CODAS Shipboard ADCP processing

Marine Technology Unit,
Spanish Research Council
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Dr Julia Hummon
University of Hawaii
http://uhdas.org

UHDAS + CODAS Documentation

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

- CODAS processing introduction
  - show 10 slides of this ~40-slide presentation
- Switch to the “live” demo
  - slides for the demo are here

CODAS Documentation is here

- section for adcp_database_maker.py VmDAS LTA

DATA ACQUISITION

Time, ADCP, Position, Attitude

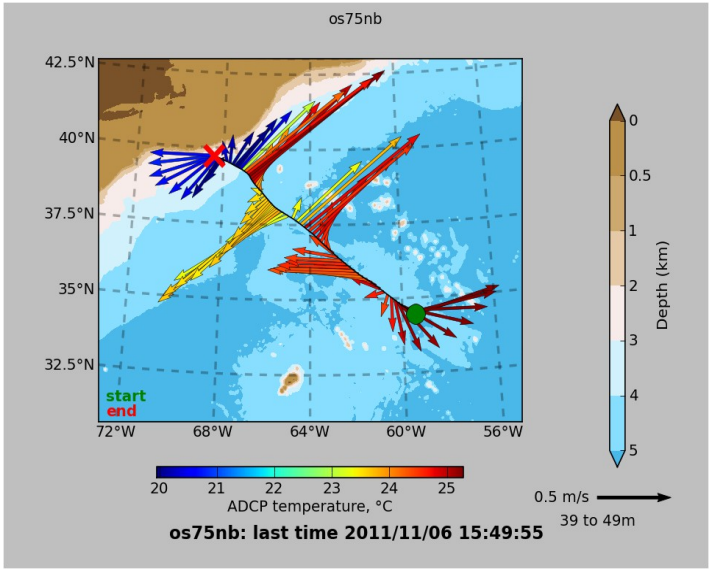
primitive (raw) data

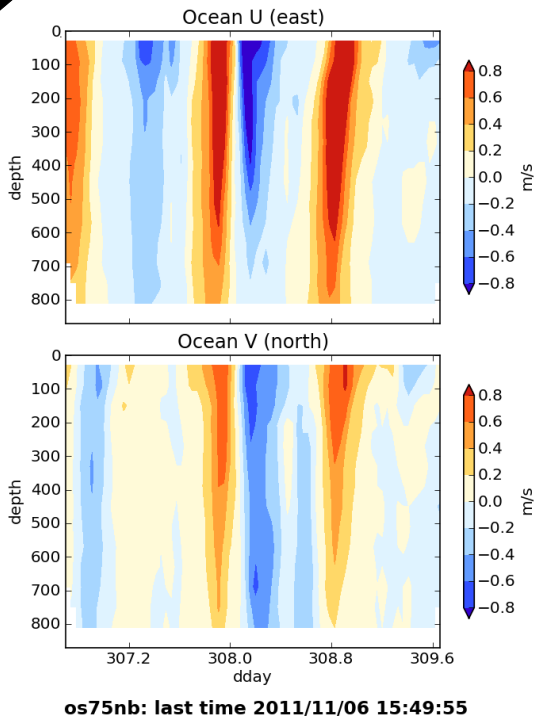
Time
ADCP
Position
Heading

Timestamp, Write to disk

DATA PROCESSING

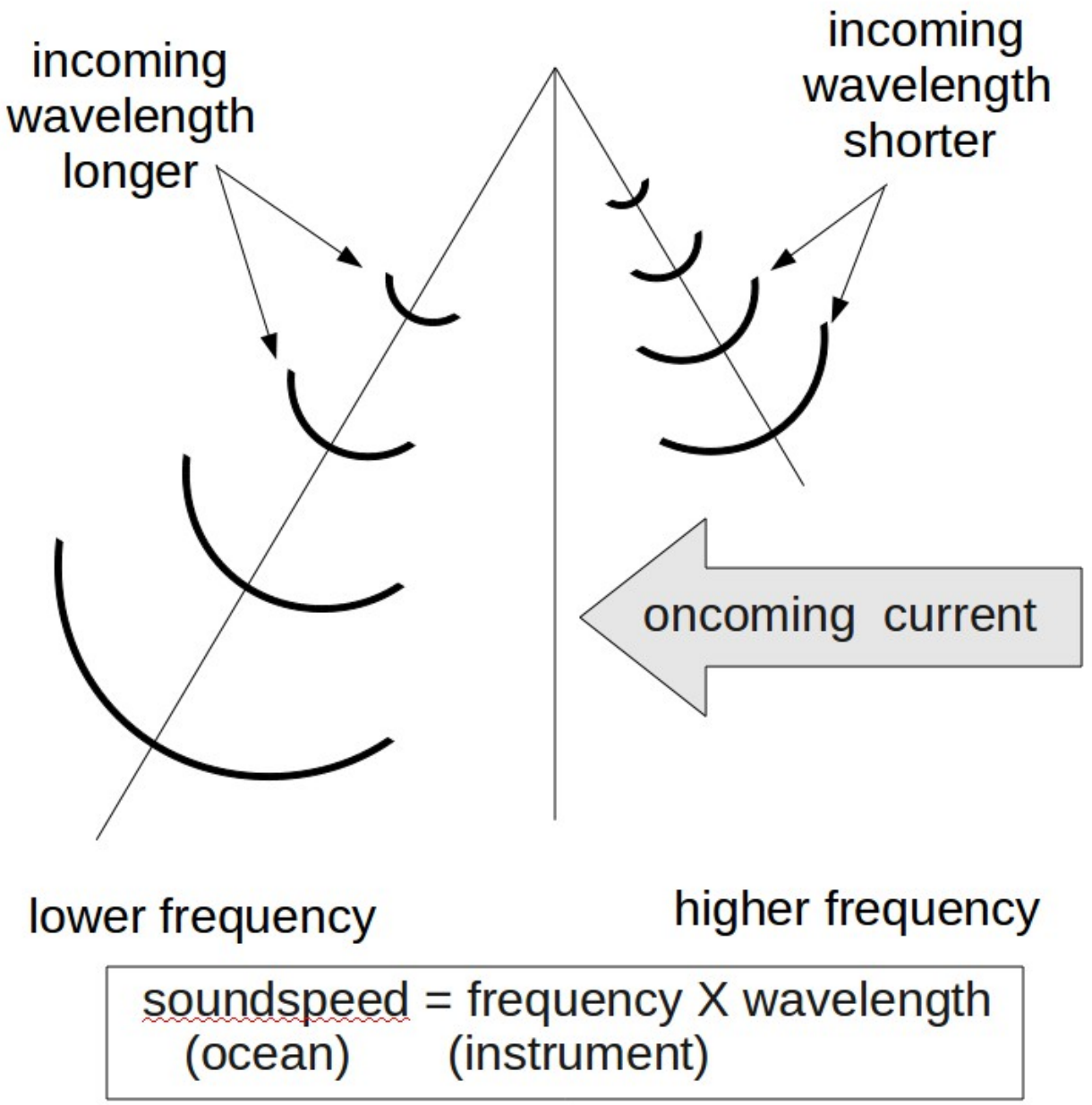
(Data Products)
(Visualization)





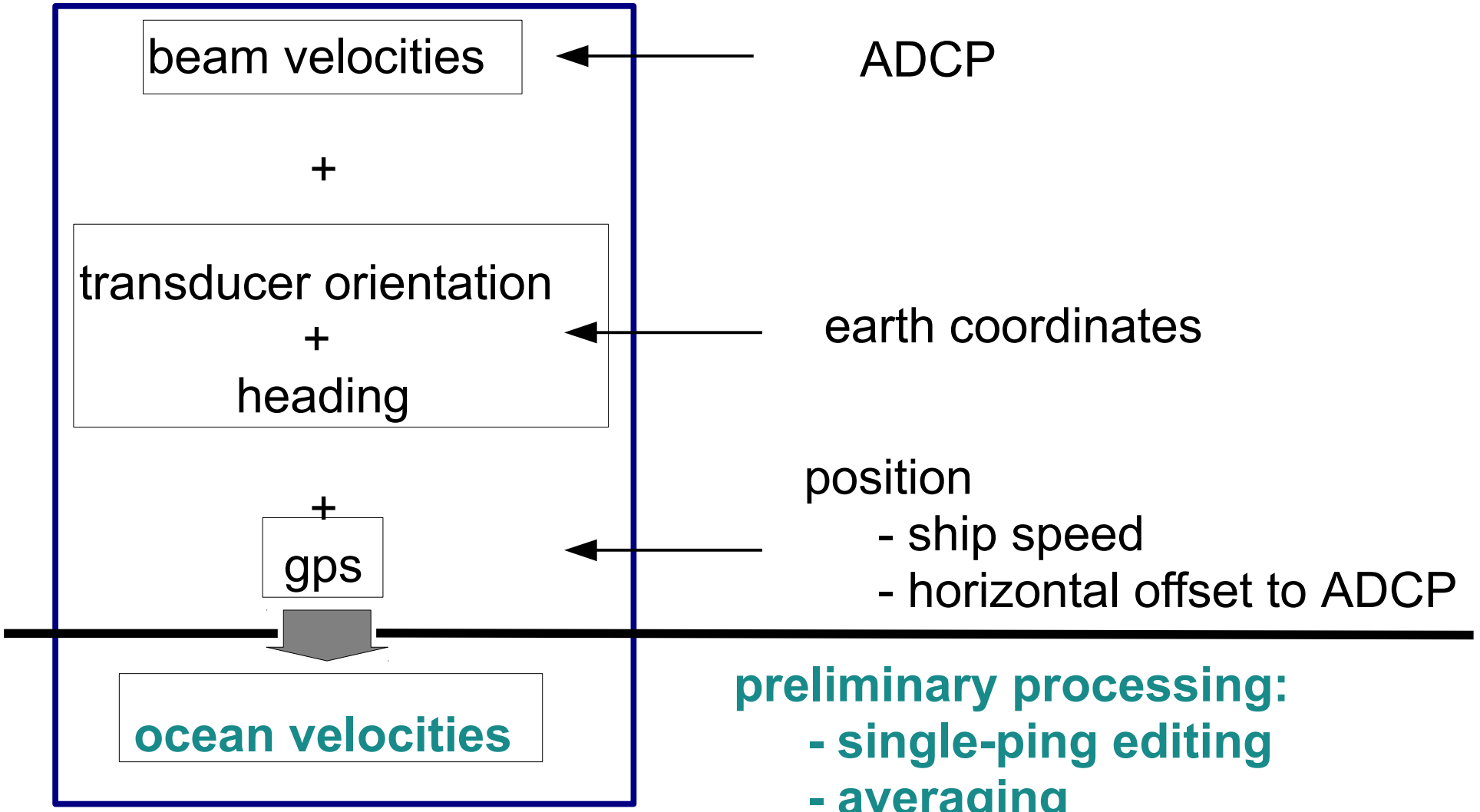
ADCP

Acoustic
Doppler
Current
Profiler



more details: Calculating ocean currents from ADCP

ADCP: Acquisition, Processing



ADCP: Getting Ocean Currents

Collect Data

ADCP

heading

position

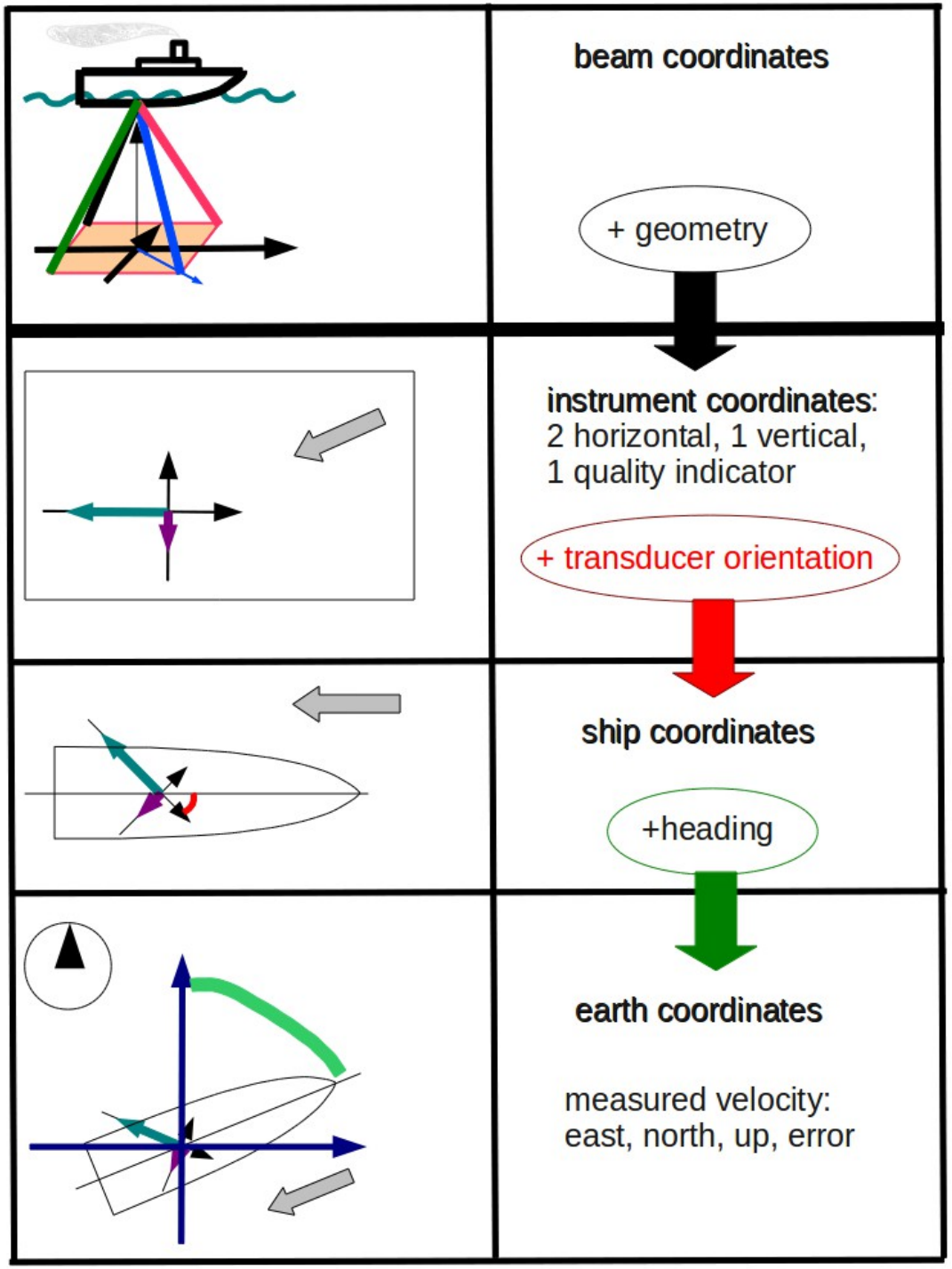
Transformations

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



“CODAS” ADCP Processing

Goals

- Run on multiple operating systems
  - (Windows,(*) OSX, Linux)
- Open source, free (Python)

(*) via VirtualBox pre-configured Linux computer

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

- UHDAS + CODAS Documentation

CODAS preliminary processing: 2 flavors

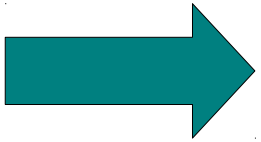
(1) **Preliminary processing single-ping data**

- 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 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**

***.VMO**

uhdas-style single-ping data

single-ping processing

CODAS averages after single-ping editing

CODAS post-processing:

(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)

VmDAS Demonstration

- Point Sur data
  - LTA
  - ENR
  - compare: effect of
    - single-ping editing
    - heading correction
    - transducer angle (calibration)
- Knorr Norwegian Sea
  - compare LTA vs/ ENR
  - show effect of GPS-ADCP offset

The rest of this presentation will be “live”.

- running adcp_database_maker.py, showing
  - work flow
  - how to find and apply calibration values
    - transducer angle
    - scale factor
    - ADCP-GPS horizontal offset
  - where this is all documented
  - information about the dataset
  - how to view the data
  - how to process
    - LTA
    - ENR
- how to make a little web site with figures
- how to compare LTA and ENR

Slides for adcp_database_maker.py are here

CODAS preliminary processing

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

} Automated at-sea processing

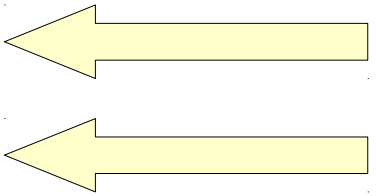
- Fix time-dependent heading correction (eg. if gaps)
- Apply calibrations
  - Rotation
  - Scale factor
  - Horizontal offset between GPS and ADCP (new)
- Manually edit CODAS database averages

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



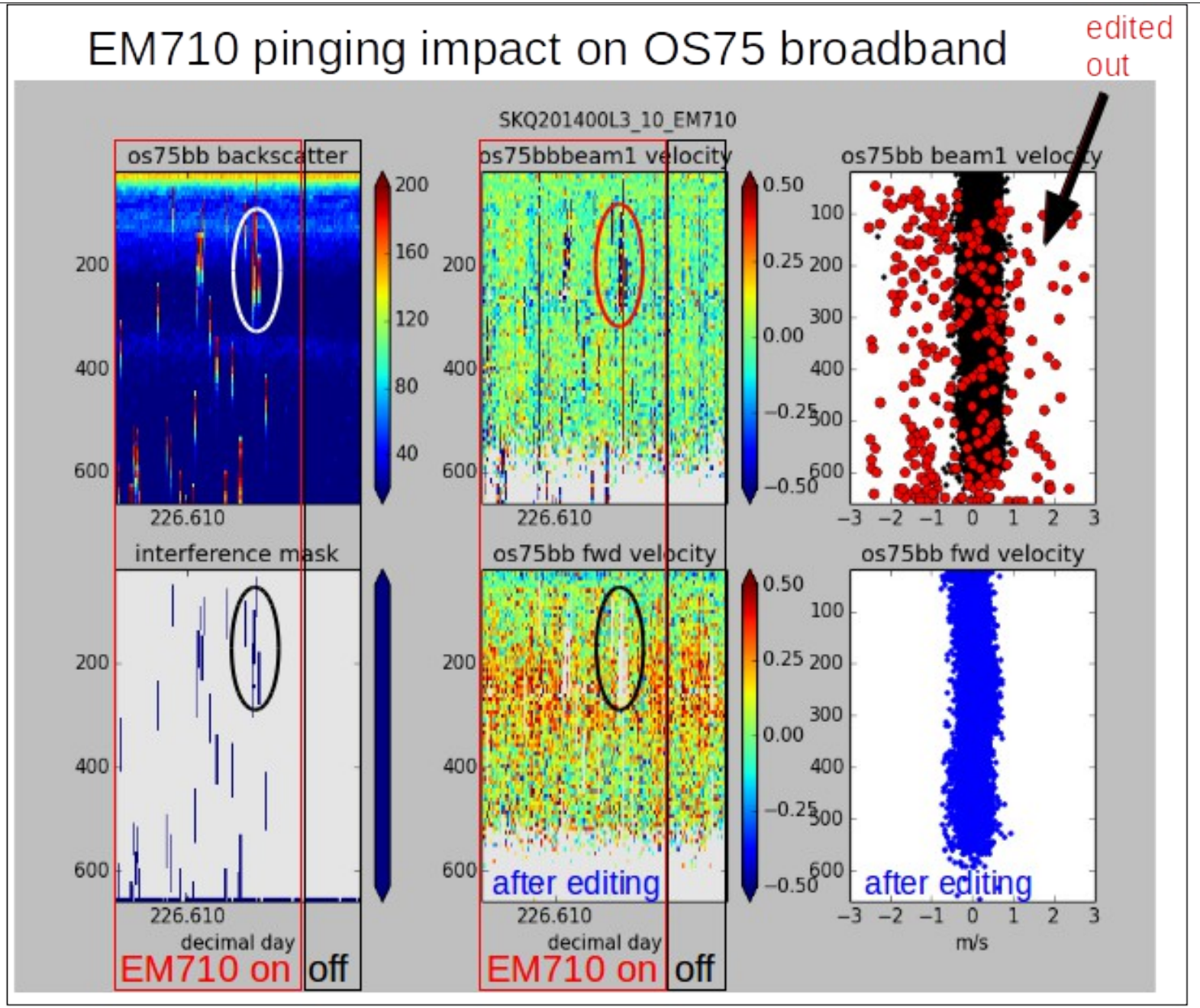
Both tend to cause bias towards zero
in measured velocity

ADCP Single-ping Editing

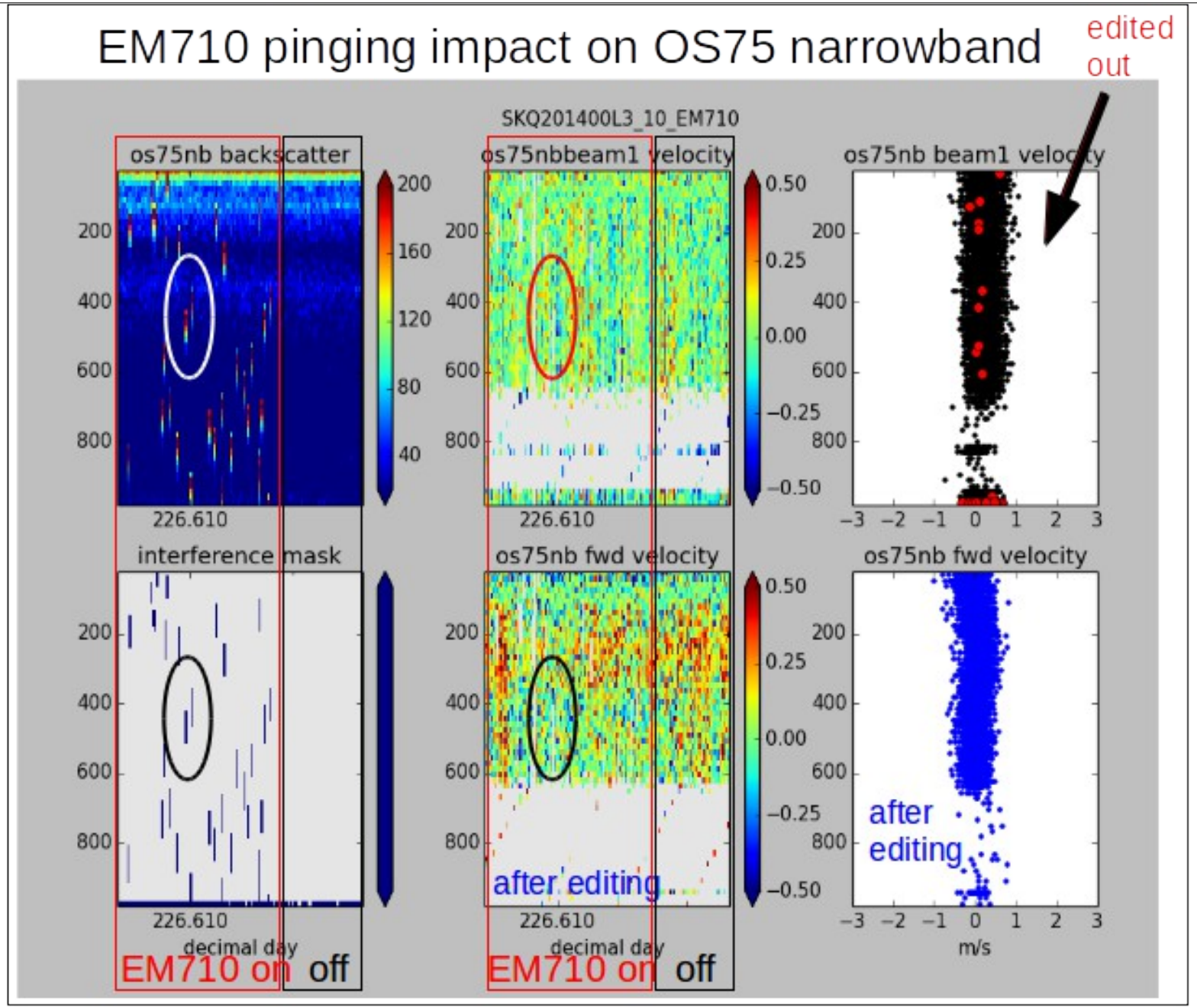
The most common causes of error (addressed by single-ping editing)

- Acoustic Interference
- Bubbles
- Below bottom

ADCP Processing: editing out interference

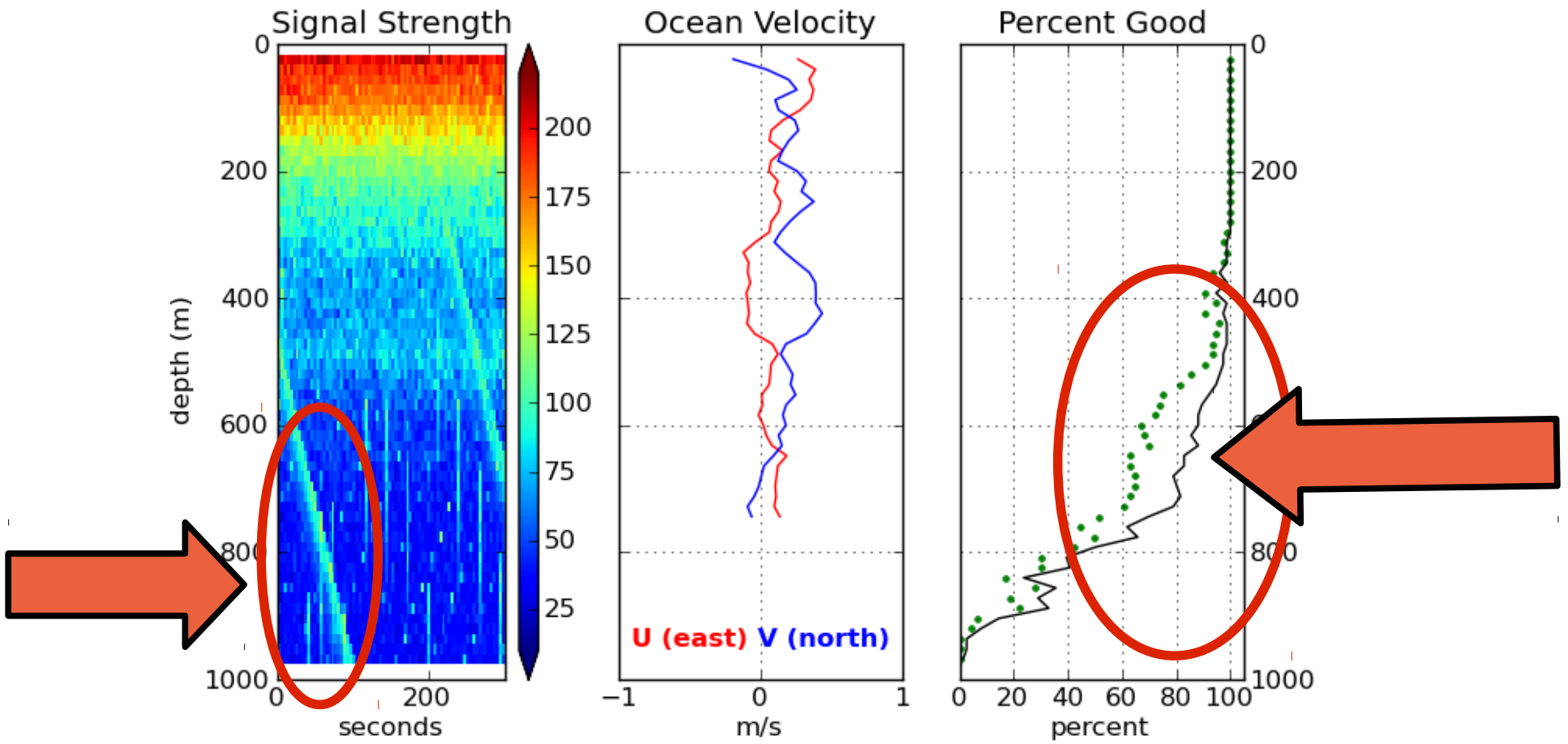


ADCP Processing: editing out interference



ADCP Processing

Singleping editing: acoustic interference



ADCP Single-ping Editing

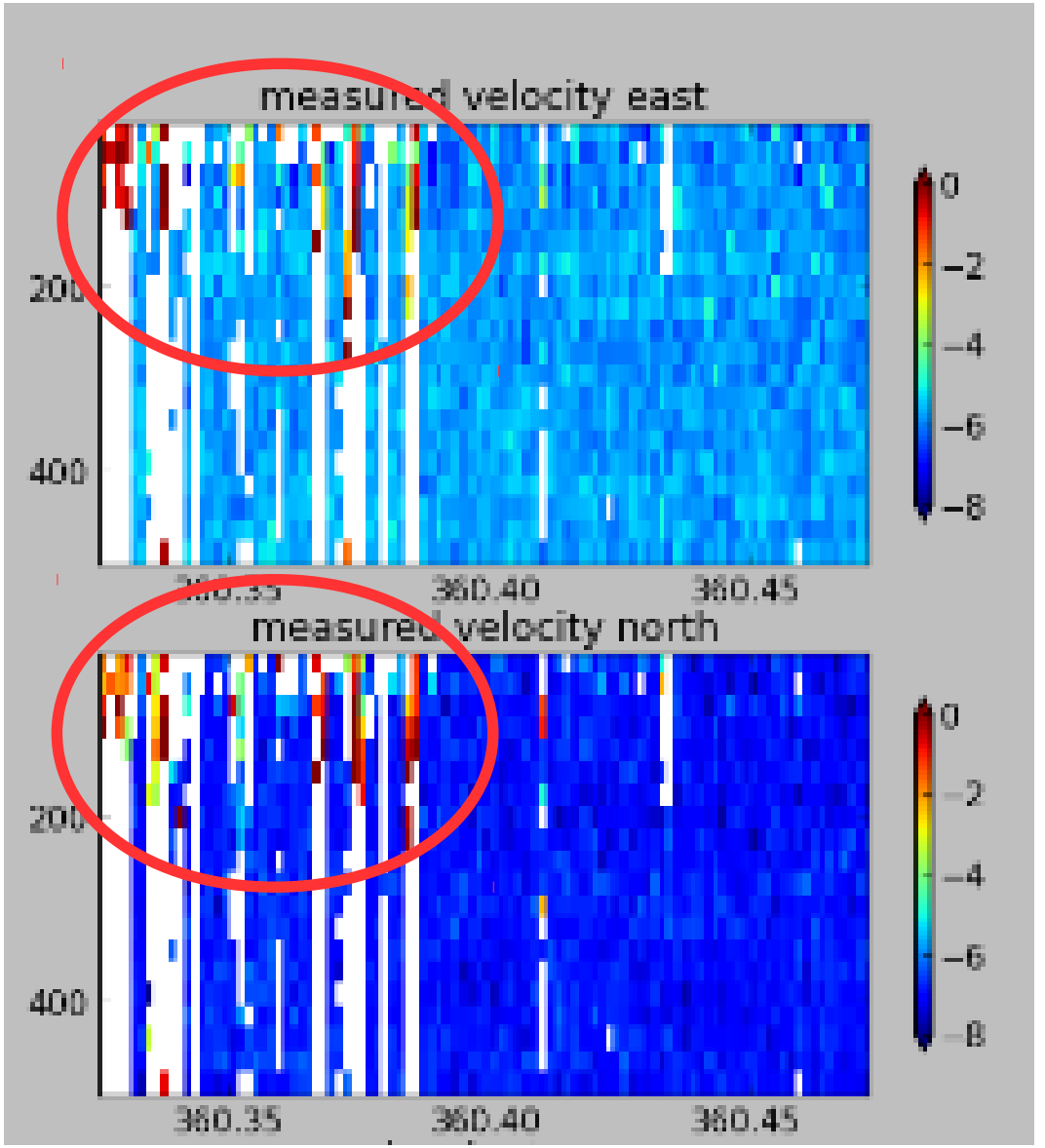
The most common causes of error (addressed by single-ping editing)

- Acoustic Interference
- Bubbles
- Below bottom

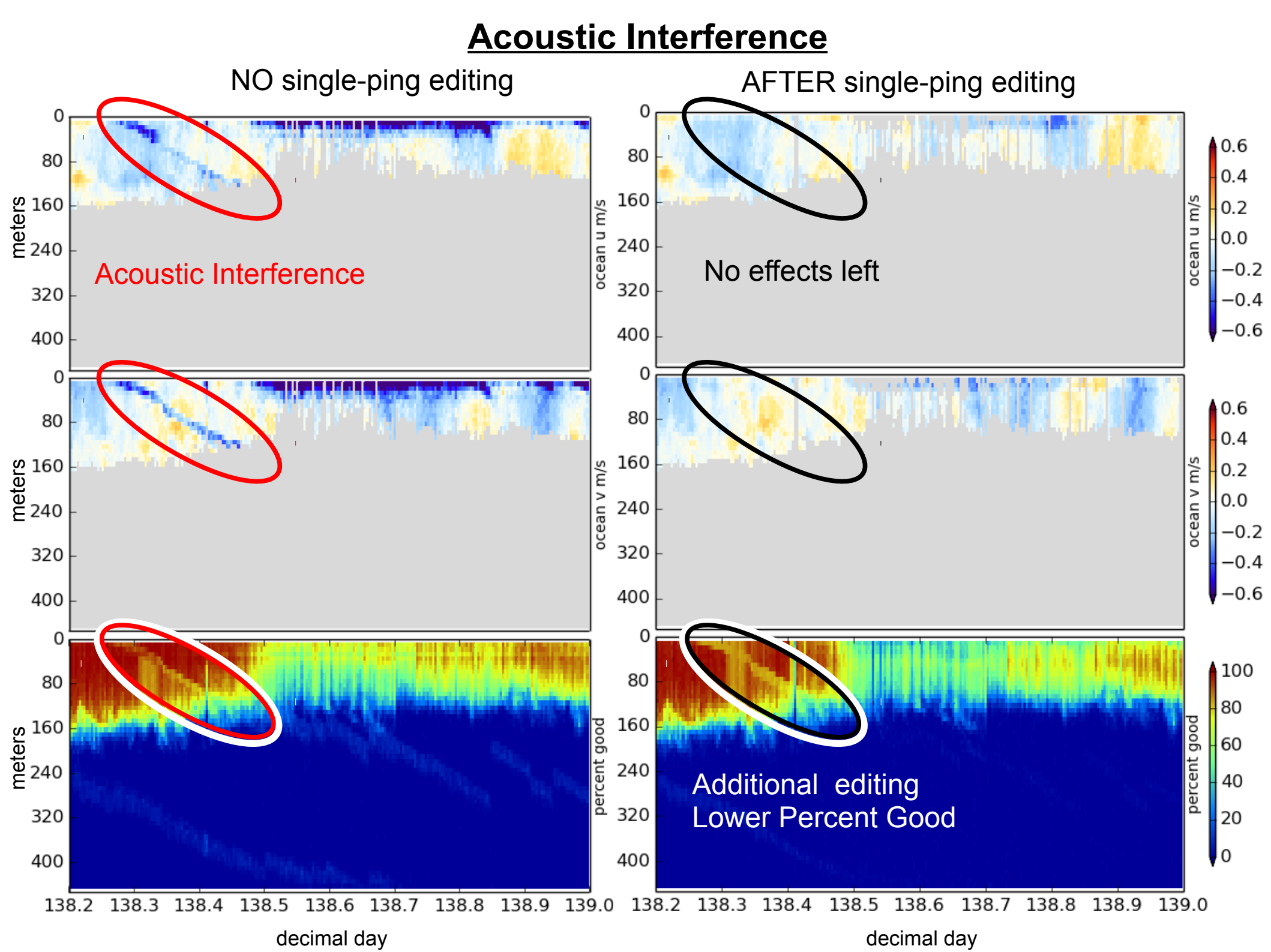
ADCP Data: effect of bubbles

Bubbles:
- short profiles
- strongly biased towards zero

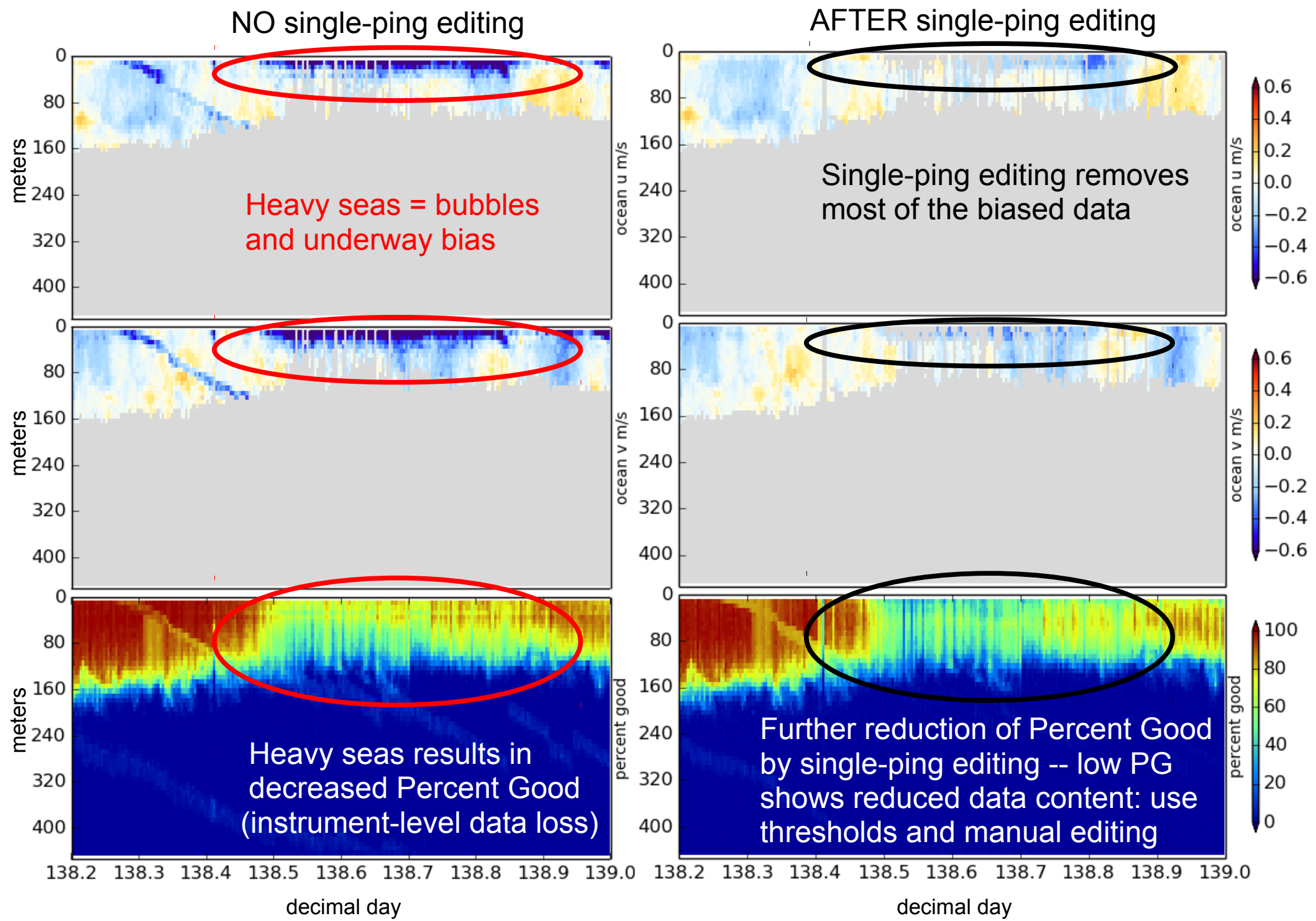
Untreated:
- biased ocean velocities



Acoustic Interference



Bubbles and alongtrack bias



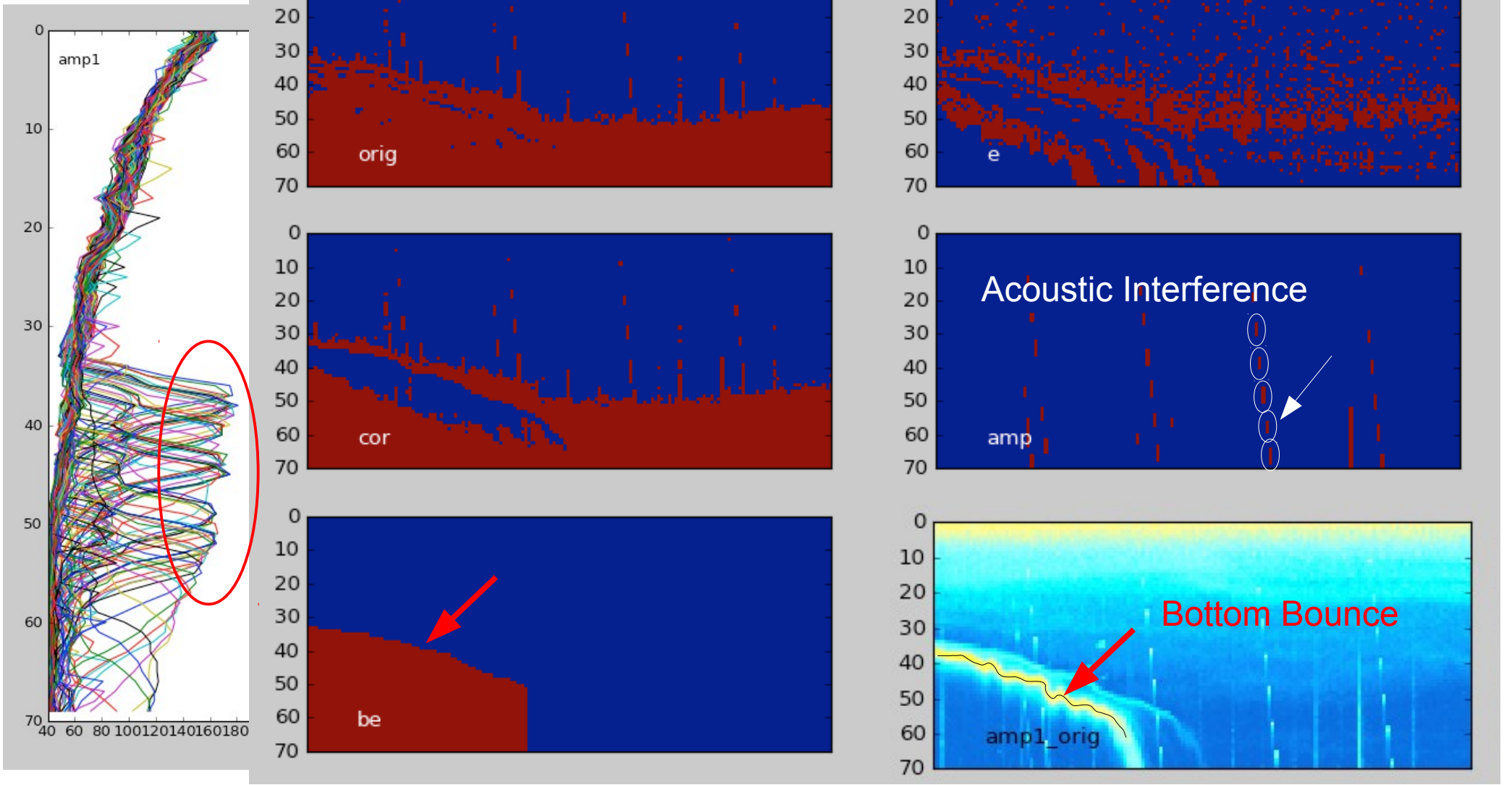
ADCP Single-ping Editing

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

- Acoustic Interference
- Bubbles
- Below bottom

Bottom Editing:

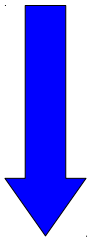
- remove acoustic interference, identify maximum amplitude
- calculate region of side-lobe interference
- flag as BAD all data below the bottom or with side-lobe interference



CODAS Post-processing

- 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:

(1) View figures and logfiles

(2) Fix heading:

- patch gappy but accurate heading correction (if relevant)
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(3) Determine corrections/calibrations, then apply

- remaining transducer angle offset
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- 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

(1) Cross-track error (angle error)

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

(2) Alongtrack bias (scale factor)

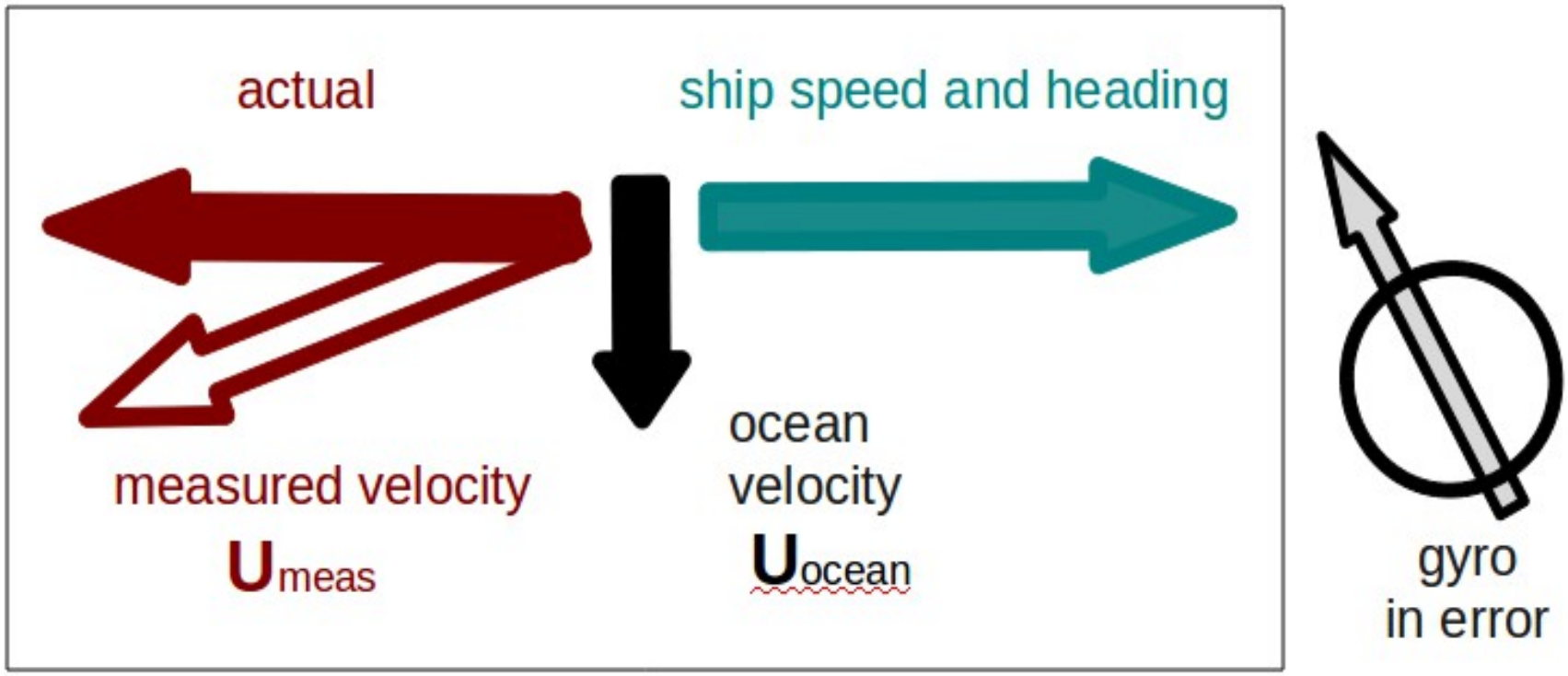
- Soundspeed (single-ceramic transducers only)

(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 w/ QC fields)

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

Angle applied comes from

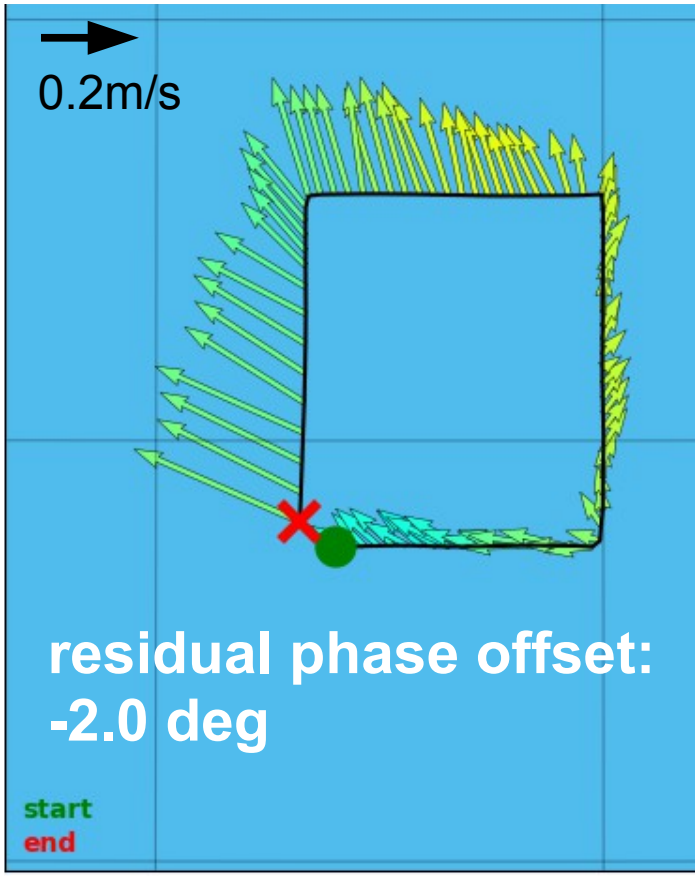
- Transducer angle (beam “3” clockwise from bow)

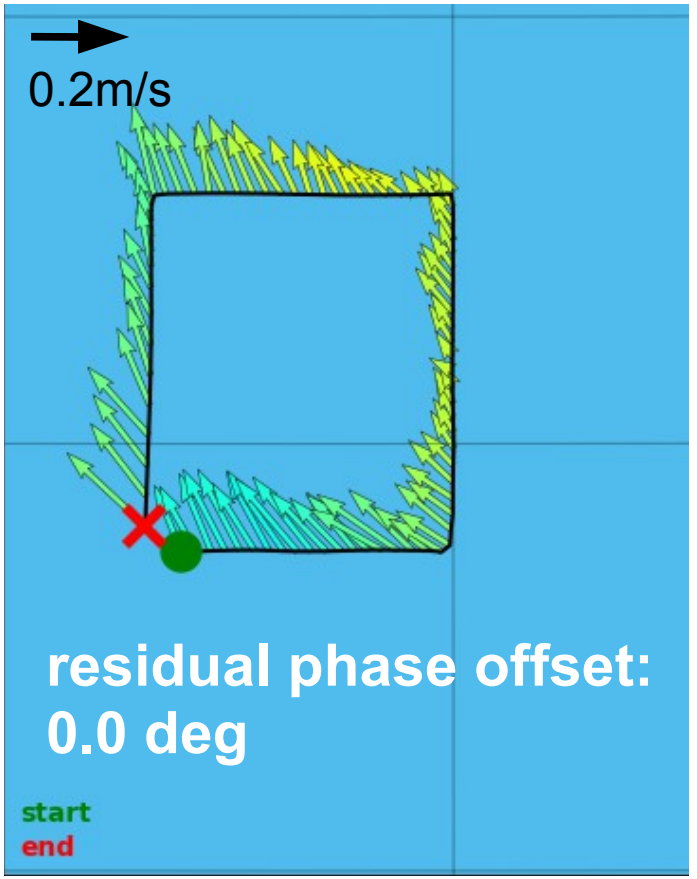
This is a **constant value** for the whole cruise

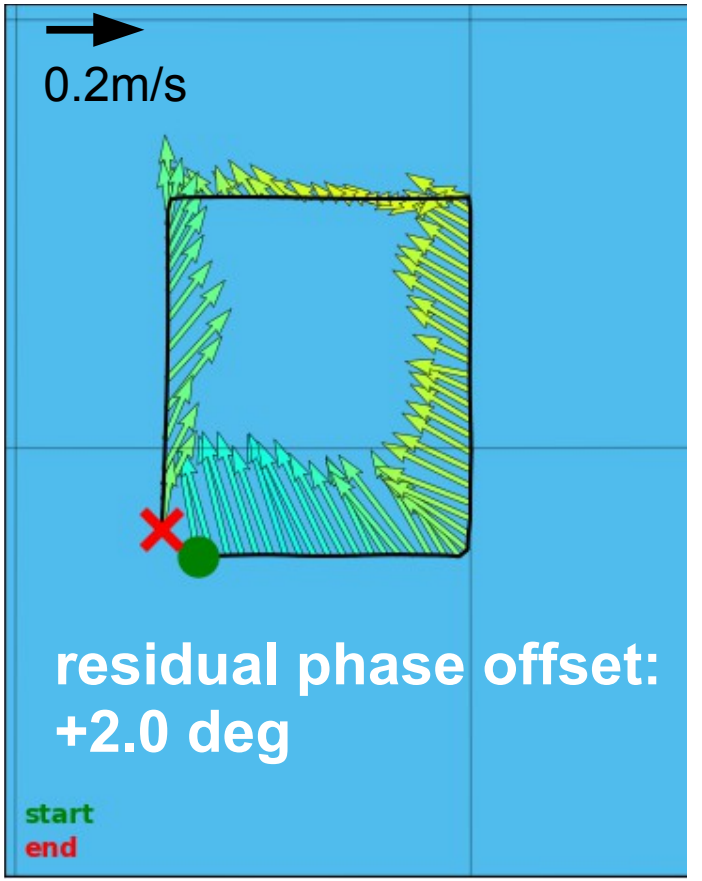
Examples of error in transducer angle follow...

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)

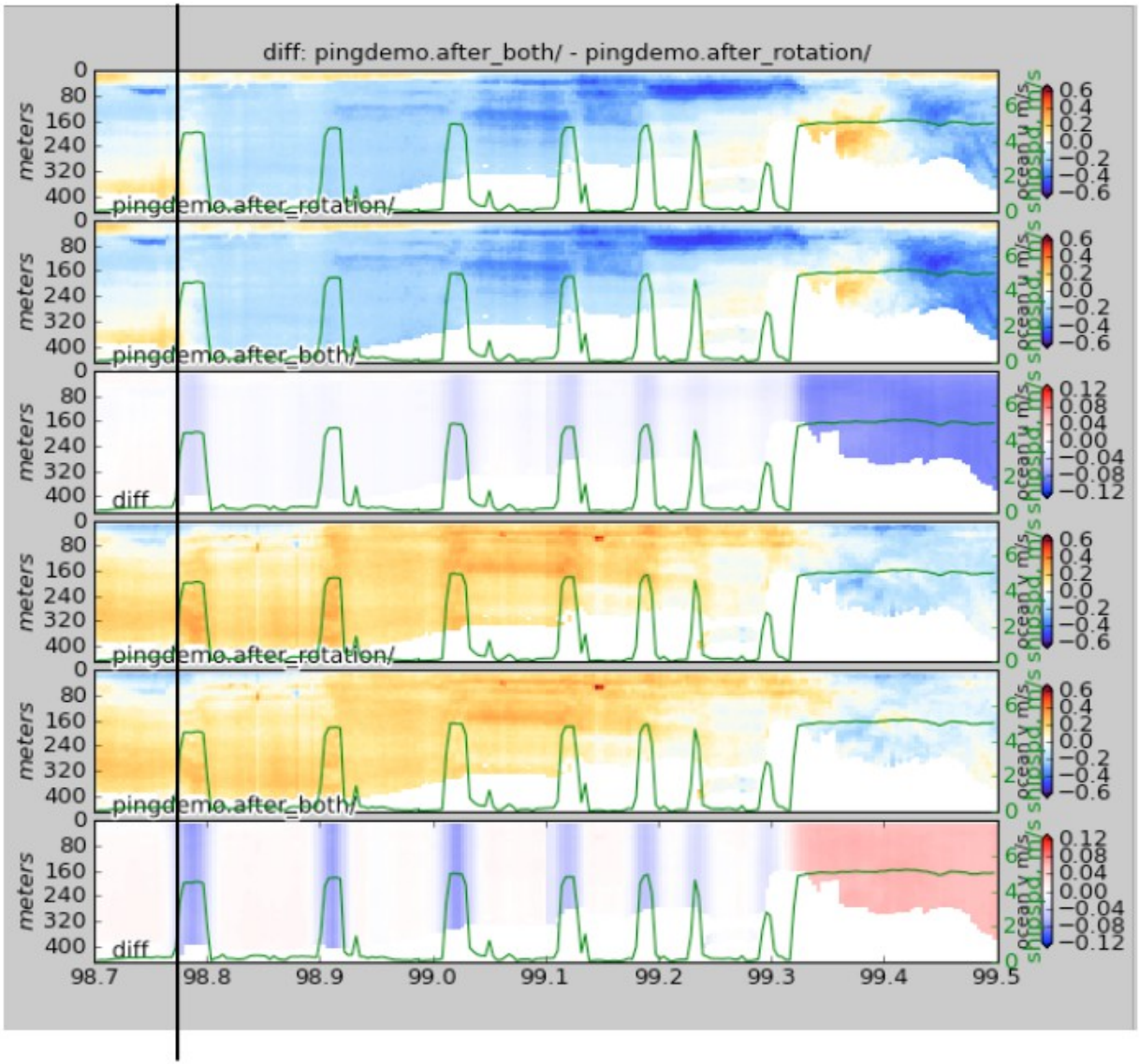
Ocean U (after scalefactor)

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

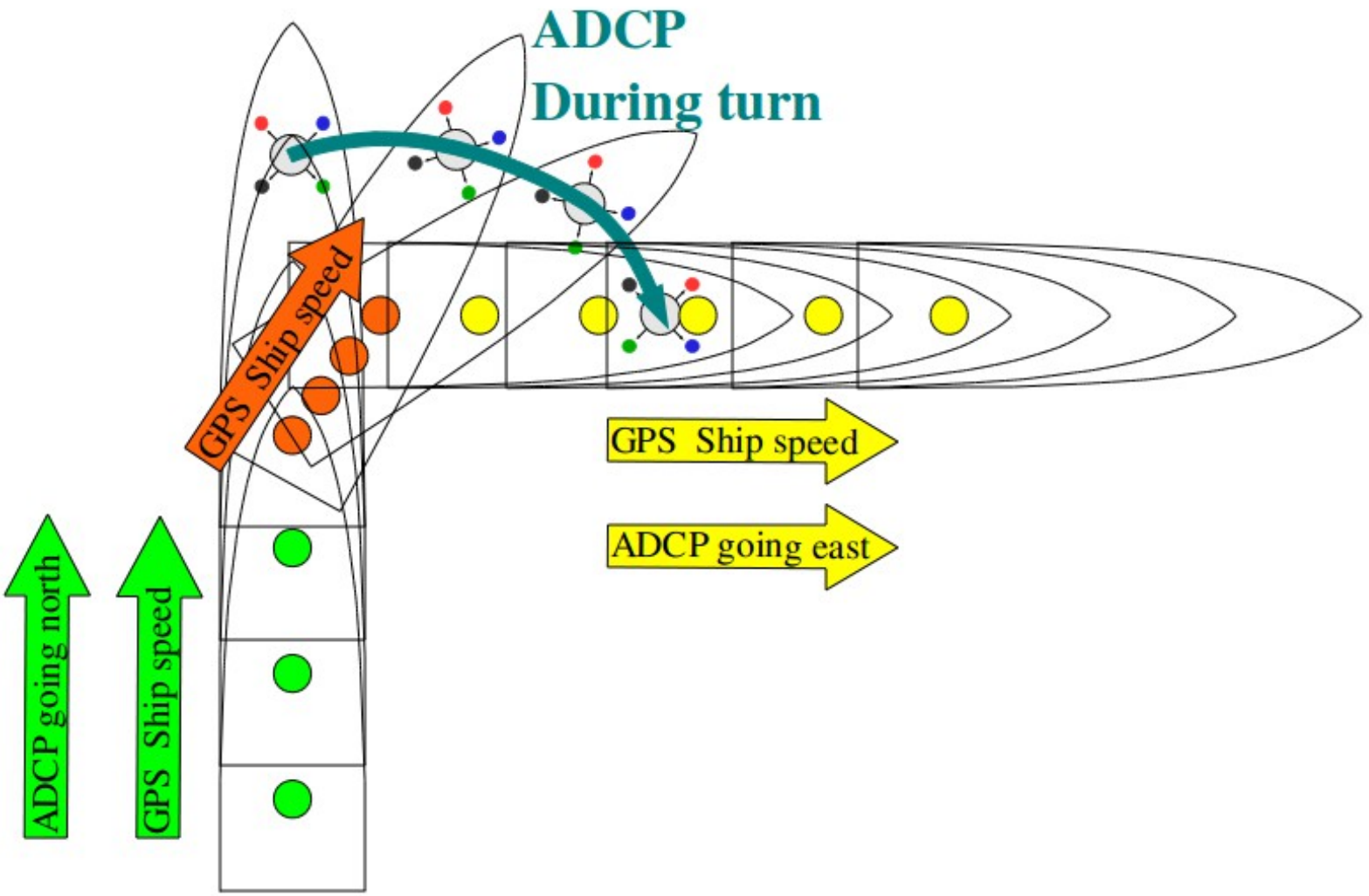
(2) Along-track error:

- 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

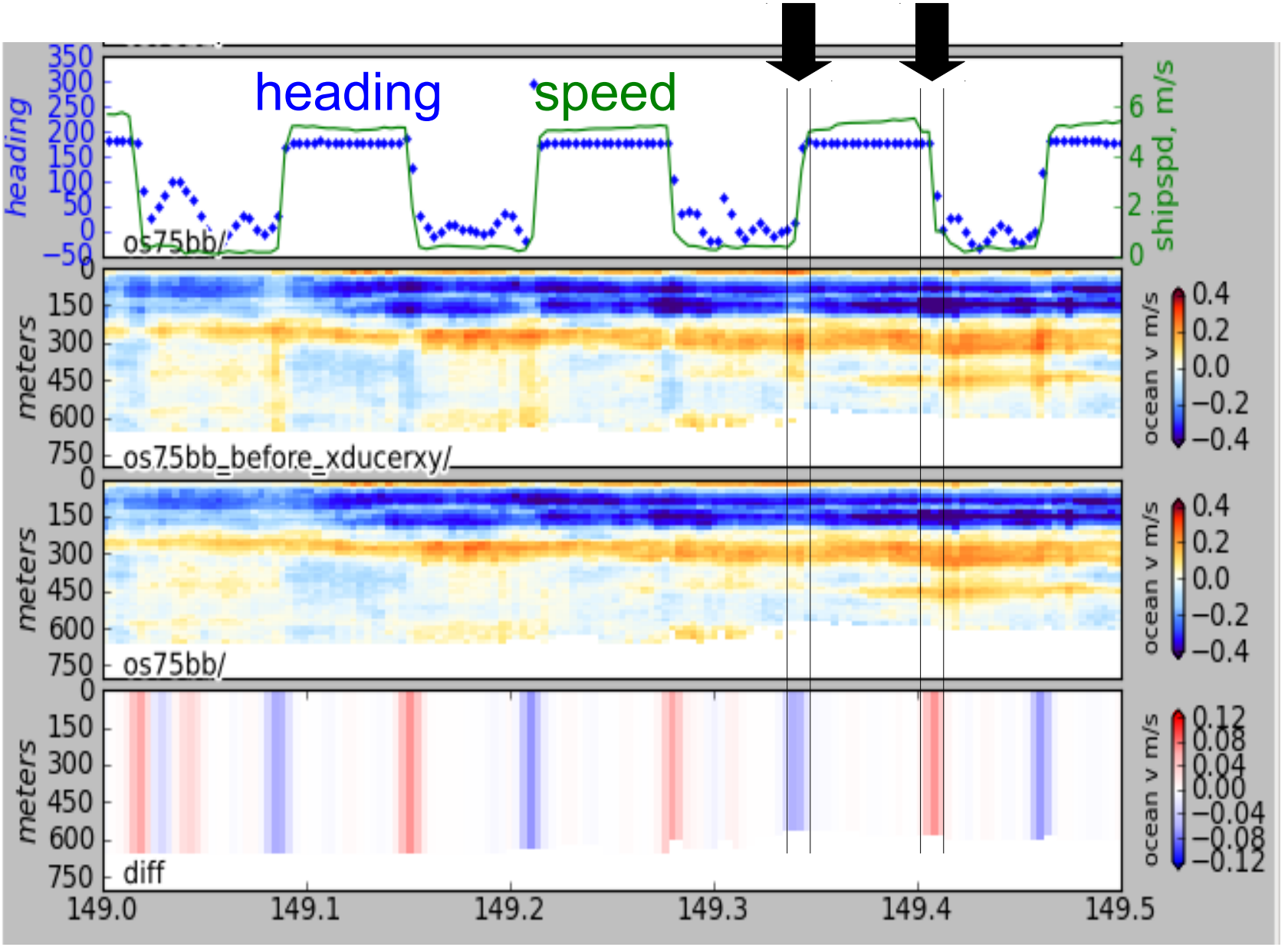


Transducer offset from GPS--error occurs: **transition** between on-station and underway

...using actual location

...using shifted GPS location

difference



Then go do science!