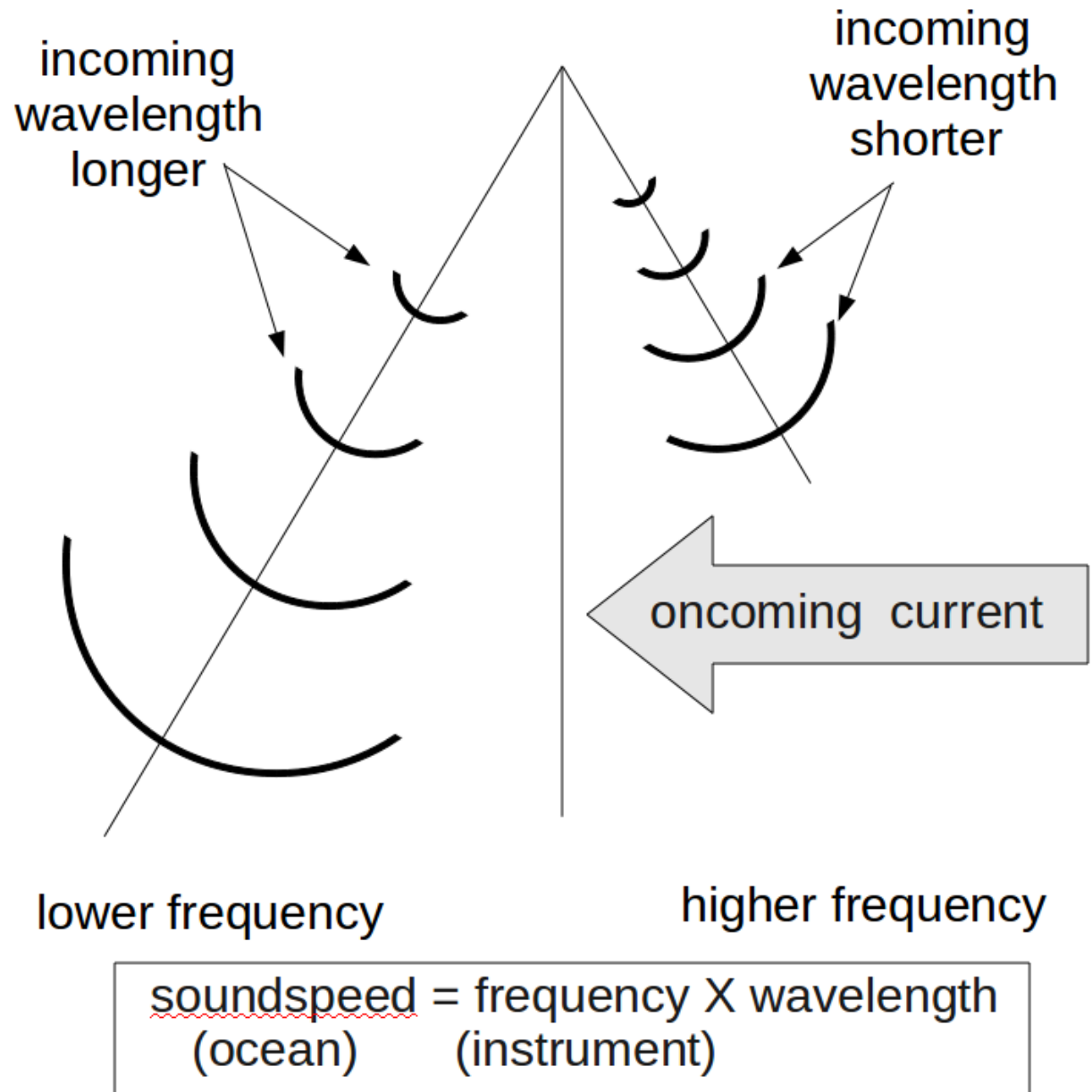
# DATA PROCESSING

(Data Products)  
(Visualization)



# ADCP

## Acoustic Doppler Current Profiler



more details: [Calculating ocean currents from ADCP](#)

# ADCP: Getting Ocean Currents

Collect Data

## Transformations

Doppler to beam  
(occurs in the ADCP)

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

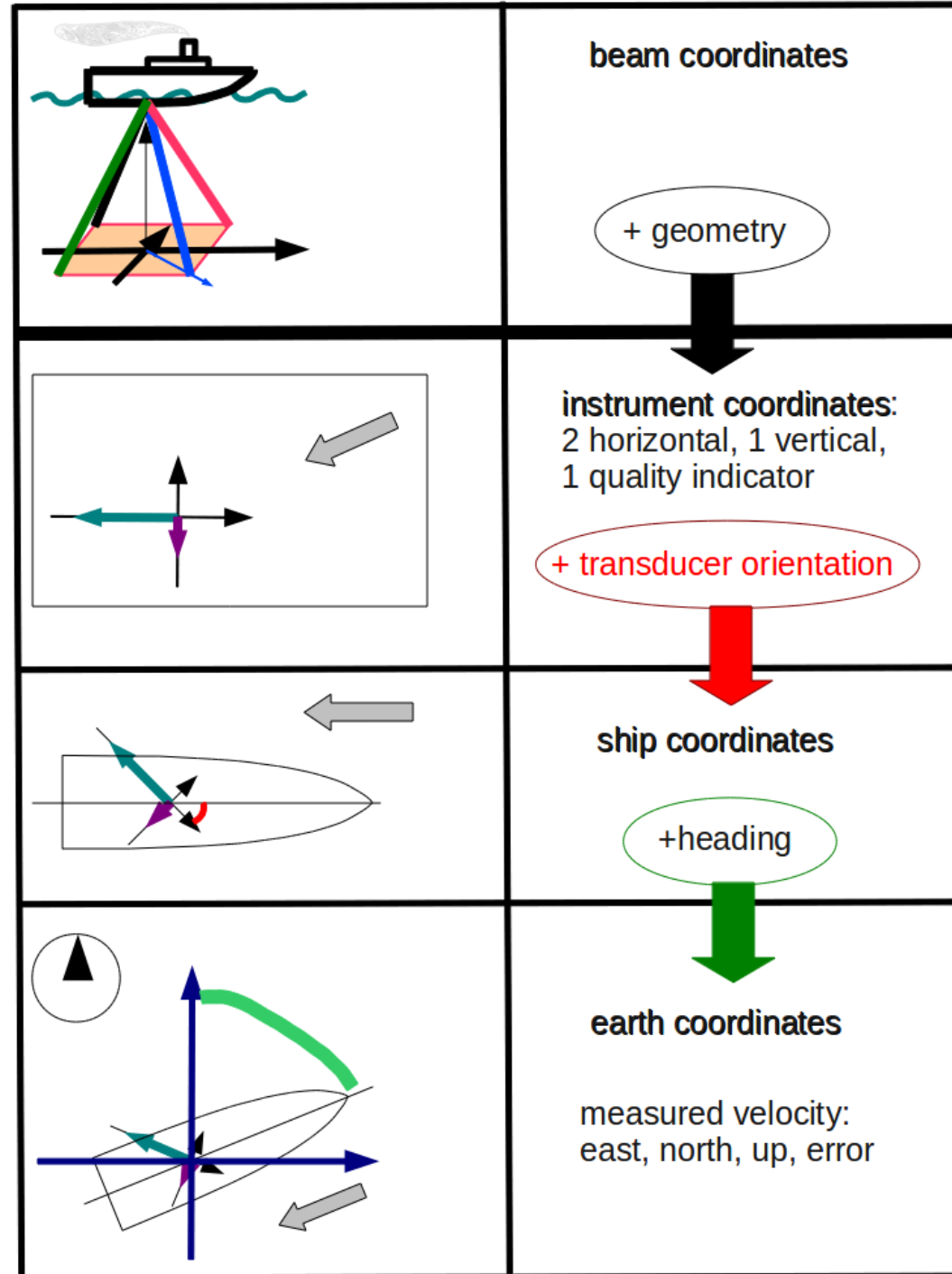
## Preliminary Processing

- single-ping editing
- averaging
- remove ship's speed

ADCP

heading

position



# CODAS Processing Overview

## CODAS: Common Ocean Data Access System

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

“CODAS Processing” → produce ocean velocities

# “CODAS” ADCP Processing

## Goals

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

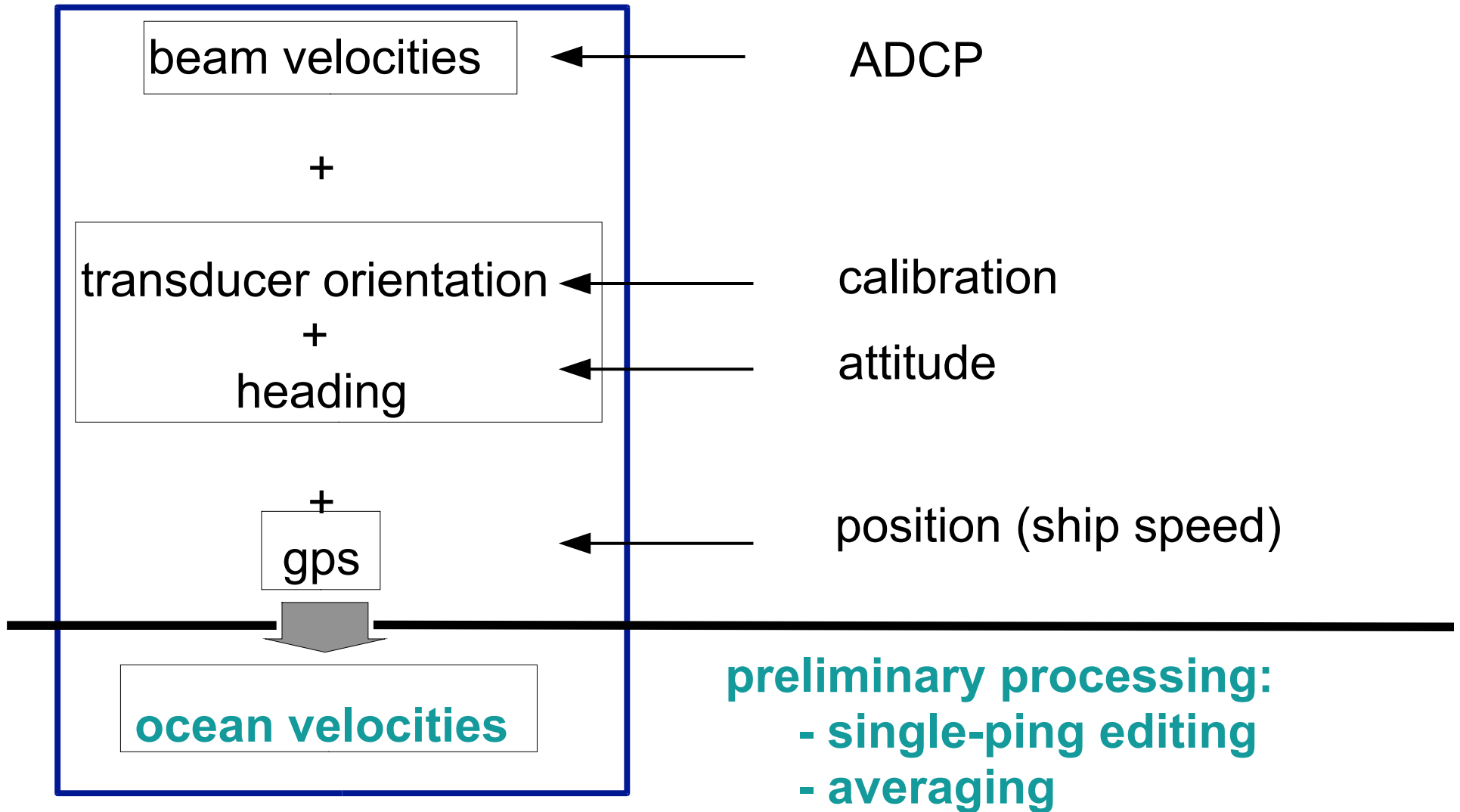
## Processing

- 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 visualization tools
- Export in matlab or netCDF format
- Documented

(\*) via VirtualBox pre-configured Linux computer

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

# ADCP: Acquisition, Processing



# CODAS preliminary processing: 2 flavors

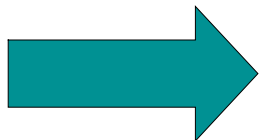
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## (1) Preliminary processing **single-ping** data

- 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 Processing Overview

UHDAS  
single-ping  
data



single-ping  
processing

CODAS  
averages  
after  
single-ping  
editing

VmDAS data

**\*.LTA, \*.STA**

reformat LTA averages to CODAS averages



CODAS  
Averages

**\*.ENR  
\*.N1R, \*.N2R**

uhdas-style  
single-ping  
data



single-ping  
processing

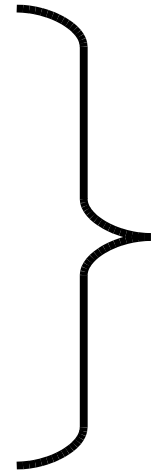
CODAS  
averages  
after  
single-ping  
editing

**\*.VMO**

# CODAS preliminary processing

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



Automated at-sea processing

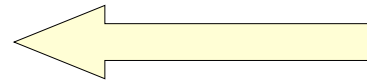
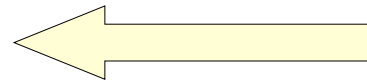
- Fix time-dependent heading correction (eg. if gaps)
- Apply calibrations
  - Rotation
  - Scale factor
  - Horizontal offset between GPS and ADCP (new)
- Manually edit CODAS database averages

**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

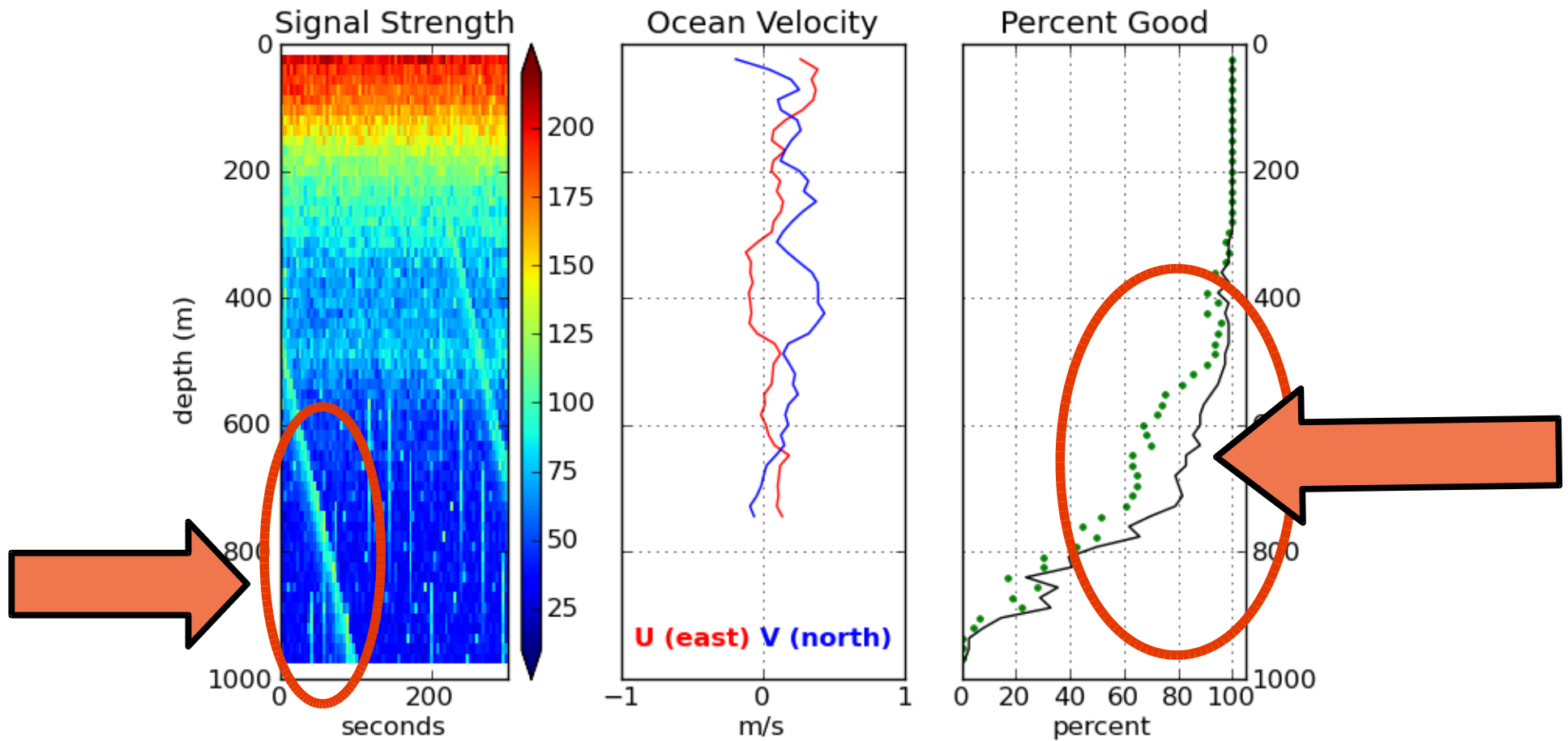
# ADCP Single-ping Editing

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

- **Acoustic Interference**
- Bubbles
- Below bottom

# ADCP Processing

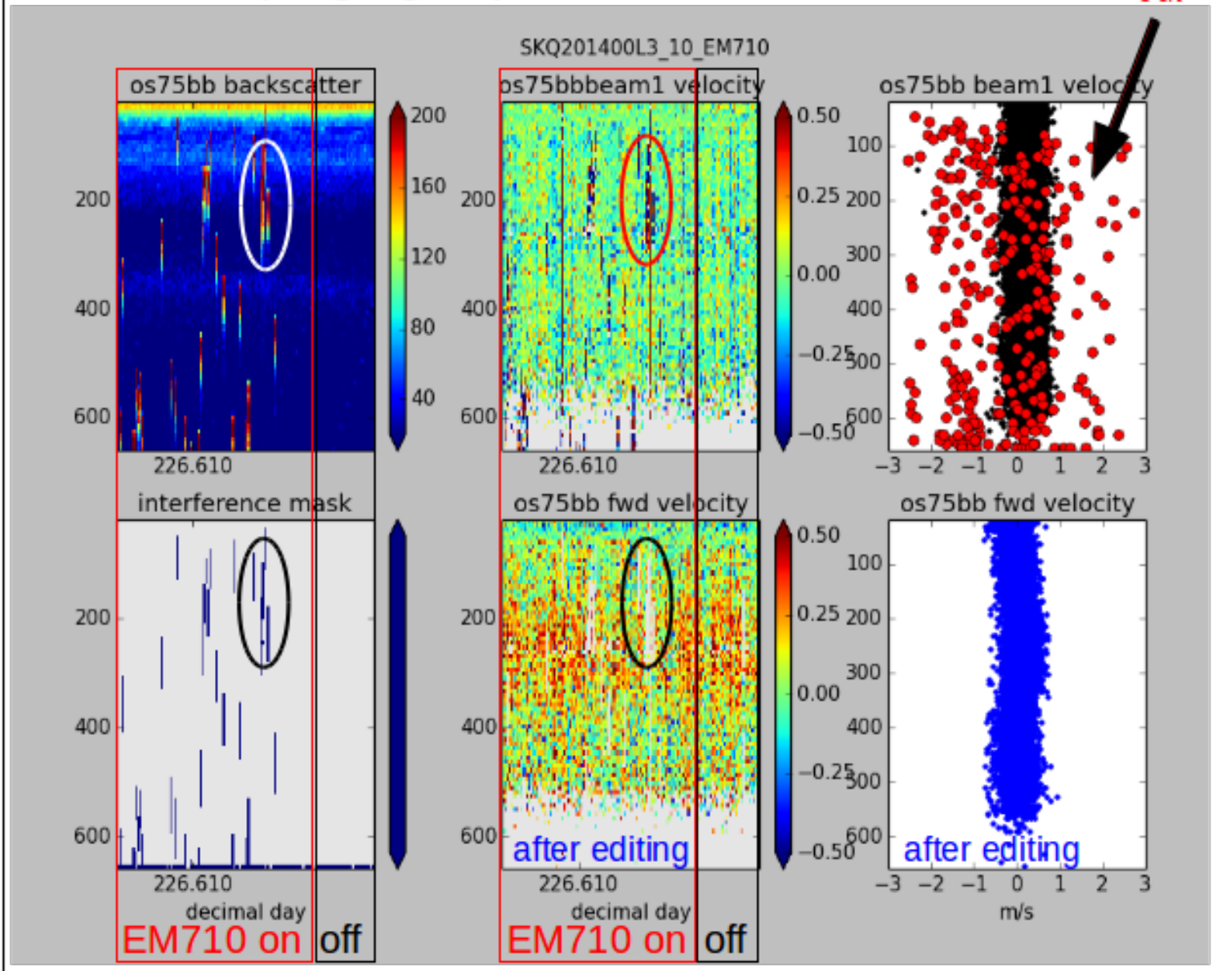
## Singleping editing: acoustic interference



# ADCP Processing: editing out interference

EM710 pinging impact on OS75 broadband

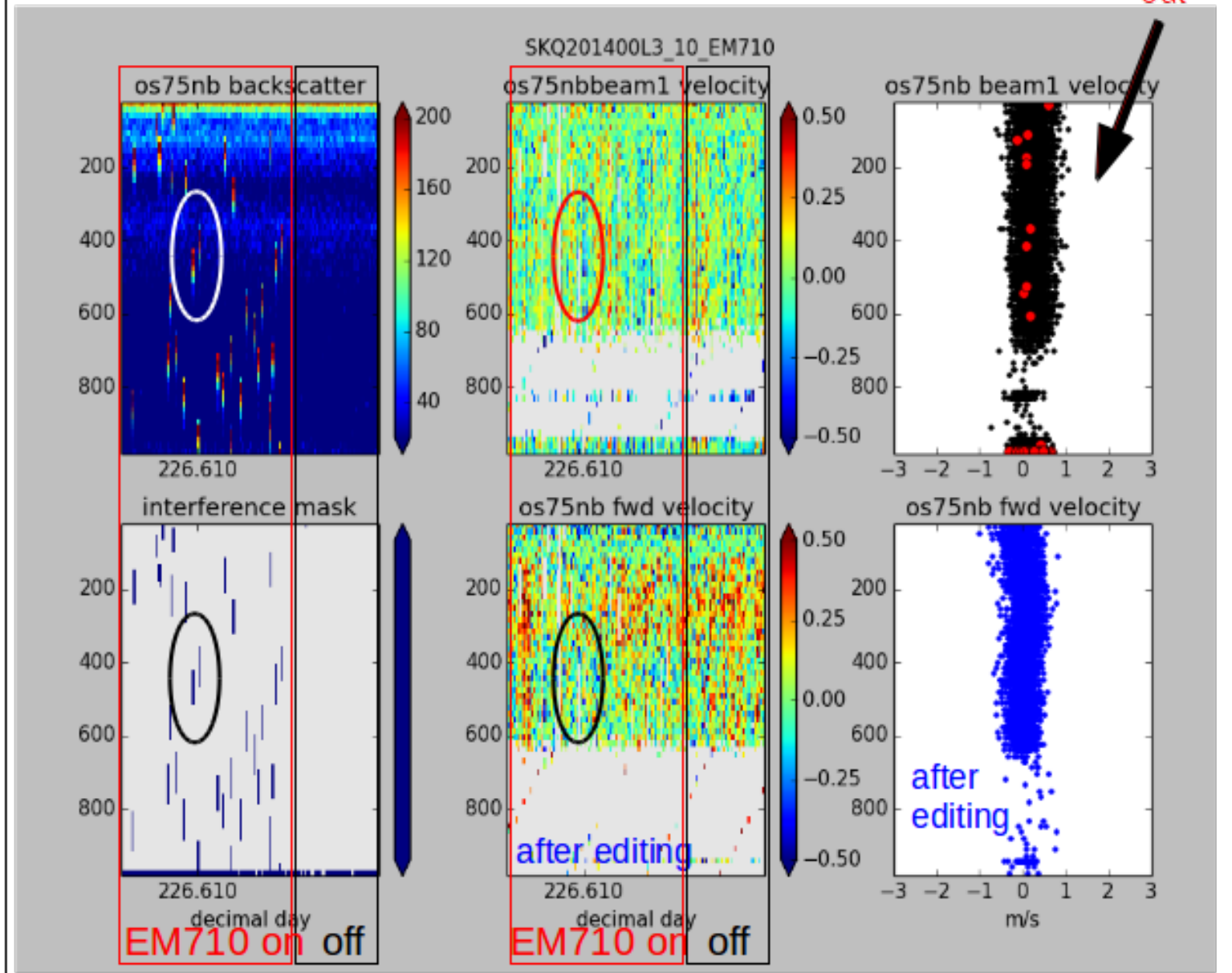
edited  
out



# ADCP Processing: editing out interference

EM710 pinging impact on OS75 narrowband

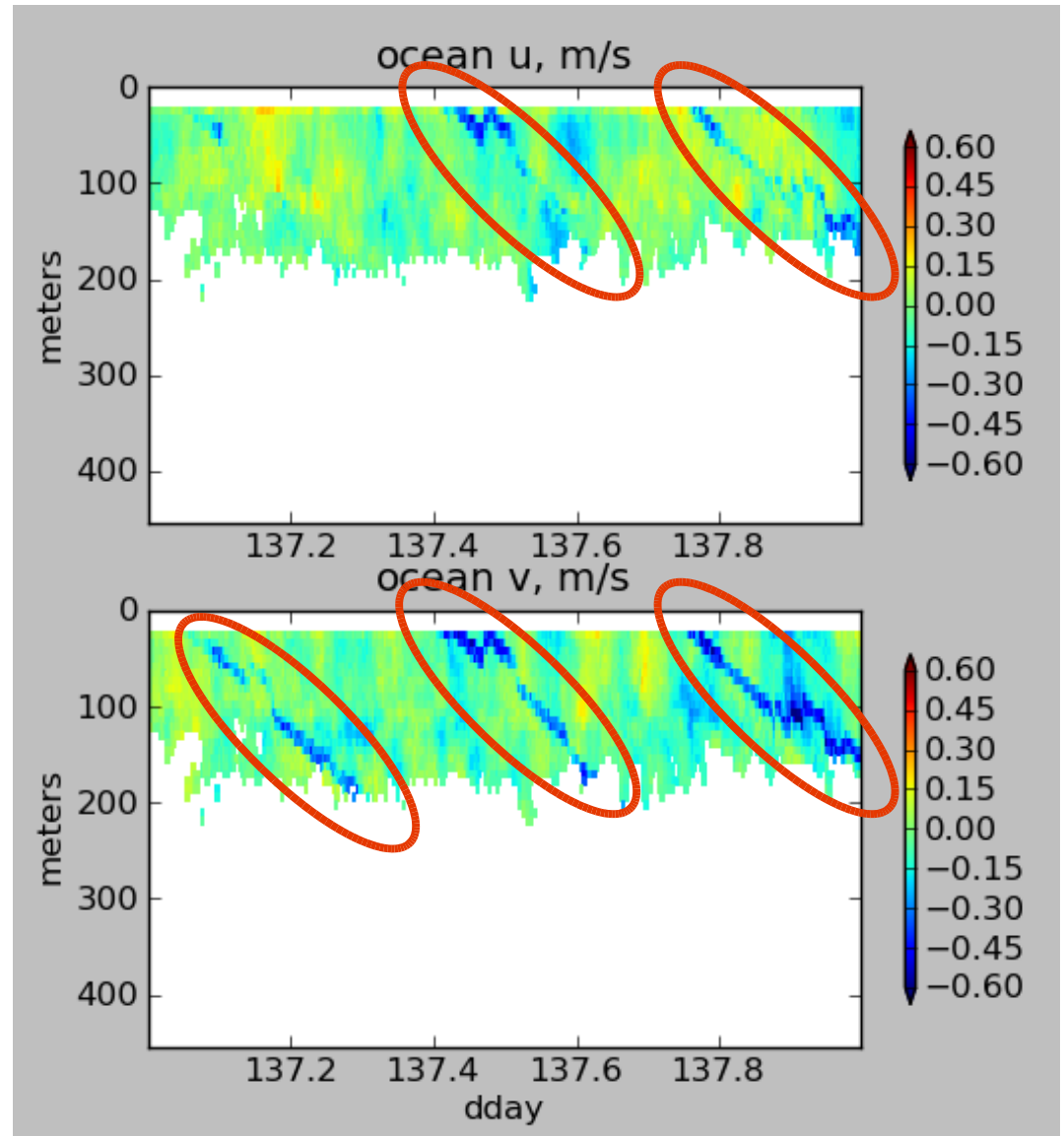
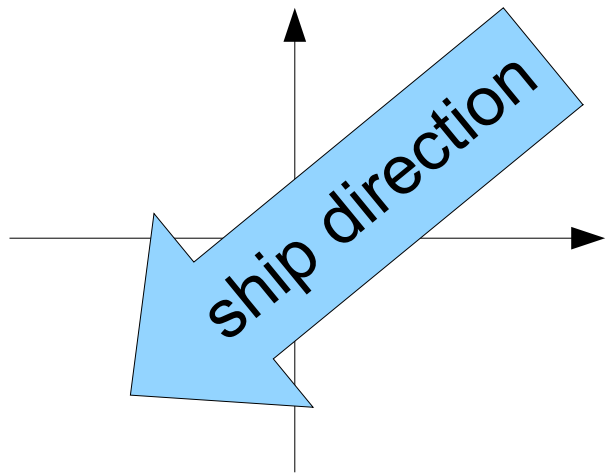
edited out



# ADCP Processing **without** singleping editing

Averaged  
ocean velocities

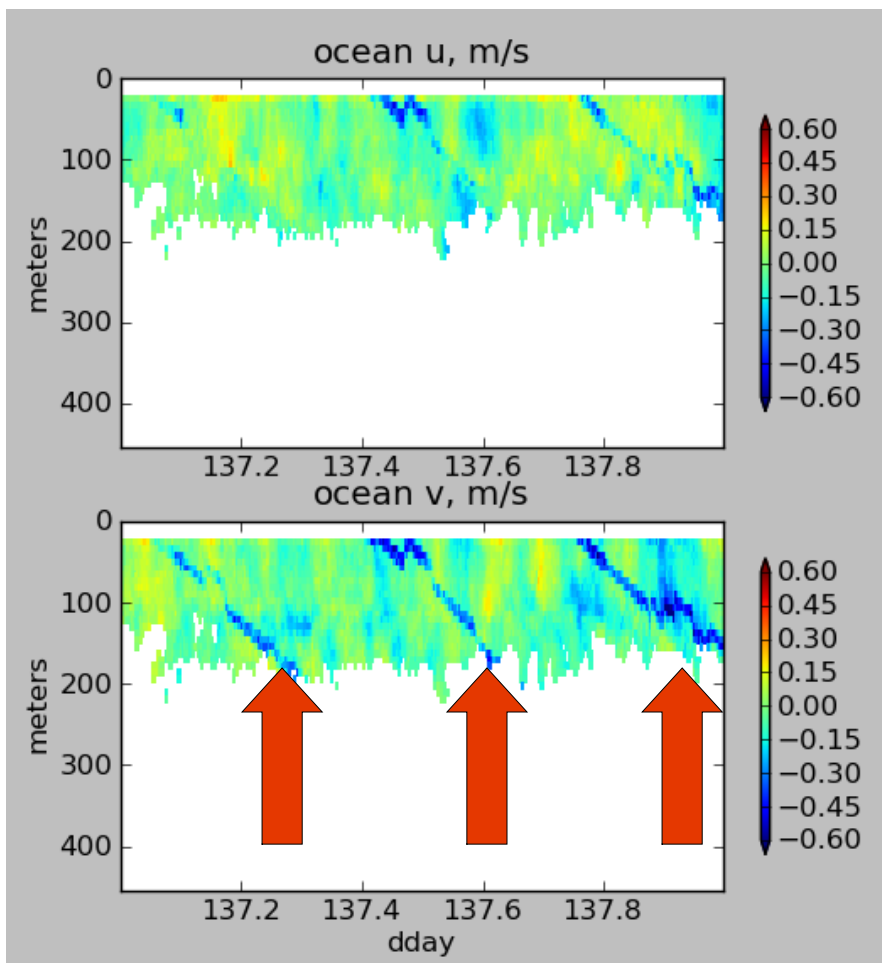
NOTE: along-track  
direction bias



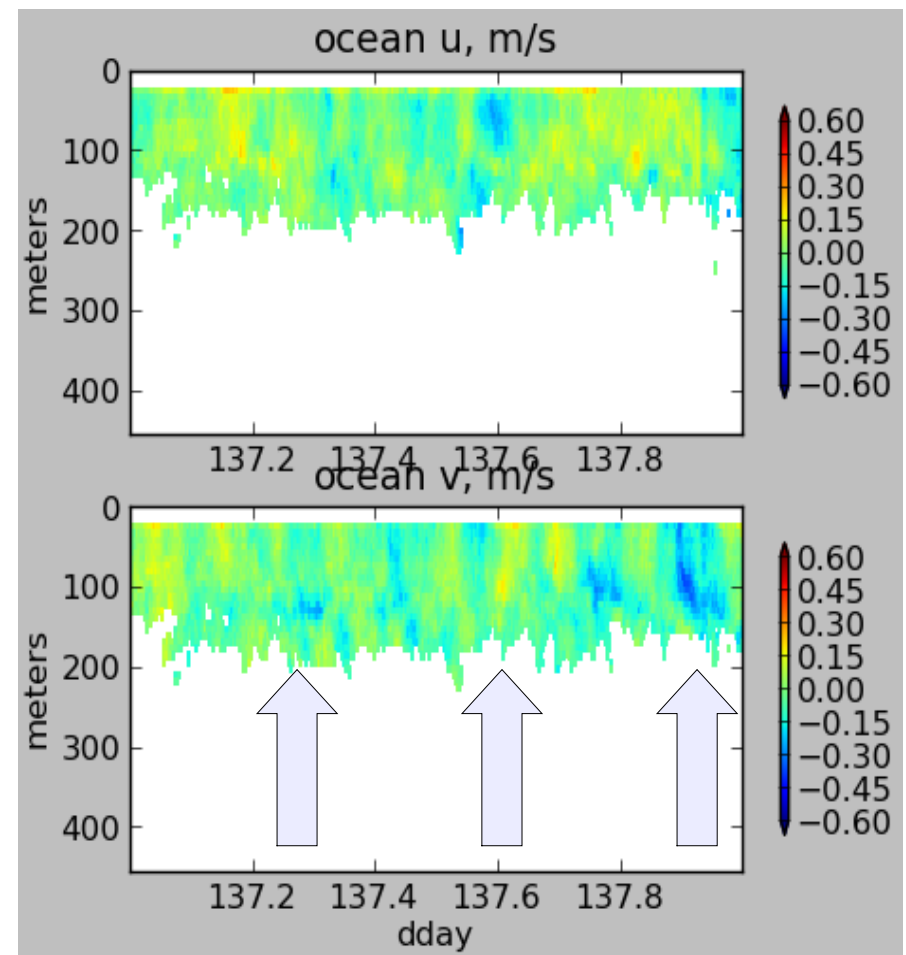


# ADCP Processing: acoustic interference

WITHOUT  
singleping editing



USING  
singleping editing

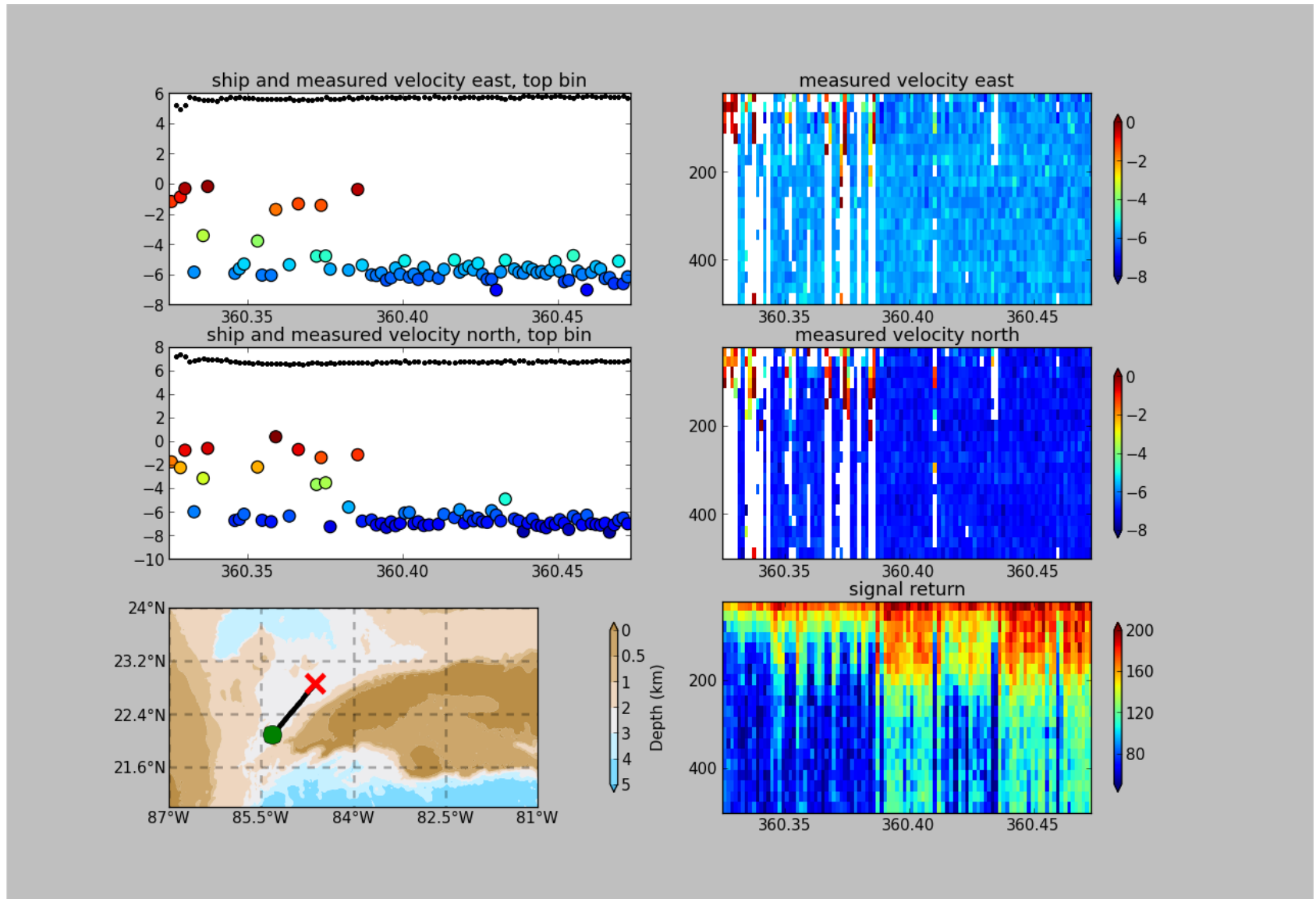


# ADCP Single-ping Editing

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

- Acoustic Interference
- **Bubbles**
- Below bottom

# single-ping editing: underway bias



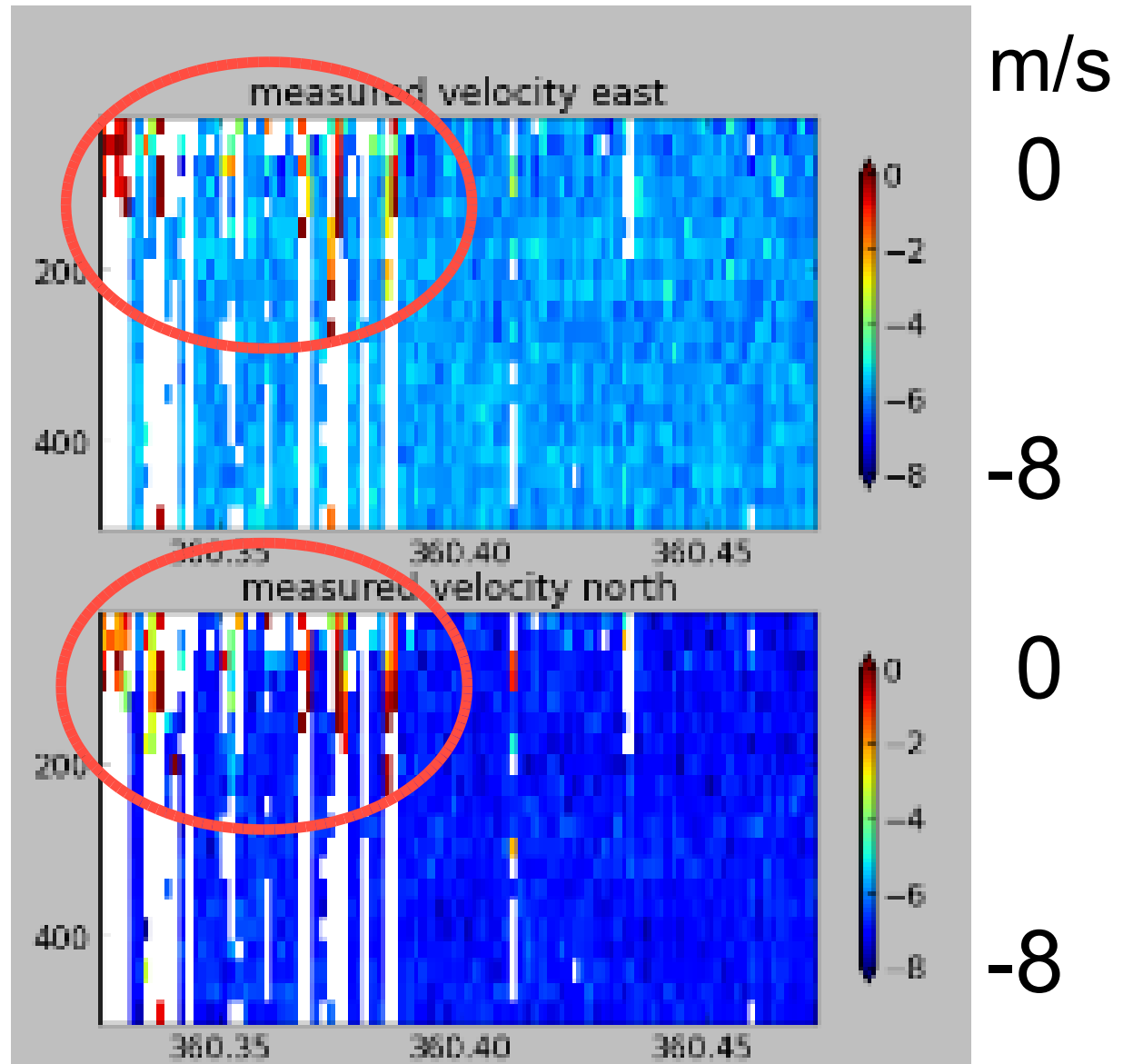
# ADCP Data: effect of bubbles

## Bubbles:

- short profiles
- strongly biased towards zero

## Untreated:

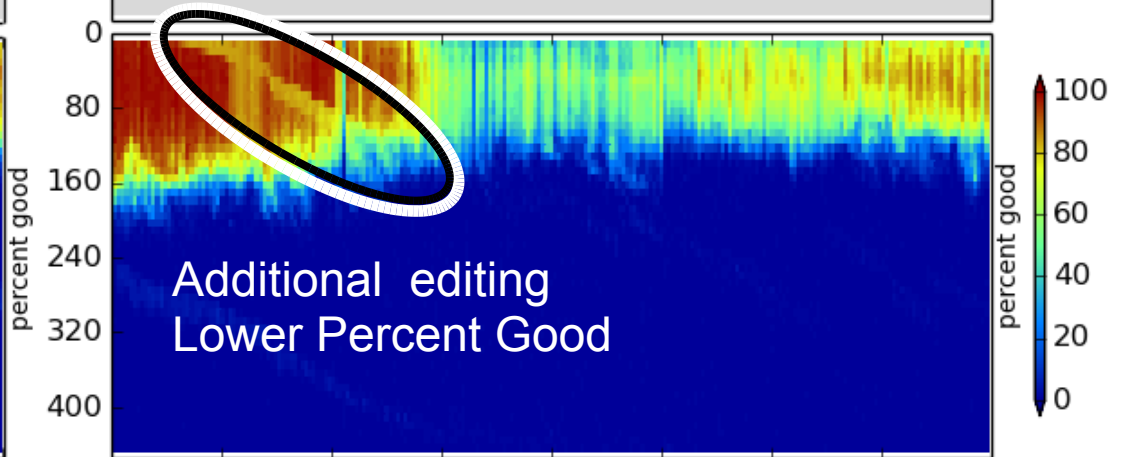
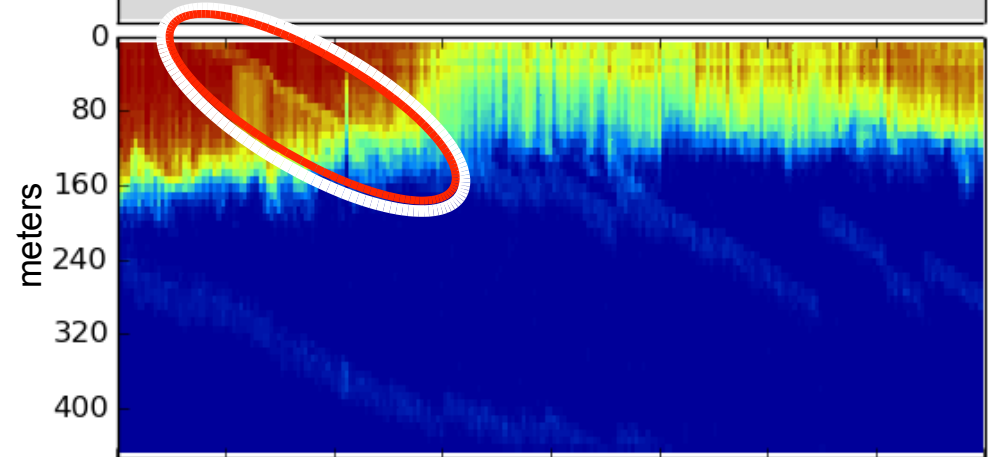
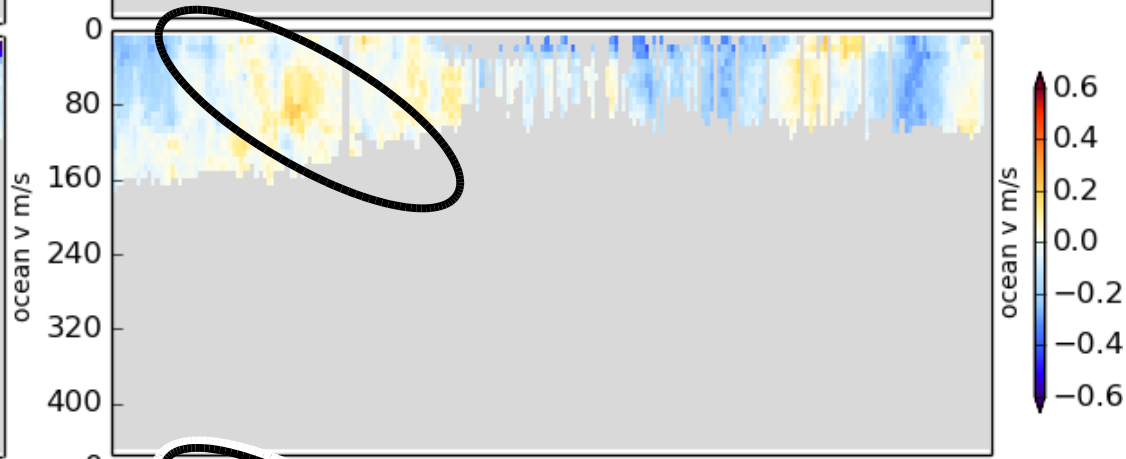
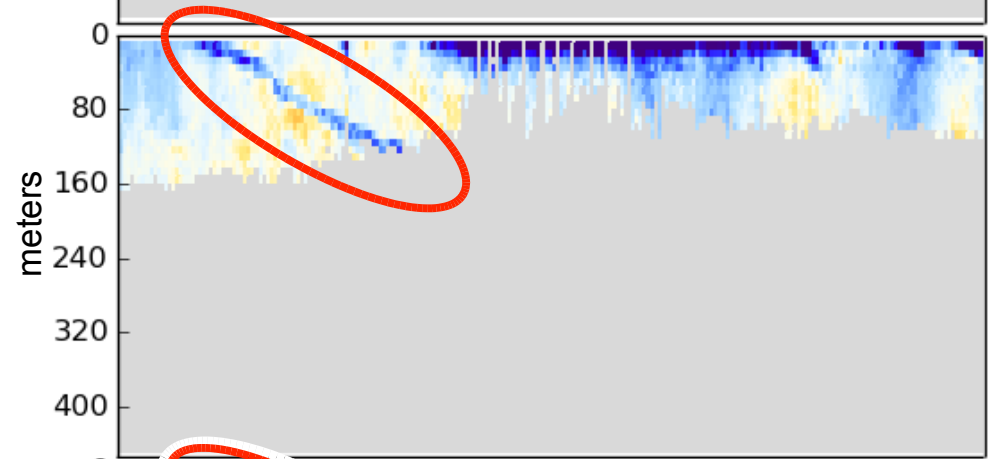
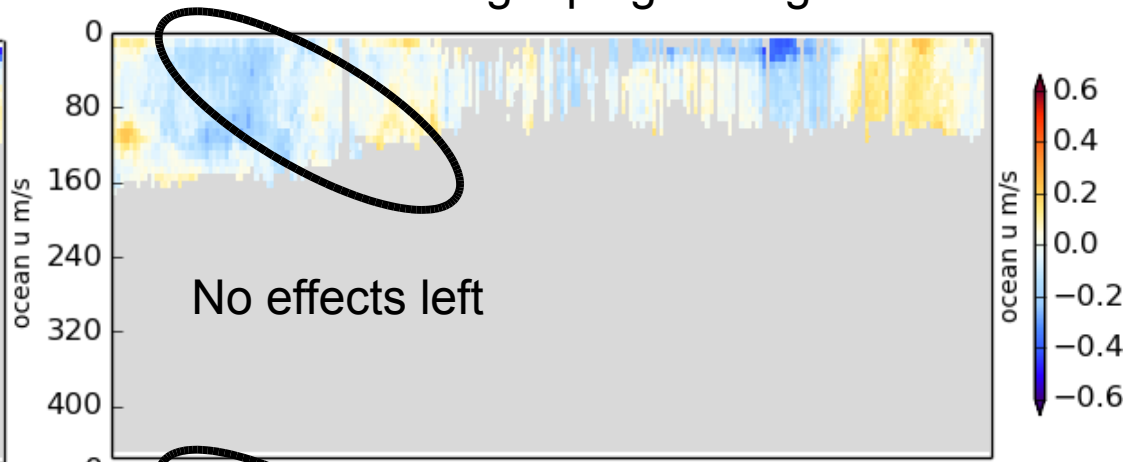
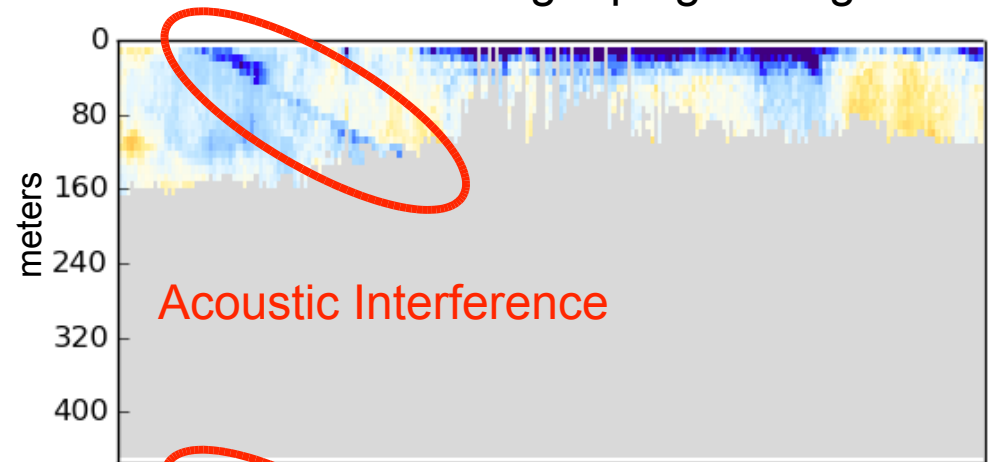
- biased ocean velocities



# Acoustic Interference

NO single-ping editing

AFTER single-ping editing



138.2 138.3 138.4 138.5 138.6 138.7 138.8 138.9 139.0

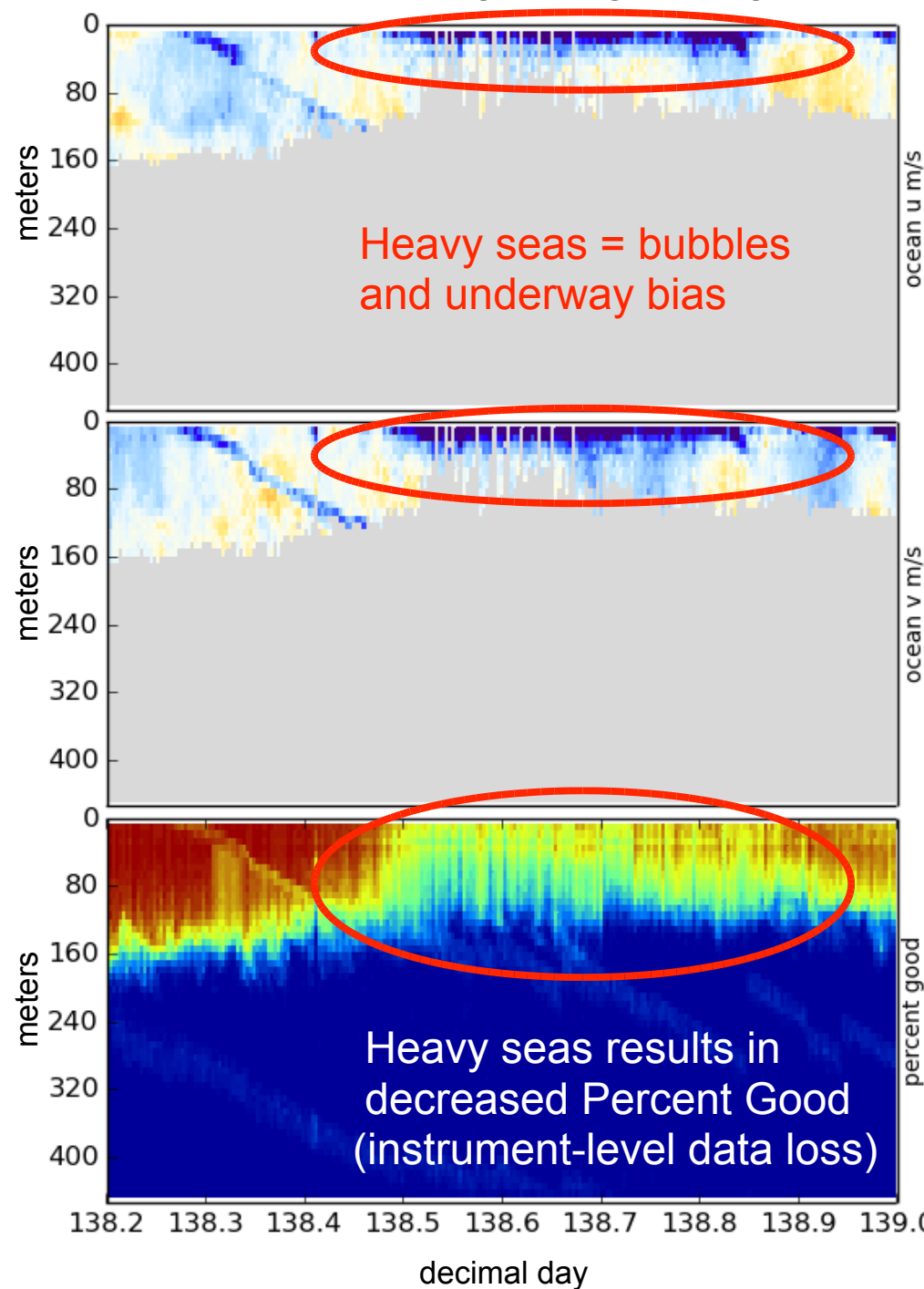
decimal day

138.2 138.3 138.4 138.5 138.6 138.7 138.8 138.9 139.0

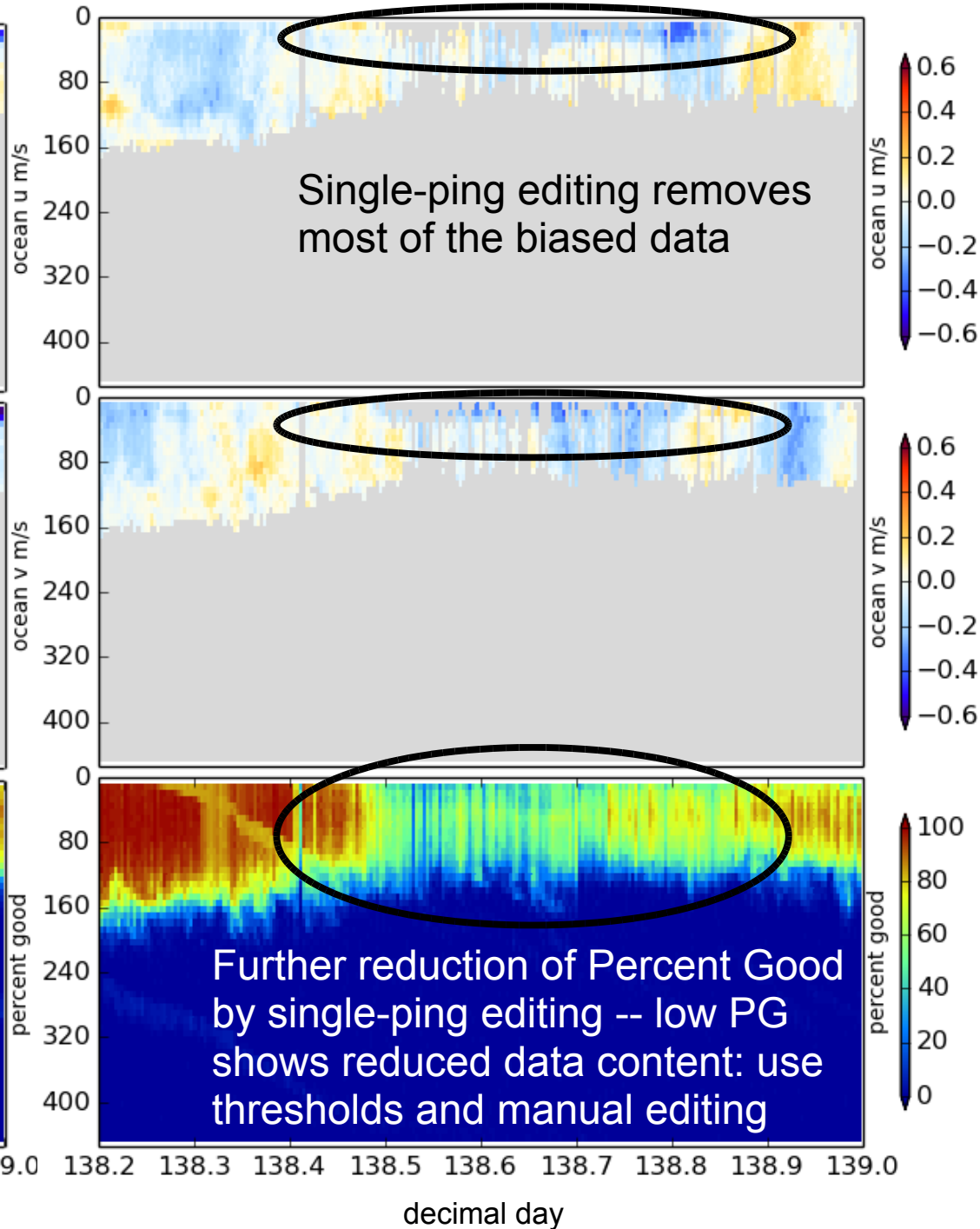
decimal day

# Bubbles and alongtrack bias

## NO single-ping editing



## AFTER single-ping editing



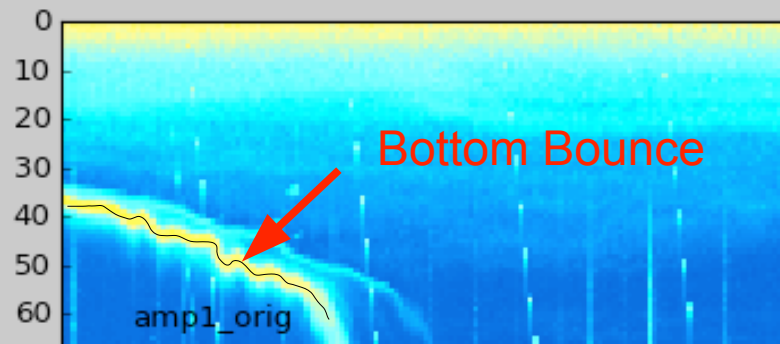
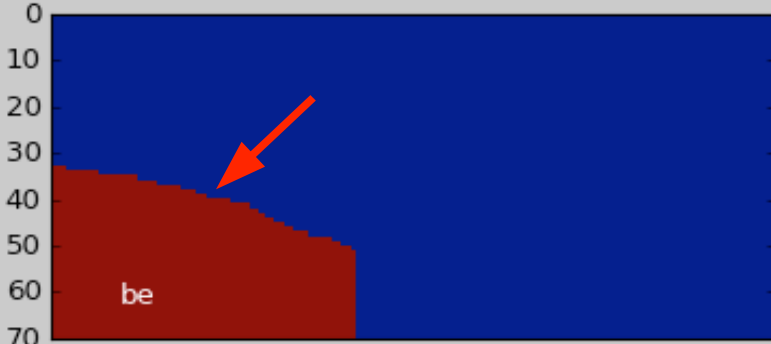
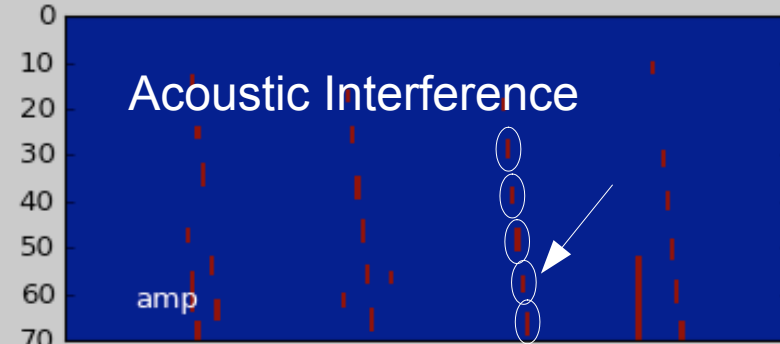
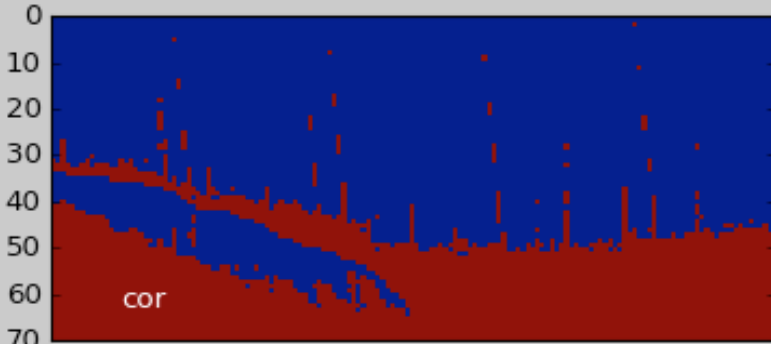
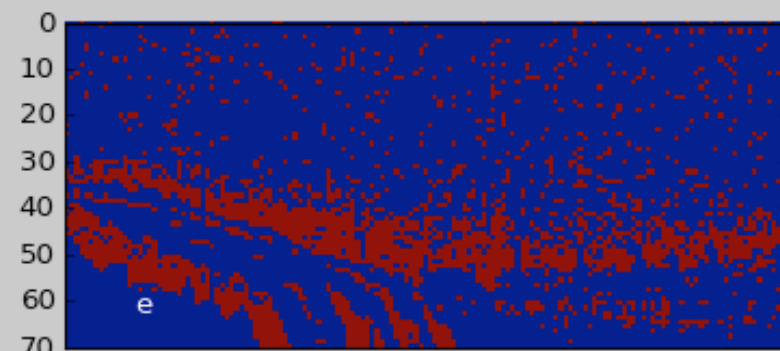
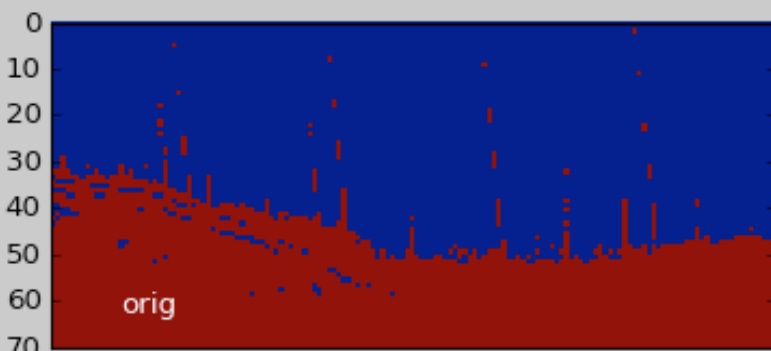
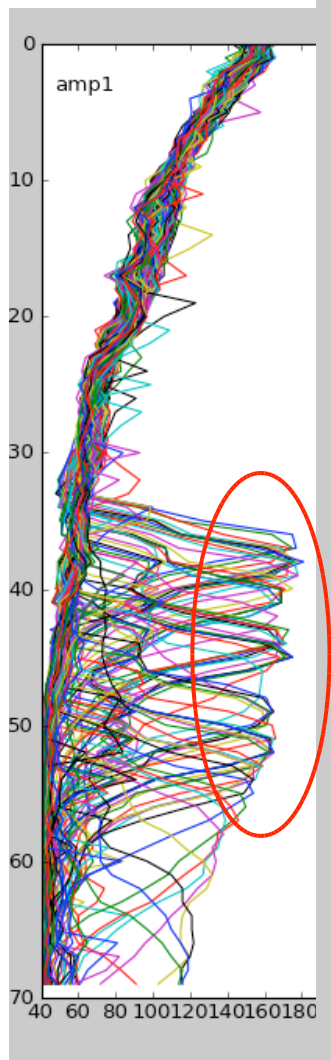
# ADCP Single-ping Editing

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



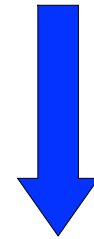


# CODAS Post-processing

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- 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

# CODAS post-processing:

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(1) View figures and logfiles

(2) Fix heading:

- patch gappy but accurate heading correction (if relevant)
- apply time-dependent heading correction

(3) Determine corrections/calibrations, then apply

- remaining transducer angle offset
- scale factor (if relevant)
- transducer-GPS offset (in meters)

(4) Manually edit out bad data ([dataviewer.py](#))

- use thresholds for bulk editing
- graphically select bins or profiles; use Seabed Selector for bottom

(5) check calibrations (angle, scale factor, gps-ADCP offset)

(6) make figures ([web page](#)) export data (matlab, netCDF)

# Manual Editing

- Bottom interference
- Wire interference
- Scattering layers
- Ringing
- Bad shallow PG and underway bias

(see [dataviewer.py](#) documentation)

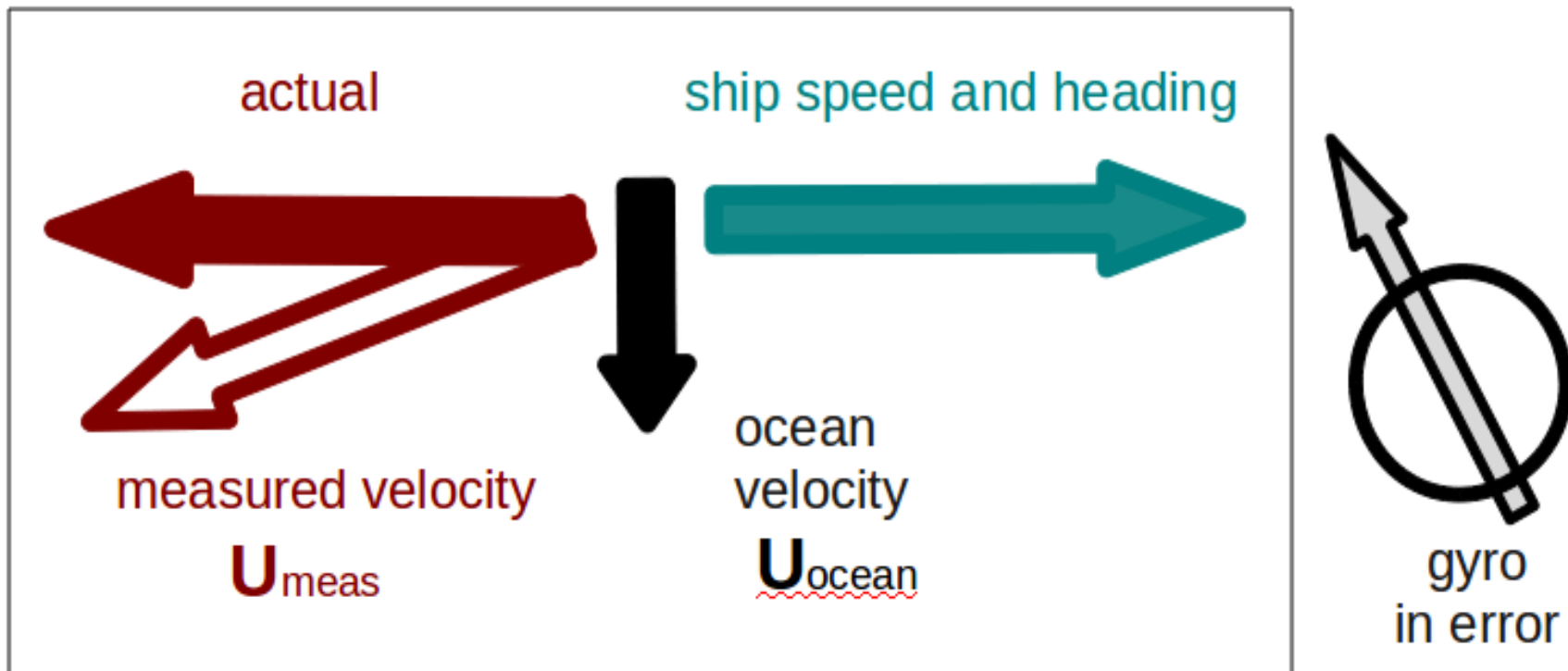
# Post-Processing: Calibration of Averaged Data

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- (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

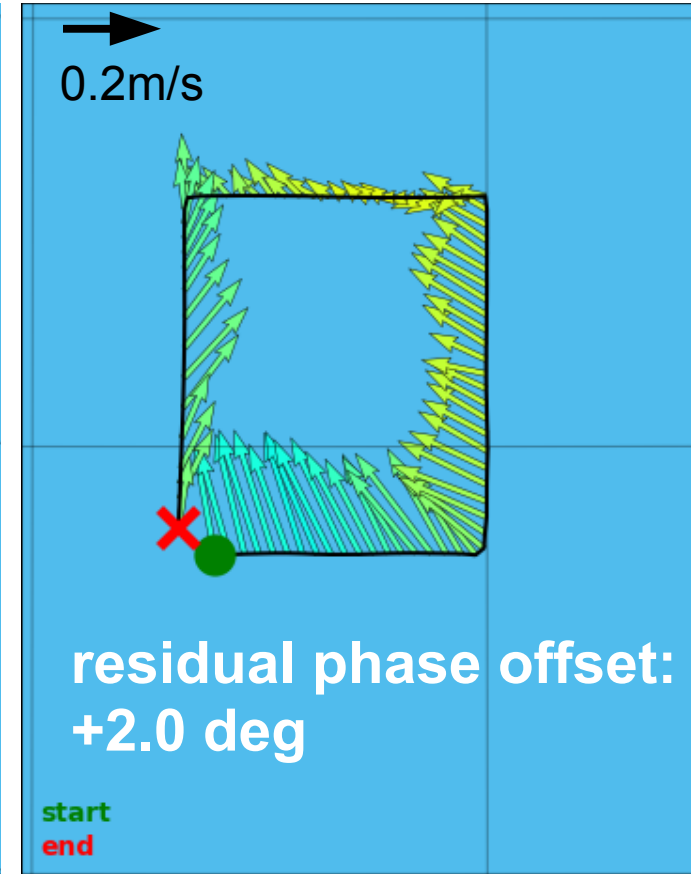
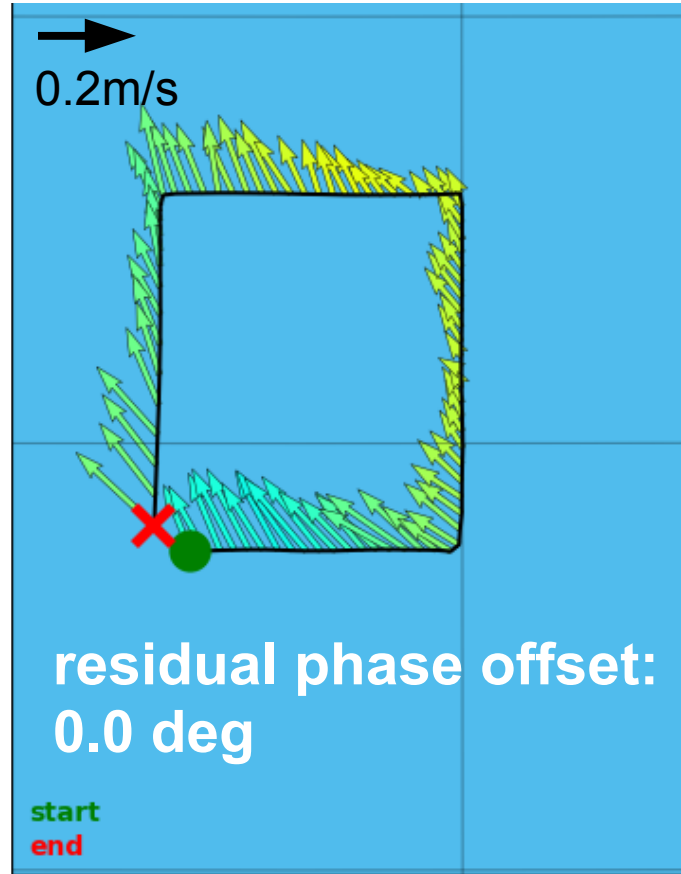
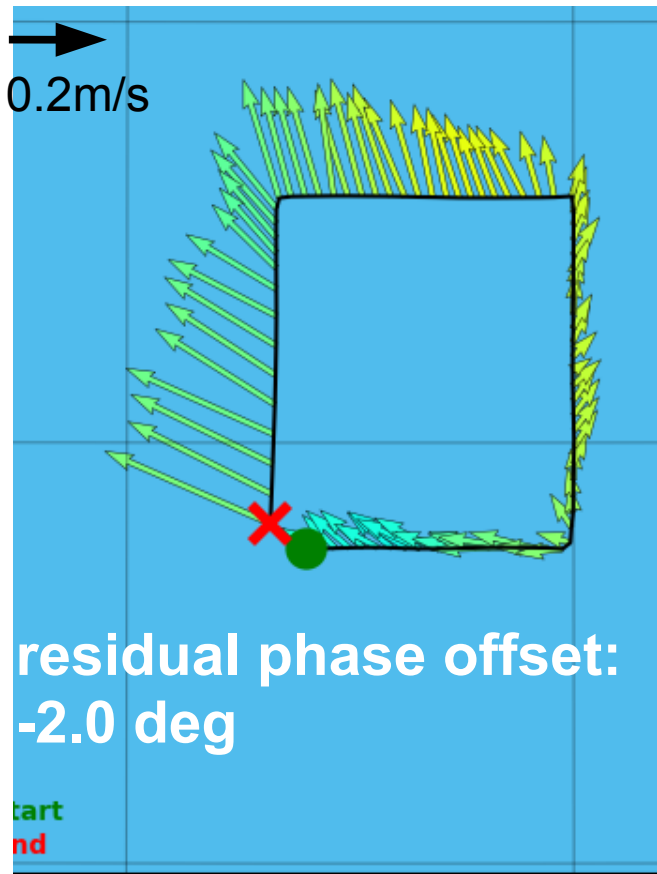
- Transducer angle (beam “3” clockwise from bow)

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)

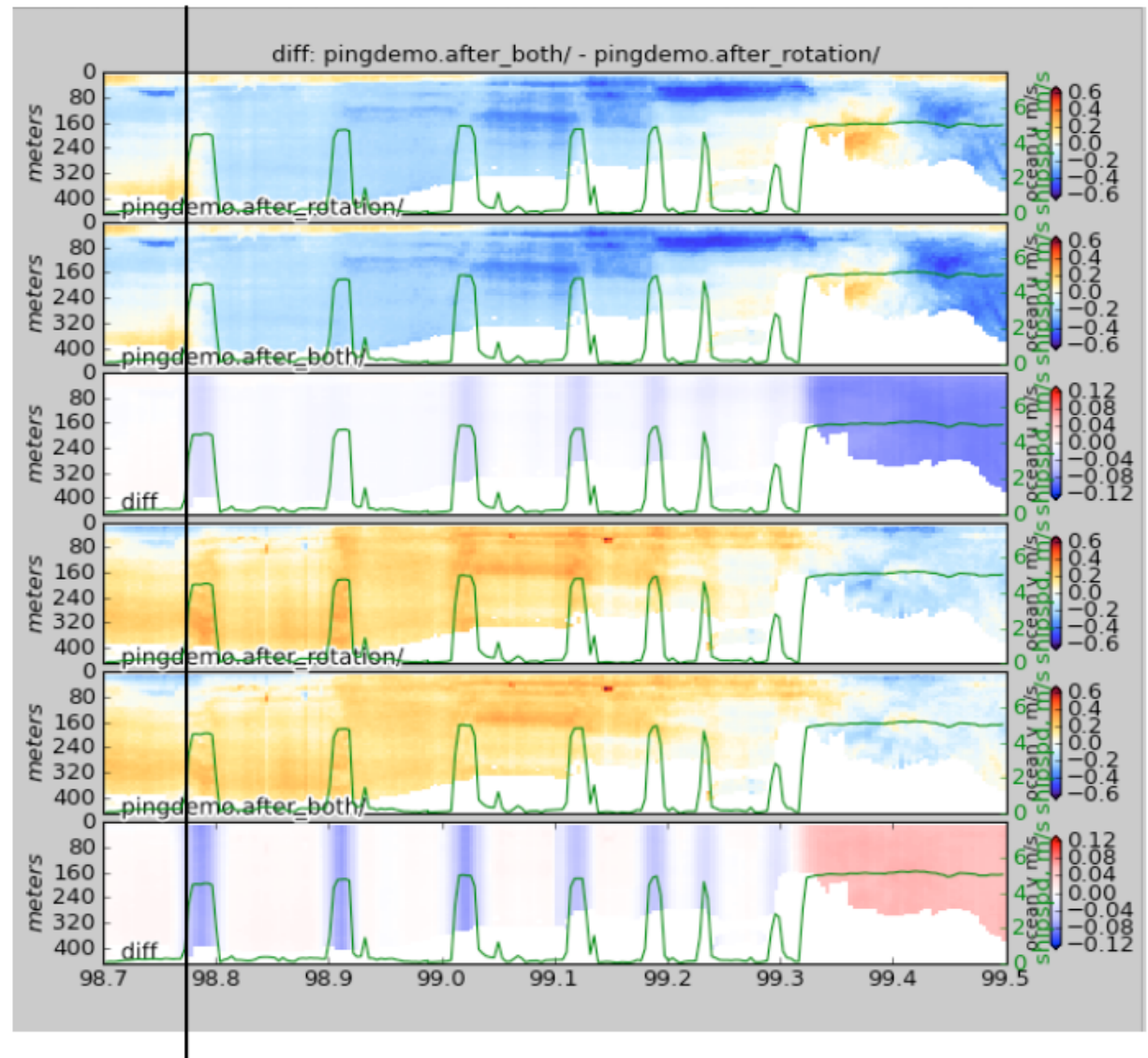
Ocean U (after scalefactor)

Diff: after-before

Ocean V (original)

Ocean V (after scalefactor)

Diff: after-before



# Calibration: ADCP-GPS offset

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## (1) Cross-track error:

- recovery requires accurate heading

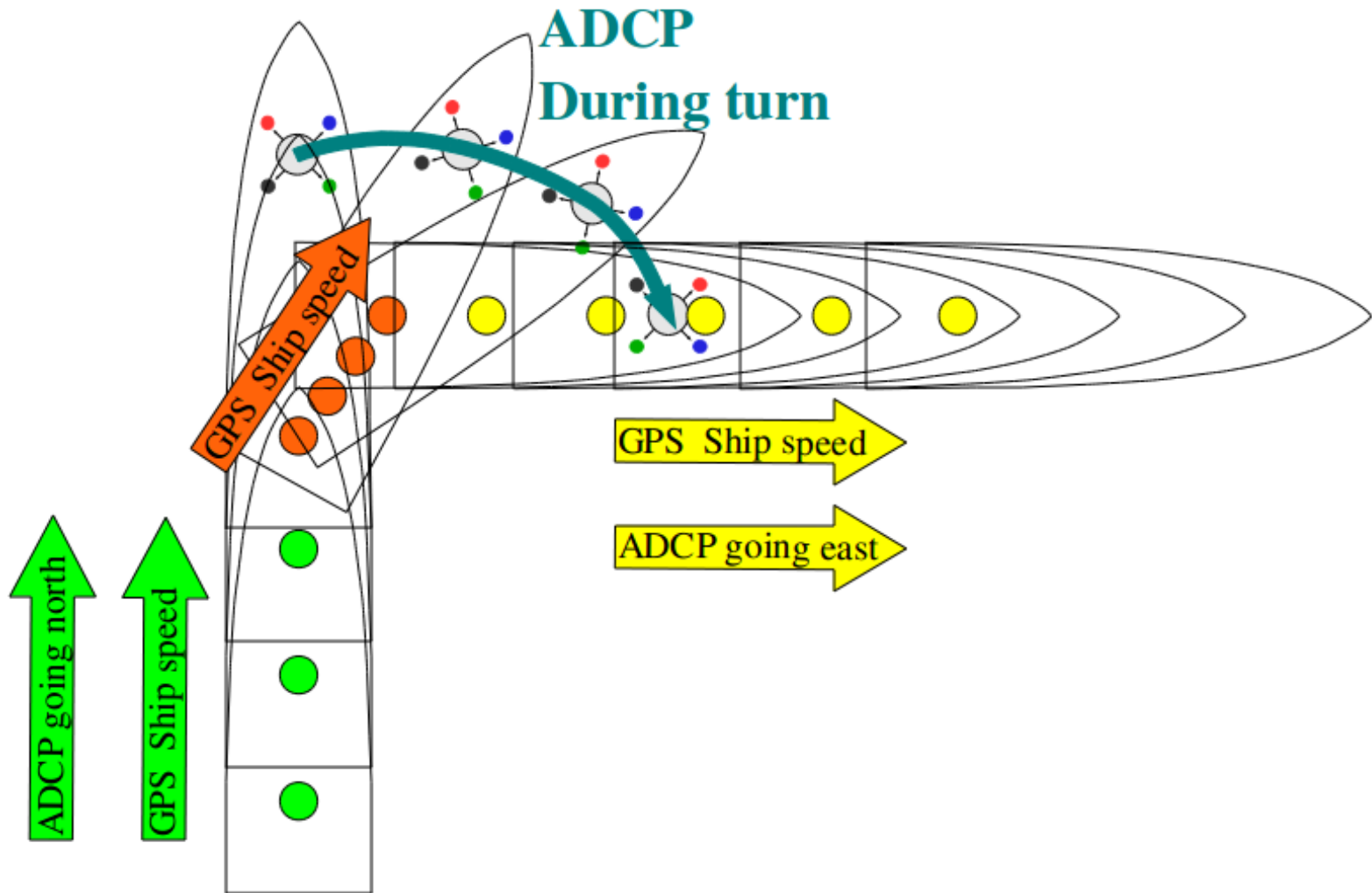
## (2) Along-track error:

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

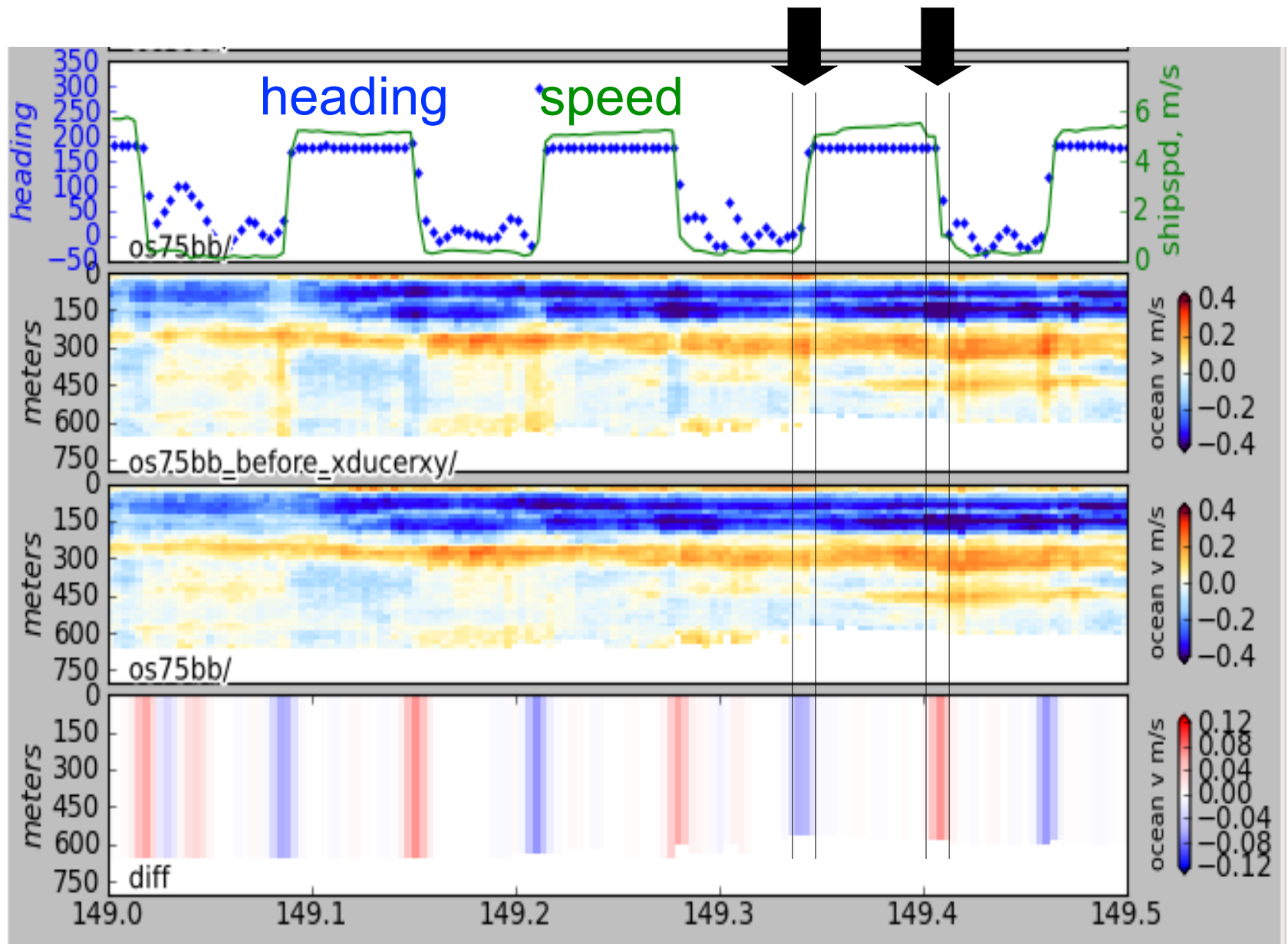
## (3) Transition/maneuvering error

- 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

**Then go do science!**