

Oceanography Seminar

Naval Postgraduate School

Jan 30, 2012

ADCP Acquisition, Processing, and Monitoring on Oceanographic Research Vessels

UHDAS + CODAS Documentation

Outline

1. ADCP

2. Processing (“CODAS”)

3. UHDAS

- Acquisition
- Processing
- Monitoring:
 - At Sea
 - On Land

4. Oceanography

Outline

1. ADCP

2. Processing (“CODAS”)

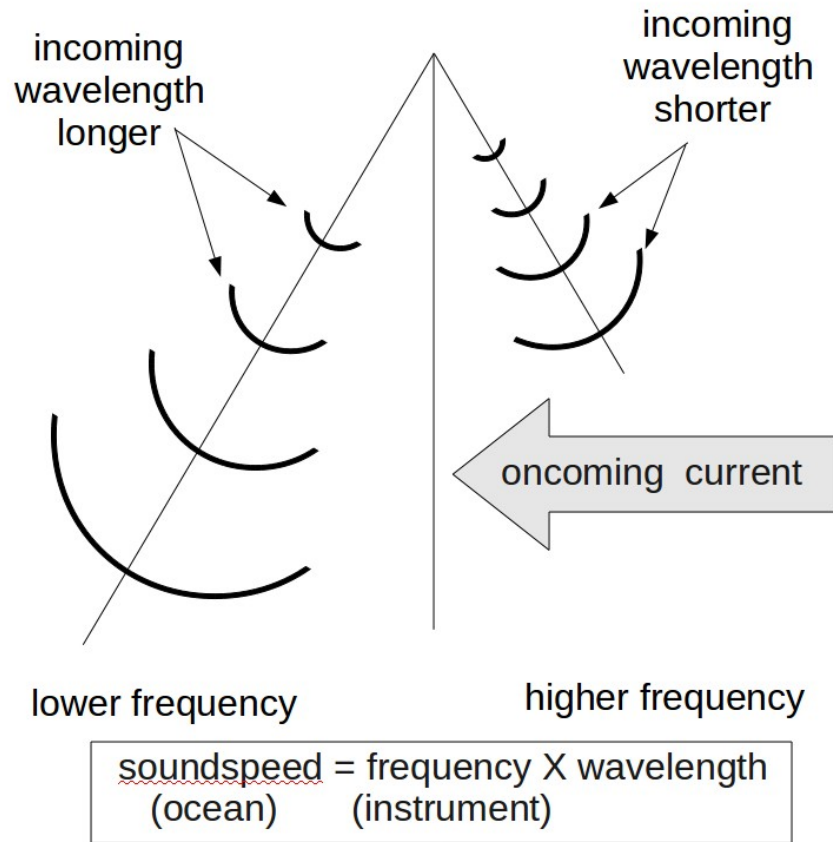
3. UHDAS

- Acquisition
- Processing
- Monitoring:
 - At Sea
 - On Land

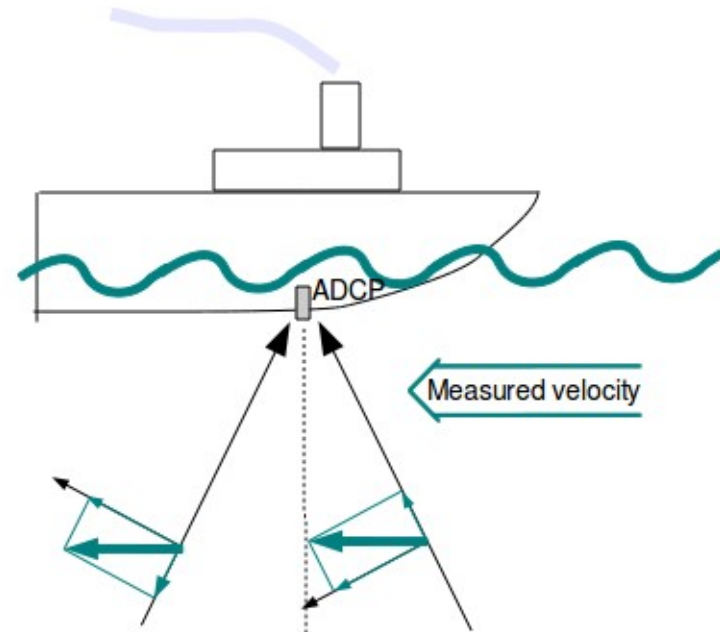
4. Oceanography

ADCP: Acoustic Doppler Current Profiler

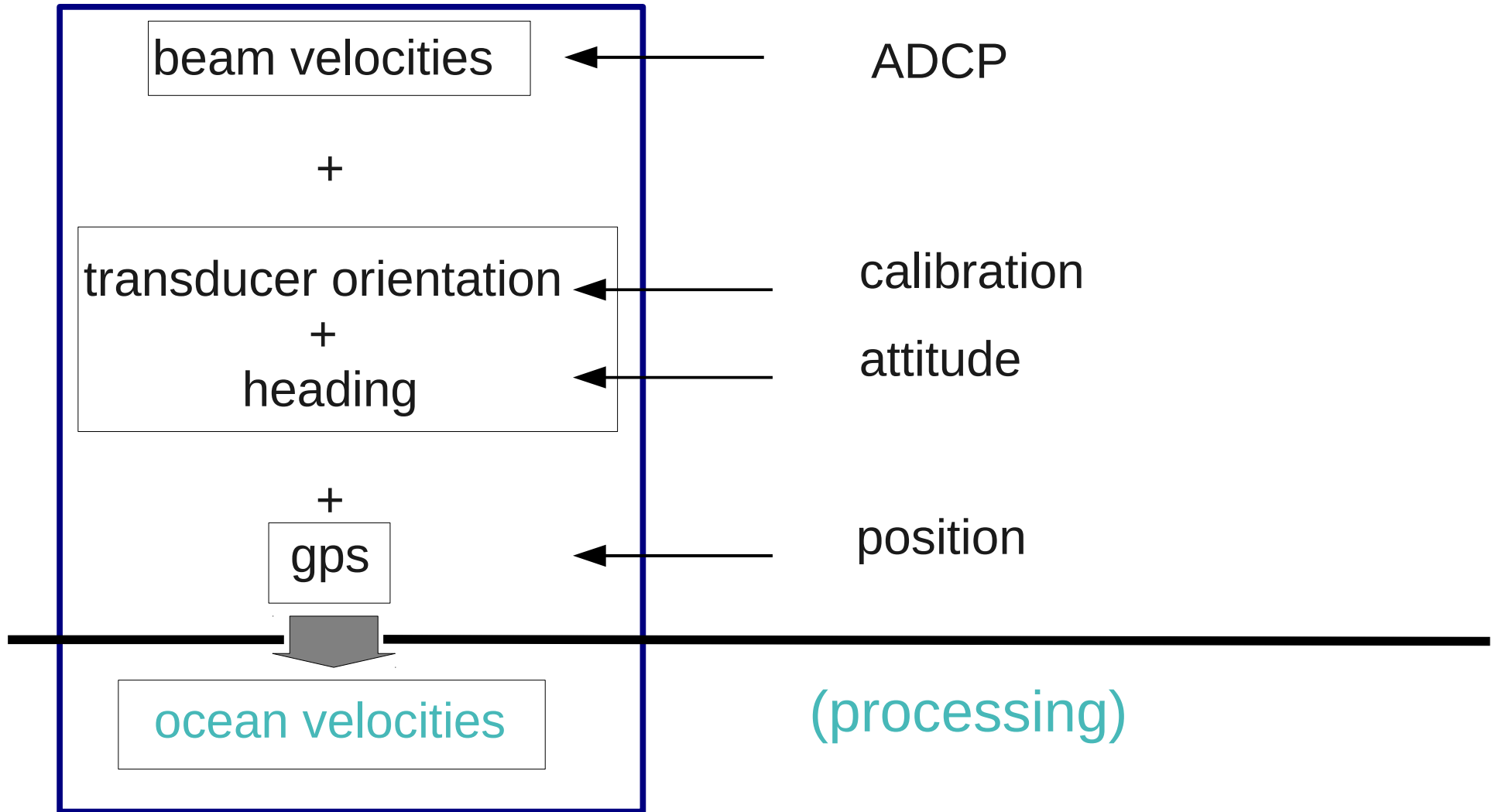
Doppler Shift



Hull-Mounted



ADCP: Data components



Outline

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- Acquisition

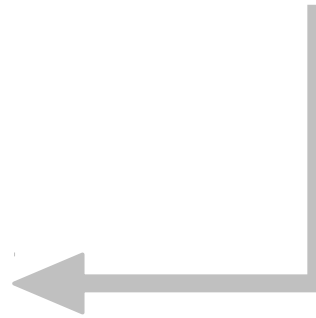
- Processing

- Monitoring:

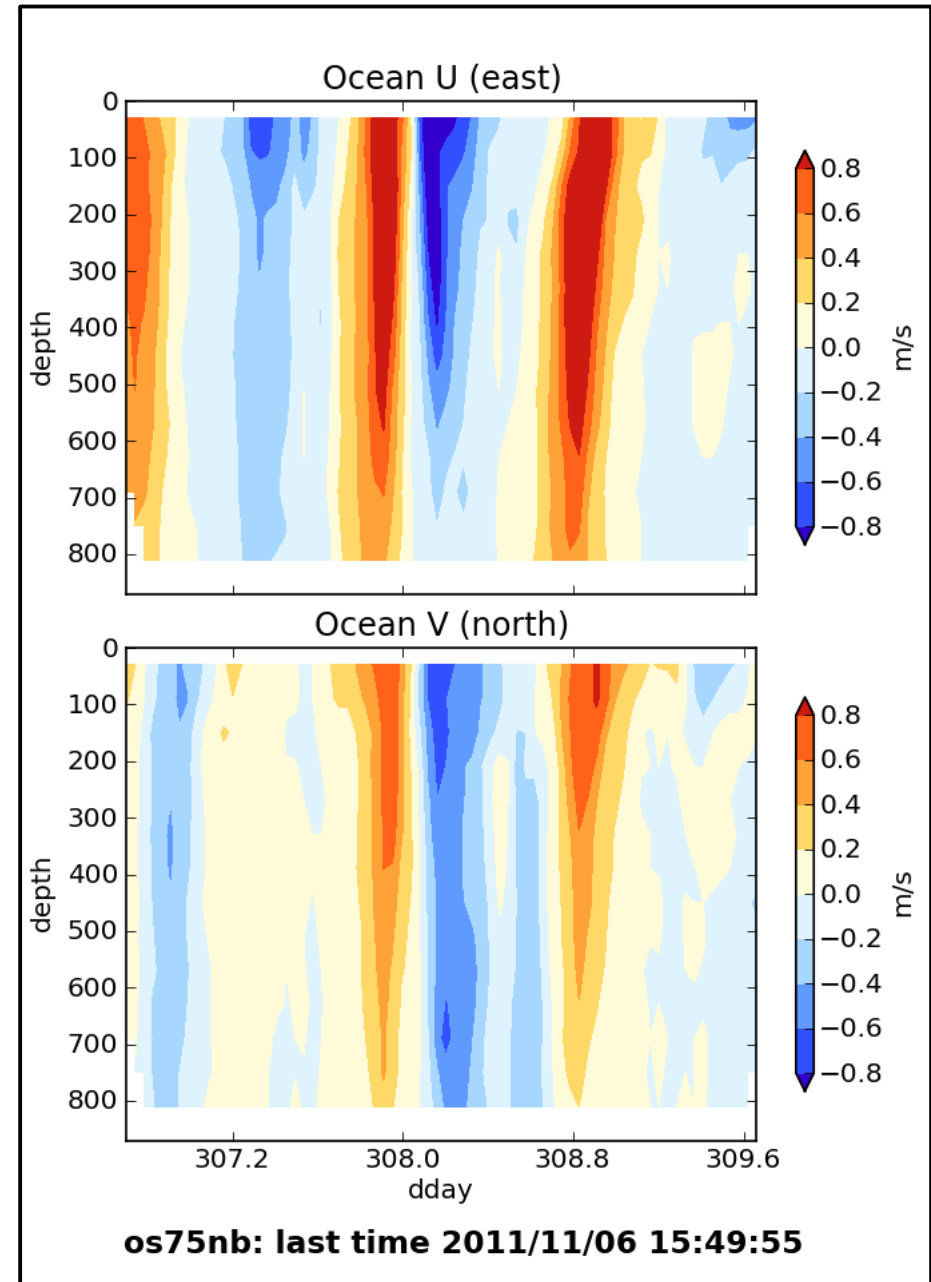
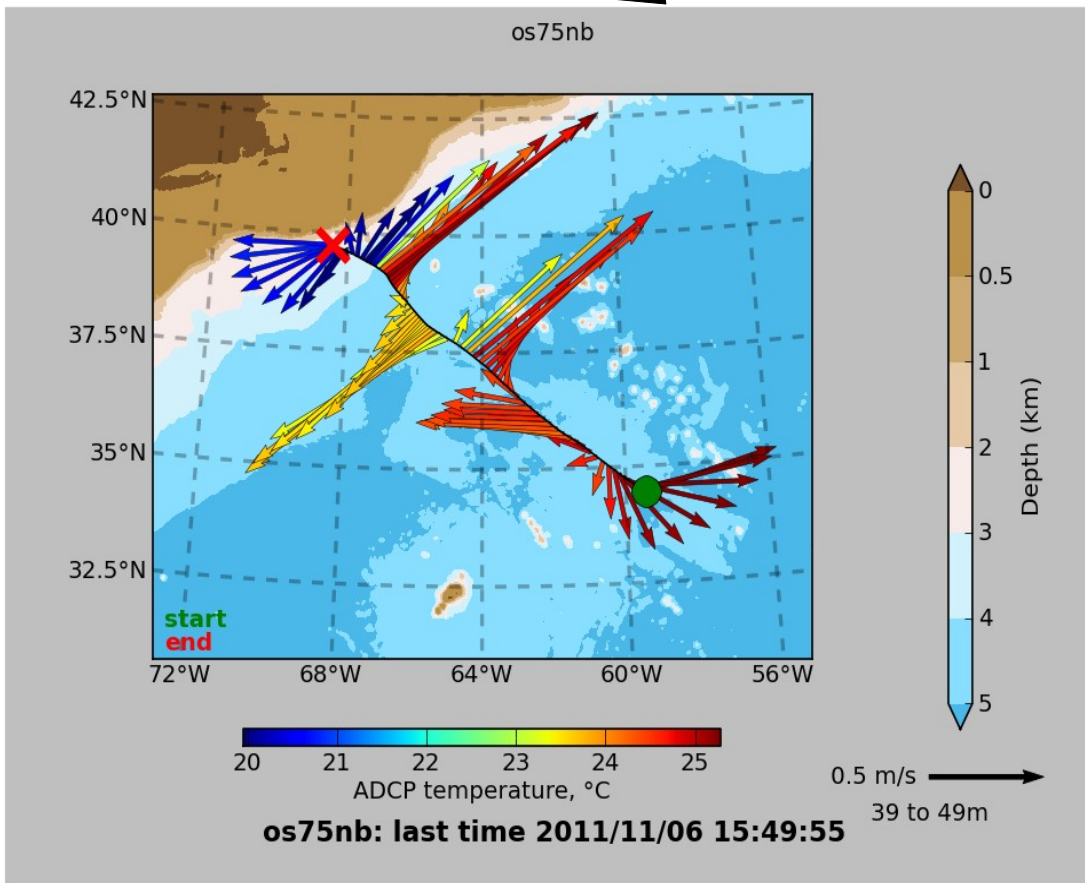
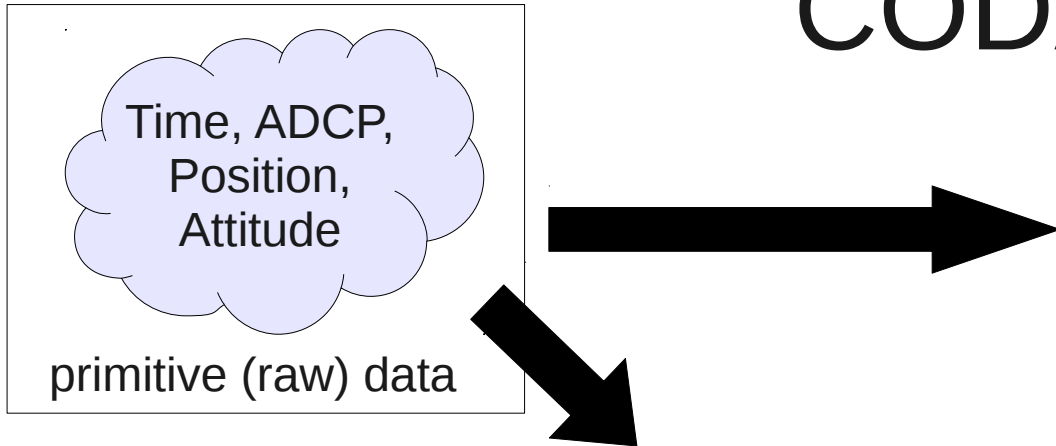
 - At Sea

 - On Land

4. Oceanography



CODAS Processing



“CODAS” ADCP Processing

Goals

- run on multiple operating systems (Windows, OSX, linux)
- open source
- now free (Python) or Matlab

Processing

- written for ADCP data
- works on **most ADCP data acquisition systems**
- balance real-time product with recoverable dataset
- single-ping editing
- calibration

“CODAS” ADCP Processing

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- **calibration**

ADCP Single-ping Editing

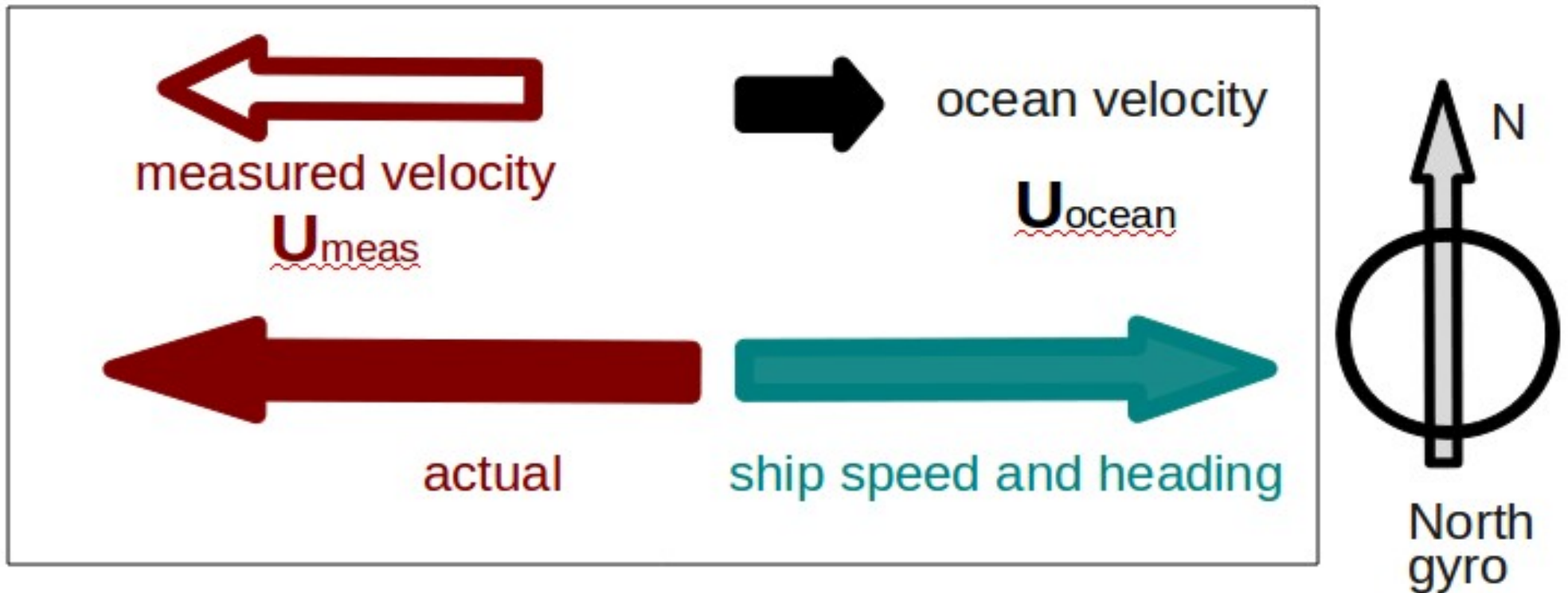
The most common causes of error
(addressed by single-ping editing)

- Acoustic Interference
- Bubbles

Both tend to cause bias towards zero
in measured velocity

Bias towards zero in measured velocity

Alongtrack bias in ocean velocity



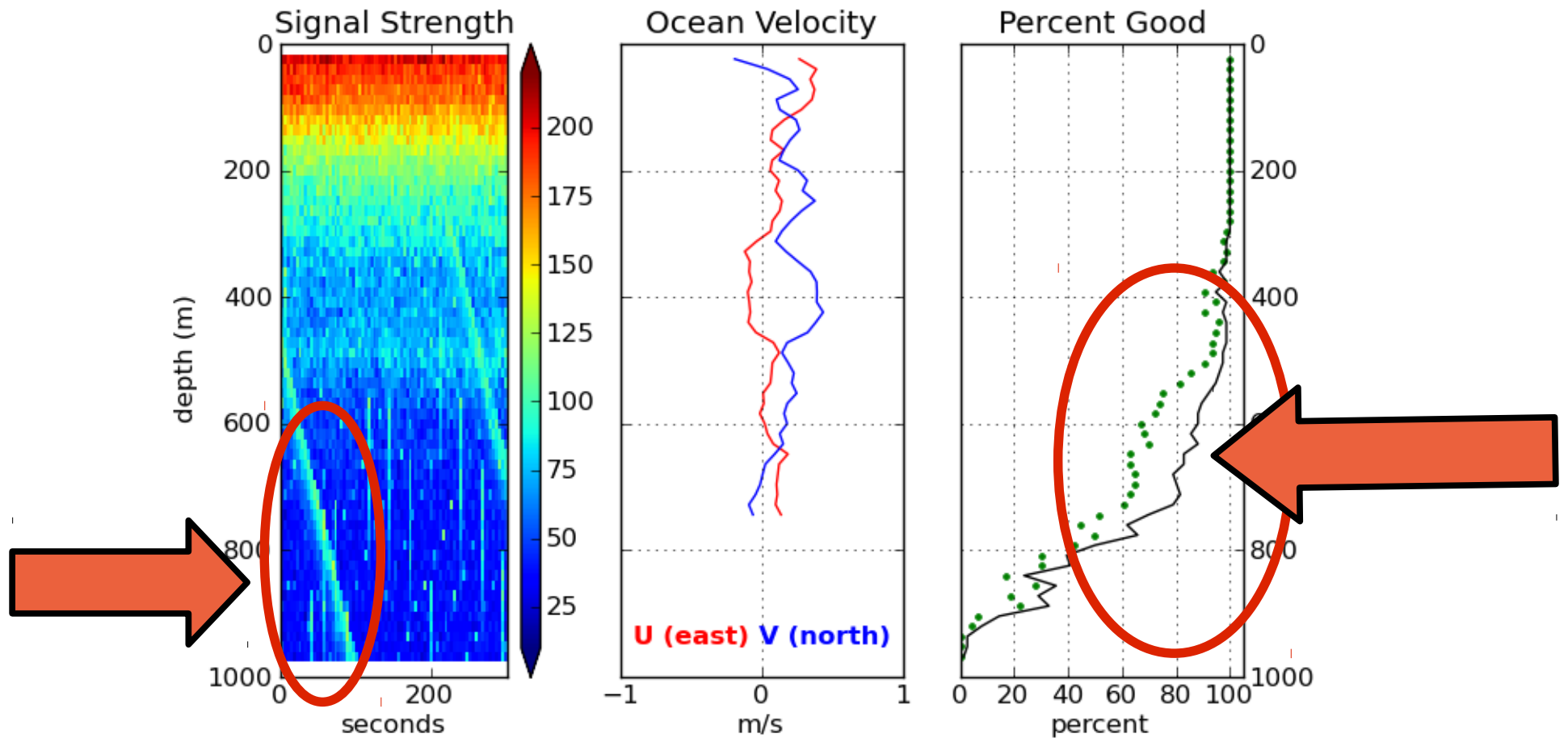
ADCP Single-ping Editing

The most common causes of error
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- **Acoustic Interference**
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ADCP Processing

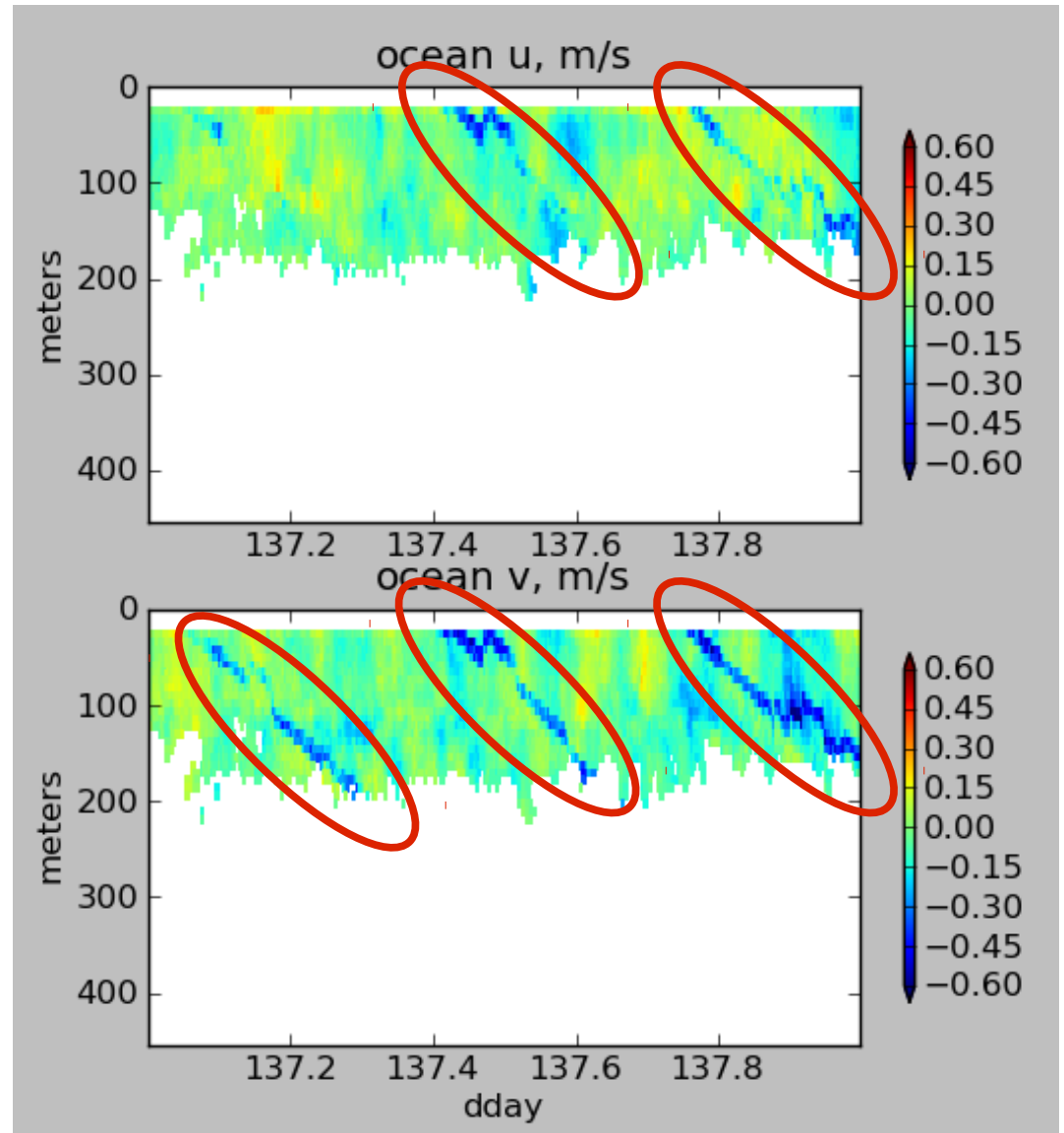
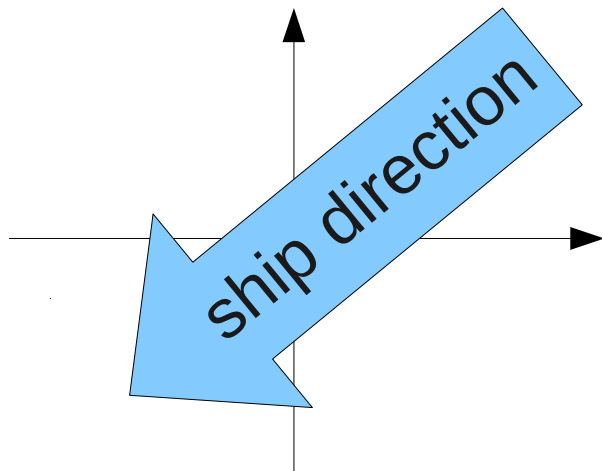
Singleping editing: acoustic interference



ADCP Processing **without** singleping editing

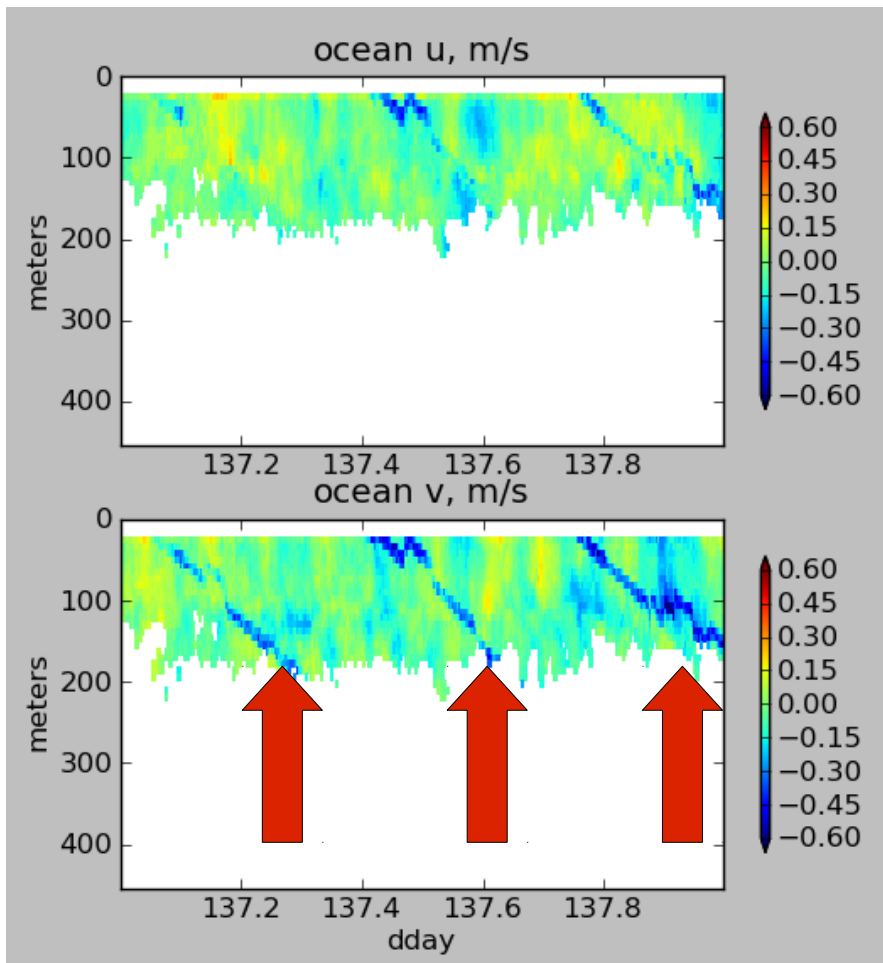
Averaged
ocean velocities

NOTE: along-track
direction bias

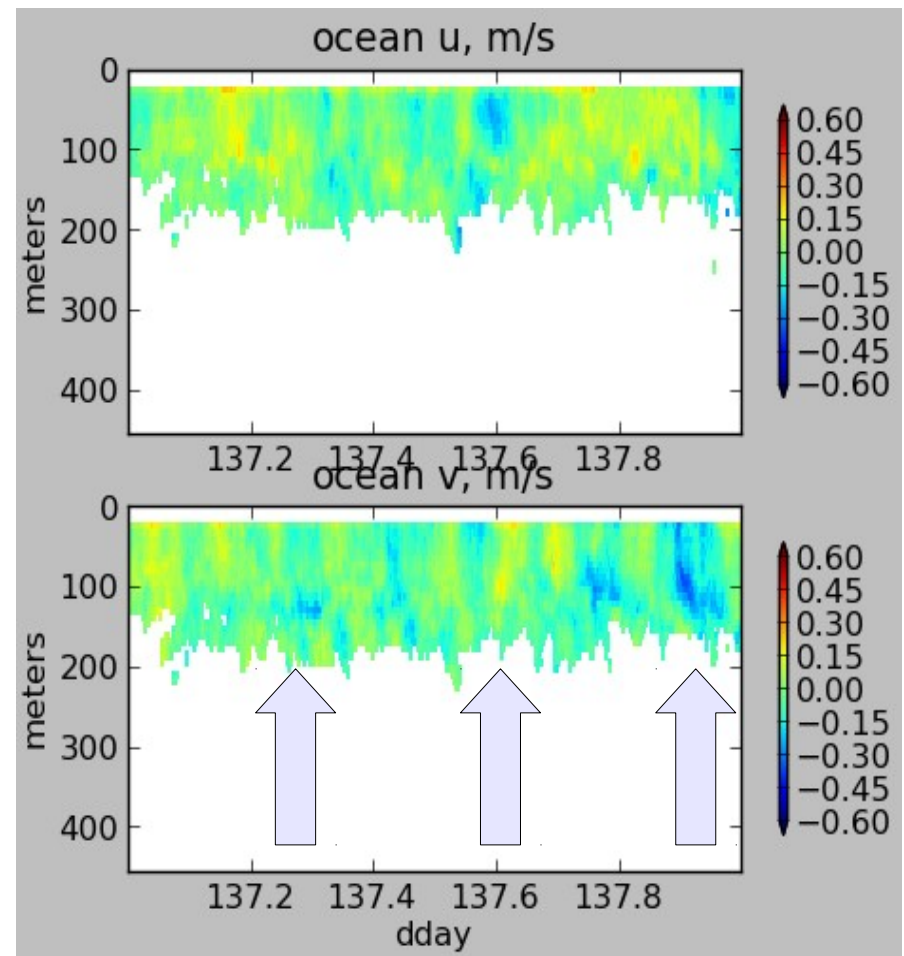


ADCP Processing: acoustic interference

WITHOUT
singleping editing



USING
singleping editing



ADCP Single-ping Editing

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

- Acoustic Interference
- **Bubbles**

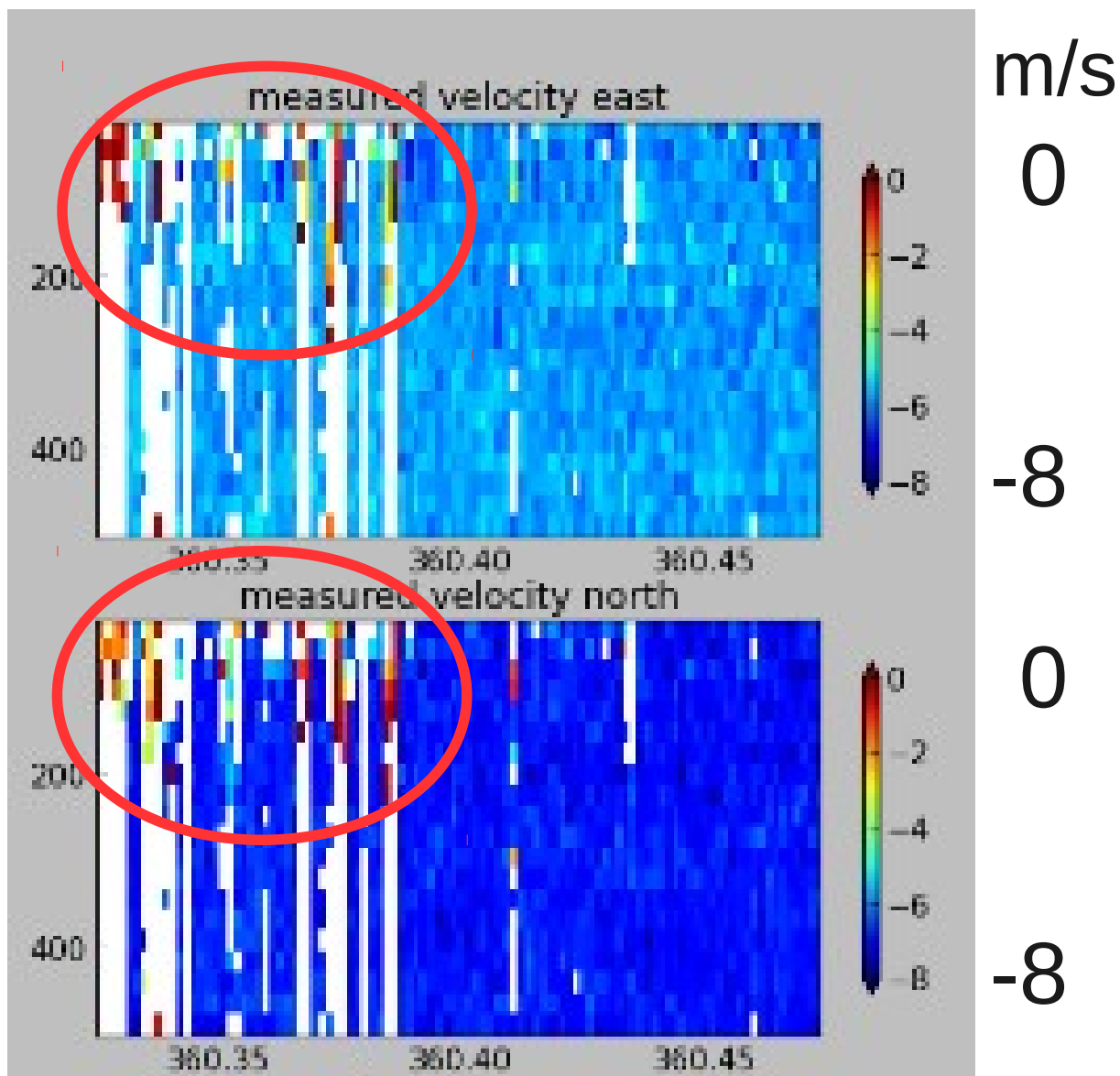
ADCP Data: effect of bubbles

Bubbles:

- short profiles
- strongly biased towards zero

Untreated:

- biased ocean velocities

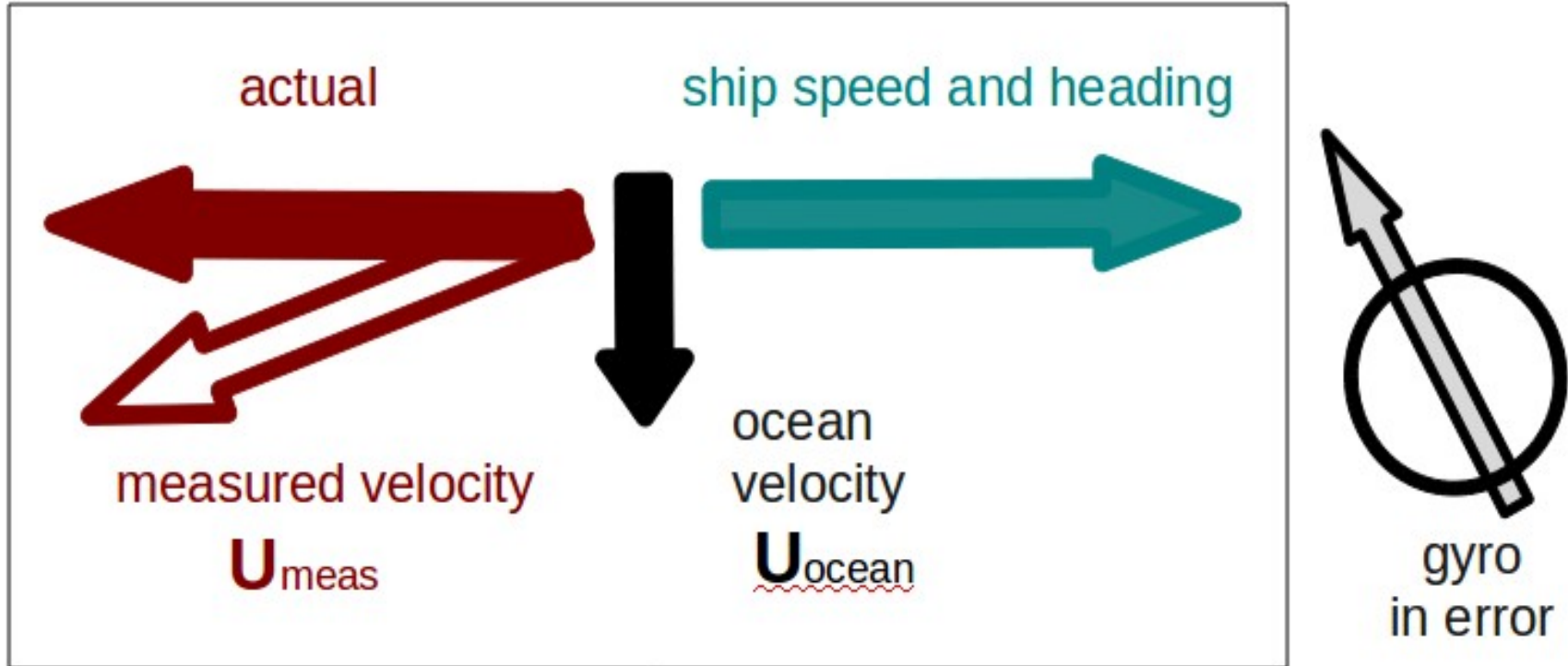


CODAS Processing: Calibration

- After single-ping editing, create averages
- Calibration of averaged data:
 - (remaining) alongtrack bias (scale factor)
 - Soundspeed (single-ceramic transducers only)
 - Cross-track error (angle error)
 - Incorrect transducer angle (constant)
 - Inaccurate heading (time-varying)

Calibration: Angle Error

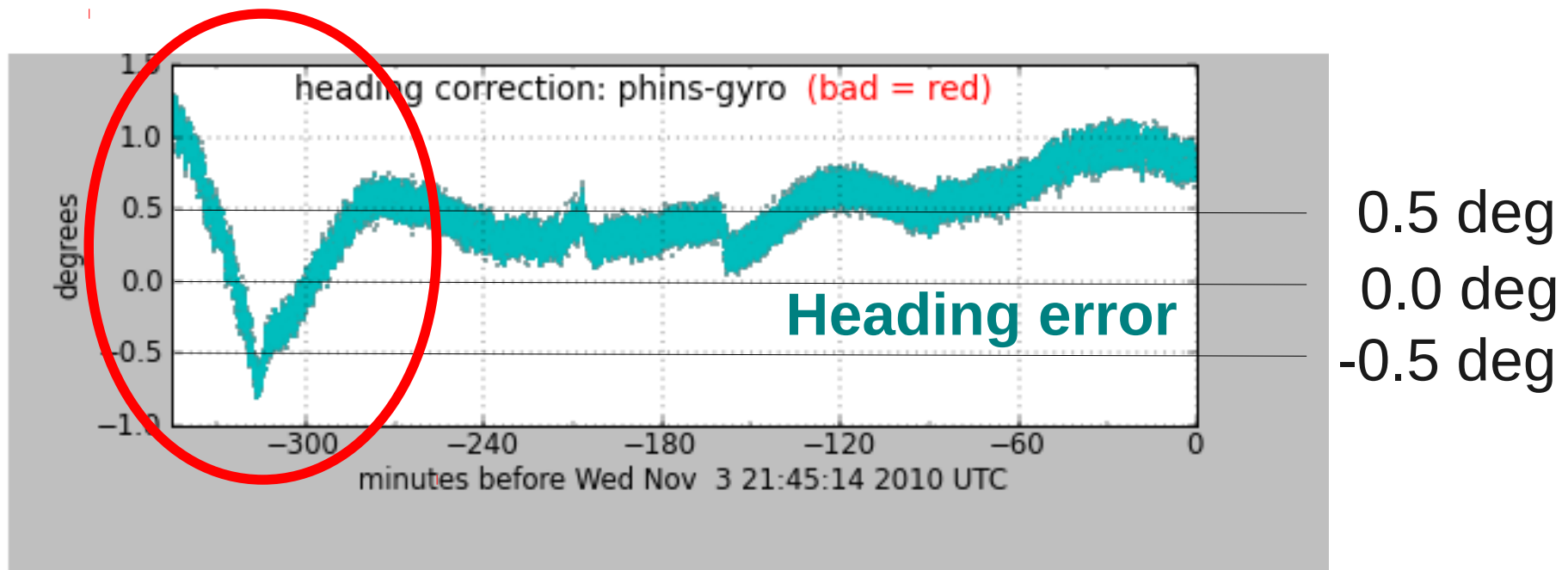
Cross-track bias in ocean velocity from angle error:
(heading + transducer angle)



Effect of Time-Dependent Heading Error on Ocean Velocities

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

Outline

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3. UHDAS

- Acquisition

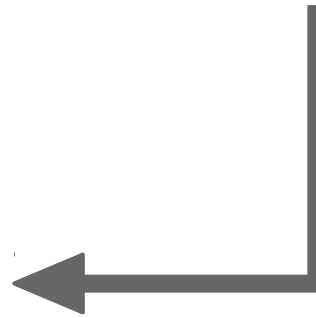
- Processing

- Monitoring:

 - At Sea

 - On Land

4. Oceanography



UHDAS: What it does

- **(1) Data Acquisition**
 - Gather and timestamp data
 - ADCP
 - Position, attitude
- **(2) Processing**
 - parse NMEA messages
 - grid NMEA messages
 - all CODAS processing

UHDAS: What it does:

(3) Data Access...

- web site on ship with
 - 5-minute profile (updated 5min)
 - 3-day vector and contour plot (updated 15-30min)
 - matlab files via web (used in 3-day plots)
 - full-resolution data (matlab, netcdf, CODAS)
- on land
 - 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
 - diagnostic files
 - data snippet for shore-based figures

Monitoring at Sea

UHDAS

os38 nb150 Soundspeed Seapath GPS Tm Gyro

Control Terminal Monitor Plots Avg Plots Info Log Errors

<p>os38 ttyS0</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 856 2004/10/01 03:16:30</p> <p>Errors: 2 2004/10/01 02:51:45</p>	<p>275 03:16:18 np2004_274_08144.raw 2272170 2670</p> <p>275 03:16:22 np2004_274_08144.raw 2274840 2670</p> <p>275 03:16:26 np2004_274_08144.raw 2277510 2670</p> <p>275 03:16:30 np2004_274_08144.raw 2280180 2670</p>
<p>nb150 ttyS1g</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 3619 2004/10/01 03:16:34</p> <p>Errors: 0</p>	<p>275 03:16:31 np2004_274_08144.raw 2092506 579</p> <p>275 03:16:32 np2004_274_08144.raw 2093085 579</p> <p>275 03:16:33 np2004_274_08144.raw 2093664 579</p> <p>275 03:16:34 np2004_274_08144.raw 2094243 579</p>
<p>Soundspeed ttyS1e</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 5765 2004/10/01 03:16:04</p> <p>Errors: 0</p>	<p>1555.31</p> <p>1555.31</p> <p>1555.43</p> <p>1555.31</p>
<p>Seapath ttyS1c</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 10953 2004/10/01 03:16:34</p> <p>Errors: 0</p>	<p>\$PSXN,23,-0.21,-0.12,102.42,-0.01*11</p> <p>\$GPGGA,031634.17,3649.895438,S,17447.058891,E,1,10,0.9,29.55,M,,M,,*66</p> <p>\$PSXN,20,1,0,0,0*3A</p> <p>\$PSXN,23,-0.22,-0.07,102.39,0.01*37</p>
<p>GPS Tm ttyS1a</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 3650 2004/10/01 03:16:34</p> <p>Errors: 0</p>	<p>\$GPGGA,031630.493,3649.8950,S,17447.0586,E,1,06,1.2,040.1,M,-026.4,M,,*53</p> <p>\$GPGGA,031631.493,3649.8950,S,17447.0587,E,1,06,1.2,040.2,M,-026.4,M,,*50</p> <p>\$GPGGA,031632.493,3649.8950,S,17447.0587,E,1,06,1.2,040.3,M,-026.4,M,,*52</p> <p>\$GPGGA,031633.493,3649.8950,S,17447.0587,E,1,06,1.2,040.3,M,-026.4,M,,*53</p>
<p>Gyro ttyS1d</p> <p>Logging</p>	<p>Start: 2004/10/01 02:15:15</p> <p>Good: 3649 2004/10/01 03:16:34</p> <p>Errors: 0</p>	<p>\$HEHDT,102.83,T*17</p> <p>\$HEHDT,102.93,T*16</p> <p>\$HEHDT,103.03,T*1e</p> <p>\$HEHDT,102.94,T*11</p>

Monitoring At Sea: UHDAS web site

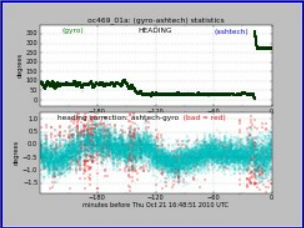
ADCP Figures (with frames)

[HOME](#)

Monitoring: click opens a new figure

Attitude Devices

- ashtech [heading correction](#)



Beam Diagnostics (OS only):

- [last 30 min](#)
- [last 24 files \(stats\)](#)

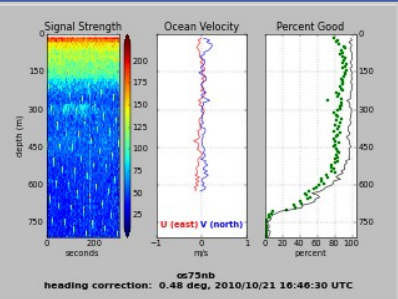
Bridge plots:

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

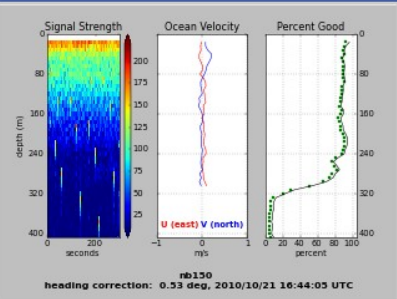
Click shows figures on the right:

[all thumbnails](#)

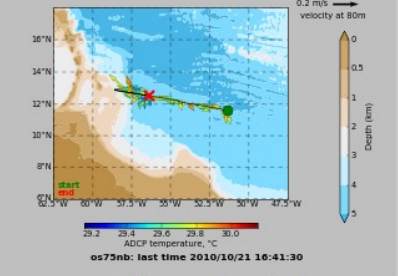
[HOME](#)



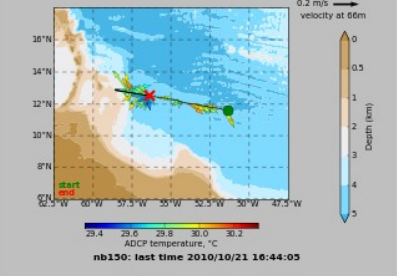
os75nb 5-minute profile



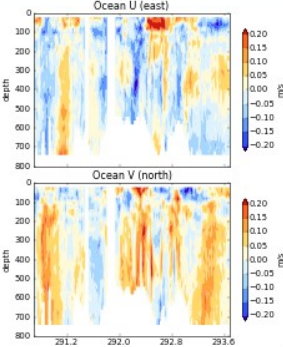
nb150 5-minute profile

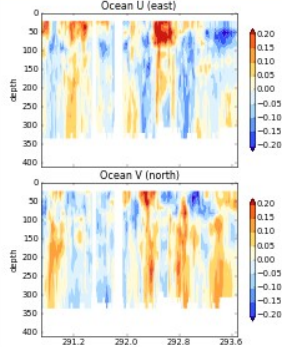


os75nb vector plot



nb150 vector plot





UHDAS: Monitoring from shore

Link to on-shore monitoring: [UHDAS ships](#)

- text email
- figures
- diagnostic files

Monitoring: on Land

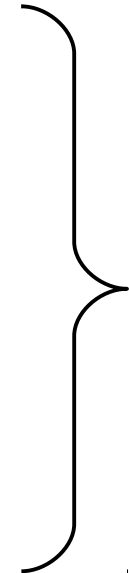
- **from the text email:**

- CODAS Processing
 - health of components (Ashtech)
-

- **data snippets for figures**

- **from the diagnostic files:**

- data acquisition
- processing
- troubleshooting



tarball

Summary: Benefits of UHDAS

- At sea
 - real-time operations
 - navigation and deployment of instruments
 - science: predict trajectory, identify feature, calculate flow
 - happy techs
- On land
 - monitor for error or failure (or poor decision in setup)
 - after the cruise: tools for calibration, editing
 - beautiful data, happy and productive scientists

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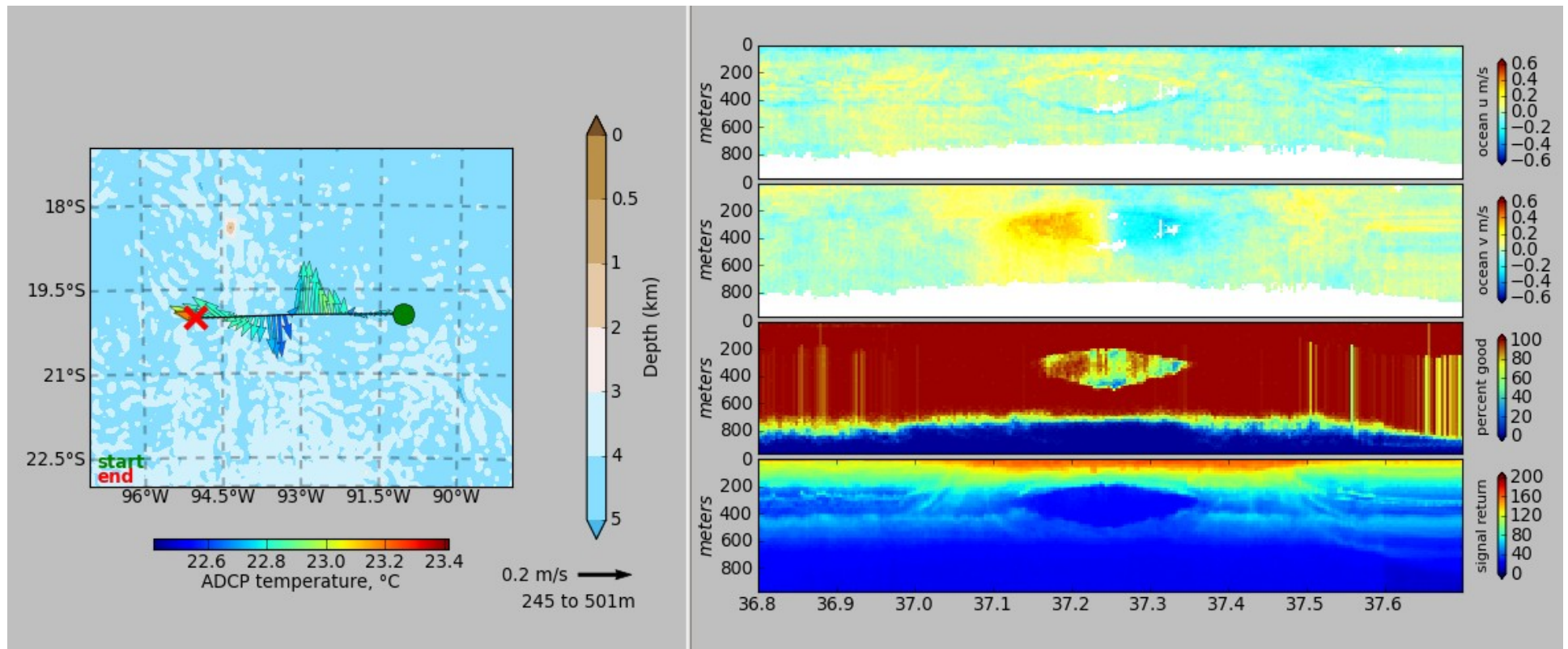
Oceanography

- **Features**
 - Eddies
 - 20S Eddy
 - Chile coast
 - Subsurface flow
 - Lau Basin
- **Energy: Internal waves**
 - Coastal Oregon
- **Repeat Sampling**
 - Equatorial Pacific

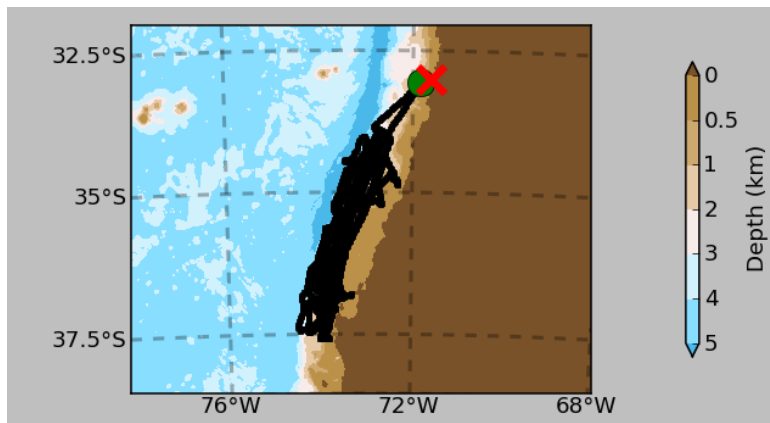
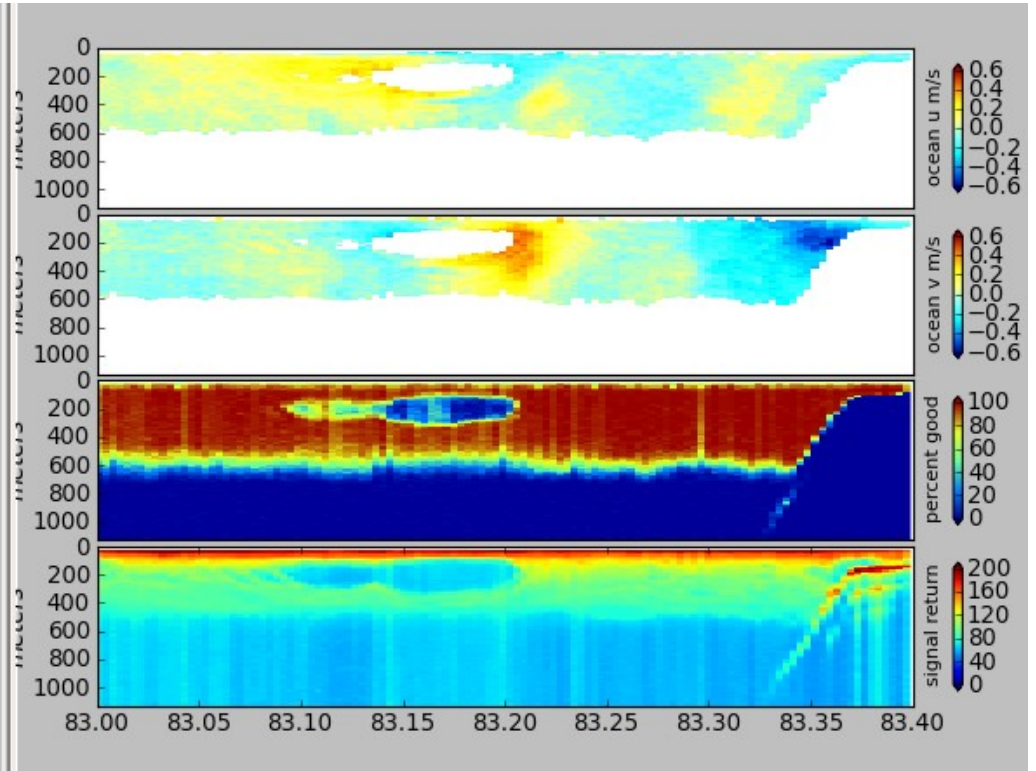
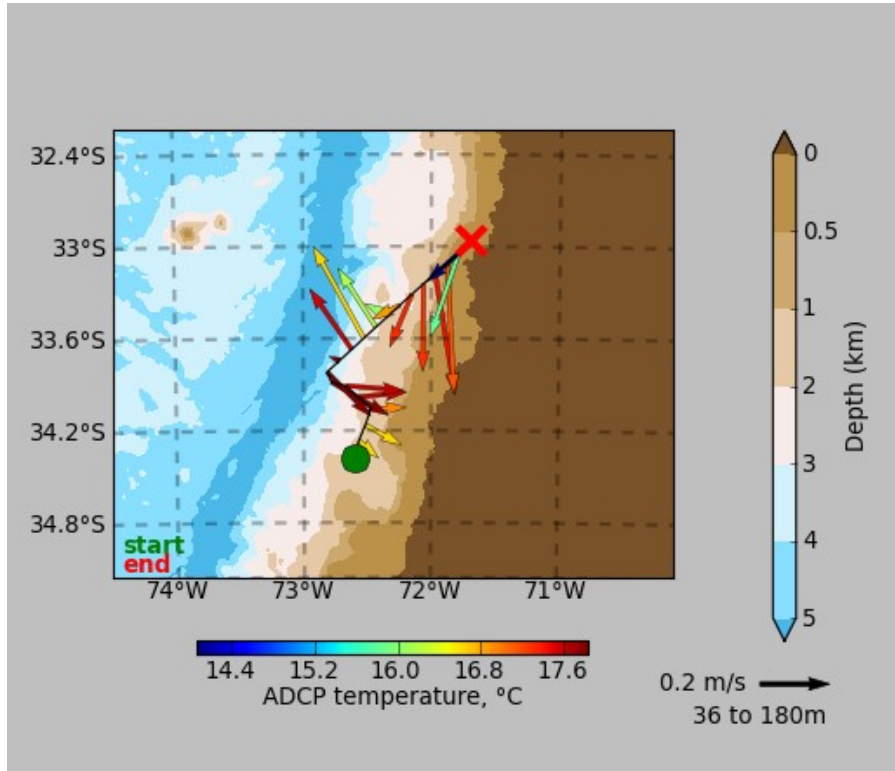
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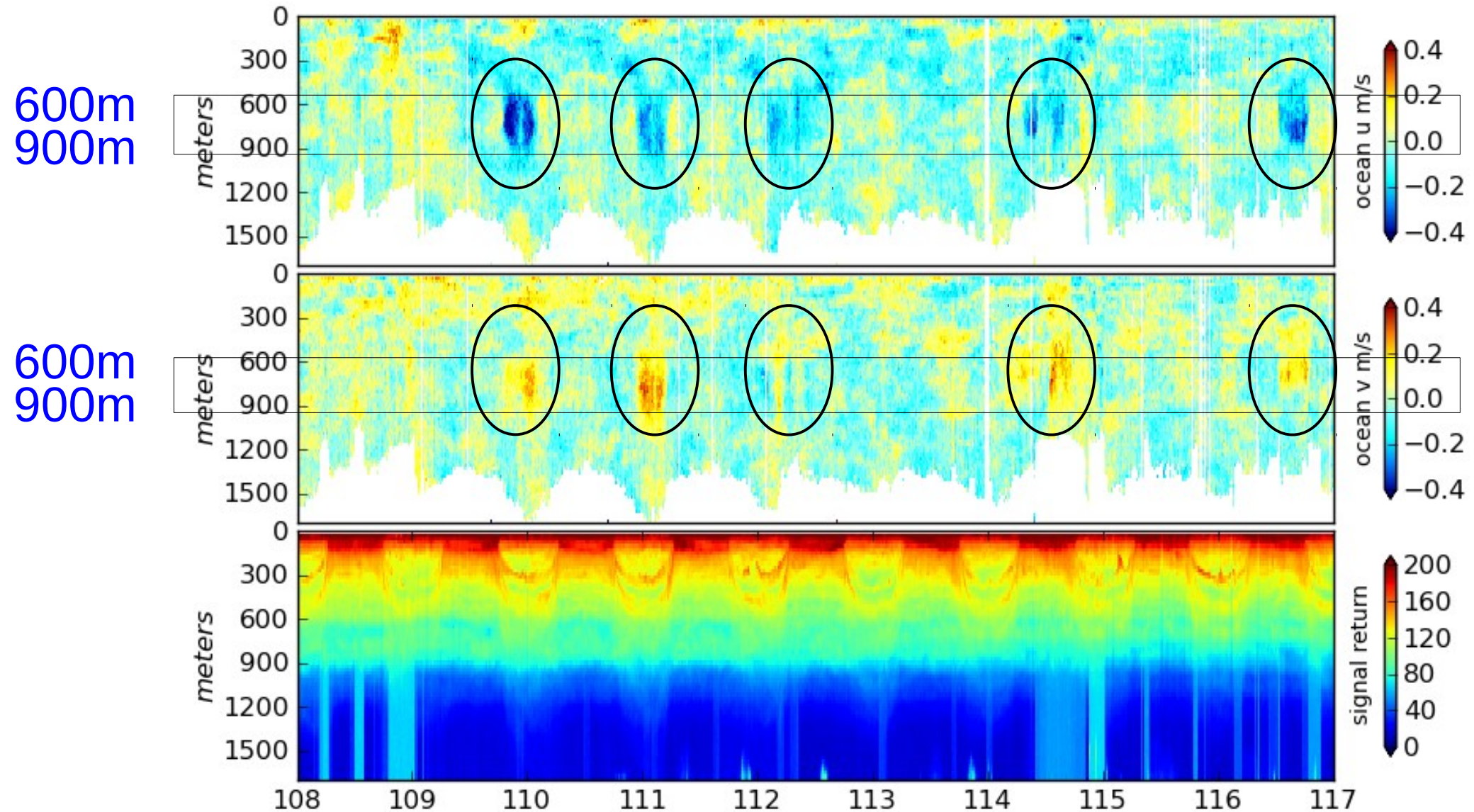
Features (eddies), 20S Eddy



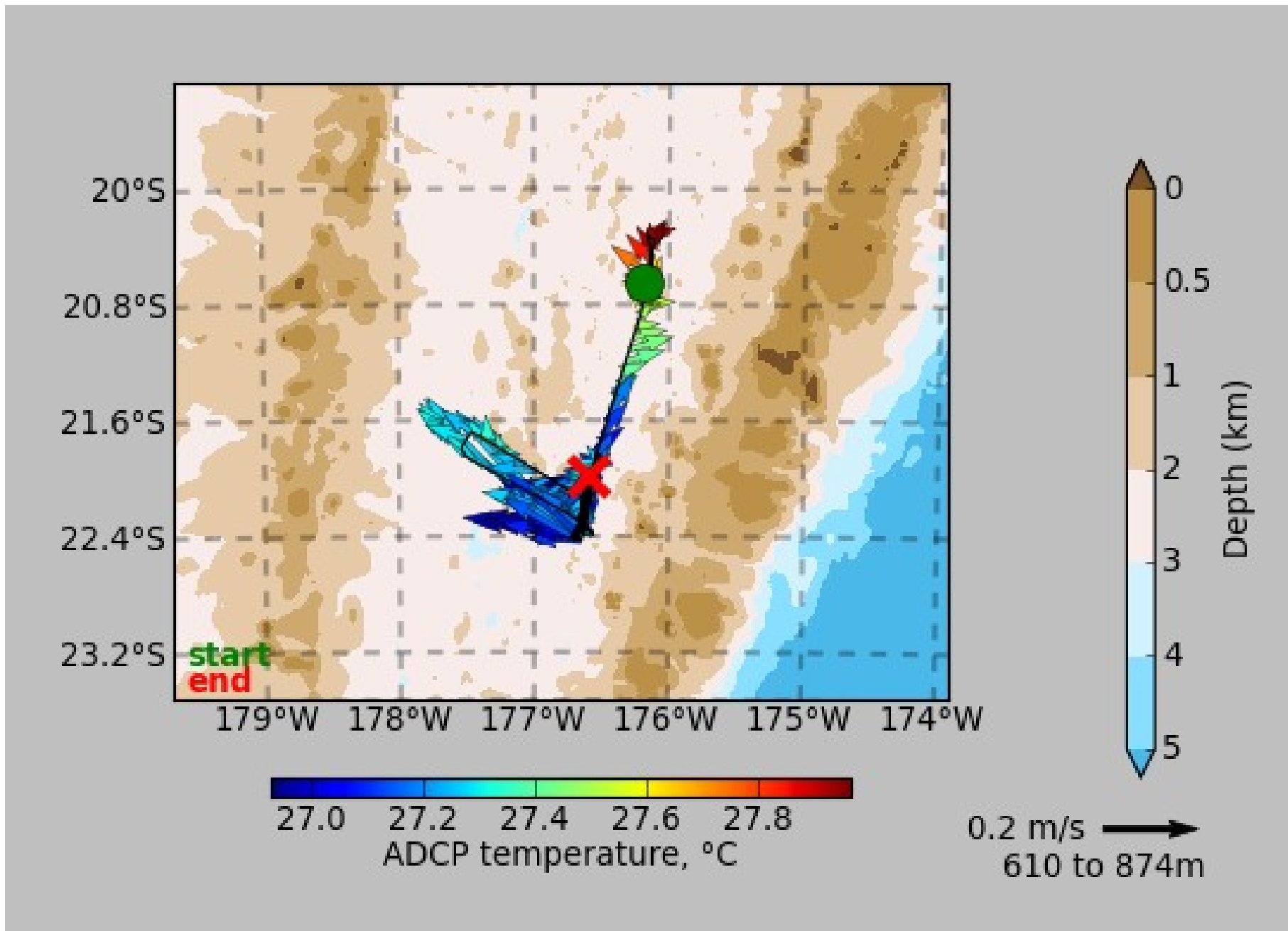
Features (eddies), Chilean Coast



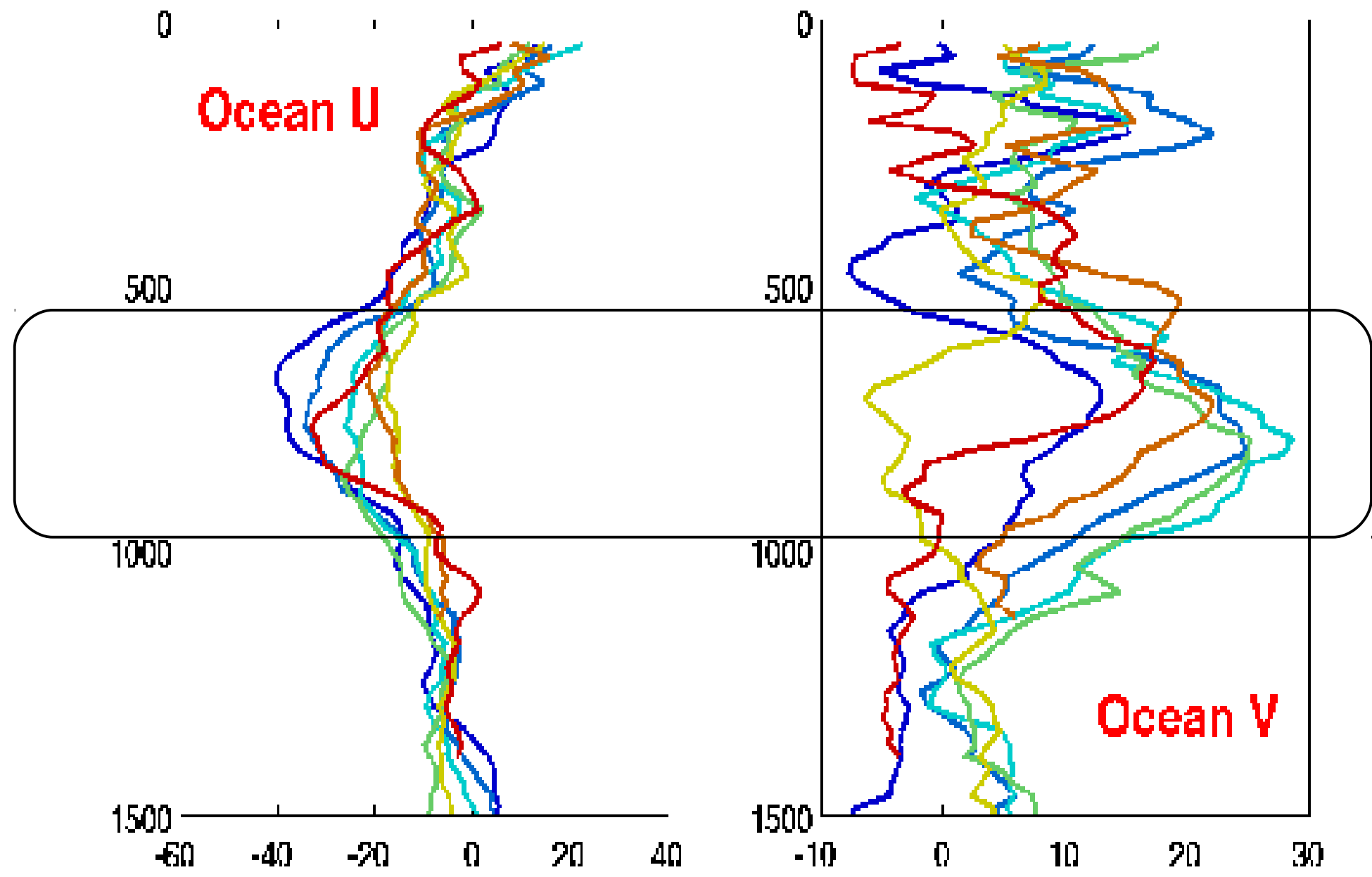
Features (subsurface flow): Lau Basin



Features (subsurface flow): Lau Basin



Features (subsurface flow): Lau Basin




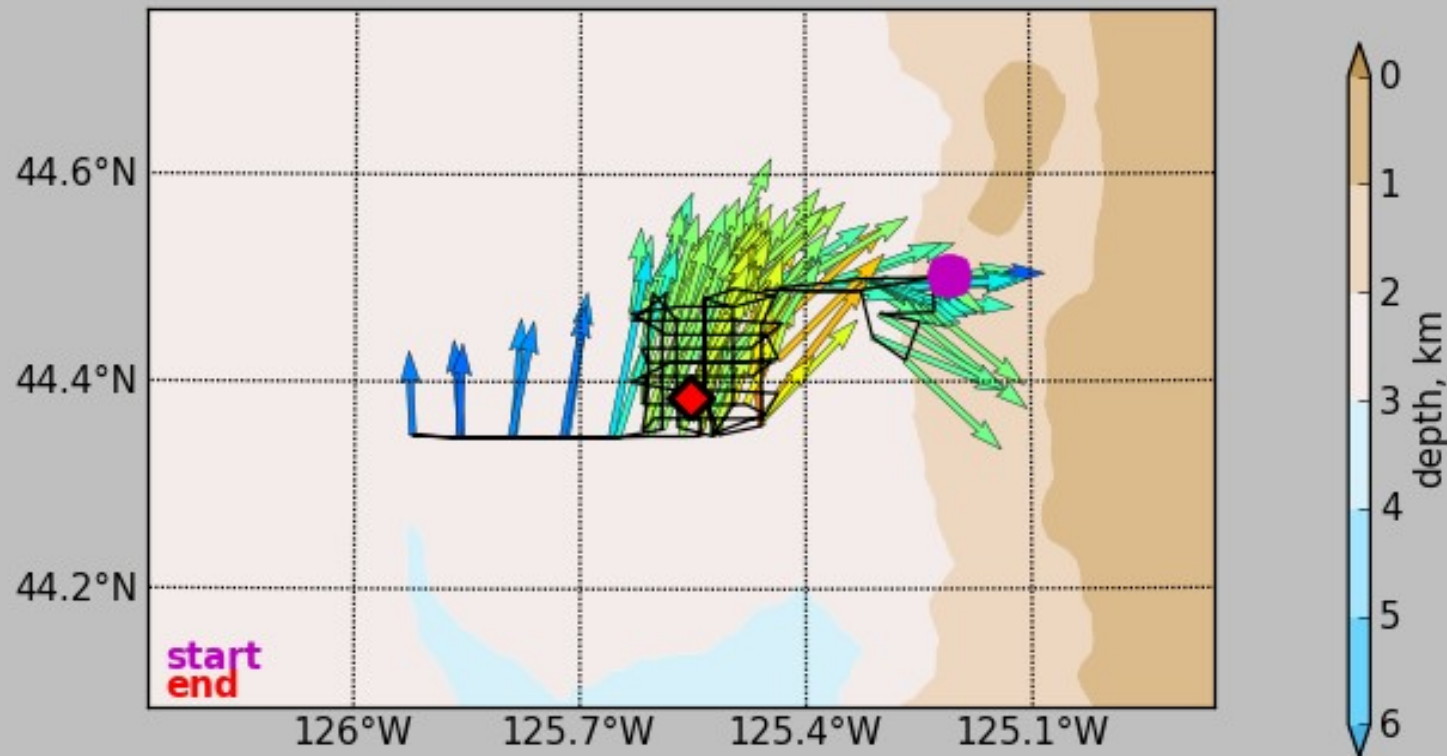
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Energy: Surface Coastal Eddy Oregon Coast

km1001c wh300: shallow velocities

50 cm/s 
velocity at 55m



10.8 11.0 11.2 11.4 11.6

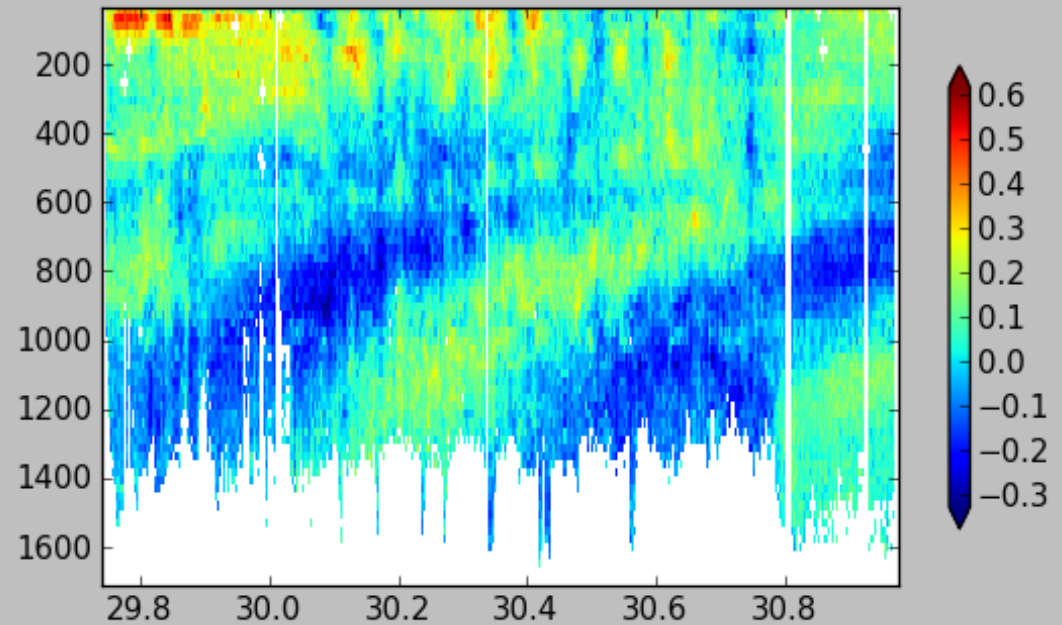
ADCP temperature, degC

last time = 2010/02/01 01:17:13

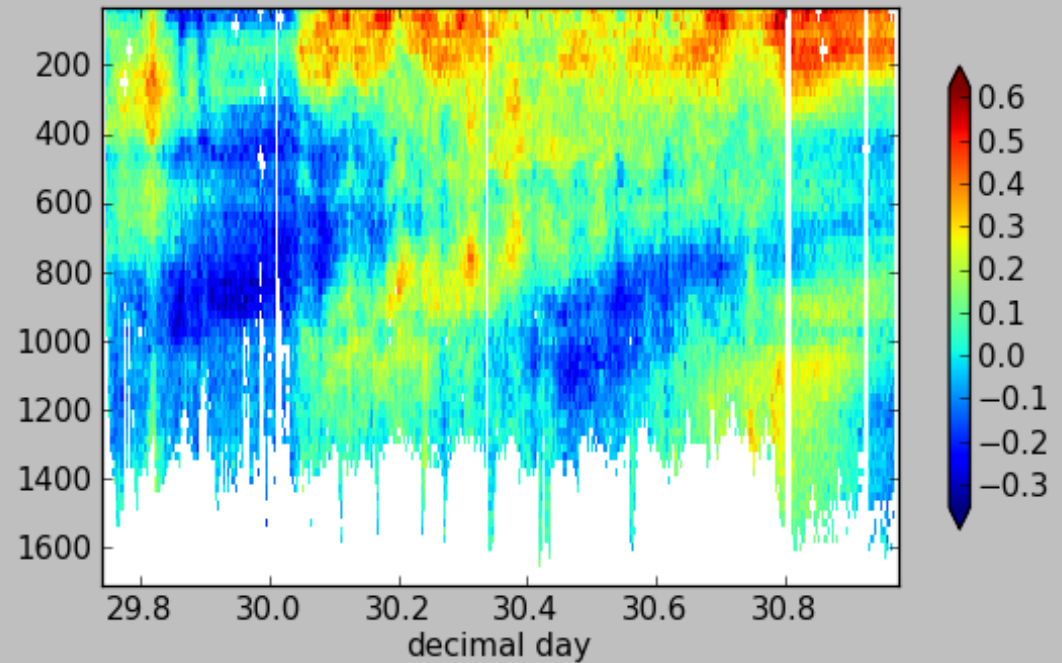
Energy: Deep Internal Waves Oregon Coast

km1001c os38nb velocities

ocean velocity east, m/s



ocean velocity north, m/s



600m



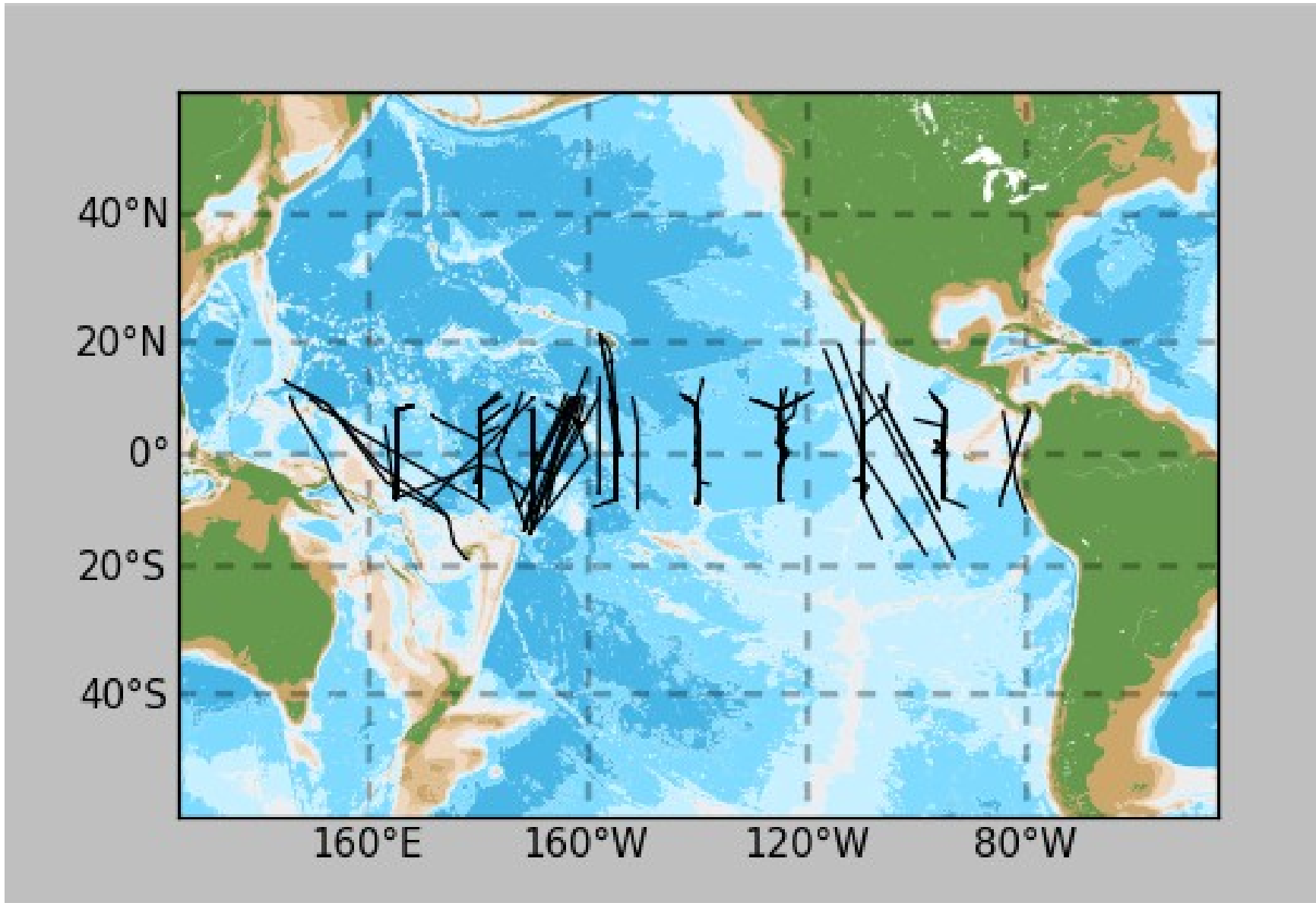
1400m



Oceanography

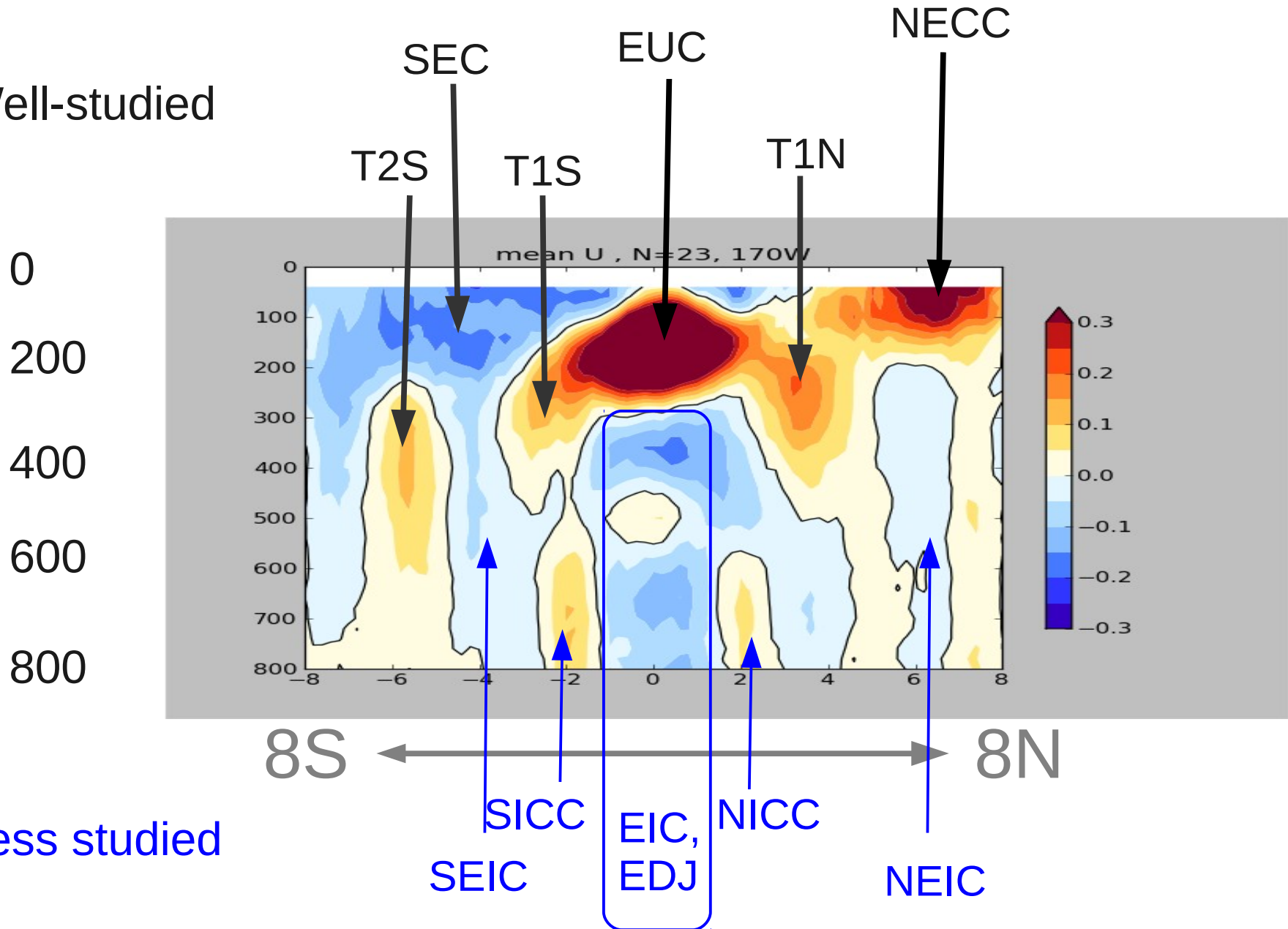
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Repeat Sampling: Equatorial Pacific



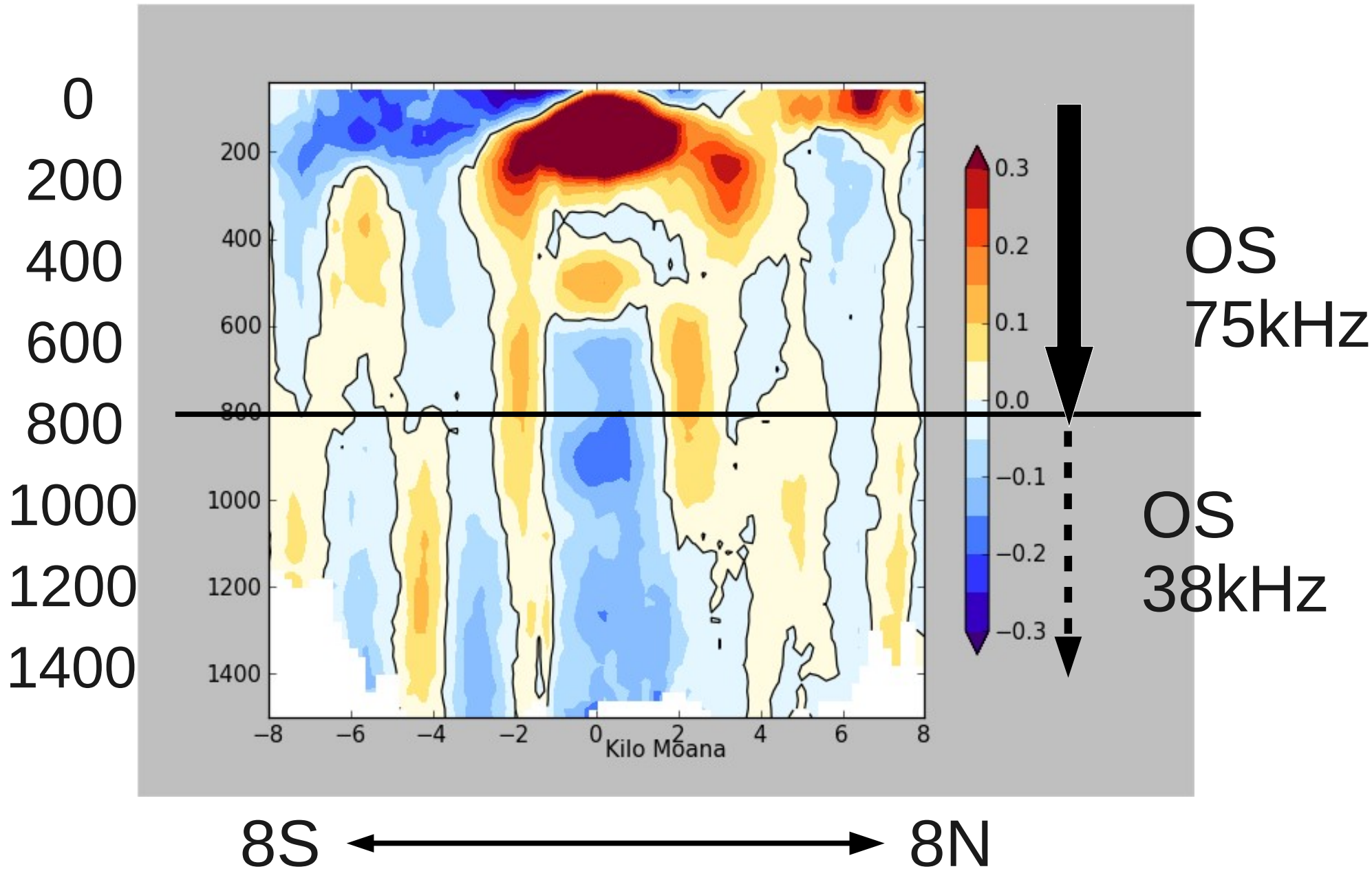
Equatorial Pacific, 170W

Well-studied



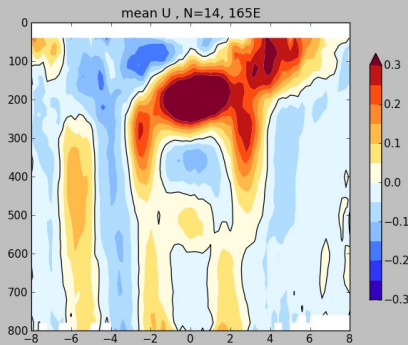
Less studied

Equatorial Pacific, 170W (38kHz)

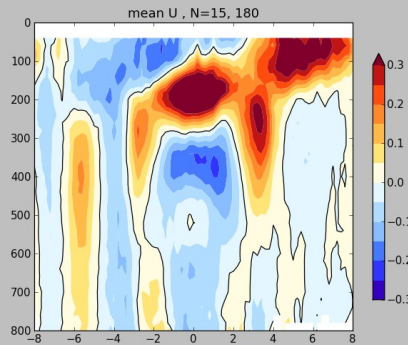


Equatorial Pacific

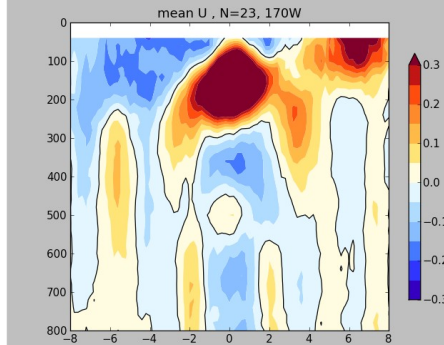
165E



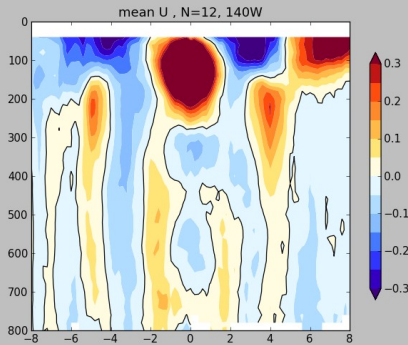
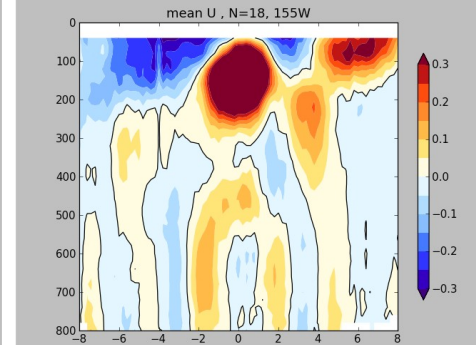
180



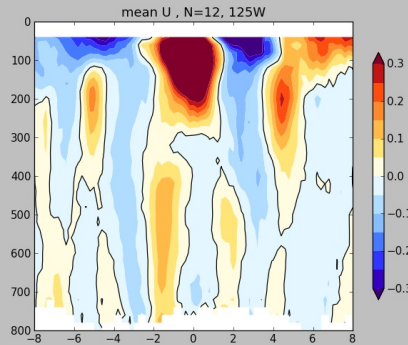
170W



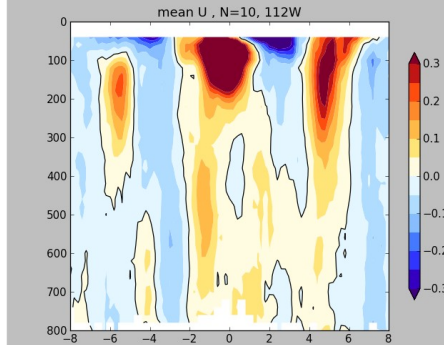
155W



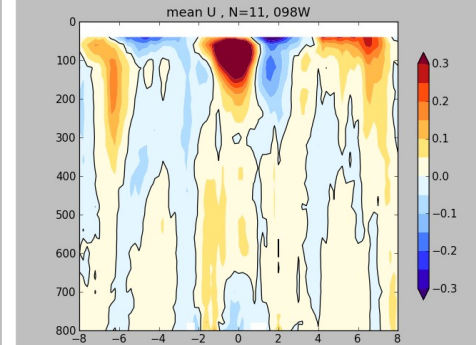
140W



125W



112W



98W