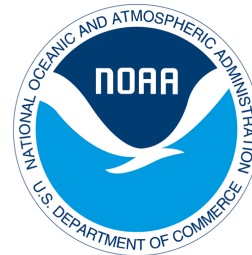
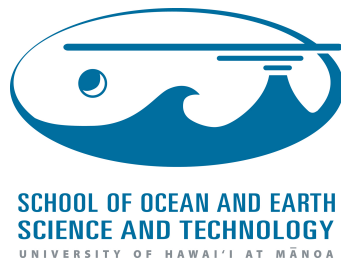


Maximizing the Scientific Value of Ocean Current data from Shipboard ADCP

Marine Institute
Galway, Ireland
Nov 29, 2022



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<https://currents.soest.hawaii.edu>

Overview

- 1) What is shipboard ADCP?
- 2) How is SADC data used?
- 3) Maximizing quality of SADC ocean current data
- 4) Data acquisition: VmDAS and UHDAS
- 5) What does UHDAS do?
 - **at sea**
 - acquisition
 - processing
 - serving, data products
 - **on land**
 - data products
 - monitoring

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ADCP: Getting Ocean Velocity

Acoustic (it pings along beams at a frequency)

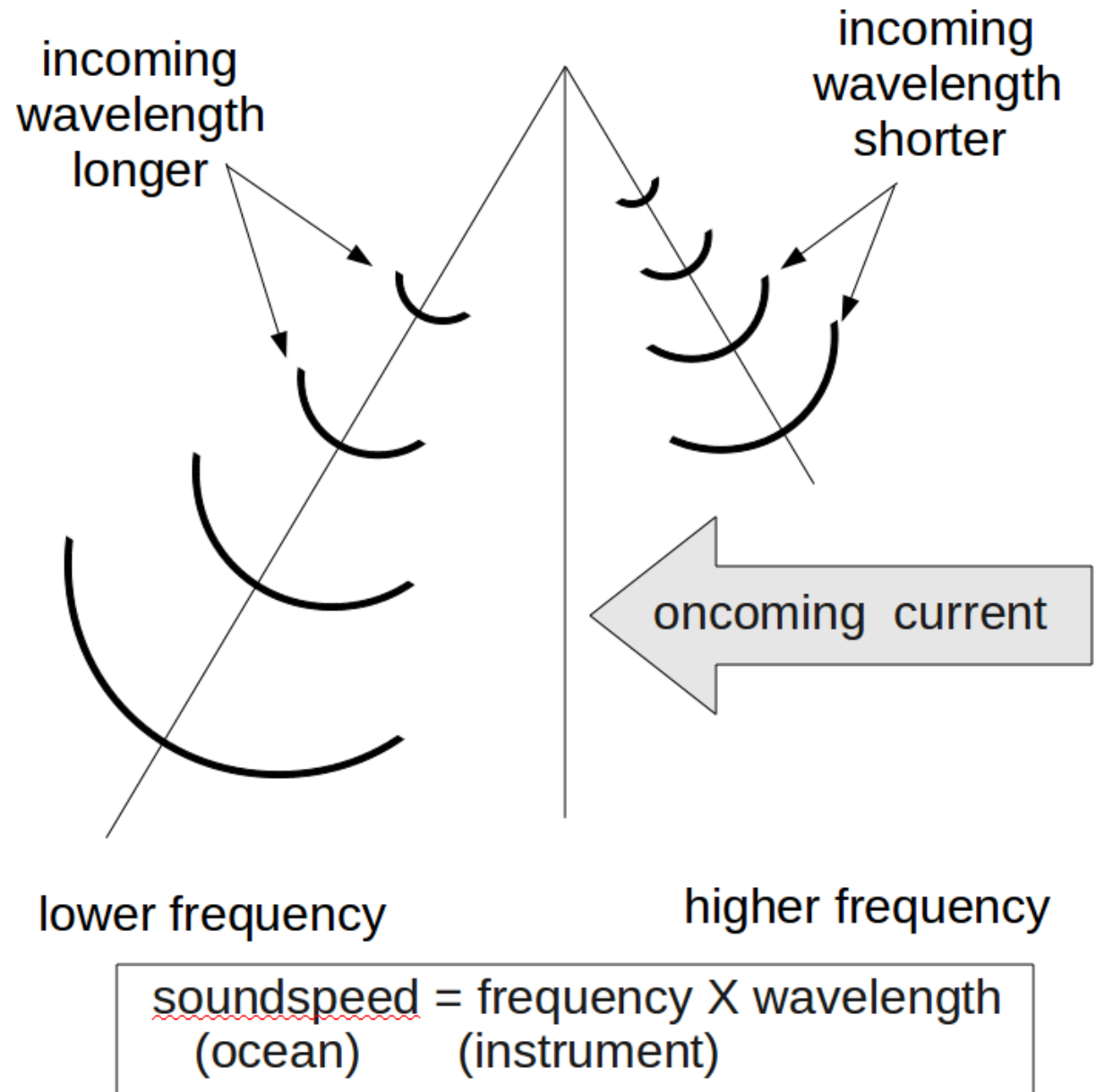
Doppler (uses frequency shift to get velocity along the beam)

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

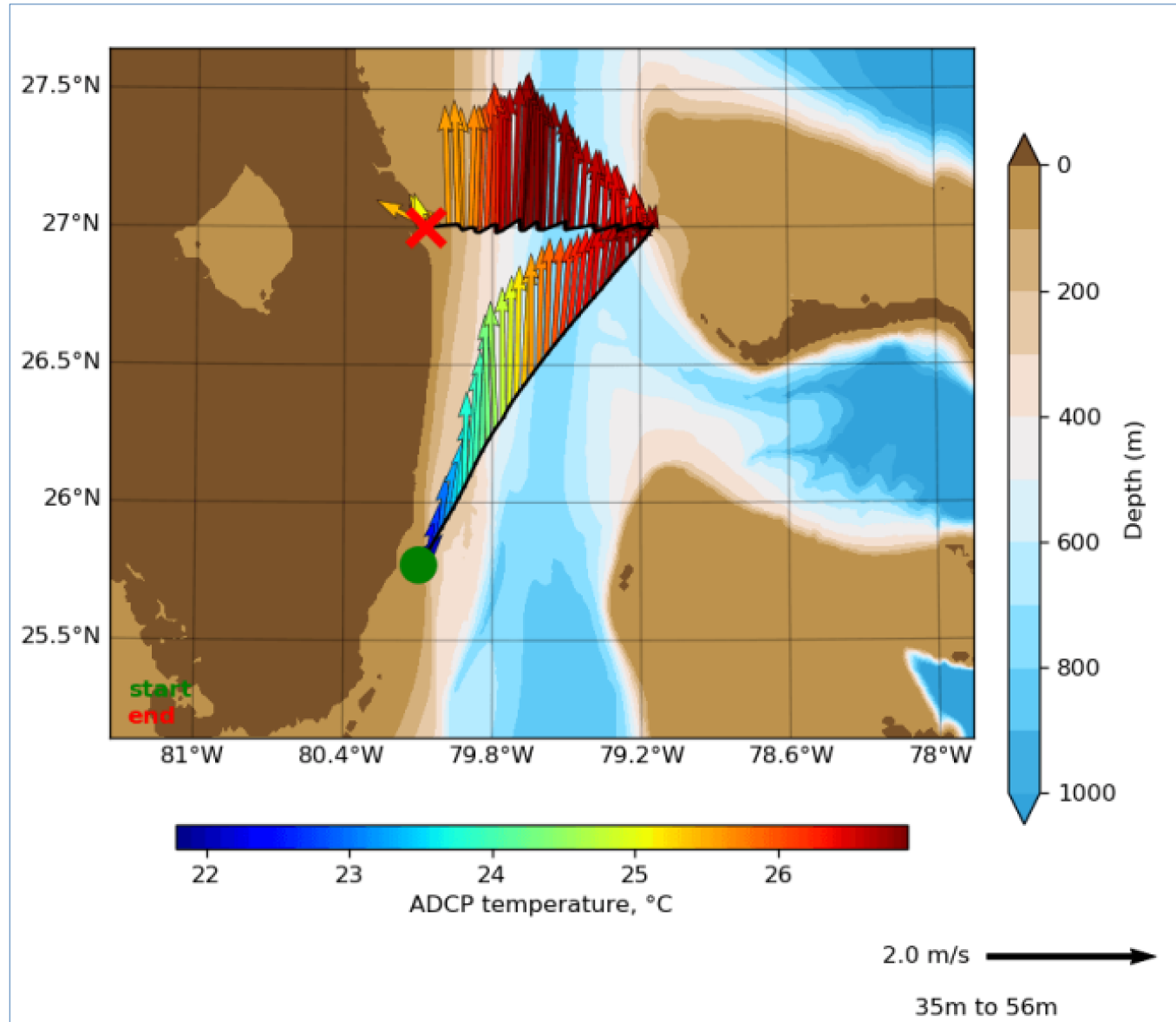
Acoustic Doppler Current Profiler



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

ADCP data to ocean currents

Time,
ADCP
Position
Attitude



primitive data

ocean velocities

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Operational uses of shipboard ADCP data

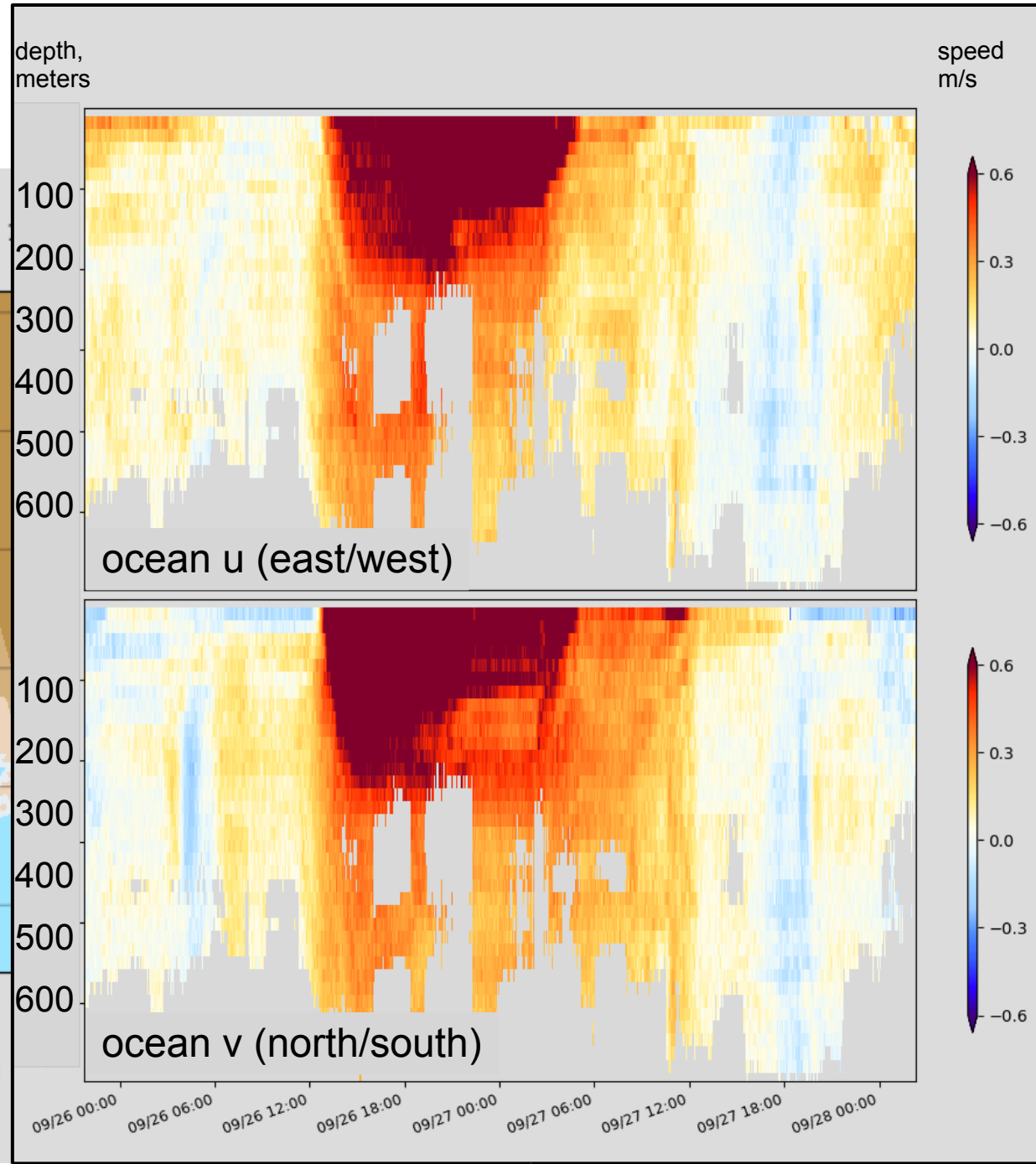
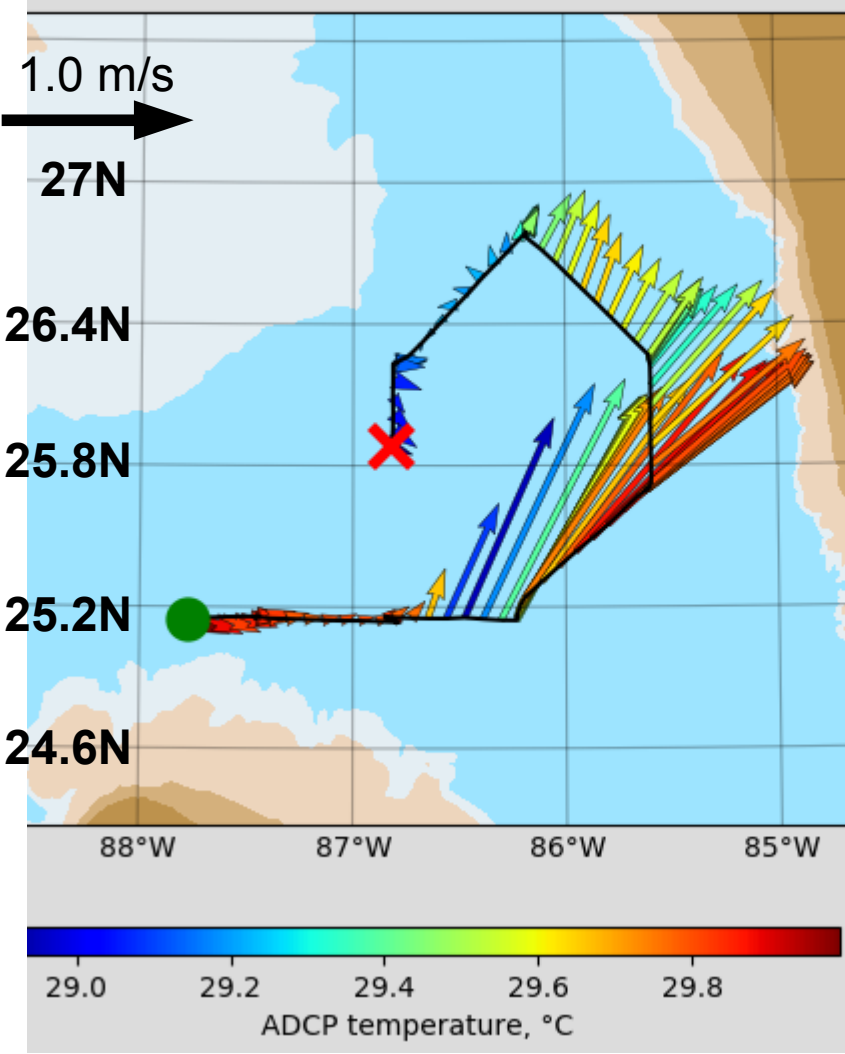
at sea:

- operations, eg:
 - currents for over-the-side work (moorings, CTD)
 - backscatter levels for targeted biological sampling
 - currents for ROV operators
- dynamic sampling, eg:
 - where is the front?
 - when did we cross the front?
 - which direction will the instrument drift after deployment?

R/V Pelican Mooring cruise, Gulf of Mexico

Donohue, PE20-06

Ocean currents 35m-175m



Scientific relevance of shipboard ADCP data

- backscatter (even if uncalibrated)
- process studies:
 - near-inertial motion
 - internal wave energy (upward propagation of phase)
 - high-frequency internal waves (on station)
 - deep eddies
 - context for small-scale mixing studies
- time series
 - dedicated, on station (HOT, BATS)
 - transects: Drake Passage, Bermuda to New Jersey
 - after the fact: equatorial Pacific (servicing TAO moorings)
- comparison with satellites

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Maximizing quality of SADCPC ocean current data

- collect good quality data
 - ADCP installation (free of bubbles, no electrical interference)
 - reliable and accurate heading and position
- collect it well
 - good timestamps, good acquisition practices
 - multiple feeds, record QA messages where available
- processing:
 - include single-ping editing in the processing
 - provide data products for immediate and future use
- monitoring:
 - make sure things are OK using data products
- after the cruise:
 - be able to reprocess with different inputs, new algorithms

ADCP Acquisition Systems: Overview

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



Core

-
- Processing
 - Monitoring



Extra

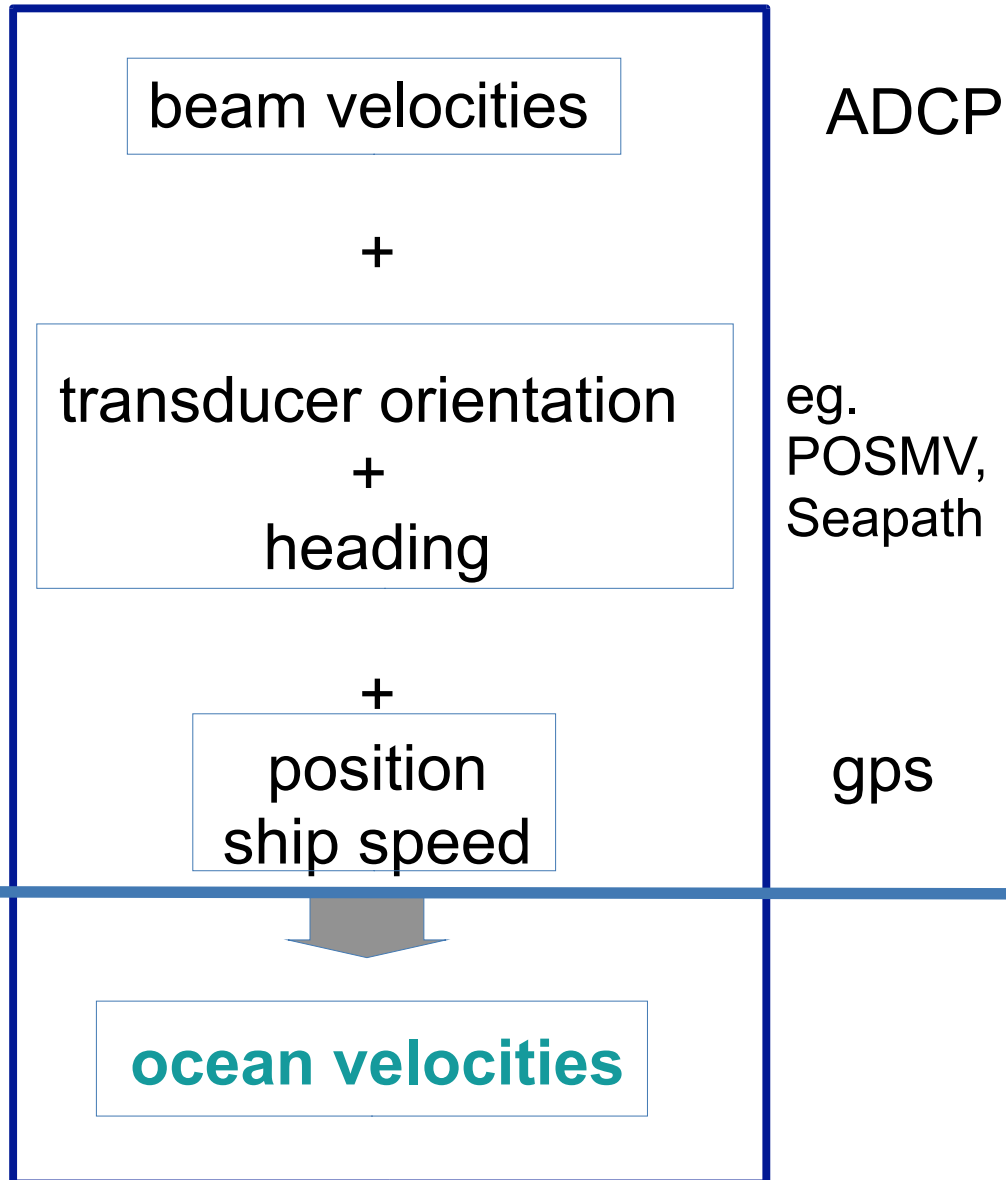
ADCP: Acquisition, Processing

for best data:

- few bubbles, no elec. noise
- many pings

- accurate** heading (0.1deg)
1deg heading error
→ 10cm/s vel error
- record multiple devices
- record QA messages

- record multiple devices



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 - serving, data products
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 - data products
 - monitoring

ADCP Acquisition: VmDAS and UHDAS

- VmDAS

- monolithic Windows program provided by Teledyne RD Instruments (TRDI)
- files go into a single directory
- stores raw components, [intermediate files] (ENR, N1R, N2R [ENS, ENX])
- transforms and averages the data (STA, LTA)

- UHDAS

- collection of programs, procedures, and configurations
- installed on linux
- files stored in a nested directory structure
- leverages **CODAS** processing
- stores raw components, intermediate files
- transforms, edits, and stores averaged data

more detail ([here](#))

Maximizing quality of SADCPC ocean current data

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 - ADCP installation (free of bubbles, no electrical interference)
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 - good timestamps, good acquisition practices
 - multiple feeds, QA messages where available
- processing:
 - include single-ping editing in the processing
 - provide data products for immediate and future use
- monitoring:
 - make sure things are OK
- after the cruise:
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How does UHDAS address these aspects?

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- **at sea**

- acquisition
- **processing**
- serving data, figures

- **on land**

- data products
- monitoring
- **processing/editing/visualization tools**

CODAS

free,
open source,
supported

UHDAS: What are our goals?

- Enhance the utility and visibility of S-ADCP data
- Provide viable ocean currents at sea:
 - Data should be useful for science and operations
 - Data should be as close to "final" as possible
(for an automated system)
 - Require minimal post-processing for science
- Reprocessing on multiple operating systems
(Linux, Mac, Windows) – see **CODAS** notes

UHDAS: What are our ^{people} goals?

- Happy Scientists (good data)
 - Happy Techs (operationally useful, easy)
 - Happy Managers
 - data managers (predictable, documented)
 - ship operations (monitored, useful displays)
 - funding (happy scientists, techs, ship ops)
-

Summary: Everyone is happy

Everyone is excited about ADCP data

How UHDAS improves the quality of shipboard ADCP data

- acquisition (ADCP, position, heading)
 - easy to use; can return to known-working settings
- automated processing (“**preliminary processing**” at sea)
- data and products
 - operations and science at sea
 - ease of post-processing after the cruise
 - reprocessing if necessary (new algorithms, different feeds)
 - data products and visualization
 - discovery/evaluation in the future
- monitoring
 - on ship
 - on land



CODAS

free,
open source,
supported

UHDAS Installation Note

UHDAS is not a program, but a complex set of code and system configurations.

Setting up a new UHDAS installation requires Linux system administration skills, an understanding of UHDAS, and detailed knowledge of the particular suite of instruments and network environment on the ship.

Public installation of UHDAS is not supported

but the open source **CODAS processing** code is free!

- supports UHDAS and VmDAS,
- is open source, supported, documented,
- continually improved

How UHDAS improves the quality of shipboard ADCP data

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CODAS

free,
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ADCP preliminary processing

“processing” requires (at minimum):

- transform from beam velocities to horizontal+vertical
- rotation of horizontal into ship coordinates
- further rotation based on heading
- account for ship's speed
- averaging

In addition: prior to averaging: remove bad bins due to:

- acoustic interference
- data below the bottom
- short, biased profiles (bubbles)
- remaining statistical outliers

CODAS

single-ping editing

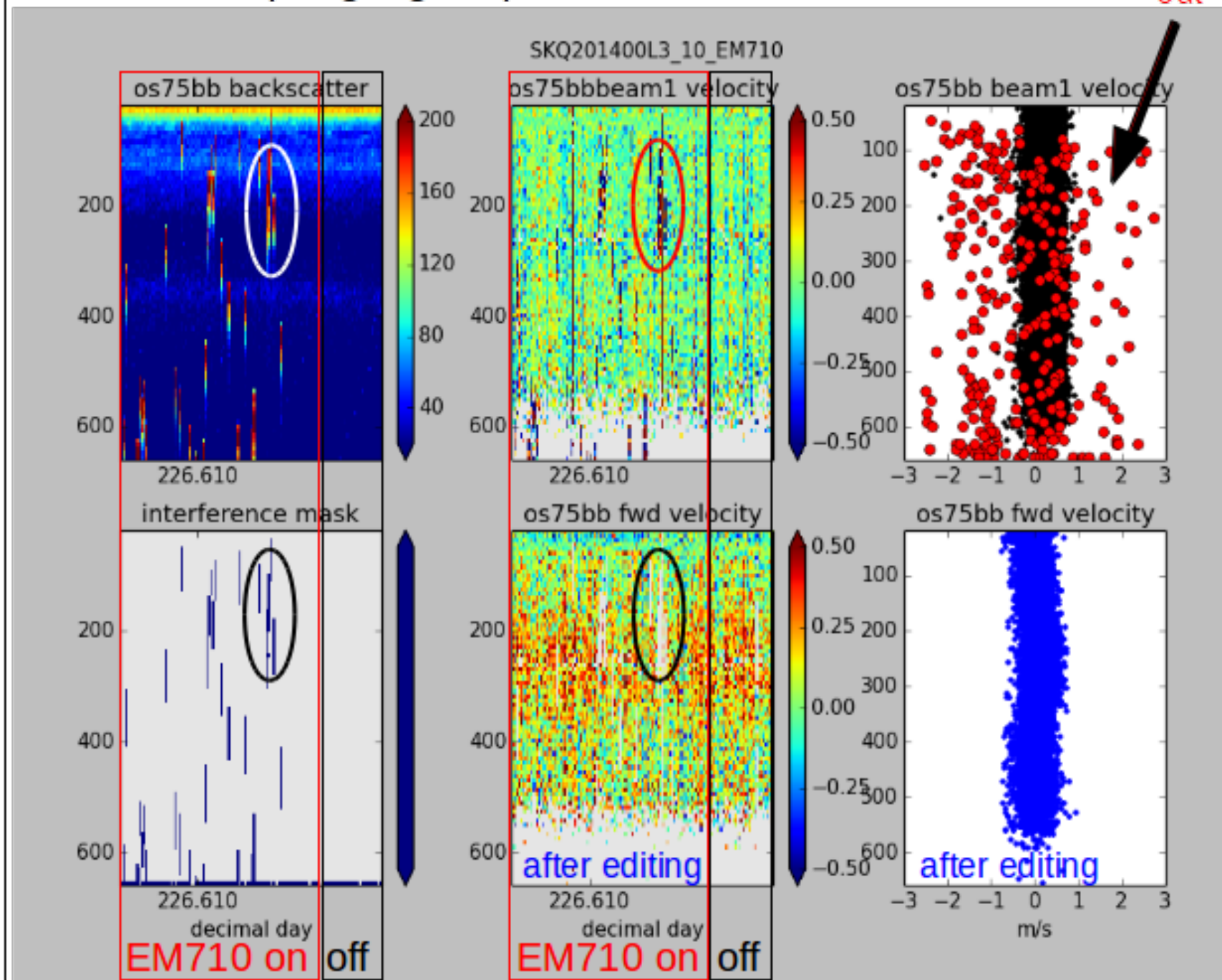
CODAS directory is staged for post-processing

link: [CODAS+UHDAS documentation](#)

CODAS single-ping editing based on acoustic interference

EM710 pinging impact on OS75 broadband

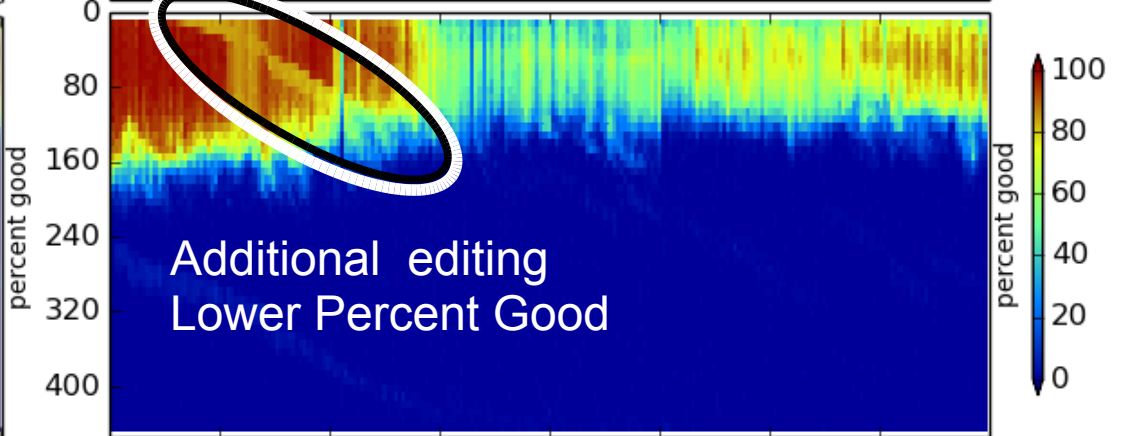
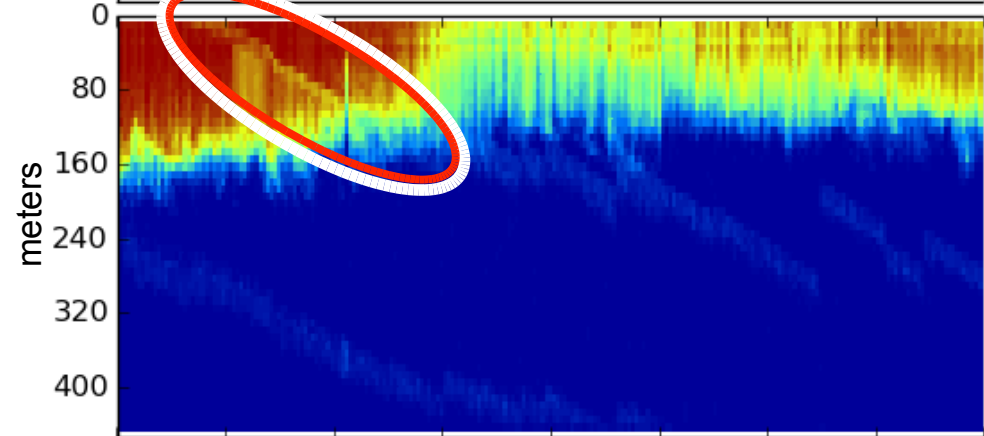
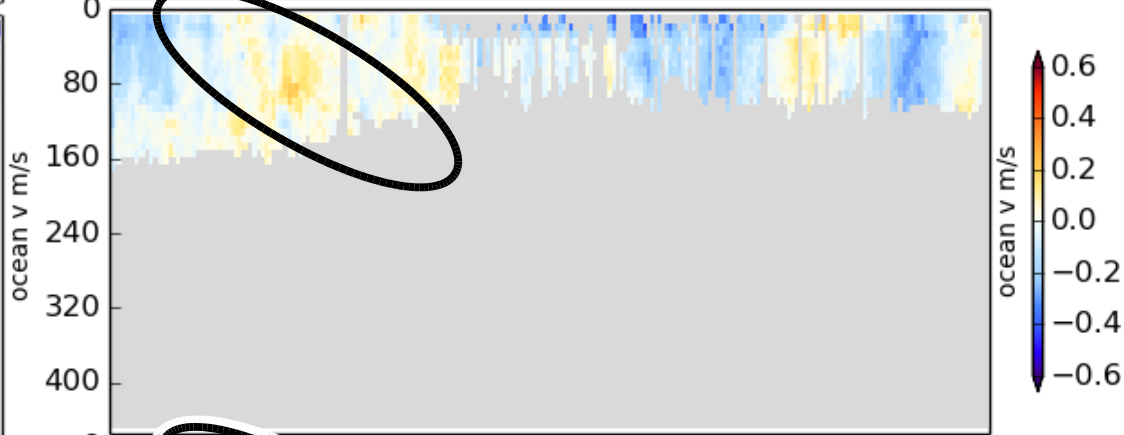
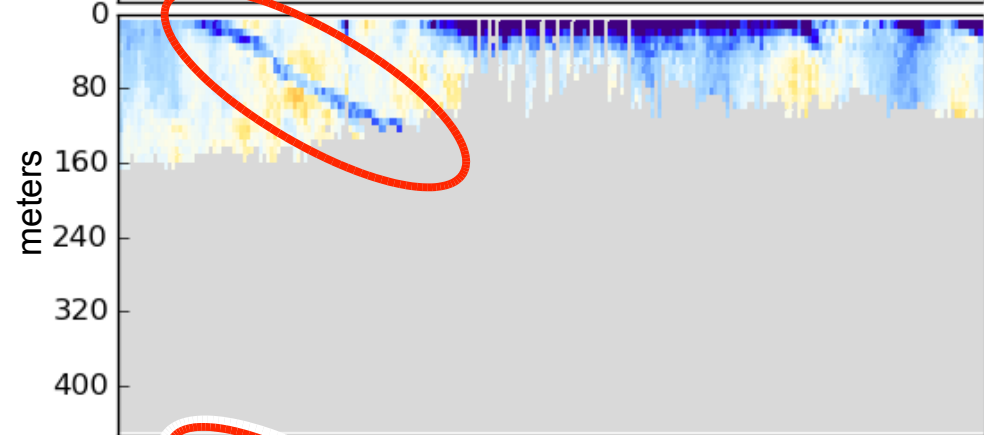
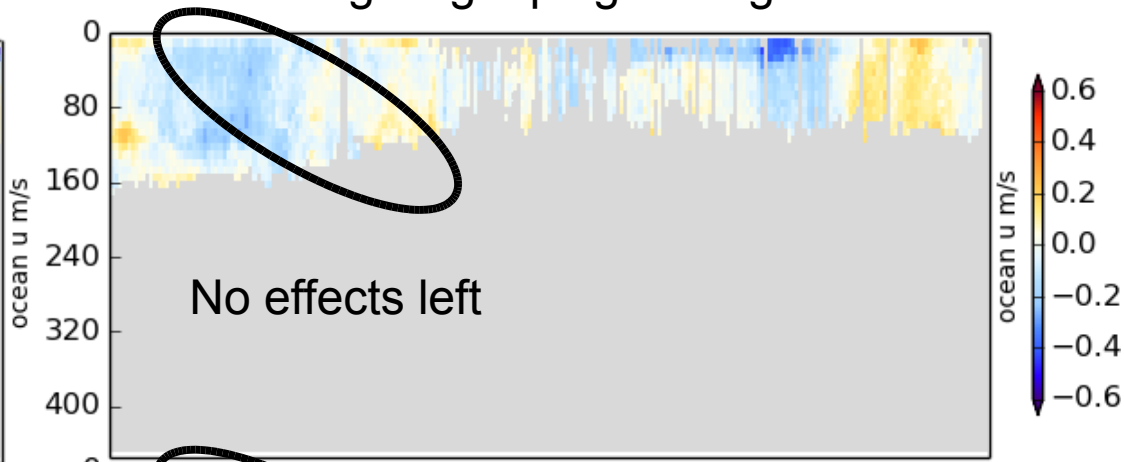
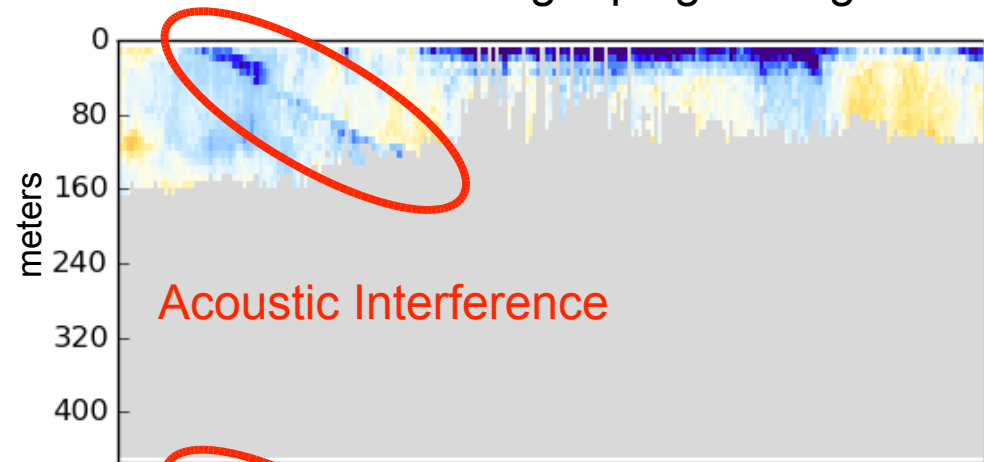
edited
out



Acoustic Interference

NO single-ping editing

Using single-ping editing



138.2 138.3 138.4 138.5 138.6 138.7 138.8 138.9 139.0

138.2 138.3 138.4 138.5 138.6 138.7 138.8 138.9 139.0

decimal day

decimal day

ocean u m/s
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6

ocean v m/s
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6

percent good
100
80
60
40
20
0

How UHDAS improves the quality of shipboard ADCP data

- acquisition (ADCP, position, heading)
 - easy to use; can return to known-working settings
- automated processing (“pre-processing” at sea)
- **data and products**
 - operations and science at sea
 - ease of post-processing after the cruise
 - reprocessing if necessary (new algorithms, different feeds)
 - data products and visualization
 - discovery/evaluation in the future
- **monitoring**
 - on ship
 - on land

UHDAS/CODAS data and products

	at sea	on land
• Example At-Sea UHDAS web site <ul style="list-style-type: none">• figures for operations and science	yes	no
• CODAS data products: <ul style="list-style-type: none">• netCDF data files for science• matlab data files• archive of daily figures• calibration results from processing• settings used during processing	yes	yes
• complete CODAS+UHDAS documentation	yes	yes

Monitoring

- on ship:

- via [web site on ship](#) (science and diagnostic figs)
- documented [here](#)

- on land:

- automated daily emails to UHDAS Team
- monitoring [dashboard](#) with
 - cruise status
 - links to figures, diagnostic files
- Ticketing system (internal): first pass at identifying problems:
 - notifies the UHDAS team of a problem
 - mechanism for tracking problems – eg, based on
 - cruise, ship, instrument
- UHDAS Team provides feedback to technicians on the ship

UHDAS: Troubleshooting and feedback

- problems with ADCP instrument
- data acquisition:
 - computer: timestamps are bad
 - serial (or UDP) NMEA feeds glitchy or fail
 - switch to another feed for at-sea processing
 - quality of ancillary data is poor
 - can the shipboard technicians do anything?
- preliminary processing:
 - a bug, or timestamp problems
 - change in calibration (instrument replacement)
 - bad beam

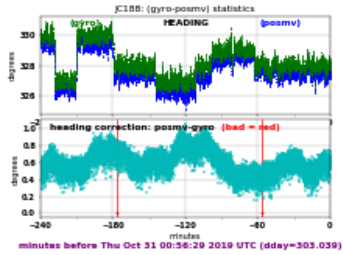
At-sea web site overview

[HOME](#)

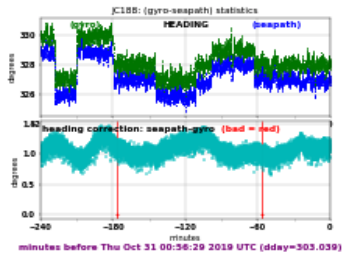
Monitoring: click opens a new figure

Attitude Devices

- posmv-gyro comparison ([thumbnail](#))



- seapath-gyro comparison ([thumbnail](#))

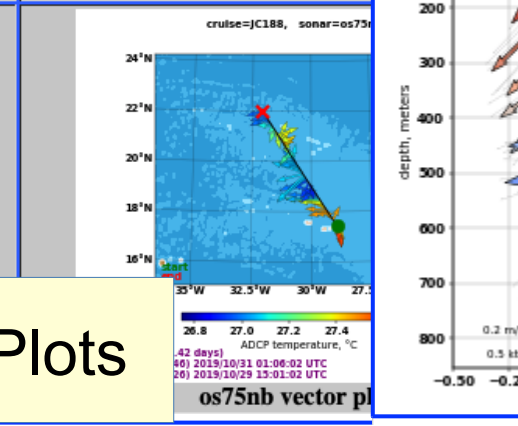
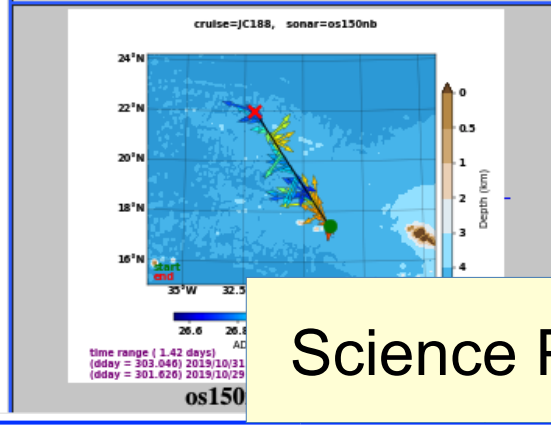
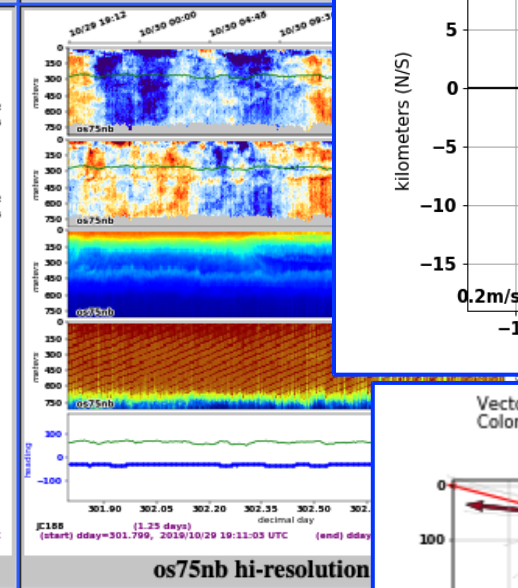
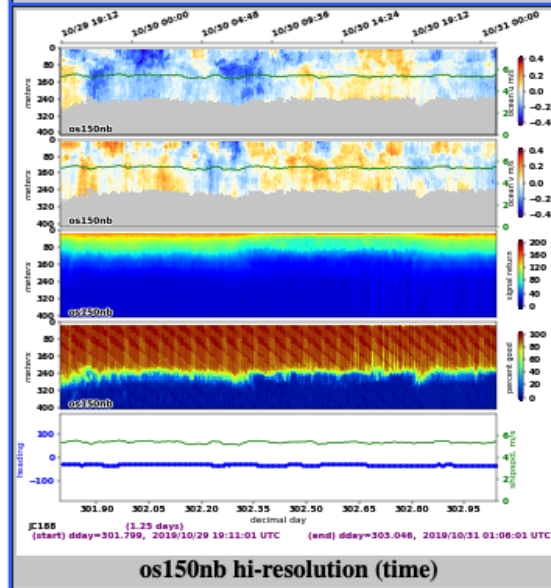
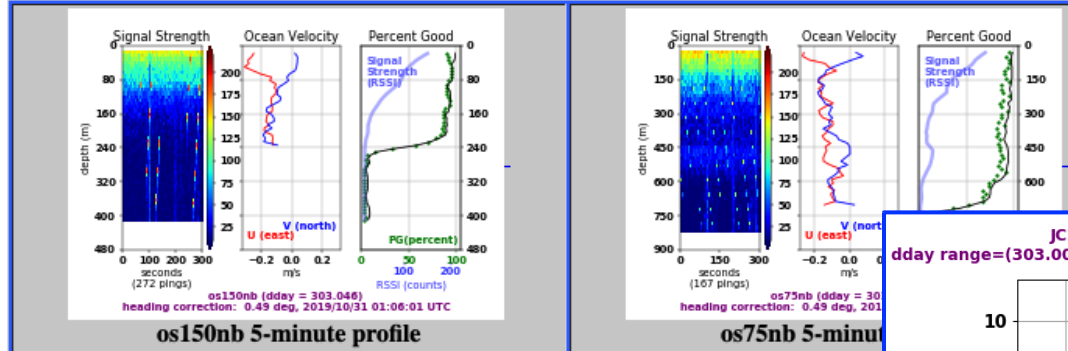


Bridge plots:

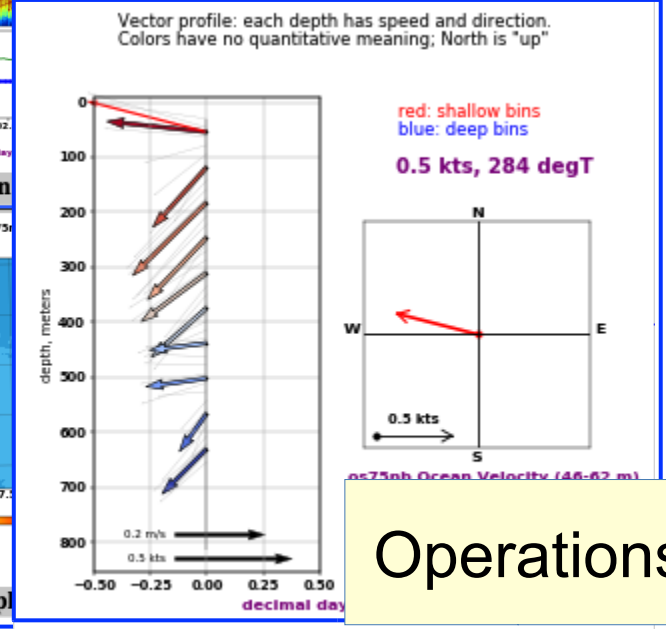
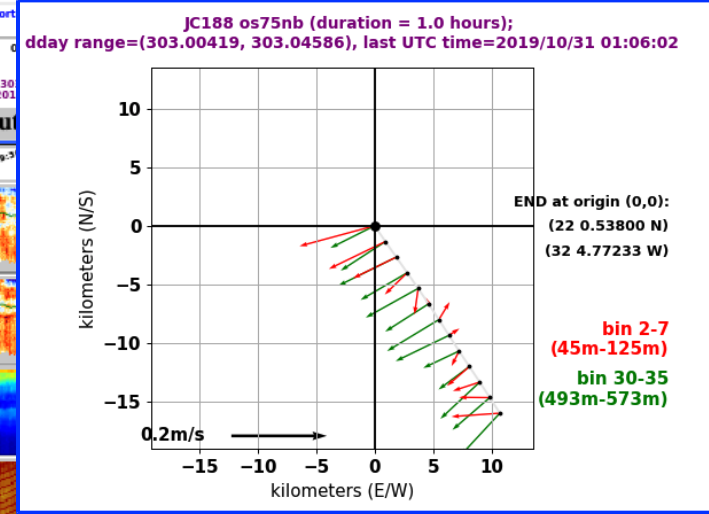
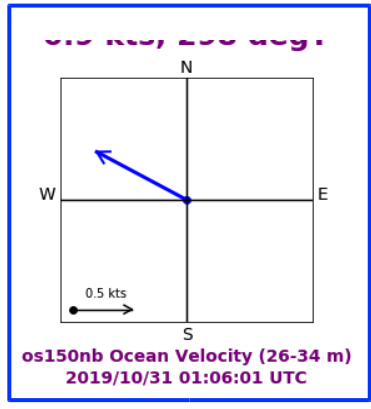
- surface vector :
 - [day](#)
 - [night](#)
- kts and direction profile:
 - [day](#)
 - [night](#)
- kts E/N + scattering [profile](#)

Diagnostic Plots

ADCP Thumbnails



Science Plots



Operations

letters	ship name	figures	last email	cruise name	status	daily report	daily email	OS	last update
ae	Atlantic Explorer	figs	6hr	Pierside_PostAE2016	logging	dir	email	18.04	2020-Apr-23
ar	Neil Armstrong	figs	6hr	ar47	(not logging)	dir	email	18.04	2020-May-30
at	Atlantis	figs	210d	(not set)		dir	email	16.04	2018-Aug-02
bh	Blue Heron	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
en	Endeavor	figs	6hr	(not set)		dir	email	18.04	2020-May-30
hly	Healy	figs	43d	(not set)		dir	email	18.04	2020-May-30
hs	Hugh Sharp	figs	6hr	(not set)		dir	email	18.04	2020-May-30
km	Kilo Moana	figs	6hr	km2012	logging	dir	email	18.04	2020-May-25
lg	L.M.Gould	figs	6hr	(not set)		dir	email	18.04	2018-Dec-23
mgl	M.G.Langseth	figs	6hr	(not set)		dir	email	16.04	2017-Aug-15
np	N.B.Palmer	figs	1d 6hr	nbp2010a	logging	dir	email	18.04	2018-Dec-19
oc	Oceanus	figs	6hr	(not set)		dir	email	18.04	2020-Apr-23
pe	Pelican	figs	6hr	PE21_06_Fugro_ADCP	(not logging)	dir	email	18.04	2020-Aug-01
rr	Roger Revelle	figs	0hr	RR2002a	(not logging)	dir	email	18.04	2020-Aug-01
skq	Sikuliaq	figs	6hr	SKQ202014S	logging	dir	email	18.04	2020-May-02
sp	R.G.Sproul	figs	3hr	(not set)		dir	email	14.04	2015-Mar-25
sr	Sally Ride	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
sv	Savannah	figs	6hr	(not set)		dir	email	18.04	2020-May-30
tt	Thomas G. Thompson	figs	17d	TN384	logging	dir	email	18.04	2020-Apr-25
ws	Walton Smith	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01



- NSF funds the Academic Research Fleet ships;
- NOAA funds the NOAA ships;
- Various institutions or projects fund the “other” ships

NOAA ships

letters	ship name	figures	last email	cruise name	status	daily report	daily email	OS	last update
dy	Oscar Dyson	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
ex	Okeanos Explorer	figs	205d	EX-Transit-2020-03-23	logging	dir	email	18.04	2020-Jan-14
fh	Ferdinand Hassler	figs	6hr	(not set)		dir	email	14.04	2017-Jan-17
gu	Gordon Gunter	figs	35d	(not set)		dir	email	18.04	2020-May-30
hb	Henry Bigelow	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
nf	Nancy Foster	figs	3d	(not set)		dir	email	18.04	2020-May-30
pc	Pisces	figs	6hr	PC2020_atpier_october	logging	dir	email	18.04	2020-Aug-01
rb	Ron Brown	figs	6hr	RB2006	logging	dir	email	18.04	2020-Aug-01
rl	Reuben Lasker	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
se	Oscar Elton Sette	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01
sh	Bell Shimada	figs	6hr	(not set)		dir	email	18.04	2020-Aug-01



We also have some science funding to process SADCP data, eg. GOSHIP

[Monitoring Page \(link\)](#)

other UHDAS ships

letters	ship name	figures	last email	cruise name	status	daily report	daily email	OS	last update
fk	Falkor	figs	6hr	(not set)		dir	email	18.04	2020-May-25
inv	Investigator	figs	6hr	in2020_v06	logging	dir	email	18.04	2020-May-30
kb	Kristine Bonnevie	figs	6hr	KB2020620	logging	dir	email	14.04	2017-Mar-09
nor	Norrone	figs	6hr	(not set)		dir	email	16.04	2018-Jul-05
olr	Oleander	figs	6d	(not set)		dir	email	18.04	2020-May-30
ps	Point Sur	figs	6hr	(not set)		dir	email	18.04	2020-May-30
ukdy	Discovery	figs	8hr	DY120	logging	dir	email	18.04	2020-Aug-01
ukjc	James Cook	figs	8hr	JC209	(not logging)	dir	email	18.04	2020-Aug-01



National Oceanography Centre



THE OLEANDER Project

Kilo Moana (45N) off the Oregon Coast: internal tide beam, energy downward (phase upward) below 600m

60m-1280m

upper ocean velocities



126.3°W 126°W 125.7°W 125.4°W 125.1°W

10.8 11.0 11.2 11.4

ADCP temperature, °C

