

Maximizing the Scientific Value of Ocean Current data from Shipboard ADCP

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

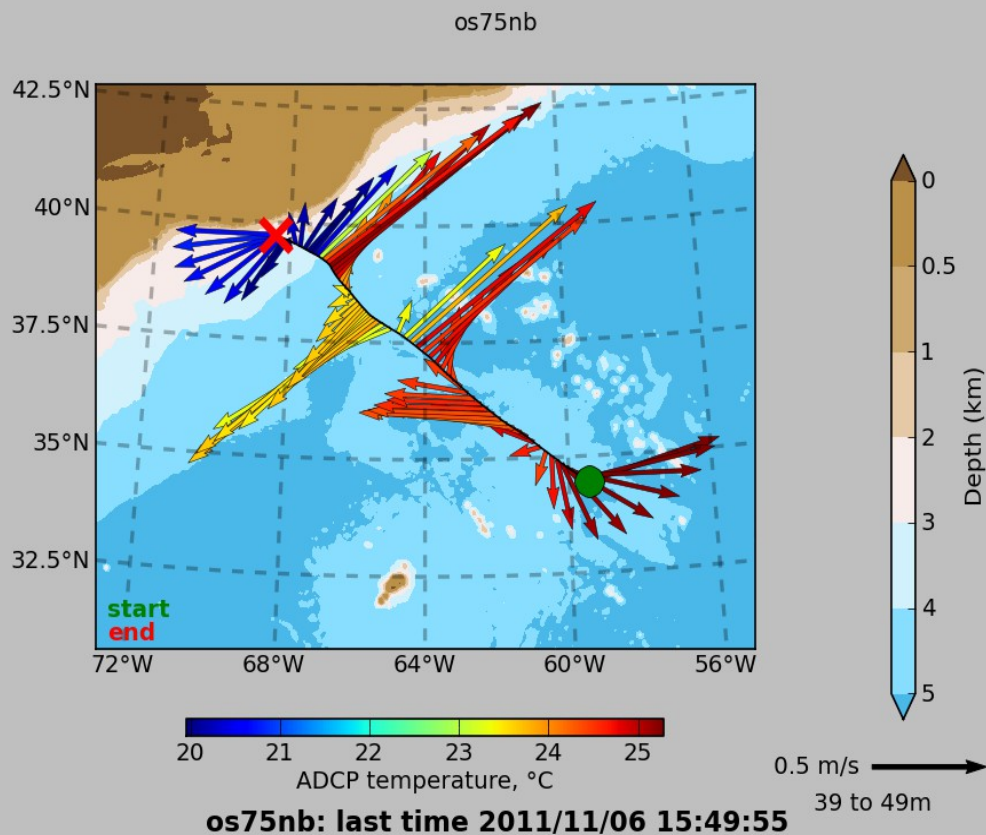
Overview

- what is shipboard ADCP? who uses the data?
- where are SADCs installed?
 - introduction to U.S. Academic Research Fleet; NOAA
- data flow (part 1):
 - acquisition, data on the ship
- maximizing scientific value of shipboard ADCP
 - make it work well; keep it working well
 - make it available immediately and in the future
 - be able to reprocess after the cruise
- data flow (part 2):
 - roles of processing, scientists, national archive

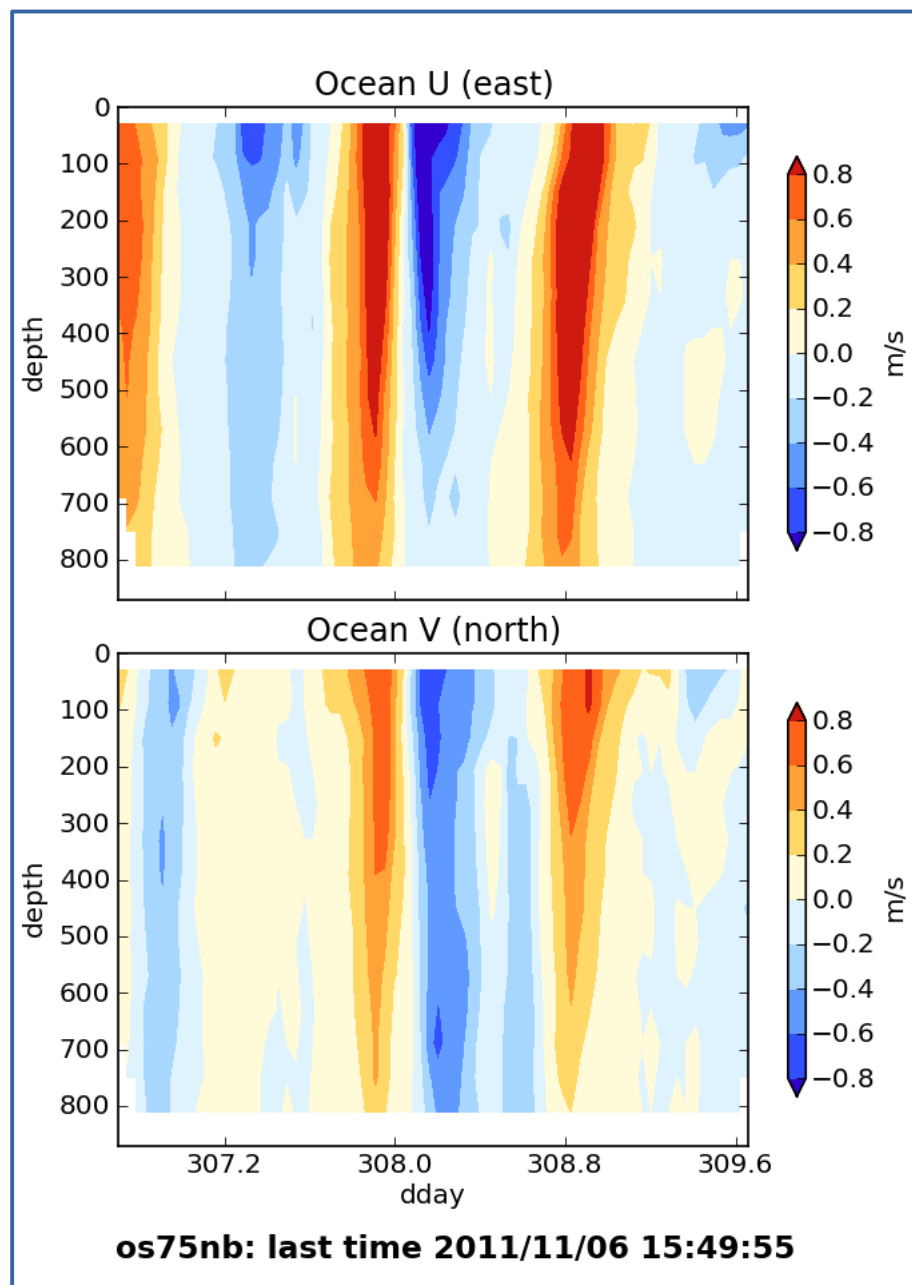
Time, ADCP,
Position,
Attitude

primitive (raw) data

AfterProcessing



After Processing



Who uses the data? What is it good for?

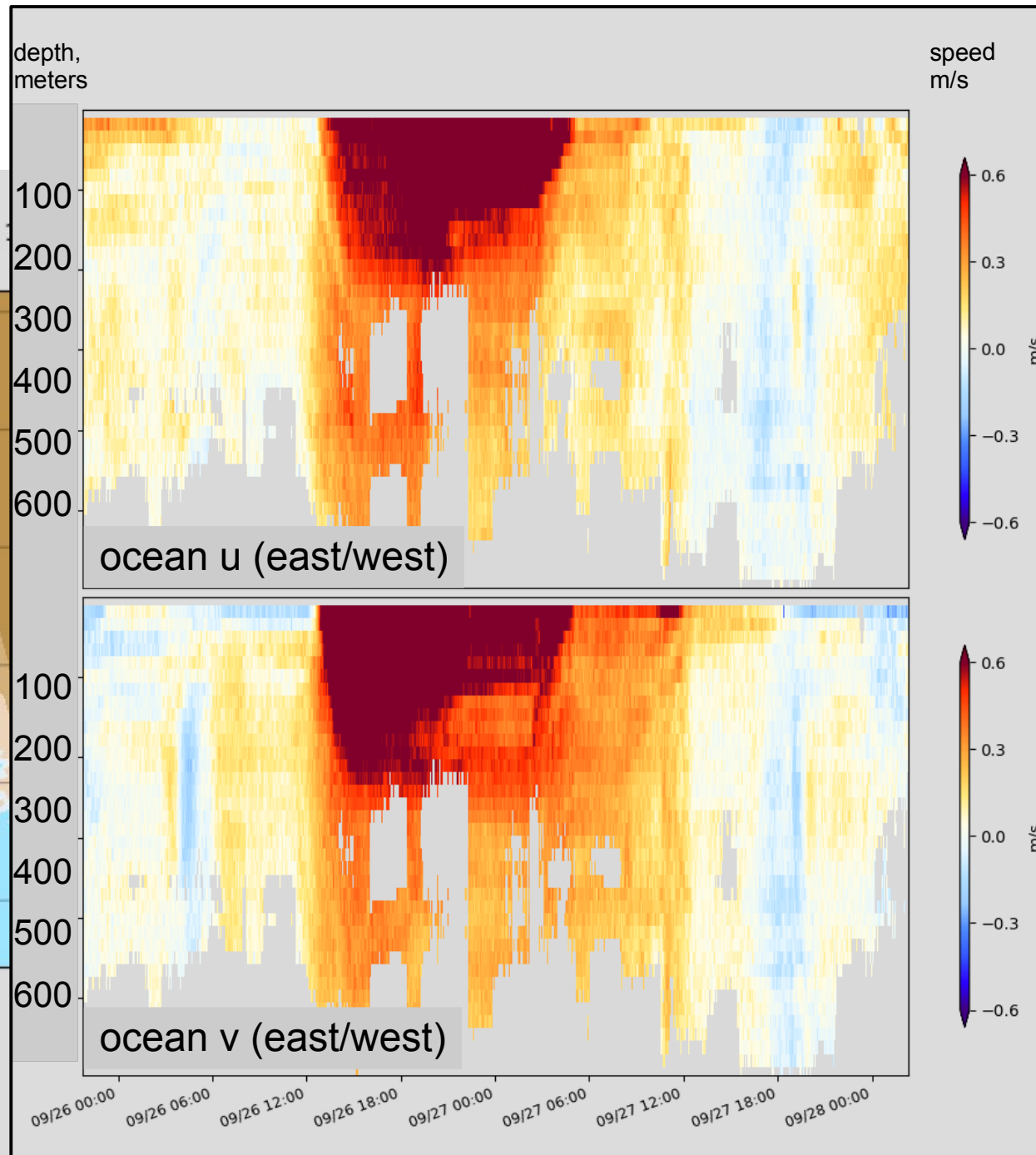
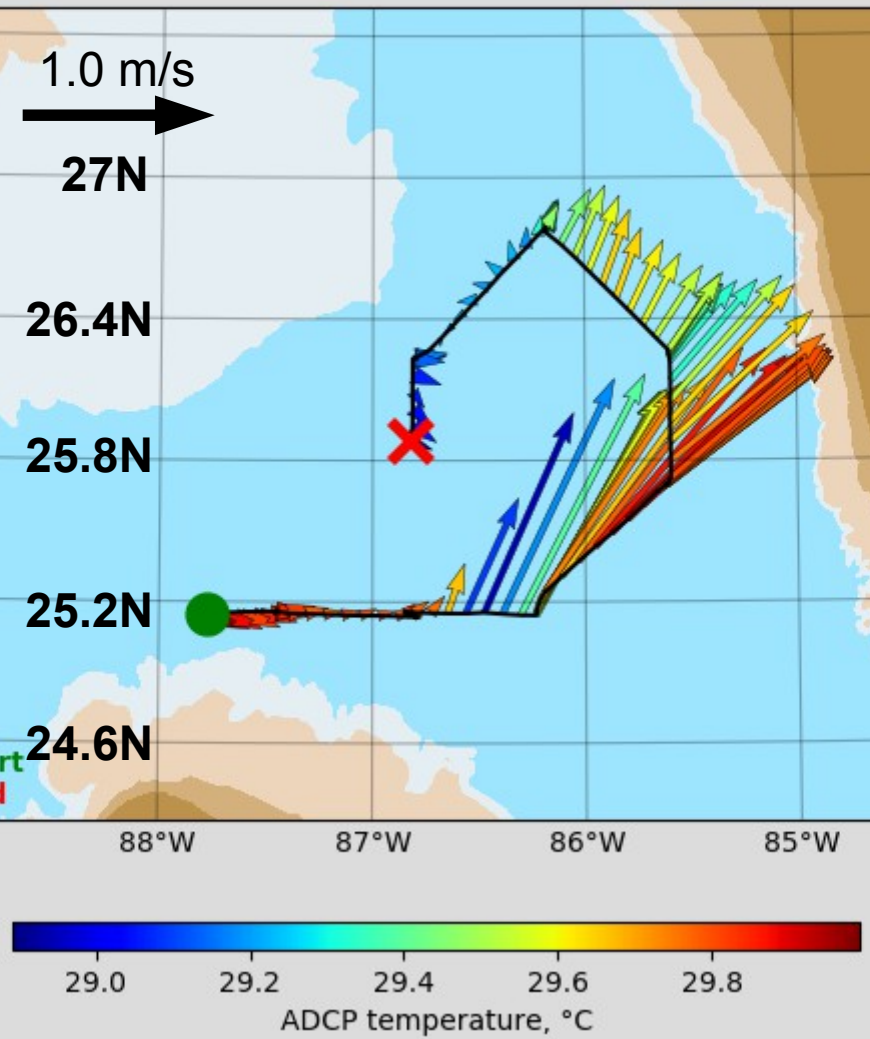
at sea:

- 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

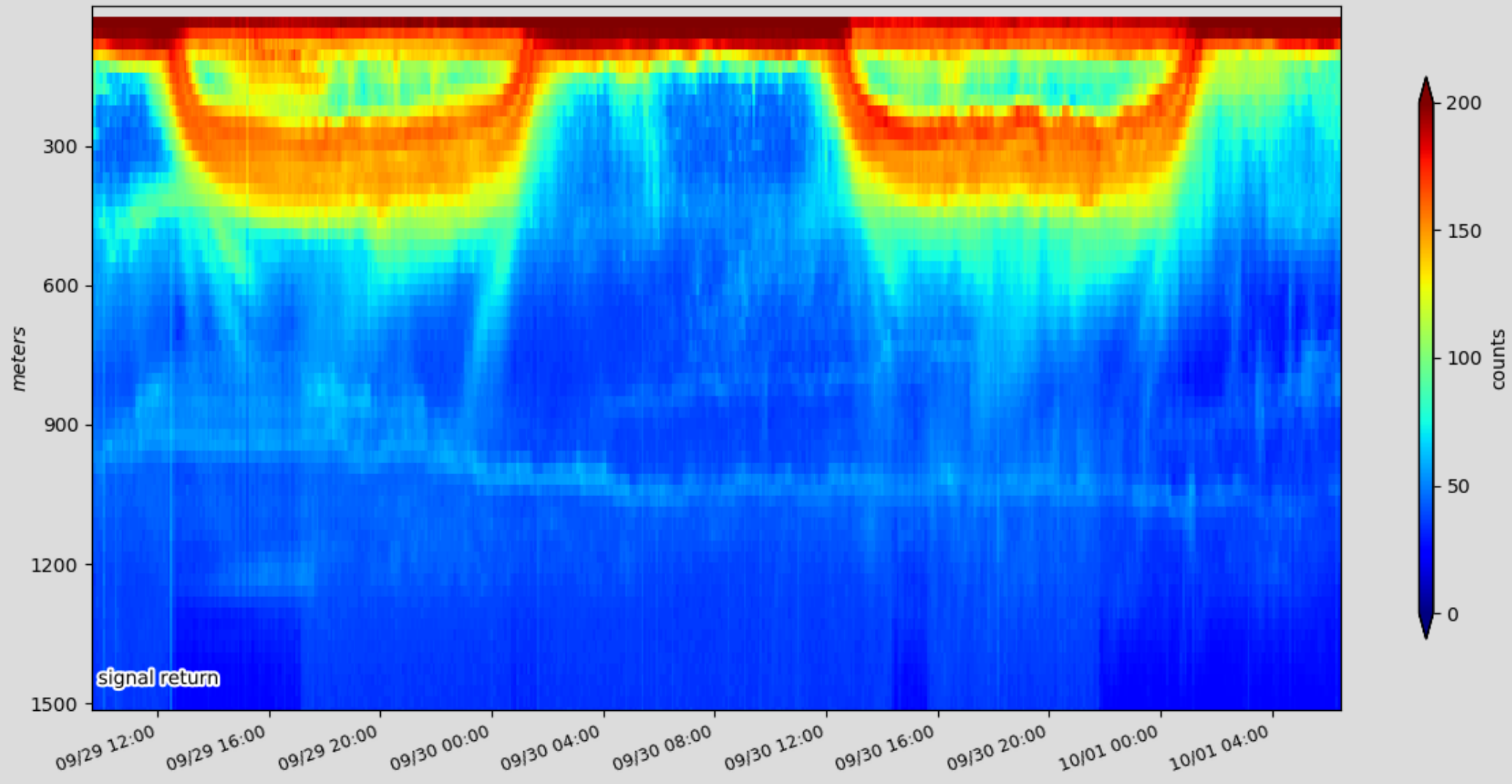


Scientific relevance of shipboard ADCP data

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

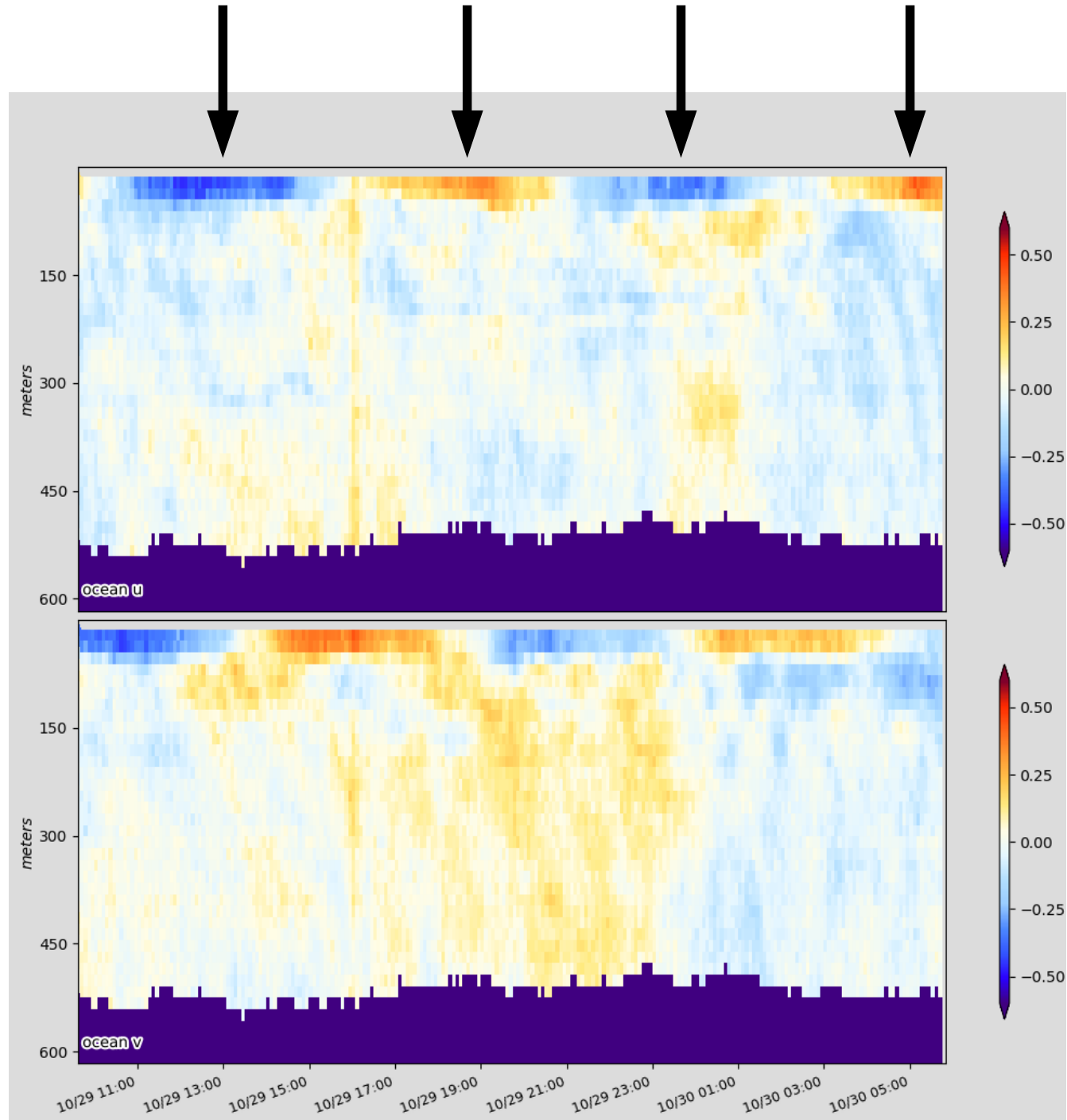
examples
follow...

Kilo Moana: 38kHz ADCP backscatter (tropical eastern pacific)

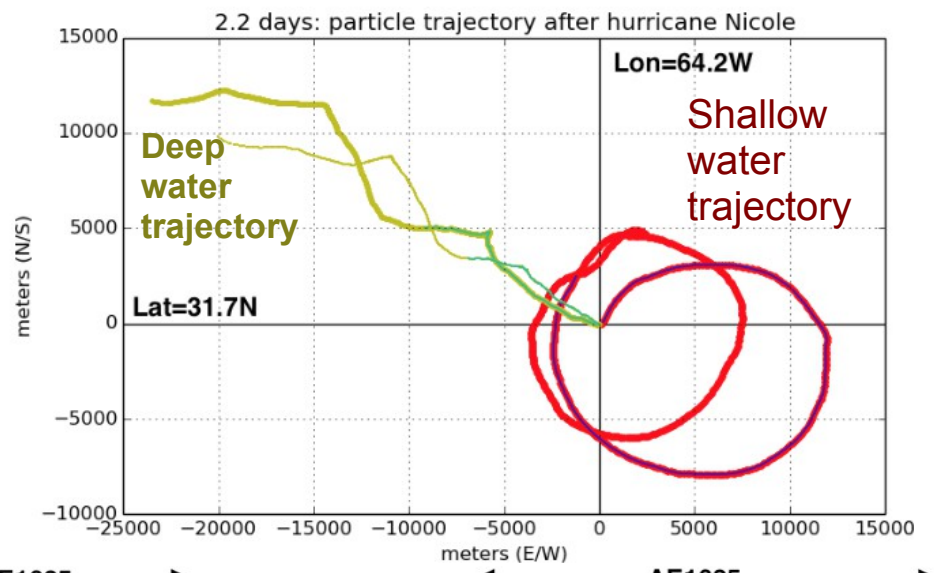
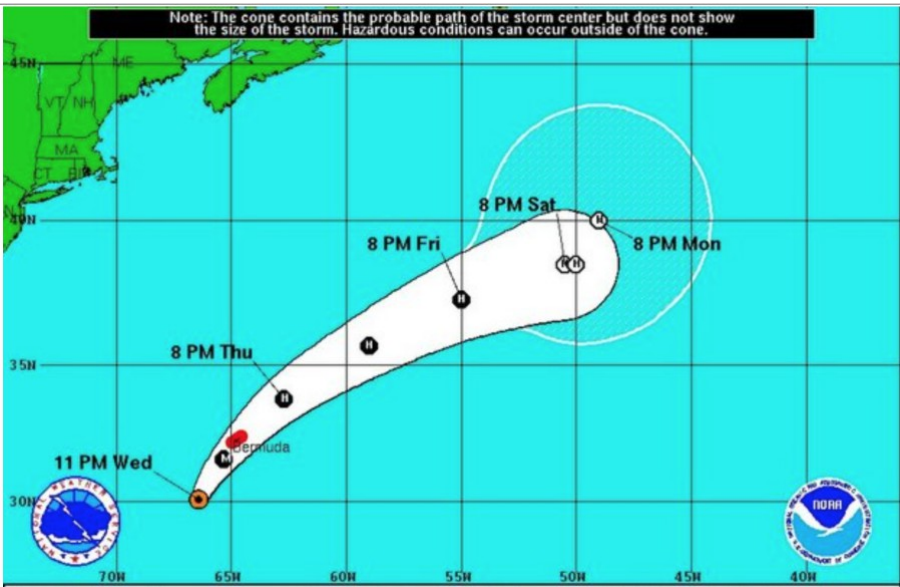


Near-inertial
motion caused
by strong winds;

stratified ocean
keeps the energy
at the surface



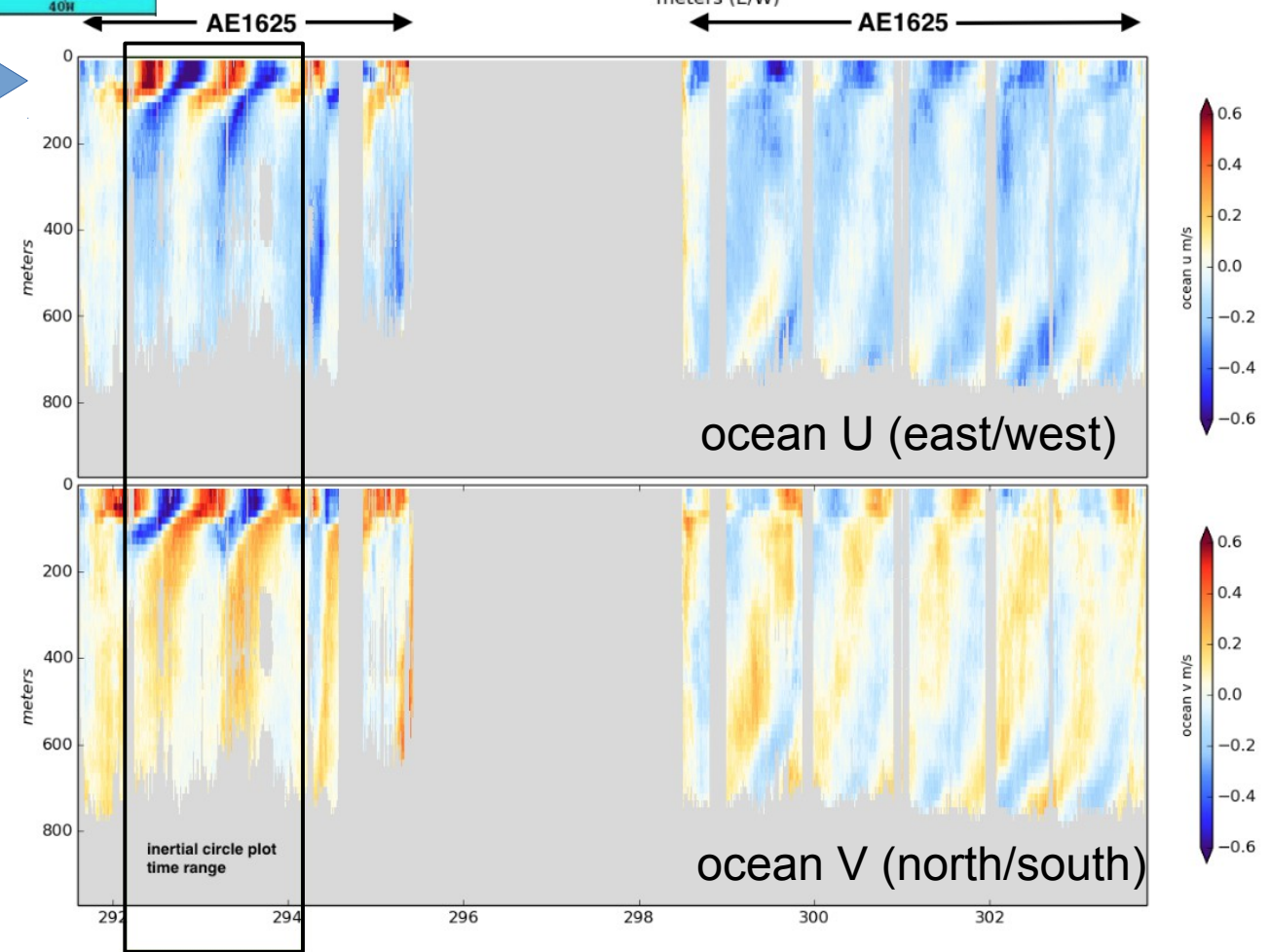
Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



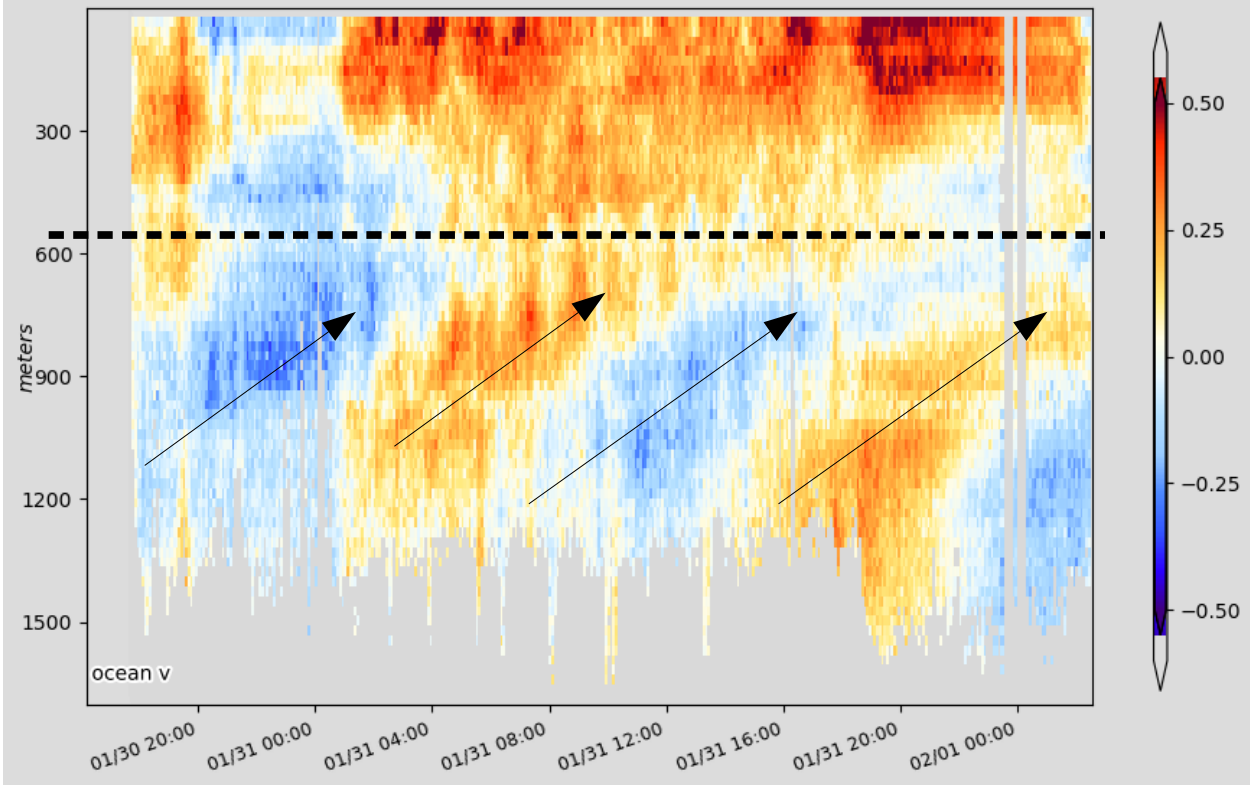
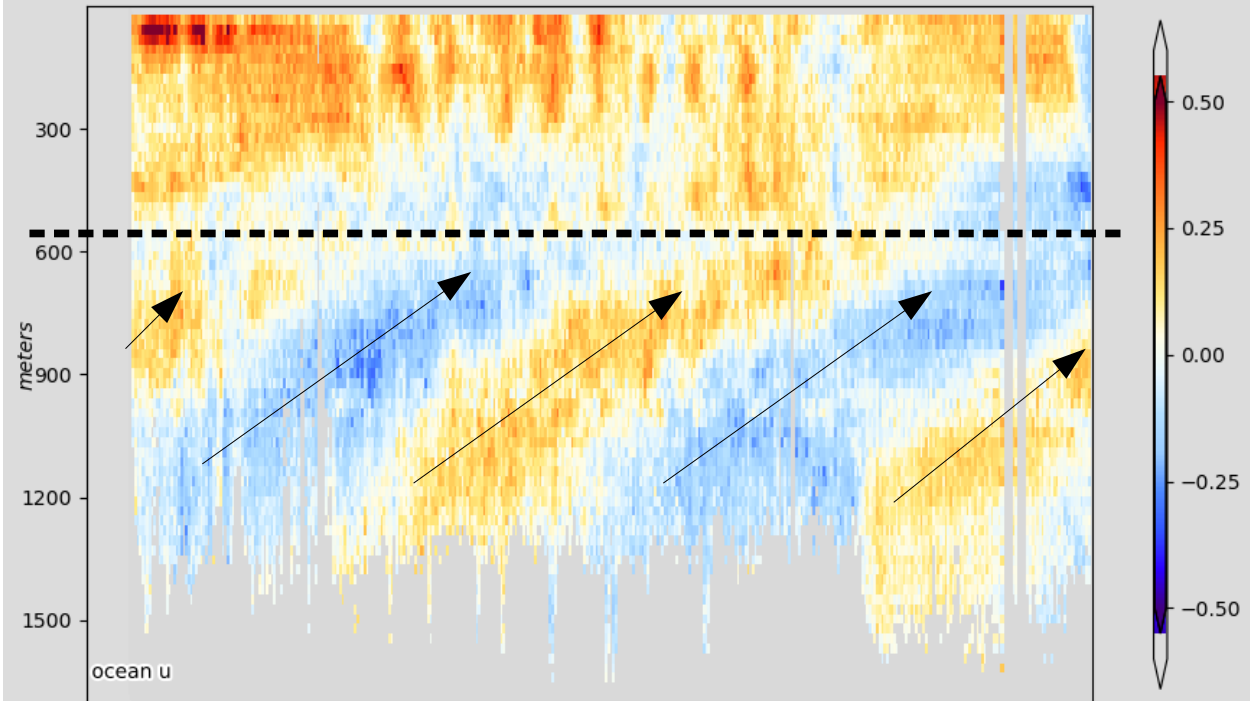
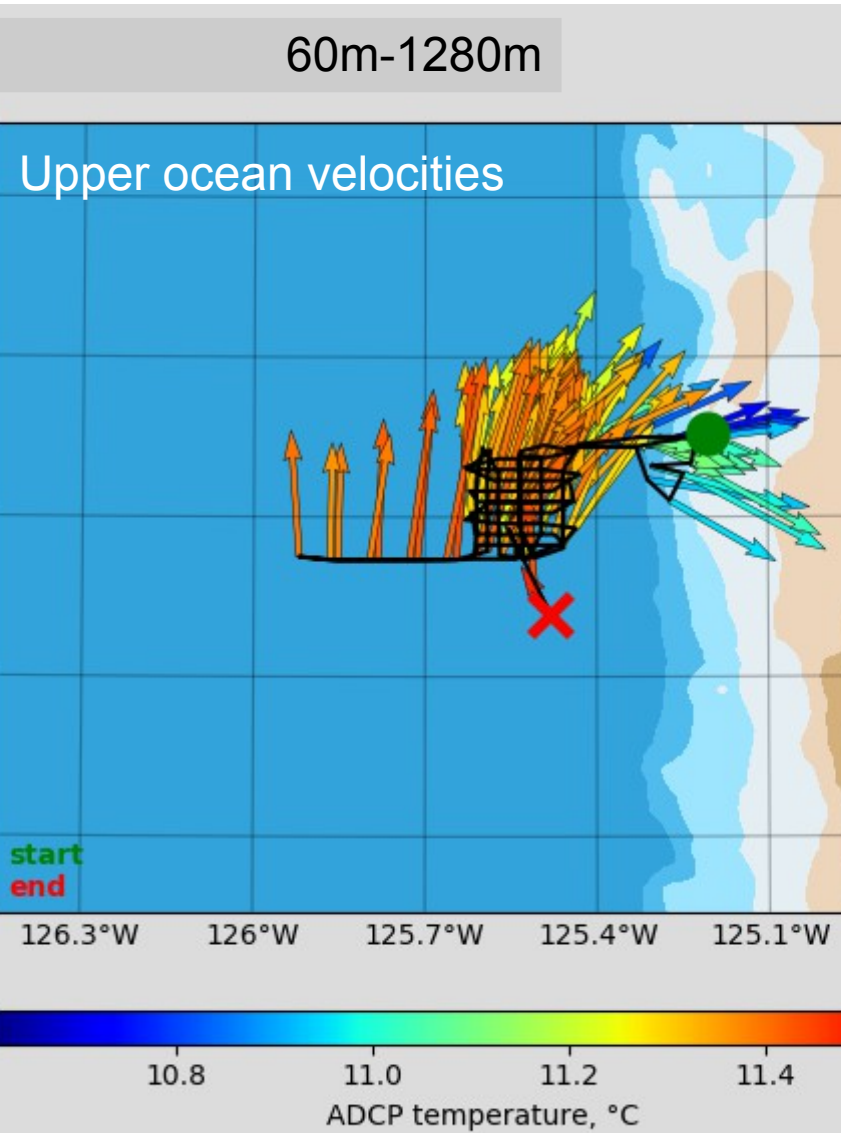
shallow inertial signal →

Hurricane Nicole Oct 12, 2016

deep inertial signal later



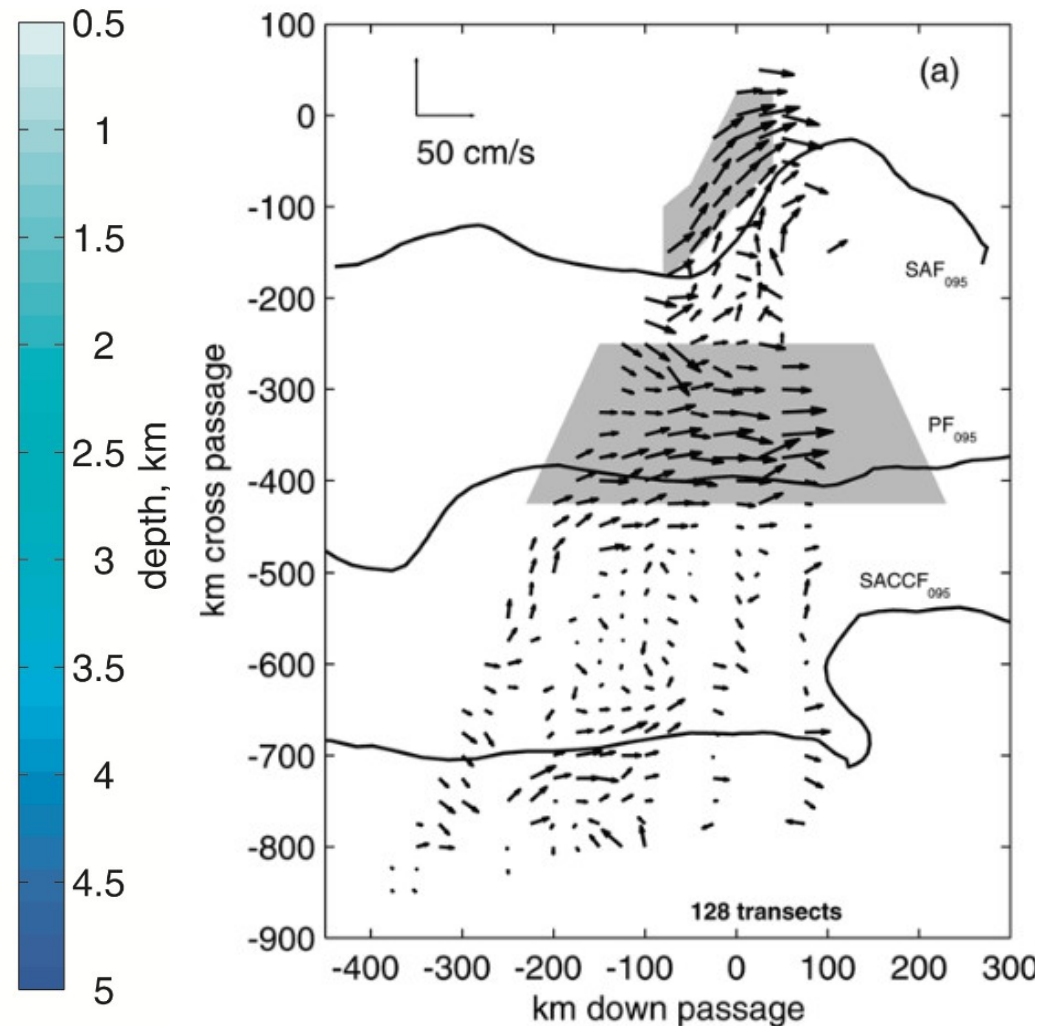
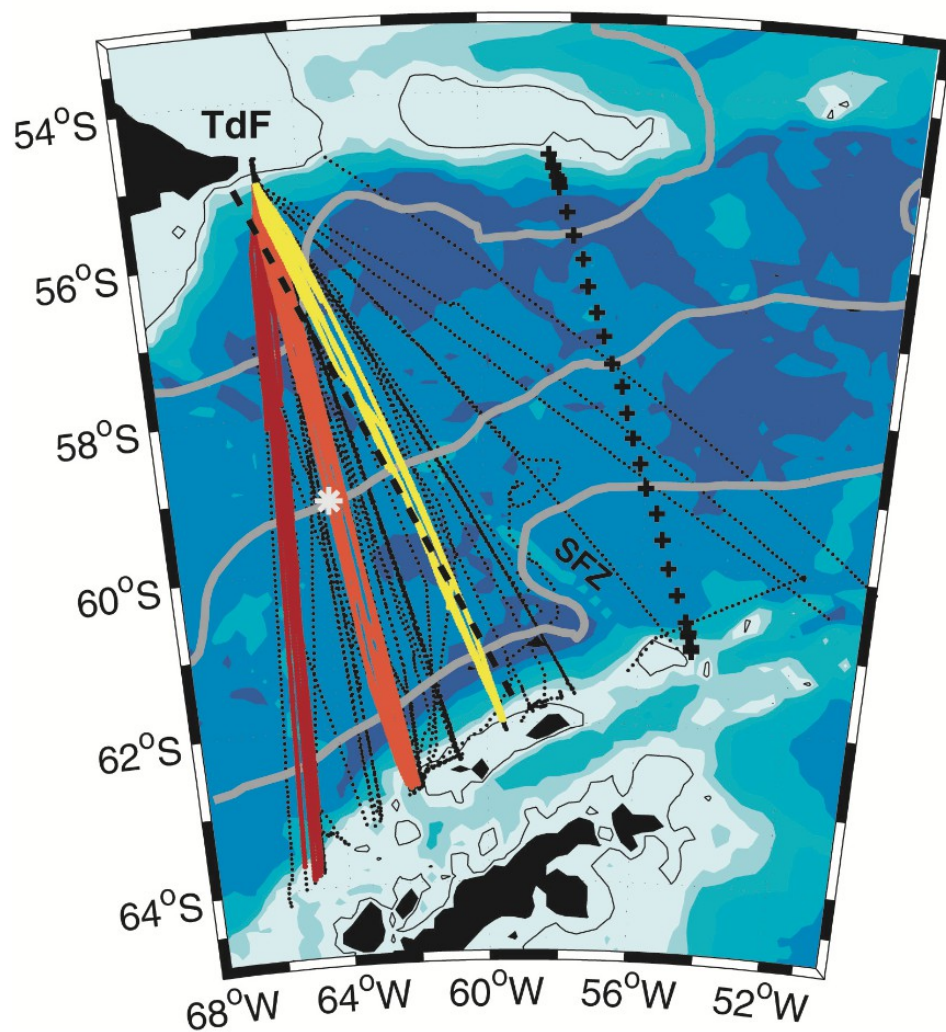
Kilo Moana (45N)
off the Oregon Coast:
internal tide beam,
energy downward
(phase upward) below 600m



Time Series Examples

Laurence M. Gould: Drake Passage

Lenn et al, JMR, 2007



Time Series: Equatorial Pacific

SADCP from TAO sections
Crevatte et al, JMR 2017

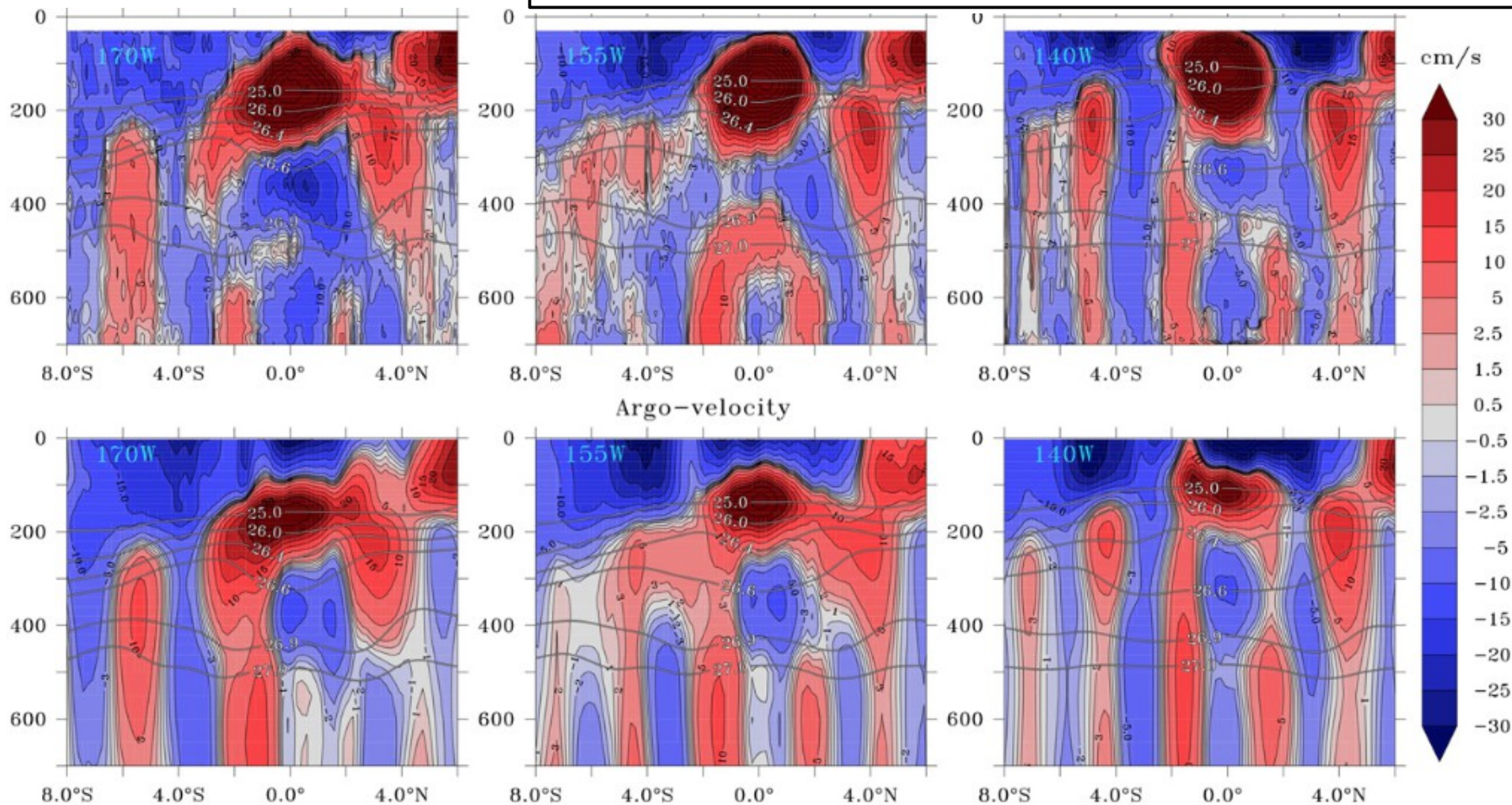
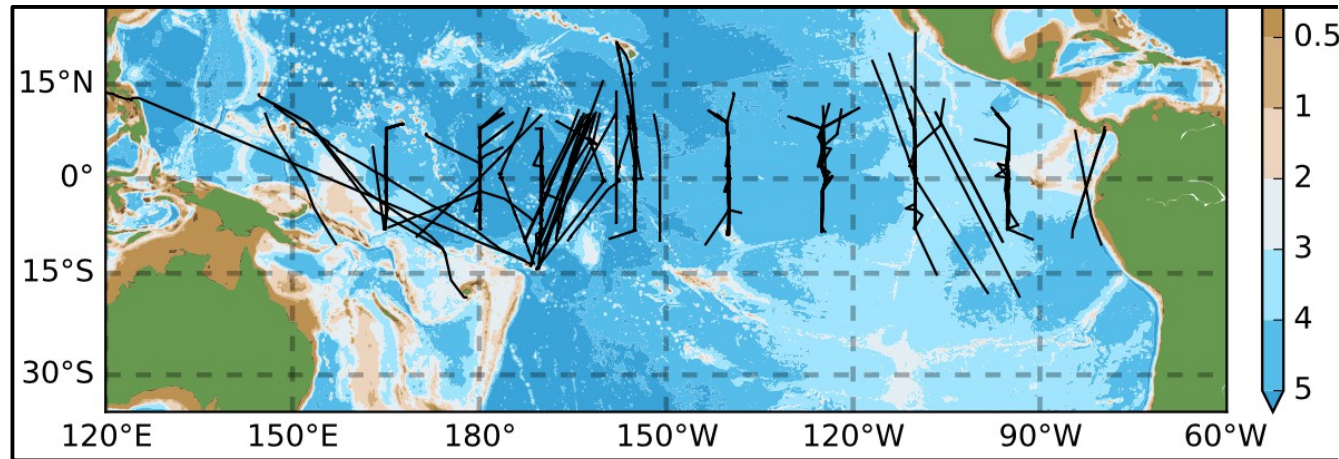


FIG. 12. Mean zonal velocity from (top) SADCP data and (bottom) Argo velocity product at (left) 170°W, (center) 155°W, and (right) 140°W in cm s^{-1} . Superimposed are some selected isopycnals.

References

Drake Passage

- ***Vertical structure and transport of the Antarctic Circumpolar Current in Drake Passage from direct velocity observations***

Journal of Geophysical Research, 116, C08015; 2011; Y. Firing, T. Chereskin, M. Masloff

- ***Mean jets, mesoscale variability and eddy momentum fluxes in the surface layer of the Antarctic Circumpolar Current in Drake Passage***

Journal of Marine Research, 65, 27–58, 2007; Y.-D. Lenn, T. K. Chereskin, J. Sprintall, E. Firing

Equatorial Pacific

- ***Subthermocline and Intermediate Zonal Currents in the Tropical Pacific Ocean: Paths and Vertical Structure***

Journal of Physical Oceanography, 47, 2305-2324, 2017; S. Cravatte, E. Kestenare, F. Marin, P. Dutrieux, E. Firing

- ***Annual Reversal of the Equatorial Intermediate Current in the Pacific: Observations and Model Diagnostics***

Journal of Physical Oceanography, 40, 915-933, 2010; F. Marin, E. Kestenare, T. Delcroix, F. Durand, S. Cravatte, G. Eldin

Where are scientific shipboard ADCPs installed?

- Internationally:
 - oceanographic research vessels
 - smaller science vessels
 - Navy ships

- In the United States:
 - Academic Research Fleet (“**UNOLS**” = ~20 ships)
 - general oceanography: 30m-85m, polar: 70m-130m
 - operated by 12 different institutions
 - each ship sails with 1-6 techs (depending on ship size)
 - Nat'l Oceanographic and Atmospheric Admin (**NOAA**=11 ships)
 - each ship sails with 2 techs
 - smaller science vessels

Maximizing the Scientific Value of Shipboard ADCP

- make it work well; keep it working well
- make it available immediately and in the future
- be able to reprocess it in the future

links:

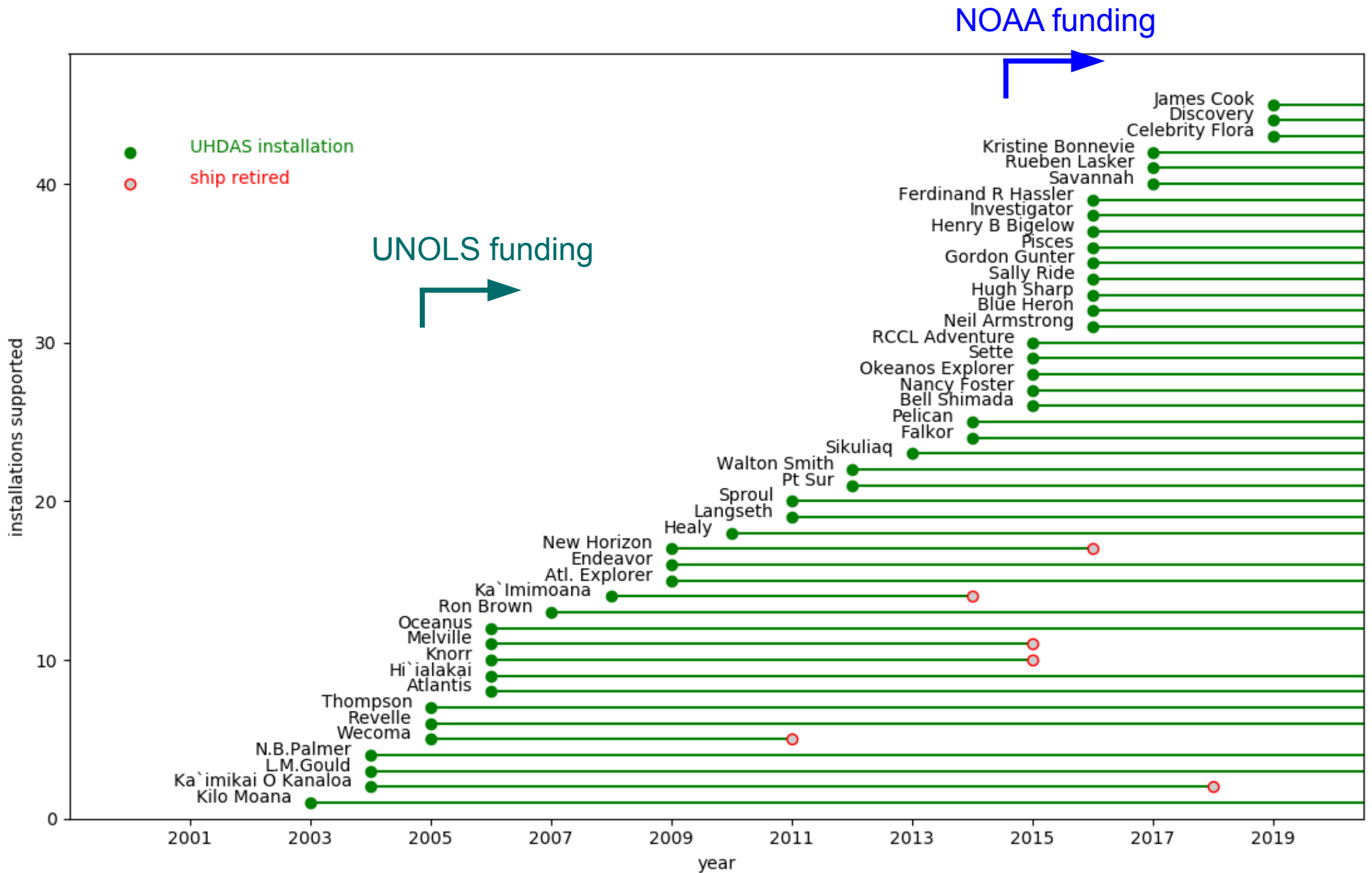
[UHDAS Operations](#)

[Comparison between UHDAS and VmDAS](#)

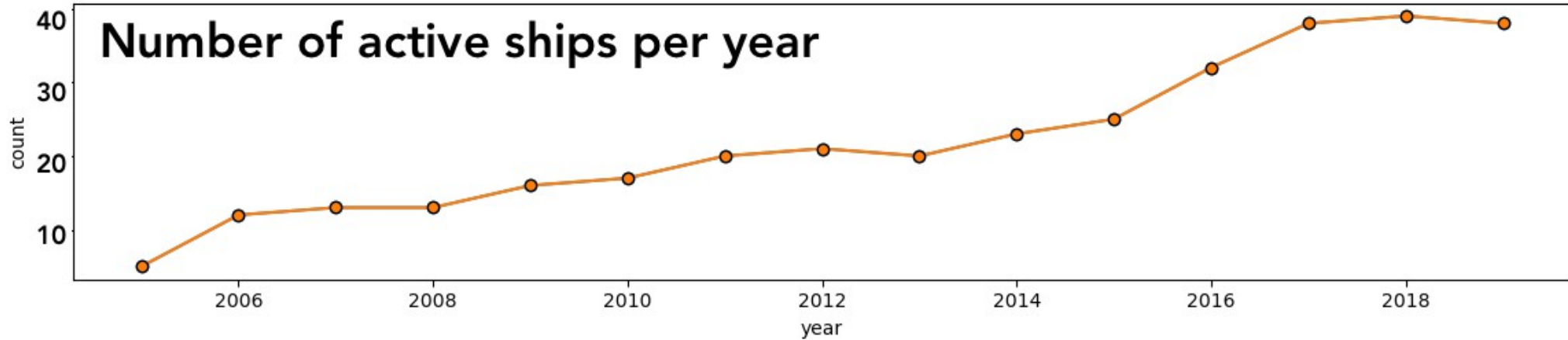
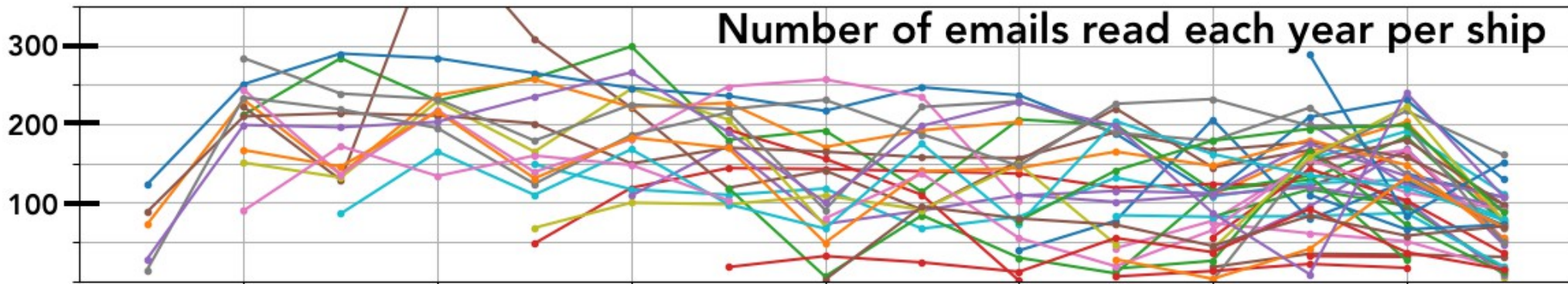
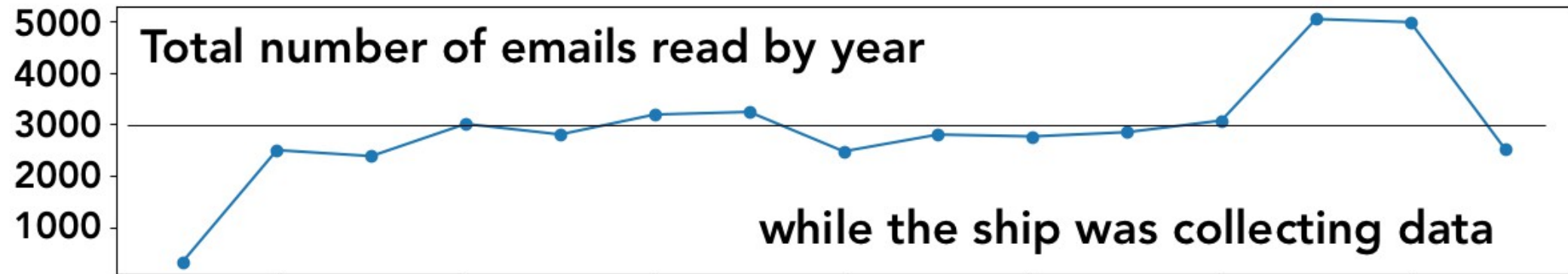
Data flow: from ship to science

- acquisition, data on the ship
 - VmDAS (available from RDI, windows)
 - **UHDAS** (from University of Hawaii, linux)
- roles of processing
 - On the ship?
 - Does the scientist process the data?
 - Is there a “processing facility” cleaning the data?
- U.S. national archive
 - JASADCP (for processed science-ready SADCP)
 - NCEI (via R2R) “as collected” UHDAS SADCP

UHDAS Installations supported: by year



UHDAS ship and email metrics



ADCP:

Getting Ocean Currents

Summary of steps:

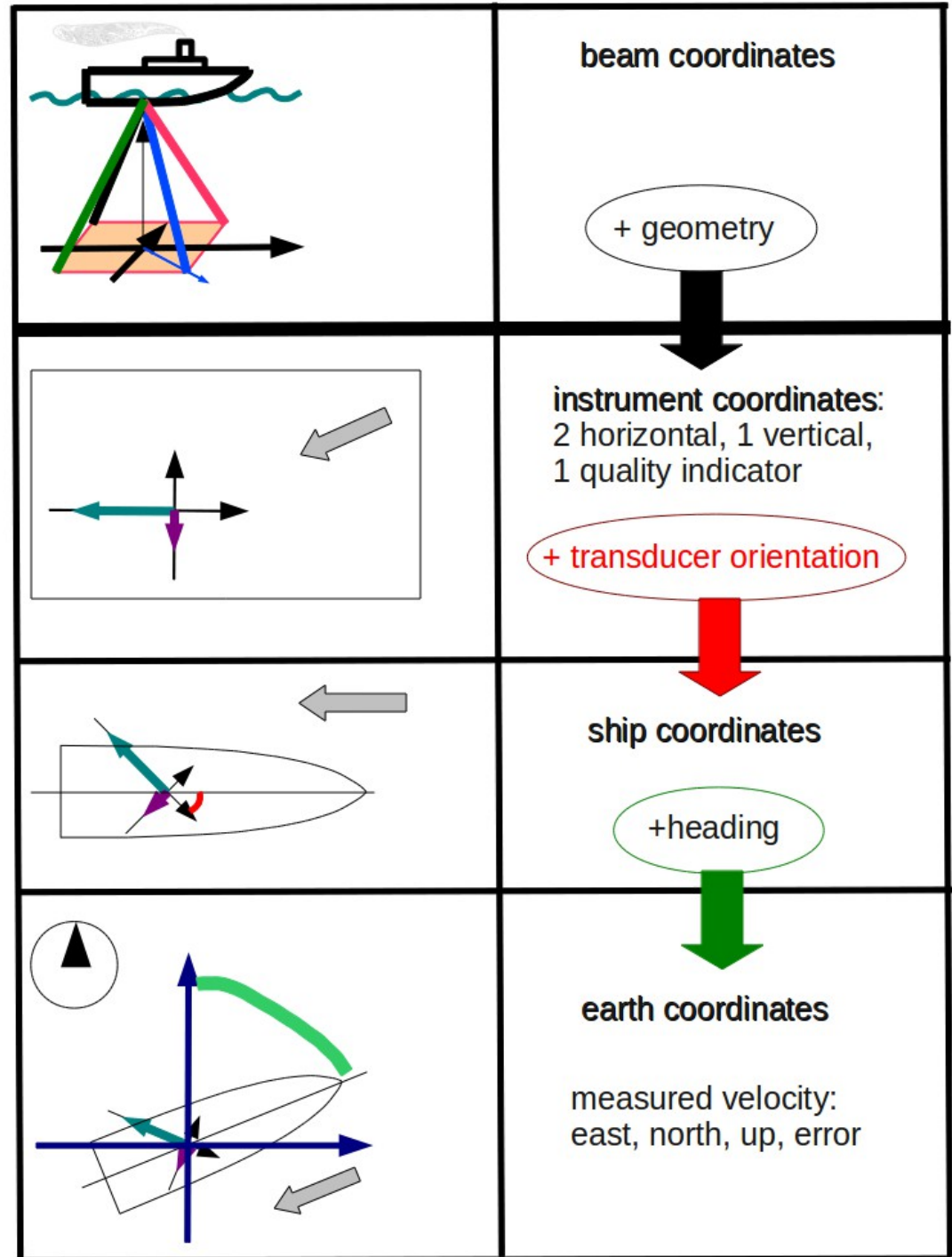
Doppler to beam (not shown)

below here: measured velocity
(coordinate transformations)

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

below here: ocean velocities

- remove ship's speed



ADCP preliminary Processing

“processing” requires (at minimum)

- transform from beam coordinates to horizontal
- rotation into ship coordinates
- further rotation based on heading
- removal of ship's speed

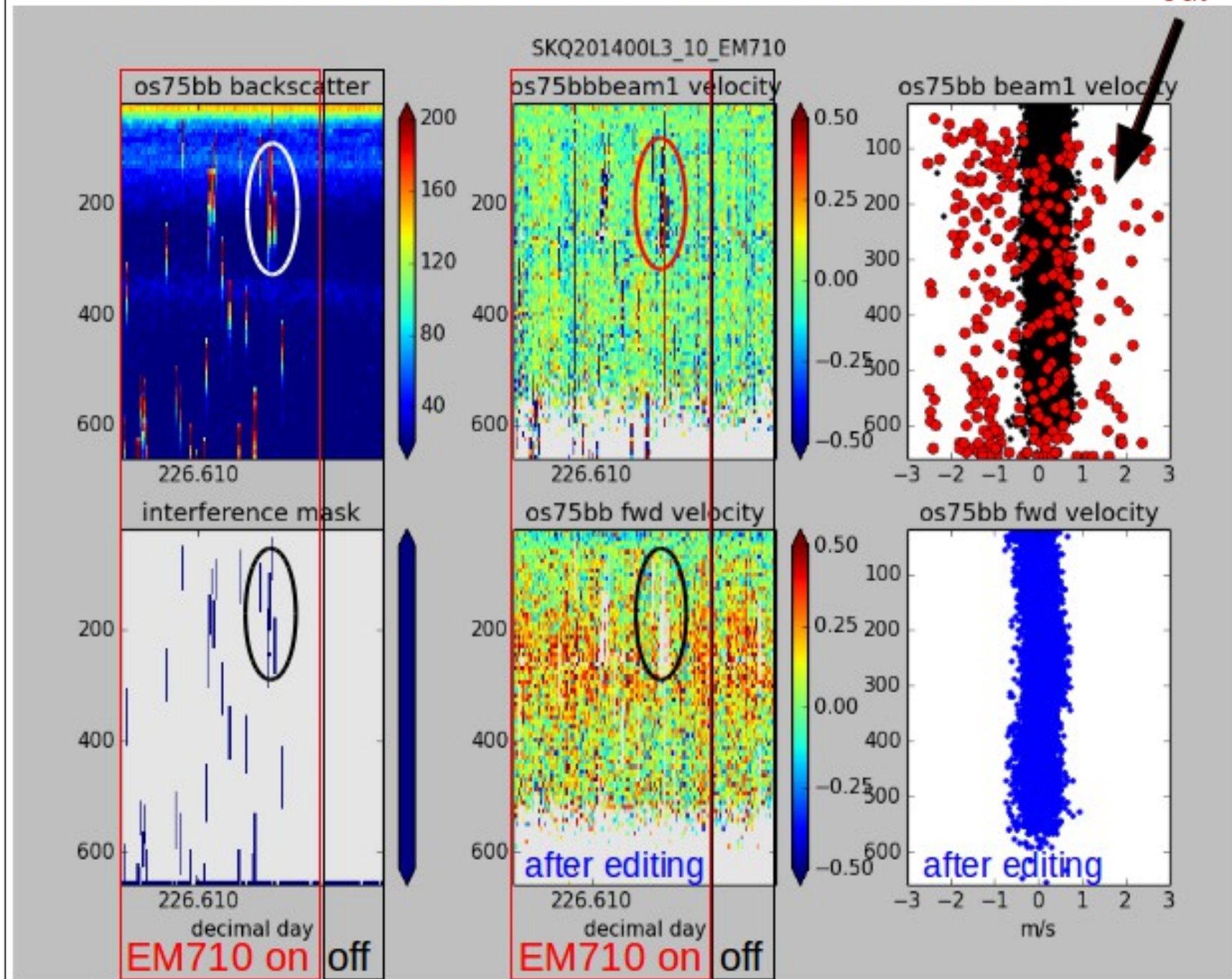
CODAS processing also has single-ping editing:

- **velocity editing based on acoustic interference**
- **removal of data below the bottom (and side-lobe)**
- **weak (short), biased profiles**
- **remaining statistical outliers**
- averaging
 - **CODAS directory is staged for post-processing**
 - **5Gb cruise directory distilled down to 50Mb-100Mb**

CODAS single-ping editing based on acoustic interference

EM710 pinging impact on OS75 broadband

edited out



CODAS processing overview

- built from scratch for shipboard ADCP
- data are stored in a CODAS database; routines for manipulation
- open source (Python3, C)
- runs natively on Mac, Linux
- fully functional virtual linux computer available (Virtual Box)
- modular, configurable
- pairs well with UHDAS data, (can be used for VmDAS data)
- visualization tools, calibration tools
- documented and freely available

link: [CODAS+UHDAS documentation](https://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

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

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)
- monitoring
 - on ship: via at-sea web site
 - on land: automated daily emails to UHDAS Team
 - feedback to technicians on the ship
- data and products for
 - operations and science at sea
 - ease of post-processing after the cruise
 - discovery/evaluation in the future



CODAS

Monitoring

- on ship:
 - via [web site on ship](#) (science and diagnostic figs)
- on land
 - automated daily emails to UHDAS Team
 - dashboard with
 - cruise status
 - links to figures, diagnostic files
 - ticketing system: first pass at identifying problems:
 - notifies the team of a problem
 - mechanism for tracking problems (eg, cruise, ship, instrument)
 - has guidance for common problems
- Team provides feedback to technicians on the ship

CODAS data and products

At sea:

- **example web page at sea** (James Cook Oct 31,2019)
 - figures for operations and science at sea
 - netCDF data files for science
 - complete CODAS+UHDAS documentation
- access to data+processing directories
 - matlab data files
 - archive of daily figures

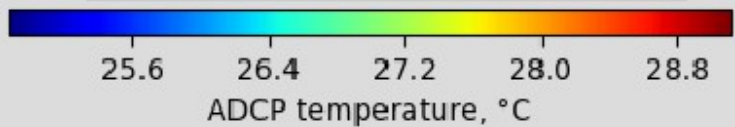
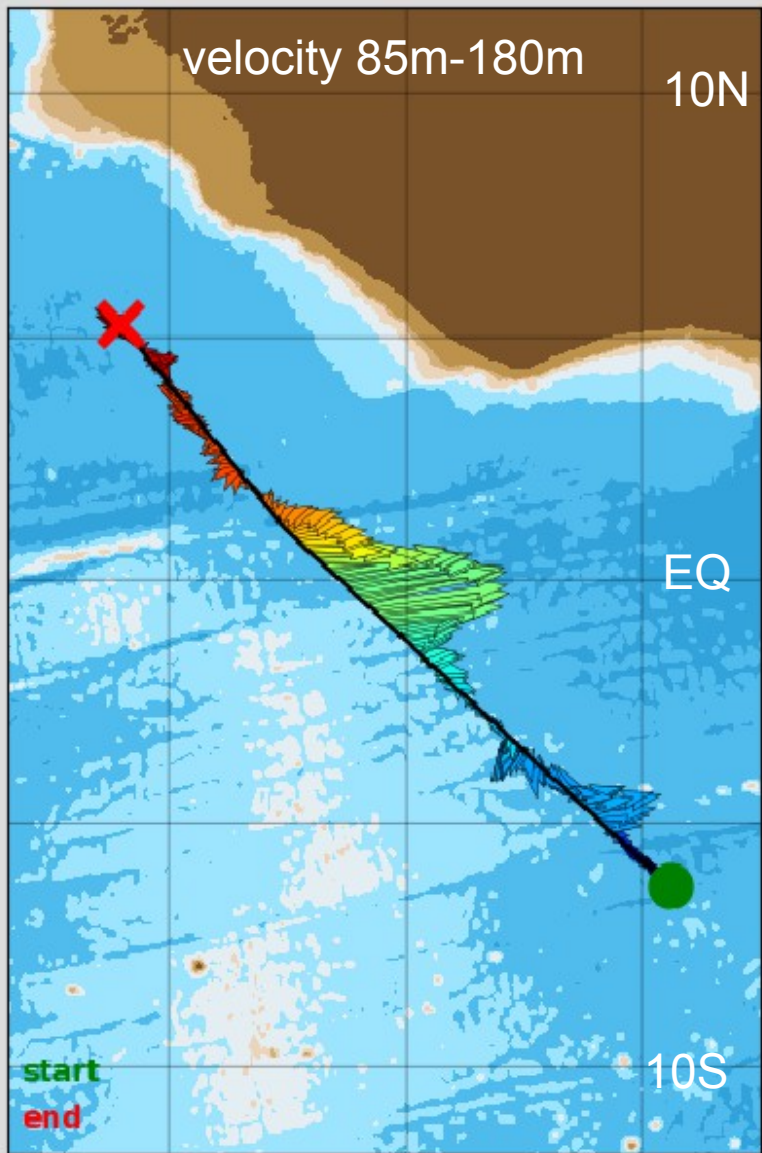
CODAS data and data products, cont

After the cruise:

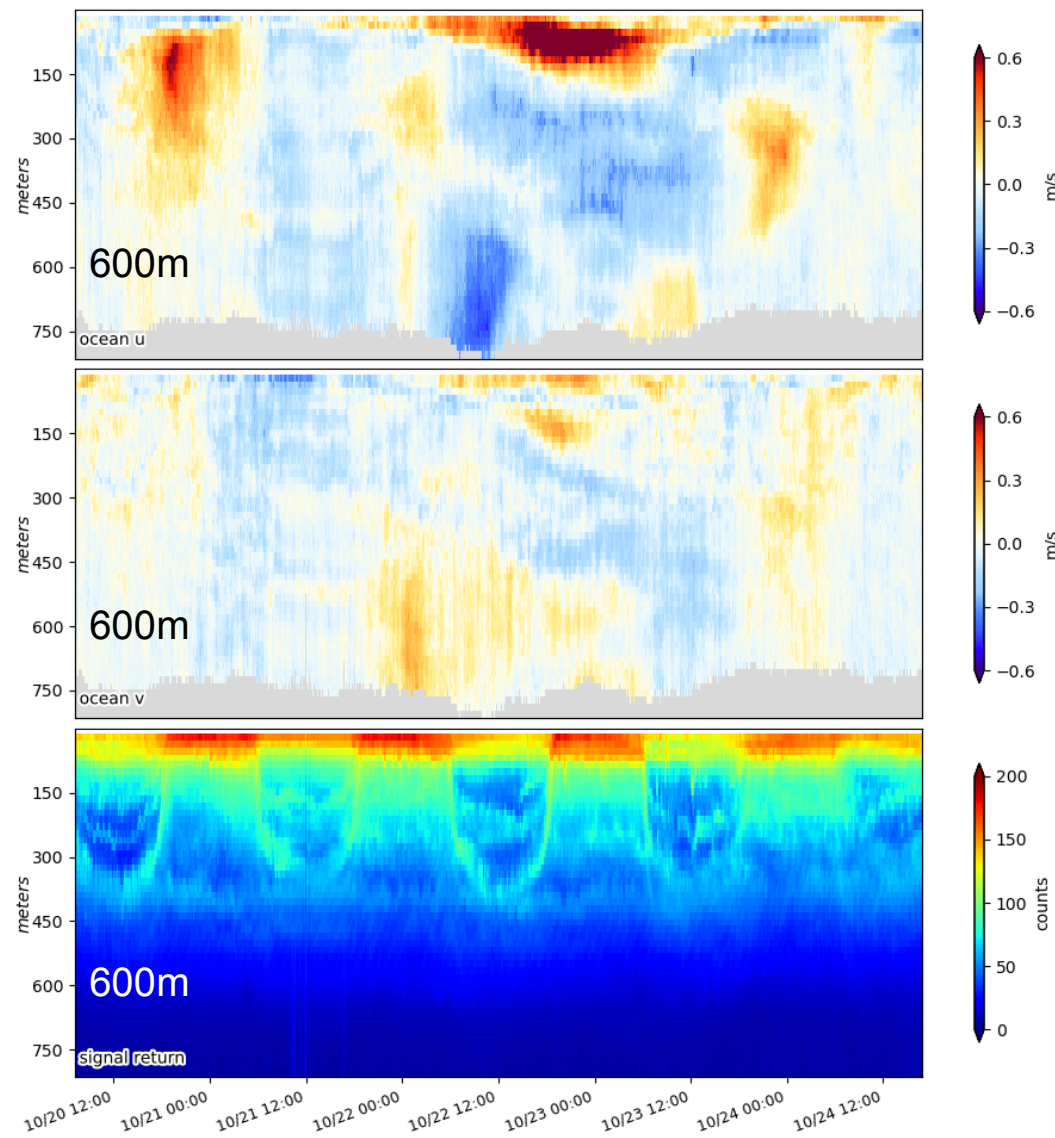
For immediate use, cruise directory has

- processing directories
 - matlab data files
 - netCDF file
 - archive of daily figures
 - ready for post-processing
- raw data directories
 - evaluate quality of the ADCP or ancillary data
 - reprocess with different inputs
 - reprocess with different averaging duration

0.2 m/s →



Equatorial Cross-section R/V James Cook Oct 21-24, 2019



CODAS data and data products, cont

After the cruise:

For future use, cruise directory has

- “reports” directory, with summaries of
 - calibration
 - settings used
 - figures from the cruise
- This is suitable for showing on a web site, to allow exploration of older datasets, and to find “low-hanging fruit”

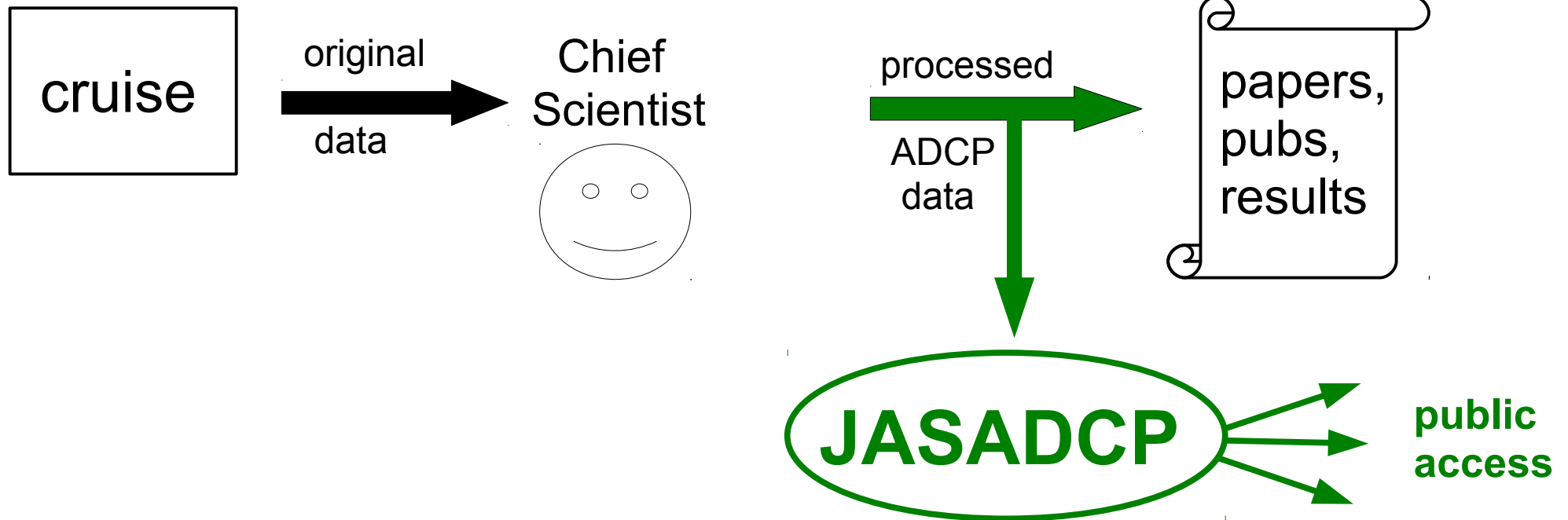
example (Atlantis)

Archiving and long-term use ...



Historically in the U.S.

Past and Present



Joint Archive for Shipboard ADCP

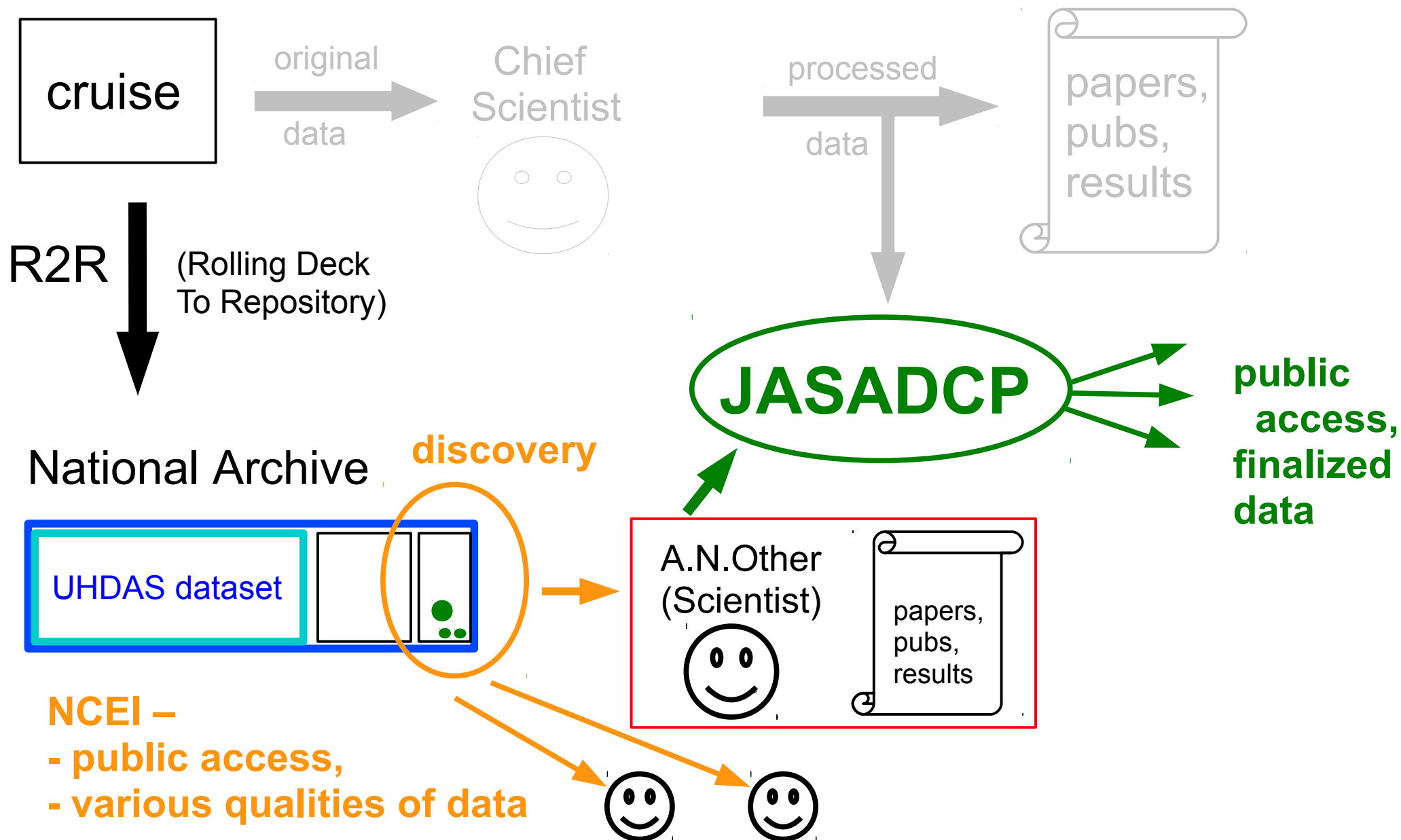
Part of NCEI

Serving science-ready data since 1992.

Over 800 cruises so far...

Present and Future:

- two paths to finalized public data
- more opportunities for original data to be used

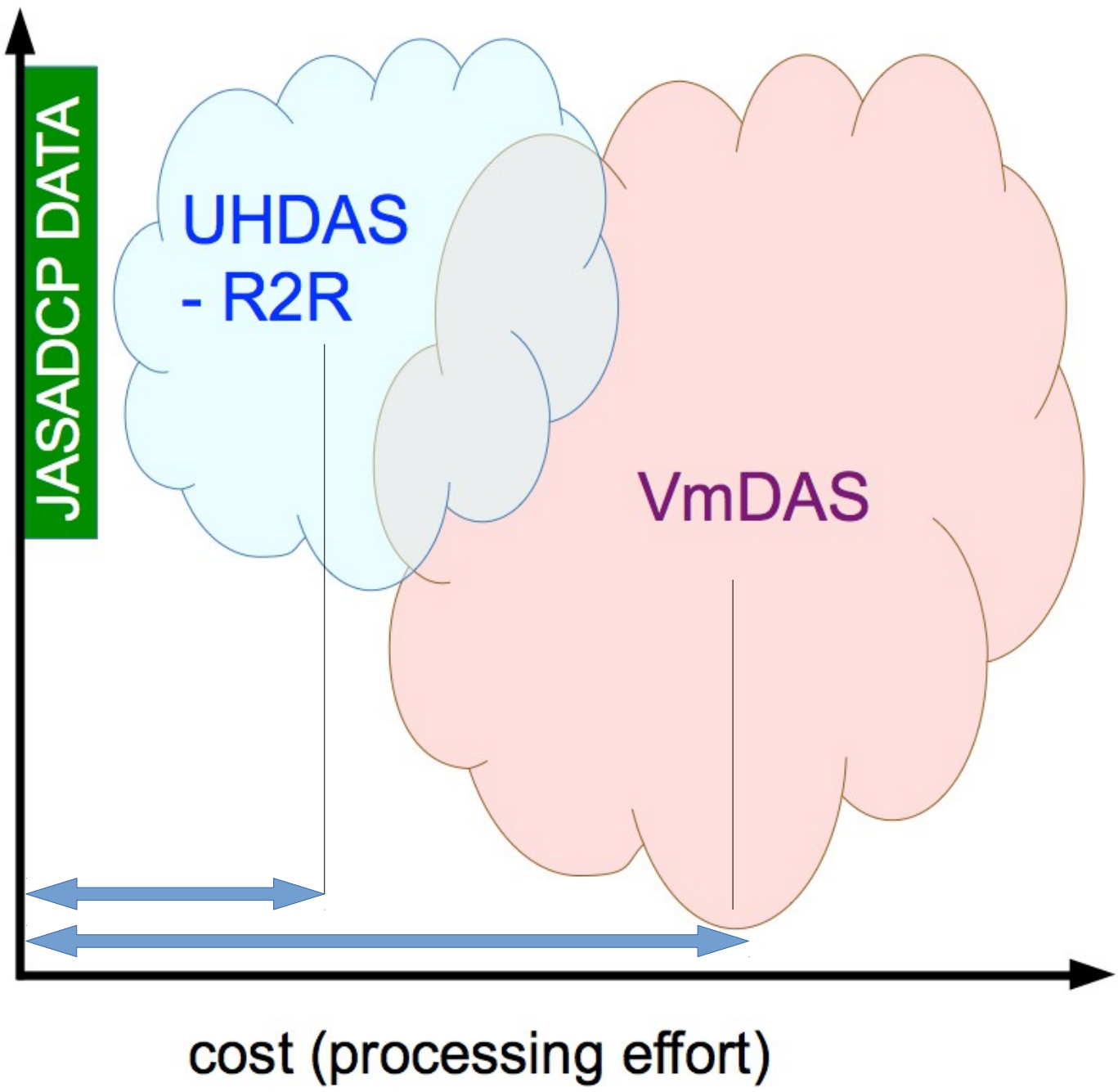


UHDAS vs/ VmDAS data quality and processing effort

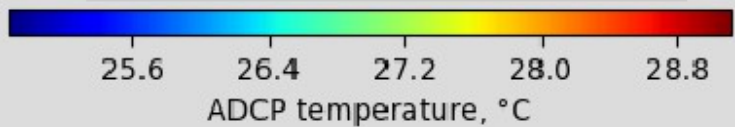
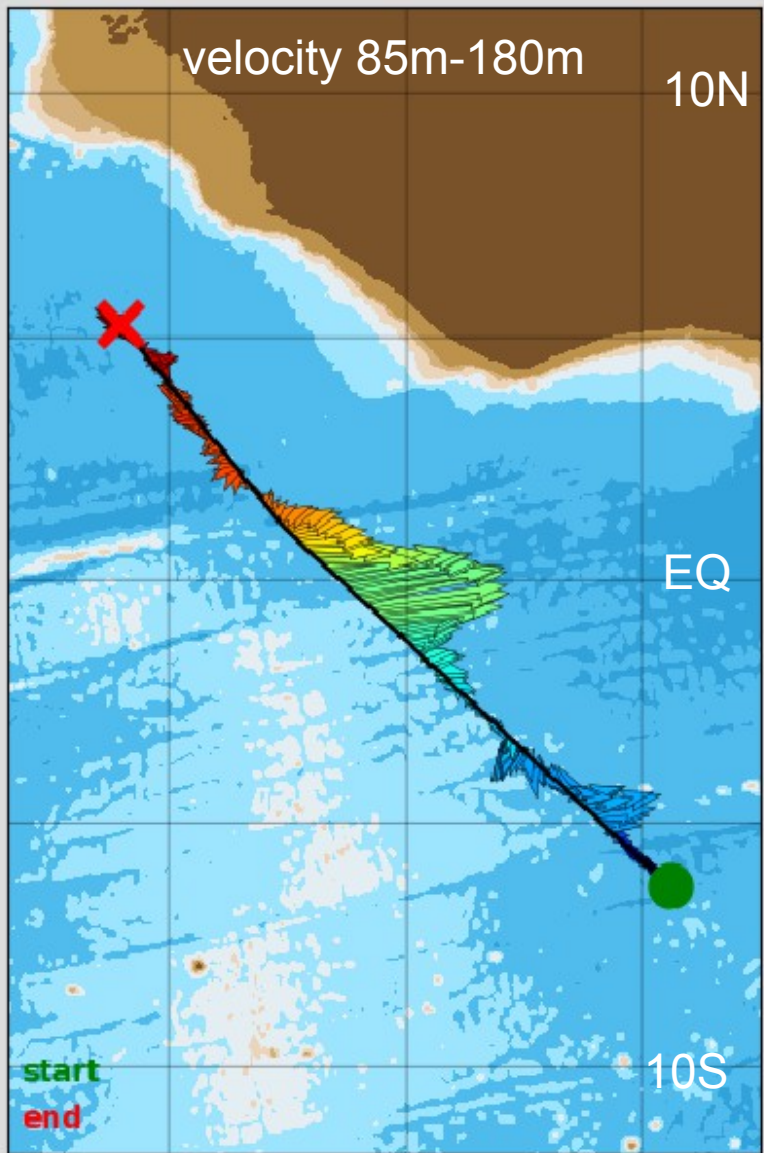
JASADCP:
science-ready
shipboard ADCP
ocean currents

potential
benefit
to
science

- UHDAS designed to:
- maximize raw data quality
 - reduce total processing effort



0.2 m/s →



Equatorial Cross-section R/V James Cook Oct 21-24, 2019

